

NCHRP

REPORT 586

**NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM**

Rail Freight Solutions to Roadway Congestion— Final Report and Guidebook

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**Rail Freight Solutions
to Roadway Congestion—
Final Report and Guidebook**

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TRANSPORTATION RESEARCH BOARD

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

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The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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FOREWORD

By Christopher J. Hedges

Staff Officer

Transportation Research Board

This report presents guidance on evaluating the potential feasibility, cost, and benefits of investing in rail freight solutions to alleviate highway congestion from heavy truck traffic. An extensive research effort is documented and accompanied by a set of guidelines that present a three-phased approach to evaluating rail freight solutions: preliminary assessment, detailed analysis, and decisionmaking. This report will be useful for transportation planners in state and regional transportation agencies, freight planners in private transportation companies, and senior decisionmakers who control the funding and implementation of transportation investments.

Interaction between rail and other modes of freight movement continues to be an issue for transportation planners. Concerns about reliability, flexibility, and timeliness have contributed to a decline in market share for rail freight movements (despite their role as a workhorse for international trade). On the other hand, congestion, air quality, safety, energy, and security concerns lead planners to consider rail options. There is a particular need to analyze the impacts and opportunities for public investment in rail freight capacity to help mitigate roadway congestion.

Congestion in urban areas and intercity corridors is a growing concern. Truck traffic has become a significant contributor to road congestion. In addition, many planners see rail as an underutilized mode. Increasing the opportunities to move freight by rail could help decrease deterioration of existing highways, while positively affecting congestion, safety, and pollution. Federal, state, local, and private-sector transportation planners can use the products of this research to develop cooperative relationships, which might include cost sharing in construction and operation of future facilities that include rail as a necessary component of transportation corridors.

Under NCHRP Project 08-42, a research team led by Joe Bryan of Global Insight, Inc., developed a Guidebook to help assess the potential for rail freight solutions to relieve roadway congestion. The study had a number of components: a thorough review of relevant literature and ongoing research, case studies where rail freight solutions have been applied to help relieve highway congestion, and examination of factors leading to the choice of freight shipping mode, as well as short- and long-term trends that affect freight flow pattern. The report provides guidance on the available sources of data that are useful for assessing rail freight solutions and develops an analysis framework for using that data to assess the relative costs, benefits, and feasibility of rail freight investments. The final report includes a Guidebook that incorporates the research findings into a set of tools and methods for transportation planners to evaluate when it can be beneficial to invest in solutions that shift freight traffic from highways to rail.

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P R E F A C E

This document, produced in fulfillment of NCHRP Project 8-42: Assessing Rail Freight Solutions to Roadway Congestion, consists of

- A final report, which presents information collected and analyzed as part of the study process, including a literature review, analysis of case studies, analysis of issues in freight shipping and mode choices, analysis of trends affecting freight shipping patterns, and evaluation of data sources.
- A Guidebook, which presents tools and methods that transportation planners can use to examine the potential for rail freight as a way to help control the growth of roadway traffic congestion.

The last chapter of this final report describes the structure used in the Guidebook. It serves as a bridge to the Guidebook, an introduction to its content, and an overview of the analytical method that planners can use to apply rail freight solutions to roadway congestion.

Note: URLs were current at the time of report submission.

CHAPTER 1

Introduction and Overview

This chapter discusses the study background and goals and describes the components of the project research.

1.1 Objective

The National Cooperative Highway Research Program (NCHRP) funded NCHRP Project 8-42 to examine the potential for use of rail freight solutions as a way to relieve roadway traffic congestion by shifting some freight movement from trucks to railroads.

1.1.1 Background

Congestion in urban areas and intercity corridors is a growing concern. Truck traffic has become a significant contributor to road congestion. At the same time, some transportation planners have recognized rail as an underutilized mode for freight transport. They see the potential for increasing opportunities to move freight by rail as one way to help decrease deterioration of existing highways, while positively affecting congestion, safety, and pollution.

The interaction between rail and other modes of freight movement continues to be an issue for transportation planners. On the one hand, concerns about reliability, flexibility, and timeliness have contributed to a decline in market share for rail-freight movements. On the other hand, congestion, air quality, safety, and security concerns lead planners to consider rail options. These issues make it particularly important to develop methods that can be used to analyze the effects and opportunities for public investment in rail-freight capacity as a way to help mitigate roadway congestion.

1.1.2 Report Goals

To address these concerns, this study was developed to accomplish two essential goals:

- To assemble a base of information on key factors, stakeholders, obstacles, strategies, and constraints affecting the potential for rail freight solutions to roadway congestion, and
- To develop a guidebook for assessing the merits of public investment in rail freight solutions to relieve roadway congestion, that lays out available tools and methods for evaluation along with guidelines for bringing these considerations into transportation planning and decision-making processes.

This final report presents findings from all phases of the study process, in fulfillment of the first goal. The Guidebook fulfills the second goal.

1.2 Elements of the Study

The study was organized into a series of tasks to cover major considerations affecting opportunities for diverting truck traffic to rail freight options:

1. Prior Research Findings—relevant literature and ongoing research on rail-freight economics, rail and intermodal planning, rail relocation, rail/road conflicts, benefit-cost analysis and modeling, and public/private partnerships. This topic is addressed in Chapter 2 of the Final Report.
2. Case Studies—examples of rail freight solutions that have been applied so as to reduce roadway congestion. These examples encompass congested ports and commercial centers, congested interstate corridors, congested terminal facilities, and rapidly growing cities. Together they provide insight into the potential for rail solutions to address these problems and key factors affecting that potential. This topic is addressed in Chapter 3 of the Final Report.
3. Freight Mode Choice—factors and constraints affecting the potential and likelihood of diverting various types of freight traffic from truck to rail. This includes economic,

development, social, environmental, safety, and security factors, as applied to private sector shippers and carriers as well as the public sector. This topic is addressed in Chapter 4 of the Final Report.

4. Freight Trends—short- and long-term trends in freight movements, business patterns, and land use that affect congestion and freight flow patterns. Together, a multitude of such trends are changing the mix of situations and solutions where there is potential to shift freight modes or otherwise mitigate congestion conflicts. This topic is addressed in Chapter 5 of this Final Report.
5. Data Sources—currently available information on transportation and economic factors, as well as needs to span public and private sector sources, to evaluate opportunities for rail freight solutions to roadway congestion. This topic is addressed in Chapter 6 of the Final Report.
6. Analysis Framework—a methodology for using available data to assess relative benefits and costs and the feasibility

of public investment in rail freight solutions to roadway congestion. This topic is introduced in Chapter 7 of the Final Report and then discussed in greater detail in Chapter 3 of the separate Guidebook.

7. Public Policy—processes, practices, and barriers, at all levels of government, that can facilitate or inhibit public-sector investment in rail freight. This includes legislative restrictions, planning processes, and implementation procedures. This topic is introduced in Section 2.6 of the Final Report. Recommendations for effective public-private partnerships for both planning and funding are then presented in greater detail in Chapter 4 of the Guidebook.
 8. Decision-making Considerations—benefit-cost analysis procedures relevant for decision making on public investment in rail freight transportation. This topic is introduced in Section 2.5 of the Final Report, and then discussed in greater detail in Chapter 5 of the Guidebook.
-

CHAPTER 2

Literature Review

This literature review addresses four issues relevant to rail freight solutions to roadway congestion:

- Transportation needs or problems (including congestion and other planning issues where rail freight can be part of the problem or solution);
- Methods to evaluate the alternatives;
- Funding and implementation approaches; and
- Approaches to developing guidebooks and tools.

The review discusses major issues around six topic areas:

- Rail and general freight economics;
- Intermodal planning, including truck and/or rail freight;
- Studies of congestion costs;
- Rail relocation and road/rail conflict issues;
- Benefit-cost assessment and modeling; and
- Public-private partnerships.

These areas are each covered in more detail below. For each area, an introduction presents several key themes or issues relevant to this project.

2.1 Rail and General Freight Economics

2.1.1 Themes

A base of academic and operational literature documents the institutional opportunities for enhanced reliance on rail freight as a transportation solution. Several themes are evident in this literature:

1. **Logistics performance is important.** Freight flows are determined largely by customers concerned with minimizing logistics costs, obtaining better materials, reaching broader markets, employing their logistics strategies as competitive tolls, and, in general, improving their business results. The direct costs of a transportation option, and its consequential costs in terms of the type of distribution system it supports and the degree of management oversight it requires, shape the decisions of customers. Customers generally do not consider the effects of their decisions on highway congestion, air quality, or other public concerns.
2. **There are many different segments to freight transportation.** In some segments, rail is dominant; in many segments, truck is dominant; and in some segments, rail and truck are competitive. Public action needs to address specific segments because of their discrete behavior (e.g., intermodal traffic originating or terminating within the region, automotive traffic, port traffic, bulk freight moving to local industry, or bulk freight moving through the region).
 - **Rail is not always cheaper and more fuel-efficient than truck.** Rail will not be cheaper for light-density lines and rail will not be more fuel-efficient for very short trains and cumbersome switching moves.
 - **Trucks provide superior service for most movements.** Truck service is usually more flexible, faster, and more reliable than rail service; for many movements, truck is cheaper than rail, especially when the associated logistics costs are considered.
3. **Infrastructure costs are markedly different for railroads and for highway users.** Railroads, for the most part, own and maintain their infrastructure, while competing modes use infrastructure provided and maintained by the public. Railroads must pay for maintenance and rehabilitation as the work is done. Railroads themselves cause—and suffer from—the effects of railway congestion and track deterioration; they have an incentive as well as the responsibility to invest in track and equipment based on the marginal effects on train speed, line capacity, and life cycle costs of the track structure. Trucking companies use highways where the causes and costs of congestion are borne by all

users; most of the major highways are toll free, and the public is generally against the use of congestion pricing to reduce highway traffic during peak periods; equipment design is based on the structure of the user fees, taxes, and size/weight limits mandated by public agencies.

4. **There are still opportunities for rail network rationalization.** The rail infrastructure was largely designed and constructed before 1925. In many areas, the network is designed to serve customers who no longer exist or who no longer use rail; in other areas, the rail network does not well serve the traffic that does exist. The greatest problems are in urban areas, where it is difficult to change terminal locations, add routes, or even make substantial modifications to existing routes. Rationalization in this sense does not mean merely reduction; it means alignment of the geography of the network with the geography of the modern market.
5. **Private decisions by railroads can have important public consequences.** The location of intermodal terminals affects the volume of shipments that will move by rail and the vehicle-miles traveled in urban areas by draymen moving trailers and containers to and from the terminals. Line characteristics and freight volumes determine the marginal cost of and capacity available for commuter operations. Train size and routing decisions affect delays to highway users at grade crossings.

2.1.2 Railroads and Economic Development

When first introduced, railroads transformed the world of business and changed the scale and dispersion of economic activity and the locus of population growth. Vance (1986) describes the evolution of the rail and highway systems of Europe and North America in terms of economic geography—new technologies provide better ways to overcome the geographic barriers to trade and development. Cronon (1991) describes how rail technology and the benefits of rail networks allowed Chicago to become “Nature’s Metropolis,” the gateway to the American west. Trucks and the interstate highway system have long since reduced the role of rail in shaping economic geography, but Cronon’s history still is highly informative about how details of transport cost and innovations in finance and marketing can lead to rapid growth in some locations while eliminating whole ranges of business activity in others.

2.1.3 Declining Marginal Costs

Like many other transportation systems, railroads use a network to provide service to widely dispersed customers with many different service and handling requirements. Generally, in such systems, marginal costs decline both as the network

expands and as traffic is added to the system. As the system grows, costs decline and, if there is competition, prices also decline. In fact, given that competition tends to push prices toward marginal costs, systems with declining marginal costs have an inherent problem. Unless they can somehow keep prices at or above average costs or find a way to keep reducing costs, the companies eventually go bankrupt—and bankruptcy was a common occurrence in 19th century railroading, even with no competition from trucks. To deal with this problem, railroads try to charge higher rates where possible, which leads directly to inequities in pricing; some customers receive rates that reflect marginal costs, while others face monopolistic rates—“what the market will bear.”

Large-scale pricing inequities fuel political impetus for rate regulation. The U.S. rail industry was highly regulated from the late 1800s to the late 1900s. In the 1970s and 1980s, rail and truck transportation were “deregulated,” (i.e., substantially less regulated). However, the history of rail expansion, bankruptcies, robber barons, and regulation remains of great importance to public agencies. Locklin (1966) discusses in detail the logic for regulation and the history of the various public actions to regulate, assist, or restrict railroads in the United States.

2.1.4 Service Capabilities

The service and cost capabilities of various approaches to moving containerizable freight have been well-documented in prior studies, including Temple, Barker & Sloane (1986); Smith (1990); Norris and Haines (1996); and Muller (1999). Kwon et al. documented typical trip times and reliability for three types of rail service: general merchandise moving in boxcars, grain and other commodities moving in unit trains of covered hoppers, and intermodal. This study used a random sample of car movements for 1991 to calculate average trip times and various reliability measures. One conclusion of the study was that rail service in 1991 was very similar to what had been found in studies of rail service 20 years earlier. A typical boxcar trip took about 8 days, with considerable variation in trip times. A unit train typically made a trip in just a few days, although longer time was needed to assemble full train-loads of grain. Intermodal trains were faster and more reliable than the other train services, but not so fast or reliable as commonly achieved by truckload carriers.

Intermodal operations can provide fast, more reliable service than carload operations because motor carriers are much quicker in picking up and delivering trailers or containers to customers. Intermodal operations can be cheaper than truck operations because of the economies inherent in train operations. Under ideal conditions, where there are high volumes of traffic moving in a well-defined corridor with restricted highway capacity, intermodal can be competitive for relatively

short trips. There is considerable interest in shuttle trains serving ports and inland terminals. Ports are typically located within highly congested urban areas, so the possibility of moving significantly more traffic by rail, if only for short distances, is very attractive. For example, Northwest Container Services moves 60,000 loaded and empty containers annually over the 170 miles between the Ports of Seattle, Tacoma, and Portland. In the Netherlands, the Betuwe Railfreight Line will run between the Port of Rotterdam and the border with Germany, connecting the port with the main freight lines of Europe. These cases are discussed in greater detail as part of Chapters 2 and 3.

Intermodal service features few intermediate handlings and, under favorable conditions, can be fully the equivalent of over-the-road trucking. It mainly runs on schedules, some of them geared to the requirements and customer commitments of motor carriers. For many years, the huge trucking operation of United Parcel Service was the railroads' top intermodal client and had substantial influence on train time commitments backed by guarantees. More recently, the railways have struggled to keep up with the efforts of UPS to tighten transit time standards as part of the company's product improvement (Wallace, 2006). Although UPS and other major truck lines remain among the leading users of intermodal trains, rail intermodal capacity seems to have gravitated toward the international container market, where service demands generally are less stringent.

Rail carload service has always suffered from the difficulties of developing and implementing scheduled service. The typical move requires cars to be carried on three to five trains with classification at a similar number of freight yards. Given the variability inherent in processing, the difficulties of operating in all terrain around-the-clock, and the lack of a reservation system, it is not surprising that rail service tends to be unreliable for general freight. The best service typically is offered when railroads are guided by an operating/service plan and provide the resources necessary to implement the plan, even when traffic volumes fluctuate day-to-day and month-to-month. The worst service occurs when weather problems cause prolonged disruptions in service or when management fails to provide sufficient resources to move the freight. High-density shipping lanes, even at short distances, can support effective rail service, primarily when intermediate handlings can be avoided. Short line rail carriers particularly have become adept at local service for traffic within their networks, through a favorable cost structure that makes the business attractive and a sharp focus on customer service for shippers along their routes. The road congestion relief this can produce is of limited scope, but it can be material for specific roads in an urban or other circumscribed areas.

The late 1990s were a period of prolonged service disruptions for the major rail systems, as rising traffic volumes and

declining infrastructure finally led nearly to gridlock when the system was stressed by the implementing of various large-scale mergers, most notably the UP/SP merger. Service was so bad for so long that it led to feature articles in the popular press, before and long after the UP/SP merger (e.g., Machalaba, 1995; Whittaker, 1999). Substantial investments in equipment and in track allowed the railroads to recover to normal levels of reliability. The first part of the new century saw a widening movement to introduce scheduled carload operations as a way to elevate service. Some of the pioneering work on this in the United States was undertaken by the Wisconsin Central, Ltd., (WCL) and adopted on a larger scale by the Canadian National, which purchased the WCL; other large railroads followed suit. However, to get further improvements in service, McCarren (2000, then with the WCL) believes that the industry must adopt a reservation system linked to car scheduling and terminal management systems.

The Australian Department of Transportation, as part of a study to address the proper public role with respect to railroads, benchmarked performance of their railroads against railroads in other countries (Bureau of Industry Economics, 1995). Their report provides interesting contrasts concerning the types of traffic, levels of service, and costs of transportation for railroads around the world.

2.1.5 Truckload Competition

Multiple market segments are served by the trucking industry, not all of which are competitive with rail. Local and regional trucking accounts for most truck movements in urban areas, and rail is competitive for almost none of this traffic (high-volume moves of sand and gravel, road salt, coal, or oil products are the major exceptions). Rail and intermodal are options for intercity traffic traveling several hundred miles or more. This traffic includes small shipments that are commonly shipped in less-than-truckload (LTL) amounts as well as truckload (TL) shipments. Rail/truck intermodal is an option for both LTL and TL shipments, if the service is reasonably fast, reliable, and efficient compared with the trucking option. Rail carload must have rates that are low enough to offset the added logistics costs associated with the slower, less reliable service and the requirement for larger shipment size.

There is no hard-and-fast distance that demarcates rail and trucking zones. Trucks provide some transcontinental service, while rail provides some local and regional services. However, the average rail shipment is more than 500 miles, whereas the average truck shipment is less than 300 miles. The better the rail service in comparison with truck service, the shorter the distances for which rail is competitive—and vice versa.

Before the 1970s, trucking was highly regulated in terms of entry into particular markets and prices that could be charged. Most trucking firms were unionized and handled both TL and LTL freight. The average cost per ton-mile for all freight handled was much greater than the average cost of shipping by rail. Some people erroneously used average numbers to support an argument for much greater reliance on rail. However, TL costs are much lower than LTL costs, and it is TL that is competitive with rail. TL costs of perhaps \$0.05 per ton-mile for a full truckload shipment can be competitive with rail costs, assuming that TL services are offered at competitive rates by efficient carriers.

Three factors led to the development of highly efficient truckload operators. First, the construction of modern turnpikes and the Interstate Highway System allowed single drivers to travel 500 miles per day, at least doubling the reach of 1-day service. Second, owner-operators and other non-union drivers were willing to drive 100,000 miles or more per year in truckload service. Third, the ICC allowed the so-called "Irregular Route Common Carriers" to offer highly specialized service, involving a few commodities moving over a few routes. These carriers obtained various operating authorities from the ICC, which allowed them to avoid empty backhauls and thereby achieve greater operating efficiencies. In the 1970s, when much of the national rail system was experiencing severe financial problems, these irregular route carriers flourished.

Deregulation of truck service in 1980 accelerated the trend toward highly efficient truckload operators. By the mid-1980s, advanced truckload firms such as J.B. Hunt Transport and Schneider National were strong competitors for long-distance intercity merchandise traffic because they were able to minimize operating costs, use wide-open networks, and provide excellent service (Corsi and Grimm, 1989). Each shipment was managed by the individual who booked it; each shipment was carried by an individual driver who normally had responsibility for it door to door; and each driver was monitored by a single dispatcher in communication with the booker. There were other advantages in addition to the tight, reliable performance this form of organization allows. These firms used non-union drivers; they minimized empty miles through careful load planning and direct marketing; and they used their size to reduce costs of truck acquisition, maintenance, and fuel. Contrary to the predictions of economists, there were economies of scale in trucking, and these large, low-cost firms kept pressure on rates for rail-competitive shipments of general merchandise. For most of the 1980s and 1990s, truckload rates remained at about \$1 per mile for dry van, truckload movements of intercity freight (each year TTS published revenue per mile and other financial and operating statistics for trucking companies). Note that \$1 per mile, the prevailing rate for more than a decade after deregulation (Roth, 1995), is \$0.05/ton-mile for a 20-ton shipment.

2.1.6 Role of Technology

Technology has always been a hallmark of rail systems. Evolution in technology for equipment, track, and signals and communications has steadily increased capabilities and reduced costs for nearly 200 years. Furthermore, as the first type of organization to require communications and cooperation over a national scale, railroads pioneered many of the innovations necessary to manage the modern corporation (Chandler, 1962).

Track and Equipment

Technology has continued to be a key factor in improving railroad performance over the past 30 years. Two areas where technology has been critical are heavy-haul railroading and double-stack container trains. Heavy-haul railroading refers to the use of larger cars, more powerful locomotives, and longer trains operating over better track to sharply reduce the costs of hauling coal, ores, grain, and other bulk commodities. Innovations in track have allowed the rail industry to increase the gross vehicle weight for bulk commodities from the 200,000 pounds standard in the 1960s to 286,000 pounds beginning in the early 1990s. Because the newer cars use aluminum bodies, the gain in payload has been even greater.

More than a decade of research and testing at the Transportation Technology Center in Pueblo has enabled the rail industry to improve track integrity through the use of better materials, better equipment designs, and advanced track components; with a stronger track structure, railroads have reduced the total costs of shipping bulk commodities on the order of 2 to 5 percent by allowing axle loads to be increased from 33 to 36 tons [i.e., to the so-called 286,000-pound car (gross vehicle weight)]. In fact, the advances in track technology have allowed railroads to reduce track maintenance costs, despite handling more freight using heavier cars (Chapman and Martland, 1997 and 1998). The annual benefits from using heavier axle loads have been estimated to exceed one-half billion dollars per year (Martland, 2000; Kalay and Martland, 2001).

However, the AAR studies have all cautioned against using the heavier cars on poorly maintained lines. Heavy cars can cause rapid deterioration of weak track structure and necessitate expensive upgrades to bridges. The costs of infrastructure improvements may not justify the operating savings available for light-density lines. Still, two other factors must be considered. To the extent that the 286,000-pound car is an industry standard, short lines and their customers believe that they will be at a disadvantage if they are restricted to the use of smaller cars. They, therefore, have sought public funds to upgrade track to handle HAL (Heavy Axle Load) traffic. The costs to society of using trucks instead of rail on rural roads

may justify public investment in upgrading short lines to carry heavier loads.

Also, it is possible to redesign equipment to gain nearly all of the HAL advantages without increasing axle loads: shorter, higher cars can increase the loading density of the train while retaining 33-ton (or even lower) axle loads. Chapman, Robert, and Martland (1997) recommend that the interest in HAL loads be broadened to a discussion of equipment design, especially if there are to be significant public investments to enable light-density lines to handle heavier loads. Investing in better-designed equipment might be a better option in some circumstances than investing in track and structures.

While heavy-haul technology has provided savings in hauling coal, it has had fairly modest effects on mode choice. Rail has long been dominant in the bulk market, except for shipments where barge or coastwise transport is an option, and the same situation broadly prevails today as in 1980 or earlier.

In the intermodal arena, technological innovation caused dramatic changes in handling general intercity freight. Double-stack trains cut the line-haul costs of rail intermodal services nearly in half, which made these services highly competitive with direct TL operations. Double-stack services were promoted by ocean carriers serving the Pacific Rim, who sought a faster way to reach eastern U.S. markets than by going through the Panama Canal. Once lightweight rail platform equipment was available, double-stack services quickly linked the major West Coast ports (e.g., Los Angeles, Long Beach, Oakland, Portland, and Seattle) with major Midwest and eastern destinations (e.g., Houston, St. Louis, Chicago, and New York). Seeking backhauls for their containers, the ocean carriers secured considerable domestic freight and soon a double-stack network was in place linking the major metropolitan areas of the United States. Coupled with the tremendous expansion of United States-Asian trade, the international container business became the primary driver of rail intermodal growth, leading to the intermodal sector overtaking coal as the top revenue generator for Class I railroads.

Operating double-stack trains requires clearances well beyond what was generally provided on rail lines. In the west, where double-stack services began, bridges and other clearance restrictions were much less of a problem than in the older and more populated east. In some locations, notably New York and Pennsylvania, public assistance helped raise the clearances required to operate double-stack trains.

Because of the history, public agencies may think of double-stack trains as a matter of international trade and port access. However, outside of the major port cities, double-stack trains are potentially much more important for domestic freight than for international trade, simply because there is so much more domestic traffic. Access to double-stack terminals is, therefore, a concern for any metropolitan area, not just for ports.

These points notwithstanding, there is a second retardant to the domestic use of stack services that comes from the dimensions and practical advantages of truck trailers versus containers. Intermodal services by definition have an on-road component; a container requires a wheeled chassis to go on road, and the separate pools of chassis equipment have to be maintained and managed. Truck trailers carry their wheels with them, but they cannot be stacked. Moreover, the containers normally favored for steamship operations have smaller cubic capacity than the trailers typical of domestic service, rendering them an inferior good for the cube-limited shipments that make up most domestic boxed freight. Domestic high-cube (53-foot) containers have taken hold in the industry to offset this disadvantage; however, they are operated mainly for the intermodal services and are not blended into the regular over-the-road (OTR) networks of motor carriers¹. This sacrifices various fleet and balance benefits, and yet the intermodal spine cars that railroads use to carry trailers do not have nearly the cost-efficiency of stack equipment. A newer technology that makes up some of the efficiency gap is the continuous moving platform successfully operated by CP Rail in Canada under the trade name Expressway and known as the Iron Highway in earlier incarnations. Described in Chapter 3, Expressway has been able to attract short-distance highway business between Montreal and Toronto (337 miles) and between Toronto and Detroit (230 miles), carrying standard, non-reinforced highway trailers—including tank trailers, flatbeds, and units owned by private fleets. Equipment expense can be high, although CP has found ways to reduce it, and it is offset by lower terminal costs. (A U.S. application of Expressway technology was explored in the Virginia I-81 study, presented in the next chapter.)

Information Technology

Railroads have historically been heavy users of communications and information technology. Customer service, equipment management, traffic control, service design, and maintenance planning have all benefited from information technology (IT) applications. Investment in IT has been justified by the ability to increase labor productivity (e.g., reduce clerks), to improve equipment utilization, or to reduce operating or maintenance costs.

However, it is not always easy for railways to justify the costs associated with new IT, and the industry has generally

¹The truck line that made the greatest investment in high-cube containers for domestic use—which it did for the sake of tapping stack train economies—was J.B. Hunt Transport. It did so with the original intention of running a blended network. However, this eventually was abandoned and the intermodal and OTR systems were separated, with the OTR component returning to conventional trailers.

been unwilling to adopt technology for technology's sake. The industry has been criticized by both IT experts and by public officials for moving too slowly to adopt new IT, especially in the area of train control. (Given the fate of the high-technology companies over the past few years, the railroads should perhaps be congratulated for their prudence rather than chastised for their backwardness.)

The train control issue deserves some elaboration, given that this is a topic raised by public officials and the press whenever there is a serious train accident. Interest in communications-based train control began in the late 1970s, when an industry group began formulating standards for what was then called Advanced Train Control Systems (ATCS) (Moore-Ede, 1984). The basic ingredients of ATCS were a digital communications link between trains and headquarters, on-board computers linked to various sensors in the locomotive, and a positioning system. In principle, the train and headquarters could both know the location and speed of the train, so that it would be possible to slow or stop the train if it were in danger of going too fast or exceeding its operating authority. There are multiple approaches to advanced train control, and the digital communications link can serve many business purposes as well as potentially reduce accidents (e.g., reducing the load on dispatchers or making it feasible to transmit new switching assignments to local train crews). Advanced train control systems offer the potential for eliminating wayside signals, which can lower costs and, in some circumstances, improve capacity. For example, instead of the fixed blocks defined by signal locations, a communications-based train control system can maintain what are known as "moving blocks." Each train would have authority over a section of track that would continuously be updated as it progresses down the track. Minimum headways would therefore be determined not by the signal system, but by the terrain, train speed, and braking characteristics. With moving blocks, trains can generally follow more closely, which will increase line capacity; although the same effect can be achieved by using short signal blocks, the communications-based approach would be much cheaper. It is unclear how much benefit can actually be achieved from rolling blocks (or shorter signal blocks). Route capacity is more often limited by terminal capacity or meet/pass requirements than by headways, so that the benefits of shorter headways may be most useful in special circumstances (e.g., recovery from disruptions in service related to accidents or track maintenance).

In the late 1980s, the Burlington Northern Railway decided not to implement an advanced, communications-based control system, despite the potential for achieving some improvements in service. An extensive analysis of the costs and benefits was undertaken, which indicated that marketing and business benefits could justify the investment expense. However, the marketing benefits were perceived as too "soft" to

justify the \$1 billion investment. A good summary of the issues is available as a case from the Harvard Business School (Hertenstein and Kaplan, 1990), while more detailed papers describe the manner in which better communications and dispatching enable faster and more reliable trains (Smith, 1990), which translates into more reliable terminal performance (Martland and Smith, 1990). Public interest in ATCS persists because of the potential for safety improvements, given that these systems can prevent certain kinds of collisions and overspeed derailments. The costs of the systems have proved to be a stumbling block. For example, a congressionally mandated study of train control's potential for improving safety concluded that the safety benefits alone could not justify the multi-billion dollar investment that would be required (Office of Safety, 1994); this same report includes an excellent introduction to signaling and communications for railroads.

The federal government has invested heavily in research on Intelligent Transportation Systems, most of which relates to highway technologies. The range of applications includes traffic control, use of transponders to allow vehicles to avoid lines at toll booths, weigh-in-motion scales, predicting traffic conditions, and facilitating emergency response. It is now feasible to collect tolls without requiring traffic to stop. In Toronto, cameras capture the license plate, character recognition software reads the license, the license is linked to the owner, and the owner of the car receives a bill as part of their phone bill. The technology for much more extensive use of tolls and congestion pricing is available, although little has yet been implemented.

Fuel Efficiency

Railroads, on the whole, are more fuel-efficient than trucks because of the inherent efficiency of the steel wheel on the steel rail and the use of gentle grades on rail routes. However, fuel use varies greatly with the commodity and the car type, and public agencies need to be able to go well beyond "average gallons per ton-mile for rail versus truck." Heavy trucks operating on good roads may, in fact, be more fuel-efficient than very short trains operating on poorly maintained, circuitous routes. Detailed assessments of energy and environmental factors are available for freight (e.g., Abacus Technology, 1991), with a major EPA study examining fuel efficiency in great detail, especially for trucks (ICF Consulting, 2001).

2.2 Intermodal Planning Including Truck and/or Rail Freight

Conferences over the last decade have provided a wealth of material on intermodal capabilities and intermodal partnerships, including the National Conference on Intermodalism

(1994), the Intermodal Freight Terminal of the Future (1996), and the Partnership to Promote Enhanced Freight Movement at Ports and Intermodal Terminals (2000). There is a base of planning reports at state, metropolitan, and local levels that show how truck and rail freight alternatives and solutions can be, and in fact have been, successfully included in transportation planning, evaluation, and implementation practice.

The major themes are as follows:

1. Intermodal transportation at its best combines the efficiency of rail with service levels normally associated with trucks.
2. There are many intermodal options for moving freight, including bulk and break bulk transfers, as well as the transloading of trailers and containers. There are many supply chain options for the size and location of warehouses, the source of supplies, and the nature of markets served. Changes in supply chains made by remote companies can affect local freight flows significantly.
3. Intermodal transportation is rapidly growing, but there are potential problems in providing sufficient capacity.
4. Even if intermodal transportation doubled, there would be only a minor reduction in truck traffic.
5. The location of intermodal terminals is critical: terminal location is a major consideration in customer use of this mode as well as a major determinant in the nature of drayage flows within a region. Terminal location therefore affects the extent to which intermodal transportation affects air quality, energy consumption, and congestion.
6. There are several types of intermodal terminals, including major facilities serving local pickup and delivery, interchange terminals, port support terminals, and terminals where trailers and containers are transferred from one train to another. Larger terminals often serve multiple functions, and there is considerable flexibility concerning how traffic is or could be routed between terminals. Although railroads have traditionally tried to provide direct, single-train service, there are also possibilities for creating more of a hub-and-spoke network. The nature and location of hubs could be much different than for other kinds of intermodal terminals.
7. Public support could conceivably lead to intermodal shuttle systems aimed specifically at alleviating congested portions of the highway network.

Various simple models can be used to estimate the costs and service levels associated with intermodal transportation. Simple analytical models can be used to provide quick estimates of cost (e.g., Martland and Marcus, 1987); such models have been used to estimate the effects of providing double-stack

service to the Port of Boston and options for relocation of intermodal terminals within eastern Massachusetts.

New planning techniques are being developed that make extensive use of traffic flow data and graphical analysis for intermodal freight planning. These techniques have been applied, for example, in Pennsylvania (Gannett Fleming, 1999), New York State (Erlbaum, 2001), and Ohio (Gad, 2001).

New technology, especially information technology, can be very useful in coordinating intermodal operations. A study conducted for the National Commission on Intermodal Transportation summarized the technological opportunities for improving rail/truck coordination (A&L Associates, 1994).

Research sponsored by the AAR identified ways that information technology can be used to increase the capacity and reduce the cost of terminal operations (Zhu and Martland, 2002). This study found that investment in IT on the order of \$1 million could increase capacity by 5 to 10 percent, while providing net operating benefits on the order of \$3 to 7 million. The study called for greater cooperation among terminal operators, carriers, customers, and public agencies in using IT to coordinate movement of trains and trucks to and from intermodal terminals. The information requirements for economic analysis were addressed during a TRB conference (TRB, 2000).

2.3 Studies of Congestion Cost

The central purpose of this report is the potential for moving more freight by rail so as to reduce truck traffic on congested roads, especially in urban areas. Most of the literature on congestion, and most of the measures for dealing with congestion, deal with peak-period automobile traffic generated by commuters, which does address the costs of congestion. However, it is otherwise of limited use for examining the ways that truck traffic contributes to and suffers from highway congestion. Also that rail freight can contribute to congestion in any location where trains use routes with grade crossings warrants consideration.

Some major themes can be identified with respect to congestion cost:

- Congestion costs are typically calculated using the value of time for the people caught in traffic, including commuters, other automobile users, bus riders, business travelers, local truck drivers, and intercity truck drivers.
- Consequential costs can extend well beyond time value. A truck that misses a 15-minute delivery window can (1) disrupt the production or merchandising of goods by the recipient; (2) interfere with other trucks maneuvering into tight spaces and scheduled door capacity at customer docks; and/or (3) be held outside or turned away—and in the latter case, the VMT of local delivery is tripled, as the truck departs

for a holding point and returns later. Chronic and variable delay makes modern logistics strategies less effective.

- Congestion is a phenomenon where marginal costs can be much greater than average costs: a user encounters average delays that depend on the time of day, but causes incremental delays to other users that in the aggregate can be many times greater.

Congestion tolls can reduce peak use of facilities by encouraging some users to make fewer trips or to shift trips to other modes, other time periods, or other destinations. Despite the effectiveness of congestion tolls, they have rarely been implemented because of lack of public acceptance of the concept, although recent years have seen the level of interest rising. For commercial traffic, there is also a question as to how directly the incentive bears on the point of decision. While freight recipients normally set the delivery schedule, responsibility for paying the bill usually rests with the shipper. Thus if a truck line wishes to recover the cost of tolls, the charge goes to the shipper—not to the party who controls timing.

- Adding highway capacity to handle peak loads is very expensive because the incremental capacity is needed only for a small fraction of the typical week.
- Urban freight is adversely affected by congestion because it takes longer to reach customers and drivers can make fewer pickups or deliveries per day. The costs of congestion for trucks will, for high-valued freight, include the time value of the freight.
- Truck movements do not follow the same patterns as other traffic; trucking companies and their customers have some flexibility in when they use congested facilities, and truck fleets actively make an effort to operate off peak. As a rule, a commercial vehicle traveling at peak hour is obligated to be there by its customer and schedule.
- The composition of truck traffic exposed to delay varies by time of day, because of the diurnal shipping cycle. Morning peak will have a relatively large number of vehicles at the end of their runs and making deliveries—with looming appointments and no cushion left in their schedules. The quantity of vehicles traveling empty may be relatively high mid-day as trucks move from delivery point to the next pick-up point.
- Restrictions on truck movements have been implemented in some cities and discussed in others. Such restrictions do not necessarily affect congestion, given that more people may drive, but restrictions certainly will increase costs of moving freight within the city. Studies generally show that the costs to truckers and their customers outweigh the benefits to commuters.

Congestion increases both the average time and the variability of time required for trips. As traffic flows approach capacity, congestion rapidly increases and accidents or bad weather can lead to gridlock. In congested conditions, the marginal delays can be many times higher than the average delay. Each additional vehicle not only suffers from slower speeds and long delays at intersections, it increases the delays to subsequent vehicles. Likewise, diverting a vehicle from a congested route will have benefits much greater than the average travel time along that route.

Large trucks have a much bigger effect on congestion than automobiles because they are longer, less maneuverable, and underpowered compared with typical automobiles. They accelerate more slowly; need larger gaps, more lane width, and more time to make turns; and may slow down on long grades. Thus a single truck is equivalent to several cars in terms of capacity.

Methods for estimating the effects of trucks on highway operations are given in the *Highway Capacity Manual* published periodically by TRB. The larger the truck, the greater the effects, assuming similar equipment design and operations; a special TRB report investigated the ways in which larger combination vehicles affect highway and intersection capacity (TRB, 1989). On a level, multi-lane highway, a large truck is equivalent to 1.7 passenger cars [i.e., a large truck equals 1.7 “passenger car equivalents (PCEs)”.] If there are steep grades or sustained grades, the trucks will slow down and represent 8 PCEs on freeways or even more on 2-lane highways where passing opportunities are limited. At intersections, a large truck can represent 3 to 4 PCEs. Increasing the percentage of trucks in the general mix of traffic therefore can cause a marked reduction in capacity. For example, if 10 percent of the vehicles are heavy trucks on a route with signaled intersections, capacity will drop 20 to 25 percent. To look at this another way, if this route is operating close to capacity at rush hour, diverting the trucks would allow approximately 50 percent more automobiles on the road.

An NCHRP study of congestion costs (Weisbrod and Vary, 2001) focused a major element of its analytic work on urban freight deliveries. This study included case studies, of Chicago and Philadelphia, that provide useful insights.

2.4 Rail Relocation and Road/Rail Conflict

Both the rail and the highway networks evolve in response to changes in economic geography, transportation needs, and competitive capabilities of the various modes. As traffic volumes grow, as traffic shifts to new routes, and as new customers ship more freight, there are bound to be increasing pressures for network improvements. Where traffic is

Table 2-1. Standard planning issues for rail network structure.

Planning Issue	Factors
Rationalization of center city rail network	Port access
	Commuter rail
	Redevelopment potential
	Access to rail/truck intermodal terminals Rail clearances (vertical) Highway clearances (lane width, corners, intersections) Highway connections to service area
	Facilities suitable for through as well as local traffic Rail clearances Line capacity
Conflicts among traffic flows	Rail freight and rail passenger Capacity and schedule effects Commuter rail effect on highway congestion
	Rail and highways Improved protection Enforcement Rail operations during rush hour Grade separation and closing of grade crossings
	Intermodal, merchandise, and bulk trains on high density rail lines
Intermodal issues	Terminals Capacity for growth Centralized versus dispersed facilities In-town versus perimeter facilities Location and highway access
	Equipment Containers versus trailers Potential for non-standard technologies
Grade crossings	Closure of crossings with low highway traffic
	Protection for crossings with high road traffic volume
	Effects of rail routing changes on roadway congestion
Service to industry	Rail service to industrial parks and large potential customers
	Provision of sidings and support yards for potential customers
	Rail inclusion in economic development planning
Heavy-haul railroads	Axle load limits for track structure
	Weight limits for bridges
	Assistance to short line and regional railroads Upgrade tracks and bridges for common Class I trains

declining, there is pressure to reduce maintenance or abandon certain line segments. Where traffic is growing, there is pressure to add line or terminal capacity. Where traffic is shifting to new locations, there is pressure to add new routes or new terminals. Wherever there are grade crossings, growth in either highway or rail traffic leads to greater highway congestion and pressure for restricting rail operations, grade separation, or closing the crossings. Thus, a number of standard planning issues relate to the structure of the rail network as shown in Table 2-1.

2.4.1 Rationalization of Rail Facilities

Rationalization involves restructuring the network so as to reduce costs, reduce conflicts between rail and highway traffic, improve service to rail customers, and free land for redevelopment. In the 1970s, following the collapse of the Penn Central, extensive public debate focused on two major types of rationalization: abandonment of light-density lines and railroad mergers. At that time, both processes were

under the jurisdiction of the ICC. Rail abandonments were highly contentious—the railroads emphasized their financial losses while customers and local governments emphasized the effects on local communities. In general, the ICC approved most merger and abandonment applications, but the railroads thought that the proceedings dragged on too long [Sloss]. As they pushed for more rapid abandonment, the public resisted. Eventually, as part of the legislation creating Conrail, abandonment was put on a more rational footing. Railroads were allowed to abandon lines unless customers, local or state agencies, or someone else covered the railroad's operating losses; federal funds were allowed for states to use to keep light-density lines in operation.

Gradually, the emphasis shifted from abandonment to the transfer of light-density lines from the large railroads to short-line and regional railroads, some of which were owned or supported by the states [Levine]. The impetus for divesting light-density lines was that the smaller railroad would not be bound by the same labor contracts and would have closer contact with customers, thereby eliciting more freight.

The results, not unexpectedly, have been mixed. Where lines had a reasonable traffic base and some prospect for growth, without major capital requirements for continuing operations or heavy debt service, then lower costs and better marketing have helped the short lines to succeed. Where the traffic base was declining, because firms were moving or mines were closing or markets were changing, the added benefits of short-line operation could not postpone the inevitable decline. An example of the latter case is the Lamoille Valley Railroad, which was upgraded with approximately \$20 million in support in the 1980s from the state of Vermont, but which had no traffic at all by the end of the 1990s. A study commissioned by the Northeastern Vermont Development Association (Martland and Wong, 1997) concluded that the best use of the railway would be as a recreational trail, which would allow four-season use of the route while preserving the right-of-way for possible resurrection. A lesson from this experience, and indeed from the entire experience with state support of light-density lines, is that investing substantial public money in rail facilities does not necessarily create a competitive advantage for rail, nor does it mean that the rail system will be used.

2.4.2 Redevelopment of Urban Rail Facilities

The rail system was largely constructed in the 19th century, long before trucks offered competition with rail or suburbs offered competition with city centers. The rail network was necessarily dense, because it served numerous industrial sidings and port facilities. Given that many railroads served each major city, a vast complex of classification yards, interchange yards, and industrial support yards developed in all the major cities of the east and the Midwest.

As trucks became available, the scale and density of the urban rail networks were clearly inconsistent with the demand for rail. Trucks could handle most port and regional traffic more quickly and efficiently than rail, so many of the urban facilities were underused. Railroads responded in part by consolidating yards, freeing valuable urban space for redevelopment. Many notable buildings, centers, and parks are built on former rail freight or passenger terminals, including the Prudential Center in Boston, the Crystal City development opposite Washington National Airport, and various waterfront developments in New York and New Jersey. After the Penn Central Railroad went into bankruptcy in 1970, the Penn Central company survived in part because of the value of its extensive holdings of obsolete rail facilities.

Today, there is still a common interest among railroads, public agencies, and railroads in restructuring the urban rail system so as to improve land use. Railroads no longer need the extensive inner city terminals, but may have difficulty in

assembling land in the suburbs for facilities closer to their current customers. Public agencies have difficulty in determining whether or not a particular terminal is well-sited for rail or whether better opportunities exist where real estate is cheaper.

Beacon Park Yard in Boston is an example of current discussion about land use. The site, which is under long-term lease to CSX, is next to the Massachusetts Turnpike and is conveniently located with respect to the urban road network. It is also located strategically between Boston College and Harvard University and a new biotechnical industrial center. In the early 1990s, the site was owned by the Massachusetts Turnpike Authority, which was very interested in moving the intermodal operations to another site so as to allow redevelopment of the real estate. MassPike commissioned a study of possible alternative locations, but, because of the local geography and development patterns, was unable to find a large enough site that had good highway and rail access, that was relatively close to Boston, and that did not have unique environmental features. MassPike did not pursue the matter, and the site was sold by the Turnpike Authority to Harvard University. CSX retained its lease, but a new study was launched subsequently by the Massachusetts Executive Office of Transportation and Construction, now considering how to balance railroad requirements and regional transportation objectives with Harvard's need for educational facilities expansion.

2.4.3 Location of Intermodal Terminals

The location of intermodal terminals is essential to the effectiveness of intermodal operations in reducing local truck traffic. A study of intermodal terminal movements in the Los Angeles basin found that having multiple terminals throughout the region allows significant reduction in truck-miles traveled on local streets (Frazier et al., 1996). Conversely, centralization of intermodal operations in a single terminal would likely increase truck-miles traveled, even if the terminal were centrally located. Locating terminals at the periphery of the region would certainly increase truck-miles moving containers and trailers to and from the facility. Shuttle systems that move containers between major hubs and downtown terminals can reduce drayage, but may increase operating costs for the railroads. Minor subsidies might enable shuttle systems to be operated, thereby retaining the air quality and congestion benefits of rail for central business districts (CBDs). Moving intermodal operations to remote hubs would also reduce the land required for terminals in expensive urban areas.

There is a trend toward locating new intermodal terminals away from the central cities, which will affect both highway traffic and future development. Norfolk Southern located a new

facility outside Atlanta in Austell, Georgia (Norfolk Southern, 2001); UP decided to add capacity outside of Chicago in Rochelle, Illinois (Union Pacific, 2001).

Ideally, truck transload facilities will be located close to the rail intermodal terminal. UPS has constructed major sorting centers in Jacksonville and in Chicago in locations next to the rail facility, thereby minimizing drayage costs and highway effects.

2.4.4 Grade Crossings and Grade Separation

Grade separation will eliminate highway delays at rail crossings and reduce the risk of crossing accidents. Closing crossings where there are low volumes of highway traffic is an alternative way to reduce the risk of accidents; however, travel times for some highway users may increase.

A study conducted by Florida DOT estimated the potential to eliminate as many as 19 rail-highway at-grade crossings in the Sarasota-Bradenton, Florida Urbanized Area. The eliminations would require consolidation of trackage operated by the Seminole Gulf Railway (SGLR), lessee of CSX Transportation branch lines in the area. Consolidation of operations of CSXT predecessors Atlantic Coast Line and Seaboard Air Line after their merger resulted in two separate, but parallel, tracks serving the immediate study area with a connection in downtown Sarasota. One track had few rail users, with most of the railroad's freight traffic in the area being generated on the second line.

Two means of consolidating the trackage were considered and designed. The preferred alternative involved a new connection, which required a grade separation of very heavily traveled U.S. 301. Rail traffic and operating data were obtained from the railroad and highway data from the FDOT national railroad-highway grade crossing inventory for the existing crossings. Highway traffic counts were obtained from FDOT for the proposed grade-separated crossing, and existing rail users located on the line segment to be eliminated were interviewed.

Construction estimates were prepared, and a benefit-cost analysis performed. Benefits were as follows:

- Highway user vehicle operating and maintenance costs were avoided;
- Vehicle occupant time delays were avoided;
- Grade crossing crashes were avoided;
- Railway operating savings accrued;
- Railway and crossing maintenance savings accrued; and
- Track material and right-of-way salvage value accrued.

These benefits were reduced by the cost of relocation of one rail user who would have to be relocated. The results of the study were presented to the Sarasota/Manatee MPO in September

1993. The MPO accepted the report, but recommended that FDOT not pursue any improvements at that time because the MPO did not believe that the proposed project would “necessarily represent a great benefit to the community at large.”

Elimination of grade crossing delays has been a major motivation for some notable examples of public investment in rail facilities, including the Alameda Corridor in Los Angeles/Long Beach and the Sheffield Flyover in Kansas City; these two projects are examined among the case illustrations in Chapter 2.

2.5 Benefit-Cost Assessment and Modeling

State and local transport planners may be called on to consider various issues related to changes in rail systems and the resulting effects on such public concerns as highway congestion and land use. A number of themes run through these considerations:

- Public agencies must demonstrate that total benefits of a project are sufficient to justify the costs of the project, taking into account the time value of money in order to compare current and future costs and benefits.
- Both costs and benefits may include much more than financial matters, and many ways have been used to quantify non-monetary factors.
- There are various methodologies for assessing projects with multiple categories of costs and benefits. Many types of weighting schemes have been used or proposed, but weighting schemes still require political input in establishing the weights.
- Public agencies also are concerned with equity—how are costs and benefits distributed? Major public projects must ultimately be approved by a political process.
- Public policies are often subjected to vigorous debate concerning what types of projects should be considered, how projects should be structured, and whether or not regulations or other public actions may be able to reduce the need for public investment.

MPOs or other public agencies may be asked to carry out a study involving several distinct steps:

1. Identify the effects of proposed investments in rail facilities or changes in rail operations on rail cost and performance;
2. Predict the effects of the anticipated changes in rail performance on highway traffic flows;
3. Estimate the effects of the predicted changes in traffic flows on congestion and air quality;
4. Predict the effects of the proposed rail investments on land use, employment, economic growth, and economic justice;

5. Evaluate the effectiveness of proposed rail investments relative to other
 - Investments in the rail system,
 - Investments in the transportation system, and
 - Approaches to reducing congestion and improving air quality.

The first two steps are likely to cause problems for public officials, given that such officials are not generally familiar with the details of rail systems or the mechanisms of freight competition. Public officials will also need help with the last step, which requires an understanding of the options for freight investments.

Railroads contemplating major investments in a metropolitan area will—in theory—go through similar steps, especially if they are seeking cooperation from local governments. Like the state agencies, railroads will be able to deal well with some steps, but will need help with other steps. Railroads will be able to predict the effects of investments on their performance and their competitive position, and they will be able to consider alternative rail investments. They would ordinarily be interested in their own costs and benefits rather than the public issues addressed in Steps 3 and 4; however, if railroads are seeking to cooperate with public agencies, then railroads will be interested in using public benefits to justify improvements in the rail system. Both railroads and public agencies will need help in finding alternatives to any proposed investment.

2.5.1 Examples of Intermodal Freight Planning Studies

I-35 Trade Corridor Study: Recommended Corridor Investment Strategies

The FHWA and the state DOTs in Texas, Oklahoma, Kansas, Missouri, Iowa, and Minnesota combined their efforts to conduct a study of Interstate Highway 35 (I-35) from Laredo, Texas, to Duluth, Minnesota (HNTB & WSA, 1999). The study assessed the need for improved local, intrastate, interstate, and international transportation services in the I-35 corridor and defined a general strategy to address those needs. The base case was a “Do Little Scenario” that included maintenance of pavement and bridges, committed highway and transit improvements, demand management, ITS, and growth management. The three best of five initial alternatives to the base case were studied in greater detail:

- Highway Upgrade with a Partial NAFTA Truckway,
- Highway Upgrade within Existing ROW, and
- Highway Upgrade with Rail Implementation.

Based on a full analysis, the Highway Upgrade with a Partial NAFTA Truckway strategy was recommended because it provided the best overall movement of traffic in the corridor and the highest benefits, taking into account travel times, accident costs, environmental impacts, and benefit-to-cost ratios. This alternative included special provisions (i.e., a separate truckway facility or a truckway within the existing I-35 right-of way) to accommodate the high-volume truck traffic between the Dallas-Fort Worth area and Laredo. In contrast, the Highway Upgrade with Rail Implementation strategy promoted cooperative rail services between Kansas City and Laredo in order to decrease freight traffic on I-35. The study did not find this to be a promising strategy:

“A limitation on the Highway Upgrade with Rail Implementation strategy relates to the reliance upon shifting significant freight to rail service. Even with a high proportion of shifted freight, there is a rather small change in the requirements for I-35 improvements, and the capability of rail companies to accommodate those increased volumes on rail is uncertain.”

National I-10 Freight Corridor Feasibility Study

This study addressed the issue of increased truck traffic and intermodal freight along an existing interstate corridor of international, national, regional, state, and local significance. I-10 stretches from California to Florida, passing through 8 states and 17 major urban areas. It is connected to key international ports, including the nation’s largest container and bulk ports and all U.S./Mexican border gateways. The Texas DOT served as the contracting agency for the I-10 Corridor Coalition (i.e., California, Arizona, New Mexico, Texas, Louisiana, Mississippi, Alabama, and Florida).

A comprehensive evaluation of the overall transportation system was researched in order to assess the need for, and the feasibility of, developing a broad range of alternatives to facilitate the movement of goods along the I-10 Corridor. Among the scenarios to be evaluated was the use of rail to alleviate congestion. The study examined freight traffic growth along the corridor and identified traffic streams that could be served by rail. The study measured the effects of rail service on the I-10 facility (e.g., capacity and operations) and determined that conventional approaches to rail service would not significantly delay construction or reduce delay on a corridor basis.

The National I-10 Freight Corridor Study was divided into three time frames: short-range, 2008; mid-range, 2013; and long-range, 2025. Short-term solutions were project specific and most of those solutions identified were state specific consisting of physical components in urban areas, including additional lane miles as well as operational (ITS/CVO) measures. Mid-range and long-term solutions were for the corridor

as a whole and focused on innovative technological and operational solutions, including the feasibility of dedicated truck lanes in certain segments of the corridor.

The Potential for Shifting Virginia's Highway Traffic to Railroads

Virginia DOT (VDOT) was directed by the Commonwealth's legislature to examine the potential for diverting traffic from highways to rail. Interstate 81 was cited as an "acute example" as its current traffic consists of as much as 40-percent trucks, although it was designed to carry no more than 15 percent. The purpose of the study was to determine if (1) the potential existed to divert enough highway traffic from I-81 to rail transport to significantly affect the need for planned improvements, and (2) the effects over time would justify public expenditures for rail improvements.

Various analyses were performed for the study. First, the various truck traffic flows contained in the various databases were examined and assigned to the highway system. The trucks that would use I-81, all or part of the length in Virginia, were identified by route segment (VDOT, 2001; WSA et al., 2001). A diversion potential of around 10 percent of trucks with dry van semi-trailers moving in excess of 500 miles was used as a reasonable expectation. Trucks with those characteristics constituted approximately 70 percent of all trucks on the corridor.

Highway effects were estimated using the Highway Economic Requirements System (HERS). HERS is a comprehensive highway performance model used to prepare the U.S. DOT's biennial report to Congress on the "Status of the Nation's Surface Transportation System." The study found that the planned improvements to I-81 would have to proceed, and, in fact additional capacity improvements should be considered. Even with additional capacity improvements, the removal of trucks (diverted to rail) affects the amount and timing of those improvements. An analysis of the present value of the benefits that would be attributable to the diversion of trucks over the 22-year study period was conducted. The results revealed that at a 10-percent diversion level, almost \$400 million worth of benefits were generated.

The study concluded that public investment in rail improvements in the I-81 Corridor should be considered based on the potential to accrue public benefits. Its recommendations led to a subsequent market assessment project that surveyed customer requirements, evaluated the appeal of conventional and unconventional rail products, and reviewed the related public investment proposals of railroads in the region. Results of the market assessment are presented among the case illustrations in Chapter 2.

Wilmington-Harrisburg Freight Study

This study investigated strategies for safer and more efficient movement of freight along the Wilmington-Harrisburg Corridor. Originally conceived as an analysis of strategies to divert Port of Wilmington traffic traversing the Corridor to other routes and modes, it was expanded after discovering that the Port generates less than 10 percent of the Corridor truck volumes. Most of the freight traffic was either originating or terminating (and often both) in the counties along the Corridor (i.e., New Castle, Chester, Lancaster, and Dauphin). Two scenarios addressed the potential for diverting long-haul through traffic either to railroads or to the Pennsylvania Turnpike. Two other scenarios focused on enhancing the efficiency of freight flows necessary to support local businesses.

The rail scenario included improvements to the Norfolk Southern route into Delaware, construction of a Triple Crown terminal in New Castle County, better use of the Brandywine Valley Railroad, and the effects of the Shellpot Bridge repair. The conclusion was that investments in the rail system offered some potential to divert existing truck freight to rail.

The shipper scenario discussed different operating strategies that could be used to reduce congestion. These included off-peak pick-ups/deliveries, increased use of warehouses and distribution centers, and alternate routes and modes. The shipper scenario also presented the results of a shipper questionnaire. The primary concern of the shippers was roadway congestion between Lancaster and Wilmington. Many of the shippers supported construction of a bypass. The study therefore examined proposed enhancements to the Corridor, specifically Route 41 and U.S. 30 bypasses and managing the flow of freight through truck bans, traffic calming, and enhanced enforcement initiatives on Route 41. A U.S. 30 bypass would have a significant positive effect on freight flows by providing an appropriate route for trucks passing through the region. By working with area shippers, it could be possible to shift some local freight activities to the U.S. 30 bypass by constructing warehouses or distribution centers. A Route 41 truck ban and traffic calming would adversely affect businesses in Chester, Lancaster, Dauphin, and York counties. A truck ban on through traffic where "through" was defined to be west of Harrisburg/Carlisle would not affect local businesses as much and was deemed worth further exploration.

The study also explored strategies to move trucks off of the Corridor and onto the Pennsylvania Turnpike. A value pricing study determined that about 30 trucks per day would divert to the Turnpike if toll discounts were offered between Exit 23 (Downingtown) and Exit 19 (Harrisburg). Allowing longer combination vehicles (LCVs) on the Turnpike and connecting roads had the potential to divert a significant number of trucks from the Corridor. This proposal faced

numerous obstacles, including strong opposition from the Pennsylvania Turnpike Commission.

A Multimodal Transportation Plan for Wisconsin

Wisconsin DOT (WisDOT) developed a multimodal transportation plan for Wisconsin called “Translinks 21” (WSA and Reebie Associates, 1996). The intercity freight planning effort began with the development of a county-level commodity flow data set for all modes. The databases consisted of information obtained from state, federal, and private industry sources. Trend commodity forecasts were developed for truck, rail, waterborne, and air shipments using employment and productivity factors through the Year 2020. Several future scenarios were developed for each mode. A Freight Expert Panel made up of Wisconsin industry and transportation leaders and a set of subcommittees representing individual modes reviewed the scenarios, databases, and traffic forecasts used in the study. A truck-rail transportation scenario was identified as the most promising freight alternative.

Translinks 21 called for making improvements to the state’s rail system to be funded through the creation of a revolving low-interest loan program supported by state bonds with debt service to be paid from the State Transportation Fund. The following types of improvement projects were identified:

- Primary corridor tracks that need to be upgraded so that entire segments operate at the same speed—a key for efficient service;
- Secondary tracks that need to be upgraded in areas that demonstrate a need for improved service levels;
- Track improvements needed to allow for higher speeds within urban areas (this could include consolidating some lines or closing some rail-highway crossings);
- Operating signal improvements needed to increase rail efficiency;
- Track and bridge upgrades needed to increase the weight capacity of rail corridors that may be required to accommodate heavier car loadings; and
- Two active program activities—the preservation of low-volume rail lines and upgrades on rail lines preserved by public ownership—that would continue.

To improve intermodal shipments using rail, the following types of improvements were also cited:

- Needed intermodal facility improvements, including terminals, intermodal yards and storage facilities, pulp loading sites, and bulk transfer facilities;
- Track improvements needed to accommodate higher speed intermodal movements; and
- Clearance improvements necessary to accommodate double-stack movements.

2.5.2 Performance Models for Specific Types of Services

Public policy must be based on costs and performance for particular locations and types of operations, not on averages. Simple models of rail costs for intermodal, general merchandise, and bulk service can be used to frame many policy questions; more sophisticated models can be used as necessary. Spreadsheet models can differentiate performance for the major classes of rail service (e.g., unit train, general freight, automobiles, chemicals, and intermodal) and of truck operations (e.g., truckload, LTL, drayage, and long-haul versus short-haul). Models can also reflect economies of scale, productivity (of equipment, facilities, and labor), unit costs, and service levels.

The decision-making process is ultimately political, in the best sense of that word. Decisions will require some weighting of financial, environmental, land use, and equity factors. Weighting schemes, which may be helpful in some cases, cannot replace the need for a political decision, because it is seldom possible to agree on an objective basis for any weighting scheme. The process therefore can build on two principles: (1) assess the entire range of relevant costs and benefits and (2) require comparisons with other ways of achieving the same benefits.

A previous section outlined the many types of investments that could be considered as a way to reduce rail/road conflicts, including the following:

- Improved access to intermodal terminals,
- Development of new terminals,
- Grade separation,
- Adding tracks to mainlines,
- Adding customer sidings, and
- Building transfer facilities.

The relevant rail and freight options can be identified for various minor, medium, and major projects. The intent is to give public agencies, carriers, industries, and others a better understanding of what is likely to be important in each type of improvement.

It is important to distinguish among projects that are of purely local significance and those of regional or national significance. Providing sufficient capacity for growth in intermodal traffic is essential for a region—but not for any point within that region. Adding a siding for a customer or eliminating a grade crossing will have local effects; creating a multi-track grade-separated corridor for rail movement through a major rail hub may have national significance.

The Guidebook in this publication supplies a framework for evaluating rail initiatives, from a scoping analysis to a comprehensive assessment, and for small and large projects.

Presented below are other resources that can be used to supplement, or in conjunction with, the Guidebook.

2.5.3 Guidebooks

Overview

A plethora of “guides” and “tools” address various aspects of multi-modal project evaluation, impact analysis, and benefit-cost analysis. Some of them provide insight and applications that are potentially applicable for parts of this study, although they are presented in forms that specialize in other types of applications. Some of the guides and tools focus on transit versus highway planning for passenger travel, without consideration of the special issues associated with rail freight. Others provide sophisticated analytical models that require data not commonly available for rail freight applications.

A useful general reference that specifically treats the interrelation of the freight rail and highway systems is the AASHTO Freight Rail Bottom Line Report, released in 2003. Although designed as a policy document, the report provides a survey of the function and state of the rail industry and is rich in illustrations. The policy challenges and choices it poses are helpful as well for framing the issues of public rail investment in a strategic context. A synopsis of the table of contents, presented below, offers a good overview of its subject matter.

Among the many other prior studies and reports are these:

- NCHRP 2-23: Update to the AASHTO Redbook;
- NCHRP 2-18(4): StratBENCOST;
- NCHRP 7-12: Microcomputer Evaluation of Highway User Benefits;
- NCHRP 20-29(2): Computer Model for Multimodal, Multi-criteria Transportation Investment Analysis;
- NCHRP 25-10: Estimating the Indirect Effects of Proposed Transportation Projects;
- NCHRP 25-19: Guide for Addressing Social and Economic Factors;
- *NCHRP Synthesis 302: Mitigation of Ecological Impacts*; and
- *NCHRP Report 462: Quantifying Air-Quality and Other Benefits and Costs of Transportation Control Measures*.

Several of these are discussed in the following subsection to illustrate how guidebooks may differ in terms of the breadth of their concerns and the depth of their coverage.

Example NCHRP Guidebooks and References

NCHRP Project 25-10 and its continuation NCHRP Project 25-10(2) addressed “Estimating the Indirect Effects of Proposed Transportation Projects” and resulted in *NCHRP Reports 403* and *466* (The Louis Berger Group, 2002).

AASHTO Freight-Rail Bottom Line Report	
I. Rail's Role in the Intermodal System	
	The Evolution of the Nation's Freight System
	Goods Movement Today
	Freight-Rail Services Today
	Freight-Rail Benefits Today
	The Freight-Rail Business Today
II. Alternative Futures for the Freight-Rail System	
	Economic and Logistic Drivers of Freight Demand
	Freight Forecasts and Transportation System Impacts
	Alternative Freight-Rail Growth Scenarios
	Assessment of Freight Corridors
III. Creating the 21st Century Freight-Rail System	
	Choices and Vision
	Public-Private Partnership Opportunity
	The Bottom Line
IV. Appendices	
	Private Sector Rail Issues and Challenges
	Public Sector Rail Programs
	Public-Private Rail Financing Strategies

NCHRP Report 466, a “desk reference,” is structured to serve as training materials for practitioners who must complete environmental impact statements for transportation projects. The 99-page report is divided into 10 course modules, each of which has an overview, a discussion of relevant considerations or methods, a summary, and references:

1. Introduction to Indirect Effects Analysis
2. Review of Case Law on Indirect Effects Evaluation
3. Step 1 – Initial Scoping for Indirect Effects Analysis
4. Step 2 – Identify Study Area Directions and Goals
5. Step 3 – Inventory Notable Features
6. Step 4 – Identify Impact-Causing Activities of the Proposed Action and Alternatives
7. Step 5 – Identify Potentially Significant Indirect Effects for Analysis
8. Step 6 – Analyze Indirect Effects
9. Step 7 – Evaluate Analysis Results
10. Step 8 – Assess the Consequences and Develop Appropriate Mitigation and Enhancement Strategies

A set of slides, published in PDF format, as *NCHRP Web-Only Document 43*, is available from the TRB website.

The report builds on surveys of more than 350 government agencies, university researchers, and other groups; it synthesizes regulatory framework, case law, published literature, and the contents of environmental impact statements; and it provides a typology of indirect effects of transportation projects. The first chapter includes a succinct 5-page literature review; additional references are included at the end of each module. This report offers a concise introduction to an important aspect of transportation planning where three decades of experience offer many potential examples and methodologies. The report benefits from several brief case studies of state programs, thorough categorization of possible effects, listing of data sources, and a well-structured review of planning questions and analytical methods.

NCHRP Synthesis 302 is a more narrowly focused study concerned with mitigation of ecological impacts of transportation projects. The body of the report is only 30 pages, including a chapter on the regulatory framework, ecological impact assessment, and ecological mitigation assessment. Seven case studies illustrate best practices (e.g., a public-private approach to banking wetlands in North Carolina and NYDOT’s proactive approach to improving the environment as a normal part of transport projects; 56 pages of documents provide the details on these programs). The bibliography includes more than 50 references, including a mix of journal articles and agency reports.

NCHRP Report 462 is concerned with analytical issues related to quantifying air-quality and other benefits and

costs of transportation control measures. Only the body of the study is published in the 61-page report; three appendices, five interim reports, and three NCHRP research results digests are available on a CD enclosed with the report. Given that this report discusses technical issues related to estimating the effects of TCM on air quality, most of the material relates to modeling approaches and calibration issues. It includes good summary charts showing the range of effects to be considered and the types of TCM strategies that are possible. This report is an incremental step toward improving analytical techniques within a mature transportation planning environment.

Other Resources

Relevant reports of other agencies include the following:

- *Guide to Economic Impact Assessment (TRB Circular 477)*;
- *Handbook for Planners to Maximize Economic Benefits of Highways (Appalachian Regional Commission)*;
- *Guide to Measurement of Highway Impacts (FHWA)*;
- *Guide to Measuring Economic Impacts of Public Transit (APTA)*; and
- *Major Corridor Investment-Benefit Analysis System (Indiana DOT)*.

The American Railway Engineering and Maintenance-of-way Association (AREMA) publishes an engineering manual that is updated annually. The AREMA manual, in addition to highly technical information, includes some discussion of the types of costs and benefits that should be considered when evaluating various restructuring decisions. Hay (1982) presents the technical information in a far more readable format. Although his textbook is now 20 years out of date with respect to the details of track and vehicle technology, it still provides a useful introduction to railway engineering concepts.

There are many texts and examples of project evaluation in a transportation systems context. Roberts and Kresge were among the first to show how to use models of cost and service to evaluate multi-modal transportation options. Their study of freight options for Columbia is well-documented, thorough, and accessible. Mannheim (1972) was the first to publish a text for transportation systems planning. Like Roberts and Kresge, he emphasized the use of planning models and the consideration of different perspectives—carrier, public agency, abutters, and the general public. Wilson’s text (1980) describes the economic issues associated with freight. A more recent text (Sussman, 2000) provides a contemporary view of transportation systems issues, with chapters that provide general background on rail operations and logistics costs.

Economists and public agencies often use sophisticated econometric analysis in support of public policy decisions.

Railroads and consultants are much more apt to use engineering economic models. The econometric approaches are best suited to situations where there is good system-level data for a variety of operations with different characteristics and traffic volumes. Econometric analysis is particularly useful at demonstrating such things as economies of scale, economies of density, elasticities of demand, and other issues that could affect public policy. The engineering economic approach is used when detailed analysis of options for a particular site or a particular movement are being investigated. Braeutigam (1999) reviews various approaches to costing for transportation systems. Button (1985) reviews approaches to costing for railways.

As computers and data sources improve, researchers are trying to link transportation and economic development within a common modeling framework. The basic notion is that economic activity and population will shift in response to changes in the transportation system: producers will seek locations where their costs are lower and people will seek locations where wages are higher. Hence, building a major bridge or upgrading a highway to superhighway status should lead both to lower transport costs and to measurable shifts in economic activity. The theory was summarized by Bröcker (2000) at a conference on integrated transportation and economic modeling (ITEM).

2.6 Public-Private Partnerships

Major transportation initiatives almost always involve some kind of public-private initiative. As a minimum, public action is needed to assemble land for rights-of-way and terminals and to authorize the construction of new facilities. Public action may also be needed to specify who will build or operate particular facilities, under what conditions (safety and environmental regulation), at what prices (economic regulation). Public powers of eminent domain and land use control have been necessary to construct both the highway and railway networks, as well as the major airports and seaports. Even when the operations are fully private, there is a legacy of public action that created the infrastructure that the carriers use and a remnant of law and regulation that affects costs, prices, and competition.

Likewise, there is almost always some private involvement in any major transportation endeavor, even if it is just the construction of infrastructure or operating a terminal under a short-term lease or other arrangement. Following are several of the themes affecting these relationships:

1. **Public costs could be an important consideration in freight investments.** Railroads and trucking companies ordinarily will invest in equipment and facilities based on a financial analysis that includes costs and benefits to

carriers and their customers. They do not ordinarily consider the effects (good or bad) of their decisions on congestion, the environment, communities, or regional economic development. Adding in these public benefits could result in different size and location of terminals, different routings of through traffic across cities, higher capacity mainlines, and further rationalization of the rail network in metropolitan areas.

2. **Public investments must be justified in the context of the specific situation.** Increases in capacity, changes in network structure, additions of terminals, and any other investments must clearly lead to changes in traffic flows or reductions in conflicts. It is possible to spend a small amount of money and achieve significant benefits, just as it is possible to spend a large amount of money without achieving any benefits at all. Also, because railroading is a service, investments in plant have to be protected with competitive operations sustained over time.
3. **Criteria for success.** Public-private initiatives can be judged to have been successful when (1) the public investment or support is sufficient for the private carriers and customers to justify more use of rail and less use of highway transport, (2) the public benefits are sufficient to justify the public portion of the investment, and (3) there were no clearly superior means of achieving similar results.

2.6.1 Brief History of Public-Private Relationships with Rail Industry

Land Grants and the Transcontinental Railroads

There are many examples in the United States of public-private partnerships for the construction and operation of railroads. The construction of the transcontinental railways is a well-known example, in which land grants, loans, and loan guarantees allowed private companies to build networks across the west. Ambrose (2000) has written an enjoyable history of the creation of the first transcontinental railroad from Omaha to Sacramento, California, via Ogden, Utah. Several interesting approaches were used to finance this ambitious project. The railway was authorized to issue bonds with interest payments guaranteed by the federal government in order to raise funds required for construction. As construction proceeded, more bonds could be issued. Land grants were also important to the private companies, given that they received what amounted to half of a 20-mile-wide strip along the route of the track (the government owned all of the land in the west and retained ownership of alternate sections of land on either side of the railroad).

It is important to separate the mythology from the history of this project. The railroad companies were caught up in some major financial shenanigans known as the “Credit Mobilier

Scandal,” and the land grants are periodically cited by anti-railroad writers as evidence that the railroads have long enjoyed federal subsidies. Even Ambrose is swept up in the wonder of the construction, and devotes very little text to the importance of and ultimate effect of the project. The interest in the building process, the allure of the financing scandals, and the debate over the vast “gifts” to the railroads can overshadow the fundamental fact that an innovative public-private partnership successfully completed a 2000-mile construction project over difficult, largely uncharted terrain within a few years.

Land grants were used extensively during the 19th century to encourage the rapid construction of railroads to enable development of the west. Railroads were given more than 130 million acres, while the government received the right to reduced rates for its freight. Rates charged the government were generally one-half the rates charged the private sector, a benefit that was used until 1940 for general government traffic and until 1946 for military traffic. Locklin (1966) compared the benefits to the railroads from the land grants and the benefits to the government from reduced rates. Both sets of benefits were large, but Locklin concluded that the value of reduced rates was much greater than the value of the land grants. The government did not “give away” the land, but in fact structured a successful financial incentive for the railroads to construct new lines very rapidly, providing enormous development potential, while delivering as well a fair long-term financial benefit to the public.

Other railroads were constructed with public assistance, and the railroads were not shy in the 19th century about, in effect, blackmailing towns into supporting the construction costs to avoid having the railroad routed through another town. That the funds were provided was indicative of the tremendous development value of having a railroad for transportation as opposed to a horse and buggy. Public involvement was common because the public benefits were so obvious.

Rationalizing, Rehabilitating, and Reviving the Railroads in the Late 20th Century

With the invention of the truck and the paving of the highways, railroads lost their dominant position. As described above, the rail industry spent the last three-quarters of the 20th century downsizing and adjusting its network in recognition of the reality of highway and later air competition. The collapse of the Penn Central in 1970 ushered in a new type of public-private cooperation. In its bankruptcy proceedings, the Penn Central identified the following strategic problems that led to its bankruptcy:

- The high costs of light-density line operations, the need to sharply reduce the size of the network, and the delays in acquiring permission from the ICC to abandon lines;

- The high costs of labor, based on both pay scales and restrictive work rules;
- The mounting deficits of passenger operation;
- The sluggish response of the ICC in allowing rate increases to keep up with inflation.

Following extensive studies and public debate, congress structured the process that led to the creation of Conrail as a publicly controlled company. The federal government acquired portions of the bankrupt railroads (several smaller railroads in addition to the Penn Central), invested billions in upgrading the equipment and track structure, and covered much of the cost of labor protection, allowing Conrail to reduce its labor force dramatically. During the late 1970s and early 1980s, Conrail made rapid improvements in productivity and eventually achieved profitability. In 1999 it was sold to Norfolk Southern and CSX for a total of \$10 billion.

The high costs of saving Conrail led in part to the deregulation of the rail and trucking industries. The notion was that deregulation would allow the railroads greater freedom in rationalizing their networks, more pricing flexibility, and room for marketing and operating initiatives. The federal government did not step in to save the Rock Island, which was dismembered with the best lines sold to other railroads, nor did it create a “Farm Rail” involving the Chicago & Northwestern, the Milwaukee Road, or other troubled lines in the Midwest. Instead, the Staggers Act allowed and encouraged further rail mergers that ultimately produced four major systems by the beginning of the 21st century.

Deregulation may not seem like a public-private partnership, but in a certain sense it was. The government changed the rules of the game and the private sector responded with innovations in marketing, operations, and technology. The main dilemma of deregulation is that the fundamental economics of network systems have not changed. When marginal costs are lower than average costs, as they are for most of the rail system, then competitive pressures cause prices to decline and financial problems to mount. A recent study estimated that the U.S. rail industry had achieved productivity gains equivalent to more than \$20 billion per year by 1996—but given almost all of it back to customers in the form of lower prices (Martland, 1999). From a public policy perspective, this is quite a nice deal. From a railroad perspective, it suggests a continuing problem; despite two decades of rapid productivity growth, the industry was little better off than in the 1960s.

State and local governments have also partnered with the railroads in projects such as the following:

- The development of double-stack services in New York and Pennsylvania;
- Public ownership of rail rights-of-way in and around Boston;

- Public assistance in improving highway access to ports and intermodal facilities; and
- Public assistance to short lines and regional railroads.

There are a number of more recent case studies where private-sector freight providers (e.g., railroads and trucking companies) have worked successfully in partnership with government agencies to fund and implement needed infrastructure or policy/operations changes. The Alameda Corridor Project is perhaps the largest example of a public-private effort devoted to improving freight operations, but there are many other examples of successful projects, including those described in various conferences (e.g., TRB, 1994; Committee on the Intermodal Challenge, 2001; FHWA, 2001).

2.6.2 Intermodal Case Studies— Public-Private Partnerships

In 1994, the Office of Intermodalism and the various modal administrations within the U.S. DOT sponsored a national conference to discuss how to promote intermodalism (TRB, 1996). The conference featured case studies and policy discussions. For freight, the case studies included discussions of the following major projects, all of which involved public-private partnerships. Although the conference is now some years past, several of the projects are more recent in implementation, and the report is useful in describing the objectives, institutional arrangements, financing, and elements of a number of interesting initiatives aimed at improving the rail, intermodal, and highway systems.

- Tchoupitoulas Corridor Project, New Orleans, LA. This \$63 million project created a freight access road to ports on the Mississippi River, thereby removing approximately 1,500 trucks per day from three truck routes formerly routed through residential neighborhoods.
- Full Freight Access Program, New York, NY. This \$300 million program involved several types of improvements to the rail system to allow modern rail freight equipment to gain access to the city. The project was coordinated with proposals for bulk transfer facilities, warehouses, and other industrial facilities. The major elements of the program were
 - Increased clearances between Albany and the South Bronx;
 - Elimination of size and weight restrictions on the equipment able to move over the Long Island Railroad;
 - Acquisition of and increasing clearances on the Bay Ridge branch to allow intermodal traffic to reach the waterfront in Brooklyn; and
 - Terminal improvements and construction.
- Double-stack Clearance Project, Pennsylvania. Described at greater length in Chapter 2, this \$81 million program cleared

163 obstacles in order to allow double-stack trains to reach Philadelphia via Conrail from Ohio and via Canadian Pacific from New York State. The Commonwealth and Conrail each contributed nearly 50 percent of the cost, with Canadian Pacific contributing the rest. The benefits were expected in terms of lower transportation and logistics costs, increased traffic through the Port of Philadelphia, and more than 6,000 direct and 15,000 “spinoff” jobs by 2000.

The conference also highlighted intermodal freight planning activities at the MPO level. These cases all noted that public transportation officials need better education and information concerning freight transportation and intermodalism. Some of the cases identified specific opportunities for public-private actions:

- Capital District Transportation Committee, four counties surrounding Albany, NY. The MPO was beginning to integrate freight concerns into its planning activities. Five initial deficiencies in the intermodal system were identified, two of which related to rail:
 - Railroad grade crossings. There was a need to “dramatically” reduce at-grade crossings, primarily through closing little-used crossings; and
 - Clearances and bridge load limits were problems for rail double-stack access.
- Puget Sound Freight Mobility Program. This \$200,000 per year planning activity was supported by the Puget Sound Regional Council with help from the private-sector Regional Freight Mobility Roundtable.
- Northern New Jersey Transportation Planning Authority. A 1993 intermodal coordination study identified various deficiencies in the intermodal system, including the following:
 - Inadequate highway access to marine and rail terminals and
 - Rail access, clearances, and capacity.

Other resources include reports such as NCHRP 2-14: Public/Private Partnerships for Financing Highway Improvements.

2.6.3 Perspective on Public-Private Investments

With this review of public-private relationships in the rail industry, the current interest in public-private investments can be put in a clearer perspective. The country no longer needs or believes in the Conrail approach to rail problems. Conrail required substantial federal investment and, after a number of years, was returned to the private sector—but Congress, the industry, and the public all sought easier and cheaper means of supporting the railroads and other

transportation companies, namely deregulation and other changes in transportation laws. After two decades of experience with deregulation, there is recognition that a deregulated, profitable, private-sector rail industry either will not or cannot play the role that the public wants it to play. At the same time, the rail industry is beginning to realize that it cannot expand in size or profitability without help from governments in adjusting the network and in providing equitable treatment of all modes.

Thus, the opportunity and the need for more limited, more focused private-public partnerships are emerging (Scheib, 2002). Based on the various cases cited in this section, it is possible to identify barriers that must be overcome and the types of local factors that will help ensure ultimate success for these initiatives. Barriers such as the following must be acknowledged:

1. The railroads do not want the acceptance of public money for a particular project to be used as a reason for future restrictions or taxes on rail activities in the future. They want to discuss projects on a stand-alone basis.
2. Given that the railroads are privately owned, some local and state governments are restricted from direct investment.
3. The railroads have a regional or national perspective that is much different from the focus of local agencies; a railroad may be dealing with dozens of states and MPOs, whereas the public agencies are only dealing with a couple of railroads.
4. Rail costs are complex and rail costing is relevant to certain public policy issues, notably track charges related to passenger use of freight lines and freight use of the Northeast Corridor.
5. The scale of and justifications for public investment are much more complex than what is used by railroads; railroads think small, are extremely concerned with return on investment, and focus on direct operating impacts. Government agencies have very large projects (especially highway) that are justified in terms of broader concepts of economics, environment, and equity.

Success factors can also be identified:

1. It helps to have a clear transportation problem where the public and private benefits can easily be understood.
2. A public agency may be able to justify devoting a portion of its transport investment to rail projects, so long as the public benefits are similar to those obtained from other transport investments. The standard for investment is not what the board of directors would want, but what the City Council and State Legislature would want. Ensuring competitive service, relieving congestion at the waterfront, and promoting attractiveness of the region for development may be convincing to the public and to public officials.

2.7 Concluding Observations

There are many examples of projects indicating that it is feasible to justify public-private projects that result in moving more freight by rail, and ample methods available for evaluating them. There are also an increasing number of public investigations into such projects, some but not all of which support investment in rail. Benefits can be found, but the potential for rail with the clearest economies is high-volume or long-distance shipments, implying that a great volume of truck traffic will remain whatever is carried by rail. Shorter distance opportunities involving heavily concentrated point-to-point or confluent flows, or tapping unconventional technology, might enlarge the railroad potential but are not widely treated in the literature. Either way, planners must choose projects carefully and assess the potential shifts in traffic flows for particular market segments.

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CHAPTER 3

Detailed Case Studies

This chapter presents case studies exemplifying public initiatives in rail freight, most of them featuring some form of public-private partnership. The goals of the chapter are to show how investments in the rail freight system can alleviate road congestion and to show the range of the potentially relevant types of situations and solutions where they may apply. Many of the issues and dynamics identified in the Literature Review appear as live elements in the cases presented here, and a number of the projects are current both chronologically and in their fresh approach to problems.

There are nine case studies examining freight rail-related projects primarily in the United States, but including examples from elsewhere in North America and from overseas. The projects are of four types: intercity corridors, urban corridors, metropolitan citywide initiatives, and facilities. Most illustrations treat a single undertaking, but the two concerned with facilities consider groups of projects or programs that centered on a single theme. Half of the examples are connected to ports, which is a reflection of the importance of foreign trade in railroad transportation and the ability of ports to concentrate freight traffic volumes into trainload quantities. The nine cases are identified by type and motivation in Table 3-1.

The case studies focus on the relevance of each project to the relief of roadway congestion and the motivations that caused the project to be funded and done. The treatment of each initiative is not necessarily exhaustive and may not dwell on aspects that in other contexts might be regarded as essential, although the main features of all projects are covered with a fair measure of completeness. Each case study begins with a description of the project or projects, then examines the relevance to this research and its motivations. Last, the case studies review the outcomes and lessons that may be drawn from the case for the guidance of planners, often with emphasis on the practical means of implementation. There are variations in the presentation of projects, mainly because of innate differences in their characteristics and status, but presentations adhere to this general format.

All of the cases considered here create solutions to roadway congestion, but in almost no case was this the primary motivation for the project. The most common impetus was economic development or the related matters of port or regional competitiveness. Viewed from the perspective of how projects attract political support and financial backing, these illustrations suggest that the economic card is a strong one to play and can win relief for roadways where a program based on congestion happens not to suffice. Even so, reduction in road congestion formed an important part of project justification in every instance, and crowded roads are linked to the question of competitiveness. Congestion was a particularly resonant issue where the relief was obvious—as in grade crossing improvements—or was bound up with safety perceptions. Finally, as truck volumes continue to grow and capacity strains increasingly turn acute, congestion may drive more projects, because of the logistical effect on economic performance and public frustration with deteriorating highway levels of service.

Case Study 1: Pennsylvania Double-Stack Clearances

Type: Intercity Corridor

The Project¹

The 1980s were not kind to the Port of Philadelphia. While ports across the country were experiencing vigorous growth as international traffic soared, Philadelphia's share of the Delaware River cargo fell from 70 percent in 1980 to 42 percent in 1987. The drop in port activity resulted in a loss of high-paying longshoreman's jobs at a rate of 6 percent per year during that same period.

¹The material presented here is based on presentations made by and conversations conducted with representatives of the Pennsylvania DOT, former Conrail employees, and several secondary research sources. Nevertheless, opinions expressed herein are those of the authors.

Table 3-1. Types of case studies.

Project Type	Case Illustration	Motivation
1. Intercity Corridor	1) PA Doublestack Clearance	Port/Regional Competition
	2) VA I-81 Marketing	1 st Safety, 2 nd Congestion
	3) Betuweroute Freight Line	Port/National Competition
2. Urban Corridor	4) Alameda Corridor	Port Capacity & Competition
	5) Sheffield (KC) Flyover	Hub Capacity
3. Metropolitan Citywide	6) Vancouver Gateway	Gateway Competition
	7) Chicago Rail Futures	Economic Development
4. Facility	8) State Rail Access	Economic Development
	9) Inland Ports	Port/Regional Competition

Efforts to diversify the Port's leadership position as the nation's leading temperature-sensitive cargo port² had been successful for several "dry" break bulk commodities such as paper, steel, and cocoa beans. Container traffic, however, was declining at an alarming rate, idling significant portions of the Tioga and Packer Avenue Marine Terminals.

The Philadelphia Port Corporation's Strategic Business Plan of that period suggested that the Port continue to focus on break bulk cargo—a sector that represented nearly 60 percent of the Port's traffic volume. Opportunities in higher margin traffic, such as long-distance international containers and imported motor vehicles would be limited, inasmuch as the regional transportation infrastructure could not accommodate the more efficient double-stack containers and multi-level automobile racks de rigueur in the rail industry and available to several competing ports along the Eastern Seaboard.

Dissatisfied with a future in which Philadelphia's role as an international cargo destination could be marginalized, the City, State, and Port officials undertook a series of bold initiatives to modernize port and regional transportation facilities and position Philadelphia to compete with Baltimore, Norfolk, and New York. But while the modernization of port facilities and highway connectors was wholly within the control of the state government and port agencies, the regional rail infrastructure was not. Without needed improvements to railroad clearances, the value of the other modernization programs could be lost. Hence, the Port of Philadelphia and the Commonwealth of Pennsylvania approached Conrail to outline their vision for the future and to solicit their support—both financial and tactical—to facilitate change. Conrail was then the leading provider of Class I rail freight services to Pennsylvania.

Critical to the public-sector coalition's success with the private sector was the assurance that the clearance investments would not upset the balance of traffic currently enjoyed by the railroad. Similarly, the Canadian Pacific railroad, and an international shipper of dimensional cargo who was one of

the Commonwealth's major employers, sought to improve their competitive position through direct investment in the project.

Ultimately, the \$100+ million investment for the Pennsylvania Double-Stack Clearance Program was shared among state and local governments, regional port agencies, railroads, and a major shipper. The funding formulas used on the project sought to allocate public funds to common use improvements. In such areas, the State's matching funds constituted as much as 50 percent of the total. For restricted-use segments, Conrail provided most funding, up to 100 percent in many places. Of the total investment, the State provided approximately 38 percent, Conrail provided 60 percent, and the balance was made up from local sources and state-sponsored bonds.

Between 1992 and 1995, the Pennsylvania Department of Transportation (PennDOT) coordinated the work of the railroads and numerous contractors, who "cleared" 163 obstacles (e.g.,/i.e., by undercutting rail rights-of-way and raising vertical clearances on railroad signal bridges and tunnels, as well as highway and township road bridges) on Conrail's east-west operating route from the Ohio border to the Port of Philadelphia, and Canadian Pacific's north-south operating route (a portion of which was over Conrail tracks) from the New York border to the Port of Philadelphia. In addition, the project improved horizontal clearances in order to accommodate dimensional movements from Wilkes-Barre to the Port of Philadelphia³.

The project brought about various benefits in three primary areas:

- **Reduced Shipping Costs and Improved Service**—The improved clearances provided both the commercial incentive and the operating efficiency for Conrail and Canadian Pacific to provide improved service and lower rates to the region's shippers. Although Conrail, as the rail dominant carrier in the region, sought to maintain the existing competitive balance, several commercial and operational concessions were required to achieve the

²<http://www.inventpa.com/>

³<http://www.fhwa.dot.gov/freightplanning/>

desired public benefits. In a few circumstances, the clearance improvements provided a viable competitive rail alternative where none had previously existed.

- **Competitive Positioning for the Port of Philadelphia**—Clearance improvements for the east-west and north-south routes helped Philadelphia recapture some dimensional traffic lost to other Mid-Atlantic ports and connected the Port to the national double-stack network for inland distribution of international cargo.
- **Improved Economic Development Opportunities**—The clearance program helped Pennsylvania capture a significant amount of regional economic growth. While the National Highway System has long favored Central and Eastern Pennsylvania as an ideal location for manufacturing and distribution activities, the lower cost of double-stack intermodal service enhanced the attractiveness of the region, such that the rate of growth in trucking and warehousing employment more than doubled in years following the completion of the Clearance Project⁴.

Relevance

The Pennsylvania Clearance Project is a moderate-scale intercity corridor project that improved the competitiveness of both the region's industrial base and the Commonwealth's primary distribution and international port facilities. Its stimulus to the development of intermodal freight services diverted traffic from the highways of the host state and its neighbors and strengthened the national intermodal network. The project is an instructive example of public-private partnership, and at the time of its inception, it was considered a radical departure from traditional railroad-State relationships. Railroads had eschewed public monies, fearing an unending demand for commercial and operational concessions. States, conversely, had viewed the railroads as obstructionists to economic development and competitive diversity. The successful implementation of the Pennsylvania Clearance Project proved both hypotheses incorrect and provided a model for future public-private cooperation for rail investment.

From the public-sector perspective, the perceived benefits included the following:

- **Preservation of High-Paying Jobs Associated with the Port of Philadelphia**—These included the direct employment jobs at the Port and the indirect employment associated with Port-related activities.
- **Preservation of Port Competitiveness**—The prospect of improved operating efficiency for the railroad was expected

to result in “lower transportation costs for businesses and, ultimately, lower prices for consumers.”⁵

- **Highway Traffic Diversion**—Absent the completion of the Pennsylvania Clearance Project, the growth of rail intermodal activities in Pennsylvania was stifled. Two markets relatively untapped prior to the clearance work blossomed following its completion:
 - **International containers moving into Pennsylvania and Maryland from the West Coast.** The movement of international containers to Pennsylvania and Maryland had previously been accomplished through long-haul drays from railroad terminals in Ohio and Illinois. The completion of the Double-Stack Program permitted these containers to move to Harrisburg and Philadelphia respectively, substituting rail movement for highway drayage.
 - **Intermodal traffic to and from the Pittsburgh market.** The ability to run double-stack trains to New York and Philadelphia through Pennsylvania provided the needed critical mass to make serving the Pittsburgh region with rail intermodal service economical. The NS Terminal in Pitcairn, Pennsylvania (former Conrail), brought long-absent premium intermodal service back to the region.

Motivation

The motivation for the Pennsylvania Double-Stack Clearance project can be thought of in terms of the combined effect of opportunity and risk. While the potential for regional and commercial economic benefit was clear to all parties, the public-sector officials also recognized the risk of economic harm to their constituents that could result from inaction. Relief to highways was a useful by-product of the initiative, but the initiative was founded on considerations of economic development and preservation.

For Philadelphia, the Port represents a significant factor in the regional economy. The Port employs approximately 3,500 people directly and supports an additional 10,000 area jobs in the service, retail, and financial sectors. These jobs provide the region with some \$16 million in City and State revenues, including wage, sales, and income taxes⁶. But while the 1980s saw modernization investments in excess of \$250 million by competing ports like Baltimore, New York, and Norfolk, Philadelphia's investment was less than \$10 million⁷. The Port recognized that without an aggressive investment program, the economic vitality of the region was at risk.

⁵<http://www.cgp.upenn.edu/CGPDocLib.nsf/>

⁶<http://www.cgp.upenn.edu/CGPDocLib.nsf/>

⁷Ibid.

⁴<http://www.bea.gov/bea/regional/gsp/>

The Pennsylvania Legislature saw the issue in terms of its potential to enhance economic development across the Commonwealth and to promote industrial development among high-technology industries that rely heavily on components imported from Asia. The legislature commissioned a study by PennDOT that concluded that such benefits could indeed be achieved through the completion of the Double-Stack Program.

Conrail recognized the potential of the double-stack clearances to improve their competitive position vis-à-vis motor carriers moving manufactured goods into the Mid-Atlantic region. The opportunity to operate stacked containers and fully enclosed multi-level automobile carriers would reduce the effective cost of providing transportation and would provide improved cargo handling.

The fortunate alignment of these strategies and the common urgency of timing resulted in a cooperative venture that succeeded in helping each of the participants achieve their strategic goals. Although there was compromise along the way, the parties recognized that no single issue was worth the loss of the whole project.

Lessons and Outcomes

The Pennsylvania Double-Stack Clearance Program has been operating for approximately 10 years as of this writing. In addition to its intended benefits, it has produced significant additional benefit to the State and the entire Eastern Seaboard. The program has produced outcomes of interest to this study through its performance and through the implementation of a successful public-private partnership.

Performance

The Pennsylvania Double-Stack Clearance Program created a powerful economic development tool for the State and for the railroads. At its peak, the Pennsylvania double-stack corridor handled approximately ten trains of excess-height equipment daily, most of them stack trains laden with 150 or more containers. The hoped-for economic development continues to be realized. Lower costs to shippers have solidified Pennsylvania's position as an East Coast manufacturing and distribution hub. In recent years, three cities along the Pennsylvania Double-Stack Clearance Route have been among the 50 fastest growing manufacturing regions in the nation. These are Pittsburgh (ranked 19), Allentown-Bethlehem-Easton (ranked 26), and Harrisburg-Lebanon-Carlisle (ranked 46)⁸.

Since their takeover of Conrail, Norfolk Southern and CSXT sought to use the benefits of the Pennsylvania Double-Stack

Clearance Program by expanding the number of cleared routes and the capacity of intermodal terminals along the routes and by further promoting economic development in the region. The creation of new and the expansion of existing manufacturing and distribution centers is a testament to the foresight of those involved in this project.

In addition, the Pennsylvania Double-Stack Clearance Program has generated significant environmental and congestion benefits, transferring a significant portion of long-haul motor carriage to rail intermodal movement. Intermodal traffic growth along the corridor served by the clearance program exceeded the average for the rest of the eastern network, and that growth came quickly. Within the first few months of operation, intermodal loadings increased 10 percent⁹.

Implementation

Part of the importance of the Pennsylvania Double-Stack Clearance Project is that it was an early success in the movement toward public-private partnerships and that it signaled a fundamental shift in the willingness of railroads to accept public funding for infrastructure improvements. Several of the factors that brought this about may be instructive for other rail projects:

- The funding program sought to use private capital to accelerate and magnify potential benefits. While a Pennsylvania Double-Stack Clearance Program might have existed in some fashion absent public-sector involvement, the urgency of timing and the desire to promote specific economic development opportunities prompted the State to initiate a joint-venture development with the railroad.
- Railroad cooperation in the project was negotiated carefully. Conrail as the dominant railroad in the region was unwilling to accept the creation of a state-subsidized competitor through the project. Because this project represented a significant departure from traditional public-sector dealings with the railroad, some additional points should be recognized:
 - Although the commercial and operational demands of the marketplace were already pressuring Conrail to invest in clearances, the railroad was concerned that public-sector investment would require unreasonable commercial compromise. To avoid the introduction of subsidized competitors, Conrail negotiated investment-matching formulas that served as a threshold for access. Other railroads—if unwilling to commit financial resources to the project—would largely be denied the benefits of the program.

⁸*Expansion Management*; January 2003; “50 Hottest Cities for Manufacturing Expansions and Relocations”.

⁹<http://www.fool.com/decaathlon/1996/decaathlon961004.htm>.

- The State, by negotiating adroitly with the railroad as to the routes to be cleared and the type of access to be provided, was able to develop a solution acceptable to Conrail and ultimately to all parties. PennDOT resisted the temptation to use this initiative as a forum to resolve all outstanding issues between the railroad and the State. By not overreaching the scope of the project, PennDOT earned the trust of the railroad and opened the door for additional ventures.
- Community support was founded on minimizing the detrimental effect of the construction. Three distinct efforts helped mitigate community backlash:
 - The participants made a significant effort to preserve the historical character of the improvements. Even in rural areas, concrete tunnel facings were carved to resemble the original cut-stonework and historic bridges were undercut or raised rather than replaced wherever possible.
 - Aiding community acceptance was the smooth handling of problems and concerns during the most controversial portions of the project. Rock blasting in two tunnels located beneath suburban Philadelphia communities caused numerous broken windows, cracked walls, and smashed household items. This incidental damage was handled quickly, and special call-in numbers were provided to ensure prompt and appropriate settlements.
 - Through the close coordination of several PennDOT agencies, many communities benefited through the acceleration of bridge replacements and repairs associated with the corridor improvements¹⁰.

Beyond its originally identified goals, the project provided a second cleared access route from the Midwest to the New York market. This provided Conrail with significantly greater operating flexibility and ultimately permitted the successful division of Conrail assets to Norfolk Southern and CSX. Shippers in the East continue to reap the rewards of the Double-Stack Clearance Program through lower rates, and industrial development in the region continues to flourish. For the Port, however, the competitive advantages brought about by the program may be more difficult to sustain. The Port of Norfolk is an unintended beneficiary of the Double-Stack Clearance Project with some trains to the Midwest moving across Pennsylvania to that region.¹¹ Similarly, competing ports in Wilmington and Baltimore are both seeking to obtain access to the national double-stack network through the Pennsylvania clearances. In many ways, the completion of the Pennsylvania Double-Stack Clearance Program

¹⁰<http://www.fhwa.dot.gov/freightplanning/>.

¹¹This will change as the advent of the Heartland Intermodal corridor opens a direct double-stack route from the Port of Norfolk to the Ohio valley.

continues to provide benefits far in excess of its anticipated results and far beyond the region it serves.

Case Study 2: Virginia I-81 Marketing Study

Type: Intercity Corridor

The Project¹²

The Virginia I-81 Marketing Study examined the potential for new railroad freight services to attract truck traffic from Commonwealth highways to alleviate roadway congestion and improve safety. The project used primary market research, competitive and operational analysis, diversion modeling with traffic data, and cooperative planning with railroad officials to establish the product features and attendant costs and investments that would be required to shift varying levels of highway volume to rail. Earlier studies had determined that the direct benefits of freight modal diversion along I-81 were significant and included improvements in highway user, safety, and pavement maintenance costs, as well as in air quality. Although formally concerned with a complex of roads that included I-95, the project chiefly focused on I-81 and the practical means to produce direct benefits in that corridor. The Virginia Department of Rail and Public Transportation undertook the work at the direction of the Commonwealth legislature, with financial support from the Tennessee DOT and the Federal Railroad Administration (FRA), and in-kind support from the Norfolk Southern Railroad.

The evaluation concluded that efficient and frequent intermodal service in the corridor could divert up to 3 million trucks annually, or approximately 30 percent of the projected truck traffic in 2020. The evaluation further determined that the investment in infrastructure and equipment required to effect such a diversion was between \$7 and \$8 billion, and identified the location and timing of the proposed expenditures. This evaluation then became a catalyst for three forms of action: (1) Commonwealth of Virginia initiatives to seek federal monies for both rail and highway improvements; (2) organization of a multi-state I-81 corridor coalition to examine, coordinate, and pursue funding for such improvements; and (3) investments by Norfolk Southern in new services consistent with the long-term opportunities identified in the project.

The study had three core elements:

- Interviews and Surveys—Primary market research was conducted among the freight users of the Virginia highway

¹²The material presented here is taken from the final report of the project issued December, 2003, and from project papers. The author of this case study was a participant in the study.

corridors. These users fell in two general categories: shippers whose goods traveled in Virginia on their way to market, and truck lines who served such shippers. Each user type made decisions that caused traffic to move by highway and could cause it to move by rail. Shippers did this by their selection of carriers, and truck lines by their choice to perform or purchase linehaul transportation. Decision makers were identified and questioned about the potential for their use of rail intermodal services and the performance characteristics required to attract their business.

- Scenario Development—Based on the findings from interviews and surveys and on traffic flow data and the experience of railroad officials, a series of alternative railroad service designs were prepared. These designs included the introduction of new services and technology and were associated with improvements to facilities and structures that would support higher quality operations. These improvements were calculated to raise railroad performance to levels sufficient for the diversion of traffic from highways. The location, timing, and capital requirements of specific improvements were developed, and their effects were summarized according to whether Virginia acted alone to invest in facilities within its borders or had cooperation for investments in other states along the corridor.
- Diversion Analysis—Scenarios were translated into intermodal cost and service characteristics for individual origin/destination traffic lanes that contributed to truck volume on Virginia highways. These performance characteristics were compared with those competitively available from all-highway operations, and lane-by-lane modal diversions were estimated. Freight volumes were evaluated with respect to four major characteristics that influence its divertibility: (1) the origin, destination, and routing of traffic in relationship to serving facilities; (2) the density of traffic in lanes and operating paths; (3) the commodity and equipment mix; and (4) the distance traveled door to door. The determination of diversion amounts was accomplished by use of a cross-elasticity model, informed and supported by the findings from interviews and surveys.

The key dynamic in the traffic diversion analysis was public investment that allowed the introduction of new intermodal trains, raised their performance characteristics, and reduced their cost of operation to the point where it could shift the competitive modal balance. Funding of infrastructure improvements was the main form of investment considered, particularly through the upgrading of right of way and also through the expansion or new development of terminals. The outline and potential from improvements was explored in the development and testing of operational scenarios, and the performance effect and influence on diversion from specific project elements were evaluated in the last stage of the study.

Relevance

The I-81 Marketing Study evaluated a major inter-city corridor for the direct purpose of roadway traffic relief through investment in freight railways. The public projects it pointed to and could impel would be multi-million dollar alternatives to interstate highway spending—not eliminating but probably reducing such spending, and certainly providing additional freight system capacity in a railroad right of way that is naturally segregated from automobile traffic. Although the study itself was small in comparison with engineering projects and dealt with prospective analysis instead of accomplished facts, it was substantial as a piece of research and encountered a number of common or important issues in the use of rail for highway assistance:

- New rail services considered in this study were exclusively intermodal, because of a joint judgment that carload services could not capture enough traffic to be meaningful for congestion mitigation. This judgment reflected the scale of the project's objective, which was to produce material changes in statewide and multi-state corridor traffic. In less ambitious circumstances, local planners might feel that carload alternatives are sufficiently productive for their smaller geographic area, and for railroads, added carload business normally is attractive if there is capacity for it.
- Deployment of alternative intermodal technology had an important role in the project, for two reasons: (1) it extended the reach of rail services beyond the dry van equipment types and long lengths of haul to which they conventionally appeal; and (2) it established competitive service for domestic highway trailers, which accounted for most of the truck volume on I-81 (and on most roadways), but are a declining portion of intermodal traffic. Expressway-style technology¹³ in particular proved useful, through its accommodation of flatbed and tank trailer equipment and its effectiveness for domestic traffic at distances dropping toward 300 miles.
- Lack of alignment between railroad capital priorities and public preference stood out as a clear challenge. Virginia's interest was in parallel rail services to compete with North-South highways. Nevertheless, one railroad had withdrawn North-South service, not because it was unprofitable or

¹³Expressway is a trade name used by the Canadian Pacific railroad to describe a long, articulated, roll-on/roll-off platform set that is designed for highway trailers. The platform can be split at many points and accessed with removable ramps. Loading and unloading is fast, terminals are cheap, but platform sets are not. Its primary advantage is a high degree of compatibility with over-the-road operations, both in equipment accommodation and in service capability. An earlier generation of the technology was known in the U.S. as the Iron Highway.

unsuccessful, but because it paid less well than East-West services that used the same terminals—and the railroad regarded terminal capacity as fixed. Similarly, the Commonwealth was interested in short- as well as long-haul services, to more thoroughly erode the traffic volume on highways. However, short-haul business had limited attraction for the area’s railroads, because profit margins were thinner than for long-haul business the carriers had yet to convert—and because railroad capacity was limited and internal hurdle rates for investment were high. The fundamental problem was that railroads were allocating resources under capacity and capital constraints and did not use public benefits in determining resource priorities. When public resources were introduced to this determination, it raised the priority of public interests.

- Looking toward implementation of investments, Virginia, like many states, needed to seek regional cooperation, not only between the Commonwealth and its neighbors, but also between the states and their municipalities. This was especially true in regard to terminals and their drayage service, whose location and operation were crucial to the intermodal product and were the dominant component in shorter distance lanes. Sixty percent of Virginia highway traffic began and/or ended its trip outside its borders, rendering Virginia and a number of other states interdependent for intermodal end-point service. This implied as well that the construction Virginia could initiate within its own jurisdiction produced a shared benefit, through the reduction of highway volumes for neighbors. Interdependence and shared benefits constituted an argument for coordinated action and contribution, and led the Commonwealth and its rail partner to a dual strategy: (1) identify improvements that could be undertaken independently, and still conform to the larger strategic objectives of the project; and (2) form a multi-state coalition to respond to joint, multimodal needs and opportunities. Both components of this strategy were pursued.

Motivation

The I-81 Marketing Study was an intercity corridor project aimed at the reduction of truck volume and improvement of safety on interstate highways, and it could act as a precursor to publicly backed railway construction for this purpose. It was commissioned as an outgrowth of directives from the Commonwealth legislature, who in two resolutions called for examination of “the potential for shifting Virginia’s highway traffic to railroads” through alternative investments in rail facilities. The study had three motivations, as expressed particularly in the resolutions HJR-704 and SJR-55:

- Safety—Improvement to highway safety was probably the core political impetus for the study and was the central

theme of SJR-55. The design standard for I-81 allowed for trucks at a maximum of 15 percent of total vehicle traffic. Truck activity in fact reached 15 percent during the morning and afternoon peaks, climbed to 20 percent during the day, and approached 50 percent overnight.¹⁴ Nearly 30 percent of Virginia truck volume originated and terminated outside its borders, so a significant subset of I-81 commercial traffic traveled the full length of the state while having little economic connection to the Commonwealth. Finally, the highway itself lay in rolling, often rural terrain. As a result, the common experience of Virginians traveling I-81 was that of being surrounded by large, heavy trucks on dark, hilly roads, with the inevitable consequence that the automobile driver felt unsafe, regardless of the actual performance of the trucks. Accidents involving commercial vehicles were said to generate strong local sentiments, presumably because they resonated with this experience, and the weak economic bond of the trucking activity with the community allowed hostility to grow. The legislature cited truck volume and not accident statistics in its call to boost safety by removing highway traffic to rail, thereby perhaps recognizing the real source of public support.

- Congestion—Relief to highway congestion is a second stated purpose of the study. The legislature cited the effectiveness of intermodal terminals for eliminating trucks from overcrowded highways in eastern Virginia and sought to extend this benefit to I-81. This was the main theme of HJR-704, and it was echoed in the later SJR-55, with its wish to “alleviate excessive volumes of traffic on Interstate Route 81.” Read narrowly, there was no explicit claim in the resolutions that I-81 was an overcrowded interstate—when compared with the more urban and easterly I-95 it was not as yet. Rather, the legislature’s emphasis was on the quantity of truck activity per se, because it contributed to such traffic slowdowns as existed, influenced capacity requirements, and shaped perceptions of safety. However, and more broadly, forecasts of congestion were very much part of the picture for state planning agencies responding to the legislature’s direction. For these officials, the federal projection of 90-percent growth in I-81 truck volume by 2020 was a concern specifically for its effect on capacity and congestion, as well as on safety. The planning agencies accordingly pointed to “the critical need to address the existing and future safety and congestion problems on Virginia’s highways” in their statement of the study’s rationale.
- Alternative Investment—Railroads, as an additional option for the public provision of overland freight capacity, with

¹⁴The time-of-day figures were based on VDOT observations outside Roanoke. The corridor-wide daylong average for I-81 in Virginia was 29 percent, according to other VDOT statistics.

an expense profile and implementation schedule different from highway investment, formed the third motivation for the study. The legislature in SJR-55 took note of the multi-billion dollar cost and decade-long development required for widening of I-81 and put forward railroad investment for investigation as a shorter term solution.¹⁵

Another set of motivations were those of the Norfolk Southern railroad, a willing partner to the study. The I-81 Corridor was an underdeveloped intermodal market for various historical reasons and offered large opportunities for rail market share growth with conventional long-haul services. As one point of comparison, intermodal market share in the lane between Harrisburg, PA, and Atlanta, GA, was 5 percent, versus 40 percent in the Harrisburg-Chicago lane of similar distance.¹⁶ In addition, the eastern coal business, which for generations had been the traffic baseload for Norfolk Southern railroads, had gone into decline, and intermodal business built with highway diversions was the only likely replacement. However, additional north-south train services required capacity additions the railroad could not finance on its own, some of it affecting right of way with a meandering, 19th Century configuration or traversing countryside whose citizens resisted development. Although hard issues of resource prioritization made some and not all of the I-81 truck traffic attractive to Norfolk Southern, those priorities could be transformed by public investment. The strategic motivation for Norfolk Southern cooperation in the project was its need to construct a new traffic baseload on a reformed network, calling on new forms of financing to remove the constraints to growth, and to ensure a future for its railroad.

Lessons and Outcomes

The I-81 Marketing Study produced useful results and approaches. Interviews with shippers and truck lines yielded typical but valuable outcomes, with service reliability, cost of transportation, and transit time predictably named as the key criteria in selecting or changing modes. Railroad performance was acknowledged as less costly but inadequate in speed and reliability, and the position of the I-81 corridor as underserved in the intermodal system was highlighted. Although buyers were willing to trade service for lower cost to an extent, they were not willing to pay more for superior service—although framed as a comparison of intermodal with

¹⁵During the period of the marketing study, Virginia transportation agencies also began to entertain proposals for expansion of the I-81 roadway. Proposals included truck-only lanes aimed at highway safety through segregation and were to be coordinated with railroad planning.

¹⁶Market figures are from Global Insight's TRANSEARCH database, employed in the I-81 project.

over-the-road performance, it is not likely that respondents took superior service as a credible option. What did seem clear was that better service required less of a cost discount, and competitive service joined with significant cost reduction probably became a compelling option.

Transit time was less flexible for motor carriers, who were concerned about the use of their assets and had made time commitments to their customers; for them, second-rate transit pushed rail into a backup role or out of their picture entirely. Finally, although shippers of the most time-sensitive goods claimed to be more willing than others to switch carriers for the sake of small improvements in on-time percentage performance, most respondents used somewhat imprecise methods of performance measurement in any case. The consequence was that on-time improvements in the 5- to 1-point range tended to be required in order to be noticeable or material.

Diversion estimates indicated that 700,000 trucks could be taken annually from the I-81 corridor in Virginia in the medium term (about 14 percent of its total truck traffic).¹⁷ In the long term, diversions could rise to 3 million trucks annually (i.e., 30 percent of corridor truck traffic). This represented a medium-term diversion of one in seven trucks and a long-term diversion of one in three. Although these proportions were large enough to be meaningful for safety and congestion management, truck growth still was expected to continue on the corridor because of the general increase in commerce. However, because rail would be able to absorb 60 percent of new truck traffic, it could prevent I-81 from becoming more of a truck-dominated highway route than it already was, and this could appeal to citizens concerned about sharing the road with these larger vehicles.

Several strategies were employed to increase the rate of diversion:

- **Segmentation**—A range of services was used to appeal differentially to distinct segments in the market. Through such a combination of appeals, a greater portion of the highway volume could be put into play. The services varied by rail equipment types and their associated terminal requirements and often called for separate trains. Conventional stack trains were aimed at international trade and such business as that of the Intermodal Marketing Companies (IMCs) that could use domestic containers. Standard TOFC equipment addressed IMCs and truck lines that depend on rail trailers or that had outfitted their trailer fleets for intermodal lift. Expressway-style service targeted

¹⁷Based on capture of traffic measured in TRANSEARCH versus the average AADTT of I-81 in Virginia. The scenario in which Virginia acted alone produced attractive but much lower diversions, because of the interstate character of truck traffic in the corridor.



Figure 3-1. Interstate 81 Through Virginia—Millions of Annual Trucks.

the great majority of motor carriers and their customers who rely on unmodified equipment or non-van trailers, among them the private fleets. This service also shortened the lane distance that could be competed for domestically. A fourth service identified but not adopted in the study was the rolling highway configuration operating in some parts of Europe, where the tractor and driver accompany the trailer on the train. The market segment for which this could appeal consisted of the small truck lines and independent contractors (“owner/operators”) who have no driver or power to meet up with a load they forward by rail. For this group, the train functions as a kind of moving truck stop.

- **Product Strategy**—Rail product design is central to its competitiveness and, therefore, its capability to divert traffic. The design for the I-81 study stressed speed, frequency, and reliability in order to offer a product that was fully the equivalent of single-driver, over-the-road service and not an inferior good. Its central focus was an appeal to a motor carrier clientele, because of the belief that market penetration may be achieved more rapidly by this route and because the door-to-door integrity of the product may be stronger and therefore satisfy shippers more fully.

The product featured trailer service, particularly through use of Expressway-style technology, because of the versatility of that equipment and its ability to accommodate trailers just as they are on the highway. This was a very substantial point, because it removed a capital investment requirement for truck lines to move their own equipment by rail, allowed their fleets to remain uniform and retain the efficiency of interchangeability, and reduced (but did not eradicate) the costly problem of trailer imbalance. This kind of equipment also lent itself well to the attraction of confluent volume, in which travel routes from multiple points converge for a time over a section

of highway and then diverge again. These routes are evident in the corridor network for I-81, displayed in Figure 3-1.

Trainload volumes could be composed between terminals peripheral to Virginia to divert its through traffic, using long dray stems with low circuitry, without necessarily providing terminal service directly to origins and destinations. The flexibility of Expressway-style technology made this kind of long-stem service feasible, and it already existed in Canada.

Short-Haul Features—The rapidity and low cost of terminal transfers in Expressway-style service also rendered it effective for the high-volume, shorter haul traffic, whose capture would raise the productivity of railway alternatives to road investments. Coupled with this was the appeal of the service design to large network motor carriers, through its use of frequent trailer service and transit speeds equivalent to the performance of single-driver trucks. These carriers could provide superior pickup and delivery service, because of the presence of operating assets in virtually all important market areas and their high degree of control over them. For those with irregular route structures, the ability to balance equipment without return trips drove down drayage costs. The combined factors of terminal lift and dray expenses approached three-quarters of the total cost of intermodal operation at shorter distances (see Figure 3-2), making the combined influence of Expressway-style service for network carriers a strategic solution for the shorter lengths of haul. Lastly and as a policy option, public allowances that supported drayage service and reduced its cost could be added to aid the viability and penetration of rail. Rebates of the fuel taxes or tolls paid by these trucks were two of the possibilities—and here again, cooperative agreements between Virginia and its neighboring states could be effective, because drayage normally is tied to an interstate rail shipment.

Network Strategy—The introduction of highway-competitive north-south rail service added a critical link to

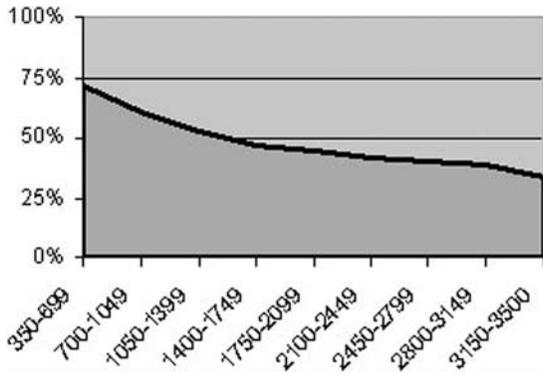


Figure 3-2. Dray and Lift Share of Total Cost by Mile Block.

the national intermodal system, by completing a network circuit in the East that was vital for equipment repositioning. Once large motor carriers could duplicate on the intermodal network the fleet balance economy they achieved on the highway, their use of rail was apt to rise and their cost competitiveness to climb. This had a second-order influence on road diversions, because the large network truck line with a low-cost structure could win business away from less efficient operators or cause them to convert to intermodal.

The Virginia I-81 Marketing Study made clear that meaningful relief to highway freight volumes in intercity corridors is possible with rail service and indicated some of the ways it could be brought about. I-81 in Virginia had certain advantages of location that tended to funnel traffic over sustained distances, but the lessons of the study are generally transferable. The adoption of a portfolio of products to address distinct market segments, frequent service that rises fully to over-the-road standards, and network and technology strategies to

deepen penetration and produce systematic effects will be fruitful approaches for highway corridors in many quarters of the Country.

Case Study 3: The Betuweroute Freight Line—Netherlands

Type: Intercity Corridor

The Project

The Betuweroute rail freight Line (BRL) is a 160-km, £4.55 billion (US \$5.1 billion) undertaking that will run from the Port of Rotterdam in the Netherlands to the German border, linking with the German rail network to continue south to the economic centers of the Rhine/Ruhr region. (See Figures 3-3 and 3-4.) From there, connecting lines run to Eastern Europe and through Switzerland to the Italian commercial centers of Milan and Bologna. Scheduled for completion by 2006, the BRL includes five tunnels with a total length of 18 km and 130 bridges and viaducts with a total length of 12 km. All tunnels are being built to accommodate double-stack trains. The implementation of the new European Rail Traffic Management System and European Train Control System (ERTMS/ETCS) for communications between trains and traffic control on BRL will allow the trains to travel at a speed of 120 km/h with up to ten trains per hour in each direction. At this writing, this is the largest freight-only rail project under construction in Europe, although several other large rail infrastructure projects with significant freight elements are under way or planned.

The Betuweroute project is made up of two sections: (1) a 48-km railway line between the Port of Rotterdam and the Kijfhoek switching yard, and (2) a 112-km connection linking

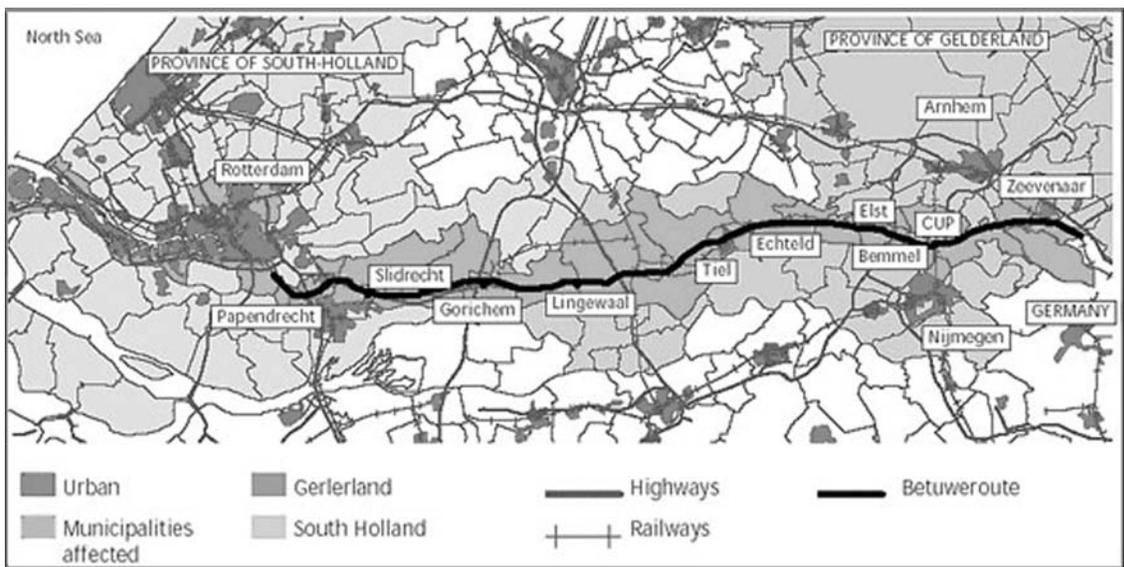


Figure 3-3. Map of Betuweroute for Rail Freight.



Figure 3-4. Betuweroute Parallel to a Roadway.

the switching yard and the Emmerich-Oberhausen rail line in Germany. Thirty-five km of the first section involves reconstruction of the existing port railway, with the remaining 13 km entailing construction along new alignments. The second section entails construction of a brand new alignment, of which 95 km is along the existing A15 expressway. The port railway line is designed to provide an efficient rail connection between the seaport and Kijfhoek, a major rail freight hub near the port that provides access to the European rail network. The 112-km connection to Germany provides speedy and efficient access to the port's most important hinterlands in Germany and southern Europe. Rail traffic from the port is already substantial—in 2001, roughly 270 container block trains connected Rotterdam with thirty destinations on a weekly basis.

When construction began in 1999, the entire project was planned for completion in 2006. The reconstruction of the existing port railway segment was to be finished first in 2003 with the remaining sections completed around 2006. The project is complex, involving not only extensive tunnel and bridge construction, but also adoption of a new-to-the-Netherlands electrification technology (25kv AC instead 1.5kv DC), and the new ERTMS/ETCS, which has only seen limited adoption thus far.

The BRL line is being built by the Betuweroute Project Organization, a cooperation of the Dutch Ministry of Transport's

Directorate-General of Freight Transport and NS Railinfrabeheer railroad, which is part of Nederlandse Spoorwegen NV (Dutch Railways)—the rail operating company working for (and under the responsibility of) the national government. NS Railinfrabeheer is charged with ensuring the construction and maintenance of existing and new rail tracks. The Betuweroute Management Group within NS Railinfrabeheer is responsible for construction of the BTR and acts as a contractor and client for the line.

The BRL is funded by the government of the Netherlands, along with some assistance from the European Commission (EC). Germany is funding connector rail improvements in that country. The idea of public-private partnerships (PPPs) is a new concept that was not even feasible until changes in Dutch government policy were enacted after the year 2000. However, on completion, it is anticipated that the BRL will be managed by a private organization that will aggressively market the BRL to any qualified train operating company. At this writing, several private freight operators are certified to operate in the Netherlands. By the time the project is completed, all of the EC rail network should be accessible in a non-discriminatory manner to train operating companies that meet the necessary requirements specified by the EC and the infrastructure providers.

Relevance and Motivation

The Betuweroute is a large-scale intercity corridor designed to expand freight rail capacity and protect the competitive trade position of the Netherlands and its major port. The European Commission appointed the BRL as one of the 14 priority infrastructure projects in Europe. This is one of a series of rail freight projects being supported by the EC as part of its effort to discourage road haulage in favor of rail freight across Europe. As such, the Betuweroute is expected to reduce roadway congestion and yield environmental benefits, which are prominent policy goals of the EC. The BRL line forms a critical link in the European Union Trans European Network (TEN) for railways and will also link up to the system of Trans European Rail Freight Freeways (TERFFs). It is, therefore, a network-level investment whose systemic effects would multiply its policy benefits beyond the local area. However, the driving motivation for the project lies in its economic influence on the Netherlands.

The existing railway lines in the Netherlands are primarily used for transport of passengers with only modest use for freight. Over time, changes in the logistics supply chain have led to increasingly flexible, diverse, rapid, and more customized transport systems of frequent small shipments. As a result, the use of road transport has increased by more than 30 percent between 1980 and 1991 and accounts for about 70 percent of all freight transport activity in the nation. In recent years, rail has

accounted for only 8 percent of transport output in the EC member countries—a very modest share. By 2010, the transport volume through the Netherlands is expected to grow to 1,106 million tonnes, an amount that cannot be transported by road alone. Expanding the use of rail to haul freight, particularly in cross-border trade, cannot be accomplished without new line construction. Whereas the Netherlands' highway and rail networks provide good cross-border connectivity, its rail network does not. The BRL will address both capacity and cross-border connectivity, by providing a direct rail route to the Netherlands' most important trading partners and critically needed mainline capacity that can be devoted to freight.

The primary and initial motivation for the BRL was to strengthen the international competitive position of Rotterdam and all of the Netherlands as a transport and distribution hub that serves as gateway to the industrial hinterland of Europe. A 1997 Dutch Study, *Mainports in the 21st Century* (by Gout, Haffner, and Van Sinderen, and published by Wolters Noordhoff) stated the Dutch policy case, which was that the nation's long-run economic well-being depended on strengthening airport and seaport facilities and their freight connections to the interior of Europe. Based on a forecast of future growth in international trade, the analysis showed that existing roadways and rail lines could not provide the necessary capacity to allow the Port of Rotterdam to maintain its economic position as the pre-eminent container port for Europe. The “no build” scenario was for increasing road congestion, ultimately causing a loss of freight growth away from the Port of Rotterdam.

Given this national objective of supporting freight growth, there was still the question of balance between expanding highways for trucking or expanding rail lines. A formal analysis considered issues of energy use, environmental impact, and traffic congestion implications. Dutch transport policy has been aimed at deploying all forms of transport in the best possible combination, with an emphasis on promoting alternatives that lessen dependence on road haulage. The analysis concluded that a rail line best supported the accessibility and congestion reduction objectives of the Dutch government's traffic and transport policy.

The Betuweroute was thus seen as playing “an important role in maintaining and improving employment levels in the Netherlands.” According to the central planning office of the Netherlands government, the added value of the total direct and indirect effects from the presence of the BRL will range between US \$4.0 and US \$6.9 billion for 2003–2010, and between US \$6.8 and US \$12.7 billion for the period 2003–2025.

Lessons and Outcomes

Since the project will not be in operation until 2006, no results or effects have occurred yet. However, the project has

been justified on the basis of achieving certain performance goals.

The estimated future use of the BRL indicates that, by 2010, the total rail freight volume in the Netherlands will triple from 18 million to 65 million metric tons—traffic that most likely would move otherwise by road or not be seen in the Netherlands at all. A substantial portion of this growth is expected to be absorbed by the BRL.

The port railway segment between Rotterdam and Kijfhoek is anticipated to carry 55 million tons, and the main stem of the BRL to the German border is expected to carry 32 million tons in 2010, or about 50 percent of the Netherlands' total rail freight volume. From the perspective of the U.S. economic and political environment, the Betuweroute can be compared with a regional project with national significance. Even though the political and planning environments are very different, significant similarities can be found with Alameda Corridor I in the Los Angeles region. Both are essentially port projects aimed at moving high volumes of international trade to inland locations. Their underlying rationales are also quite similar. Both aim to preserve and advance the market position of a port vis à vis potential competitors through improved land-side transportation efficiencies, while ameliorating a broad range of negative effects on local communities resulting from increased traffic. The extended and extensive planning process led policy makers to reach similar conclusions: the most viable route to accommodate and indeed promote growth was through investment in rail infrastructure and that continued reliance on highways to absorb traffic growth was not feasible. Of course, the institutional arrangements are quite different, and the overall BRL investment is approximately double that of Alameda Corridor I. Moreover, whereas most of the funding for the Betuweroute will come from the greater public, the Alameda Corridor is being largely paid for through user fees by the private railroads using the facility.

Case Study 4: Alameda Corridor

Type: Urban Corridor

The Project¹⁸

The Alameda Corridor connects on-dock and terminal rail facilities at the San Pedro Bay¹⁹ ports to terminals and the continental rail network at downtown Los Angeles, California.

¹⁸The material presented here is based on a case study prepared for NCHRP 8-39, publications by Alameda Corridor East, and on presentations made by and conversations conducted with a representative of the Alameda Corridor Transportation Authority. Nevertheless, opinions expressed herein are those of the author.

¹⁹Composed of the Ports of Long Beach and Los Angeles.

It is an intra-urban corridor consisting of 20 miles of public, multi-track rail line, half of it grade separated in a sub-street trench, and controlled with centralized traffic management technology. It consolidates and governs access to the country's top international container port by its two serving Class I railroads and, as such, is a nationally important infrastructure. The corridor accommodates container traffic growth for an expected 20 years, with capacity for 100 trains per day at speeds of 40 mph, in an urban environment. (See Figure 3-5.)



(a) Aerial View



(b) Construction

Figure 3-5(a, b). Alameda Corridor.

The \$2.4 billion project opened in April of 2002, after 20 years of development and 3 years of construction and is one of the largest public rail infrastructure initiatives in the United States. A planned second phase would improve connections between the space-constrained downtown operations and the huge goods distribution complex and available land in the so-called Inland Empire, at the rim of the metropolitan region. If finished, the second stage would produce a complete trans-urban rail corridor with a 55-mile span.

The project brings about various benefits through two primary measures:

- **Route Consolidation**—The Alameda Corridor Transportation Authority acquired and rationalized the network of rail lines serving the San Pedro Bay ports, consolidating all traffic to one route.²⁰
- **Right-of-Way Improvements**—Reconstruction of the consolidated route featured multi-tracking, grade separation, upgraded track material, and traffic control systems.

Relevance

The Alameda Corridor is a large-scale city project that supplies access capacity and reinforces the competitiveness of a major seaport. In so doing, it restructured portions of the metropolitan rail network and improved operations across it. Roadway congestion relief was not the chief impetus for the project, but congestion benefits certainly were claimed in the case for implementation and in the assembly of financing:

- Two hundred grade crossings were eliminated by rebuilding the right of way and by redirection of traffic to a consolidated route. This was estimated to remove 15,000 daily hours of vehicle delay from Los Angeles roads.
- The street parallel to the rail corridor was widened and improved as part of the right-of-way reconstruction, leading to better traffic flow.
- The corridor is expected to prevent a large portion of the rapid, sustained growth in port container traffic from generating new truck trips, on highways that already bear up to 28,000 trucks per day. By the year 2020, the access highways are projected to carry 60,000 trucks, and the corridor to handle another 30,000 that would otherwise have gone by road.
 - International containers serving Los Angeles regional consumption, production, and consolidation travel by

²⁰This kind of rationalization is one of the effects railroads seek when they merge their networks.

truck. Containers proceeding further inland by train can be railed directly from the ports or from an adjacent terminal or drayed over the road to more distant railheads. It is growth in the latter, drayage category that the corridor is projected to mitigate, by substituting direct rail from the port locations. However, no claims were made that current dray volumes would be diverted (and at least one local dray operator believes there is no risk of that occurring, mainly for reasons of service and operating effectiveness).²¹

- Approximately \$90 million, or a bit less than 4 percent of total project financing came from grants for reduction of congestion. Part of this money was a State of California Flexible Congestion Relief Grant, but the great majority was sales tax revenue from the Los Angeles County MTA, authorized by local voters for freight rail service in relief of rising traffic congestion.

The viability of a short-distance, high-volume urban rail project for congestion mitigation is of great interest to public planners, because rail typically is most effective at much longer lengths of haul and because most truck trips are relatively short. In the dry van markets for which rail intermodal services (like the Alameda Corridor) normally compete, one-third of the truck volume is below 100 miles, and railroad market share is not significant below 500 miles.²² If rail could penetrate local markets, its effect on congestion might be material.

The difficulty is that the Alameda Corridor is not really competing in a local market. The rail traffic is continuing to inland destinations largely east of the Rockies, and although the corridor itself is a short-distance trip, its appeal is as a *connecting* service. The competitiveness of schedules and costs exists within the context of long-haul lanes and the traditional strengths of railroading. The Alameda Corridor is not contending for Los Angeles metro area traffic, and it is not thought to be diverting current dray volumes. In addition, it enjoys the advantage of economies of density that are relatively rare in the national marketplace: an enormous, regular baseload of stackable containers going from a single origin to concentrated destinations. The unit of production in railroading is the train, and its efficiency is multiplied when cargo can be stacked; the San Pedro Bay ports routinely generate full trainload stack volumes almost by the score. There are few places like it.

Even so, the corridor underscores the importance of density in making rail operations successful, and the second phase of its program creates intriguing possibilities.

²¹From a field interview conducted for the National I-10 Freight Corridor Feasibility project.

²²From Global Insight's TRANSEARCH freight traffic database.

Alameda Corridor East extends the original structure 35 miles inland to Ontario, CA, through a series of rail crossing, signaling, and road improvement projects, some of which are now under way. Capital requirements approach one billion dollars through 2007. About one-half of this money is committed,²³ with most coming from Los Angeles County and State of California congestion relief funds. The claimed benefits focus on grade separation and attendant gains in road traffic mobility and safety, train speeds, air quality, and direct and indirect employment. Nevertheless, the completed corridor will offer a trans-urban freight bridge through Los Angeles congestion. A rising quantity of container volumes, consisting both of foreign goods that are stripped and consolidated with domestic products for shipping onward, and of imports destined locally to Los Angeles, move from the ports to Inland Empire distribution facilities, around Ontario. The Alameda Corridor makes no assertion that it will capture any of this traffic for rail. Still, it is a worthwhile speculation²⁴ whether some local containers will choose to ride atop the normal railroad baseload to avoid the highway congestion and whether rail operators—already possessing frequent train service and obligated to add terminal capacity that is apt to be near Ontario—will see this as an opportunity.²⁵

Motivation

The Alameda Corridor is a port access and grade separation project. It was not motivated by congestion relief, but it provides relief and employed that point in organizing community and financial support. Its chief objectives were as follows:

- Raise Access Capacity and Maintain Port Competitiveness—The economic and logistical performance of the San Pedro Bay ports is dependent on throughput and market access, both of which require adequate landside outlets. The ports' competitiveness substantially has stemmed from the size of the indigenous Los Angeles market and the

²³As of March 2003.

²⁴At least one Los Angeles area distributor makes this point in an article from *The Journal of Commerce*, Volume 4, Issue 16, 4/21-27, 2003, page 17, "Wide Open Spaces."

²⁵The Alameda East projects affect Union Pacific right of way and are organized under a joint powers authority independent of the Alameda Corridor Transportation Authority. A separate set of proposed and partially funded projects affect BNSF right of way, also from the downtown end of the Alameda Corridor eastward to the Inland Empire. These projects feature triple-tracking and grade separations and include a 5-mile trench structure; sponsors of different sections are the Metrolink commuter service, CalTrans, and yet another joint powers authority with the acronym OnTrac. (Source: NCI Weekly Newsletter, 7/7/03, and conversations with local agencies.)

qualities of the available inland service. With import container traffic growing at a 12-percent compound annual rate, capacity is a persistent, pressing, and strategic challenge that must be met at the piers and at the outlets. The Alameda Corridor is a response for each, because it facilitates on-dock rail loading and penetrates from the docks to the key inland staging yards.

- **Improve Road Safety and Reduce Delays**—The corridor grade crossing program is aimed at safety through lower accident risk and wider latitude for incident management on the roads and rails. Elimination of crossings means reduction in crossing delays and backups for traffic traveling the streets and tracks and for emergency vehicles that may be part of that traffic. This is accomplished by (1) funneling rail volumes to one corridor and away from alternate routes and their crossing points and (2) radical grade separation of the single remaining route. Route consolidation limits the scope of disruption while the project is under construction, affecting the displacement of people and businesses in addition to traffic.
- **Improve Train Operations**—Train speeds are doubled because of new and multiple tracks in a separated right of way. Reaching 30 to 40 mph and assisted by centralized traffic control, locomotive operating hours drop by 30 percent and the incidence of train passing delays drops by 75 percent.
- **Diminish Environmental Impacts**—Environmental benefits from the project are of two sorts. The first is air quality improvement from fewer idling emissions, which is a direct result of better train operations and traffic delay reduction. Emissions by rail were projected to fall 28 percent, and by autos and trucks up to 54 percent. Second is improvement in neighborhood noise and vibration, which is produced by better track material, sub-grade right of way, sound walls, and consolidation of traffic to a more industrial route. Both kinds of benefits make living with freight easier for residents—as do the changes to road safety and delay and the separated route itself.
- **Promote Economic Development**—The project created 10,000 short-term construction jobs and aids the productivity of the region through its congestion benefits. However, its key economic influence is accommodation of growth in foreign trade and improvement to its logistics. This has local and national dimensions, because of the value of the ports to the Los Angeles economy and the value of international trade to U.S. business. Approximately 70 percent of total project financing is to be reimbursed from user fees. These are paid by freight carriers and presumably reimbursed by their customers, making the shippers and receivers of freight the ultimate financiers and beneficiaries of the corridor.

Lessons and Outcomes

One year after opening, the Alameda Corridor was meeting its objectives. Through its performance and its implementation, it was producing outcomes of interest to this report.

Performance

The corridor was carrying 33 trains per day after 1 year,²⁶ most of them stack trains laden with 200 or more containers. Operations were attaining the 40-mph design speed and were performing 98 percent on schedule. With much faster transit and marked reliability improvements, railroads transferred 100 percent of their traffic to the new facility and kept it there from the inauguration of service.

Successful performance meant there were a number of de facto outcomes whose achievement could be taken as presumptive, although they had not necessarily been measured. Grade crossing delays will have been eliminated and road congestion therefore reduced. Rail and road emissions will have declined, and the opportunity for accidents decreased. The Burlington Northern Santa Fe reportedly stated that it would have failed to meet its commitments to customers for on-dock rail service were it not for the corridor. This statement implied that growth in street drayage had been moderated, and the throughput and competitiveness of the ports improved. Finally, as the corridor was operating at one-third of its capacity, the ports' continuing growth had been accommodated and its position as a rail-ready load center protected for a number of years ahead.

Implementation

Part of the importance of the Alameda Corridor is that it was funded and implemented despite the ambitiousness of its scale. Several of the factors that brought this about may be instructive for other rail projects:

- The \$1.6 billion in bonds and loans was expected to be repaid by user fees, but the funds were not guaranteed by the port, the railroads, or any government. Instead, the Authority achieved a kind of monopoly control by acquiring all of the rail access routes to one of the largest rail traffic generating facilities in the country, and by assessing the user fee per container, regardless of the mode by which the container actually leaves the ports. The second measure not only guarantees the fee so long as the port is active, it reduces any financial incentive a railroad might have to dray containers to an inland terminal. In combination, the two measures

²⁶By the beginning of its 4th year, train volume had reached 50 per day.

ensure that any port container that moves by rail will use the corridor and, therefore, in a pragmatic sense, these measures guarantee the benefits as well as the loans.

- Railroad cooperation in the project was bought. The railroads reportedly were not supportive of the corridor in its early stages and were brought on board by the purchase of their right of way. They contributed to the project's design specifications, but did not make capital investments and, in fact, received cash. That said, the railroads are directly responsible for payment of the use charges that will retire the corridor's debt, and they jointly agreed to the public sale of a strategic portion of their networks. Because the circumstances of rail cooperation are a sensitive part of the lessons to be taken from this project, two additional points should be made:
 - The nearly two-decade gestation period of the Alameda Corridor ran from the years just after rail deregulation, when freedom from government control was a hard-won gain, through a time when private capital was relatively accessible for railways and capacity underutilized, to the more constrained situation of the new century. Railroad needs, their managements, and their perceptions and attitudes toward public projects and financing evolved during this time, if not uniformly. A proposal of the type contained in the Alameda Corridor would not necessarily meet the same railroad reception today, although the corridor's method of winning rail cooperation is often effective in human affairs.
 - There were three railways originally affected by the corridor. One of them—the Southern Pacific, which owned the key piece of infrastructure—was later purchased by another. However, during a large part of the development phase of the Alameda Corridor, the Southern Pacific was independent and in poor financial health and its principal owner can be speculated to have had as much interest in its real estate as in its operations. Although this may not be a unique set of motivations for railroad management, it is not a typical one, and it caused a special stress to be placed on the cash payment.
- Community support was founded on frustration with daily delays at grade crossings and the recognition that they would grow. Through its use of a trench, the project separated and segregated freight traffic without imposing major adverse impacts on the surrounding neighborhoods. Aiding community acceptance were the absence of substantial changes to land use patterns and a right of way that ran mainly through industrial zones. Finally, a range of steps was taken to beautify the nexus of the corridor with residential areas, some of which were economically depressed. The recognition that grade separation can produce freight segregation in particular is useful for planners, because it

simultaneously treats concerns for mobility, safety, and community impacts.

- The national value of the corridor, in U.S. foreign trade and in supply chains reaching across the country, provided justification for the federal loan, which contributed 16 percent of total program capital. In addition, the dual character of the corridor as a private rail and public highway-grade separation project meant that almost one-half of the bonds or 21 percent of total funds earned tax-exempt status from the Internal Revenue Service. The Alameda Corridor is prominent but not alone in its strategic importance to the national freight network, and many rail initiatives that alleviate congestion will also separate road grades. Consequently, portions of the case that substantiated this project's financing are transferable to other projects of comparable or non-comparable magnitude.
- Establishment of the Alameda Corridor Transportation Authority was an effective institutional step that gave the proponents of a complex, long-maturing plan the stamina, resources, focus, and power to reach and conclude construction. Even for projects that will not warrant a stand-alone organization, the Authority demonstrates the utility of sustained and dedicated management in some form, to drive a program forward to completion.

By making freight activity easier to live with, exploiting its local and non-local significance, and tightly controlling economic incentives, the Alameda Corridor was able to mitigate roadway congestion, raise the capacity of the freight network, and encourage the growth of trade.

Case Study 5: Sheffield Flyover, Kansas City, Missouri

Type: Urban Corridor

The Project²⁷

The Sheffield Flyover increased the capacity and improved the performance of a major bottleneck in the rail network in and around Kansas City. At-grade crossing of high-density rail routes had not only led to train backups, but also caused extensive delays to highway traffic when trains blocked local streets. An innovative public-private partnership helped secure funding for and ensure the successful implementation of the flyover. (See Figure 3-6.) This project demonstrates

²⁷The project was highlighted in an FHWA conference on "Financing Freight Transportation Improvements" (Transystems Corporation, 2001). The presentation to that conference provides many details concerning the project, including the steps taken to coordinate public and private efforts as well a description of the physical improvements to the system.



Figure 3-6. Sheffield Flyover.

how public agencies can work with the rail industry to expand capacity and improve the performance of the local transportation system, with benefits to the region and the nation as well. Because of the success of the Sheffield Flyover, the railroads and public agencies decided to build a second major flyover in Kansas City in order to secure similar benefits.

The project is a large-scale urban corridor initiative. It addressed a key bottleneck in the system where the Burlington Northern Santa Fe (BNSF) main line crossed the Union Pacific (UP) and Kansas City Southern (KCS) main lines. With 100 to 120 trains operating on the BNSF, 60 to 80 on the UP and KCS, and another 40 to 60 local trains operating in the area, this was described as the “third busiest railroad intersection in the country.” Trains were inevitably delayed as dispatchers worked to route them through the interlockings; the delayed trains blocked intersections for a mile or more. The resulting delays were especially difficult for trucks seeking to enter or exit a major industrial area hemmed in between the main lines.

By constructing a flyover, it was possible to eliminate rail and highway delays associated with train interference at the crossovers. The project began operation in 2000 and covered nearly 3 route-miles almost entirely constructed on the Kansas City Terminal Railroad’s right-of-way; it included a main bridge of 6,740 feet and two other bridges of 890 and 150 feet. By double-tracking the flyover and keeping the existing tracks, it was possible to greatly increase the capacity of the intersection, improving flow of through trains, and allowing better service to local rail customers. From the public’s perspective, the most visible benefit was expected to be a reduction in delays at grade crossings. Transsystems²⁸ estimated that 530 vehicle-hours would be saved daily for cars and trucks by elimination of grade crossings, based on the train volume, the average time that each train blocked a crossing, and the 4,500

daily highway vehicle movements through the area. At \$14/hour, this was estimated to amount to a savings of \$1.85 million annually. In addition, with fewer trains and vehicles delayed in the area, emissions were expected to be sharply reduced.

Transsystems did not provide details on the railway benefits, but indicated they would be approximately three times as great as the public benefits. This is borne out by a quick assessment of the benefits from reduced train delay. If 150 to 180 trains per day each saved 20 minutes in moving through this region (as estimated by Transsystems), that would be a savings of more than 60 hours of train delay per day or 20,000 per year. The cost per train-hour is commonly estimated to be on the order of \$250 per hour based on the hourly cost of equipment ownership plus the opportunity cost associated with the loads themselves. Hence, the delay cost of an average 20-minute delay to these trains would exceed \$5 million per year.

The project cost was \$75 million. Raising the capital was a stumbling block for the railroads, even though they were willing to pay for the project on a continuing basis. Another problem was that construction would increase the assessed value of the property and, therefore, the property tax owed by the railroads. Various public agencies were interested in providing financial support, but there were barriers to using public funds. At one point, it appeared that an FHWA Section 129 loan would be approved to finance 25 percent of the project, based on the public’s share of the project benefits. This loan possibility fell through when trucking interests objected to the use of highway trust money for rail projects. State agencies were interested, but were prohibited from investing in a private-sector project.

The financing problem was resolved by creating a “Transportation Corporation,” a quasi-governmental entity that can be created under Missouri law that can receive highway funds. A “T-CORP” can issue 20-year, state tax-exempt bonds to fund transport projects, and it receives ad valorem tax abatements. A T-CORP is represented jointly by the project owner and the Missouri Highway Department; the T-CORP owns the land and the project until the loans are paid off, at which point the land goes back to the previous owners. The net result for the Sheffield Flyover was that the T-CORP issued the bonds, the US DOT provided a letter of credit, and the railroads agreed to repay the loans. In addition to benefiting from low interest rates, the corporation enjoyed a property tax abatement worth \$1.4 million per year (estimated by Transsystems as being nearly 20 percent of the annual amortization costs).

The project required a few other elements of cooperation. The project was supported by the Heartland Freight Coalition and the Greater Kansas City Chamber of Commerce, as well as Missouri DOT, FHWA, and the railroads. Some public land was needed for the flyover, and a land swap was arranged

²⁸Transsystems is the engineering firm that coordinated the project.

with the City. While the project was under way, work was done to modernize or coordinate 14 different utilities serving this industrial area. Also, a portion of one of the city streets had to be reconstructed and temporarily closed to enable completion of the flyover.

Relevance and Motivation

The Sheffield Flyover enlarged capacity and improved operating performance in a top national rail center, reducing interference with urban road traffic and raising the competitiveness of rail with highway services in the regional and cross-country markets. It affected roadway congestion in each of these dimensions, and it protected the highways from additional demand by helping to prevent depletion of the rail traffic base.

Kansas City is the second-largest rail freight hub in the country after Chicago. Despite the marked reduction in the number of rail systems in recent decades, Kansas City remains a complex railroad operating environment. It is served by four Class I railroads (i.e., BNSF, UP, NS, and KCS), while the KCS-owned Gateway Western provides a route that reaches CSXT in St. Louis. The Kansas City Terminal Railroad supplies local switching services (actually performed by the Gateway Western), and various short-line and switching railroads serve the area. The metropolitan area has an intricate network of classification yards, industrial support yards, and through tracks. A major problem in the region is that major rail routes intersect in Kansas City, resulting in extensive delays to both trains and highway vehicles.

The Mid-America Regional Council (MARC) (the local MPO) has documented the importance of rail to the region (MARC, 2002). Rail handles just over one-half of the freight tonnage moving through Kansas City. Over 80 percent of the rail freight is passing through the area, and this traffic amounted to 150 million tons in 2000. Much of this traffic is intermodal. The BNSF's route from Los Angeles to Chicago, which handles 1.6 million containers and trailers annually, goes right through Kansas City. Another 23 million rail tons was received by Kansas City industries, while about 11 million tons were shipped out by Kansas City shippers. Rail's market share varies greatly with the type of movement. Rail accounted for approximately two-thirds of the freight moving into or through the region; truck accounted for all of the intra-regional freight and more than three-quarters of the outbound freight. The rail share versus truck is growing for through traffic, stable for traffic inbound to the region, and declining for outbound traffic.

During the 1990s, it became increasingly evident that various national trends in rail freight traffic were disrupting both rail and highway traffic in the city. System rationalization was concentrating more traffic on fewer routes, leading to congestion and interference within the rail network, as well as increasing delays to highway traffic. Trains waiting for

authorization to move through an interlocking often blocked grade crossings, frequently for 20 minutes or longer. Mergers, traffic growth, and shifts in freight traffic patterns required greater capacity along key rail routes within the city, but the bottlenecks where key routes intersected threatened to limit growth of rail traffic.

The project, therefore, was seen to have both local and national significance. Grade crossings and local air quality were the obvious benefits for the local area. However, the movement of 1.6 million trailers and containers by train rather than by highway was recognized as much more than a local benefit, given that these shipments might otherwise be moving on the highways—not just through Kansas City, but also through many other cities throughout the country. Expanding the capacity of such an important rail hub was also of major significance for the national rail system. The 150 million tons of freight moving through the rail hub represented at least 7 million truck shipments, including the intermodal trailers and containers mentioned already. This is a good illustration of a network-level investment, whose broad system effects on railroad performance help retain rail traffic while ultimately diverting truck traffic from the roadways.

Lessons and Outcomes

The solution that was adopted involved construction of a rail flyover that separated major flows, expanded capacity of the through routes, improved highway access to existing industrial areas, and reduced congestion related to grade crossings. To implement the project, a mechanism was worked out to use public involvement to

- Obtain a lower interest rate than the railroads could receive on their own,
- Reduce property taxes,
- Enable related improvements to local streets and utilities, and
- Attend to details that might otherwise have stopped the project.

This project is an excellent example of a public-private partnership that reduces highway congestion through rail investments that expand capacity and improve performance. It is worth emphasizing that the Sheffield Flyover addressed critical infrastructure needs for the national, main line rail network; the benefits were large enough to support substantial investment because of the high volumes of freight already moving over these rail lines. The project demonstrates how public investment can contribute to what might be called the “top of the network,” not just to the light-density lines whose preservation has often been an important concern for state and local governments.

Performance

The Sheffield Flyover achieved its goals. Following the opening of the new facility in 2000, travel times for trains dropped from 40 to about 15 minutes (Cookson, 11/05/01). This is a clear improvement in train efficiency that translates directly into the hoped-for reduction in grade crossing delays and air quality. The institutional structure also worked well enough to be expanded. In February, 2002, BNSF announced that a second major flyover would be constructed to provide grade separation at the intersection of two of their main routes and improve access to Argentine Yard, their major freight facility in the region (BNSF, 2/15/02). The “Argentine Flyover,” which would cost about \$60 million, was initiated using the same institutional arrangements as the Sheffield Flyover.

The project has received broad recognition as an outstanding example of public-private cooperation. The Intermodal Advisory Task Force of the Chicago Area Transportation Study identified this project as one of the few best examples of “holistic” planning “involving major transportation industries, the political decision-makers, plus the industries (shippers and receivers, essentially) that stood to benefit” (Rawlings, 05/08/02). Rawlings noted the key roles played by the Chamber of Commerce and the Mid-America Regional Council, who funded preliminary freight studies and were able to focus interest on and achieve a consensus for the flyover and a few other critical projects.

Implementation

In this case, the train volumes were so high and the benefits so large that it was easy for local parties to agree that the benefits justified the costs of the project. At intersections of busy rail lines, trains back up and clearly block the local highway network. These local costs were easily identifiable and large enough to justify public participation, even though the national significance of the project is what motivated FHWA’s interest. The benefits were equally clear to the railroads, as were the costs to operations if action were not taken. This project provides various lessons for promoting public-private partnerships that seek to enhance the role of rail freight in reducing highway congestion:

- The involvement and support of the local freight interests is essential.
- The willingness of the various railroads to work together and to negotiate ways to share the costs is essential.
- Federal, state, and local cooperation can provide innovative financing mechanisms and enable a complex project to be completed quickly.

- Environmental benefits may provide part of the story in support of the project, but the financing may need to be based on a clear understanding that the system improvements—for both highway and railway—translate directly into enough cost savings to justify the project.
- The national scope of the project may add to the story and motivate federal involvement, but it may not directly affect the local assessment of the project. In other locations, where the local effects are not so evident, it may be necessary to make a stronger case for the indirect and national benefits in order to secure local support and a broader base of funding.
- Once a coalition is formed to identify, finance, and implement projects that fulfill clear needs, then that coalition can quickly move on to additional projects.

Case Study 6: Vancouver Gateway Transportation System

Type: Metropolitan Citywide

The Projects²⁹

The Major Commercial Transportation System (MCTS) for the Vancouver region of British Columbia is a system of key transportation facilities and routes that connect the region to external gateways, as well as provide connectivity to the major commercial activity centers.

Vancouver is recognized as the major western gateway to Canada, as well as a supporting international gateway for the northwestern United States. The facilities serving international travel and goods movement include several marine ports, Vancouver International Airport, rail yards for three railroads, and four major international border (rail and highway) crossing facilities.

From 2000 to 2003, the MCTS planning process identified a set of surface transportation projects designed to support a balanced flow of rail and truck movements. They were intended to minimize local traffic congestion, while maximizing the economic health of the region’s international gateway function—which is the flow of cargo via marine port, airport, and international border crossings. The “Current and Planned Infrastructure List” made the case for 17 major new investments, comprising highway upgrades, rail links, river crossings, new rapid transit lines, and an additional harbor crossing. These projects are listed in Table 3-2. Preliminary studies put the cost at \$6.2 to \$6.9 billion.

The Greater Vancouver Gateway Council is an organization of senior executives from industry and government who

²⁹The material presented here is taken from project papers. The author of this case study was a participant in the study.

Table 3-2. Vancouver major commercial transportation system projects.**(A) Freight Rail Projects**

Rail Project	Description of Project (motivation is noted in parentheses)	Trains/Day
New Westminster Rail Bridge	Replacement of the existing 100-year-old rail bridge with two-track tunnel. Tunnel preferred because this will avoid conflict with marine traffic. (Capacity of existing bridge causes significant delays, which will worsen in the future.)	46
Pitt River Rail Bridge	Short-term upgrade and long-term replacement of existing two-track bridge. New bridge to have more efficient swing bridge mechanism (Current swing bridge causes additional marine traffic delays and CP Rail crossing delays.)	45
Roberts Bank - 41B Grade Separation	Construct an overpass at 41B Avenue in Delta to provide separation between the rail line to Roberts Bank. (To permit unrestricted switching of trains and to permit longer trains at Roberts Bank. Increases operational efficiency.)	22
Mud Bay Area West Leg of the Wye	Construct a connection between the BNSF line and the BC Rail Line to Roberts Bank to permit the movement of south to west/east to north. (Relieve congestion on Roberts Bank route—shorter route for southbound trains.)	13
BN New Yard to Spruce St. Double Track	Provide two tracks between the New Westminster Rail Bridge and the BN yard. (To provide support for new Fraser River rail crossing because approach track has limited capacity.)	46
Siding Colebrook North & South	Construct new siding on the BNSF line north of east west BC Rail line. (Increases capacity on BNSF line from U.S. Border to NWRB, necessary for proposed increase in Amtrak usage)	12
Siding & Grade Sep- Colebrook East & West	Extend siding on the BC Rail line east of the north section of BNSF line. (Increases capacity on Roberts Bank route. New siding on BC Rail line west of the north section of the BNSF line.)	22

(continued)

subscribe to a common vision that Greater Vancouver become the Gateway of Choice for North America. The Council includes the gateway facility operators (i.e., airport and seaports) and freight transportation companies (i.e., airlines, railroads and trucking companies), with the BC Minister of Transport serving as the honorary chair. The MCTS and planned transportation infrastructure improvement projects were identified by members of the Greater Vancouver Gateway Council, working jointly with the Greater Vancouver Transportation Authority (“TransLink”) and BC Ministry of Transportation, to address many of these congestion issues on the road (and, by implication, transit) and rail networks.

The specific needs addressed by proposed road and transit infrastructure projects were to

- Relieve congestion on the major highway and arterial routes within the region, either by increasing capacity or by diverting automobile drivers to transit;
- Provide a bypass or give priority to commercial vehicles on congested routes; and
- Provide more direct connections to major gateways and commercial activity centers.

The needs addressed by proposed rail infrastructure projects were to

- Provide capacity to the rail network, either through additional tracks or sidings; and
- Reduce conflicts between rail and road-based traffic.

However, underlying those specific needs were several broader objectives for the MCTS, which were to

- Provide a continuous network for efficient commercial vehicle operations;
- Use multi-modal solutions (i.e., road, rail, and water courses) to alleviate traffic congestion;
- Accommodate future growth in (local and international) goods and passenger movements;
- Enable 24-hour unrestricted commercial vehicle and rail traffic use;
- Provide rail movements free of road intersection constraints;
- Enhance connectivity to north-south and east-west trade corridors; and
- Provide for cost-effective solutions to specific bottlenecks.

Although the MCTS focused largely on goods movement, it also recognized that efforts to improve goods movement would help improve passenger movement. The improved movement of passengers (as well as freight) by rail within the urban area of Greater Vancouver would also improve local conditions on the road network by diverting commuters from their automobiles. Accordingly, the MCTS project list was coordinated with plans to address the commuting needs of workers. In addition, the MCTS planning effort considered how traditional regional and provincial transportation investment assessment tended to give short shrift to freight and goods movement. By adding consideration of the importance

Table 3-2. (Continued).

(B) Highway and Transit Projects

Highway & Transit Project	Description of Project (motivation is noted in parentheses)
Highway 1 - Vancouver to Langley	Additional capacity on Highway 1 from Grandview Highway to 200th Street. Includes twinning of the Port Mann Bridge, upgrades to the various interchanges, and extension of the HOV lanes to 200th Street. (To address capacity constraints resulting in significant congestion and delays.)
South Fraser Perimeter Road, from Hwy 1 to Hwy 91	New connection between Hwy 1 at 176th Street and Hwy 91 at River Road, with extension to Hwy 99 and E. Ladner Bypass. (To provide improved connectivity between major corridors and commercial activity centers. The existing route between Highway 1 and Highway 91 as well as Highway 99 is circuitous and limited in terms of capacity.)
Fraser River Crossing	New river crossing between Maple Ridge/Pitt Meadows and Surrey/Langley. Connection at approximately 200 th Street. (This new connection provides a much-needed access improvement for the unmet demand between the communities of Pitt Meadows/Maple Ridge and Surrey/Langley.)
Rapid Transit - Richmond to Airport	New rapid transit line from Richmond and Vancouver International Airport to downtown Vancouver via Cambie Street corridor. (This corridor has high transit demand that can be expanded with the improvement of service.)
North Fraser Perimeter Road	Improvements and additions to existing road corridors between the Mary Hill Bypass and Queensborough Bridge, including segments of United Blvd, Brunette Ave., Columbia St., Front St., and Stewardson Way. (Upgrades to major goods movement route to provide needed efficiencies via reduced congestion.)
New Westminster Rail Bridge (with road tunnel)	Road tunnel to parallel proposed rail tunnel under portions of New Westminster and Fraser River, connecting McBride Boulevard and South Fraser Perimeter Road. (Combined with the rail tunnel, this road corridor will provide improved capacity across Fraser River as compared with Patullo Bridge, which experiences significant congestion.)
Massey Tunnel (Hwy 99)	Improvements to Hwy 99 corridor at the river crossing, including two new lanes under river, extension of HOV lanes from King George Hwy to Westminster Hwy. (This river crossing experiences significant congestion in both directions because the counter-flow system only partially addresses the demand in the peak direction.)
Oak Street Bridge (Hwy 99)	Widening of the Oak Street Bridge from four lanes to six. Two additional lanes to be designated as HOV lanes. This project will tie into the improvements on Hwy 99 associated with the Massey Tunnel. (The bridge experiences significant congestion in the AM peak period which can be mitigated with the inclusion of an HOV lane that gives priority to carpools to bypass the congested area.)
Hwy 15 – Hwy 1 to U.S. Border	Improvements to the Hwy 15 corridor between Hwy 1 and the U.S. Border, including increasing capacity from two to four lanes. (Current two-lanes and signalized intersections limit mobility along this route. Additional capacity is required to relieve congestion.)
Hwy 10 – Hwy 17 to Hwy 1	Improvements to the Hwy 10 corridor between Hwy 1 and Hwy 17. Improvements consist primarily of increasing capacity in the two-lane sections to four lanes. (The two-lane cross section and various signalized intersections limit mobility along this route. Additional capacity is required to relieve congestion.)
Access to Pacific Border Crossing – Hwy 99	Widening of 8th Avenue between Hwy 99 and Hwy 15 along with interchange improvements at Hwy 99. (Access to the truck crossing at Hwy 15 is limited, and as such needs to be upgraded to protect the level of service.)

and function of international gateways and their economic function, the MCTS planning effort was seen as providing a broader perspective to the multiple objectives in evaluation tools such as the Province's Multiple Account Evaluation for rating proposed transportation projects.

Motivation

The primary motivation for the MCTS and its planning initiatives was concern about threats to the economic position of the Greater Vancouver Region as an international

gateway and conduit for goods movement. At the outset, the British Columbia Ministry of Transportation and the Canadian Federal Department of Western Economic Diversification became actively involved in funding MCTS needs and planning efforts because they saw major economic threats and opportunities associated with the failure or success of the Vancouver region in addressing surface transportation congestion and capacity for growth of ports and border crossings.

The Greater Vancouver Gateway Council and its reports noted that the current transportation system, in all its

modes, was showing signs of neglect and lack of investment as congestion continued at unprecedented levels. They concluded that investment in the Greater Vancouver Region's transportation network was urgently required to reverse the past trends and to provide a transportation system that supported the nationally important gateways in the region. Many members of the Gateway Council feared that if the current trends continued, the transportation system in the region would erode to a point that the Greater Vancouver Gateway lost its competitive edge along the west coast of North America. This would adversely affect the regional economy, with effects across the Western Canadian economy (to say nothing of the effect on everyday travel conditions in the region).

The economic basis of the rationale was key. The Federal Department of Western Economic Diversification funded the Greater Vancouver Gateway Council to conduct a study of the implications of the MCTS and its proposed improvements for the economic development of four Canadian provinces. The study³⁰ showed that Vancouver's international gateway function had broad economic importance that would be threatened, if capacity constraints and congestion within the region's surface transportation system undermined the ability of the region to serve international freight movements competitively in the future.

Performance

Although the MCTS projects were not yet built at the time of this writing, they had been evaluated through baseline forecasts of freight flows in the province. Growth rates for long-distance freight movements in British Columbia were expected to vary significantly across modes, with long-distance truck cargo growing slower and air cargo growing most rapidly. However, rail and maritime shipments also included truck deliveries at origin and destinations. As a result, total trucking within Greater Vancouver was expected to grow more than 50 percent over the 2001–2021 period. It was estimated that, by 2021, almost 75 million metric tons of product would be transported by truck within the province annually. Rail tonnage was also expected to grow steadily during the period, with a cumulative increase of 60 percent. By 2021, almost 300 million tons of freight were expected to move by rail through British Columbia, mostly in the Vancouver region.

As demonstrated in the GVGC consultants' reports, these forecasts reflected expected future changes in domestic and international economies and trade patterns that would

³⁰The economic study was prepared by DelCan and Economic Research Development Group.

increase pressure on the Greater Vancouver regions' transportation system. Key findings from the transport forecasting and economic impact study were as follows:

- **Economic Performance**—The BC and Western Provincial economies depended significantly on international exports and hence the movement of goods and services to international gateway facilities. Because of its position astride the route to East Asia, Vancouver and its transportation facilities served a critical role in supporting the economies of this large region. The future economic performance of BC and other western provinces would depend on maintaining and improving the performance of the Vancouver region's MCTS.
- **Commercial Growth**—Forecasts for continued population and economic growth in the Greater Vancouver area would lead to increasing pressure on the region's ground transportation system. The growth of road and rail traffic was expected to be particularly strong for commercial movements, which serve freight cargo moving to and from airport, marine port, and international border crossing facilities. As a result, future congestion delays and future capacity constraints would hit commercial traffic particularly hard.
- **Capacity Repercussions**—Projections of future road and rail demand indicated that this demand would surpass the current capacity of significant elements of the current transportation system. As a result, severe effects on future travel times and travel costs were expected unless there was a significant investment made to upgrade and expand many aspects of the region's transportation facilities. The magnitude of these travel impacts represented very large dollar values.
- **Risk**—The stakes for the future of British Columbia's economy, as well as that of other western provinces (that depend on Vancouver's ports as a gateway to Asia), were high. Without investments made to upgrade the performance and capacity of the region's transportation facilities and services, there could be significant losses of business activity as travel times and costs for commercial shipping were increased. To maintain the economy of BC and other western provinces, there would, therefore, need to be careful attention to making investments necessary so that costs of doing business in this area did not become prohibitive.

Implementation

The initiative to formally designate a Major Commercial Transportation System was initiated by the Greater Vancouver Gateway Council (GVGC) in 2000, following a series of studies in the late 1990s that showed the strong economic

importance of the region's gateway transportation facilities. Over the 2001–2003 period, the Greater Vancouver Transportation Authority (“TransLink”) developed its 3-year short-term plan and worked to solidify its long-range investment plan by working closely with the GVGC to affirm and prioritize a list of major infrastructure projects. These lists were coordinated so that the regional list of high-priority projects would be consistent with ongoing work on the MCTS being led by the GVGC. Additional consultations were held with local municipalities, the province and federal agencies, and stakeholders such as the Board of Trade. In 2001, the Greater Vancouver Board of Trade sponsored a public policy forum on “Regional Transportation: Gridlock or What?,” featuring a discussion of the Major Commercial Transportation System and its maps of current infrastructure and planned infrastructure requirements.

In 2002–2003, the Canadian Federal Department of Western Economic Diversification and the BC Ministry of Transport provided support for a study documenting the costs and economic benefits of the recommended infrastructure plan. The study also examined the economic development implications of alternative scenarios for either investing in the MCTS or maintaining the status quo. This study affirmed that some but not all of the recommended projects passed a traditional user benefit-cost analysis (that effectively valued goods movement based on driver and vehicle operating costs). However, it was also found that the overall package of projects provided even greater economic development benefits when additional issues such as the value and timeliness of goods being transported, and the competitiveness of international ports were also considered.

As of 2003, regional, provincial, and federal agencies were discussing options for funding the 17 major projects. It was expected that the proposed projects would be funded over time through a combination of federal and provincial public funding, as well as public-private partnerships for rail-related facilities and tolling to pay the costs of planned bridges and tunnels.

Case Study 7: Freight Rail Futures for the City of Chicago

Type: Metropolitan Citywide

The Project³¹

Chicago's stature as the nation's rail freight hub has immersed that city in the issues of multi-modal policy development. The region's vast network of terminals and track

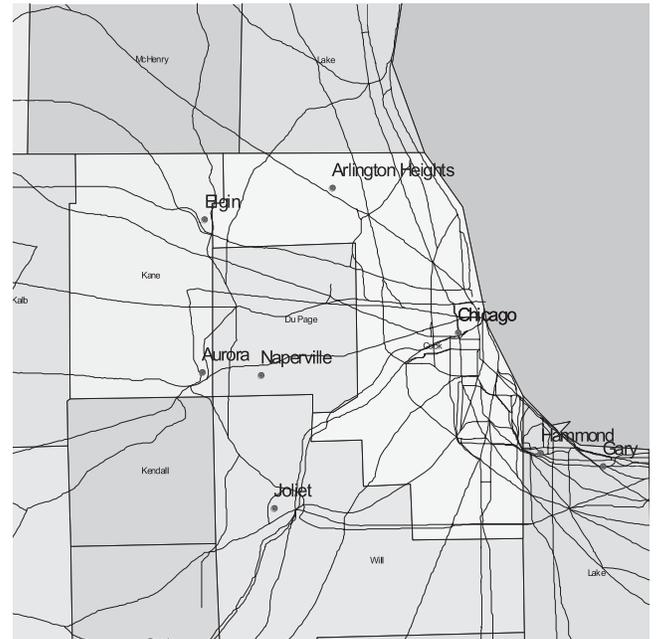


Figure 3-7. Chicago's Regional Rail Network.

constitutes the world's most densely packed rail-rail and rail-truck transfer point³². Since its emergence as the largest interchange point between the western and the eastern rail carriers during the latter half of the 19th century, Chicago has served as the most important hub of the North American railway network. With the advent of rail intermodal traffic during the 1950s, its significance as the central point of interchange has become even more critical. At present, nearly three-fifths of all U.S. rail intermodal traffic and one-third of all U.S. rail traffic flows through the Chicago region. Despite the massive volumes and transformation in the railroad's business, Chicago's rail infrastructure remains largely unchanged from the early 20th century. See Figure 3-7.

As overall traffic volumes have grown and mergers have concentrated volumes on fewer and fewer traffic corridors, the region faces a rail congestion problem. Although trains can make the trip from the West Coast to Chicago in a truck-competitive 2 days, once they get to Chicago they can take 3 more days just to move across town.

In recent years, expanding traffic and increased competitive pressures have forced the railroads to undertake concrete steps to reduce the delays encountered by traffic moving through the Chicago region. Although the primary tactical response has been to improve coordination among the carriers and operational adjustments, over the longer term, more extensive changes will be necessary, including development of new intermodal terminals (some already constructed) and

³¹The material presented here is based on an analysis performed by Global Insight for the Chicago Department of Transportation. Nevertheless, opinions expressed herein are those of the author.

³²Rawling, Gerald F.; “Are we still eligible for the Yellow Jersey?”; C.A.T.S.; 08/29/00.

restructuring of the physical network to better meet present and future needs. Given that railroad operations are still largely concentrated in the City of Chicago and the urban core of the region, any major changes in terminals and trunklines could have a significant effect on the City.

Recognizing the evolving changes in the railroad industry and its potential effect on the City of Chicago, the City commissioned a study to better understand trends within the railroad industry and to evaluate whether Chicago's economic interests would be better served by preserving its role as the nation's premier rail freight hub or by supporting other activities in lieu of rail freight. "Freight Rail Futures for the City of Chicago" was sponsored by the Chicago Department of Transportation and undertaken from 2001 to 2003. The study assessed the economic effect of rail freight on the City in terms of its effect on labor, land use, business activity, congestion on roadways, and passenger train expansion and presented development options for the future. Through a combination of interviews and surveys, transportation data analysis, forecasting, and economic modeling, the study estimated the economic consequences for a set of distinct scenarios, each representing a strategic direction for the City and the railroad industry.

Relevance

Roadway congestion was just one of the many inter-related issues touched by this study, whose real focus was economic and whose ultimate purpose was political. Still, such focus and purpose are relevant to the circumstances commonly faced by planning agencies, which must possess or assemble a body of public support for their projects. The extent to which freight rail is tied to the vitality of a region is the extent to which investments in rail have clear payoffs and are therefore easier to justify—so long as the investments themselves are productive, roadway conditions may be relieved ipso facto. Chicago admittedly is an extreme case, in that it is very large as a city, a rail center, and a freight market, but these elements make the measurement of railroad influence more obvious and help to point up the benefits of which a healthy rail sector is capable.

There are 600 grade crossings in Chicago; traffic interference at these points is one of the chief road-related issues and important in the question of network rationalization. Other prominent roadway concerns in this study were as follows:

- The ability of the rail industry to handle projected growth, particularly for the intermodal traffic that offers the best prospect for relief of highway congestion. This growth can only occur if there is sufficient line and terminal capacity. However, railroads building capacity are content to position terminals outside major cities, where land is cheap,

economies of scale are readily achieved, and highway access is good. This trend, evident in Chicago as well as many other cities, may reduce truck traffic on the rural interstates, but it will leave many trucks in dense urban areas where air quality, safety, and congestion concerns are greatest. For Chicago, a feasible strategic response appeared to be a twin terminal system, whereby older downtown facilities would operate in tandem with new ones at the urban rim, using shuttle trains to preserve rail service to the urban core.

- Efforts by the railroad industry to improve all-rail connections and to rationalize infrastructure and operations in a complex operational environment. These have been underway through an industry-wide initiative, the Chicago Coordinating Committee, whose work led to the proposed Chicago CREATE project. The financial ability of private industry to make appropriate investments, however, has been somewhat in doubt, and the form of rationalization it might favor in these circumstances is a concern for public planners, because any traffic shed from rail is probably headed to the highways. Cooperation with the public sector must be established if rail infrastructure investments are to favor the city, where opportunities—but also construction costs, project complexity, and collateral impacts—are high.
- Cross-town drayage is the main way that railroads interconnect their intermodal services in Chicago, moving trailers and containers between terminals by truck across city streets. This adds to urban congestion and can be reduced with rationalization in the rail system. However, not all drayage is undesirable. Because car loading sequence and car blocking requirements demand greater destination volume densities for all-rail than for drayage connections, some cross-town trucking actually supports through rail service to more markets than could be accomplished without it.

Motivation

The rail freight system provides various economic benefits to regional and national economies. Direct benefits include employment opportunities in rail and rail-related industries and access to competitive transportation services to and from major economic centers in the United States, Canada, and Mexico. Cost savings resulting from transportation efficiencies and the competitiveness of the freight system permeate the local, regional, and national economies. Although, as a percentage, relatively few people or firms have direct contact with the freight railroads—except at grade crossings—they all benefit from the existence of the national rail freight system.

Chicago sustains a tremendous concentration of rail freight. Over 70 million tons of rail intermodal traffic are hosted by the region's railroads and highways; translated into

trailers and containers, this means that 4.6 million loads begin or end their trip in the Chicago region. The City's motivation for undertaking the rail futures study was to understand the economic effects from this high level of activity, to know whether its infrastructure demands should be accommodated, and to project the consequences of policy courses ranging from status quo to strategic development.

Between 1985 and 1998, overall traffic for the Chicago region grew by over 150 percent. Rail carload tonnage approximately doubled, while intermodal tripled. At the same time, the volume of traffic moving by highway grew by over 200 percent. Volume growth is forecast to remain strong over the next two decades, albeit at a somewhat slower rate of 62 percent between 1998 and 2020. This means that Chicago's transportation infrastructure must accommodate an additional 439 million tons of inter-regional traffic (inbound, outbound, and through), above the 707 million tons handled in 1998. Out of these 439 million tons, 156 million are expected to use rail for at least part of their journey.

Where and how this additional tonnage—and millions of additional vehicle trips—will be handled depends on decisions being made by private carriers and public planners. For rail, the expected continued growth in traffic could result in significant collateral effects: more frequent interruption at rail/highway grade crossings, greater noise from more frequent trains, and growing truck traffic over City streets traveling to and from intermodal terminals. The existing rail infrastructure, such as bridges and viaducts, will, without substantial additional investment, become more severely stressed and deteriorated than it already is.

This recent and impending growth, combined with the many changes in Chicago's economy, population, and development trends, have made it apparent that the traditional relationship between the railroads and the City has changed greatly. Effectively addressing these alterations requires a conception of how much of the Chicago economy continues to be linked to the fortunes of the rail industry. The study found that coordinated planning efforts could create a more effective and more efficient rail system for passenger and freight services, with lower impacts on neighborhoods and highways. Left to themselves, railroads and their customers will pursue strategies that, while in their own best interest, could be damaging to the City economy. The economic benefits to the City of a coherent planning process for the rail freight system are both significant and attainable.

Lessons and Outcomes

The study determined that it is in the best interests of the City of Chicago to remain the leading rail hub in North America. Although rail freight service is no longer the driving force for economic development that it once was, it remains

an important underpinning for the City's economy. From an economic development perspective, it was indicated that the City should support continued or improved freight operations rather than seeking to constrain or eliminate them. The best available strategy for the City will be to support the rationalization of freight operations so as to reduce conflicts between rail and highway operations, improve coordination of freight and passenger services, offer better access to intermodal terminals, enhance freight service, and reduce freight costs. The study concluded that rationalization of the rail freight system would increase the City's Gross Regional Product (GRP) by more than \$1 billion per year by the year 2020 and provide more than 8,000 additional jobs. The successful redevelopment of land freed by rationalization would more than double these benefits.

The problem arising from aggressive efforts to move freight operations outside of the City is that some rail users will follow the rail facilities, others will end up using more trucks, and a significant amount of economic development will shift to the suburbs. The City may avoid some problems if rail operations are reduced, but could lose much more than just the trains. Results from the regional economic analysis show that moving freight away from the City would, by 2020, reduce GRP for the City by \$1 to 3 billion annually, while eliminating 5,000 to 15,000 jobs. Redevelopment opportunities could offset some or all of these losses, but the net benefits would still be substantially lower than under a network rationalization scenario. The total swing between upside and downside is about 3 percent of GRP, which is material as a marginal economic shift.

As this was written, results from the study were being incorporated into strategy development discussions with Chicago's major railroad partners. The study highlighted the role that the railway industry played and could continue to play in Chicago, or any other locale's economic firmament. The study further suggested that, although the focus of planners has traditionally been on the absence or presence of regional infrastructure, the effects of transportation on the regional economy are more logistical in nature. The presence of infrastructure is a necessary requirement for quality transportation service and economic vitality, but not a guarantee of economic success. To maintain the competitiveness of rail operations in a region, there are four generic strategy options for investment that a public agency might want to consider:

- **Invest to obtain public benefits**—This strategy could include such things as elimination of grade crossings in order to reduce highway congestion and curtail the noise from train whistles, or, reduction of intermodal rubber tire interchange, again to alleviate congestion and to slow the deterioration of pavements. Required by such an approach is the demonstration that rail is an equivalent or superior

option to the provision of highway service and that the potential benefits justify significant public expenditures.

- **Invest to maintain rail infrastructure for long-term growth**—The goal of this strategy is not necessarily to alter current mode share, but to ensure that deficiencies in the rail system do not become a deterrent to regional growth or a significant cost factor for local industry. The economic analysis from the Chicago study suggests that annual economic costs rise far into the millions of dollars if rail infrastructure problems restrict industrial development—and can reach the billions in a major urban network center like Chicago.
- **Invest to relocate rail facilities to allow redevelopment**—This strategy seeks to make better economic use of land and rights-of-way currently used for rail operations. Such a strategy must be carefully implemented however, because the costs and benefits of each such proposal will be highly site specific.
- **Invest to rationalize the system**—This strategy seeks to achieve both the economic and environmental benefits that are possible. This differs from the first approach primarily in the level of coordination, planning, and investment required. Rationalization implies a systems approach to the regional rail network, with considerable restructuring and investment to achieve more efficient operations, better service, more effective control, or higher capacity.

In Chicago, as in other rail-heavy economies, the continued growth of the region is vitally linked to maintaining the capacity and performance of the local railway network. Capacity-limited performance will, over time, weaken the attractiveness of a region as a location for businesses and industries that use rail service. If transport costs rise and service deteriorates, local firms will have more difficulty competing both regionally and nationally. They will be forced to relocate outside the region, and a significant part of the local economy—and much of the future development of freight-dependent activities—will slowly slip away.

Case Study 8: State Rail Access Programs

Type: Facility

The Programs³³

Many states have local transportation grant programs designed to help fund local rail and/or highway projects needed to help attract and expand industry in the state. Several of these states operate separate rail programs specifically focused on

supporting local projects addressing these economic development objectives. Among them, Maine and Ohio offer particularly interesting examples of rail economic development programs, because the programs in those states have documented how their projects have explicitly served to reduce highway demand and associated needs for highway-related investment. These two programs are offered as case study examples; because of similarities in their design and operation, they are discussed together. Key aspects of the programs are summarized below:

- **Maine Industrial Rail Access Program—IRAP** was designed by the Maine DOT to encourage economic development and increased use of rail transportation. Type of projects eligible for funds include accelerated maintenance, rehabilitation, new siding improvements, right-of-way acquisition, and inter-modal facility construction. Project applications are solicited from any and all interested parties and are ranked using a competitive rating scheme that focuses on economic enhancement and public benefit. Project grants are subject to a 50/50 public-private cost-sharing agreement.
- **Ohio Rail Economic Development Program—REDP** was designed to induce companies to locate or expand in Ohio. REDP funds are available for the construction or rehabilitation of industrial lead tracks, rail spurs or other rail infrastructure, and passenger rail facilities. The program provides both grants and loans. Qualified applicants can include railroads, private corporations, and industries requiring rail service; political subdivisions, government agencies, and boards or commissions; regional transit boards; and port authorities. Grants are used for cases with the most need or without a direct revenue stream. Grants are generally limited to less than 50 percent of project costs and up to \$1,000 per each job created or retained.

In both states, most of the projects are new or rehabilitated rail sidings and spur lines, although the eligible projects can (and occasionally do) also include transload facilities, bridges, rail/roadway crossings, track interchanges, and rail yards. Examples of specific projects for both states are listed in the Section 4.1 discussion of implementation in the Guidebook.

Relevance

Rail programs in the two states provide funding for local rail projects that allow new and existing companies to use rail rather than trucking for their incoming and outgoing freight shipments. Local rail projects are funded to facilitate the location of new businesses and the retention or expansion of existing businesses at specific sites in the state. This is accomplished

³³The material presented here is drawn from State sources.

by providing new rail facilities and upgrading existing rail facilities to effectively serve those sites.

Among projects that address these basic goals, each state also has a series of additional criteria for evaluating applications. These criteria assess the extent to which the project will lead to effective use of the rail facilities, support economic activity as a result, and lead to environmentally positive benefits in terms of reduced road congestion and truck emissions. There are also criteria to ensure that the level of funding maintains some reasonable ratio of public benefit per dollar of investment. Specific criteria for each state program are as follows:

- **Maine Industrial Rail Access Program**—Project selection criteria are based on five types of attributes: (1) transportation and logistics cost savings for rail users; (2) employment and economic development opportunities for rail users and the community served by rail; (3) benefit-cost ratios justifying expenditure of public funds; (4) the significance of the project for continuous and productive improvement of rail service levels; and (5) environmental benefits through decreased air emissions, decreased highway maintenance requirements, decreased dependence on foreign oil, or decreased levels of highway congestion.
- **Ohio Rail Economic Development Program**—Benefit analysis is often used to determine eligibility for assistance. Eligible benefits include, but are not limited to (1) job creation and job retention, (2) transportation cost savings and preservation of existing competitive transportation costs, (3) new investment in plant and facilities by rail users and the associated tax benefits to the state, (4) increased viability of the rail operation, (5) relief of highway congestion and maintenance, and (6) improved safety for Ohio’s citizens.

Motivation

These programs are all fundamentally justified and funded as a form of support for economic development—specifically to encourage new and expanded business activities in the state, so as to create more jobs and income for state residents. In both states, there are various programs, operated by different state agencies, all focused on supporting this underlying goal. These rail programs are authorized by the state legislatures and administered by the state transportation departments as one aspect of those broader economic development strategies.

Each state DOT has its own version of the wording that explains the program motivation. These are as follows:

- **Maine Industrial Rail Access Program**—“The Industrial Rail Access Program has been designed by the Maine

Department of Transportation to encourage economic development and increased use of the rail transportation mode.”

- **Ohio Rail Economic Development Program**—“The goal of this program is to induce companies to locate or expand in Ohio. The Ohio Rail Development Commission (ORDC) often works closely with the Ohio Department of Development in administering this program.”

Lessons and Outcomes

The specific projects and outcomes vary from year to year. Maine DOT has noted that projects improving and expanding rail facilities under this type of program generally have four common outcomes: (1) providing shippers with lower cost transportation; (2) providing railroads with increased revenue; (3) providing the state with reduced highway maintenance costs; and (4) providing the public with reduced highway congestion. The same common outcomes also appear to apply for the Ohio DOT program. However, both states fund projects that fall into two categories: (1) projects that primarily enhance existing rail service for *current rail users*, and (2) projects that bring new rail services and *new rail users*. In the context of this report, interest was focused on projects of the latter type, which effectively increase rail use as an alternative to reliance on trucking. Admittedly, projects of the former kind also may prevent the loss of rail traffic to highways.

Tables 3-3 and 3-4 provide examples of Maine and Ohio’s state-funded projects during FY2001, focusing on the subset of projects that explicitly increase rail use. The tables include notes on the project and its highway avoidance impacts, as well as other economic development benefits when documented. (Because of differences in the reporting among the states, their project descriptions vary in breadth and detail.)

Implementation

Both Maine and Ohio have programs operated by public state agencies, with most or all of the financing coming from funds allocated by the state legislature. Specific details of the implementation and funding process for each state are shown below:

- **Maine Industrial Rail Access Program**—The Office of Freight Transportation within Maine’s DOT operates the Industrial Rail Access Program. Annual funding has been around \$4.4 million/year, with the Maine DOT share being a combination of general obligation bonds (representing over 2/3 of the funding) and federal CMAQ (Congestion Mitigation/Air Quality) dollars accounting for the rest.

**Table 3-3. Maine industrial rail access program
(selected projects, 2001).**

- Location - Project - Program Cost	Highway Investment Avoidance
Winterport New rail siding \$215,000	75,000 tons/yr of gravel shipped by rail that would otherwise travel by highway, keeping 2,000+ truck trips/yr off highways
Stockton Springs New rail siding \$210,000	125,000 tons/yr shipped by rail that would otherwise travel by highway; keeping about 4,000 truck trips/yr off highways
South Portland Rehab siding & new transload facility \$570,000	New rail access to gravel pits, shifted clay-carrying truck trips to rail for access to seaport; reduce port truck trips by 100,000 to 150,000/yr; reducing traffic congestion in Maine's largest metro area
Easton New and rehabbed siding \$125,000	50,000-75,000 tons/yr of French fries shipped by rail that would otherwise travel by truck; reducing congestion on I-95 from N. Maine to NH border
Hinckley New siding at paper mill \$550,000	Created 700 carloads/yr of rail movements, removed 2,100 log truck moves from northern Maine to Hinckley (300 +/- miles)

**Table 3-4. Ohio rail economic development program
(selected projects, 2001).**

- Location - Project - Program Cost	Rail Support; Highway Investment Avoidance	Economic Benefits
Nickles Bakery Spur New track from W&LE Brewster Canton Line and Nickles Bakery spur track; \$265,000 grant, \$265,500 loan	Re-institute service to Nickles Bakery. Keeps 750-1,000 trucks off local roads	Helps preserve 550 jobs
Panhandle Georgetown branch Reopen track on the Panhandle Georgetown Branch to serve Oxford Mining coal traffic; \$138,292 grant	Re-institute rail service, facilitating coal movements to the Conesville Power Plant	Creates three new jobs Helps retain 50 coal mining jobs
City of Lebanon New 3,800 ft. track to serve Quantum Metals; \$340,000 loan, \$25,000 grant	Opens up Columbia business to rail service as alternative to trucking	Creates 25 new jobs Retains 15-20 jobs Generates 240 rail cars annually
Miami Products & Chemical Company New 950 ft. and 545 ft. rail spurs at new chemical company facility in Fairborn, Ohio; \$200,000	Generate 64 rail carloads	Creates 12 jobs Retains 31 jobs
Walton Agri-Service, Inc. Expansion of 39-car spur in Upper Sandusky to handle 65-car unit trains of grains and fertilizer; \$25,000 loan	Generate 1,926 rail carloads	Retains 38 jobs Generates more than \$400,000 in private investment
New Bakery Co. Transload Track New 2,878 ft track at East Point Industrial Pk (Muskingham County); \$200,000 grant	Promotes development of rail use at industrial park	Creates 74 jobs Retains 230 jobs
Cloverleaf Cold Storage New 1,300-foot rail spur and bridge to serve proposed warehouse in Massillon; \$328,000	Generates 1140 rail carloads	Creates 30 jobs
Jackson warehouse Spur Cost Increase Complete new 3,000-foot spur; \$235,250 grant, \$160,250 loan	New transload facility	35 jobs created Lower storage cost for food industry.
20/20 Custom Molded Plastics, Ltd New 1,500-ft. rail spur for new facility in Holiday City; \$50,000 grant	Generates 96 rail carloads	Creates 62 jobs

The latter source of funding is targeted for projects that reduce traffic congestion and improve air quality, thus confirming the role of Maine's IRAP in reducing traffic congestion.

- **Ohio Rail Economic Development Program**—The Ohio Rail Development Commission (ORDC) was created by the Ohio General Assembly in 1994 and is governed by 14 commissioners. ORDC's mission is to plan, promote, and implement the improved movement of people and goods, faster and safer on a rail transportation network connecting Ohio to the nation and the world. In practice, ORDC provides direct loans and grants and may issue bonds for qualified rail projects. It is set up to provide this support to public and private entities. For fiscal year 2002, the legislature allocated nearly \$5 million for the agency's annual budget, most of which is spent on grant programs.

The Rail Economic Development Program is just one of ORDC's programs. It is administered by ORDC working closely with the Ohio Department of Development and other public and private development related organizations to induce companies to locate or expand in Ohio. ORDC has other funding programs for projects that are not related directly to economic development, but rather, to functioning of the state's rail system. This includes special funding for Branch Line Preservation, Branch Line Enhancement, the Rail Acquisition Program (purchasing short lines to prevent cessation of service) and the Strategic Corridor Program (funding improvements on Ohio's mainline system).

Case Study 9: Inland Ports

Type: Facility

The Projects³⁴

A true Inland Port is a remote freight processing facility and body of infrastructure that provides advanced logistics for ground, rail, and marine cargo movements outside the normal boundaries of marine ports. In effect, it extends a marine port to an off-site, inland location by providing (1) a remote, inland multimodal distribution center for marine/rail and marine/truck transfers, with (2) a direct rail or barge shuttle that moves cargo between ocean-going vessels at the main port and the intermodal transfer site on a frequent basis, and (3) advanced scheduling and tracking of cargo so that the inland port is effectively functioning as an extension of the main port.

By relocating the truck and rail distribution facilities away from the main port site, the inland port facility

- Reduces congestion from truck traffic in the area of the main port,
- Reduces rail/roadway intersection delays, and
- Removes constraints on port expansion that are attributable to truck capacity limitations.

There are several similar examples of inland port infrastructure projects, which are all discussed here because they incorporate similar characteristics. They are the Virginia Inland Port (VIP), the European Container Terminal (ECT) in the Netherlands, Nilai Inland Port (NIP) in Malaysia, and New York's Port Inland Distribution Network (PIDN). Each of these inland port facilities includes all three of the numbered criteria listed above, and addresses all three of the issues identified in the preceding bullets. Each of them is operated either directly by the main port management or through an entity that is closely integrated and coordinated with the main port management. Following are brief descriptions:

- **European Container Terminal, Venlo (ECT)**—The ECT is a remote port cargo processing facility in Venlo, Netherlands, near the German border and close to the Belgian border. It is 120 miles inland from the Port of Rotterdam. It works as a central processing center for container traffic flowing between the port and other parts of northern and central Europe. Containers are transported by rail to and between the ECT and the Port of Rotterdam, and by truck between the ECT and other locations in Europe. A new rail line to Germany (the Betuweroute) is also under construction. Land is available to steamship lines for container storage. A key feature is that the ECT controls inland port freight rail service and runs the trains on schedule to ensure timely deliveries in an advanced logistics network with the Port of Rotterdam.
- **Virginia Inland Port (VIP)**—The VIP was inspired by the Netherlands ECT. Operated as an intermodal container transfer facility, the VIP provides an interface between truck and rail for the transport of ocean-going containers to and from the Port of Virginia. It is located west of Washington, DC, in Warren County, VA—220 miles inland from the Port of Virginia and its marine terminals in Hampton Roads. Containers are transported by truck to the VIP for immediate loading on a rail car or for short-term storage prior to loading. Containers arriving from Hampton Roads terminals are unloaded from the train and dispatched by truck to inland destinations. Daily trains run between the VIP and the marine port. The VIP allows for both USDA inspections and SGS inspections

³⁴The material presented here is taken from reports and presentations of the various projects.

and is a U.S. Customs-designated port of entry, with the full range of customs functions.

- **Nilai Inland Port (NIP)**—The NIP is a new logistics facility combining the services of a port and a distribution center. The facility is about 50 km south of Kuala Lumpur, 22 km from the International Airport, and roughly 40 km from Port Klang. It is directly accessible via an interchange of the North-South Highway and has its own rail spur connected to the main railway line connecting Kuala Lumpur to Thailand in the north and Singapore to the south. The complex includes container handling, port services such as documentation and customs clearance, cargo handling and consolidation, transportation to and from the Port Klang seaport, local and domestic distribution, bonded and third-party warehousing, and administrative services. It also features 522 commercial units (for small and medium-size factories and commercial businesses), an 8,500 sq. meter bonded warehouse, a container yard, a four-story office block, a temperature-controlled building, and a Customs office complex. Unlike the other three examples, NIP does not have direct rail service to the seaport. However, it functions as a central location along the main international rail line, from which goods can be efficiently distributed via truck to and from Malaysia's main airport and seaport. As such, it functions as a remote facility for port services and container transfers to the railway system.
- **NY: Port Inland Distribution Network (PIDN)**—The PIDN is an emerging network of remote facilities for processing and distributing containers moving into and out of the Port of New York and New Jersey by barge and rail—in addition to trucks. Started in early 2003, the system is designed to represent a “hub and spoke” extension of the Port of NY-NJ, with direct transshipment of containers between ocean-going vessels at the marine terminals, and barges or trains serving the marine terminals and inland regional truck and rail distribution facilities. The remote facilities are to (1) offer cargo handling, consolidation, and intermodal logistics for freight movements to and from the Port of NY-NJ and (2) reduce the need for container storage in the space-constrained NY-NJ Port district. The initial Spring 2003 startup was a direct barge connection to a new container facility in upstate New York, at Albany on the Hudson River. Plans for the subsequent period were to stimulate development by the railroads of remote facilities linked by rail to Pennsylvania (Pittsburgh) and western New York (Buffalo) and to develop additional barge connections to upgraded facilities in New Jersey (Camden or Salem), Connecticut (Bridgeport or New Haven), Rhode Island (Davisville), and Delaware (Wilmington).
- **Other Inland Ports**—Whereas all the above examples effectively operate as extensions of the main port, the term “inland port” is sometimes also applied more loosely, as

a marketing concept. In this usage, it is promoting any location that features inland freight warehousing and distribution facilities, with barge or rail connections to international ocean ports. The term was actually introduced with the opening of the Erie Canal and was featured in “The Inland Port,” an article by Nathaniel Hawthorne published in 1835. Today, St. Louis promotes the fact that it is “the country’s second largest inland port with barge connections to 29 U.S. metropolitan centers and the world via the Mississippi River.” The Greater Columbus Inland Port (in Ohio) was set up in 1992 as a marketing and coordination effort to promote the fact that the Greater Columbus, Ohio, region has a set of transportation infrastructure, freight-handling facilities, and support services for distribution-sensitive companies that need freight shipped in a timely manner via air, rail, and/or sea. The Kansas City Smartport is an “Inland Port Trade Processing Demonstration” that markets the Kansas City region by developing and demonstrating the application of super-efficient international trade processing for movements between Mexico, Kansas City, and Canada. Finally, there is the March Inland Port—the name for an industrial park at the site of March Air Force Base in Riverside, California, which is being marketed as featuring a cargo airport along with freeway access and rail lines that make it desirable for businesses requiring multi-modal access. Each of these other examples uses the term “inland port” to apply loosely to inland locations with transportation connections to seaports. However, none of them work as integrated extensions of the seaport.

Relevance

All four of the examples of Inland Port facilities address the same port transportation goals:

1. To make specific international seaports more cost-competitive for customers by reducing dwell times for transshipping containers to trucks and other modes. This is achieved through more efficient intermodal logistics activities relocated away from the crowded seaport.
2. To reduce space requirements and congestion at the port by reducing demand for truck traffic. This effectively allows the port to further expand container capacity and throughput, without the limitations of increasing space being needed for truck facilities.

Both of these goals—the reduction in customer cost and the reduction in space constraints on future growth—are directly associated with moving truck traffic out of the port, and substituting a remote logistics facility that furthermore makes it easier to use a broad set of rail connections for longer

distance ground transport. By encouraging or facilitating rail transfers, the Inland Ports also end up supporting rail options as an alternative to truck movements along congested routes.

Motivation

All four of the examples of Inland Port facilities were motivated by a desire to preserve and enhance the market competitiveness of their associated marine ports. Specifics of these motivations are noted below:

- **European Container Terminal, Venlo (ECT)**—The ECT Venlo facility was initiated as a joint venture of the Port of Rotterdam with private-sector banking and transportation organizations, as part of a master strategy to maintain the Port of Rotterdam as the world's number one container port. The Betuweroute rail line, profiled elsewhere, is also part of that same strategy of expanding the reach of the Port of Rotterdam into regional distribution centers. A consistent part of this overall strategy has been recognition that expanded rail connections can provide cost efficiencies and environmental benefits over alternatives that would further increase truck traffic congestion at the port area and along major regional and international travel routes.
- **Virginia Inland Port (VIP)**—The VIP was motivated by a desire for the Virginia Port Authority to strengthen its position as a center of maritime commerce. A market analysis research study showed that the Virginia port was primarily handling cargo traffic originating or destined outside of eastern Virginia, with a significant share of its current traffic (and a higher potential for growth) originating or destined for the U.S. Midwest and Southeast. Following the example of the ECT in Netherlands, the study concluded that an inland port with rail connections to the Midwest could allow the port to expand its business base, add new customers, and aid ship lines in protecting their own customer base. In addition, it was noted that the VIP gives operational flexibility and competitive cost savings over existing methods for handling intermodal containers.
- **Nilai Inland Port (NIP)**—NIP was initiated by the State Development Corporation of Negeri Sembilan, the Malaysian state that includes Kuala Lumpur. The facility was designed as a distribution and advanced logistics resource to encourage small and medium-size businesses to locate and expand in the region and to use the air, sea, and rail resources the region offers. Although it offers land and building space for businesses, it was motivated by a desire to provide a resource and advanced service that can work with, rather than compete with, existing transportation and distribution service providers.

- **NY: Port Inland Distribution Network (PIDN)**—The PIDN was initiated by the Port Authority of New York and New Jersey. It was motivated by a realization that increasing truck congestion in the New York City metropolitan area can undermine the cost competitiveness of the Port of New York and New Jersey and in the future threaten its market position as the leading East Coast U.S. port. It was also seen that future increases in truck demand would limit the future growth of port activity. Of the containers handled at the Port of New York and New Jersey, 84 percent are transported by truck, and truckers at the port already have to wait long hours for pick-ups at local terminals because of increased volume and security. The PIDN program was designed to improve connections to and from the port, reducing the dwell time through transshipping containers by barge and rail, and thus taking demand off trucks and speeding turnaround in the container yards. It was estimated that this could reduce the average cost of inland transport distribution by 20 percent. With future expansion of the PIDN, there would be the opportunity to locate inland terminals near or at centers of marine custom and service distribution activities in 13 states.

Lessons and Outcomes

The Inland Ports generally are run by private operators, which limits available information on their level of use. That they work in conjunction with the main ports also limits the availability of data separating inland port activity from total marine port activity. As a result, there are no hard statistics on the observed impacts of inland ports on shifting container handling or reducing truck traffic at the main ports. However, some information can be gleaned on the actual and expected evolution of these inland port facilities over time, based on past history in the case of the Netherlands ECT and on future expectations in the case of the New York PIDN.

- **European Container Terminal, Venlo (ECT)**—The ECT system has expanded from the first inland port facility in Venlo, Netherlands (opened in 1982) to include a second inland port facility in Willebroek, Belgium (opened in 1999) and a third in Duisburg, Germany (opened in 2001), as well as Rotterdam's largest container port (Delta Terminal). The Port of Rotterdam opened two new rail service centers in 1999. The ECT Inland Terminal at Venlo started with one daily shuttle train to and from the Port of Rotterdam, but has now expanded that operation to three trains daily—two between ECT Venlo and the Maasvlakte Rail Service Center (at Rotterdam's container port) and one between ECT Venlo and the Waalhaven Rail Service Center (at Rotterdam's bulk port). Container handling growth at the ECT Venlo facility was up by 20 percent in 2002, which ECT

attributed to the reliability of the rail link to the main port and to the reduced level of congestion on national motorways that had helped improve truck access to and from the distribution center.

- **NY: Port Inland Distribution Network (PIDN)**—The inaugural barge service to Albany lasted about 3 years and moved approximately 8,500 containers. It was terminated because of the lack of long-term funding commitments able to support the service through 5 years or more. However, the constraints and congestion at New York remained severe, and the promise of PIDN for systematic reduction of these problems still remained attractive to the Port and its regional partners. Consequently, the lessons from the Albany experience have since been applied to the development of roll-on/roll-off barge service across Long Island Sound to Bridgeport, CT. Not ready for launch at the time this is written—and a short-sea initiative instead of a rail-based one—the Bridgeport service is appealing because of its potential for economic stimulation in a lagging area of Connecticut and its ability to reduce truck travel on the busy Interstate 95. The original projections for the PIDN program held that when all of the regional ports were in place, the percentage of marine containers moved by truck would fall by one-third, and almost 1,000 truck trips a day would be diverted from New York State roadways to other transportation options. Possible traffic shifts of this magnitude sustain interest in overcoming the program's setbacks.

Implementation

All four of the inland port facilities were set up by public initiatives involving local or regional public agencies, working in concert with private operators of shipping, rail, or barge lines.

- **European Container Terminal, Venlo (ECT)**—ECT is a private limited liability company (BV) that provides advanced logistics and operation of container services for three-fourths of the container traffic at the Port of Amsterdam. ECT is an entity set up by three organizations—the public port operator (Rotterdam Municipal Port Management), a private company (Hutchison Netherlands BV), and the financing bank (ABN AMRO). ECT first established the Inland Terminal at Venlo in 1982, with daily rail service to the Port of Rotterdam. ECT has fully incorporated the Venlo facility into ECT's container control system at the main port, allowing for seamless scheduling and handling of containers that successfully allows users to view the inland port as an extension of the main port.
- **Virginia Inland Port (VIP)**—The Virginia Port Authority (VPA) is a state agency that operates marine terminals at

Newport News, Norfolk, and Portsmouth, VA. In 1983, VPA set up a separate company, Virginia International Terminals, to operate its marine terminals. In 1984, VPA and VIT conducted a study mission to Europe, which examined the success of the new ECT inland terminal in the Netherlands. Subsequent discussions with Norfolk Southern Railway led to common interest in the concept and the development of a plan to establish an inland port facility in Warren County, near Washington, DC. In 1987, the Governor of Virginia announced plans for state funding to establish the facility, to be owned by VPA and operated by VIT, working with the railroad. In 1989, the Virginia Inland Port was opened. VIT has linked the inland port into its computer operations at the main ports, thereby coordinating all container movements with rail availability and ship line departures and arrivals. With the addition of the inland port, VPA operates at a profit, although it receives capital development and maintenance support from the state through its Transport Trust Fund and its Commonwealth Port Fund.

- **Nilai Inland Port (NIP)**—NIP was set up as a public-private joint venture, involving Syabinas Holdings Sdn. Bhd and the State Development Corporation of Negeri Sembilan (Perbadanan Kemajuan Negeri, Negeri Sembilan-PKNNS). Seventy percent of the equity is owned by Syabinas Holdings and thirty percent by PKNNS. NIP commenced operations in mid-1995. The facility was developed at a total investment cost of RM120 million (US \$32 million). That includes the building of offices, factories, shop houses, a warehouse, and a container yard. The built-up factory units were specifically designed to cater to small- and medium-scale industries.
- **NY: Port Inland Distribution Network (PIDN)**—The PIDN is a public-private partnership. Its partners include the Port Authority of New York and New Jersey, prospective feeder port operators, and state and local government agencies that support PIDN development. The Port Authority of New York and New Jersey initially committed \$6 million to assist with the start up costs for the new distribution system, beginning in 2001. With an estimated total cost of \$1.8 billion, the PIDN development process was expected to go through mid-decade in order to be completed. Federal Congestion Management Air Quality Program (CMAQ) money was used to provide almost 3 years of capital and operating funding for the initial PIDN service, which ran barges up the Hudson River to an inland container port at Albany, NY. Even so, this service did not become self-sustaining during the period and ultimately was discontinued for lack of funds. Although other potential ports in surrounding states have been slated for possible start-ups in subsequent years, a major obstacle to development of the full PIDN program remains the lack of external funding commitments to cover anticipated

deficits in operating and investment capital, during the long periods required for services to mature in the market.

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CHAPTER 4

Shipper Needs and Structural Factors

4.1 Introduction

For railways to produce material relief for the congested roads of the nation, the rail system must capture highway traffic. Therefore, in many ways, diversion of traffic from road to rail is the heart of the issue that forms the subject of this report. This chapter examines shipper needs and structural factors that produce conditions favoring diversion or constraints that hamper it. The chief objective of this chapter is to assist planners in coming to a realistic judgment of the market and operating conditions that shape and show the probable payoff from rail solutions to congestion.

Analysis of diversion options becomes quite complex when the analysis takes in the interaction of factors and motivations at the level of individual shipments. The purpose of this chapter is to reduce those factors to broad, true outlines that offer a compass to planners, by which they can navigate the forest from amid the trees. In a sense, diversion can be brought down to a simple proposition: good, low-cost service wins business from competitors, and the obstacles and advantages for rail in delivering this are what have to be understood. An evaluation in practice will not play out simply, yet this perspective is important for testing whether a result makes sense: diversion analysis is competitive analysis, and strongly competitive service should succeed.

Given that the overarching goal of this report is reduced congestion and greater effective capacity for the highway system, then preservation of rail traffic is important, because it prevents additional, often heavily laden volume from being introduced to the highways and further eroding their performance. It means that the problem of pickup and delivery is important, because these trip-end services occur more frequently in urban areas. If pickup and delivery must operate by truck instead of direct rail, then there will be limited rail relief in urban areas, which are among the most congested. Incremental traffic has a greater detrimental effect on system performance in already congested networks. This implies that

as freight traffic on the roadways continues to build, the value of diversion to rail grows greater.

This chapter moves through five additional sections, beginning with a presentation of basic customer motivations, then builds toward an understanding of the limitations and opportunities for diversion, and concludes with a review of diversion's effects.

- Section 4.2, Shipper Needs. Understanding of modal preference starts from the foundation of customer needs. Their portrayal in this section ranges from service, cost, and other requirements to carrier selection. The market positions of modes are indicated, and the discussion introduces the concepts of equivalence, conversion, and categorical distinctions in service.
- Section 4.3, Structural Factors. Important limitations to rail are posed by the conditions of access and the addressable extent of the highway market. The characteristics of truck fleets are described as modal competitors and intermodal partners, and the challenge of interoperability as well as the urban problem are highlighted in this section.
- Section 4.4, Market Segmentation. Recognition of the differential nature of market sectors helps to uncover diversion opportunities and to verify their realism. Markets are considered in this section from the demand and supply sides, in retail and wholesale aspects. A freight rail typology and market benchmarks are presented, and the discussion concludes with a framework for market segmentation, useful as a basis for diversion evaluation.
- Section 4.5, Diversion Opportunities. The prospects for highway diversion are different for the railcar and the intermodal businesses, while the short-haul freight market is large, significant for congestion relief, and difficult to approach. This section considers the singular qualities of opportunity in each of these areas, using case examples and distinguishing prospects of national magnitude from those with local promise.

- Section 4.6, Impacts of Diversion. Modal diversion alters the locational impact of freight, creating new traffic concentrations on rail lines and around transload facilities, yet improving mobility for other traffic left on the roads. The marginal effects of diversion in economic and social dimensions are reviewed in this section, including congestion, economic development, and environmental, safety, and community consequences.

4.2 Shipper Needs

Purchasers of freight transportation are motivated by a series of factors in their selection of providers. Chiefly they are concerned with performance specifications and value, within the overall context of the logistics of their business and its contribution to customer satisfaction. These factors are variously described as purchasing criteria or selection requirements, but are most simply called shipper needs (although the purchasers of transportation may be receivers or managers of freight and not properly shippers at all). Adopting simple terms for this discussion, the two primary needs of shippers are service and cost.

4.2.1 Service

Service fundamentally means the reliability with which goods are picked up and delivered as scheduled or expected and the transit time or speed of that process. Reliability can be understood as the variability of performance versus a standard, which typically is an appointment time and a tolerance range around it. An example of a reliability measurement would be “95% of deliveries on time,” where ‘on time’ means within 1 hour of the appointed moment. Precision arises as an aspect of service when the tolerance range narrows to 15-minute windows around appointments, or with financial guarantees for a fixed, daily deadline. Service on the pickup end also entails equipment capacity to collect the shipment and the turnaround time for equipment to cycle back. Examples would be the railcar supply during the harvest season or the availability of trucks around big retail distribution centers, and it is routine for shippers to require commitments of equipment from their freight carriers. Finally, frequency of service effectively is a facet of transit time, because it adds to the hours elapsed between the point when a shipment is ready for pickup, and the point when it can be delivered. In irregular route systems (like significant parts of the U.S. truckload business), frequency is a direct function of equipment supply, but in regular route operations the availability, number, and timing of departures is a major determinant of effective service. In railroading, departures correspond to the number of trains running per day and per week; in other planned route networks, the departures might be planes (in air freight) or

linehaul trucks (in LTL and small package trucking). It is worth noting in these systems that departures have a high fixed cost component that tends to depress service frequency and creates a temptation to consolidate departures, thereby reducing costs but downgrading performance.

Two additional points should be made about service. First, it is measured door-to-door, which means from the shipper’s door to the door of the receiver. This is a salient point for railroading in the context of highway relief, because in the commonplace absence of direct rail access to the customer facility, goods must be transloaded and drayed, and this can¹ add to time and cost. Furthermore, the railroad and the drayage truck performing pickup and/or delivery normally are not under common operating control, implying that door-to-door service performance depends on the cooperation of independent agents. This issue of cooperation affecting service also exists for interline handoffs between the major rail systems prevailing today in the eastern U.S., the western U.S., Mexico, and Canada.

Second, there is a common misperception that the speed of transit is not especially important so long as deliveries are predictable. Reliability or predictability is the most crucial feature of service, and shippers may exist who value it to the exclusion of transit time, but speed of transit is an essential factor in modern logistics:

- There is a well-documented movement in industrial management to reduce the cash-to-cash cycle time of business, which refers to the time between the purchase of inputs or merchandise and the point when goods are sold and paid for. Time compression is sought in every aspect of the cycle, implying that speed is important everywhere. One core motivation for this trend is market responsiveness, whereby the productive capacity of a supply chain reacts swiftly and flexibly to local activity at the points of sale. Adoption of low-inventory, high-speed logistics systems is key to this capability. In a large survey of freight shippers released by Morgan Stanley Equity Research, the number one reason that shippers had not shifted more truck freight to rail intermodal was slow transit, followed closely by unpredictability of service.²
- Truck lines form an important intermediate customer group for rail intermodal services, providing both the pickup and delivery operations and the retail marketing to shippers. In market research conducted for the Virginia I-81 corridor, motor carriers made the significance of transit time performance quite clear. For fixed-route truck

¹For customers with direct rail access, the switching of cars between the rail yard and their facilities also consumes time and expense.

²“Freight Pulse Survey: Second Round Insights,” 1/9/02, Morgan Stanley Equity Research.

lines that have published schedules, rail must meet or improve the schedule or it cannot be used; for irregular route truck lines, the standard of comparison is the over-the-road speed of a single driver, and the utility of rail is diminished if it cannot match or improve on the standard. An additional finding in this research was that transit time performance behaved as a step function measured in whole or half days. Speed improvements are significant when they cross this threshold, but are not very meaningful in smaller increments. Coupled with the fact that speed is evaluated door-to-door, this finding points up a competitive hindrance to rail in short-distance lanes, which will be explored later in this chapter.

4.2.2 Cost

Cost considered narrowly is the price charged by the carrier for the shipment, but more broadly and substantially it is the total set of costs attendant to doing business with the carrier and mode. Like service, it must be totaled door-to-door and include any separate charges for pickup, delivery, and transfer. Costs are compared by unit shipped—per piece or per pound, for example—and thus are sensitive to the loading capacity of transport equipment and to the size of the shipment. Comparisons also have to be aligned by miles traveled (commonly called length of haul), first because distance is a primary and obvious driver of transportation costs, and second because of the changing proportion of pickup and delivery to linehaul costs, as miles lengthen. Pickup and delivery tend to be time and therefore asset intensive; railroads in particular find their comparative advantage lies in the efficiency of linehaul.

Total logistics cost is the most comprehensive way to view the sum of the expenses attached to doing business with a carrier or mode. The term ‘logistics’ especially brings in the inventory carrying costs associated with the lot sizes, transit time, and service reliability offered by the carrier. The inventory itself expands into the building space, the staff, and the administrative expense required to support it. Provided the value of the goods shipped is known, the inventory financing charges for lot sizes and transit time are calculable; however, the cost of some of the other elements can be difficult to measure, notably for analysts (like public planners) who are not privy to shipper’s internal information. From a practical standpoint, there are two observations to make about logistics cost and its effect on carrier selection and diversion:

- Low-inventory logistics are a manifestation of a deeper business process. When just-in-time practices were introduced to industry, they were focused not so much on stock reduction as on eliminating the process failures that inventory covered over. As the evolution of supply chain

strategies has turned the focus to market responsiveness, the value of that strategy to business overwhelms other considerations,³ and logistics practices are engineered to execute it. Shippers in this sense are seeking the right transportation products in terms of service performance and carrying capacity; while transportation costs matter, additional logistics factors have been obviated by the performance standard. In other words, if a transportation product imposes significant inventory burdens on the logistics system, it cannot meet the engineering requirements and does not qualify for purchase.

- Apart from rates, the logistics cost differences between carriers are largely a function of modal technology. Motor carriers certainly compete on service, but they are broadly substitutable one for another in terms of their logistics effects. The logistical implications of rail carload service can be significantly different from motor carriage, on the other hand, and are an impediment to diversion. Even so, the class of railroad service that competes most aggressively with highway transportation and is most likely to produce congestion relief is the intermodal product, which strives to emulate truck performance and offers the shipper equivalent loading characteristics. As the rail product becomes substitutable for all-highway service, supply chain effects start to become immaterial, and total logistics costs collapse to the difference in transportation costs.

Transportation costs are structurally dependent on modal technology and are fundamentally influenced by two forms of volume efficiency: consolidation economies and economies of density. Consolidation (which is the ability to combine shipments into larger lots by grouping or unitizing them or by accumulating them to travel together) can be performed by the shipper in tendering larger amounts of freight or by the carrier or intermediary in combining freight from many shippers into quantities that will fill a truck or make up a block of cars on a train

Density refers to the concentration of market volume in time and space. Its major components are

- Balance—the ratio of delivering (inbound) shipments to originating (outbound) shipments in an area;
- Proximity—the distance between delivering and originating shipments or the interval distance between sequential deliveries or pickups in a chain;

³ The “International Trade Flow Study” by the Fleet Management Department of TTX Corporation (9/03) describes retail importers stopping, stripping, and transloading international containers for the purpose of delaying a decision about the final destination for goods. This is done so as to react most optimally to point of sale information from stores. Market considerations in a case like this completely offset the added logistics expense.

- Vector—the direction of volume, often characterized as a lane;
- Confluence—the joining of vector volumes in common arterial sections of a network. Vector and confluence are critical to railroading, because its unit of production—the train—depends on directional traffic concentration;
- Frequency—the timing of volume, as it determines the immediate relationships of balance, proximity, vector, and confluence in a spatial zone.

Consolidation and density both are concerned with the organization and dynamics of traffic flow and, in turn, are determinants of transportation asset utilization. Utilization measures the productive work of assets—facilities, right of way, and especially mobile equipment—in terms such as revenue per day, cycle time, and loaded to empty proportions, and it keenly affects return on investment. A strong positive relationship usually exists between density and utilization on the one side and service performance on the other, such that quality and efficiency can be mutually reinforcing attributes. Because of this, the advantage of density can be thought of as conferring a service economy. Finally, carriers can control utilization by a variety of means; an important one is management of the dispersion of assets across geographic territory, where less concentration is detrimental. This is equivalent to the military principle, under which the effectiveness of armies is related to the force they exert, in ratio to the space in which they operate.

4.2.3 Other Needs

Beyond the two primary requirements, shippers consider a series of additional factors in carrier selection: geographic coverage, affecting lane service and the ability to single-source; relationship, including customer communication and incumbency; and ease of doing business. Three of the most prominent are visibility, risk elimination, and specialization, which are discussed below. The relative significance of these factors varies with the shipper's industry and can rise to the importance of service and cost in some cases. The chemical industry, for example, values risk elimination highly, while shippers of produce care about the equipment and knowledge specialization that delivers their products fresh and unbruised to the market.

Visibility

The movement to low-inventory, market-responsive supply chains has caused the visibility of product inside the system to become vital. The objective ideally is to be able to locate and affect any item in real time anywhere in the chain: at the factory, the warehouse, the store, or aboard the freight carrier. The traditional role of inventory as a guarantee of

goods to customers has been transferred to information systems, transportation systems, and integrated supplier management. Shipment tracking historically was a carrier support function for service assurance; under fast cycle logistics, it makes a crucial contribution to total supply chain management. Development and adoption of a range of mobile communications tracking technologies have created the ability to follow and direct the movement of power units; trailers, containers, or cars; and the goods inside them. A carrier who provides visibility to a customer offers a combination of technology (transponders, cellular devices, bar codes and radio tags are examples as this is written), data processing and communication systems (currently including web-based platforms for shippers to tap carrier data), and operational controls, all combining to produce actionable information about goods in transit.

Risk Elimination

The components of risk are safety, claims, and environmental protection; equipment maintenance; insurance; security procedures; and the stability of finances and labor. They are directed at four issues: (1) the safe handling of goods, including hazardous goods, and the ability to respond and make recompense in the event of incidents or loss; (2) the protection⁴ of goods from theft, vandalism, and violence, and of the transportation system from hijack and terrorism; (3) the safe conduct of transportation, and the avoidance of accidents harming people and property; and (4) the dependability of the carrier as a going concern, so that shipments tendered and logistics programs built around the company can be expected to proceed without disruption.

Specialization

Expertise in the shipper's business is helpful to the client in many industrial segments and is critical in some. Specialized equipment is a prerequisite in numerous areas: temperature controlled goods, automobiles, apparel, and heavy machinery are examples. Equipment (specialized or not) may be dedicated to a shipper, or an entire operation may be contracted, including motive power and on-site staff. Training or simply experience in product handling and plant procedures turn carrier personnel into approximate extensions of the shipper's staff. Where dedicated or specially trained work forces are used, the carrier may assume logistics functions such as preparing store-ready merchandise with tagging and displays. Specialization in these instances crosses into out-sourcing and third-party logistics.

⁴Railroads maintain private police forces that are licensed and armed as peace officers.

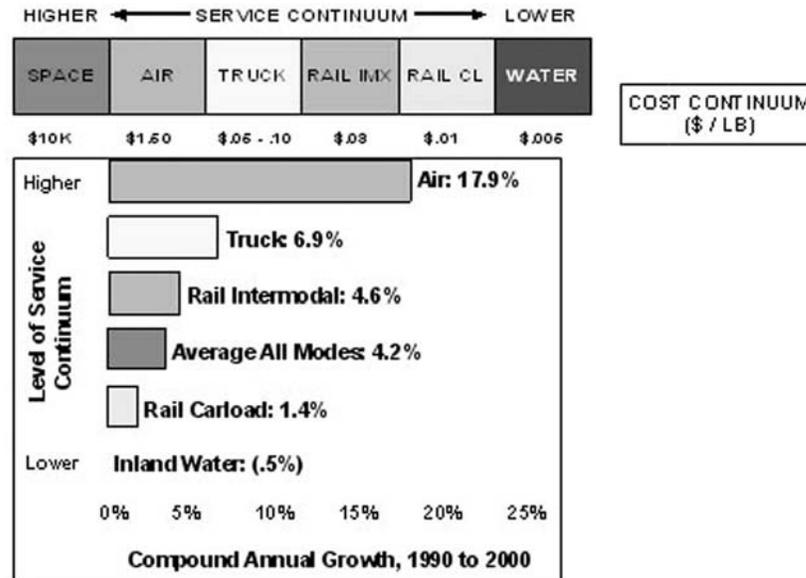


Figure 4-1. Transportation Cost Advantage Continuum.

4.2.4 Carrier Selection

Freight modes offer a characteristic mix of service and transportation cost advantages and can be arrayed in a continuum as shown in the first chart of Figure 4-1. Individual carriers and operations may perform above or below the tendency of their mode, but it generally holds that motor carriage offers superior service to railroading and earns a higher price, while the intermodal product for rail is the closest to truck performance. The importance of service is borne out by modal growth rates in the 1990s, which directly correspond to position along the continuum (seen in the second chart of Figure 4-1). These illustrations suggest the fronts of modal competition and the areas of the market where traffic diversion is most apt to take place: intermodal versus highway, highway versus air, and barge versus carload rail. Two points should be acknowledged about this profile:

1. Shippers may employ a portfolio of carriers and modes, according to the span of their logistics requirements, geographic exigencies, and movements in their markets. Their needs therefore may require a diversity of solution.
2. Freight carriers or companies seek to transfer the portfolio function from shippers to themselves by using multiple modes beyond the one they may be known for. A current expression for this is mode neutrality, indicating that carriers market certain performance specifications to shippers, while trying to reserve to themselves the responsibility for deciding the method of accomplishment. Of course, the selection of modes and sub-modes matters to the execution. In practice, some specifications are

synonymous with a particular mode, and some shippers will penetrate the veil of neutrality if they are concerned for the risks that a mode may pose or want to assure themselves a share of a cost advantage.

Shippers consistently rank their needs as service first and cost second. Numerous studies through the years⁵ demonstrate this and typically stress reliability or on-time delivery as the foremost feature, followed by transit time. Priorities after the cost feature fluctuate by industry group, as noted above, and individual shippers may deviate from the norms. Freight carriers react with cynicism to the primary ranking of service, because their competitive experience is that shippers care chiefly about cost.⁶ Understanding this apparent discrepancy is useful, because it points up dynamics that influence analysis of diversion.

Figure 4-2 presents the prioritization of shipper needs in the terms of Maslow's hierarchy. Abraham Maslow was an American psychologist who posited a theory of human needs under which basic requirements such as food and shelter had precedence over emotional requirements such as social esteem, but each level of the hierarchy formed a threshold below the next.

⁵One particular reference is a 1996 paper "Shipper Carrier Decision Making: Post Deregulation Quality Factors" by Professor Bud LaLonde, formerly of Ohio State University. LaLonde in turn references the findings of Michael McGinnis and others. A 1997 shipper survey by Cahners Publishing is another of many sources (*Logistics Management*, September 1997, "The High Rollers," page 72.) Private research by the authors for railroads, motor carriers, and public agencies from the 1980s through 2003 show the same thing.

⁶This is the author's long-standing experience.

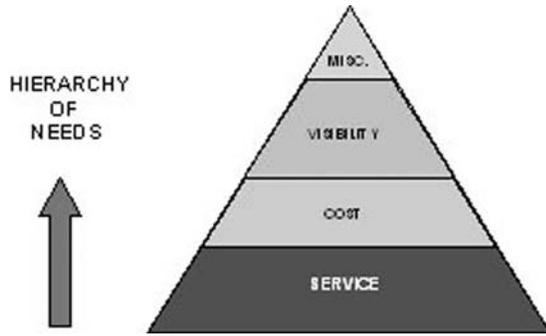


Figure 4-2. Hierarchy of Shipper Needs.

This meant that, so long as more fundamental requirements were being met, the focus and object of behavior would move up to higher levels of need, and the basic needs would recede as motivations unless they were threatened. For example, in the Second World War, the survival needs of middle-class citizens rose strongly to the fore, and then fell back behind social concerns after the conflict ended.

As an interpretation of shipper behavior, the hierarchy places service at the level of basic needs.⁷ Because the first job of the shipper is to satisfy such needs, normally they have already done so, and the focus of their behavior has moved up to cost. In competitive markets, cost is so often malleable (and shippers work hard at improving their power over it), that even when shippers are seeking to satisfy higher level demands, cost is rarely a wholly resolved need and does not drop out of the picture. This explains the carrier perception that customers care chiefly about price. The precedence of service is evident from the vigorous and early steps shippers take to respond to the threat of a strike or the collapse of a carrier: traffic is diverted to more stable, even more costly alternatives, until the

disruption is ended.⁸ Service disruption is not the normal state of affairs, of course, and under normal conditions, service needs stand as satisfied.

However, the modal differences function as categorical distinctions in service—meaningful and plain—and shippers manifestly observe these distinctions in their modal portfolios. Interpreting this in terms of the Maslow model, shipper satisfaction at the basic level of service is touched by disruption or carrier failure or by categorical differences such as the several modal technologies produced. The service positions of modes, then, can be conceived as a series of hierarchies along the continuum (Figure A) or as a shifting of the hierarchy across its line (Figure B) in Figure 4-3. To summarize, shippers slot their carriers into logistical roles according to their categorical levels of service, and within those roles in an everyday way, carriers principally compete on cost.

This renders service as a step function in the dimension of reliability, as well as in the dimension of transit time. This is reinforced by two factors:

1. Reliability entails a measure of trust. For that reason, a carrier who has proven reliable wins loyalty and is not easily abandoned, except for another who is equivalently trusted. Therefore, there is a certain amount of resistance to shifting of carriers over issues of reliability: the prevailing sense of satisfaction has to be disproven or disrupted, and shippers take time to change their position.
2. Carrier performance in the aspect of reliability is not finely measured, because of the structure of business relationships. Shippers typically select the carrier, pay freight charges, and are held responsible for delivery failures—but they do not directly observe delivery.⁹ Instead, they depend on customer complaints and exception reporting,

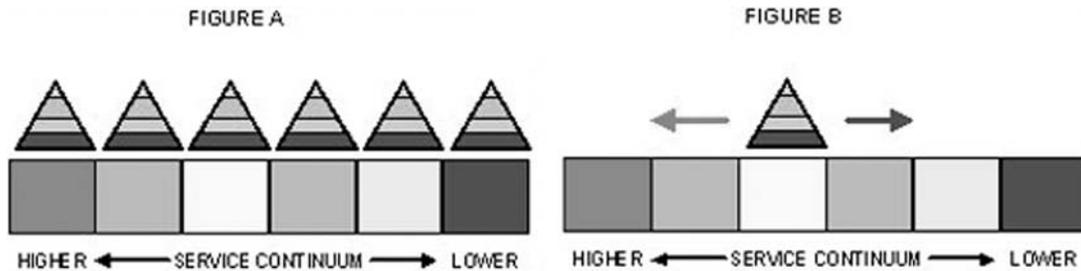


Figure 4-3. Mode Service Position Hierarchies.

⁷This interpretation is principally the author's conclusion from observation of behavior. Others have drawn the same conclusion, however, nor is application of the hierarchy unique. LaLonde states, quoting McGiniss, "performance and quality requirements are constraints to be satisfied before rates become a significant issue in logistics service provider selection."

⁸The West Coast port strike of 2002 and the UPS strike in the mid-90s are well-reported examples.

⁹These issues were explored in research for the Virginia I-81 market study, detailed in the Chapter 3 case reports.

on statistical shipment sampling or tracking of urgent shipments, and on carrier-generated performance reports (which allow slippage through tactics like resetting appointments). Hence, shippers “know” carrier performance, but not precisely and not with complete data, and the implication is that shippers will not be sensitive to small gradients of reliability due to the imprecision of measurement. Prominent exceptions include cases where shippers control their inbound freight and so have direct data on performance (some of the large retail chains do this),¹⁰ and cases where a carrier purchases contract linehaul transportation (such as a truck line buying intermodal service from a railroad).

Carriers within modes consequently are operating, and are perceived to be operating, all on the same plateau of the step function. Clear product differentiation in such circumstances is difficult—and this is what carriers report. To the extent differentiation exists, it is usually related to a cost advantage derived from network service economies or to a transit time advantage produced either by the service economies or by specialization.¹¹ Railroads competing with motor carriers are a step behind and contend as an inferior good: shippers have to be offered a substantial risk premium to offset service deficiencies, provided they can use rail service at all.

To divert highway traffic sufficiently to affect congestion, rail services must climb to the step that motor carriers occupy. Small gradients in speed and reliability will not matter much, but equivalent performance is a categorical change in the railroad product proposition. Equivalence is achieved today in market segments that play to traditional railroad strengths and is rewarded with market share. Intermodal rail, for example, holds a commanding position for long-haul transportation of containerized goods in dense intercity lanes. In these conditions, density supports dedicated train-load operations, and linehaul distance offsets inefficiencies in pickup and delivery; the result is that rail performs as well as a truck, with a lower cost.

Railroads are not likely to improve on truck performance and do not really need to; when the service plateau is reached, the shipper’s objective turns to cost, and advantages in cost will win business. The objective is *equivalence*, and since

¹⁰Even here, information quality is mixed. A study of major retailers by the Soleus Group (reported in *trafficWORLD*, 2/2/04, page 16, “Retailers in the Dark”) reveals that less than 70% of truck lines are able to provide electronic shipment updates to retail customers, and 50% of those who can have accuracy problems.

¹¹Carriers commonly complain of commoditization in their markets and struggle to separate themselves from their brethren. Examples of transit time differentiation are regional LTL lines that use network density and labor flexibility to lengthen the distance limit on overnight service and truckload lines specializing in team driver operations.

motor carriage already can be equaled by rail in some circumstances, the core question in traffic diversion is, how broadly can equivalence be produced?

A final point on the value of parity is that it is an effective way to win motor carriers as allies of railroads and through them to transform product equivalence into significant modal market share gains. Truck lines need cost superiority for their competition with one another, and some view intermodal linehaul as one method to obtain it, so long as (1) the rail product matches their competitor’s performance over the road; (2) rail linehaul blends smoothly into their fleet operation; and (3) rail usage can be translated into sustainable advantage. This last provision can be satisfied through a number of means: specialized equipment, knowledge of how to use railroads productively, train ownership, yard and slot priority, price preference, and pickup and delivery costs. Motor carriers have to develop trust in the railroad, but once they acquire it, their existing relationships with shippers help to reduce the resistance to change and accelerate the diversion of traffic. Equivalence in this way is an instrument of conversion, in the sense of persuading opponents to cross to a position of support.

4.3 Structural Factors

4.3.1 Access

Railroad sidings as a feature of industrial facilities have been declining for decades. Many businesses that possessed them have paved them over or allowed them to fall into disrepair, and new industrial development for generations has been widely heedless of access to the rail system. Meanwhile, the long-term rationalization of the railroad network has caused it to shrink from many areas that it once closely served and has left it far smaller than the highway system. A network whose major development ended early in the 20th Century has adapted to shifts in economic geography primarily through contraction, not growth.

The trends reflected in these conditions are explored in the next chapter of this report. To indicate the consequences for traffic diversion, an illustration was prepared using a commercial database of American businesses, consisting of all manufacturing establishments with twenty or more employees. Establishment addresses first were geocoded to prepare them for cartographic examination. This process successfully coded 61 percent of the establishments, or about 100,000 businesses; additional effort could have raised the proportion captured, but with no evident bias to the coding failures, the result was an adequate sample for analytic purposes. Then, the coded establishments were checked for their proximity to rail lines, using a cut off of 500 yards (about one-quarter mile) from the current, active network. This process found

that just 34 percent of manufacturing businesses were within the cutoff distance, representing perhaps 35 percent of shipping volume. This assessment is not fine enough to identify the presence or absence of sidings,¹² but it is safe to say that a number of these businesses near the network will not possess an active or indeed any spur. The conclusion suggested by this exercise is that at least two-thirds, and perhaps four-fifths of U.S. manufacturing sites have no on-line access to the railroad system.

The result is that most shippers require pick up and delivery at their facility to be handled by a truck, and use of rail service is predicated on transloading between modes. There are two primary types of transload and many subtypes:

1. Conventional Intermodal involves the transfer of freight-carrying equipment—truck trailers or containers—between a rail and a road unit. The rail unit usually is some variant of a platform like a flat car, and the road unit is either a truck tractor to which a trailer may be hitched or a tractor with trailing chassis onto which containers may be placed. In most cases, the equipment is designed or outfitted to permit transfer via a lift or crane and thus is specialized for the rail environment in ways unnecessary for road operation. Subtypes include bi-modal equipment (where the rail unit instead of a platform is a set of steel wheels swapped onto a modified trailer), Expressway-style equipment (where the rail car is a roll-on, roll-off platform that accepts standard, non-specialized highway trailers), and arrangements where tractors together with trailers ride on the rail platform (seen in some circumstances in Europe, but not currently in North America).
2. Carload Transfer involves the transloading of goods between an ordinary rail car and a standard highway trailer. Subtypes include bulk transfer (such as the transloading of liquids via hose from railroad tank cars to tank trailers), break-bulk (such as the movement of metals via outdoor or indoor crane, from rail flatcars or gondolas to flatbed trailers), and finished automobiles (which are driven via ramp from railroad auto racks onto highway car trailers). This also is a form of intermodal transportation in the pure sense of the word, but for ease of reference, we will limit the term ‘intermodal’ to the transfer of equipment not goods.

¹²In other words, the GIS network does not capture sidings. The 500-yard figure is a reasonable limit, and it is imposed as the crow flies, so that track distance may be greater and still fall within the cutoff. Longer sidings exist (some stretch a couple of miles), but they require large traffic volumes to sustain them, and topographical problems grow with distance. When the Mercedes auto plant opened in Alabama, its siding was perhaps half a mile long, and track construction required major investment by the State for highway bridging.

Provision of rail access via transloading requires networks of on-rail facilities equipped to conduct the various forms of transfer and trucking operations at each facility suited to handle the intermodal units or goods. The full spectrum of transload business demands multiple networks with distinct operations and few efficiencies of combination, and they need management and information support systems as well. Access costs are a major contributor to door-to-door transportation expense and are the primary component of cost at shorter distances. Figure 4-4 demonstrates this for intermodal service. Extracted from the Virginia I-81 study and reproduced from the Chapter 2 case study, it displays lift costs plus pickup and delivery drayage as a percentage of total expense, by mileage door-to-door. As distance drops to 350 miles (the shortest haul examined in the study), access costs climb to 75 percent of the total.

Two important implications should be drawn from this:

1. Given the importance of access cost, the requirement for transload and drayage at one end or both ends of a freight shipment becomes an essential consideration. Direct loading to rail in shipside or automobile plant environments, for example, produces one-end drays that improve the economics for those shipments, and clearly single-end drays matter to the viability of short-haul rail. The carload transfer business is most often a one-end, destination dray.
2. The composition of access costs emerges as a critical factor. The absence of cranes and the heavy pavement to support them are an advantage to ramp-style terminals. The high rates of empty return associated with local intermodal drayage drive up its cost. An advantage to intermodal services with network motor carriers can be better load balance, produced by the situation of intermodal inside a larger trucking operation and by the interchangeability of equipment.

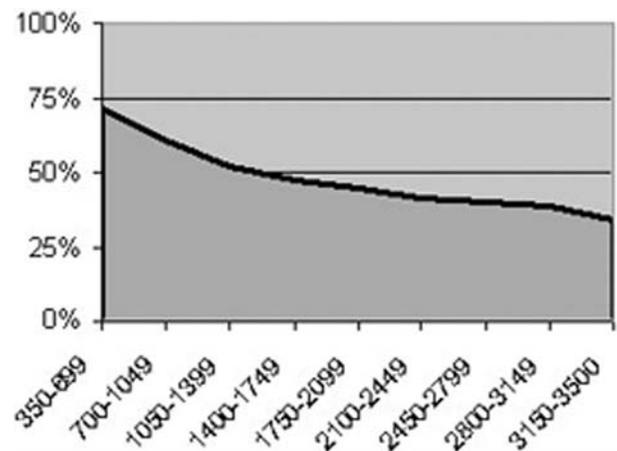


Figure 4-4. Intermodal Access Costs by Mile Block (2-End Dray).

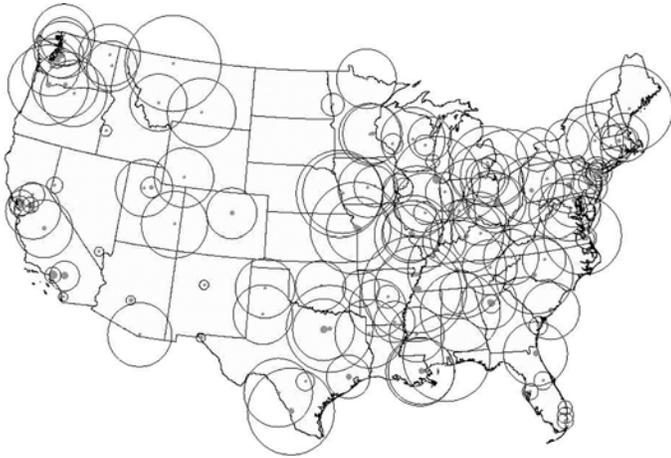


Figure 4-5. Intermodal Dray Coverage.

The significance of access expense also suggests a public planning policy lever. If public investment in terminal connections and facilities reduces transload expense, it improves the capability of rail to attract traffic. An experiment conducted for the Virginia I-81 project tested the influence of a diesel fuel tax credit aimed at intermodal drayage. The result was a boost in diversion from highway to rail, especially at shorter lengths of haul.

The effectiveness of the intermodal system at producing access is shown partially in Figure 4-5, which displays the dray radius¹³ within which 80 percent of pickup and delivery activity occurs for rail facilities that handle at least 1,000 annual units. Larger facilities appear as larger dots; the underlying data are drawn from TRANSEARCH and reflect operations both of local draymen and network motor carriers. The map suggests reasonably thorough coverage of urban markets and of territory as a whole in the East. Even so, there are gaps—notably in the Southwest and along the Gulf—and large portions of the less populated West are not served. Dray distances tend to be longer where there are fewer terminals or population is less concentrated and at the East/West rail gateways along the Mississippi, where railroads will dray instead of interlining with one another. An important caveat to this display is that it does not capture the lanes where these terminals do and do not offer service. A full picture of traffic coverage addresses the questions of whether or not shippers can be reached by a terminal and whether or not the railroad runs trains to the right destination markets. Figure 4-5 shows the first, not the second.

¹³Radii for a given lane really have an elliptical, not circular shape, with most of the coverage area extending beyond the terminal and extending in the lane direction of travel. The reason is that a shipment is less likely to backtrack to a terminal and more likely to use one that lays enroute, because the former adds to cost and time versus an all-highway route, and the latter does not. Circles nevertheless are a reasonable display of coverage for the total collection of lanes that a terminal serves.

A final and major implication of the conditions of access is the urban problem. As shown by the FHWA maps reproduced in the next chapter of this report, congestion at root is an urban challenge, expanding through time from metropolitan districts into the roads between adjacent city pairs. The marginal public cost of heavy truck operation is materially higher as well on urban versus rural roads, for pavement, environmental, and particularly congestion elements.¹⁴ Nevertheless, if railroad access is to be primarily via truck drayage, then it is precisely the urban areas that railways will find most difficult to relieve. Benefits from highway diversion will accrue to the regions through which the rail linehaul travels, but pickup and delivery will be consigned as before to the road.

The urban problem as an instance of access limitation is one of the chief obstacles to solving road congestion with rail diversion. While it is difficult, still it is neither a one-dimensional nor wholly intractable problem, as the following considerations demonstrate:

- Through truck traffic can be a substantial contributor to urban highway congestion in some segments and is substitutable by linehaul rail. Moreover, as congestion threatens to grow well beyond city limits, its appearance on intercity routes can be headed off, at least in part, by rail alternatives.
- Direct rail access continues to exist and can be exploited or extended in some circumstances. The competitiveness of carload service probably does not justify broad expectations for diversion (this is discussed further below), and this is the normal form for direct rail service to shipper doors. However, there are pockets of traffic where carload works and can work well, notably in dedicated train operations where service quality improves. Single-end drays are an important example of direct rail usage in the intermodal sector; port cities encouraging on or near dock rail and factories capable of loading to rail at or beside their property keep appreciable volumes of truck traffic off city streets. Capabilities of this sort can be developed, negotiated, or possibly zoned by city planners.
- Proximal rail access is an attempt to establish or retain transload facilities so as to hold down drayage distances (and truck VMT). The next chapter highlights the national trend for railroad terminals to move to the urban periphery, where land is cheaper and more plentiful, the neighborhoods sometimes more accommodating, and the roads less congested. This trend results in central business districts losing close-in rail service; a twin terminal strategy like that recommended in the Chicago Rail Futures Study (described in Chapter 3) offers a resolution. In this approach, the peripheral terminal becomes a hub for

¹⁴1997 Federal Highway Cost Allocation Study (FHWA)

suburban and exurban shipments and builds shuttle trains for a downtown facility. Plentiful freight traffic in the Chicago market supplies density to justify the shuttle and the second terminal; in a smaller city, a public and/or shared use facility could consolidate traffic or underwrite costs with congestion tolls. A virtue of the ramp-style intermodal technology is that terminals are less costly and need less land, so it may be well suited for multiple facilities and central business district locations.

- Trans-urban corridors are a fourth way for rail to target city trucks. Motivations for existing examples¹⁵ include line rationalization and reduction of road/rail interference, but they also diminish rail-based truck drayage and conceivably could be directed toward cross-town truck traffic streams. An instance of the latter is the Chicago Transit Authority (CTA) air package express¹⁶ scheme, described in the accompanying inset box. While this service was still in the planning stages and the associated volumes were light, it removed some of the most time-sensitive trucks from the city's most clogged roadways at the most valuable times of day. Here, as elsewhere, the support and conversion of the truck operators is essential to the prospects for success.

Case Study 1: Chicago Transit Authority Air Package Express

In 2003, the City of Chicago Department of Transportation, with the Chicago Transit Authority (CTA), launched a market study to determine the demand for scheduled rail freight service between a downtown terminal and the two major Chicago airports, O'Hare and Midway. The goal was to tap spare capacity in dedicated baggage cars aboard the Airport Express transit service to carry freight, thereby by-passing the region's congested roadway network. The study found that the large integrated package express companies (such as UPS, FedEx, and USPS) operating out of O'Hare saw significant benefits to using the proposed service to reduce the need for large-scale trucking along urban freeways during peak travel hours. Initially, the primary interest would have been to use the rail service as a 'fallback' mode for when delivery deadlines were jeopardized as a result of severe congestion on the Kennedy Expressway. Progressively, as logistics chains were re-engineered to take advantage of the reliable service and the region's

roadways became even more congested, the rail freight solution could become the least-cost mode and an effective means to maintaining a high-quality service into the Chicago downtown. The primary contribution of rail freight in this case was to leverage the schedule reliability associated with a dedicated right-of-way transit service to allow a later last-pickup and a more efficient sorting at airport cargo facilities. If recurring highway congestion prevented reasonable package delivery windows from being met, the package express firm would suffer, but the productivity of downtown firms would also decrease, and Chicago would become less competitive for businesses relative to the suburbs and other cities.

The Chicago Express case demonstrated several important concepts in applying rail freight solutions to roadway congestion. First, the direct benefit of removing trucks from highways may be marginal and contributes relatively little to easing congestion that is predominantly attributed to commuting automobiles that demonstrate high time-of-day demand peaking and poor utilization of highway capacity. The entire Chicago Express scheme could remove about 20 trucks per hour in total, against a background of approximately 4,800 peak-direction vehicles that could theoretically move along the highway. However, the impacts of such schemes may be far more important than the marginally diminished congestion that motorists may experience as a result. The Chicago Express scheme attacks freight congestion in an area that is most leveraged: small packages are highly time-sensitive, urban corridors are highly congested, and removal of peak-hour vehicles has the highest value. The net contribution to the Chicago economy due to expedited freight packages may be substantial. Although such schemes may not have the system-wide impacts associated with the Kansas City Flyover and the Alameda Corridor, its significance for the City of Chicago should not be understated. Since congestion occurs mainly in dense urban areas, intra-urban schemes such as this could be as effective as large-scale highway or railroad capacity expansion to provide for time-critical freight needs. Infrastructure investment in rail freight could allow rail to become competitive in commodities that require a higher level of service, and the efficiencies associated with rail transport may provide significant benefits to regional economies over other options, such as continued expansion of highway networks to accommodate peak-period traffic. An Urban Intermodal Network constituted from dilapidated branch lines and underutilized city yards could

¹⁵The Kansas City Flyover and the Alameda Corridor presented in the Chapter 3 case studies are some, as are aspects of the proposed Chicago CREATE project.

¹⁶The CDOT/CTA-sponsored study was led by Global Insight, one of the authors of this NCHRP Report.

Table 4-1. Length of haul distribution by trucking segment.

Distance	All Truck	Fleet Operation		
		Truckload	LTL	Private
200 Miles & Under	74%	71%	55%	78%
500 Miles & Under	91%	87%	75%	95%
Over 500 Miles	9%	13%	25%	5%
Proportion by Segment:		47%	1%	51%
Proportion 200 Miles & Under:		45%	1%	54%
Proportion Over 200 Miles:		53%	2%	44%
Proportion Over 500 Miles:		69%	4%	27%

Distance	All Truck	Trailer Type						
		Dry Van	Reefer	Flatbed	Bulk	Tank	Auto	Livestock
200 Miles & Under	74%	75%	39%	61%	85%	70%	27%	52%
500 Miles & Under	91%	92%	71%	85%	92%	92%	51%	68%
Over 500 Miles	9%	8%	29%	15%	8%	8%	49%	32%
Proportion by Segment:		69%	2%	5%	10%	14%	0%	0%
Proportion 200 Miles & Under:		70%	1%	4%	11%	14%	0%	0%
Proportion Over 200 Miles:		66%	4%	7%	6%	17%	0%	0%
Proportion Over 500 Miles:		64%	6%	9%	9%	13%	0%	0%

conceivably reduce both congestion and intermodal drayage times by minimizing truck moves through a congested urban street network and funneling intermodal traffic to the intermodal ‘terminals’ located in suburban and rural areas more efficiently.

4.3.2 Addressable Market

Five hundred miles is the rule of thumb limit for the distance a truck can travel overnight in the United States; originally it reflected the typical performance of a rested single driver on good roads over a 10-hour shift. Like any rule of thumb, it is not always and everywhere true. The hours of service regulations introduced by the U.S. DOT in 2004 lengthened the driving shift to 11 hours, but straitened the definition of off-duty time. The effect was that a pure linehaul driver (like LTL carriers use or truckload operators when pickup and delivery is a quick ‘drop and hook’) could take the overnight distance out to 550 miles and more; conversely, a driver tied up waiting for pickup or delivery, or physically loading and unloading trailers, could travel less far. Driver teams can manage a longer distance if they get an early start; distances are shorter when drivers are not fresh, or run many miles empty before starting off with a load.

The outcome of all this is that 500 miles probably remains an adequate measure for overnight distance over the road. In the most common business arrangement, shippers tender

freight at the conclusion of the day and want to receive at the beginning, so the overnight distance describes the transportation service standard between the end of the work day and start of the next. Ninety-one percent of truck freight shipping falls within this limit, as Table 4-1 demonstrates, and some three-quarters of it lie within 200 miles.¹⁷ Interestingly, 44 percent of all rail freight tonnage also moves within 500 miles, and 22 percent within 200 miles; however, rail transit times typically are much longer than overnight.¹⁸ In intermodal services, which are the chief alternative when direct rail access is absent, and are the most substitutable for truck transportation, just 14 percent of rail tonnage is below 500 miles and perhaps 2% is below 200.¹⁹ For service reasons, and for reasons of access and costs explored above, it is difficult for rail to address the distance segment of the freight market where most of the truck traffic lies.

¹⁷ The table is derived from Global Insight’s TRANSEARCH database. TRANSEARCH coverage does not extend to some portions of local truck activity, which would raise the proportion at the shortest distances.

¹⁸ The figures are from the 2002 Surface Transportation Board (STB) Carload Waybill Sample. The miles are rail miles, which are approximately 10% circuitous (longer) than highway miles, so the tonnage proportions on a highway mile basis would be somewhat less. The sample also is subject to rebilling error, which causes overstatement of short-distance rail volume and understatement of long distance. It is nevertheless true that rail traffic outside of the intermodal business has a significant short haul component. Table 4-2 presents a detailed mileage distribution.

¹⁹ These percentages derive from the Carload Waybill Sample, which does not capture traffic local to shortline railroads. For the intermodal business this will not miss much, but there will be an understatement of short-distance carload traffic.

This explains the acute interest among public planners in short-haul rail; that subject is treated in detail later in this report. Of course, greater inroads by rail into the medium and long-distance markets still would reduce freight highway traffic by an appreciable amount and matter to congestion in many localities. However, there are meaningful ways that these markets, too, are not being addressed by prevalent rail technology and practice.

Fifty-eight percent of intermodal unit volume in 2005 was international containers ultimately tied to international trade, according to figures from the Intermodal Association of North America (IANA).²⁰ This proportion had climbed from 52% in 2000, and international units accounted for 78 percent of the intermodal volume growth during this period. Truck tonnage on U.S. highways, on the other hand, runs 95 percent domestic, and of the part that is international trade, about 40 percent is NAFTA traffic.²¹ While rail intermodal has done a very good job in absorbing the transportation burden of U.S. foreign trade, it has not been aggressively addressing the domestic highway market.

Domestic intermodal unit volume grew 14 percent from 2000 to 2005, compared with 49 percent for international units, again according to IANA. All of this growth was in domestic containers, since the trailer traffic dropped by 2 percent. Trailers accounted for only 19 percent of the intermodal business in 2005, down from 26 percent 5 years previously. The significance of these shifts is this: the domestic container is another specialized piece of intermodal equipment. It is designed to capture the cost saving of container stacking in linehaul train service; while the longer 53-ft-long units (which not all are)²² have the same carrying capacity as a standard highway trailer, they have to be matched to and mounted on wheeled chasses to function over the road. The added expense, maintenance, and management of a separate chassis fleet renders containers an inferior option for highway operations, and motor carriers normally do not deploy them. In consequence, the standard truck equipment seen on the road is not compatible with the principal type of intermodal service.

Highway trailers can be and are handled intermodally, but they require modification to suit the lift devices that transfer trailers onto railcars. Again, there is a need for specialized equipment. Moreover, and returning to information about

trucking segments in the table, significant portions of trailer activity cannot be outfitted for intermodal lift: the box-type equipment (dry vans and refrigerated units) can be adapted, but 30 percent of truck traffic in medium- and long-haul lanes is flatbeds, tanks, and bulk trailers that cannot. Although there are alternatives—the isotainer, for instance, is a tank rigged for handling as a container—the equipment is even more specialized and less efficient. As a result, intermodal usage imposes a barrier of customized equipment, and even then there are important segments of the market it does not really address. One solution is the ramp-style intermodal railcar that accommodates *any* style of highway trailer, without modification; while these cars see very limited service today, they substantially enlarge the addressable market for intermodal rail.

The table also indicates the distinct characteristics of truck fleets:

- The private carriage of shippers and distributors that works mainly as a cost center in support of customer service and logistics strategy and is heavily short distance;
- The much lower volume LTL segment that consolidates and distributes small shipments through terminal networks, runs full-load linehaul on regular routes between terminals, and is split between regional and long-haul service (although regional has grown more);
- The fragmented full truckload group, whose for-hire members range from national irregular route network carriers, through small regional lines and draymen, to the freelance independent contractors (owner/operators), and is the principal form of long-haul motor carriage but also figures prominently in regional and local markets.

The various segments also intermingle: truckload carriers make multiple stop pickups and deliveries and contract for LTL linehaul, while some LTL operators avoid terminals. The private fleet group is particularly fluid; it will add or subtract traffic with common carriers according to how its flows balance, and it will outsource operations entirely to commercial fleets, whose dedicated carriage adopts the functions of the private truck line.

The characteristics of truck fleets are pertinent for at least three reasons. First, to the extent that the intermodal customers are motor carriers whose linehaul is to be converted to rail, their business influences the requirements for operational integration. For example, LTL volume is concentrated in nightly departures with a fixed schedule to which the railroad must conform; truckload volume is spread during the day and has greater need for more frequent trains. Second, the traffic capture experience of railroads differs by segment. Private fleet business typically is difficult for railroads to attract, yet the Canadian Pacific has had success through its Expressway service; alternately, the outsourcing of private

²⁰ From IANA's "Intermodal Market Trends & Statistics," fourth quarter publications for the corresponding years.

²¹ Based on a Reebie Associates analysis conducted for AASHTO, using 1998 FHWA Freight Analysis Framework tonnage data, further adjusted for the international portion of intermodal dray. The international contribution to truck tonnage may have risen since then.

²² International containers also appear in domestic service, but their smaller size (40-ft is the most common length) limit their utility against the standard 53-ft highway trailers.

traffic to commercial truck lines can produce greater opportunity for rail participation.²³ Third, utilization of intermodal services requires trucking capacity to be in place at the pickup and delivery ends. For an independent contractor with one or a handful of trucks, this is out of the question, unless the load is (improbably) interchanged with another operator. The equipment and driver deployment of regional and private fleets is similarly sparse, so that railroads cannot convert these loads and must win them away from their current carrier. One way this can be done,²⁴ however, is truck-to-truck diversion: when large network carriers capture business from smaller operators, the deployment obstacle is reduced and the traffic becomes rail-convertible. From this perspective, defragmentation of the trucking industry is desirable for rail.

Another, more subtle aspect of compatibility is concerned with the integration of rail with highway operations. Because intermodal services are dependent on trucks, they should be understood as a variant form of motor carriage, as much as they are a variant of rail, and they need to be effective as such. American intermodal trucking falls into two broad categories:²⁵

- Intermodal marketing companies (IMCs), who are specialists in rail-based services, historically depended on equipment owned by other parties (but increasingly supply some of their own), and provide pickup and delivery as draymen; and,
- Network motor carriers, who offer road-based services, own their equipment, and perform intermodal pickup and delivery as a subset of their larger operation.

Inevitably there are ways these distinctions become blurred, but both categories need density to be efficient: loads must be balanced, and assets must be deployed in proximity to traffic sources. High rates of empty return are typical for rail-based services (as they are for most local trucking); for cost and performance reasons, this tends to keep equipment deployment near the ramp, and more remote business is not handled. Road-based operations have greater loading options and the balance advantage of an irregular route, non-local, multi-modal system. Equipment deployment tends to be more ubiquitous and so closer to more shippers, and empty return rates probably are better; it is certainly true that the serving radius from an intermodal ramp is longer with road-based than with

²³ These conclusions come from conversations by researchers with railroad officers and from direct observation.

²⁴ The obstacle also is eliminated when the tractor and driver travel by rail with the load, as some European services allow.

²⁵ American railroads for the most part do not supply intermodal trucking services. Currently, the most prominent exception is the Norfolk Southern Triple Crown division, which nevertheless accounts for a minority of NS intermodal business.

rail-based operations.²⁶ Highway operations also boost the feasibility of the extended length, en route dray. While the normal intermodal dray is under 100 miles, extended drays are run like a highway load, traveling hundreds of road miles toward the delivery point, then intercepting and using rail ramps along the way with little out-of-route²⁷ mileage. The service area of intermodal ramps is orders of magnitude longer for the lanes that lie en route.

Compatibility of equipment between intermodal and over-the-road operations becomes important, because the blending of highway with rail networks creates greater drayage efficiency and wider rail access. The stress on the word 'operations' is significant in distinction from 'environment': the specialized equipment that dominates the intermodal rail environment all functions on the road, yet it is not the equipment of choice for carriers in the highway network. In consequence, the specialized units are leashed to the railway network, and fleet balance²⁸ must be produced inside a system that is far smaller than the roadway and has many fewer balancing flows. Utilization of intermodal services thereby is constrained, and the size of the addressable market again is reduced;²⁹ conversely, free flow of equipment between railroad and highway operations substantially releases this constraint.

These considerations can be summarized as the issue of interoperability between highway and rail, and it is another of the key barriers to traffic diversion. Equipment compatibility restrains the integration of networks, narrows the breadth of access, and limits the size of the market railroad solutions can target, with the result that intermodal as a class of truck operation is less effective. Thus, there are strictures on the segments of the highway freight market that rail is able or else currently designed to address. They are due to the emphasis on international container trains and the problem of interoperability, the character of truck fleets, and to the effect of transloading on serviceable distance. The question of design is made more difficult by the limits that also exist on railroad capacity and capital, coupled with the fixed cost of train starts. The fact is that a container stack train can carry more revenue-producing boxes than a trailer train simply because of its second tier and so usu-

²⁶ Internal analysis by Global Insight from primary sources found the road-based intermodal serving radius to be 50-percent larger than the rail-based radius.

²⁷ Out-of-route mileage is deviation from the normal highway route of operation and is an inefficiency because of the added cost and time of extra, circuitous travel distance.

²⁸ These issues are prominent in the thinking of major network motor carriers working with rail: the carriers restrict their rail usage to ensure fleet balance, and they press their rail partners for expansion of the high-performance intermodal network to enlarge their options.

²⁹ Fleet balance is the way equipment is resupplied to a shipper after it departs with a load. Simplistically, the unit can come straight back empty or reloaded with a different shipment, or it can work its way back through triangulation or a more complex irregular route loading pattern.

ally produces a better return per unit of capacity, capital, and train commitment. Stack trains then are favored for a good reason. However, railroad decisions about the market they prefer to address tend to institutionalize their preference in technology and methods of operation that are not the best suited to the domestic freight market. While the many containers hauled by rail should be appreciated as relief of the roads, they also denote an institutional barrier to diversion of the common highway trailer tied up in most of the traffic jams of the country.³⁰

4.4 Market Segmentation

Market segmentation is a basic approach to understanding buying behavior, establishing the differential requirements of customers, and determining where a product or service would or could find its best appeal. Buying behavior and service appeal, in a competitive context, lie at the core of diversion dynamics for any kind of business. The question becomes, what is a practical way to employ segmentation to describe the barriers and opportunities for the shifting of freight business between highway and rail.

4.4.1 Demand Side

To this point, market and diversion issues have been discussed in terms of shipper needs and trucking characteristics. These can be called the retail and the wholesale perspectives:

- Retail encompasses shipper supply chain factors, such as industrial, commodity, and geographic composition; time performance requirements; and the configuration of customer orders, because it is a determinant of the size, frequency, and volume of shipments.
- Wholesale takes in the service requirements, equipment specifications, and operational features of the carriers of goods, who may tender their loads to railroads: parcel, LTL, and full-load truck lines, independent contractors, private operators, steamship companies, and intermediaries.

The retail perspective is a traditional level for market research and would seem to be basic for diversion analysis. However,

³⁰This barrier may be undermined in some ways. A 2003 study by the railroad equipment cooperative TTX (TTX op cit) documented a trend toward container stripping at West Coast ports; the phenomenon has since grown, though on-dock and near-dock rail services may be holding it in check. It signifies that containerized import goods are being transloaded and remixed with domestic product into highway trailers, and it reflects (a) an effort by retail chains to defer selection of the final destination of consumer goods, in order to respond to point-of-sale information; and (b) an effort by marine container lines to keep boxes close to port, by reducing free time and increasing fees. On the one hand, this development could stimulate a concentrated demand for trailer services; on the other, railroads have preferred to respond with domestic containers.

information about its components is not systematically available from transportation sources and can be fragmented so as to be heteroskedastic for analytic purposes. This does not demean its value and there are ways to use it,³¹ but other methods more readily produce planning guidance.

Use of the wholesale perspective is one. It is informed and shaped by the retail (because wholesale needs incorporate and respond to retail needs) and captures aspects of service and shipment size through summary dimensions like equipment types, and it is the wholesale level at which major railroads for the most part try to do business. For example, temperature-controlled equipment (which includes refrigerated vans or “reefers”) describes a segment of the market that tenders mainly full loads outside of the local sphere can be adapted for intermodal loading, but has stringent service and monitoring requirements that are challenging for railroads to meet. Shippers in this market are not all alike—frozen goods and produce are more sensitive than chilled foods and differ from chemicals that need temperature protection—but they are broadly alike, and this forms a constructive way to distinguish a sector of the market. The wholesale level also is quite effective for the competitive analysis essential for diversion estimation, because in a number of instances the wholesale customer is both a potential client and a modal rival, so that the client’s needs from the railroad reflect the rival’s performance characteristics.

4.4.2 Supply Side

These are demand-side factors. There are benefits, too, from examining the supply side. The chief of these is that it gets at the operating economics critical both to the qualities of service and to the transportation costs on which customers are acutely focused. A primary analysis starts from division of rail operations into the three classes used elsewhere in this report: unit train, carload, and intermodal services. Figure 4-6 lays out these classes and shows how they differ in the dimensions of markets and economics. (Figure 4-6 also identifies differences in public benefits as well, which will not be discussed here; the figure is reproduced from Chapter 3 of the Guidebook, which considers them). Like any set of generalizations, some elements of the typology will be found arguable by some observers; it is intended, however, as an overview of the major railroad business groups, and it is functional as such.

The Unit Train business handles high-volume bulks like coal and grain in trainload quantities. Dedicated operations make time performance fairly good, and the emphasis of service principally is the turnaround time of equipment to keep shippers resupplied. Dense, non-stop, door-to-door transportation in imbalanced lanes conforms to railroad strengths, and this is the traditional baseload of the industry.

³¹The treatment of diversion modeling, below, shows one.

RAIL FREIGHT TYPOLOGY				
DIMENSION	ELEMENT	UNIT TRAIN	CARLOAD	INTERMODAL
Markets	Commodities	Coal, grain, minerals	Chemicals, forest, bulk food, metals, waste, auto parts	Merchandise, automobiles
	Competitive dynamic	Rail dominion	Eroded dominion Network access issue	Competitive, divertable
	Intermodality	Water; truck gathering	Truck (bulk transfer, breakbulk)	Marine & truck
	Service requirement	Equipment turnaround	Equipment supply	Speed & reliability
	Captivity	Some	Some	Little or none
	ASPECT	UNIT TRAIN	CARLOAD	INTERMODAL
Economics	High empty return	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	No (but imbalance affects)
	Private/Sequestered equipment	<input checked="" type="checkbox"/> (not grain)	<input checked="" type="checkbox"/>	Box, not car
	Heavy, periodic eqpt. demand	<input checked="" type="checkbox"/>	No	International marine
	Long haul	Mixed	Mixed	<input checked="" type="checkbox"/>
	High lane density	<input checked="" type="checkbox"/>	No	<input checked="" type="checkbox"/>
	Heavy axle loads	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	No
	Serves commodity business	<input checked="" type="checkbox"/>	Usually	No (but transport a commodity)
	Operational	Door-to-door	Door-to-door	Ramp-to-ramp
	Capital	Non-stop	Intermediate switch & interchange	Intermediate mixing & interchange
		Self-funded Traditional Baseload (sine qua non)	Mainly unfunded	Under-funded New Baseload
	BENEFIT	UNIT TRAIN	CARLOAD	INTERMODAL
Public Benefits	Bridges & pavements (heavy axle loads)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	No
	Congestion & capacity	Avoided traffic	No (but rail is door-to-door)	Avoidable traffic (highway relief)
	Private maintenance & security (pertinent if public investment)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Economic development	Cost of production Viability of plant	Production costs Rural communication	Supply chain efficiency
	Defense	<input checked="" type="checkbox"/>	minor	<input checked="" type="checkbox"/>
	Emissions	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Fuel efficiency (today, a national security benefit)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Safety (truck perception; freight separation)	Avoided trucks	Hazmats; positive record	Avoidable trucks

Figure 4-6. Rail Freight Typology.

Table 4-2. Rail volume by rail miles and class of operation.

RAIL VOLUME BY RAIL MILES & CLASS OF OPERATION								
Source: 2002 CWS; no rebill adjustment								
TONNAGE (000'S)	TOTAL	UNIT TRAIN ≥ 50 CARS	CARLOAD ≤ 50 CARS	INTER- MODAL	TOTAL	UNIT TRAIN ≥ 30 CARS	CARLOAD ≤ 30 CARS	INTER- MODAL
All Tons	2,090,835	982,644	935,778	172,413	2,090,835	1,061,617	856,805	172,413
% of Tons	100%	47%	45%	8%	100%	51%	41%	8%
< 100 Miles	260,929	149,343	109,187	2,399	260,929	174,449	84,082	2,399
% of Tons	12%	15%	12%	1%	12%	16%	10%	1%
< 200 Miles	456,647	240,722	212,331	3,594	456,647	282,738	170,315	3,594
% of Tons	22%	24%	23%	2%	22%	27%	20%	2%
< 500 Miles	927,566	443,100	460,476	23,990	927,566	508,278	395,298	23,990
% of Tons	44%	45%	49%	14%	44%	48%	46%	14%
> 500 Miles	1,163,269	539,544	475,302	148,422	1,163,269	533,339	461,507	148,422
% of Tons	56%	55%	51%	86%	56%	52%	54%	86%
UNITS (000'S):								
All Units	33,366	9,187	12,641	11,537	33,366	10,014	11,814	11,537
% of Units	100%	28%	38%	35%	100%	30%	35%	35%

The Carload group carries industrial goods, chiefly for further processing, in mixed train consists that require intermediate switches (which is essentially a kind of hubbing). Shippers who can use this service typically are focused on equipment supply and low-cost transportation for higher lading weights, because performance can be slow and erratic: in a 2004 anecdote, a metals shipper reported to a researcher carload transit between 7 and 40 days over a 1,400-mile haul (truck transit would consistently be 3 days).³² The time and cost challenges of handling non-unitized carloads has caused this historical traffic of the railroads to contract steadily, as heavy manufacturing also has diminished in the American economy.

The Intermodal business³³ moves consumer goods and general merchandise, half of it imports and exports, primarily in solid trains with some intermediate hubbing. Service is among the railroad's best, and although it is mostly slower than highway, on premium trains or in well-developed lanes such as Los Angeles–Chicago, it is fully the equivalent of over-the-road. Intermodal trains run in a smaller, more concentrated network than carload traffic, but in these markets they are at the front of modal competition between highway and rail. The Intermodal business became the top source of Class I revenue in 2003, surpassing coal and in some ways rendering itself the new baseload of the industry.

³²Train speeds are another measure. The manifest trains that bear carload traffic are regularly the slowest, and intermodal trains the fastest class of service, with unit trains lying in between. Railroads publish such statistics, but one citation showing this pattern is *trafficWORLD*, 3/8/04, page 30, where there is a table of comparative speeds on the Union Pacific.

³³Finished automobiles have been grouped with conventional intermodal here, while carload transfer business has been classified with carload.

Table 4-2 shows the relative magnitudes of the three business groups in physical terms. Using a minimum block size of 50 cars to define a unit train, the carload and the unit train groups are about even in volume and account for most of the tonnage, with the light-loading intermodal much smaller. However, substituting unit volume to adjust for load factors makes the three groups roughly equal in size at around one-third of the traffic each, with the carload somewhat the larger and unit trains somewhat the smaller. The table depicts in addition the length of haul profile of the groups, displaying substantial short-haul activity for carload and unit train yet not for intermodal, as mentioned before. (Applying the units instead of the tonnage measure has no effect on the distance distribution of the three operating classes.) It is important to notice the way the traffic split changes when the definition of a unit train is reduced to 30 or more cars from 50: the unitized business climbs to become clearly the tonnage leader. This underscores how consequential car blocks are to railroad traffic, especially under 500 miles where 80 percent of the definitional shift occurs. Below the 30-car threshold are smaller groups of 5, 10, and 20, all of them aiding operating economics and forming major constituents of trains. Carloads by no means come just in singles and pairs.

There are two further points in this context:

- The size of trains is variable. They have a heavy fixed-cost component for crew, power, and marshalling, so there is a potent reason to run them large, up to the limits of siding lengths (sidings allow trains to pass one another). However, solid blocks improve the marshalling (pickup, delivery, hubbing, and interchange) costs of trains and keep smaller ones viable. Capacity is another consideration. When track space is constrained, consolidation of traffic into fewer, bigger trains uses less of it.

Table 4-3. Modal market share by lane density and distance.

MODAL MARKET SHARE BY LANE DENSITY & DISTANCE RAIL INTERMODAL (IMX) Vs OVER-THE-ROAD (OTR) DRY VAN TRUCK								
Source: TRANSEARCH 2000								
HIGHWAY MILES	LANE DENSITY (Annual Tons [000] by IMX+OTR)							
	< 100		100 - 400		> 400		Total	
	IMX	OTR	IMX	OTR	IMX	OTR	IMX	OTR
1 - 100	0.1%	99.9%	0.1%	99.9%	0.4%	99.6%	0.4%	99.6%
100 - 299	0.3%	99.7%	1.1%	98.9%	1.4%	98.6%	1.3%	98.7%
300 - 499	0.8%	99.2%	2.3%	97.7%	3.6%	96.4%	3.0%	97.0%
500 - 699	1.3%	98.7%	5.8%	94.2%	11.1%	88.9%	6.6%	93.4%
700 - 999	1.3%	98.7%	8.3%	91.7%	27.2%	72.8%	12.6%	87.4%
1000 - 1499	2.6%	97.4%	8.7%	91.3%	28.1%	71.9%	11.4%	88.6%
>1500	7.3%	92.7%	24.8%	75.2%	62.0%	38.0%	37.1%	62.9%
Total	2.4%	97.6%	6.6%	93.4%	8.2%	91.8%	7.0%	93.0%
Total > 500	3.0%	97.0%	10.8%	89.2%	33.8%	66.2%	16.8%	83.2%
Total < 500	0.6%	99.4%	1.5%	98.5%	1.5%	98.5%	1.4%	98.6%



- Car blocks normally are multiple cars moving under a single bill from one shipper to one receiver. In the conventional intermodal and carload transfer business, it is different, because transloading performs a kind of consolidation function, allowing blocks to derive from multiple shippers grouped around single geographic origin and destination points. This is the same benefit small package and LTL truck lines obtain from consolidating intercity freight at terminals, which in turn permits rail to participate in the small shipment market through terminal linehaul transportation. The development of railroad logistics parks take this one step further, by concentrating multiple transload functions at a single location in order to build up car block and even train-load volume.

Car blocks signify lane density, and lane density both augments and trades off with distance in its competitive influence. This is demonstrated in Table 4-3 (reproduced from Chapter 3 of the Guidebook), which presents the progression of market share for conventional intermodal rail, as highway miles lengthen and lane volumes grow. The market here is defined as over-the-road dry van trucking, that being the wholesale sector where the standard intermodal product competes; it is also the largest sector of the trucking market, accounting for two-thirds of the volume, as was shown earlier

in this chapter. Lanes are origin-destination pairs of Business Economic Area (BEA) metropolitan markets,³⁴ this being a pragmatic way to reflect the consolidation effect of terminals within the definition of an economic region. Two additional technical factors affect the table: (1) it excludes truck volume outbound from wholesalers and distribution centers, because this is regional and local traffic for which rail intermodal does not compete—if included, over-the-road (OTR), market share below 500 miles would go up; and (2) an attempt has been made to correct for rebilling in railroad statistics, which diminishes intermodal (IMX) tonnage and locates more of it in long-haul lanes.

The table displays intermodal market share clearly and consistently climbing with distance and lane density. Market share rises as mileage rises within each category of density, and market share rises as lane volume rises within each category of distance—the combined influence of these elements (the diagonal vector of the table) generates the strongest gains. This share pattern is a direct result of service economies: railroad service performance and unit costs both improve as the linehaul component overtakes pickup and

³⁴The federal Bureau of Economic Analysis divides the nation into 172 metropolitan areas, based on the economic relationships of counties and covering all of the geographic territory of the fifty United States.

Table 4-4. Dimensions for market segmentation.

RAIL OPERATION	ACCESS CONDITIONS	ECONOMIC GEOGRAPHY
<ul style="list-style-type: none"> ■ Intermodal ■ Unit Train ■ Carload 	<ul style="list-style-type: none"> ■ Drayage <ul style="list-style-type: none"> • Rail Direct • 1-End, 2-End Dray ■ Transload <ul style="list-style-type: none"> • Unitized Lift, Ramp • Bulk Transfer • Break-bulk 	<ul style="list-style-type: none"> ■ Distance ■ Lane Density ■ Equipment Type ■ Competitive Modal Share

delivery in the transportation mix, and as the railroad production function is satisfied with train-lot quantities. OTR trucking shares the economies, but less strongly, and the competitive balance moves in the direction of rail. The same relationship holds for other equipment types, and it has held historically:

- Matrix analyses for flatbed and bulk equipment showed an equivalent pattern, although the progression was less pronounced and rail share was greater in cells where short distance unit trains operate.³⁵
- A version of the dry van/intermodal matrix prepared³⁶ 5 years earlier exhibited a like progression and higher market shares. The railroad service disruptions of the latter 1990s, combined with vigorous economic growth that rail was not positioned to enjoy, drove intermodal market shares down in the intervening years.

As a method of market segmentation, the intermodal matrix reflects a hybrid of demand- and supply-side features. Equipment type captures demand at the wholesale level in the market sector where intermodal principally operates. Distance and density are supply elements in that they embed, and in a sense are proxies for, service and cost characteristics of the intermodal product, which are the properties that customers care most for. They are demand elements as well, because they are descriptions of market activity, just as equipment type has a supply-side facet through its connection to technology. Market share introduces a competitive dynamic that is critical to the understanding of diversion and its opportunities and is helpful as a depiction of competitive fronts. The upper left half of the matrix can be understood as a truck domain and the lower right corner as something of one for rail. For rail to improve its penetration and produce relief to highways, it must be able to exploit business in its own domain with capacity and additional services, and it

must be able to push across the matrix vertically and horizontally for smaller gains, and diagonally for larger ones, with new classes of product. The location of push is the front. For intermodal in the latter 1990s, the line was rolled backward, but for the rail business as a whole, it has been on the intermodal front that traffic gains have been made.

A final supply-side factor with telling influence on the competitiveness of rail is access. The conditions of access, and the forms of drayage and transfer when access is not rail direct, are determinants of service, cost, and the addressable market. These points were explored earlier in this chapter; suffice it to say here that pickup, delivery, and transfer are major ingredients, and sometimes the principal ingredient, of door-to-door performance. Their demand-side implications are straightforward and profound.

In summary, the freight market can be segmented in three primary dimensions that are both meaningful and broadly measurable for the question of rail relief to roadways. They are the classes of rail operation, the conditions of access, and economic geography, by which is meant the combination of wholesale trucking characteristics with geographic service economies that was condensed in the competitive matrix. Table 4-4 recapitulates these classes. They utilize supply- and demand-side features and, in the former, there are demand elements also signified or embedded. They are not the only productive method for segmenting freight markets, but they are usually a relevant method and treat questions about business conditions that need to be answered.

For diversion estimation in particular, segmented market shares offer benchmarks by which to categorize susceptible traffic or can be developed further into predictive models. Data for this can be assembled from sources like the Carload Waybill Sample, public information like the federal Commodity Flow Survey, commercial databases, traffic surveys, and even planning model trip tables if they are robust enough. Equipment types can be observed directly, found in some data sources, or extrapolated from industry or commodity information using bridge tables, or with carrier cooperation. The differentiated comprehension of markets produced in this way supplies a basis for understanding the significance of barriers to diversion and the opportunities to reduce them.

³⁵These were 1996 Global Insight analyses conducted for the FHWA Truck Size & Weight study, comparing non-intermodal rail to OTR trucking in these equipment groups.

³⁶For Global Insight internal research.

4.5 Diversion Opportunities

This chapter began with an examination of shipper needs and structural factors, developing from there a segmentation scheme to consider rail projects in their market and operational contexts. There remains to review the opportunities that may exist for diversion and to classify them for planning purposes. Railroads typically approach this in terms of markets, lanes, and corridors, which is the terrain that terminals can cover and where trains will run. Public agencies are oriented to the elements of infrastructure, reflecting their mandate and the objects that congestion afflicts and railways may relieve. They can be defined as five types:

- Facilities and districts, like bridges and ports;
- Urban corridors, such as prime arteries;
- Citywide networks or the urban grid;
- Intercity corridors, like interstate highways; and,
- Regional networks, such as statewide or multi-state systems.

Four of the five types appeared as categories of rail project in the Chapter 3 case studies, but they work equally well as classifications of congested roadways and road-dependent structures. The fifth—regional networks—is broader in scope than recent rail projects really have been, and it also points up the need for comprehensive, coordinated strategies in pursuit of road relief. While state rail plans do establish programs with more of a territory-wide purpose, the key consideration is that harmonized initiatives at multiple levels—facilities, cities, and corridors—not only are mutually reinforcing, they can produce cumulative effects: within networks, within markets by changing load availability, and upon fronts of competition. In this way regional networks are a kind of meta-category, because individual projects in fulfillment of broader strategy may accomplish more than sensible, yet stand-alone, initiatives.

For the mitigation of congestion on these classes of infrastructure, the questions are what sets of traffic can be removed (or prevented from appearing) and what forms of rail service will yield results. Traffic can be considered simply as originated/terminated or overhead, meaning freight that derives from the locale of the infrastructure, or freight between external points that passes through. Traffic can be further categorized or grouped in four ways, by utilizing variations of density as a way to uncover diversion options:

- Lane volume is the basic form of traffic concentration. Sufficient volume between an origin and destination may support train block or direct train operation, each representing a step up in competitive service performance.

- Confluent volume is intermediate or combinant concentration, supporting train operation where the strands of a network come together and before they part. This is produced inside the rail system by the way traffic is marshaled and directed, or in the highway system by the dispatch routes of trucks. In the latter case, confluent volume can be intercepted in train or train block lots, provided efficient shipper door service is available through interoperability with motor carriage or through equivalence in direct rail.
- End-point density is concentration produced at the start or finish of a series of routes, by a common path prior to dispersion or by funneling into a termination point. Examples might include all of the truck traffic leaving Houston for the Northeast or all of the highway freight destined to South Florida. End-point density can be generated by physical or network geography or by logistics strategies like forward distribution, and it supports train or train block operation through the juncture where traffic is dispersed. Like confluence, end-point concentration may be divertible, provided efficient service is available to the shipper door.
- Hub or terminal concentration is produced by logistical staging. One important type is truck traffic resulting from railroad systems. This occurs at some rail-to-rail interchanges, where cross-town drayage substitutes for direct rail connection; at territorial gateways, where trucks instead of a connecting railroad carry shipments to and from the network border; and at end-point terminals, where dray trucks debouching from rail may travel an extra distance, because of the remote location of the transload facility. These cases are highly divertible to a continuous or extended rail haul, on the grounds that the business already supports train operations. On the other hand, there can be numerous difficulties in keeping the traffic on rail; for example, volume may be staged at the point of dispersion; land or land use obstacles may be prohibitive; or institutional structures may be impractical to overcome. Truck concentration at hubs and terminals can be created by other modes (such as ship lines or the motor carriers themselves), by facilities (like an inland port), and by shippers (at distribution centers). While this can present a significant business prospect for rail, it will not always present one. Block or train lot volume typically exists either on the inbound or outbound side of the facility, but not on both, and in instances like a motor carrier hub, the rail opportunity may not be larger than single shipments that are fanned out in multiple directions.

In each of these four groups, volume en route to market either offers density or is brought together to offer it, and this improves the likelihood that effective rail service will be possible. Concentrated traffic sections may be shorter than the

total lengths of haul and may consolidate multiple lanes, but diversions remain dependent on door-to-door performance. Enlarging this perspective to the full dimensions of market segmentation—moving from density to the wider scope of economic geography and examining the conditions of access—then begins to reveal the traffic that rail might remove from infrastructure and provides a foundation for analysis and evaluation with market participants. From this the questions of viability and readiness, and of appropriate levers to use, start to be answerable.

Rail operations are the remaining dimension of market segmentation and have different abilities to yield traffic results. The general opportunity for railcar and intermodal services to capture highway business is discussed next, along with treatment of the special circumstances for short-haul rail.

4.5.1 Railcar

In the 10 years from 1990 to 2000, railroad coal tonnage grew at a compound rate exceeding 2 percent, intermodal tonnage rose at a rate close to 5 percent, intercity trucking expanded at a pace of almost 7 percent, and growth in the rest of the rail business was under 1 percent annually.³⁷ Clearly, the carload traffic³⁸ was losing market share; this is the customary business of the Class I railroad industry, and it has been in long-term decline. It is also the mainstay of shortline railways and principally transports heavy loading goods that are damaging to pavements and slow moving in the traffic stream if they should divert to highways. The AASHTO Freight Rail Bottom Line Report estimates that the national road network annually avoids 20 billion truck miles traveled due to the existence of carload service and 25 billion miles due to unit trains.³⁹

Concerned that the carload business might cease to be financially supportable, a 2004 Federal Railroad Administration report evaluated the potential for scheduled train operations to keep the carload segment viable.⁴⁰ Scheduling works against the tendency of operating departments to delay train departures until more cars arrive, which improves train productivity but disrupts service (this tendency is discussed in

Chapter 2 of the Guidebook). The FRA report found that utilization benefits and the associated cost savings would meet the viability objective and retain the traffic on rail. Nevertheless, according to railroad officers interviewed for the study, the service improvements brought by scheduling would not win significant new traffic from highways. The most optimistic of a range of opinions was that carload growth might come close to the GDP expansion rate in some lanes—in other words, the business would expand far more than it has in decades, but it would not gain market share.

Setting aside the merits of these findings, the position that the carload sector is not a major venue for diversion is consistent with the Class I outlook from other contexts. Railroad merger applications during the 1990s claimed carload gains from their combinations, yet never as the primary source of traffic new to rail; for that, they looked to intermodal. In another perspective, a railroad executive who had reviewed company marketing plans for a generation concluded that carload prospects always held some promise, but for an engine of corporate growth or a meaningful alternative for highway planners, it was the wrong candidate.⁴¹

It is not necessary to foresee the future of the carload sector for the purposes of this chapter. It is possible that scheduled operations may do more than seems anticipated or that different yard technology or transloading strategies may aid them or that they may be spurred by combination with some other development. It is nonetheless true that the sector has important handicaps: marshalling is costly and time consuming, the historical business base is a shrinking part of the economy, and direct access continues to diminish. Transloading works, yet it is somewhat less efficient than the unitized intermodal: intermodal lift at \$30 to \$35 per box translates to \$2.00 to \$2.50 per ton, versus \$5 to \$6 per ton for carload goods like steel and chemicals, and the vans used for intermodal dray have better reloading options than flatbeds or tank trailers.⁴² At the high-volume end where large unit trains operate, railroads vigorously pursue and invest in the business and can be counted on to do so; while sidings, line extensions, and other access requirements may attract public support, the utility of rail should be apparent.

Rail retention of carload traffic is of clear benefit to the congested highway system, in urban districts as well as on intercity routes, and it is necessary to take this into competitive account during development of public road programs

³⁷Source: TRANSEARCH

³⁸A breakout of unit train versus carload volume is not readily available for 1990; railcar tonnage excluding coal acts as a proxy.

³⁹Table 2, page 26 of the cited report.

⁴⁰Comprehensive train scheduling is a relatively new practice among Class I railroads in the first years of the 21st Century and has been credited with contributing to the strong service and industry-leading financial performance at the CN. It had been used prior to this overseas and on at least one U.S. regional railroad, The FRA report is titled “Scheduled Railroading and the Viability of Carload Service”; citations here derive from a press article in *trafficWORLD*, 4/5/04, page 24.

⁴¹From a private conversation with a researcher.

⁴²Transload costs come from 2004 quotations obtained in the Pittsburgh and Houston markets; costs may be less in lower cost labor markets or in high-volume operations, like logistics parks. Vans are the most versatile equipment and have the lowest empty return ratios—though ratios still may be high in local markets.

and policies. As carloads segue into unit trains, the importance of retention intensifies, and since rail can do well with trainload volumes of carload goods if access is solved, repeating shipment lots starting from 2,000 to 3,000 tons apiece in a lane can become opportunities. Most substantially, the local outlook for diversion will vary from the national. If carload prospects seem underwhelming on the grand scale, their effect on an urban heavy truck corridor can be penetrating and deep. The shortline rail industry plainly has been successful at diverting or withholding bulk and other freight from congested urban areas and inadequate rural roads, and its influence primarily is on specific and local infrastructure. Three examples follow:

- The New Hampshire Northcoast (Conway Branch) operation hauls aggregates from Ossipee, NH, to the Boston Sand & Gravel transloading terminal in Somerville, MA, a distance of 100 miles.⁴³ In addition to removing an estimated 100 aggregate trucks per day from the parallel I-93 and I-95, the carrier also delivers plastic and propane to Rochester, NH, as needed. The line carries 8,950 carloads annually⁴⁴ and benefits the region in two distinct ways: (1) removal of heavy trucks improves air quality and reduces congestion and (2) the lower cost of transportation allows New Hampshire quarries to be competitive in the Boston metropolitan area, lowering construction costs.
- Many short lines carry seasonal bulk traffic (particularly grain) in the Midwest. One such carrier is the Iowa Interstate Railroad, owned by the Railroad Development Corporation. The 687-mile regional line carries 6.1 million tons per year⁴⁵ or approximately 75,000 carloads. The IAIS transports grain, steel, scrap, intermodal, chemicals, and forest products. In addition to handling ‘bridge’ traffic that substitutes for barges in the winter or providing access for bulk customers, IAIS switches many industries along its route, including major customers at Newton, Iowa City, Cedar Rapids, and Rock Island.⁴⁶ Although the bridge traffic is an important source of revenue, chairman Posner claims, “our bread and butter really is serving private-siding customers with a local freight schedule. A lot of IAIS’ traffic originates or terminates on branch lines served by short trains.”⁴⁷ This type of operation can be very effective in removing trucks from local roads, and in the right circumstances may generate substantial profit.

⁴³Blanchard (2003) <http://www.rblanchard.com/resources/texts/NE%20Railroads%2030900.html>

⁴⁴ANRP (2004) <http://www.atlanticnortheast.com/reg/railroads.html>

⁴⁵RRDC (2002) http://www.rrdc.com/company_overview.html

⁴⁶Atkinson (2001) <http://www.drgw.net/iais/railguide/operations.html>

⁴⁷Posner (2003) http://www.rrdc.com/spch_london_rsa_2003_pg_1.html

- On the West Coast, a 2003 study⁴⁸ found that the 372-mile, 10,700 carloads per annum, grain-hauling system known as the Palouse River and Coulee City Railroad (PCC) is highly susceptible to abandonment in private ownership. However, the PCC saves shippers \$2.2 million per year, in addition to keeping 29,000 heavy trucks off county roadways—creating a benefit of \$4.2 million per year in avoided highway damage. By all standards, this is a very light density line. However, even at this level of density, substantial diversions and resulting benefits are generated.

The core advantage of a shortline railroad is its low-cost function, gained from a combination of inexpensive equipment, flexible labor agreements, and light track. They act as efficient pickup and delivery networks that consolidate traffic for Class I roads, and they provide viable, light-volume local service on their own systems. Studies⁴⁹ have demonstrated some lines can operate with significantly less than 50 loaded cars per mile per year. Shortlines operable at low traffic densities are able to compete for seasonal traffic or to focus on a single bulk commodity or even a single shipper. This kind of adaptability can be a powerful answer to particular traffic problems, so that reviving disused but intact shortline railroads or increasing traffic volumes on existing ones in a local setting may be highly productive for roadway relief.

4.5.2 Intermodal

Standing on the front line of modal competition with the highway, the railroad intermodal business faces aggressive and routine rate pressure and is sometimes perceived as questionably profitable. At Conrail in the 1990s,⁵⁰ however, standard costing formulae were modified to unburden this business of expense allocations for features that Intermodal did not require—heavyweight track and certain yards and branch line networks would be examples. The restated Intermodal financial picture was then found to be one of the more profitable operations on the railroad and thereafter earned a higher priority for capital usage.

There is rich and ample opportunity for railroad expansion in the intermodal sector, more than the carriers have resources to pursue.⁵¹ If Intermodal did no more than recover the ten points in long-haul, dry van market share that it lost

⁴⁸Tolliver (2003) http://www.wsdot.wa.gov/rail/plans/pdf/grainhauling_rpt.pdf

⁴⁹“The Experience with New Small and Regional Railroads, 1997–2001” J.F. Due et al., *Transportation Journal*, Volume 42, Issue 1, pages 5–19, 2002.

⁵⁰The source of this anecdote is a former Conrail executive who was on the scene at the time. There do not appear to be any published accounts.

⁵¹This at any rate was the opinion of one Intermodal officer who talked to researchers and was speaking just of immediate opportunities.

during the service disruptions of the latter 1990s,⁵² it would take six million trucks off the road. In the 800-mile, dense and mature traffic lane between Chicago and New York, Intermodal carries 25 percent of the total traffic (intermodal plus all truck types combined); if it achieved such penetration across the board in long-haul, medium- and high-density lanes, fourteen million trucks would come off intercity roads.

The Virginia I-81 study⁵³ utilized alternative technology to resolve the problem of interoperability and called for major, corridor-wide public investment to improve capacity, terminal coverage, and track speeds. The study found that 14 percent of I-81 AADTT (average annual daily truck traffic) in Virginia could be diverted to Intermodal over 3 to 5 years and 30 percent in the longer term. However, the majority of I-81 truck traffic is overhead to Virginia and therefore longer haul; the rail services proposed for development did not address traffic shorter than 350 miles. Even so, employing interoperable technology and applying the same distance-sensitive diversion rates to national traffic, Intermodal would attract 9 million highway loads in the medium term and 27 million loads when services reached maturity. The latter represents 2 to 3 percent of current nationwide truck volume, but a threefold increase in intermodal activity, and would require considerable new capacity in lines, terminals, systems, equipment, and crews.

These are illustrations of possibilities. They focus mainly on longer distances, and they still leave dray trucks on the road. While short-haul options are reviewed in the next section, for the purposes of congestion reduction and roadway relief, the long-haul opportunities nevertheless have impact. Table 4-5 offers a different perspective on highway volumes: where three-quarters of truck trips are concentrated under 200 miles, just one-quarter of truck VMT (vehicle miles traveled) falls in this bracket. This profile comes from TRANSEARCH, and even allowing that this data source does not capture all local truck activity, it is plain that rail reduction of medium- and long-haul truck traffic has real repercussions for road demand. The consequences for highway relief are clearer than the consequences for congestion: rural roads will account for a greater proportion of truck VMT than they will for over-capacity road miles. Diversion of

Table 4-5. Length of haul distribution: Truck VMT.

LENGTH OF HAUL DISTRIBUTION: TRUCK VMT (Loads & Empties)	
Source: TRANSEARCH	
Distance	All Truck VMT
200 Miles & Under	25%
500 Miles & Under	53%
Over 500 Miles	47%

through trucks certainly matters for congestion mitigation, but interior cities will derive more benefit than a metropolis like Los Angeles or Miami situated in a kind of geographic corner, and for all of them the urban problem looms large.

It was stated earlier in this chapter that the core question in traffic diversion was, how broadly could equivalence be produced? In fact this is a twofold question, because it is not only a matter of comparable product performance between rail and over-the-road services and of interoperability. It is also a matter of the breadth of deployment, and breadth requires capacity and capital beyond what is available as this is written. Public investment to moderate the capital intensity of railroading can lift the limits on possible opportunity and modify the markets to which rail services are introduced. The bottom line for traffic diversion lies in the twofold nature of this core question: can the product be good enough, and can enough of it come to market?

4.5.3 Shorthaul Rail

Three out of four loaded truck trips travel within 200 miles, and nine out of ten within 500 miles. The shorthaul market draws the attention of planners because the truck volume is found there and because diversion of short city and intercity trips will relieve congestion where it is most common and where highways are most costly. The distance definition of shorthaul varies. To some interpreters, it is the 20 miles of the Alameda corridor; to others, it is many times longer. This chapter will use 500 miles for inclusiveness, on the grounds that it is the overnight distance for a truck. Within this, it will distinguish between local traffic up to 200 miles (which is the out-and-back distance for a truck in a work day) and regional traffic from 200 to 500 miles.

As observed before, approximately one-fourth of the carload and unit train business is local and another fourth is regional. The intermodal business is entirely different: only a bit over 10 percent is regional, and the local activity is minor. There is an assortment of caveats with these numbers, of course: rebills overstate the shorthaul tonnage, shortline traffic is under-represented, and Alameda Corridor volume is long haul because it is an end-point shuttle feeding inland

⁵²Alluded to earlier, internal Global Insight reports show Intermodal with 30 percent of the 1995 dry van business over 500 miles, versus 17 percent 5 years later. The numbers are not entirely comparable because of corrections for rebills in the later and not the earlier figures, but share losses in the ten-point range are reasonable. Because of merger-related service disorders during this time frame, Intermodal grew only moderately, while the economy expanded with vigor and logistics requirements became more stringent, so that the volume went to trucks. Traffic data here and elsewhere in this section are from TRANSEARCH, and the term 'long-haul' means beyond 500 miles.

⁵³Referenced in the Chapter 3 case studies.

trains. The obvious reason for the distinction in length of haul profiles is access: intermodal, by definition, is a transloaded operation, whereas railcar traffic enjoys direct access to a significant degree. A second reason is service: the majority of shorthaul railcar activity is in train blocks or unit trains, implying that it is sensitive to equipment capacity and can be handled through the rail network with relative expedition. Moreover, after decades of traffic erosion, it is safe to conclude that the remnant railcar business can tolerate the service it receives and disappears slowly because better alternatives (or industrial changes) are slow to arise. The general merchandise market where Intermodal competes does not travel by rail because it requires better door-to-door service, it encounters important barriers of interoperability, and its volume is comparatively fragmented on a per-shipment basis.

These are explanations of the status quo. Since an objective of this report is diversion, the true interest is in new traffic opportunities, and there the profile alters. Whereas Intermodal retains the difficulties that depress its participation in shorthaul markets, the railcar sector loses its advantages: access for new customers becomes much more of an issue, block volumes have to be sought, and service has to stand up to incumbent competition. The biggest obstacle for both sectors is the time factor. Regional overnight truck transit is 11 hours or less; local transit is 4 to 5 hours and can be same-day delivery. High-speed rail operations do not help much, because there is not enough distance over which to gain time—freight rail usually benefits from higher speed when it can run for 24 hours straight through. Delivery windows are vital: customers who can accept next afternoon or evening receipt are much more serviceable by rail, but this is not the normal pattern of business. Finally, complexity of operation is the enemy of transit time and of reliability. Solid trains that can be quickly assembled may be successful if yards and main lines are uncongested; conversely, marshalling requirements and scheduling conflicts bring delays and service failures.

The second major obstacle is the relative profitability of traffic. The Florida East Coast Railroad (FEC) is a regional line offering corridor services between Jacksonville and Miami.⁵⁴ Multiple intermodal trains operate daily on the 350-mile lane along the Florida coast, supporting local service but especially providing interchange at Jacksonville to motor carriers and Class I railroads traveling further into the continental United States. Railcar business includes unit trains of stone and cement; in one operation, two to three million tons of rock are brought 200 miles from south Florida to Cocoa, then transloaded and drayed 50 miles to construction sites around Orlando. Traffic of this kind is attractive to the FEC for at least

⁵⁴The information presented comes from the Florida East Coast website and from the Freight Goods and Services Mobility Plan of MetroPlan Orlando (the MPO for Orlando, FL, region).

two reasons. First, the peninsular structure and economic geography of Florida makes for famously imbalanced traffic and channels it into dense lanes. These features play to the strengths of railroading, they keep rate levels high, and they discourage motor carriers from committing their own assets to the territory. Second, as a regional network in isolated geography, the FEC is not considering other prospects.

Profit contribution is a function of margin and quantity; in freight transportation, the quantity is composed of shipment volume and distance. Shipments of equivalent size and margin are more attractive to carriers at longer distance and, when the efficiency of linehaul is factored in, there is sound reason for railroads to prefer longhaul business. Even so, the decisive element for Class I railroads in considering traffic opportunities is the rationing of capacity and capital. The business prospects for these carriers are not seriously limited by the size of the market, but rather by what they can act on. In most cases, the profit contribution from shorthaul traffic is lower than from longhaul, causing assets to migrate from one to the other and depriving the regional and local business of any exclusive investment. Class I choices will continue to favor the long-distance options, unless the ground rules are changed by new resources.

The motivations for shortline railroads stand in contrast. On light-density networks, the non-traffic-related maintenance-renewal burden (such as corrosion, weather, and degradation) dominates the capital requirements, and the shortline business model therefore has tended to focus on generating traffic to build up traffic density.⁵⁵ This is a different and more accepting regimen than asset rationing, although it is unclear what happens when capacity is tapped out. As to business mix, opinions differ as to whether interchange traffic or local, single-line traffic is the primary money generator on a shortline.

For a carrier that is not a switching road (whose rates are tied to the serving Class I's), the dollars generated from interchange traffic can depend mainly on negotiating ability with larger carriers over revenue splits and on Class I strategy with respect to shortlines and carload shippers. The local traffic, on the other hand, is entirely under shortline control and has various cost advantages over interchange business—more intensive equipment utilization is possible, for instance, and much reduced management overhead—so that the lower revenue per car in local lanes still is very attractive. Shortlines

⁵⁵There had been much research into the economics of shortline railroads, most of it treating the cost aspect of the business. References include "Success and Failure of Newly Formed Railroad Companies," John Due and Carrie Meyer for US DOT, 1988; "Short-Line Railroads Performance," Michael Babcock et al., *Transportation Quarterly*, 49.2, (1995), pages 73–86; and "Financial and Demographic Conditions Associated with Local and Regional Railroad Service Failures," Eric Wolfe, *Transportation Quarterly*, 43.1, (1989), pages 3–28.

also can extend their role as low-cost carriers to contract for trackage rights and operate over secondary Class I right-of-way, turning interchange into single-line business. Where the Class I track space is not constrained, such tactics may be productive and generate additional profits for the smaller railroad. Shortline strategy directed at single-line opportunities thus can be effective at combating local congestion, since goods may be moved in volume and at lower rates than interchange traffic. A prominent⁵⁶ example is the Nittany & Bald Eagle division of the North Shore Railroad Company, which operates a 12-car shuttle train twice daily on an 8-mile run, bearing 1.1 million tons of stone annually and keeping trucks in the tens of thousands off central Pennsylvania roads.

Class I Railroad officials discussed short-haul operations in Intermodal at the Transportation Research Board meeting in Washington, DC, in January of 2003.⁵⁷ Only two of the active examples cited actually were under 500 miles, but the success factors identified were notable: routes were single-line and not circuitous, drayage requirements were significantly curtailed, traffic was concentrated, volume was balanced by the lane or network, terminals were efficient and well situated, and trains were fast, reliable, and sufficiently frequent. One highlighted service was the CP Rail Expressway, which is believed to carry 2 to 3 percent of the truck volume on the continuous corridor from Montreal to Toronto (330 miles) and then on to Detroit (230 miles) (see Figure 4-7). Using ramp-style intermodal technology, Expressway is highly interoperable with motor carrier fleets, and its twice-daily departures in each direction produce dependable overnight service. The mature potential of the operation was estimated at 12 to 15 percent of corridor volume without capacity expansion and, with expansion, one out of three trucks was projected to be divertible. All rail officials, including CP Rail's, stressed the necessity of high- (or excess-) capacity corridors for short-distance intermodal operations, not because the services specifically required it, but because the short-haul profit contribution would not justify right-of-way investment, barring public support.

The local and independent intermodal corridor service of Northwest Container is described in the inset box. This company has stepped outside of pure freight carriage in order to boost financial returns and uses a management approach comparable to truck lines to drive out utilization inefficiency. As a business model, this firm represents a home-grown version of open access and is reminiscent of the effi-



Figure 4-7. Rail Expressway.

cient regional players in the trucking industry, who construct an effective set of operating economies within disciplined territorial bounds. The operation is analogous to a shortline taking on Class I trackage rights in that both produce some control of train service and yet neither one ever escapes the problem of capacity. Northwest Container is able to acquire a contract train because its payment is competitive with other uses for the Class I track; if high-volume, long-haul corridor service began to consume track space, the Northwest train slot (or its financial feasibility) might be jeopardized. Moreover, as a case study in short-haul highway relief, Northwest Container is instructive for what it does not do as well as for what it does. In the view of this company, conventional intermodal service is not competitive for the truly local domestic market.

Thus, the two major barriers of time factors and relative profitability remain in place. Shortlines and purchased transportation can be effective, but eventually they will reach capacity constraints and must deal with the limits of geography and density (and be helped by industrial development programs). Short-haul rail plainly does work in niches, perhaps including trans-urban corridors like the Chicago Airport Express, and it certainly can function as an end-point service feeding longer haul traffic. Nevertheless, without public investment to change the profit comparison, short-distance rail is not likely to succeed as a broad alternative to road congestion, and with public investment, the predicament of time performance may be intractable in very many instances or require unconventional technology or exceptional innovation. The truck VMT distribution suggested that road relief reached through the regional and long-haul markets can have a material result for congestion. In the local and urban markets, there are strategies to employ that will touch the problem, but there is also a dilemma.

⁵⁶Prominent because it earned an American Short Line and Regional Railroad Association 2003 marketing award. The information is from the North Shore website.

⁵⁷Points are taken from notes at the session by the author of this chapter and from subsequent interviews in Canada.

Case Study 2: Northwest Container Services⁵⁸

The core operation of Northwest Container Services is a daily stack train supplied to the international trade, between the Portland, OR, market and the seaports at Seattle and Tacoma, WA. Containers drayed through a Portland terminal are railed 170 miles to Seattle piers. Trains run north and south 5 to 6 days a week, bearing 110 to 140 units and removing 60,000 trucks annually from the crowded I-5 highway corridor. The company claims 99 percent on-time performance against container-ship cutoff times and backs up rail with over-the-road service if necessary. Northwest owns the terminal and the railroad wellcars used in the operation and purchases dedicated trainload service from the Union Pacific, which provides track (including maintenance and signaling), power, and crews. The firm is Oregon-based and privately held, receives no public funds, and is neither a railroad nor a motor carrier.

The economic geography of the Pacific Northwest supports this operation by creating a north-south funnel for freight in a strong foreign trade basin. The call pattern of container ships has rendered Seattle/Tacoma a major load center port and has placed Portland in a feeder role, so that there is heavy traffic between the two. Containers are in ample supply because of trade imbalances, and those bearing the region's forest products load above interstate highway weight limits, which rail is able to accommodate. These natural advantages help to establish a niche market, and stack train economics paired with a single-end dray help rail to contend for it, but the critical factor for this short-haul corridor is the service window of the ship lines. Sailing schedules create slack time at either the origin or destination of every load, covering for the terminal handling and dray delays attendant to rail, and allowing it compete against 4-hour highway drive times in a way the domestic market does not allow. Rail intermodal can meet the ship schedule without being as fast as a truck door-to-door, and according to the company, this is the key reason Northwest has stayed out of the domestic business.

Beyond these market factors, the company succeeds for three critical reasons:

- A high degree of operational control is created by asset ownership and train purchase. The Union Pacific can change the time of train departures, but it does not decide whether a train will run. This is strengthened by local hands-on staff, motor carrier alliances, and good customer relationships, so that Northwest knows the full logistics detail for any load.
- The Northwest approach to managing train utilization is comparable to truck line tactics. Customer service representatives book loads and work with customers on individual container schedules, in order to keep trains full. The company also builds up inventories of loaded containers and uses them to balance trains.
- Northwest markets a full-service transportation package, which has two important advantages. First, the product is a turnkey set of services, which together make it easier to do business intermodally. The firm inspects and maintains equipment, handles logistics, and offers complete container yard functions, with chasses, repair, storage, and pre-tripping. Second, the profitability of the operation derives from the cumulative contribution of the set of services, each of which has thin margins; the company believes that the rail service alone would be insufficient to sustain itself.

4.6 Social and Economic Impacts of Diversion

Modal diversion changes the location and technology of freight carriage. This implies that its social and economic impacts mainly are incremental, modifying an incumbent body of traffic, rather than introducing a fresh influence⁵⁹ to a region. Diversion brings more volume to rail routes and rail facilities, where the relatively favorable rail emissions profile, for example, may still mean more total emissions in the vicinity. Diversion reduces traffic on highway routes, providing a better operating environment for trucks that remain on the road, and safer, faster travel for passenger vehicles. Given the service characteristics and network density of the U.S. rail system, most opportunities for diversion from highway to rail will require transloading of freight; thus, trucks performing pickup and delivery will stay on the road and will acquire new patterns of traffic concentration. Analysis of the effects of modal shift thus requires a careful examination of the complete logistics chain, for direct and indirect impacts.

⁵⁸Information presented here is taken from an on-site interview by the author with executives of the company. Conclusions about success factors are those of the author, unless specifically attributed to Northwest.

⁵⁹Due to the configuration of the rail network and the way it is operated, traffic diversion of long-haul shipments sometimes moves the route of travel into a new region of the country, in contrast to the highway route.

The societal impacts of diversion of freight from highway to rail can be classified into four areas: shipper related, direct highway, direct rail system, and indirect or collateral effects. In addition, there are four main drivers of negative social externalities for freight movements: (1) physical volume; (2) traffic distribution, in space and in time; (3) load characteristics; and (4) operating profile. These underlying variables related to the way freight flows combine to place a burden on the host community through their collateral impacts, resulting in effects such as accident risk, noise, vibrations, visual quality impacts, detriment to community cohesion, impact on property values, and vehicle pollution such as particulates and nitrous oxides. Beyond their negative consequences, freight flows reflect economic vitality and generate economic benefits. As freight is produced or consumed, value is being added in supply chains and gross regional product is augmented.

Diversion produces a new net result from these varying influences, transferred in location and transformed in the method of operation. This section reviews the classes of incremental impact and the factors that affect them, and it closes with an overview of diversion models.

4.6.1 Forms of Incremental Impact

The ways in which freight transportation affects a community are many of the same ways that modal diversion affects it marginally: through economic development and competitiveness, safety and security, congestion, and quality of life. In each category, however, there are circumstances and implications that are particular to the character of modes, so that the ramifications are complex and diversions involve trade-offs. Truck traffic removed from the highway, for example, shrinks the highway's maintenance requirements by eliminating some of its costliest vehicles, and the burden is moved to the private maintenance budgets of the railroad right-of-way. On the one hand, the added traffic may strain railway capacity and cause it to seek public support for expansion. On the other hand, capital injection may be a one-time expense, while maintenance costs are permanent and ongoing, and the latter might be recovered from shippers through freight rates, instead of through the general funds of DOTs. The major forms of impact and some of their multiple facets are

- **Economic Development and Competitiveness:** A primary benefit of more efficient transportation systems is enhanced economic productivity, development, and competitiveness. In various periods during U.S. history, evolution in transportation technology from canals to railroads to interstate highways allowed much of the interior to be developed through improved accessibility. Today, as the transportation system continues to evolve, the focus has turned to using intermodal networks and choosing an appropriate mode for each flow, allowing transportation

costs to be diminished and the accessibility benefits of a multimodal freight transportation system to better realize its potential.

Freight transportation upgrades raise the productivity of businesses in a region in one or more of the following ways:

- Reducing the cost of shipping;
- Reducing the time-variability of shipping (thereby improving supply chain performance);
- Reducing the time for shipping (also improving supply chain performance);
- Reducing the risk associated with shipping (thereby avoiding cargo loss and damage); and,
- Improving access and responsiveness to markets.

Diversion from truck to rail normally will reduce transportation costs at the expense of a longer journey time. In highway-congested areas, rail can have lower time-variability, although rail typically is less dependable; in rail-congested areas, highway drayage is often offered as a by-pass route. For low-valued bulk commodities that divert to rail, the net effect of time and expense will be lower total logistics costs and, in some instances, a rail-connected distribution center may be replacing a local processing site. For rail intermodal, in lanes where it offers genuine truck-equivalence, transit time will match the highway and overall service performance will be competitive. In these cases, total costs will be lower because rail will reduce the transportation component, and equivalence will render the logistical effects immaterial—but there will be no logistical gain. Cost reductions produced in these ways have impact by generating a direct benefit to the shipper's business and a trickle-down benefit to the rest of the regional economy, leading to increased economic competitiveness. In the aspect of loss and damage, rail haulage changes the nature of risks associated with these factors, as is discussed below.

- **Safety and Perceived Safety:** When truck freight activity is replaced by rail freight activity, risks in rail accidents are substituted for risks in highway accidents. The risks are different in nature and cause different problems, although both can be mitigated effectively with appropriate safety programs. The highway is an open environment; other than driver licensing programs and DOT inspections, there is little centralized control over the movement and condition of driver and vehicles. It is also a shared facility—accidents involving trucks usually result in many more fatalities than automobile-only accidents; disruption caused by truck accidents can inconvenience many automobiles. However, compared with rail accidents, even major truck accidents seem non-catastrophic. Routine railroad incidents usually result in lesser consequences than a comparable incident involving a truck, because of the design of railcars, but a major rail incident can result in the evacuation of a neighborhood or an entire town. When

railcars fail, damage to freight, equipment, and the environment tend to be much more severe simply because of the much greater equipment capacity.

In the chemicals sector, replacing truck flows of bulk dangerous chemicals with rail improves safety in transit and loading. Tank railcars, by design, allow a more controlled discharge process and have a smaller likelihood of spills per volume of liquid transported (*TRB Special Report 243: Ensuring Railroad Tank Car Safety*). The safety benefit extends beyond the terminals. Diversion also changes the risk exposure profile, shifting the spill risk from public highways and main streets to private railroads. Tank cars in addition are engineered to much higher standards and are usually not ruptured in derailments. In general, conversion of bulk chemical flows from truck to rail is considered a safety improvement, especially in the public perception because of its obvious effect in removing large chemical tankers from the highways.

Evaluation of safety benefits is based on risk assessment and risk mitigation. Risk assessment involves identifying accidents that may potentially occur and estimating the likelihood of their occurrence. Probabilities are generally calculated by taking an average over a number of past years. Risk mitigation means to devise a scheme that can reduce the probabilities of accidents occurring or, given that the accident will occur, how their severity and public impact could be reduced. Relating to chemicals transportation safety, this might mean making funding available for training of operating and emergency-response personnel. In the context of rail freight solutions, rail diversion might be explicitly stated as a mitigation strategy that could reduce the probability of spills and highway accidents. In some cases, for highly hazardous commodities, the cost of delay associated with rail shipments could be budgeted as a risk mitigation item, which the government, or a particular shipper, could commit to as a part of a deal to reduce unacceptable levels of risk.

- Security Impacts: Rail and highway transport plainly present different security risk exposures. However, the extent and direction of these impacts are not well understood. 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 exceptionally difficult, while thieves and others sometimes intercept truck shipments. Railcars also tend to carry far larger quantities, but it may be easier to keep track of one unit-train or block of cars, versus hundreds of truck movements. 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.

- Quality-of-Life Effects: There are many quality-of-life impacts associated with freight traffic moving by rail; some of these are found in Weisbrod and Vary (2001, *NCHRP Report 456*):
 - Pollution: Particulate matters, NO_x, Volatile organic compounds, and CO;
 - Noise and vibrations;
 - Visual quality;
 - Community cohesion;
 - Property values.

Rail carriage generates less air pollution per unit of freight than motor carriage. Diversion to direct rail shipments produces a fairly straightforward benefit in this respect. Transloaded rail is more complicated, because while emissions are lower during linehaul, trucks performing pickup and delivery concentrate around terminals instead of being dispersed and can drive circuitous loaded miles and additional empty miles by comparison to an all-highway operation. The net result normally is positive, but it is dependent on linehaul distance, and thus is lessened in shorter lengths of haul. Whether direct or transloaded rail is the recipient of diverted freight, the travel route almost always is different and will affect new zones, while the smaller rail network may tend to channel traffic volume to a greater degree than highways.

Noise and vibrations relate mainly to residential neighborhoods and are particularly prevalent where interstate corridors or railroad corridors run adjacent to highly developed urban areas. Visual quality is difficult to assess. Transportation facilities generate visual impacts in proportion with their size. Diversion to rail normally would not solve this problem; it merely changes the location where such cosmetic problems occur.

The adverse effect of transportation arteries on community cohesion is well documented in the literature.⁶⁰ The issues relate mostly to the existence of infrastructure, but also to an extent their operations. A new bulk traffic generator, such as a transload facility, could adversely affect formerly cohesive small towns along the route of the new freight movement. The town may have to trade off potential for economic development against drayage congestion or grade crossing traffic, when deciding whether or not to allow new facilities to be constructed. Property values may change, attracting commercial interests but harming the residential; similarly, removal of freight traffic from roadways can be an adverse development for businesses that serve it, yet may make the facility more benign for dwellings in the area.

⁶⁰For example, see Community Impact Assessment Website at: <http://www.ciatrans.net/ciahome.shtml>.

- Congestion: Trucks are slower in acceleration and deceleration than automobiles and are both larger vehicles and possessed of a larger footprint in highway capacity. Volume delay curves show that incremental trucks contribute disproportionately to deterioration in highway levels of service and imply that small amounts of diversion have extra leverage in their impacts. As they did for emissions, the conditions of access matter for congestion effects, with diversion to transloaded rail offering less benefit and possibly introducing new issues. Road-rail interaction at grade crossings grows with diversion unless it is explicitly headed off in project plans. Finally, undiverted trucks operate in less congested, more efficient conditions, making them more difficult to capture as rail services mature.

The consequences of diversion for congestion also are two-sided. Although an interstate lane nominally carries 1,200 vehicles per hour,⁶¹ at super saturation the capacity can be much lower. Removal of perhaps, 30 heavy vehicles per hour, each with a passenger-car-equivalent (PCE) of 3.0 to 4.0 during the rush contributes 10 percent more capacity to a single lane. This impact can be significant if the roadway does not attract additional traffic as a result of its decreased impedance.

On the rail side, removal of 30 trucks per hour translates to about 240 boxcars per day—perhaps two to three merchandise trains and a somewhat larger number of intermodal trains, depending on the equipment profile. The impact of this on rail system congestion varies, depending on the system. Most rail lines can support one additional train per day without great difficulty, but if the yards or lines are already running near capacity, the incremental traffic removes any delay recovery margin, which can lead to a gridlock of rail systems.

Rail congestion can have additional impacts on abutters. If existing trains are lengthened, the gate downtime at grade crossings could increase. Yard congestion potentially leads to more yard movements, which produce more noise. If a significant amount of traffic is diverted, formerly quiet mainlines could become quite busy, increasing risks for trespassers and others.

4.6.2 Factors Affecting Incremental Impact

The burdens and benefits that diverted freight flows produce for a host community have several determinants. Some are inherent characteristics of the freight and are dependent on the economic geography of the area and thus not easily changed—diversion will tend to reduce congestion on some highways and increase congestion on the railroads and near transload centers. Others could change over time or be modified by operational design. The prominent factors are

- Volume of freight diverted,
- Persistence of traffic diverted,
- Economic value of flow,
- Operational profile of modes, and
- Local conditions.

The influence of volume is obvious, since the externalities generated by freight movements are proportional to the number of discrete equipment movements that take place. It is modified by operational profiles in ways that this chapter previously has described: by modal loading characteristics, network geography, routing and consolidation, and access. Transloading, for example, replaces trucks operating over a variety of routes—thereby spreading the congestive effect through a wide area—with routes consolidated around rail terminals. The smaller rail network with its need for trainload volume favors traffic concentration, even as it relieves the highway, so that externalities also become concentrated. Communities that will tolerate small and gradual growth around existing rail facilities—particularly when such growth is attained by increased terminal utilization without major construction or property taking—will react differently to the substantial new volumes and infrastructure that material reduction in road congestion may entail.

The local considerations this points up are manifold. Heavy truck traffic through residential neighborhoods, on narrow streets, and near schools and other public gathering places tends to get more attention than that traveling on the interstate highway system. Rail solutions may relieve these situations (as with direct rail service to ports) or they may create them. On some interstates, where trucks make up a proportion of total traffic that becomes meaningful to motorists, diversion of freight can develop political urgency, but its rerouting can meet resistance. For example, increased traffic on rail lines or truck concentrations around intermodal terminals may be found objectionable. (One possible solution is to borrow from the interest in truck-only lanes and create exclusive truck connectors between interstates and intermodal facilities, especially when the distances are short.) The diversity and conflict of the local conditions that surround freight traffic—social justice concerns, jurisdictional layers and turf, residential versus employment interests—can exceed what railroads have the ability or the stakeholder mandate to balance. As such conditions shape the impact of diversion, their effect may be to stifle it, simply because the conflicts are too troublesome to reconcile.

The persistence and economic value of flow bear on the impact of diversion from a number of angles:

- Persistence of Traffic: Some traffic is a short-term, one-off movement of a single significant shipment—for example, a large transformer, space-shuttle parts, or tent rigging and

⁶¹NCHRP Report 350: Highway Capacity Manual

scaffolding for a special event. Some traffic is of a one-off nature, but occurs over a number of months due to the volume of material that requires shipping—such as a large construction project or the decommissioning of a nuclear plant. The remainder of traffic is broadly continuous and cyclical—a flow expected to continue for an indefinite amount of time, fluctuating depending on marketing, seasonality, and other periodic factors, like the movement of grain after harvest, movement of ores for processing, coal going to power plants, imported apparel moving to stores, and manufactured parts or products moving from factories to the consumer.

The environmental damage done by large volumes moving in a short period or small volumes moving throughout the year might be the same, yet the public perception of the problem is likely to differ, and therefore evaluation of potential impacts of diversion should account for this perception factor. Since setting up rail access requires substantial infrastructure investment, traffic that could be ongoing is more likely to succeed than one-off moves, making rail diversion better suited to traffic that is sufficiently persistent to be considered consistently problematic. Investment could be effective for peak-level traffic that is highly seasonal, such as grain gathering or construction traffic that is concentrated in the summer months, as well as steady if cyclical traffic, such as container flows from large ports.

- **Economic Value of Flow:** Different commodities correspond to distinct industries and supply chains, with characteristic job densities, job features, and economic relationships. These variables in turn determine to what extent transportation infrastructure investments produce local development (or indeed, how diversion to slower modes or how lack of suitable capacity will retard local economic progress). Value of goods also is related to the risk of transportation failure: if a single truckload of seasonal goods does not arrive on time due to road or rail congestion, loss of revenues from a single 1-day delay can be significant—perishable goods may perish, fashionable goods may miss a day of their ephemeral market. Diversion from road to rail may increase such risk, since rail disruptions affect full trainloads of goods. An open question is the degree to which current logistics and supply-chain processes can be re-engineered to take advantage of rail; where this happens, it changes the influence of rail services. Private enterprises undertake such evaluations on their own and public planners may not be privy to them, but dialogue could be revealing.

4.6.3 Modal Diversion Models

Modal diversion of freight traffic follows from the creation of a shift in the competitive balance. Typically this comes about

through a change in the available door-to-door service or cost or through the lifting of a constraint. The shift will be greater if the change is structural, such as a rise in input costs, a technological advance for service, or an expansion of network. More commonly, though, the change is the introduction of a grade of transportation that is offered in other markets but is new to the one in question or that sometimes represents a new generation of product offering. Assessment of the diversion prospects for a project or program should examine first its competitive dynamics and the durability of the modal advantage it ought to produce. It should next consider the barriers to diversion, as they are relevant to the case, and how satisfactorily they will be answered. Projects that make sense in basic ways can then be subjected to deeper analysis.

This chapter has reviewed the use of market segmentation, traffic benchmarking, and classification of opportunities to commence such analysis. Diversion models are tools for further and detailed assessment, at the level of individual lanes and commodity, equipment, or industry groups. The latter function as a way to generalize retail or wholesale customer needs and the former to isolate and differentiate competitive performance, with volume reckoned in both dimensions. Three types of models in active use focus on logistics cost, market share, and customer preference. They are designed to construct quantitative estimates of traffic swings, and all of them in some form call for market data, establishment of algorithms, and the contrasting of rival transportation products.

- **Total Logistics Cost models** aim to compare the comprehensive costs of modal choice alternatives, including direct transportation expense, and inventory dollars associated with modal lot sizes and service profiles. The models assume that customers rationally select the lowest cost option, and they require extensive information about logistical factors in transportation and industry to produce this comparison. They can be deterministic in that shipments become assigned to one mode or another, while retaining stochastic features to treat inventory risk and carrier performance, or they can allow for probability in the modal choice itself. The FHWA has employed a model of this type in its truck size and weight studies.
- **Market Share models** develop a statistical correlation between modal performance factors and traffic capture, then project traffic swings when relative performance changes. The correlation is derived from historical traffic patterns and, in that sense, is experiential, reflecting the results of carrier behavior as embedded in share. Performance factors typically include comparative transportation but not total logistics costs—first because transportation costs by themselves produce strong correlations, and sec-

ond because logistics burdens can be regarded as accounted for, or ‘discounted’ in historical capture rates. The models assume that experience is a rational basis for projection, they require historical information for their preparation, and they produce probable shifts in share from the alteration of competitive position. A model of this type has been employed by Class I railroads in a number of merger applications.⁶²

- Stated Preference models are developed from structured interviews with transportation purchasers. Through an extended set of forced choice comparisons by which the buyer makes trade-offs between performance characteristics, the process seeks to reveal decision points for mode shift. Statistical analysis of interview results can then be applied to project probable traffic diversions in response to changes in competitive service offerings. The models assume that statements replicate decision conditions and behavior, they require a program of interviews for their preparation, and they can be targeted to retail or wholesale participants. Models of this type have been employed for customer research at some railroads and for public rail initiatives like the New York Cross Harbor major investment study.

⁶²One of the authors of this report provided the model referred to here.

Freight flow is not a constant. In some circumstances, the traffic will evaporate due to factors outside the transportation arena—for example, local labor rates or exhaustion of natural resources may force certain industries to relocate from the region, however much the transportation costs are minimized. For very-high-volume flows and modest investment, it is possible to set up rail flows that pay back the initial investment within a short period. For more ambitious schemes, a more general local economic assessment is required, to ascertain whether the target flows will remain for the foreseeable future.

4.7 Summation

This chapter has considered how shipper needs and structural factors delimit the expansion of rail freight, how market analysis techniques can point toward promising segments where diversion challenges might be overcome, and where real opportunities are more and less likely to lie. It has summarized the effects of diversion when it occurs—and these effects in turn may form the justification for programs that produce it. Railroad solutions clearly can be an effective method to reduce road congestion and just as clearly have their own limitations and consequences.

CHAPTER 5

Trends Affecting Freight Movement

5.1 Overview of Trends Discussion

5.1.1 Objective

This chapter is focused on a single straightforward objective—to summarize key transportation and economic trends that affect the nature of roadway congestion and potential opportunities for using rail freight as a solution to that problem. Since this need to address congestion and the opportunity to use rail freight is already presumed in the justification for this very report, informed transportation planners may consider many of these trends to be self-evident. However, the priority that politicians and decision-makers may give to rail freight solutions will in fact be driven by first establishing the strength of the case that: (1) congestion is a growing problem, (2) it is changing in its nature due to shifting economic and land development trends, and (3) rail freight can sometimes be part of the solution.

5.1.2 Organization

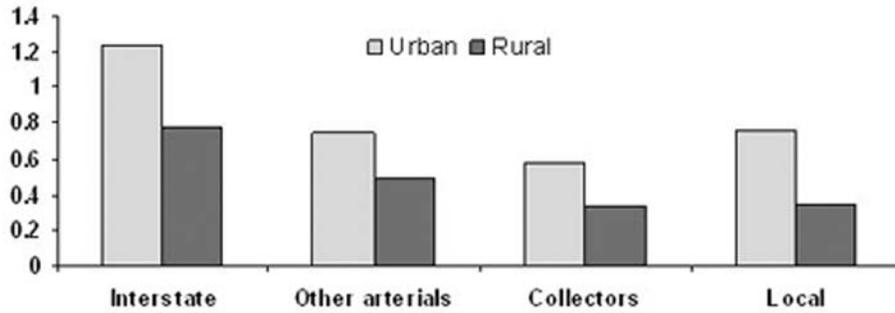
Accordingly, this Chapter is organized in five additional sections:

- Section 5.2, Congestion Cost Trends. This section documents the fact that growing traffic levels are leading to increasing road congestion problems. In addition, rising transportation labor costs are exacerbating the costs of congestion delay to shippers. These factors help to justify increased public attention to the business costs of congestion and the need for solutions that reduce those costs in the future.
- Section 5.3, Role of Trucks in Congestion. This section provides summary data illustrating the fact that truck traffic is a major contributor to overall roadway traffic. As more and more roadways approach full capacity, the incremental impact of trucks on congestion delays is also rising. These facts help to explain the need for attention to trucks

as an increasingly important part of the congestion problem, and thus an important part of its solution.

- Section 5.4, Growth in Freight Activity Levels. This section examines how changes in the U.S. economy are increasing freight volumes, particularly for small size, shorter distance, and higher value shipments. These trends are useful to highlight, since the feasibility of rail freight alternatives to truck shipments also vary systematically by distance, commodity value/weight ratio, and ultimate destination. Freight diversion and public investment decision models, discussed later in this report, will build on this type of information.
- Section 5.5, Business Location and Land Development. This section examines how business location and urban land development patterns are systematically moving toward a dispersion of activities that tends to favor highway shipping and disfavor rail shipping. This helps to explain what is already known—that truck is growing faster than rail as a mode for freight movements. However, this information has further use, for it also helps to establish a basis for determining the situations under which rail can (or cannot) be a potentially feasible alternative to truck for freight movements.
- Section 5.6, Technology Trends. This section outlines key aspects of technological change affecting the feasibility and cost-effectiveness of both rail and truck to serve freight movements. There is still much debate in the industry over which technologies will blossom in the years to come, so this discussion is focused on documenting what is now occurring and how potential future changes may affect future tradeoffs among rail and truck to move freight in some congested areas and corridors.

Note on Freight Data Sources: Some of the information contained here derives from the FHWA's Freight Analysis Framework. This body of information is undergoing an update that was not completed when this chapter was assembled. Similarly,



Source: U.S. Department of Transportation, Federal Highway Administration, Highway Statistics

Figure 5-1. Highway Vehicle-Miles Traveled by Functional Class, Percent Change 1980-97.

some of the national estimates of freight shipment characteristics presented in this report are based on Commodity Flow Surveys (CFS), conducted by the Bureau of Transportation Statistics and the Census Bureau every 5 years. Conducted first in 1992 and then in 1997, the CFS is the nation's primary and most comprehensive federal data source on domestic freight movement. Earlier commodity surveys were conducted between 1962 and 1982, but data for 1982 were not published. No data were collected for 1987. When the information presented in this chapter was assembled, a preliminary report on CFS 2002 had been published. Final CFS data were still coming, so some of the traffic and commodity flow trends shown here could be displayed to 2002, and some only go through 1997. Nevertheless, these variations in data availability do not affect the nature of validity of the trends illustrated here.

5.2 Congestion Cost Trends

This section provides summary data illustrating the key fact that traffic demand is growing and leading to increasing road congestion over time. Additional factors are also increasing the economic stakes, in terms of the unit cost of congestion delay to shippers. While these facts may seem obvious to informed transportation planners, the depth and breadth of this growing problem is not universally known to all public decision-makers. Yet, an appreciation of the problem is a necessary first step for even considering the investment of time in exploring multi-modal solutions and public-private cooperation.

5.2.1 Road Travel Demand Continues to Increase

Total vehicle-miles traveled (VMT) on public roads has continued to grow. It increased 68 percent between 1980 and 1997. The urban VMT growth (83 percent) outpaced rural VMT growth (49 percent) over this period, which is

a reflection of population shift from rural to urban areas (see Figure 5-1).

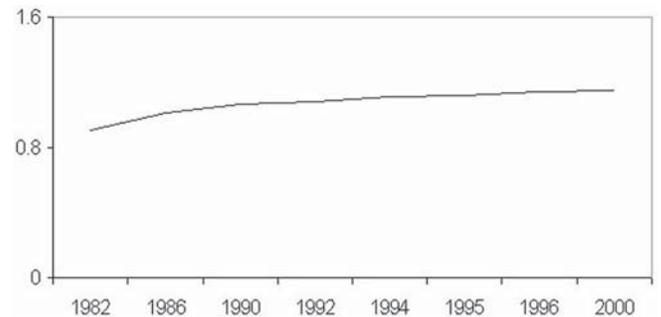
5.2.2 Rising Congestion as Supply Does Not Keep Up with Demand

According to the Texas Transportation Institute's annual report, the average highway congestion index (measured by volume per road lane) has been steadily rising over time. It increased 25 percent between 1982 (average value of .91) and the year 2000 (average value of 1.15) (see Figure 5-2).

Urban highway congestion and traffic delay in the United States is particularly rising. According to the urban congestion indicators for 70 urban areas compiled by TTI, drivers experienced an average 40 hours of delay in 1996. This was 8 percent more than in 1990 and 150 percent more than in 1982 (see Figure 5-3).

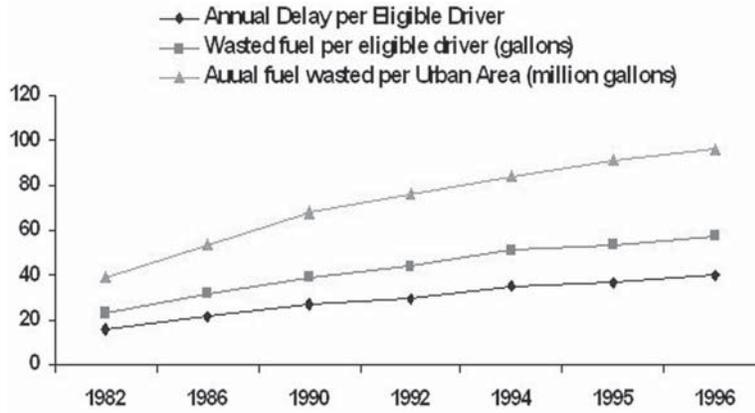
5.2.3 Rising Cost of Congestion

The TTI study estimated that the total annual cost of congestion in 75 urban areas reached \$67.5 billion by the year 2000. That value is estimated to include \$58.5 billion due to time delay (labor productivity loss) and \$9 billion due to wasted fuel. Aver-



Source: Texas Transportation Institute

Figure 5-2. Average Roadway Congestion Index.



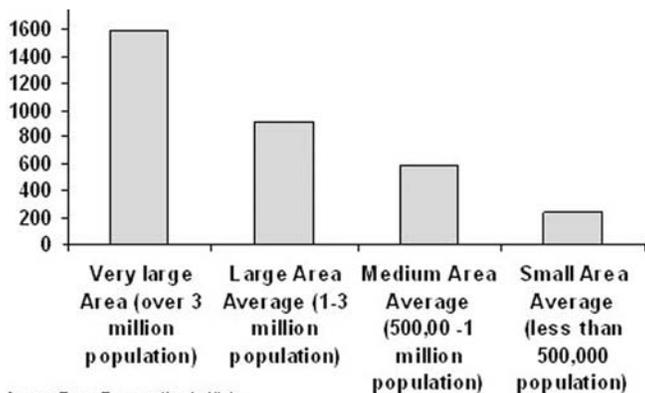
Source: Texas Transportation Institute

Figure 5-3. Urban Congestion Indicators for 70 Urban Areas (selected years).

age costs of congestion ranged from \$595 per driver in smaller cities to \$ 1,590 in large cities (see Figure 5-4). Even after adjusting for inflation, the unit cost of labor in transportation industries has continued to grow. Between 1990 and 2002, transportation labor costs increased by 47 percent (see Figure 5-5). In trucking operations, driver wages constitute about 30 to 50 percent of the costs of operations. Altogether, this means that the unit cost of truck driver time delay is continuing to rise, making the total business cost of congestion rise even faster than the growth in congestion time delay. Recent increases in the cost of motor fuel since 2003 (Figure 5-6) represent another factor exacerbating the increasing costs of congestion over time.

5.2.4 Increasing Breadth of Congestion

Traffic congestion is expanding across the United States. Figures 5-7 and 5-8, developed by Battelle Memorial Institute from FHWA data, show the geographic breadth of highways that are over-capacity and approaching full capacity, for both 1998 conditions and forecast 2020 conditions. The growth of congestion among inter-city corridors is particularly striking.



Source: Texas Transportation Institute

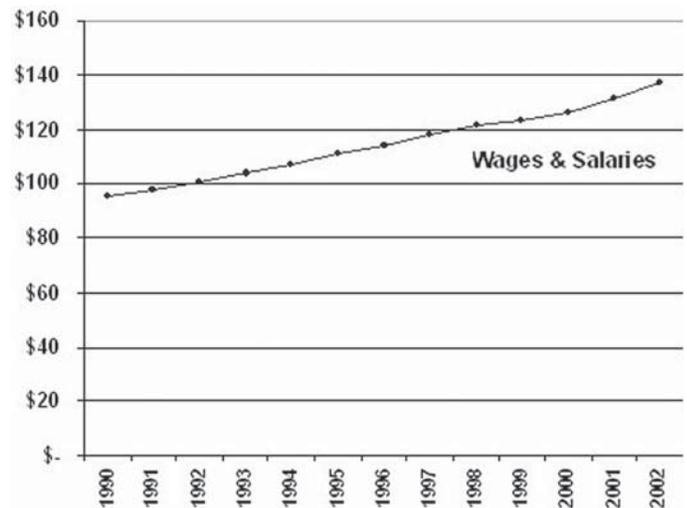
Figure 5-4. Average Cost of Congestion per Driver.

5.3 Role of Trucks in Congestion

This section provides data illustrating how truck traffic is a major contributor to overall roadway traffic, in addition to passenger cars. As more roadways approach full capacity, the incremental impact of trucks on congestion delays is also rising. Again, many of these facts are well known to informed transportation planners, but public decision-makers can sometimes consider congestion to be largely a problem of nuisance among rush-hour commuters. It is therefore important to help public decision-makers understand the critical role that trucks and freight flow patterns can play as part of the congestion problem and its solution.

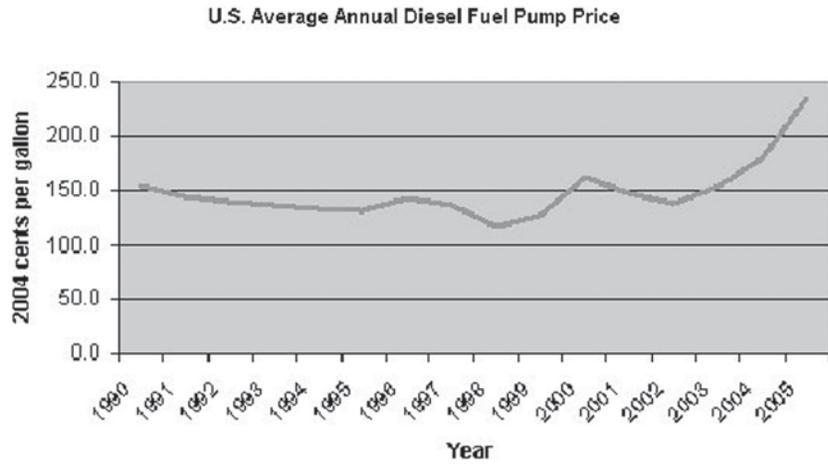
5.3.1 High-Volume Truck Routes

Figure 5-9 presents data from FHWA's Freight Analysis Framework showing that the portion of national highway segments with over 10,000 trucks is forecast to rise dramatically



Source: Bureau of Labor Statistics; all values are adjusted for inflation and shown in constant 1992 dollars)

Figure 5-5. Labor Cost for Transportation Industries.



Source: Global Insight; All values are in current dollars (not adjusted for inflation)

Figure 5-6. Cost of Truck Motor Fuel.

between 1998 and 2020, for both urban and rural segments of the Interstate Highway System (IHS) and the rest of the National Highway System (NHS). Figure 5-10 shows that a large and growing amount of highway mileage in the United States is forecast to have *both* high total traffic levels (average total daily traffic over 100,000 vehicles) and high truck volumes (average daily truck traffic over 10,000 trucks). These segments are located among many inter-city corridors all across the nation, as shown in the figure.

5.3.2 Truck Contribution to Total Congestion

When trucks are added to other traffic on the National Highway System, there is a doubling of the highway miles that

approaches or exceeds capacity. This is true for current conditions (1998 values) and it remains true as congestion is forecast to grow over time (through 2010 and 2020 forecasts) (see Table 5-1). This effect becomes even more dramatic when viewed cartographically. Figures 5-11 and 5-12 map the breadth of rising congestion, when truck traffic is added to forecast car traffic levels.

5.4 Growth in Freight Activity Levels

This section examines how change in the U.S. economy is leading to continued growth in freight volumes and also focusing that growth on smaller size, shorter distance, and

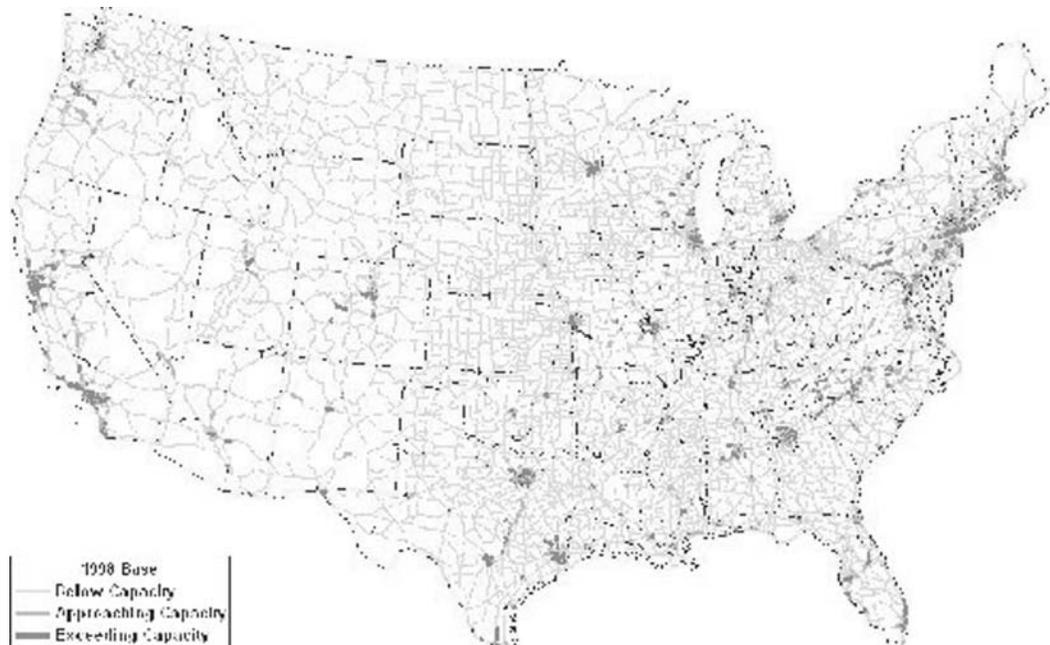


Figure 5-7. Traffic and Congested Segments—1998.



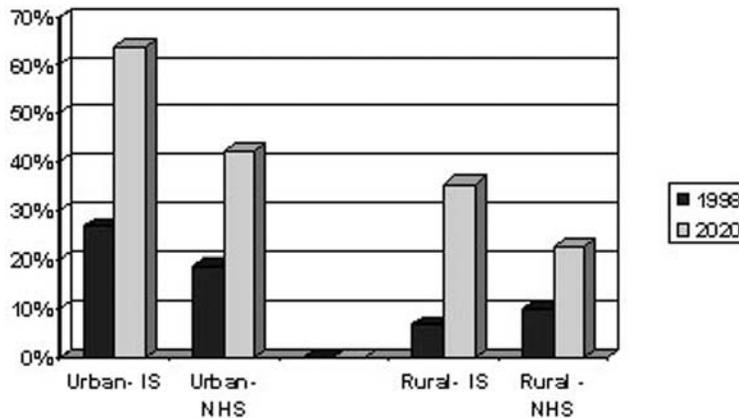
Figure 5-8. Traffic and Congested Segments—2020 Forecast.

higher value shipments. These trends are useful to highlight, since the feasibility of rail freight alternatives to truck shipments also vary systematically by distance, commodity value/weight ratio, and ultimate destination. Freight diversion and public investment decision models, discussed in later chapters of this report, build on this type of information.

5.4.1 Rates of Freight Growth

In general, population growth and economic activity growth are commonly viewed as key factors determining freight demand growth. However, with much news about the

loss of manufacturing jobs in the United States, there is a common belief as well that freight output also is declining. All of these beliefs are wrong, as freight value and volume continues to grow at rates exceeding population growth. While population increased 9 percent between 1990 and 2000, total employment increased 18 percent due to a robust service economy. During this same period, freight ton-miles increased 19 percent and the value of manufacturing shipments increased 38 percent after controlling for inflation. Sales by the manufacturing sector, wholesale sector, and retail trade sector grew (in constant dollars) by 38, 57 and 70 percent, respectively. Figure 5-13 shows the relationships among



Source: FHWA, Office of Freight Management and Operation

Figure 5-9. % of National Highway Segments with Over 10,000 Trucks/Day.

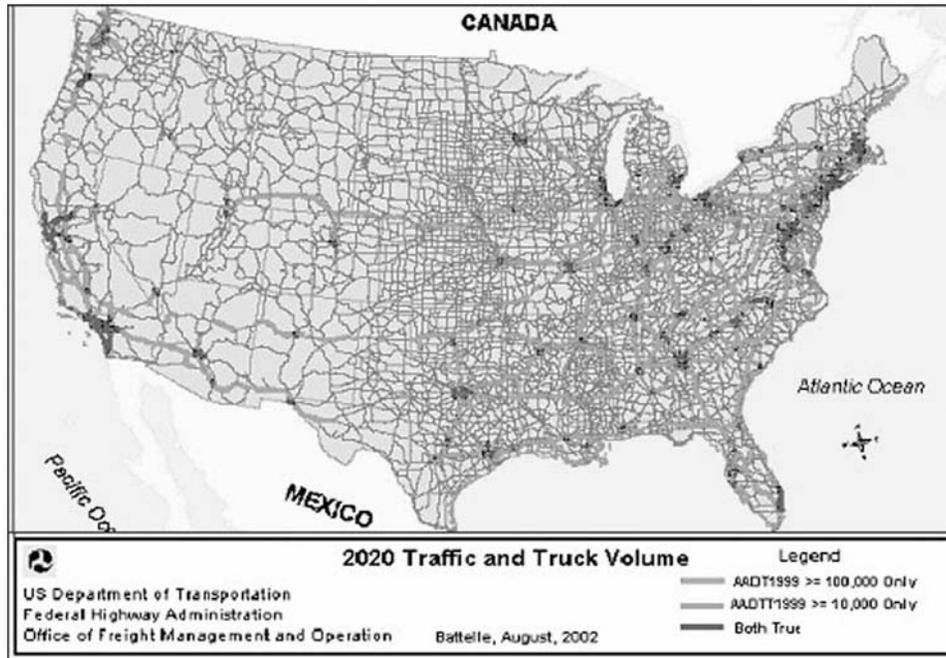


Figure 5-10. Highway Segments with High Traffic & Truck Volume—2020.

manufacturing value of output, freight tons, and population growth.

5.4.2 Mode Shifts

Trucks account for over two-thirds of the total value of all shipments in the United States, as shown in Figure 5-14. This dominant share held by trucking has continued to grow over time, though air travel has the fastest growth rate (as shown in Figure 5-15).

5.4.3 Shipment Value and Weight

Over this same 10-year period, there has been a continuing trend toward growth of higher value, lower weight,

and longer distance freight shipments. Figure 5-16 shows the growth in freight shipments among different weight classes. When measured in terms of either *total value* or *ton-miles*, the rate of growth was greatest in the lower two weight classes. In most weight classes, there was faster growth in value than in tons or ton-miles, implying a shift toward higher value shipments. In all weight classes, there was also faster growth in ton-miles than in total tons, implying a shift toward longer average distance for freight movements.

5.4.4 Shipment Distance

The complexity of weight, value, and distance trends becomes more apparent when viewed from the perspective

Table 5-1. Mileage and portion of NHS that is under approaching or over-capacity (current and forecast future).

V/C Ratio	1998 NHS Mileage (%)		2010 NHS Mileage (%)		2020 NHS Mileage (%)	
	No Trucks	With Trucks	No Trucks	With Trucks	No Trucks	With Trucks
v/c < 0.8	151,457 (95.7%)	145,969 (92.2%)	144,792 (91.5%)	131,203 (82.9%)	139,933 (88.4%)	118,839 (75.1%)
0.8 < v/c < 1.0 (Approaching)	3,731 (2.4%)	6,577 (4.2%)	5,707 (3.6%)	11,940 (7.5%)	7,078 (4.5%)	14,849 (9.4%)
v/c > 1.0 (Over capacity)	3,076 (1.9%)	5,716 (3.6%)	7,764 (4.9%)	15,120 (9.6%)	11,253 (7.1%)	24,576 (15.5%)

Source: FHWA, Office of Freight Management and Operation

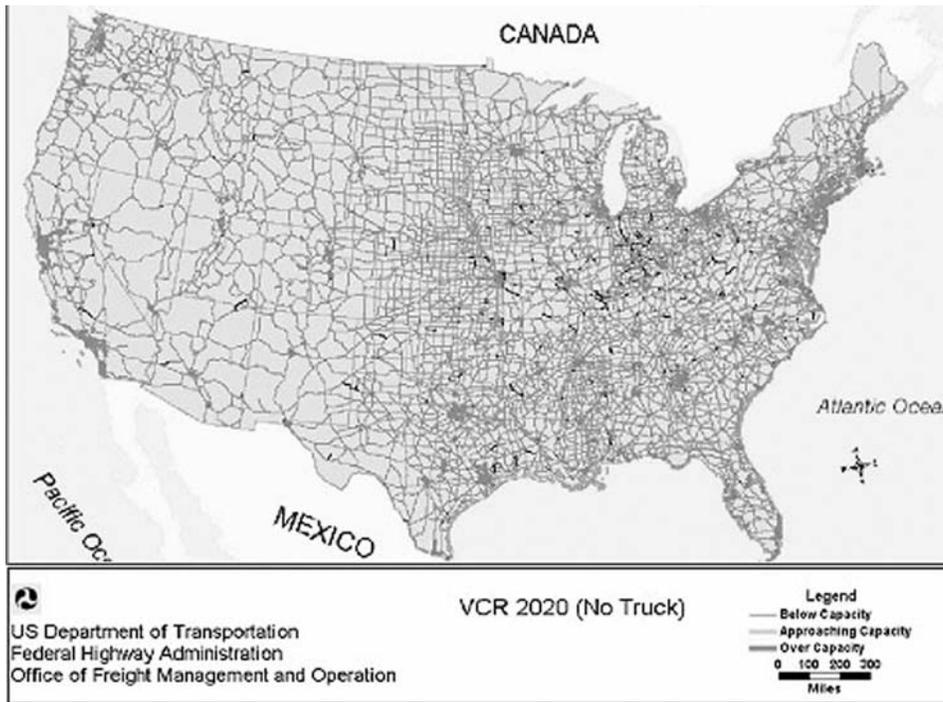


Figure 5-11. 2020 Congestion without Trucks.

of Figure 5-17. Using the same database and the same study period as the prior two figures, this figure shows profiles of total value, total tonnage, and total ton-miles by distance class:

- The very short distance class of deliveries (0–99 miles) accounted for the greatest share of total tonnage.
- The second shortest distance class of deliveries (100–999 miles) accounted for the greatest share of total value and ton-miles.
- Together, the two shortest distance classes account for approximately 45 percent of the value of goods shipped, 29 percent of tons shipped, and 62 percent of ton-miles shipped.

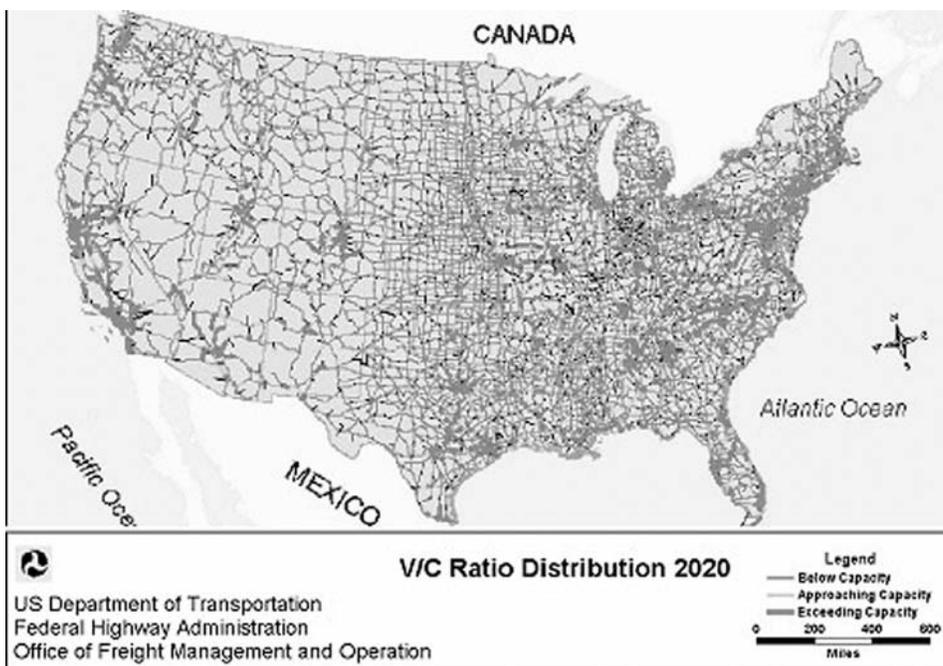
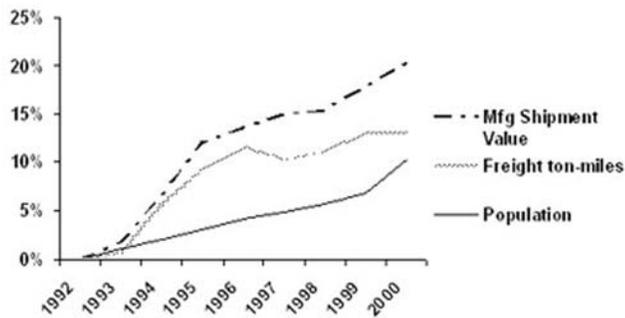


Figure 5-12. 2020 Congestion with Trucks Added.



Source: Ton-Miles: Bureau of Transportation Statistics, *Transportation Statistics Annual Report 2001*; Population: U.S. Department of Commerce, Census Bureau, *Statistical Abstract of the United States, 2000*, table 2; Manufacturing: US Census Bureau, *Annual Surveys of Manufactures 2001*.

Figure 5-13. Growth in Shipment Value, Ton-Miles and Population.

Changes in the location of manufacturing plants and assembly units and increases in just-in-time (JIT) productions and distribution systems over the last two decades are partially responsible for the notable increases in interregional (1,000 to 2,000 mile) freight shipment in ton-miles.

5.4.5 Import and Export Shipment Patterns

With continued globalization of business markets, it is becoming increasingly important to understand the pattern of freight flows to and from international borders and ports. First, it is notable that imports are growing at a rate faster than the U.S. economy (measured in Gross Domestic Product), while exports are growing at a rate slightly lagging the national rate of economic growth (see Figure 5-18.)

Canada and Mexico continue to represent the top two trading partners for the United States, accounting for 32 percent of all U.S. foreign trade (see Figure 5-19.) Of course, nearly all of the freight flows to and from Canada and Mexico are transborder movements via surface modes—road and rail. However, the fastest rate of growth in imports and U.S. exports is with Asian nations, and China has already recently passed Mexico as the number 2 source of U.S. imports. Of course, the growing overseas trade requires increasing reliance on sea and air freight, and that puts additional demand on the major U.S. international seaports and international airports. That trend is accentuating the problem of congestion along major highway freight corridors.

The commodity mix of export shipments shows that agriculture and fish products, coal and petroleum products, and wood, textile, and leather products represented the highest trade share of tonnage. Waterway is the most common mode of transportation used for these exports. However, when

viewed in terms of shipment value, motor vehicles, computers, telecom equipments, and aircraft are among the top U.S. export commodities (see Figure 5-20.)

Altogether, the changing nature of freight activity is involving some systematic shifts in products, weight, distance, and destination patterns. Shifts toward smaller size and shorter distance shipments¹ are related in part to increasing attention to tight scheduling and logistics planning. Shifts toward higher value exports reflect emerging global trade patterns that are increasingly concentrating export movements at key border and air/seaport sites. However, while a growing portion of the higher value exports are being shipped via air, it is still important to keep in mind that *all* exports going via airport or seaport still have to travel via surface modes (truck or rail) to those ports. Thus, these trends serve to underscore that the pricing and the economic feasibility of rail diversion will be defined, in large part, by emerging freight movement patterns.

5.5 Business Location Trends

This section examines how business location and urban land development patterns are systematically moving toward a dispersion of activities within urbanized areas that in many (but not all) cases serves to favor highway shipping and disfavor rail shipping. This helps to explain what is already known—that truck is growing faster than rail as a mode for freight movements. However, this information has further use, for it also helps to establish a basis for determining the situations under which rail can (or cannot) be a potentially feasible alternative to truck for freight movements.

5.5.1 Development of Rail and Urban Industry

In the latter half of the 19th century and first half of the 20th century, industrial businesses were most commonly characterized by firms located to serve their surrounding regions. Business location surveys showed that industrial sites were often located where there was good accessibility to large labor pools, transportation (rail and canal), industrial supplies and raw materials, and major markets. This resulted in concentrations of industrial sites that minimized the costs of inbound and outbound freight movement and worker commute logistics.

During that period, the locations of manufacturing facilities were often close to the inner core of metropolitan areas. Because of the relatively high cost of constructing railroad rights-of-way and more constrained engineering parameters,

¹While absolute length-of-haul is rising, shipment growth still is concentrated in the low end of the distance spectrum.

Percent of Total Value, 1993-2002 (in constant 1997 \$)

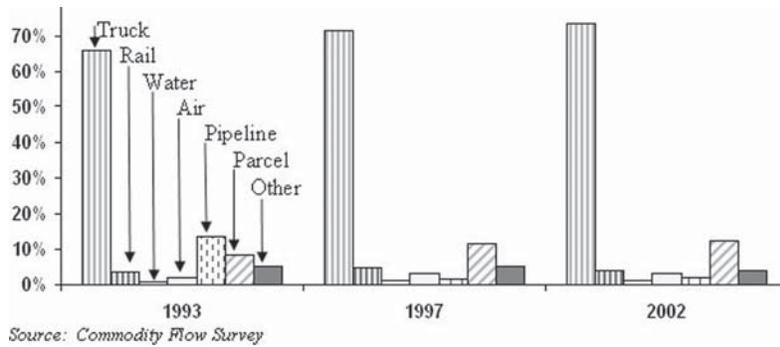


Figure 5-14. Domestic and Export Bound Shipments Within the US, by Mode.

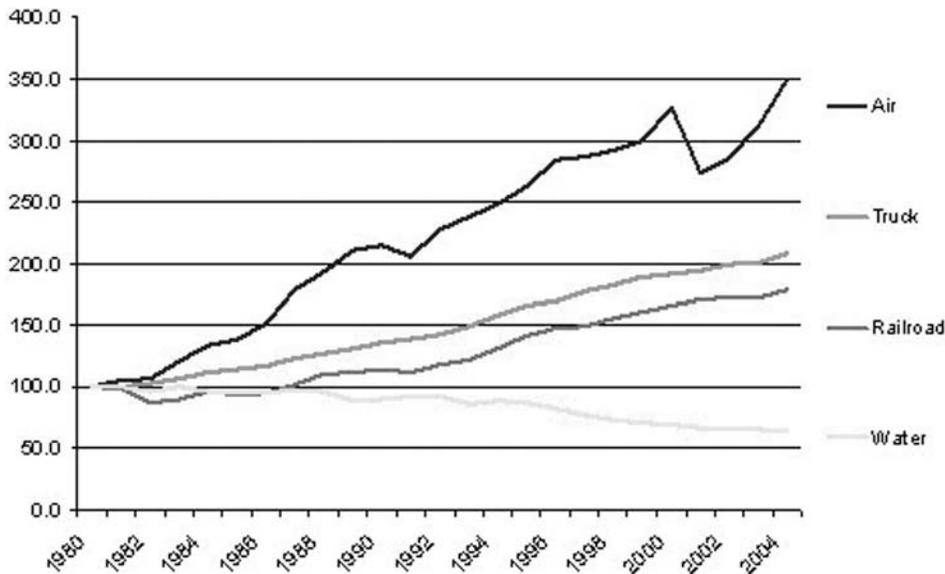


Figure 5-15. Growth in Ton-Miles by Mode (index 1980 = 100).

rail lines tended to take more circuitous routes than today’s highway network. The resulting network was often a hub-and-spoke type operation with sidings woven together to form branches, which merged to form mainlines and trunk routes—taking its cues from the natural system of waterways which often provided logical rights-of-way that decreased the costs of engineering.

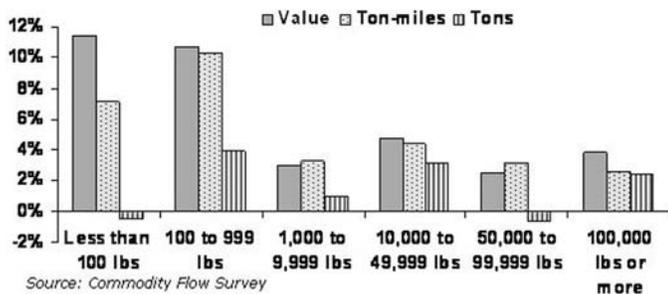
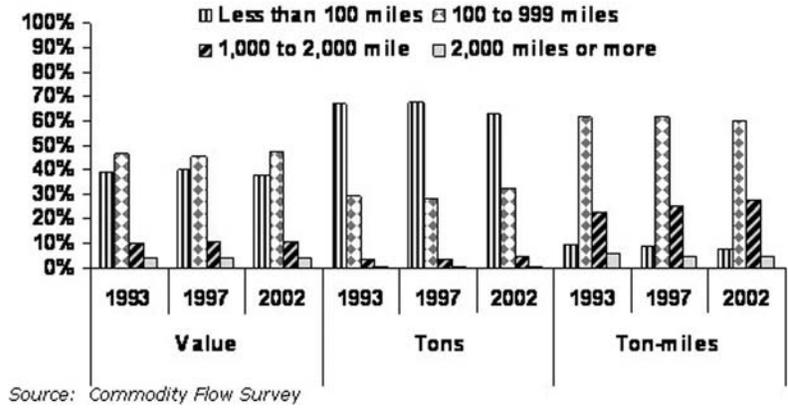


Figure 5-16. Shipment Size Percent Growth, 1993-2002.

The national rail network, which developed during that period, still reflects this pattern of industrial development and freight shipping. Figure 5-21 shows that the U.S. national rail freight network has clearly identifiable hubs in Chicago, Kansas City, St. Louis, Cincinnati, Cleveland and other cities. Hub by-pass flows exist, but less on a local level (as evidenced by the streaking lines throughout most of Nebraska, and the lack of direct connections between some large city pairs).

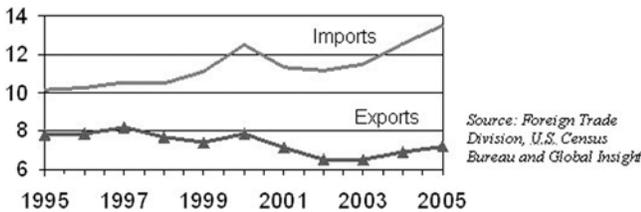
5.5.2 Development of Highways and Dispersed Industry

The national interstate highway network, on the other hand, was developed during the latter half of the 20th century. Figure 5-22 shows that the highway network reflects a different sort of spatial pattern in which origins and destinations are more diffused than the hub-oriented rail network.



Source: Commodity Flow Survey

Figure 5-17. US Freight Shipment by Distance Shipped.



Source: Foreign Trade Division, U.S. Census Bureau and Global Insight

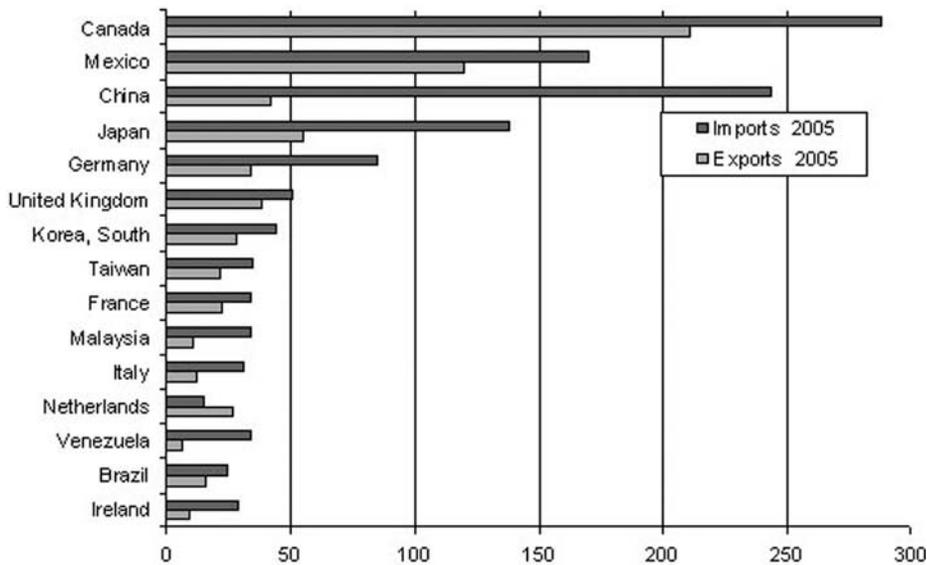
Figure 5-18. Value of Imports and Exports as a % of US GDP.

It clearly has visible ‘mainlines,’ but even the smaller cities have direct connection with one another.

Today’s more dispersed pattern of development and industrial activities is almost entirely the logical result of the development of automobiles and highways—a transportation system that handles capacity in smaller chunks. This

more dispersed pattern of highways and truck movements helped to grow a pattern of industrial activities and freight flows that does not always lend itself to more consolidated shipping methods such as rail. This becomes a key issue in screening alternatives, as the Guidebook discusses.

Today, we see that the evolution of business location and freight movement patterns has caused a shift toward increasing dispersion of business locations. This is evident at two different spatial levels. Figure 5-23 shows the relative shift of business growth within metropolitan areas toward suburban locations. Employment in suburban areas increased by 39 percent over 1970–1980, and by nearly 14 percent over 1990–2000. Figure 5-24 shows that there was also an increase in manufacturing employment in non-metro areas and a decline in manufacturing employment within metro areas between 1990 and 2000.



Source: Foreign Trade Division, U.S. Census Bureau

Figure 5-19. Value of US Imports and Exports, by Trading Partner (\$ billions).

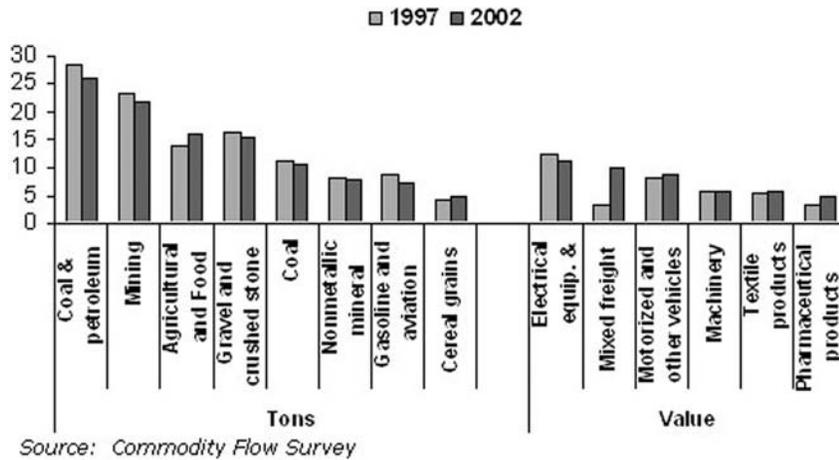


Figure 5-20. Shipment Characteristics of Selected Commodity Groups—Percent of Total for 1997 and 2002.

Along with the dispersion of manufacturing and freight shipping patterns, there has also been a location shift in manufacturing across America during the last three decades of the 20th century. In general, the pattern has been a loss of manufacturing employment from the North Atlantic and New England regions toward the west, northwest and Midwest region. However, the South and Midwest regions still dominate as main manufacturing regions.

5.5.3 Industry Examples

Automobile and textile industries provide two examples of location shifts in the manufacturing sector. In early times,

transportation cost was the decisive factor in industry location. Hence, traditional U.S. manufacturing industries were based in big cities, with access to transportation (rail and canal), near major markets, and near industrial supplies. With modern times, markets opened, trade policies changed, and, most important, as operation cost rose, new manufacturing methods, like JIT penetrated, thus leading to shift in the industrial location.

In the 1950s, automobile manufacturers had assembly plants distributed across the country. As the U.S. share in automobile production declined, fewer plants were needed. In the 1990s, new plants were located in the center of the country in order to minimize distribution costs and vehicles

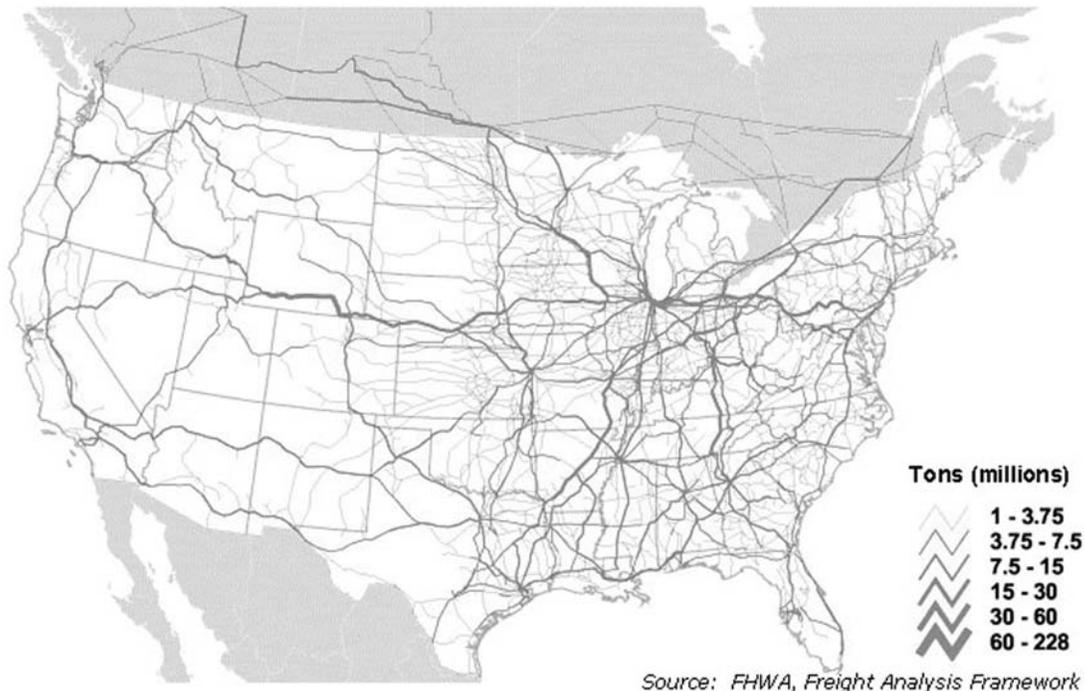
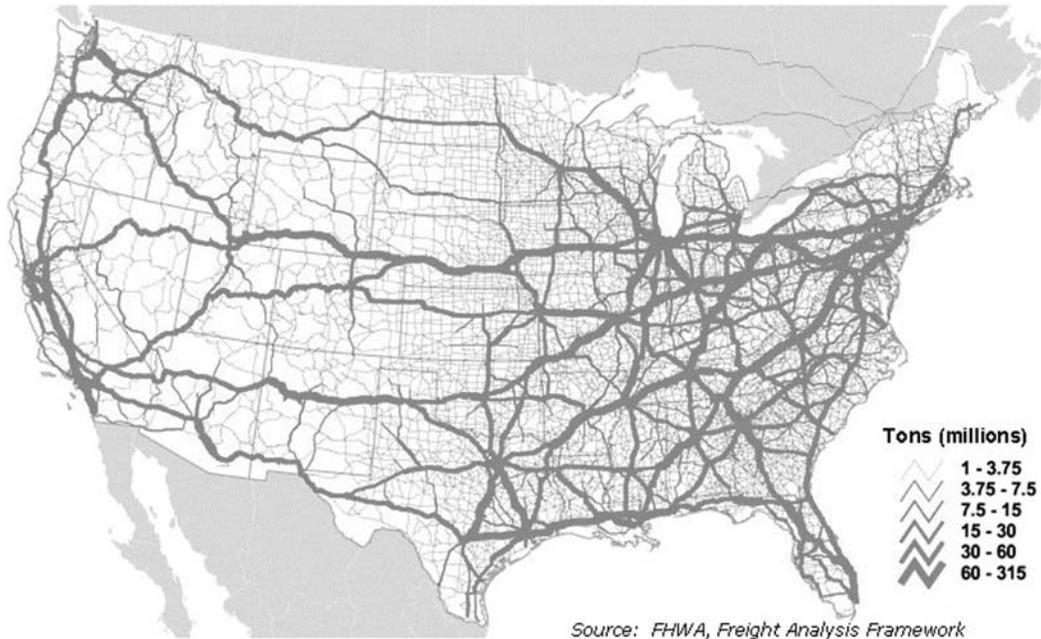


Figure 5-21. Rail Freight Network.



Source: FHWA, Freight Analysis Framework

Figure 5-22. Truck Freight Network.

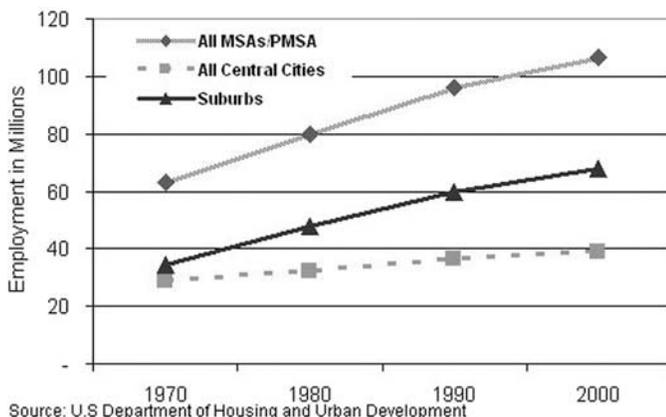
had to be shipped to the rest of the country (see Table 5-2). However, the changing manufacturing and supply relationships, the use of JIT systems, and the impact of the Internet on supply chains have further complicated the manufacturing process. Today, two types of automobile plants are in existence—a few automobile and truck assembly plants and several thousand component plants that manufacture parts. Consequently, manufacture, assembly, and the sale of a single product may involve several different facilities located hundreds or even thousands of miles apart from one another.

The textile, clothing, and apparel industry is another example of a business that has taken on a “global dimension” in the location shift pattern. In the 1960s and 1970s, Taiwan

and Korea were the dominant textile export countries. However, in the 1980s and 1990s China, Malaysia, and Indonesia emerged as leading exporters.

Lastly, the freight railroads’ share has been declining in part because freight railroads are inherently less flexible than trucks. The freight railroads have slower speed and hence are often less compatible with JIT delivery methods. Railroads can complete direct movements only on a network of 100,000 miles and must transfer loads or cars between railroads. Such transfers take a significant amount of time. In addition, the operating environment of railroads is far more complex than that of trucks. Railroads are one of the nation’s most capital-intensive industries. As a result, it is especially challenging for railroads to maintain and expand infrastructure.

Altogether, these trends and examples illustrate the need for any economically realistic analysis of rail freight diversion to focus clearly on differentiating commodity markets and then focus on those most conducive to increasing use of rail freight options.



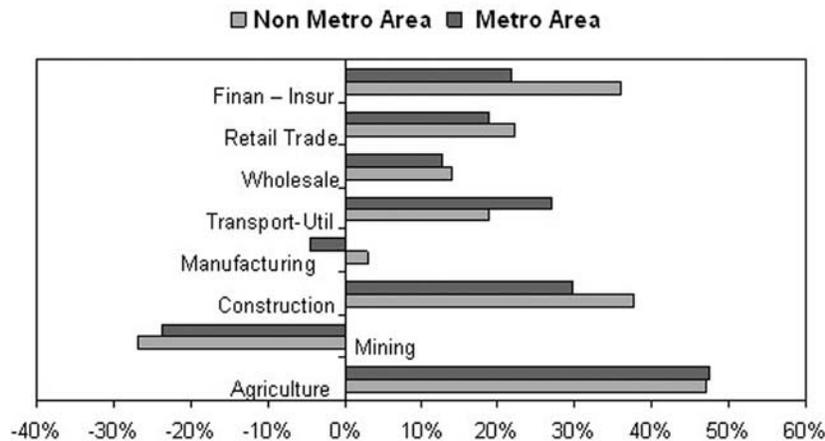
Source: U.S. Department of Housing and Urban Development

Figure 5-23. Level of Employment by Urban/Suburban Location.

5.5.4 Land Development Trends

While industrial locations are dispersing across the country, localized development is being concentrated in built-up parts of metropolitan areas. According to the Annual NRI “Urbanization and Development of Rural Land” Report for 2001, growth in urban land area development increased by 65 percent between 1982 and 2001, while total land area development increased by a much lower 46 percent (see Figure 5-25).

Employment Percent Growth: 1990-2000



Source: Bureau of Economic Analysis, U.S. Department of Transportation

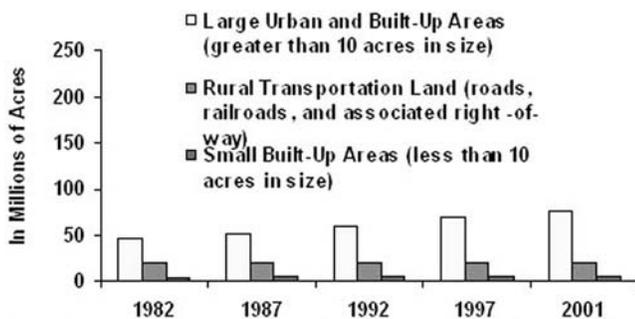
Figure 5-24. Percent Growth in Non-Farm Employment by Location Type.

Table 5-2. Employment in motor industry: 2001-2003.

State	Main Manufacturers	Numbers Employed	Year
Alabama	Honda, Hyundai, Daimler Chrysler (Mercedes-Benz)	83,710	2002
Georgia	Ford, General Motors	64,000	2002
Kentucky	Ford, General Motors, Toyota	87,659	2003
Mississippi	Nissan	30,000	n/a
South Carolina	BMW	42,000	2001
Tennessee	General Motors (Saturn), Nissan	62,273	2001

Source: State Statistics; includes part supplies

This same trend toward urbanization in terms of population can be seen in Figure 5-26. This figure shows the concentration of population growth in metropolitan areas, while there was population loss in non-metropolitan areas. This trend toward metropolitan areas is partially responsible for increasing urban traffic (vehicle-miles traveled) and congestion levels.



Source: National Resource Inventory, U.S. Department of Agricultural's Natural Resources Conservation Service

Figure 5-25. Trend in Developed Land by Location Type.

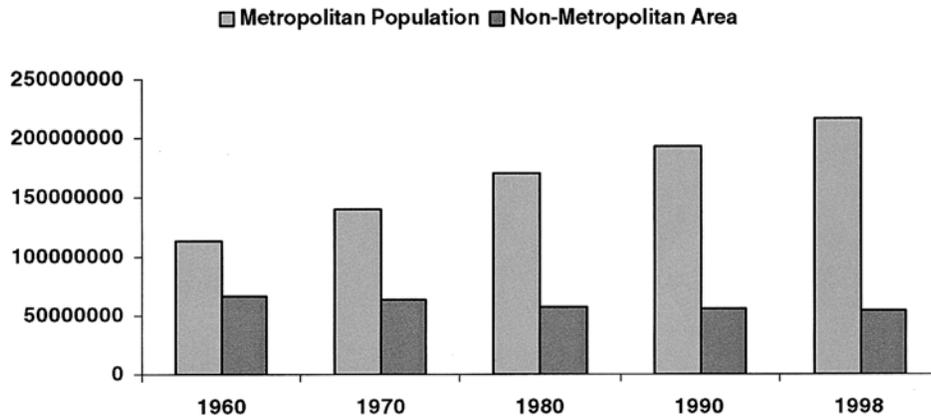
5.5.5 The Example of Chicago

The evolution of freight railroads in Chicago illustrates the type of transformation occurring across America. Chicago has long had the highest concentration of railroad activity in the United States since the first railroad reached there in 1850. Recently, as the railroad industry transitioned from the box-car age to the intermodal age, Chicago's many classification yards were re-cast as intermodal yards in a series of widely documented schemes. Union Pacific's recent effort to focus its resources on growing the intermodal business has seen the construction of Global III, a dedicated intermodal facility, at Rochelle, Illinois, about 80 miles from The Loop. The inability to expand its capacity at the downtown and inner-suburban sites, plus protests at a number of suburban sites closer to the downtown, contributed to the decision to construct the facility in the exurban area. Higher property values in the inner urban core also contributed to the decision.

This is not the first time freight facilities have been moved from the downtown in Chicago. The Rock Island Railroad's Chicago Terminal, LaSalle Street Station, was a large station with a head house and an adjoining break bulk freight facility constructed in 1903. After the demise of the Rock Island Railroad in 1975, the facility fell into disuse and was replaced by office buildings.

The opportunity cost of land in the downtown is clearly extremely high, and not all of Chicago's downtown freight facilities of yesteryear would be relevant today (for instance, transfer freight terminals that were intended as warehousing for break bulk cargoes are no longer required). However, it is not clear that rail freight options were considered at the time when the cityscape was being dramatically altered—during the transition from an industrial-based economy focusing on

Metropolitan & Nonmetropolitan Population: 1960-1998



Source: U.S. Census Bureau

Figure 5-26. Trends in Metropolitan and Non-Metropolitan Population.

warehouses and factories to a service-based economy focusing on office towers.

Figure 5-27 shows a sequence of three maps illustrating the evolution of developed land in the Chicago region over the period from 1920–1990. The original pattern in 1920 shows land development extending radially along the rail lines. By 1970, motor vehicles using the road network had become more important and land development became more dispersed, filling in areas not served by rail lines. By 1990, that trend had increased further. These Chicago examples thus illustrate how the role of rail freight today is necessarily different from the role it played as the city first developed.

5.6 Technology Trends

This section identifies examples of technology trends affecting the feasibility and cost-effectiveness of both rail and truck to serve freight movements. Technology trends clearly have great significance for the determination of economic feasibility of truck to rail freight diversion. Diversion feasibility is accordingly discussed in detail in the next chapter of this report, so the overview provided here is merely intended to illustrate the existence of long-term technology shifts that are coincident with shifts in economic, freight, and business location patterns.

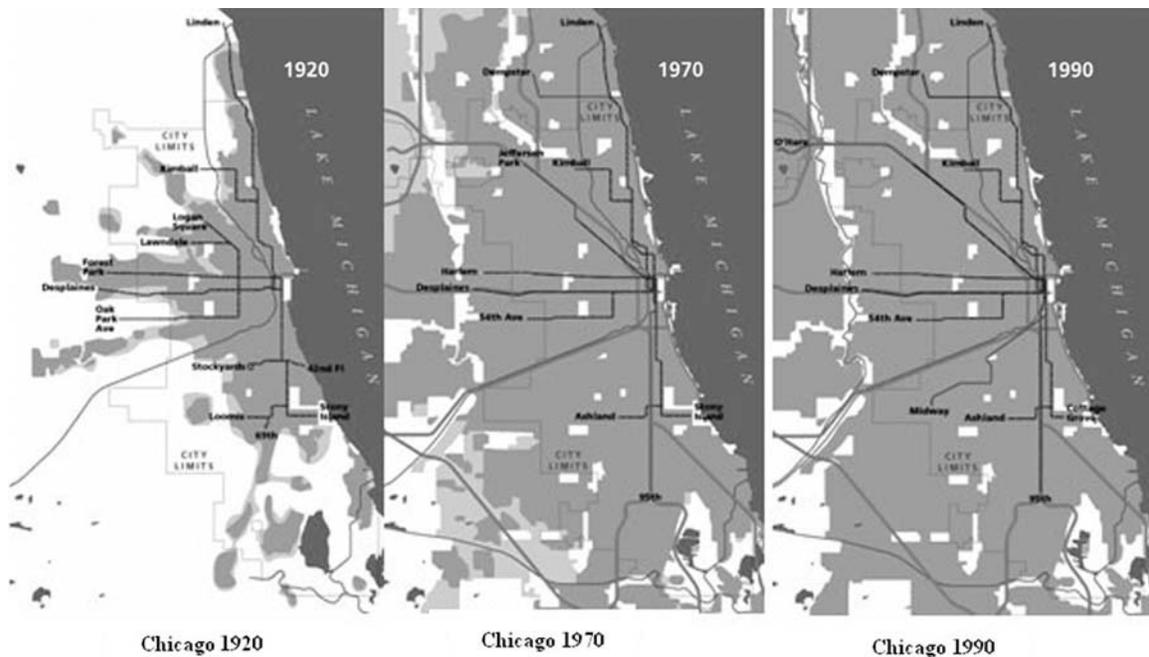


Figure 5-27. Urban Development Pattern in Chicago Relative to Rail Lines.

5.6.1 Intermodalism

On the macro level and apart from information systems, transportation technology has changed relatively little in the past 20 years. Although legislation has forced truck manufacturers to produce more fuel-efficient and less polluting vehicles, and size limits expanded, the basic form of the truck has not changed. The ocean-going container cube standard, at 20 by 8 by 81/2 feet (and the double-length 40-ft types), has also remained fixed. Operations of trailer-on-flatcar trains, pioneered by the Chesapeake & Ohio in the 1950s and later pushed into production phase by the New York Central, have remained largely unchanged since the advent of stack trains in the 1980s. The ‘intermodal’ revolution is more of an evolution than a revolution, in the sense that the traffic mix on the railroad evolved from one dominated by carload traffic to one becoming dominated by intermodal traffic.

5.6.2 Motor Carriage

There has been a variety of “extensions” to truck size and weight standards, which have modified the economics of trucking and shipping in the background. Domestic trailers and containers, for traffic in the United States, were progressively extended from 40 to 45, 48, and finally to 53 feet at the beginning of the 1990s. Progressive changes in highway design standards have allowed these longer trailers to run without causing safety problems. The hi-cube containers have also made an impact, extending the height from 81/2 to 91/2 feet. The newer domestic trailers with low-profile wheels, low floor, 91/2-ft minimum height, and 53-ft length, could replace ocean-going containers on a two-for-three basis. This has contributed to increased transloading activities at West Coast ports for light-density imports that ‘cube-out’ before they ‘weigh-out.’

Driven by changes in highway standards, many states allowed double and triple trailers to operate. Increases in tractor diesel engine performance have allowed higher tractive effort, thus making it possible for a single tractor to tow multiple trailers at acceptable operating speeds. Engine improvements also boosted fuel efficiency and prolonged operating life. Although these changes have been incremental, they expanded competitiveness and market reach for trucks as operating costs were reduced. Costs and business capture have been further improved by the substantial gains in equipment utilization and service quality afforded by control technology. Two-way mobile voice and data communication, global positioning systems, truck monitoring devices, optical readers, and information software have made assets in the field more productive and more responsive to customer requirements.

5.6.3 Railroads

In general, railroad technology improvement in the last 20 years has been focused on (1) larger/longer equipment or consists; (2) lower operating and maintenance costs, including signaling; (3) the double-stack innovation; (4) the automobile-rack innovation; and (5) safety improvements. To understand the philosophy ‘bigger is better,’ one simply needs to examine a list of equipment that has increased in size in the past 20 years: the boxcar, the coal hopper, the grain hopper, the articulated flatcar, the locomotive horsepower, and the length of train. The only piece of equipment that has not evolved much in this manner is the plain gondola car.

Lower operating and maintenance costs have come from a variety of sources. The elimination of the caboose and of crew positions and the use of the remote-controlled locomotives have allowed railroads to compete for freight at even lower costs. Changes in network and operating practices have also decreased the railroad’s cost base—by cutting maintenance of way, concentrating trains on increasingly fewer core lines, and by eliminating intermediate classification yards while focusing on long-haul through traffic. The incremental improvements in both maintenance of way equipment and the components (such as concrete ties and Pandrol fasteners) have allowed railroads to achieve higher axle loads, higher tonnages, lower costs, and less downtime. Signaling improvements have allowed many towers to close while centralized dispatching evolved to deal with trains with increasingly tighter headways. As a result, railroads have become capable of handling large loads more efficiently while becoming less efficient at handling smaller loads. This has allowed them to conquer certain dense traffic markets while continuing to cede carload traffic to trucks.

The double-stack and automobile-rack innovations permitted the carriers to make more effective use of a great rail asset: the ability to carry heavy, consolidated loads with efficiency. Double-stack trains almost halved the cost of intermodal operations, making it much more competitive with road-based transport—to the extent that the majority of marine import freight today travels by train. The three-level automobile racks made much more effective use of train capacity while protecting the cargo (compared to finished automobiles carried on flatcars). Since 1980, railroads have also developed a safer operating environment, due to incremental improvements in tank car design. Development of new types of couplers, defect detectors, and fiber-optic network have both reduced the instances of failures and enhanced the railroad’s ability to detect problems.

5.6.4 Marine

Technological changes in marine shipping have been dominated by the quest to build increasingly larger ships. As the

volume of containers being shipped throughout the world increased, the generation of very large ‘Panamax’ class ships—the largest that could fit through the Panama Canal—was surpassed, and it became economical to construct super-size vessels and routes without dependence on the Panama passage. In the meantime, clearance-restricted routes, such as the St. Lawrence Seaway, became less important as railroads replaced ships in those trade lanes. On the whole, propulsion and loading/unloading technologies have not changed a great deal in the shipping industry. There have been incremental improvements in coatings and engines, and environmental regulations have forced changes from single to double hull and separate ballast and cargo tanks, but all of the ‘break-through’ technologies proposed, including nuclear propulsion, ‘fast-ship,’ and hovercraft, have received limited niche acceptance or none at all. Navigation has greatly benefited since global positioning systems were developed and satellite communication improved. This has made it cheaper to transmit information about shipments and increase safety by allowing advance notice of dangers.

5.6.5 Commodities

While the technology of sea transport has not changed a great deal over the past 20 years, technologies behind the commodities being shipped have undergone fundamental transition. The advanced technology and high degrees of automation, along with the high level of wealth generated by technological innovations at the turn of the 21st Century, have allowed many everyday items to migrate from the durable to the disposable category. Greater information technology and data processing capability have allowed a much greater degree of customization than in the past.

Technology-driven economies, rather than manufacturing-driven economies, have a tendency toward generating non-material products such as intellectual property, software, banking, medical, and legal services and highly customized products in small batches (such as scientific instruments) created to order in smaller production facilities. This has contributed to some regeneration of cities and higher degrees of congestion, as it is now possible to be productive without consuming great tracts of land area to set up mass-production plants.

For the freight industry, this has meant trends toward (1) disposable goods, with higher use rates and more shipments; (2) greater customization, with more seasonal product categories; (3) non-material or made-to-order products, with smaller shipment sizes; and (4) miniaturized goods, with high cost per unit volume, higher logistics costs, and higher speeds required.

Although some goods are still sold with methods similar to those of 20 years ago (e.g., gravel or coal), others have

migrated to the Internet and mail-order market, resulting in more small packages than before. Goods distribution and supply chains have become based more on a “totally connected network” than a “hub-and-spoke network,” and the network itself has begun to define the business enterprise. New forms of knowledge-based specialization have occurred, where design may take place in one location, production in several others, and assembly in a third.

This is one of the mechanisms of globalization; linkages take place in the information and transportations systems, which replace inventory and centralized structure as the methods of control. The organization typically aims to produce and locate goods according to immediate demand rapidly communicated up the chain, and this form of demand-oriented pull logistics has begun to dominate over production-oriented push-logistics. (As illustrated in Figure 5-28, “Pull” means that events at the consumption point draw product through the system, instead of product being pushed down toward an expected demand.) Consolidation of freight is increasingly difficult due to small order sizes issued frequently, and this leads to new methods being created to organize product flow. Thus, the staging of goods and the integration of the far-flung supply chain become critically important functions, and the precision of transportation along with its operational information are made vital parts of the system. These changes in the logistics market have created opportunities for rail through the growth of containerized imports, yet they are also changing consolidation patterns and are placing new demands on all carriers for their cost and level of service.

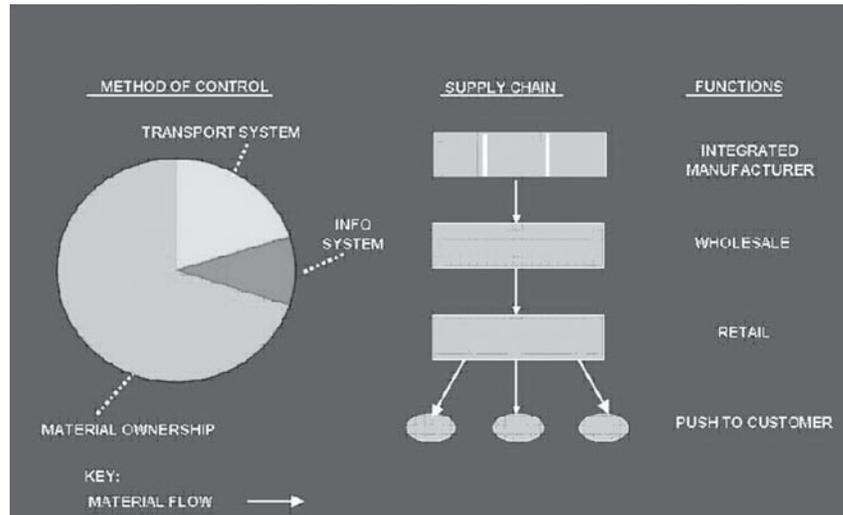
5.6.6 Economy

New technologies such as radio frequency and computer-directed storage and handling systems, satellite-supported GPS for tracking and expediting shipments, and use of the Internet to connect trading partners and customers are being widely used to create more effective and efficient distribution of raw material and goods.

Internet-based catalogues offer products such as consumer electronics, luxury goods, sports goods, freshly produced foods, prescription medicines, and replacement parts. Customers are expecting overnight deliveries of this Internet-based e-commerce. This is leading to either a network of market-based distribution centers filled with inventory, or fewer fulfillment hubs requiring much less inventory, where overnight delivery is possible.

The movement toward globalization with the emerging markets, cheap supply sources, new trading partners, and increasing industry competitiveness is compelling enterprises to develop new strategies to track orders and react to changes in real time in the handling and transporting of materials, as

(A) Push Logistics



(B) Pull Logistics

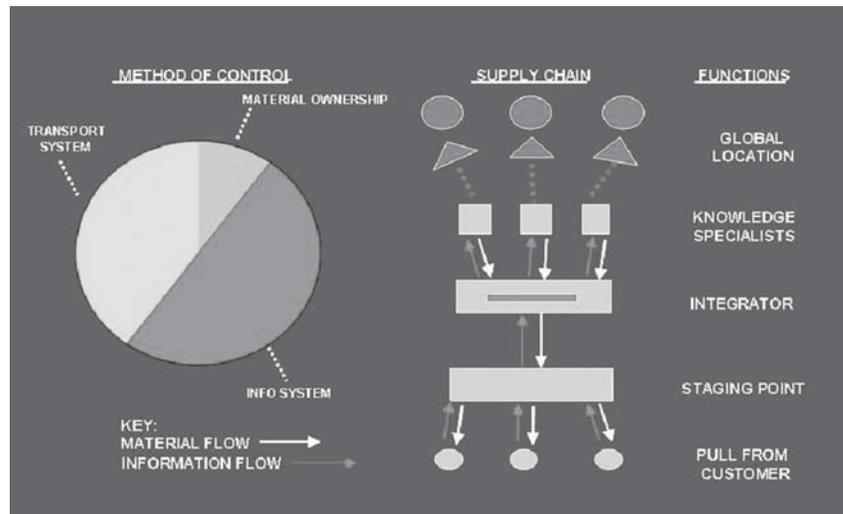


Figure 5-28. Urban Development Pattern in Chicago Relative to Rail Lines.

they move across the supply chain from originating suppliers to end customers.

5.7 Summation

This chapter has reviewed the spread of congestion and the rising dependence on trucks, the expansion in freight

activity and shifts in business location, and the changes to technology and business forms. Together these trends make for steady ferment in the transportation industry. The need is growing for alternatives of the sort that rail can represent, while the factors that shape its economic feasibility are offering new opportunities and imposing higher demands.

CHAPTER 6

Data Sources

6.1 Introduction

The purpose of this chapter is to review for planners and analysts the range of data sources that are useful for assessing rail freight solutions to highway congestion. It describes each type of data source in turn, explains why it is useful, and tells how to collect or acquire the data. This chapter also assesses the adequacy and limitations of the currently available data and suggests ways in which information could be further enriched. Its central focus is data sources that can support the modeling framework presented in the Guidebook. It is meant as a companion to that framework and generally will not repeat treatments (including data points and rules of thumb) that may be found there.

There are various levels of knowledge and increasing degrees of detail and sophistication in collecting data. What is appropriate can depend on the size of the project or opportunity, its phase of development, and the capabilities and resources of the decision makers. To come to grips with the options for rail, there is a need to understand how well the system is functioning, where it could do better, and where there are opportunities. A motivated and informed group of public officials, freight carrier officials, and chamber of commerce people may be able to provide workable answers to the central questions, if they can be brought together to look at them. In this sense an “expert system” can substitute for data in some stages, dimensions, or magnitudes of projects. Ultimately, data are a means to an end: they are vital, but there can be alternate ways to reach an objective, both in the kinds of information utilized and the kinds of approach taken. The Guidebook’s framework moves progressively through analyses of increasing complexity, and data should be thought of as following in its path.

Data of several sorts may be needed to support freight planning studies:

- Traffic flows, depicting freight by lane and mode—for identifying trends, traffic distances and densities, and diversion possibilities;
- Traffic volumes on infrastructure—for determining truck contribution to highway demand, overall traffic activity, and rail requirements;
- Congestion on highways—which is the specific problem being addressed, and information will be needed in areas like level of service, recurring and non-recurring problems, and temporal variations;
- Freight customer characteristics—such as who is shipping or receiving what commodities within the area of interest, annual volumes, service sensitivity, loading/unloading needs and capabilities, rail access, and modal usage;
- Commodity characteristics—value per pound, product density, perishability, storage requirements, equipment needs, and so forth; and
- Carrier characteristics—such as actual or typical service, cost parameters, capacity indications, and asset ownership.

The different data needs are diagrammed in Figure 6-1. Commodity flow data document various aspects of shipments, which go from a particular origin by a particular mode to a particular destination. Commodity flow data will identify the type of goods, but will not directly give important attributes of the commodity, such as value, density, shelf-life, and special packaging requirements. Nor will the flow data provide direct information about the shipper or the receiver, although data will give some indication. Attribute and customer information, which are pertinent to mode choice, must be obtained from another source.

State and local transportation planning typically is less well supported for freight than for passenger planning. Local movements are the predominant form of passenger travel, with most travelers beginning and ending the day at home. Planning procedures have developed that include sophisticated network models, frequent surveys of travelers, well-funded data collection efforts, and large planning groups at the state or regional levels. Freight is much different. Freight travel covers a broader region, with trip lengths an order of magnitude longer than passenger trips. Surveying is difficult

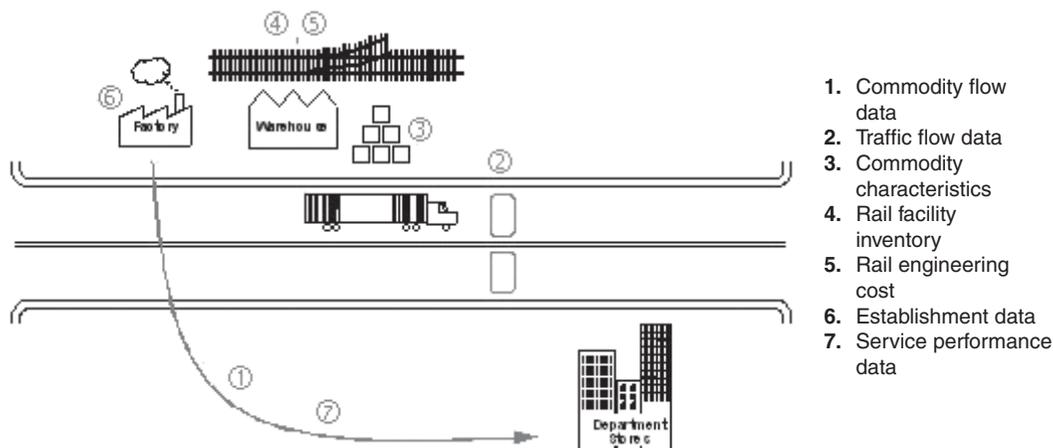


Figure 6-1. Rail Freight Diversion Data Needs.

because a diverse range of industries is involved, with a significant portion of mode and route decisions not made locally and shaped by shipment staging and supply chain structures. Trips typically are one-way, displaying seasonal as well as diurnal patterns to flows. Planning procedures on the whole are not well developed, nor are the data sources as good as those available for passenger planning. The private sector is much more dominant in freight transportation, so that knowledge about the freight infrastructure, freight flows, and the characteristics affecting freight demand is seldom automatically accessible to public agencies.

Nevertheless, a great deal of information about freight and freight transportation is available. This chapter discusses various sources of data and the procedures that planners might use to obtain relevant input. It is beyond the scope of this report to present detailed strategies for assembling comprehensive databases suitable for all levels of freight planning. Instead, this chapter considers the primary data sources and discusses each of them. It does not demonstrate how disparate sources of data could be joined together or manipulated to derive insights regarding freight transportation or economic development. To understand data joining and manipulating techniques, other NCHRP reports on freight and economic planning¹ should be reviewed, particularly NCHRP 8-43 which treats freight planning in the statewide context.

Many of the data sources discussed are readily available, either as part of the data sets that State DOTs, economic development agencies, toll authorities, and other public agencies already collect or as part of a commercial data service. However, there are many incremental ways in which State DOTs could

further leverage their freight data streams. With some effort and outreach, public agencies should be able to collect or assemble data and gain analytical insights that may not be immediately at hand.

6.2 Practicalities

Together with the Guidebook, this report considers how the public sector can work more effectively with the rail industry to allow the rail system to carry more intercity freight. If there is a public/private partnership for a study, then some of the problems of data collection will disappear. The railroads are well aware of the strengths and weaknesses of their own services and facilities; freight customers know why they use trucks instead of rail and what it would take for them to shift freight to rail; highway officials know where roads are congested and where heavy trucks are most common. The challenge is for the various parties in such a study to combine their knowledge and expertise in order to (1) identify areas where rail solutions may be effective; and (2) evaluate specific options for improving rail mode share. For freight, the questions, data requirements, and solutions are different from those commonly used in the four-step planning process for transportation planning, but it is possible to assemble groups of knowledgeable people who can, as a group, identify workable strategies. One way to begin is with Freight Advisory Councils, which are becoming common fixtures in state and urban jurisdictions and are employed by the federal government as well. They offer a proven and available method for making realistic assessments of the public planning options and for opening doors to other stakeholders who can contribute requisite data and participate in project opportunities.

These points suggest a basic and pragmatic orientation that planners should remember. Information is required to meet the objective of roadway congestion relief. Data are one way to

¹NCHRP 20-29 Development of a Multimodal Framework for Freight Transportation, NCHRP 2-19(2) Economic Development Toolbox, NCHRP Report 456: *Methods to Assess Social and Economic Effects of Transportation Projects*, NCHRP Report 463: *Economic Costs of Congestion*, NCHRP Synthesis 290: *Economic Effects of Transportation Investments*.

supply this information; direct observation and professional judgment are others. Data are especially useful as inputs into analytical models, but when they encounter limitations—and they often will—estimations can be adopted (as the Guidebook demonstrates). A combination of all these methods can be and usually is the way that projects get done. This means that while better data are desirable, a data challenge often can be reframed as an information challenge and solved in another way.

For example, each of the remaining sections of this chapter addresses a specific kind of data and begins with a short summary of why such data are needed. In each case, planners may only require general information, such as “where are the most congested highways where heavy trucks account for a significant portion of VMT?” A set of observant truck drivers who worked throughout the region could answer this question, probably with details concerning the time of day. The individuals who report traffic conditions for the local radio stations or who monitor operations for the DOT could also answer this question. Alternately, public agencies ordinarily have databases that incorporate traffic counts and estimates of congestion levels for segments of major roadways; from those, a planner can derive a list of segments with a level of service of D or worse where heavy trucks make up at least 15% of the traffic. Both kinds of sources produce practical information—yet it is helpful to note that it is not necessary to create a database to get a reasonable answer to the initial question.

In general, any MPO or state transportation agency should be collecting data related to freight, including such things as potential rail customers, truck usage of highways, trends in truck traffic, and congestion levels on major roads. If they lack such data, they should initiate data collection efforts. However, the lack of such data should not be taken as an impediment sufficient to defer freight planning efforts. As the Guidebook describes, analyses can vary widely in their data intensity, depending on the scope of the problem and its stage of development, and there are a number of ways to get at them. It is usually possible to proceed on some basis, if not with detailed material then with the information and insights that can be provided by carriers and their customers, along with rules of thumb and whatever data is available to the public agencies.

This chapter therefore is not a checklist of data sets required to begin a freight study. Rather, it is a guide to possible data sources that a planner will use flexibly, imaginatively, and differently, according to the needs of the problem and the options open at the time. It emphasizes alternative ways of developing information, because this is a practical and productive approach. Previous chapters of this report have cited almost two dozen rail freight projects in North America that have assembled information by the means described here, leading to investments of public funds across the range from small to very large. The types of data most commonly collected and used for assessing rail freight solutions are

- Commodity flow data,
- Traffic count data,
- Commodity characteristics,
- Maps & inventories of rail infrastructure and service,
- Railroad engineering cost data,
- Shipper characteristics & needs—establishment data,
- Modal service and cost parameters,
- Trend Data—traffic & economic projections, and
- Institutional and privacy factors.

The remainder of this chapter reviews eight types of data and concludes with a look at the institutional and privacy factors that can affect the accessibility of information and the rules governing its use. The eight types correspond to the seven needs diagrammed above, with the addition of trend and forecast data. For each type, four sets of considerations are discussed:

- What is the problem? What kind of data would be useful?
- Are there readily available sources for the data?
- How can the data be collected?
- Levels of accuracy and precision.

6.3 Commodity Flow Data

What is the problem? What kind of data would be useful?

Commodity flow data are needed for two reasons: (1) to understand what type of freight is causing congestion; and (2) to determine whether such freight can, in fact, be feasibly diverted with a suitable rail freight service. When used in conjunction with other data, the information can also be used in determining a suitable rail freight service program.

Commodity flow data also are an important driver for many types of forecasting activities. As a measure of freight activity levels from an economic perspective, they give insight into not only how much freight is moving, but also what type of freight is moving, which will begin to imply *why* the flow exists. The reason for freight movement can be important in predicting whether shipments will continue and whether they can be expected to grow.

Are there readily available sources for the data?

For rail traffic information, the key source is the Carload Waybill Sample (CWS), issued annually by the Surface Transportation Board. The Waybill Sample is a statistically based stratified random sample of shipments terminated by U.S. rail carriers. All carriers terminating 4,000 or more carloads per year are required to report and 62 railroad systems thus are captured, encompassing all Class I and II roads, and

the more prominent short lines. (Carriers smaller than 4,000 annual loads may be sampled when they act as haulage agents for larger railroads, and the latter appears as the carrier of record on a shipment.)

The full (and confidential) Waybill Sample file contains highly detailed information on the origin, destination, commodity, and volume of each sampled movement. Intermodal and unit train traffic can be separated from single or small block carload, and the rail carriers handling the traffic are identified. State DOTs have access to this data source for activity in their state, subject to certain requirements on the confidential handling of the information. MPOs may petition their State for access and usually can gain it. A public edition of the Waybill also is available, with far less detail released but without privacy restrictions; in addition, there are commercial versions of the public data that interpolate some of the missing detail and can make it easier to use. A separate, semi-commercial source exclusively for intermodal traffic data is the Intermodal Association of North America (IANA), which publishes monthly flow volumes by trailer/container type between large geographic regions. These data have less specificity but more currency than the CWS.

For truck data in the public domain, the U.S. Bureau of the Census publishes the Commodity Flow Survey every 5 years, as part of its economic census. It provides a sound, basic body of information on the flow of goods between U.S. markets by mode, with highway freight traffic separated into for-hire and private fleet volume and multimodal activity identified. (The CFS also has information on shipments by other modes, although for rail the CWS offers more detail and usually is more current.) Flows in the CFS are released by state and major metropolitan markets, which can be adequate for some applications and are a good scaling tool for sketch planning. (The Guidebook presents an example of this.)

The most recent CFS at this writing was completed in 2002. In addition, the FHWA's Freight Analysis Framework contains a database of 1998 commodity flows for several classes of truck (and other modal) traffic, on a state-to-state basis. FHWA has begun the update of this information and issued a 2002 data set based on the CFS that (1) interpolates traffic flow information covered but not released by the CFS; and (2) supplements CFS coverage with modeled information, much of it covering truck activity. The geographic units in this FAF II data are the 114 regions utilized by the CFS.

Truck data are available from commercial sources as well. Commodity flows between counties, based on proprietary samples and incorporating public information, are updated annually for various classes of truck fleets and equipment types. Data of this kind have been used in a variety of rail studies, including complex truck diversion analyses. Such databases usually incorporate the STB Waybill to facilitate modal comparisons; a typical example appears in Figure 6-2.

Finally, truck trip tables often are a part of state and urban transportation models and can be adapted for other kinds of analysis. While commodity information sometimes is absent, the tables can be reflections of local survey work or an amalgam of public and commercial data with local observations.

How can the data be collected?

Intercity commodity flow data is collected through surveys, exchanges, or legal reporting requirements. The STB Waybill sample is a mandated collection from rail carrier records, and the CFS as an aspect of the Census also is a legal obligation on freight shippers, who are its respondents. There are no similar reporting requirements for motor carriers, and data sharing from this source has been accomplished through voluntary surveys or through commercial trading of information.

Data procured through a survey of selected shippers and receivers can be effective for locally based shipments, but will not pick up overhead traffic. Intercept surveys can detect overhead truck traffic as well as that locally based, although a comprehensive set of information can be challenging to obtain. Both methods can be time-consuming and expensive, yet many studies have been successfully completed that relied on the use of survey data. Responsiveness is a further obstacle. Because of growing privacy concerns and aversion to government monitoring (as well as the explosion of surveying and tracking in modern society), cooperation in surveys increasingly is difficult to obtain. One solution is the use of an intermediary (such as an external contractor) as a way to ensure confidentiality. Data collected by an independent third-party and blended with other information before delivery to the public agency can avoid subjection to the Freedom of Information Act and encourage participation by transportation stakeholders in data compilation efforts.

Combining and cross-referencing information derived from multiple sources is one of the key techniques used by planners to assemble truck information. One or more forms of data collection—such as the shipper interviews, truck driver surveys, or intercept data mentioned above—are used with commercial or national information to produce a local picture against a regional backdrop. Data assembly is done within the processes of an urban or statewide travel demand model or processed more narrowly to answer the immediate needs of project or program development. Numerous state, urban, and project studies have been approached in this way, for overall freight planning as well as for rail initiatives.²

²The Metroplan Orlando (FL) Freight Goods & Services Mobility Strategy Plan and the New Jersey Portway Extensions project are just two of many.

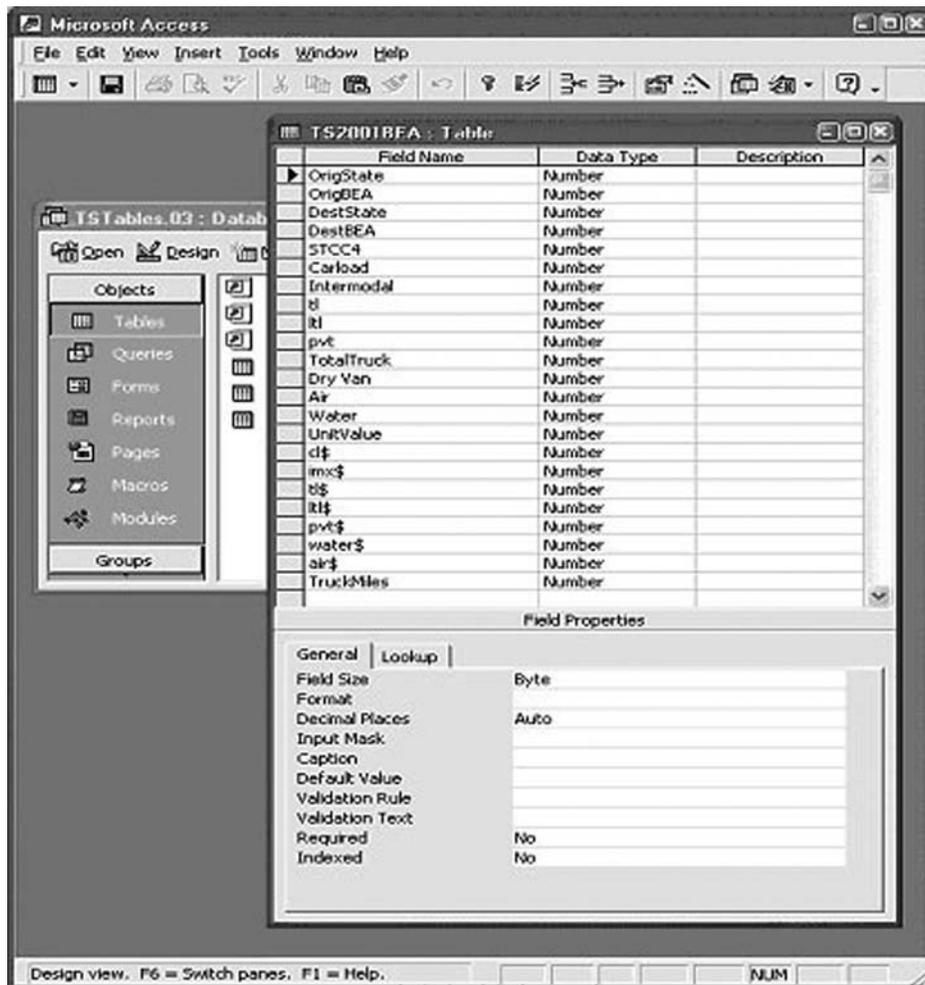


Figure 6-2. Illustration of Waybill Database.

Levels of Accuracy and Precision

Commodity flow data is available at different levels of granularity. Geographically, the data can be collected at the state or county level or even by zip code or railroad freight station. Time-wise, the data might be compiled daily, monthly, quarterly, or annually. Different resolution is also possible along dimensions of vehicle types, commodity detail, and so forth.

Daily or monthly data will capture diurnal variation and the effect of seasonality, whereas annual data will capture effects of longer term business cycles. Getting accurate samples with shorter time periods or finer geographic granularity tends to be more difficult, because a larger sample size is required to estimate flow data with higher precision.

Commodity flow data may be quoted to the ton or vehicle unit, but whatever its degree of historical accuracy, the current picture is subject to change. Variability from month to month or year to year can be significant, due to economic, seasonal, and random effects. However, when considering

rail freight diversions, although a reliable base volume is going to be important, fine precision often is not as critical. A 10-percent error in the average base volume may only have a small impact on the viability of the service, compared with other factors such as the quality of performance or the condition of pre-existing rail freight infrastructure.

6.4 Traffic Count Data

What is the problem? What kind of data would be useful?

The first step in the analysis is to find sections of the highway system that (1) are congested and (2) have a significant portion of heavy truck traffic. Facility-level traffic count data are needed first and foremost to assess the level of congestion on existing roads and highways and to determine whether or not trucks are prevalent in the congested area. Detailed facility-level traffic data will provide a base case for the development and evaluation of suitable strategies and solutions. The greater

the congestion and the greater the proportion of heavy trucks, the more likely that a rail freight solution may be feasible.

If traffic counts are available for multiple years, they may illustrate trends in congestion and in truck traffic. Since traffic counts do not show the origin or the destination of the traffic, this type of data is not sufficient for modeling flows over the network, although they are commonly used for calibrating trip tables and flow model constraints. Moreover, detailed facility data (including breakouts at the equipment-type level) can be very helpful in determining the impact of proposed solutions and developing relief performance measures. Similarly, volumes and trends for rail facilities are important if there are concerns for railroad capacity or to understand capital investment needs.

Are there readily available sources for the data?

Captured in the Federal Highway Performance Monitoring System (HPMS), state DOTs maintain databases of historical and current facility levels-of-service (LOS) between A and F, which is an indicator of roadway traffic flow and degree of congestion (traffic tie-ups are at level F). DOTs mainly derive this type of data through continuous or spot placements of automated loop count equipment, whose raw data streams are informative but require some processing to remove anomalies prior to use. The counts specifically measure the passage and timing of vehicle axles; algorithms then are used to provide an interpretation of vehicle type and other details, which may be stored in a DOT database. Counts have the additional virtue of depicting temporal patterns: time-of-day and day-of-week

volume variations as well as seasonal fluctuations when traffic is monitored often enough.

How can the data be collected?

Traffic count data in fact are collected in a number of different ways. The commonplace loop count data are regularly compiled by states along major routes and at strategic intersections to determine the passage of traffic. More advanced systems will differentiate between automobiles, light trucks, and heavy truck classes. Other advanced methods of monitoring traffic exist and can enrich the data substantially beyond interpreted counts. Weigh-in-motion stations, traffic cam sites (as shown in Figure 6-3) joined with the appropriate data-extraction software, and aerial photography all can be used to identify vehicle volumes by type, assess the degree of congestion, and characterize and understand some of its causes.

In toll facility territory, data from collections can also be used to develop enriched traffic count data, especially with advanced billing and information systems such as EZ-Pass. Truck counts by vehicle size and time of day can be taken from bridge and turnpike records. However, past attempts to use advanced information (such as operator identification and histories) for traffic demand management or transportation planning have been met with resistance due to valid privacy concerns on the part of the users. With toll territory apparently set to expand aggressively and nationally, mechanisms and opportunities for utilizing these data are apt to expand in parallel, and a legal framework similar to that applied to the STB private waybill sample might finally allow the more



(Courtesy of Maryland DOT)

Figure 6-3. Traffic Camera Can Also Generate Flow Data.

detailed data to be used in planning. Another issue with collecting traffic count data is that counting devices may be owned and operated by different entities; state DOTs traditionally controlled inductive loops on non-toll routes, while turnpike authorities controlled tollbooths, and traffic cams may be privately owned or operated by a state contractor.

Railroad counts can be constructed for current and historical years from the CWS, with the aid of a routing model. Waybill records have indicators for the path traveled by shipments, and a model can turn these into a complete picture of linehaul traffic, provided carrier operating preferences are observed. Railroads also prepare and can make available track density figures; many state DOTs have access to these. Pickup and delivery traffic at intermodal transfer centers can be estimated from the CWS, although railroads may be willing to offer lift figures as well. Volumes at other kinds of terminal are harder to derive because they are a function of blocking practices and train configurations. There are models that can estimate this information, but if it is important to have it, it is probably best to request it directly from carriers.

Levels of Accuracy and Precision

Rail counts of the sort just described are reasonably detailed and accurate. On the highway side, traffic count data are available at different levels of granularity. Geographically, the data may be collected simply for a given highway segment, although more sophisticated systems will differentiate among northbound/southbound, turning or passing vehicles, vehicles using exit ramps, and different classes of trucks. Some systems will also convert vehicle counts into rates at different resolutions, e.g. counts per hour, per day, and per year. One conventional output is the quantification of Average Annual Daily Truck Trips (AADTT).

Vehicle identification by means of interpretative algorithms presents two kinds of difficulty: (1) the conversion of axle observations to truck counts may be off and (2) the definition of “trucks” may include light vehicles (and even pickups) that have almost no susceptibility for rail. The more advanced systems do a much better job of isolating the heavier freight that rail can remove from the roadway, but, thus far, there is much less of such data available. In addition, when using data at the hourly level or daily level, the usual caution about spurious accuracy from small sample sizes applies; if the truck count during a given hour on a given day is 30, the truly representative value might actually be somewhere between 15 and 50. An average of counts during the same hour over a number of days will give a narrower confidence interval of the normal range.

Rail freight diversions may make the most noticeable reductions in the number of trucks or observable reductions in congestion, in specific circumstances. For example, there will be locations where a large portion of the highway traffic

is attributed to a few bulk truck trip generators, such as ports or major manufacturing plants. Also, in certain locations on the highway network, through trucking may fill one or more lanes of highway, especially where multiple routes converge at or near major cities or geography causes traffic to be funneled along a coast or mountain range. In that sense, the accuracy of the traffic count, which gives an idea of overall levels of congestion, is less critical than the accuracy of the distribution of vehicle types that measure proportion of total congestion for which trucks or heavy trucks are responsible.

6.5 Commodity Characteristics

What is the problem? What kind of data would be useful?

Commodity characteristics are important, because certain types of commodities are more suited to rail than others. Bulk commodities, lower value general merchandise, and commodities that are shipped in large quantities are typical targets for rail. Commodity price data can also be used to assess the impact of changing freight flows on the economy and on economic development.

Conversions of commodity weight information to price information (e.g., dollars per ton) are useful in this connection. The prices of commodities may not simply depend on the physical goods, but also on their location and other factors like packaging or extent of processing—for example, paper may be more valuable in consuming markets than in production regions, due to added transportation costs and localized demand-supply equilibrium.

In addition to price, other commodity characteristics may be important in considering rail freight diversion feasibility. These can include such factors as equipment requirements, storage needs, loading and unloading demands, perishability, and product density.

Are there readily available sources for the data?

Several federal publications have been good sources for key elements of such data. Until its discontinuation in 2006, the Vehicle Inventory and Use Survey (VIUS)³ supplied equipment types and payload (loading) factors for broad categories of commodities hauled by truck; the same things can be derived in even greater detail for rail commodities from the CWS. The CFS contains commodity values overall and by mode; in addition, the Bureau of Transportation Statistics produces the Surface Transborder Commodity Data, which

³VIUS data were collected on a 5-year cycle. The last collection was in 2002, and the data were released substantially later. Thus under the traditional cycle, the 2002 VIUS would remain current through about 2009.

Table 6-1. Tonnage to truckload volume conversion by commodity type.

STCC2	Description	Tons /Load	STCC2	Description	Tons /Load
20	Food and Kindred Products	18	31	Leather Products	11
21	Tobacco Products	17	32	Concrete, Clay, Glass, Stone	14
22	Textile & Mill Products	17	33	Primary Metals	20
23	Apparel Products	13	34	Fabricated Metals	14
24	Lumber & Wood Products	21	35	Machinery	11
25	Furniture	11	36	Electrical Equipment	13
26	Pulp or Paper Products	19	37	Transportation Equipment	11
27	Printer Matter	14	38	Instruments	10
28	Chemical Products	17	39	Misc. Manufactured Goods	15
29	Petroleum or Coal Products	22	41	Misc. Freight	16
30	Rubber & Plastics	9	50	Secondary Traffic	8

Source: derived from FHWA Freight Analysis Framework

contain flows of NAFTA goods and their declared values at the border crossings. The Bureau of Economic Analysis also produces various input-output tables and accounts, which can be used to derive the value of goods traded per ton when combined with a commodity flow database and a matrix to map such flows to specific industrial sectors.

Other sources on commodity pricing are available from various industry associations and government departments, such as the U.S. Departments of Agriculture and Energy, and the Western Wood Products Association. Some web news services and investment information services also carry up-to-the-minute as well as historical commodity price data for selected commodities on their websites; however, getting it to a form usable for rail freight assessment may represent significant work.

Tonnage-to-volume and tonnage-to-value conversion matrixes also can be an element of commercial freight flow databases, whose equipment type classifications help to address storage and equipment requirements as well. Example metrics based on the FHWA Freight Analysis Framework, representing an amalgam of federal and commercial resources, are given in Tables 6-1 and 6-2.

How can the data be collected?

The information sources described above are readily available and adequate for most planning purposes, making the collection of original data unnecessary. Moreover, some published elements can be sufficient proxies for others that are harder to come by: equipment and commodity payload characteristics can stand in for product density, for example, and also shed light on storage and handling aspects. When more current or specific price data are needed, it can be possible to compile it from web and other reference sources into a database with modest effort. However, results should be scrutinized to be sure that values are reported on the same basis: some figures may relate to wholesale, retail, delivered bulk, or spot-market prices, and others to costs of production. Collecting such data from empirical observations or through calls to vendors probably is impractical except as cross-checks; alternately, local chambers of commerce, economic development agencies, or economic research consultants may have some pre-existing data points that they use for internal purposes.

On a limited basis, for very specific freight flows and economic sectors (e.g., cement, coal, building materials, wood,

Table 6-2. Value to tonnage conversion by commodity type.

STCC2	Description	\$/Ton	STCC2	Description	\$/Ton
1	Farm Products	230	27	Printer Matter	37000
8	Forest Products	470	28	Chemical Products	690
9	Marine Products	1000	29	Petroleum or Coal Products	200
10	Metallic Ores	140	30	Rubber & Plastics	1600
11	Coal	30	31	Leather Products	15000
14	Non-Metallic Minerals	10	32	Concrete, Clay, Glass, Stone	100
20	Food or Kindred Products	850	33	Primary Metals	770
21	Tobacco Products	6900	34	Fabricated Metals	2400
22	Textile & Mill Products	4100	35	Machinery	9300
23	Apparel Products	6500	36	Electrical Equipment	19000
24	Lumber & Wood Products	210	37	Transportation Equipment	9400
25	Furniture	3170	38	Instruments	11000
26	Pulp or Paper Products	910	39	Misc. Manufactured Goods	3500

Source: derived from FHWA Freight Analysis Framework

and other such bulk materials), shippers and producers may be willing to provide rough price data for planning purposes. If special equipment or storage requirements apply, these will become evident during the course of dialogs with the shippers.

Levels of Accuracy and Precision

High degrees of accuracy in commodity value data are not critical to developing a successful rail freight diversion scheme, and the information resources described in this section normally are adequate indicators. If a scheme can be shown to be possible and likely to deliver a positive return on investment, it is unlikely that short-term changes in commodity value will overturn it, and other features like handling characteristics ordinarily do not shift very much. It is not usually prudent to pursue plans or schemes where the diversion hinges on having a low estimate for commodity values. In most cases, relatively modest changes to the plan, particularly in infrastructure or operating requirements, can strengthen its business case substantially.

Two exceptions that planners should keep in mind pertain to long-term market trends. New entrants or new production sources, especially in commodity markets where transportation is a significant component of delivered cost, can cause an otherwise viable rail service to become uncompetitive. Usually the traffic pattern then will change completely, with the commodity production moving elsewhere instead of just switching mode (although that may happen, too), but this certainly can disrupt the return on a rail investment. Modification to logistics practices are a second way the ground can shift: the move to low-inventory, high-speed supply chains, for instance, favors smaller shipment sizes and tends to reduce commodity payloads over time.

6.6 Maps and Inventories of Rail Infrastructure and Service

What is the problem? What kind of data would be useful?

Knowledge about the location, design, condition, and utilization of rail facilities is basic information for strategies and policies aimed at increasing the role of rail to relieve congestion. Several questions should be asked at the beginning of any study:

- Does the rail system have the capacity to handle more freight?
- If not, what are the limitations and where are the key bottlenecks?
- Do the railroads have plans (and capabilities) to expand the system to meet traffic growth?
- Are rail terminals well located in terms of handling additional freight?

- How important are grade crossings (rail-highway and also rail-rail) in terms of delays to highway traffic and to rail traffic?
- How well are the facilities performing?

Information about the current system is necessary in order to determine how much and what kinds of changes might be needed to improve its performance or increase its capacity. The essential question is where a public investment or a program of investments can be made that will make rail transportation more attractive or more available and induce a traffic shift.

The answer will begin with access: the location of prospective shippers along the network, their connection to it through sidings or transfer terminals, and the distances involved. Public initiatives here may be able to establish or improve the conditions of access, shorten distances, or even encourage a different pattern of location among shippers. The next part of the answer will consider the physical conditions that affect service: track speeds and geometry, terminal functions and design, network connections and circuitry, and grade crossings. In addition are the network features through which performance is bound up with capacity, including such elements as double tracking, siding profiles, and signaling. Public initiatives here will seek out the sensitive components, in order to make them targets of a set of investments that may enable system performance and competitiveness to rise. Capacity itself is the third part of the answer and perhaps the most complex. Its obvious importance is to ensure that if rail performance improves, the network can accommodate the diverted traffic—or, if rail performance already is high, that the network can be marketed for additional volume and can accept growth. Basic elements of capacity include features of line (e.g., tracks, siding lengths and frequencies, speeds and limitations, weight restrictions, and train controls), yards (e.g., total and receiving tracks, track lengths, and humps), and terminals (chiefly track length and storage). Public investment at least nominally is able to address any of these elements and expand the traffic volume available to rail.

By no means is it necessary to have all of these pieces assembled in order to evaluate the prospects for rail. An overview of the line and terminal network, the kinds of traffic it serves, expert but subjective views of capacity, and performance indicators like train speeds may be sufficient to get started. Greater specifics then can be sought where they seem most warranted by conditions and opportunities.

Are there readily available sources for the data?

The Carload Waybill Sample and a compendium of operators and networks like the railroad Official Guide are ways

planners can start looking at the systems in their districts. Going further, statewide rail plans setting forth an inventory of freight rail infrastructure are in existence around the country, with varying degrees of depth, detail, and currency. In some cases, the state plan will also describe the operations of railroads within its jurisdictional boundary briefly, giving an insight into what kinds of service might be available and how intensively and in what manner the infrastructure is utilized. Class I and smaller railways report a range of information on their web sites, including schedules and, in some cases, performance figures. The web site of the Surface Transportation Board also carries current and historical Class I performance measures, with data like train speeds and cars on line.

Access information can be obtained directly from large shippers if it is a question of sidings; rail carriers also will have this for facilities with recent activity or where sites are known to have been constructed off line. Transfer terminals and the kind of traffic they support will be published and more or less readily available. Engineering charts kept by owning railroads and public authorities will contain detailed information on types of signaling installed, location of infrastructure, and the state of infrastructure. Large railroads keep computer-based asset registers that will contain similar information. However, neither the plans nor the computer database may be totally up to date, unless the maintenance of way and signal departments make a routine effort to maintain it.

Third-party mapping companies or GIS solution providers, such as DeskMap Systems, Delorme, or ESRI, often will have databases of rail infrastructure covering entire regions, with some more complete than others. However, unless the company specializes in rail operations, it is unlikely to have information such as signaling systems and location of yards, sidings, interchanges, and switches. Equivalent rail networks for carload freight and intermodal also can be obtained from the Oak Ridge National Laboratory, although (as with other sources) the network may not be entirely current. In some communities, digital or aerial mapping of rail infrastructure would have already been carried out for specific projects. Those are often the most accurate source for the condition of local rail infrastructure.

Capacity assessments for the most part will not be ready to hand, unless either the rail carrier or a public agency has conducted a local study of the network. Capacity assessment can be conducted with models, and with railroad cooperation in the assembly of input data, but this detailed exercise rarely is appropriate in the early stages of project evaluation. The most practical initial measure probably is professional evaluation by persons familiar with the operation—railroad personnel or sometimes their customers—whose subjective views nevertheless can be well informed and directionally or entirely correct.

When dealing with previously abandoned lines, local historical and railroad societies may produce publications

detailing the status of local rail lines, and some will include detailed civil surveys. Independent producers have produced detailed U.S. rail atlases, some of which are more accurate than those provided in generic GIS sources.

How can the data be collected?

Maps, or GIS databases and routing networks, can generally be acquired from third-party providers. Some agencies may also have internal teams who develop the data or will have done so in the past for rail plans. Railroad carriers ordinarily can provide much of the information needed if they feel motivated to do so, deriving it from various sources—operations databases, asset registers, and their own capital planning team. Service plans can usually be obtained from the railroad or a knowledgeable intermediary such as an intermodal marketing company or publishers of railroad freight information and schedules.

Where there is a need for information not presented on typical rail network maps, railroad engineering departments represent effectively the sole source of information. Track maps can be found from third-party sources, but these can become outdated and do not contain often vital signaling capacity information. When the question concerns abandoned lines, or an uncooperative railroad, approved field visits and dialogue with knowledgeable personnel (such as retired employees) can be useful to obtain information.

Levels of Accuracy and Precision

For existing and operational infrastructure, railroad operating and engineering departments are the authoritative and most accurate source of information. Elements like yard and mainline condition and utilization can be reliably defined and can be substantive indicators of performance and capacity. Public agencies planning rail freight schemes with capital components based on upgrade of rail infrastructure must ensure that railroad carriers are part of the dialogue and planning process. Planners considering operational changes in ways the railroad infrastructure is used should also contact the railroad operating department to assess the feasibility of the plan being proposed and identify any infrastructure upgrade or additional maintenance costs that may be incurred by changes in operations. Conditions shape project specifications and investment requirements, so dependable figures are important. One method of checking carrier-supplied numbers is to have them reviewed by an experienced, independent party who is able to judge magnitudes, calculations, consistency, and overall reasonableness.

For planning purposes with abandoned infrastructure, cost assumptions can be made based on information gathered from maps, aerial photographs, asset databases, and reference figures

to the extent that they are available. These “planning-only” numbers should not be used in cost-benefit calculations, as the physical condition of the plant may be substantially different from the planners’ assumptions, leading to inaccuracies in service restoration cost.

Field visits can be another direct and accurate way to determine infrastructure conditions, if undertaken by knowledgeable personnel. Such visits can also be relatively cost-effective, given the time required to research and reconcile different reference sources or to reach out to engineering departments and other stakeholders. They are one of the fundamental ways that short-line investors evaluate properties, and it is usually helpful for planners as well to have on the ground exposure to facilities in order to develop a practical understanding of issues.

6.7 Railroad Engineering Cost Data

What is the problem? What kind of data would be useful?

The investment costs in proposed engineering projects obviously have to be quantified and generally have three major components: materials, construction labor, and equipment. In addition, there may be other outlays associated with a capital improvement scheme, such as land acquisition, design, permitting, management and planning. The most detailed cost estimation falls into the domain of engineers, but with intelligent use of data points and a grasp of the physical requirements, planners can develop good estimates of the cost of projects.

The Guidebook presents various figures and contextual information to help understand the range of costs associated with different kinds of rail investments. These will not be repeated here, but they generally employ two types of data. First, costs from past construction contracts (and actual costs once construction is completed) give an idea of what the cost would be if a similar project were carried out—for example, the addition of a siding or a spur. Second, financial factors such as the cost of railroad materials, lease rates for equipment, and labor rates can be used to estimate expenditures by enumerating each activity. The first method offers a view of the way various project components may total up, and the second allows for dissimilarities and gives a way to proceed if comparisons to analogous projects are not obtainable.

Are there readily available sources for the data?

Again, a series of factors and applications appear in the Guidebook that can serve as a resource for project evaluations. For additional specifics, there are many alternatives.

Costs of track and other materials are available from vendors, industry associations, and some independent publishers. Labor rates can be found in past cost estimations and contracts or from trade unions. Some reports will cite a standard cost per mile of track given a set of assumptions; this type of number is useful for planning purposes, although it is important to be aware that changes in the assumptions can lead to different costs.

Similarly, when using costs derived from past construction, it is important to understand the conditions under which the work was done. Constructing a railway from scratch can be cheaper than upgrading an existing one if the upgrade requires the use of restrictive work-windows between trains. Installing a new siding on a heavily traveled main line will cost more than the same siding on a branch line. The amount of earthwork required and foundation stabilization can vary greatly from site to site (also, depending on the line speeds and load ratings required from the new track), resulting in very different costs and schedules.

If signaling work is required, it should be understood that its cost estimation is difficult without some preliminary design work. Most of the cost involved in commissioning new signaling relates to specialist labor for installation and testing and the solid-state equipment to be installed. Costs tend to be dissimilar from contract to contract. Moreover, seemingly routine work such as moving an existing signal head from one location to another could be a minor or major expense, depending on the amount of other work required as a result of the change.

How can the data be collected?

Research into the kinds of primary and secondary sources cited above will yield the requisite data. Another alternative is to turn to civil engineers with rail project experience; many will have estimation methods that allow a cost projection to be done in a few hours. For more detailed cost estimation, an on-call contract with an engineering consulting firm is a way to assemble anticipated expenses before a formal project bid is released.

Levels of Accuracy and Precision

Cost estimation is vital for project evaluation, financing, and job management. This means accuracy is essential, and the need for precision will increase as a project moves toward programming. The methods presented in the Guidebook and touched on here are capable of producing sensible estimates whose reliability is appropriate to the stage of project development. Any engineering project faces an assortment of contingencies touching on anything from market cost changes to permitting and job management, and rail (like highway) projects are certainly subject to them. Allowing for this, infor-

mation resources nonetheless are sufficient to the needs for precision and accuracy.

6.8 Shipper Characteristics and Needs—Establishment Data

What is the problem? What kind of data would be useful?

Railroads or their intermediaries ultimately must be able to determine which companies might be willing or able to shift some of their freight from truck to rail. Planners will want to engage with some of them on subjects ranging from access to service design and divertible volume. Candidates would include companies originating or terminating large amounts of freight, port authorities, and national corporations known to ship substantial volumes through the region. Many of the relevant companies will be well known, because of their importance to the local economy; others, particularly shippers of low-cost bulk materials, may have a low profile and generate significant tonnages with a modest number of local employees. The geographic dispersion or clustering of important businesses also is essential to understand, because of its effect on operating density.

The available databases about commercial establishments are useful for a number of reasons. On a macro level establishment data are used to assess economic geography. Establishments are classified in terms of the Standard Industrial Classification (SIC) or North American Industrial Classification System (NAICS) codes. Based on these codes, the nature of the state's economy can be understood and the corridors where rail freight solutions have leverage can be identified.

On the micro level, establishment data are used to create a list of potential stakeholders to interview and to organize them into logical groups based on their characteristics and likely freight needs. Typical business databases contain not only the physical location and the name of the establishment, but also the number of employees and an indication whether the firm is a subsidiary of a larger corporation and, in some cases, the input-output relationships (i.e., the industrial codes of any upstream and downstream industries, as well as non-core production activities). SIC or NAICS codes can usually be translated into commodities to determine what types of goods are being shipped. Establishment databases by themselves are decidedly helpful, but when joined to other information resources discussed in this chapter, they help create a potent analytical system to determine freight needs and traffic.

Are there readily available sources for the data?

Several commercial databases are available, each with different coverage and pricing options. A basic list of establish-

ments is often within reach from the local chamber of commerce or phone book or from web-based equivalents. Some state governments also keep internal or public establishment databases as part of a census or other research support activity. Three of the main vendors providing data in the private sector are Dun & Bradstreet, InfoUSA, and Harris InfoSource; all are able to supply data at the level of detail described above. Other vendors, such as ZipInfo, offer less detail, but may represent a cost-effective solution. These data normally do not reveal the existence of rail access, yet normally are geocoded. GIS analysis of establishment data alongside a reasonably detailed rail network will show the proximity of businesses to rail lines, and this can be used for a first approximation of access.

How can the data be collected?

There are different approaches to collecting establishment data. A simple, if laborious, approach is to work through the business telephone directory, especially if it can be organized by geography. Another is through field visits—if the search is to find all businesses abutting a given rail branch line, field visits can actually be a cost-effective way to conduct research and may generate much more information than any database (Figure 6-4 illustrates this). A third approach is to use maps, charts, zoning records, and aerial photographs, combined with other reference material, to locate large industries near the rail line.

If a comprehensive database is not available from a commercial vendor, information can be extracted by joining data from the local chambers of commerce, zoning records, local knowledge, and postal or phone book address records. Zoning records will help locate industrial activity, and sometimes SIC or NAICS codes of businesses can be ascertained either from the name of the establishment, from a chamber of com-



Figure 6-4. Some Potential Rail Freight Shippers' Activities are Self-Evident from a Field Visit.

merce database, a quick phone call, through locally knowledgeable persons, or a short site visit. Railroads will have information about line access, at least for recently active customers; for inactive ones, phone calls may be required to define status because a former siding may have been paved over. Sometimes a site visit is the only way to ascertain the industrial activity and freight requirements at certain brown-field sites.

The importance of fieldwork should not be underestimated. No database fully replaces it, and sometimes fieldwork is simply a matter of driving by, observing signs, and taking digital photographs of commercial activity.

Levels of Accuracy and Precision

The accuracy of establishment data in general is good for the existence of activity, reasonable for employment levels and business mix, and less good for business levels. Surveys are utilized to obtain the data and some information is considered confidential by the respondents; furthermore, there is no integrated mandatory reporting process for commercial establishments, except for financial data on publicly held companies (which do not report site-specific data in any case). Analysts need to (1) be careful that employment estimates are particular to the local address and (2) watch for misleading codes suggesting that manufacturing takes place in a location really dedicated to services.

Commercial activity is also highly dynamic. Some industries that are transportation-intensive (such as building materials, scrapping, and some chemicals) tend to be cyclical in nature, and business levels can be tied to discrete contracts. A plant may shut down or start up again in a matter of months, or production locations may shift. Thus, maintaining up-to-date establishment information requires ongoing effort, and databases should be renewed to ensure currency.

Commercial databases are useful for systematic planning and identifying opportunities. Nevertheless, for development of a specific rail-freight initiative whose success may hinge on several major customers, locally knowledgeable persons can be a great resource, and early contact with major shippers should be considered a vital part of the planning process.

6.9 Modal Service and Cost Parameters

What is the problem? What kind of data would be useful?

Modal service and cost parameters are used to assess whether a rail freight solution is in fact feasible from a shipper's point of view. If shippers cannot reduce their overall private logistics costs by moving to rail, either a different

incentive will have to be provided, or they will continue to ship by truck. On the service side, shippers must be able to manage the logistics chain so that their business activity is compatible with typical rail performance. Except for premium intermodal and some other operations, rail shipments may be slower, require longer lead times, and perform less reliably than trucks. The business may be able to adapt, but the service it can expect to receive should be understood.

An extensive treatment of logistics cost factors appears in the Guidebook. Here, it is sufficient to say that performance indicators, operating costs for both truck and rail, and information relating to inventory and handling expenses all are useful in a comparative modal assessment.

Are there readily available sources for the data?

Shippers ought to possess accounting records of logistics costs, including the cost of transportation, warehousing, and value of inventory in transit. Without shipper contact, it is still possible to calculate a likely range of costs using standard cost functions for trucking, generic commodity dollar values, and estimates of the cost of storage. The most difficult step sometimes is in approximating the significance of inventory in transit, since business decisions affecting transit time requirements can be linked to the strategic value associated with tight channel control and point-of-sale response.

For railroads costs, commercial products will estimate the cost of railroad shipments between intermodal terminals or freight stations. Most of these models are based on the Uniform Rail Costing System (URCS) methodology developed by the Surface Transportation Board (STB) and its predecessor, the Interstate Commerce Commission; the STB makes available a URCS-type cost model as well. The AAR also publishes a quarterly Rail Cost Adjustment Factor (RCAF), as part of its Railroad Cost Report (RCR). For a general idea of costs, a simple cost function with a cost per mile could be used. Most rail users and rail service marketing companies will have such rules-of-thumb, and a variety of them are presented in the Guidebook.

The key trucking costs for rail comparisons are full truckload, which will also serve as a profile for linehaul costs in LTL. Up through 2005 there had been good information from which these could be derived in the M-1 financial reports, which larger motor carriers were required to submit to the federal government. The discontinuance of reporting in that year meant that trucking costs eventually would have to be estimated from engineering factors, although the historical figures would offer a reasonable template to work from for a fair period of time. Truckload service characteristics are reasonably well known and are shaped by distance,

travel speeds, the number of drivers, and hours of service regulations. Overnight trucking service with a single driver is typically difficult for rail to divert, as is the premium team service where two drivers alternate shifts. Longer distance trucking service that involves a layover for a single driver (thus, with a dock-to-dock average speed lower than about 50 mph) can often be diverted with rail intermodal. Beyond intermodal, rail service tends to compete on characteristics other than speed, such as costs, safety, size of shipment, and other factors.

Rail service characteristics can vary with the type of rail service purchased, proximity to major yards and mainlines, train frequencies, and other system-wide factors. Thus, predicting the service level in a given rail lane is much more difficult than for trucking. If the rail freight diversion proposed relies on existing services, then the railroads would usually have a fairly good time estimate for the shipment. If new service is being planned, then the sponsor may have more flexibility over cost and service levels—with the caveat that truck-equivalent service levels tend to be more expensive except in high-volume service lanes. Generally, the best way to validate proposed service levels is through careful operations planning, followed by test runs designed to determine the feasibility of the operating plan and its impact on other railroad operations.

The major Class I railroads (and the two Canadian majors, CN and CP) are required to report service performance levels to the STB on a weekly and quarterly basis. Although these numbers are available from a website maintained by the AAR⁴, the highly aggregated performance data are of limited value for predicting service levels within particular service lanes. Nonetheless, they are a good indicator of broad service trends (e.g., whether the probability of a regular shipment arriving on time is increasing or decreasing).

How can the data be collected?

There are two major types of service performance data: (1) empirical results, which must come from the carrier, the shipper, the agent, or another interested party who has kept historical records such as the sources mentioned above; and (2) performance simulations, which can be estimated with knowledge of current operating practices, plans, and infrastructure conditions by either a consultant or the carrier's operating managers, but must be validated by actual service performance or test runs. Ultimately, the data must be obtained from one of these sources. Unlike passenger rail, it

is generally costly and difficult to ascertain rail freight performance by direct field observation, because of the long variability of run-times and the difficulty of tracking the operations without using one of the railroad's proprietary information systems.

There are also two major types of cost data: (1) accounting data, which may be available from shippers or carriers willing to make them public or share them through an intermediary conducting a study on behalf of a public agency; and (2) cost model data, which are calibrated by a knowledgeable party based on known expense and operating factors. Price data are rarely possible to observe directly and therefore must be obtained through modeling, interviews, and other cooperative methods.

Levels of Accuracy and Precision

For typical rail freight diversion applications, service times need to be known to within one day, or perhaps half a day. Service time precisely to the hour is usually less important than the reliability factor. Under unconstrained conditions, a train may be able to move from siding to siding in a standard number of hours; however, for a feasible service plan, the number of intermediate switching moves and the probability of delay at each location must be accounted for. Even for bulk commodities, a missed delivery can lead to problems at the receiving plant unless a sufficient stockpile is maintained—which drives up the total logistics costs. Thus, errors in reliability estimations may lead to excessive costs being incurred by the shipper, resulting in a seemingly promising operation becoming an uneconomical one.

For intermodal diversion, time performance can be especially critical, since the truck-like performance it aims for is often associated with low levels of inventory. Nevertheless, typical services still are discussed in terms of morning, afternoon, or evening delivery, instead of a specific hour within which the shipment must arrive. While there are premium intermodal products that do guarantee certain time windows and cut-offs, those normally are geared to the requirements of a particular customer or group.

Operating costs are an important factor in determining whether services can be sustained. Prior to investment in expensive infrastructure, comparative analyses of modal costs should be conducted. The cost savings of moving from truck to rail need to be significant in order to allow an annual contribution toward paying off the infrastructure. If the cost savings are not significant, then even if the infrastructure is constructed, the traffic may not materialize. Thus a compelling case is required before an investment decision is made—but having made such a case, and given the magnitude of infrastructure costs, minor errors in rail operating

⁴The website at <http://www.railroadpm.org/> features such performance measures as Total Cars On Line, Average Train Speed, Average Terminal Dwell Time, and Bill of Lading Timeliness. Performance measures of shortlines have not generally been available.

costs are unlikely to change the fundamental conclusions in a freight diversion project.

6.10 Trend Data—Traffic and Economic Projections

What is the problem? What kind of data would be useful?

In planning, trend data are sometimes used to illustrate a future scenario and to convince the stakeholders that changes are needed now to prepare for the future. Congestion tends to worsen with economic growth, and if rail freight investment can keep ahead of growth while highway investment remains stagnant, railroads will become comparatively more attractive to some shippers. Trend data are therefore needed to illustrate the effect of both highway and railroad congestion if nothing were to be done, and the payoff from taking action.

In general, trend data fall in two broad categories: (1) economic trends and (2) traffic trends. Economic trends serve to suggest how fast the economy might grow in future and can be used to infer how costs, service levels, and other attributes of freight transportation may change over a long planning horizon. Traffic trends serve a shorter term purpose—if congestion is growing by a certain percentage per year on one highway route, it can be conjectured that the congestion will continue to grow at a similar rate until the facility becomes comparatively less attractive versus substitutable facilities or versus alternatives such as supply source substitution.

Are there readily available sources for the data?

Economic forecasting is a specialized discipline, and forecasting data are made available both by governmental agencies and commercial vendors. Past economic trends can be found in various reports made available by the Department of Commerce,⁵ Bureau of Economic Analysis, and the Economics and Statistics Administration, in addition to private economic research resources. However, the federal-level data may not contain enough regional detail, and state-level data should be consulted. Many states have official projections of population and other economic drivers, and some have invested in forecasts directly aimed at transportation or reasonably pertinent to it. In addition, a number of regional economic models are available⁶ in the marketplace.

⁵See <http://www.commerce.gov/> and <http://www.bea.doc.gov/> for more details on the types of data provided.

⁶Examples include REMI from Regional Economic Models, Inc.; REDYN from Regional Dynamics, Global Insight (DRI*WEFA); Fair Model (Yale University)—as well as many consultants who produce forecasts based customized versions on one or more different models.

The previous chapter of this report presented a cross section of trend and forecast information and cited relevant sources that may be consulted. For the tracking of traffic congestion, it displayed data from the Texas Transportation Institute, whose annual Urban Mobility Study⁷ is the standard compilation of developments across the nation. TTI indexes and ranks traffic congestion problems for the 85 major U.S. urban areas, and its data can be compared and extended in time series. However, forecasting future traffic congestion based exclusively on its current trend is not advisable beyond about 5 years; to understand the extent of long-range congestion, long-term economic trends should be used.

For more information on forecasting future freight congestion, a good source is the NCHRP report 8-43: Guidebook on Statewide Freight Planning. Although this manual does not specifically deal with rail freight, using the methodologies demonstrated therein to understand where future congestion and bottlenecks may occur could be helpful. Once these potential hotspots are identified, the methods in this Guidebook can help planners decide if a rail freight diversion scheme is apt to alleviate the likely problem.

How can the data be collected?

The economic and traffic trends rely on numerous data sources, and it is generally not cost-effective to duplicate the data collection effort. Economic trends require data about trade activity, which is collected by the Department of Commerce through business reporting requirements. Traffic trend data and projections may be based on Highway Performance Monitoring System (HPMS) and automated data collection devices. The source data are publicly available.

Levels of Accuracy and Precision

Economic and traffic trends are usually reliable, if their data are sound and their dynamics are accurately understood. Projecting from trends is another story, because of the underlying presumption that past events will continue on a logical course toward a future conclusion, which is not always the case. More sophisticated forecasting tries to anticipate course changes and the interaction of trends, and while inevitably imperfect, it will give a better result. Econometric forecasts of this type can be purchased from a number of sources, and banks and news services like the Wall Street Journal offer comparative performance ratings for vendors.

In many cases, predicting economic growth itself is not as important as predicting political decisions. Lack of highway investment is one catalyst for rail freight investment; how-

⁷See http://mobility.tamu.edu/ums/congestion_data/ for more details about this study.

ever, if congestion becomes too severe, citizens may demand highway or mass-transit improvements. When planning rail freight investments, many such factors should be taken into account and weighed through a scenario analysis. Planners should prefer not to rely on a single set of traffic or economic assumptions being completely correct or base the viability of a specific rail freight plan on a single scenario. The best rail freight plans will view an investment case under a range of development assumptions and test its success across them.

6.11 Institutional and Privacy Factors

To develop a successful rail freight diversion scheme or other rail freight solutions, three basic types of data are needed. The planner should have an understanding of (1) the markets in which freight travels and levels of demand; (2) the supply cost of providing freight services and infrastructure to meet that demand at appropriate levels of service; and (3) the economic trend data that reflect how the supply and demand, the associated congestion, and the area's economic development can be expected to change in the near and further future. There are a series of sources for satisfying each, with options that can be scaled to the size or phase of a project or program, from small or preliminary to very large or well advanced.

State DOTs, MPOs, and other organizations should make an active effort to make freight data collection part of their regular data collection efforts. In some cases, data collected for passenger facility performance monitoring and/or for optimization of facility maintenance strategies can be used to produce informative freight data streams. Alternately, it may be possible to add features to a data collection program that will partially feed freight planning applications. Freight activity is also heavily connected to economic activities; thus, as part of an area-wide economic development or re-development effort, data streams might have already been collected that could assist freight planning. Since ownership of these data could lie outside the domain of DOTs, it is important to establish contacts in other public organizations with overarching responsibility for economic development and become familiar with the information they may have available. Examples of such organizations include

- Local economic development agencies (e.g., the Boston Redevelopment Authority);
- Local port authorities (e.g., the Delaware River Port Authority); and
- Multi-state agencies (e.g., the Tennessee Valley Authority).

Developing a data program and encouraging working relationships with entities that may become sources of information

introduces institutional and privacy issues. Some of these issues are explored below.

Privacy Concerns

Private-sector carriers in both trucking and rail are rightly concerned that their competitors might use information about the flows on their network (and by inference, about their customers) to their own advantage. The negative effects can include customer poaching, disruption of density, and loss of network balance. This type of competition also may result in destructive price wars that can harm individual carriers or delay reinvestment by an industry. Shippers of freight have similar concerns. In addition, rail carriers may worry that any new reporting of market data begins an unwelcome return of government oversight, such as prevailed prior to the Staggers Act.

For reasons such as these, the STB waybill sample is protected by law. Decisions on using its detailed version are reviewed by the Federal Railroad Administration, and state-level governments have access only in a controlled fashion. On the occasions when a private enterprise is permitted to make use of these data, strict guidelines must be adhered to. In most cases, the data processing must be done by an intermediary, who then must use the data only for the specified purpose and destroy it after the work is completed. When primary data from motor carriers have been tapped for some public studies, it has been done voluntarily, instead of on the compulsory basis that applies to the rail waybill. Nevertheless, restrictions and protections have been built in for the benefit of cooperating truck lines: information has been aggregated, intermediaries have been employed to avoid subjection to the Freedom of Information Act, and reuse has been prohibited.

If state DOTs and other governmental organizations expect to develop the trust of industry in conducting planning studies and sharing data and plans to mutual advantage, these privacy concerns must be taken very seriously. Demonstrating a good understanding of the issues and why privacy is necessary, honoring the commitments, having a codified policy on how data may be used and distributed, and never using data in less than good faith will go a long way toward building a successful and fruitful relationship with industry partners. In joint planning, it is always important to achieve a win-win outcome; the industry cannot 'win' if the data provided for planning purposes are not treated with care and caution by trusted agencies.

Financial Data

Publicly held companies are required to report certain financial data to the Securities and Exchange Commission

(SEC), for example, on the Form 10-K.⁸ However, 10-K information typically is not very useful to the transportation planner, as it is rolled up for the whole corporation (most likely a multi-state enterprise), and there are ways to report the information such that it is difficult to understand the company's cost structure. In addition, some very large freight carriers are held by private entities, who are under no obligation to disclose financial results to the SEC. On the other hand, railways in the United States are required to submit R-1 reports annually, which set forth a substantial body of financial and operating statistics, some of it like conventional balance sheet and income statements, and some of it quite different and oriented, for example, to operating assets. (Discontinuance of the comparable if less detailed M-1 reporting for motor carriers was noted above.)

Railroad capital programs normally are published annually and can both be helpful and unhelpful to the public planner. The capital budgets will be defined in terms of number of ties to install, bridges to rebuild, and sidings or track miles to add. In addition, ongoing projects may have special line items that highlight the investment that railroads are planning using their own capital. However, it is generally difficult to extract specific cost numbers from such documents. Moreover, public agencies rarely are invited into the strategic planning process at private railroads, so public planners may believe that they have little influence.

Still, many Class I railroads have a government relations department. Taking a proactive approach to railroad capital planning at a state level can yield fruitful results. In several states, there are standing funds available for railroad infrastructure upgrades, which can be a good way to become engaged in railroad capital planning. With a stake in the process, it becomes much easier to acquire financial data needed for planning and budgeting on the public side; also, planners will develop a better understanding of whether rail freight diversion plans can work or not and how much they may cost.

Railroad Capacity and Reliability

Public planners are aware that it can be difficult to persuade railroads to release seemingly 'spare' capacity on their tracks that is not currently in use because, once an operating agreement is entered into, it will be difficult for the railway to remove that traffic, replace it with more profitable business, and not cause a public-relations problem. Without removing existing traffic, infrastructure upgrades typically are required when additional capacity is needed. These can be time-consuming and costly, especially in metropolitan areas. Thus,

spare capacity on a not-yet-congested portion of railroad is still an expensive commodity, even if infrastructure upgrades are not immediately required for new traffic. Public agencies wishing to use capacity on private railroads must understand that not only do they have to cover the operating cost of the train, they must offer a premium to out-bid any future use of that capacity the railroad may have planned. A pragmatic solution to this problem is to have the public agency upgrade a piece of private railroad infrastructure at public expense, in lieu of premium payment for a spare train path.

In some cases, loading a network with additional traffic can cause sometimes-subtle effects that lead to increased costs. For example, spare capacity may be required at strategic points about the network to prevent cascading congestion when long-distance traffic is delayed. The cost of this capacity is usually borne by the railroad. Cascading congestion can be extremely expensive, requiring many more crews and power units to move the same amount of freight compared to an uncongested network. Increasing traffic can dramatically increase the cost of recovering from such an incident and is a cost that public planners should be aware of when aiming to use apparently untapped capacity.

Data Collection is a Cost

In addition to the concerns discussed above, two further issues may give carrier management pause in respect to sharing data:

- **Rate of Return on Data Collection Activities.** Developing a relationship with public authorities and finding new freight with public support can be profitable activities for railroads in the long run. Even so, rail managers may think they lack the current resources to manage a data collection exercise or may doubt that new business is going to arise from the effort. Even in a business development environment, managers will be reluctant to do extensive data collection or grant high priority to the proposals of public planners unless the prospects of rewards are substantial. When requesting data, it is helpful to state upfront what the rewards might be—for instance, by showing that investment funds will become available through a certain feature or channel. Railroad partners may be more likely to engage in data collection if such data are made a part of the application for a specific grant or if the data are being offered on the understanding that public officials will pursue available funds and take over some of the development work based on the data.
- **The Litigation Threat.** Freight carriers, like other corporations, have a healthy respect for the legal system, and some of their caution with information release may stem from the lack of clearly codified limits on how data may be

⁸See <http://www.sec.gov/answers/form10k.htm> for more details. The Securities and Exchange Commission is at <http://www.sec.gov/>.

handled. The U.S. Census, and the STB waybill sample achieve successful data collection in part because there are clear laws on how the public may use and disseminate the data. Confidentiality is guaranteed and exemptions plainly exclude certain data-mining activities. Steps such as those outlined in the discussion of privacy issues will allow public planners to assuage concerns about litigation exposure. The establishment of clear contracts limiting the application of data for planning purposes and the use of vetted intermediaries to process it help to create a trusted framework for information exchange.

6.12 Data Environment

There are special issues concerning the electronic data environment in railroad and motor carriers alike that are worth understanding. Some data systems are legacies from development early on in the computer revolution, when each carrier sought to acquire IT capability for its own internal financial planning and operations purposes. As such, data formats occasionally predate the concept of relational databases and data mining and are driven by transactions far

more than analysis. Because the systems are intended mainly for internal use, there may be limited standardization on what kind of data are kept, how they are kept, and what format they are kept in. Public planners should understand that data simple to generate in an environment powered by latter-day data centers are not necessarily easy for every carrier to compile, despite their best intentions.

With that in mind, it is important to be patient and flexible when requesting data that may require downloading from legacy systems. It is possible that carriers in these environments will have to expend substantial effort to find the data being sought by public planners. Once the data are found, they might be available only as a line-printer output, requiring optical character recognition software to translate into machine-readable form. It is likely that carriers would want to further process such data before handing it to the public planner, in order to elide commercially sensitive information, and this imposes an expense on the carrier. Offering compensation for such expenses or maintaining a confidential data-processing expertise in house can be ways to ensure that data collected by the private sector for private purposes are not lost as a planning resource.

CHAPTER 7

Framework Structure

All of the preceding sections on research literature, case studies, mode choice factors, freight trends, and data together provide a structural foundation for the final product of this project, which is a Guidebook for planners. This last chapter of the Final Report describes the structure of an analysis framework that forms the foundation and structure for the Guidebook. This structure has three dimensions:

- **Planning Process Framework.** The methodology described in the Guidebook must be designed to address the relevant issues and needs faced by transportation planners at both public agencies and private transportation companies.
- **Decision-Making Framework.** The methodology described in the Guidebook must be structured to encompass the benefit and cost considerations involved in the mode choice decisions made by freight shippers and the investment decisions made by public agencies.
- **Structured Sequence of Steps.** The methodology must provide a structured series of steps that can be adapted to apply to a broad set of circumstances ranging from simple to complex multi-modal projects.
- **Processes for Public Investment Planning.** Traditionally, most state DOTs and MPOs have focused their infrastructure planning largely on highways and given less attention to rail investment, for the fundamental reason that they control investment in highways while they typically do not own or control investment in railroads or rail right of way. However, there is a growing recognition that (1) more multi-modal public planning is needed for freight movement; (2) such planning should include rail as well as highway options for freight movement; and (3) rail freight planning, if done well, can help address a wide range of issues relating to security, congestion, safety, and air quality.
- **Methods to Identify Transportation Issues and Assess Potential Solutions.** Before expanding multi-modal investment analysis for freight movement, it is necessary for state and regional transportation planning agencies to (1) clarify the range of possible transportation issues that should be addressed, (2) define the range of potentially feasible rail and highway solutions to be assessed, and (3) apply appropriate methods to assess their relative benefits and costs. For instance, while there is a current emphasis on addressing problems of growing highway congestion, planners need workable ways of assessing these needs and identifying feasible rail-freight solutions for them.
- **Approaches for Private-Public Cooperation.** Given the private ownership of many railroad and truck-rail intermodal facilities, it is necessary for rail freight planning to involve both private and public sectors. At the same time, key representatives of cargo shipping, trucking, and railroad companies also have a strong interest in seeing improved planning and investment, as they are keenly aware of the current shortcomings and needs for improvement in existing road and rail infrastructure systems serving freight movement. Thus, there is clear opportunity for enhancing private-public cooperative relationships in freight infrastructure planning.

The Guidebook is also available for download from the NCHRP section of TRB's web site (www.trb.org).

7.1 Planning Process Framework

As the gap between highway demand and capacity is forecast to accelerate in the future, there has been increasing recognition of the importance of multi-modal planning and, specifically, the need for more attention to rail freight issues and opportunities in the transportation planning process. This has led both public agency planners and private transportation company officials to recognize a need for tools and methods that they can use to address freight transportation planning issues. These needs fall into three broad topic areas:

To address these three sets of needs, the guide must (and does) have separate sections providing: (1) screening criteria to identify situations where analysis of rail freight solutions is warranted, (2) steps for calculating benefits and costs of rail freight alternatives, and (3) instructions on how the information can be best used as part of a broader public-private dialogue between transportation agencies and railroads.

7.2 Decision-Making Framework

The core of the guide is a set of steps for assessing the relative benefits, costs, and practical feasibility of implementing alternative policies, programs, or investments to encourage rail freight solutions as a way of reducing roadway congestion. Figure 7-1 shows the elements of decision-making. It can be summarized as follows:

- The first part of the process is to identify applicable situations where rail freight solutions are potentially applicable and focus only on them.
- The second part of the process is to evaluate rail freight alternatives by considering the technical feasibility (benefit measurement) perspective of planners and the practical feasibility (funding and regulation) perspective of decision-makers.
- The third part of the process is to develop funding and implementation plans that account for differences in the

distribution of benefits and costs, as well as effectiveness, among public and private parties. That is necessary to enable the public-private cooperation required for any strategy involving shippers, railroads, and roadway planning/operating agencies and to help ensure its success.

To carry out this process, the Guidebook lays out a strategy involving three phases of analysis:

- Preliminary assessment: situations where rail solutions appear feasible,
- Detailed analysis: evaluation of rail options, and
- Decision-making: Multi-criteria and benefit-cost analysis.

These phases are shown in Table 7-1 and explained in the text that follows.

Phase 1—Initial Screening. In general, public agencies are looking for particular rail projects or programs that can help to relieve highway congestion. As such, there is a need for guidance in identifying the types of situations where rail might help; expected benefits associated with congestion relief; and the specific types of projects or programs that might be appropriate given local conditions. These assessments are part of the first phase of the analysis, which focuses on determining whether there is a reasonable chance that the costs of rail projects or programs can be justified in terms of their contribution to congestion relief. This phase involves carrying out five steps to (1) screen for relevancy of rail freight solutions, (2) gauge

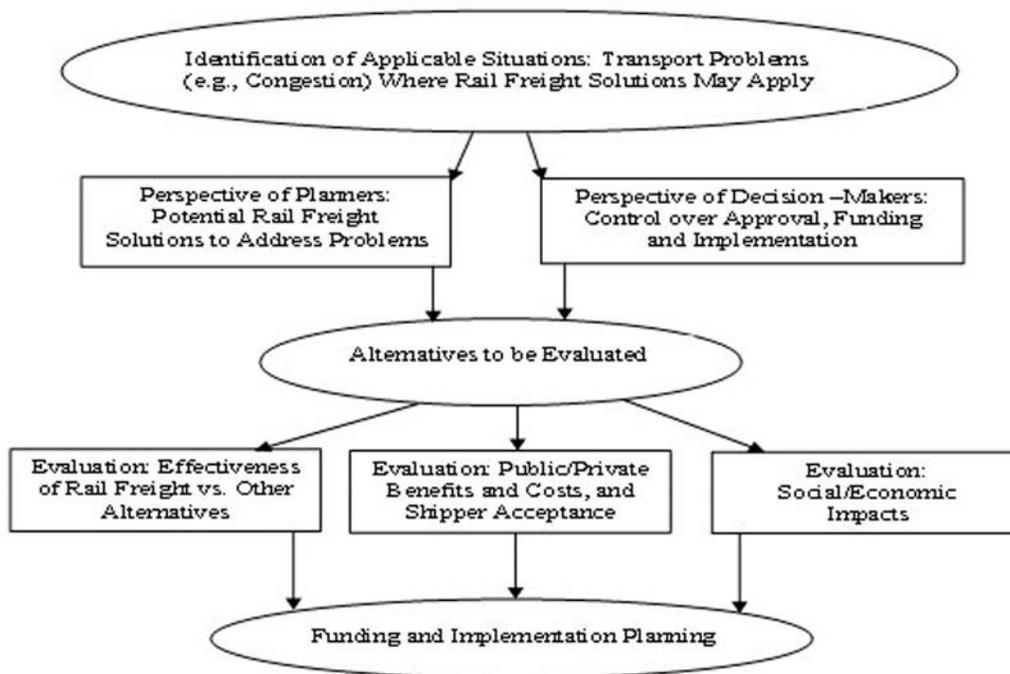


Figure 7-1. Decision-Making Process for Rail Freight Investment.

Table 7-1. Major phases of the decision-making process.

Phase	Major Activities	Main Question & Desired Outcome	Methodology
1	Preliminary assessment: situations where rail solutions appear feasible	<ul style="list-style-type: none"> - Can rail help relieve highway congestion by handling more freight? - <i>Identification of promising rail projects or programs aimed at specific solutions to congestion problems</i> 	<ul style="list-style-type: none"> - Review information on freight facilities & traffic flows - Use framework to identify problems & potential solutions - Use simple models to estimate costs & benefits of potential solutions
2	Detailed analysis: evaluation of rail options	<ul style="list-style-type: none"> - Do benefits of proposed actions justify their costs? - <i>Analysis of costs & benefits of rail solutions, including economic & environmental factors.</i> 	<ul style="list-style-type: none"> - Estimate project costs and impacts on rail service - Traffic diversion study - Benefits analysis
3	Decision-making: Multi-criteria & benefit-cost analysis	<ul style="list-style-type: none"> - Is this project or program as good as or better than other approaches? - <i>Comparative analysis of major alternatives</i> 	<ul style="list-style-type: none"> - Consider alternatives including rail, highway investments, and public policy regarding taxation & finance.

magnitude of the road congestion problem, (3) characterize the local pattern of freight shipping, (4) characterize available rail resources, and (5) use “sketch planning” approaches to assess the potential viability (benefit and cost) of available options.

Phase 2—Detailed Analysis. Only if there seems to be potential for a particular project or program should the analysis proceed to Phase 2 for a more detailed analysis of the proposed options. The logical place to begin is by looking at specific rail investment options and estimating how they could affect cost or any of the service factors that influence total logistics costs. The next step is to use a logistics cost or mode-split model to determine whether service improvements, if obtained, would be likely to affect road/rail choices and, if so, to estimate how many trucks might be diverted to rail. Given the potential diversion, it is then possible to estimate the effects on highway performance using various highway models. The changes in highway performance can then be compared to the costs associated with the rail initiatives to see if further consideration is warranted. Thus, Phase 2 makes use of (1) rail cost or performance analysis, (2) logistics cost or mode-split analysis, (3) highway performance analysis, and (4) economic and financial evaluation.

Phase 3—Decision-making Support. The final phase puts results in the context of decision choices. First, findings must be placed in the context of other options, such as doing

nothing and living with congestion, building more highways, expanding the capacity of existing highways, or using tolls, fees, or regulations to restrict traffic flows. Second, each option must be considered from the perspective of its economic, political, and practical feasibility for the various participants. This includes consideration of the levels and types of benefits that might accrue to each party and confirmation of the sufficiency of benefits for shippers to accept a change of mode. It requires direct interaction with the shipping community in any of several ways and an assortment of steps for the assurance of traffic volumes. Third, for the public evaluation component, additional analysis of social and broader economic impacts might be needed. Thus, Phase 3 makes use of procedures for comparing alternatives in a broader context that may include regional economic models and/or multi-criteria assessment tools.

7.3 Structured Sequence of Steps

The Guidebook consists of sections that readers can consult or ignore as appropriate for their particular situations. The sections fall into the following groups:

Initial Grounding. Guidebook Chapters 1 and 2 provide a basic grounding in freight analysis issues.

- *Chapter 1 (Introduction)* defines the coverage of this guide. It classifies the types of situations, issues, and solutions that

can be considered in planning and evaluation of rail freight solutions to traffic congestion.

- *Chapter 2 (Background: Context)* provides information for readers who are not already experts on rail freight planning. It discusses the process of rail freight planning and factors affecting rail/truck diversion.

General Guidance. Guidebook Chapters 3 and 4 provide the basic core guidance on technical analysis and discussions to ascertain the potential for rail freight to help reduce traffic congestion growth.

- *Chapter 3 (Guidance for Evaluation of Alternatives)* outlines a series of five basic analysis steps that can be conducted by planners at relatively low cost to screen available rail freight options for reducing congestion and identify when further discussion and analysis are warranted.

- *Chapter 4 (Guidance for Public-Private Dialogue)* discusses needs, uses, and procedures for bringing highway and freight planners in discussion with representatives of institutional players and private-sector freight operators in order to design cooperative strategies that can be acceptable to key parties.

Technical Analysis Methods. The Guidebook's final chapter provides material for advanced use in analyzing options and presenting results in ways that can gain support among diverse parties.

- *Chapter 5 (Detailed Analysis Methods)* describes the availability and application of various analysis tools, methods, and data sources for assessing road and rail options, diversion between them, and the relative benefits and costs involved.
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Guidebook for Assessing Rail Freight Solutions to Roadway Congestion

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Introduction

This introduction provides background context on the purpose and use of this report. It summarizes the motivation for considering rail freight options as a solution for addressing traffic congestion, the types of rail freight strategies that can be applied, and the types of situations in which they can be most relevant. It then describes how this report can be used to aid policy development and evaluation of alternatives.

1.1 Rail Freight as a Solution to Congestion

The Congestion Problem

Over the past decade, both urban and intercity highway traffic has continued to grow at rates far in excess of capacity expansion, leading to increasing congestion-related delays and accidents, as well as increasing concerns about congestion implications for air quality, delivery reliability, security, and vehicular incursion into residential areas.

Types of Actions to Address Congestion

There are various ways to reduce or minimize the growth of traffic congestion on highways. They fall into three basic categories:

- Expand highway system capacity through construction of new or modified lanes, ramps, traffic controls, or other traffic management systems;
- Institute pricing and regulations to shift highway use by encouraging or requiring some road travelers to shift routes or times of day; and
- Expand options for alternative modes by enhancing available options for alternative modes of travel, such as use of railroads in place of roadways.

Focus on Rail Freight

All three of these categories of solutions can, in theory, be aimed at passenger travel or freight travel. Yet while passenger travel accounts for the majority of vehicles on most roads, trucks have a particularly significant impact on highway congestion for several reasons. Trucks take up more space and require broader separation than cars. Some car drivers are also intimidated by large numbers of trucks mixed with cars on highways, which further adds to traffic congestion. Freight movement and truck traffic are growing at a faster rate than passenger movement and car traffic on highways. Finally, some policy makers see rail freight as an economically viable and sustainable alternative to intercity truck freight, while the rail option for intercity passenger movement usually requires subsidies.

These statements over-simplify complex situations and many other factors affect the viability and benefit of rail freight as an option to reduce highway traffic. However, these statements indicate the motivation for examining mode alternatives, such as rail freight, as one path for controlling the growth of traffic congestion.

Situations Where Rail Freight Enhancement May be Relevant

Railroads can offer a viable or potentially viable alternative to trucking in some situations, and that alternative becomes of particular interest when expanded use of rail freight can reduce either existing traffic congestion levels or needs for expanding highway capacity in the future. In general, the situations where rail freight enhancement may be most appropriate are cases where

- Heavy traffic growth calls for expanding highway capacity, yet highway expansion is made impractical by high cost or engineering difficulties;
- High levels of truck traffic in a corridor lead to particularly severe local congestion problems;
- Problems with the rail network structure restrict the role of rail from offering a viable alternative for freight movement;
- The rail network structure has at-grade crossings or other features that restrict the performance of roadways;
- Freight users are too small or scattered for efficient rail use, yet consolidation of demand or other strategies could make rail service economically viable; or
- The region's economic growth is or will be threatened by an overall lack of goods movement capacity.

Actions to Promote Greater Use of Rail Freight

Public agencies may consider a range of policies, incentive programs, or project investments to encourage greater use of rail freight and divert some growth of truck traffic to those rail alternatives. Public agencies may also consider public-private cost sharing to encourage such solutions. Generally, the types of solutions that may be considered can be classified into efforts to

- Better rationalize (reconfigure) the center city rail network;
- Reduce conflicts among road and rail traffic flows;
- Increase use of rail/truck intermodal transportation;
- Improve the level of rail service locally available to industry; and/or
- Upgrade rail facilities to handle taller or heavier railcars.

Those are described further in Exhibit 1-1.

Private- and Public-Sector Planning Perspectives

These various types of “rail freight solutions” span an array of different size scales, reaching from individual facilities to region-wide programs and policies. These solutions also affect a wide range of parties from whom information is required. Even the initial screening method described in this guide requires some basic information on currently (or potentially) available rail facilities and services, in order to ascertain whether rail can even be considered as a viable option for reducing truck traffic.

Freight planning differs from normal urban and regional highway planning. While the field of urban and regional transportation planning has evolved a series of standardized data sources and planning methods over a period of decades, they have focused most heavily on passenger travel. The data sources and methods required for identifying and analyzing freight transportation patterns are less well developed, partly because freight transportation needs are predomi-

<p>A. Rationalize the center city rail network</p> <ol style="list-style-type: none"> 1. Improve rail access to ports 2. Increase the capacity available for commuter rail 3. Consolidate rail terminal facilities 4. Improve rail and highway access to rail/truck intermodal terminals 5. Upgrade the condition, clearances and capacity of rail mainlines <p>B. Reduce conflicts among traffic flows</p> <ol style="list-style-type: none"> 6. Enhance capacity and service with less conflict between freight and commuter rail 7. Reduce delays and risks associated with rail/highway grade crossings <p>C. Greater use of rail/truck intermodal transportation</p> <ol style="list-style-type: none"> 8. Add terminal capacity and improve terminal locations 9. Add or upgrade main line capacity 10. Provide more effective equipment 11. Support short-haul shuttle systems (shuttles between ports and inland terminals, or shuttles to move highway freight through or around metropolitan areas) <p>D. Improve rail service to industry</p> <ol style="list-style-type: none"> 12. Support construction of rail sidings 13. Support construction of trans-load facilities that can serve multiple customers 14. Include rail infrastructure in economic development planning <p>E Upgrade facilities to handle taller or heavier rail cars</p> <ol style="list-style-type: none"> 15. Rail facility upgrade
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Exhibit 1-1. Range of Specific Actions to Promote Greater Use of Rail.

nantly served by private carriers. Planning and analysis of rail freight solutions needs a dialogue among planners and representatives of railroads, trucking companies, and local shippers to obtain information and appropriately assess opportunities.

To achieve an effective dialogue, railroad officials and transportation planners will have to broaden their perspectives. Railroads usually approach planning in terms of markets, lanes, and corridors, which is the “terrain” that terminals can cover and where trains will run. Public agencies, on the other hand, are oriented to the elements of infrastructure at various scales going from individual facilities to urban travel corridors, citywide networks, intercity corridors, and state or regional networks. This guide seeks to recognize the different public and private perspectives by presenting discussions of the issues, opportunities, and constraints that they are likely to encounter in seeking rail freight solutions to highway congestion.

1.2 Objective and Organization of this Guide

Target Audiences

This guide provides guidance on both technical analysis and processes for inter-organizational cooperation. It is aimed at transportation planners at both state and regional agencies as well as freight planners at private transportation companies and decision-makers who control funding and implementation of transportation investments.

Needs for Planning Guidance

Because this gap between highway demand and capacity is forecast to accelerate in the future, there has been increasing recognition of the importance of multi-modal planning and, specifically, the need for more attention to rail freight issues and opportunities in the planning process. This has led both public agency planners and private transportation company officials to recognize

a need for tools and methods that they can use to address freight transportation planning issues. These needs fall into three broad subject areas:

- **Processes for Public Investment Planning.** Traditionally, most state DOTs and MPOs have focused their infrastructure planning largely on highways and given less attention to rail investment, for the fundamental reason that they control investment in highways while they typically do not own or control investment in railroads or rail right of way. However, there is a growing recognition that (1) more multi-modal public planning is needed for freight movement, (2) such planning should include rail as well as highway options for freight movement, and (3) that rail freight planning, if done well, can help address a wide range of issues relating to security, congestion, safety, and air quality.
- **Methods to Identify Transportation Issues and Assess Potential Solutions.** Before expanding multi-modal investment analysis for freight movement, it is necessary for state and regional transportation planning agencies to clarify the range of possible transportation issues that should be addressed, define the range of potentially feasible rail and highway solutions to be assessed, and apply appropriate methods to assess their relative benefits and costs. For instance, while there is a current emphasis on addressing problems of growing highway congestion, planners need workable ways of assessing these needs and identifying feasible rail-freight solutions for them.
- **Approaches for Private-Public Cooperation.** Given the private ownership of many railroad and truck-rail intermodal facilities, rail freight planning must involve both the private and public sectors. At the same time, key representatives of cargo shipping, trucking, and railroad companies also have a strong interest in seeing improved planning and investment, as they are keenly aware of the current shortcomings and needs for improvement in existing road and rail infrastructure systems serving freight movement. Thus, there is clear opportunity for enhancing private-public cooperative relationships in freight infrastructure planning.

The range of analysis and decision issues covered by this guide is shown in Exhibit 1-2. The graphic illustrates how technical analysis of project and policy alternatives must be conducted

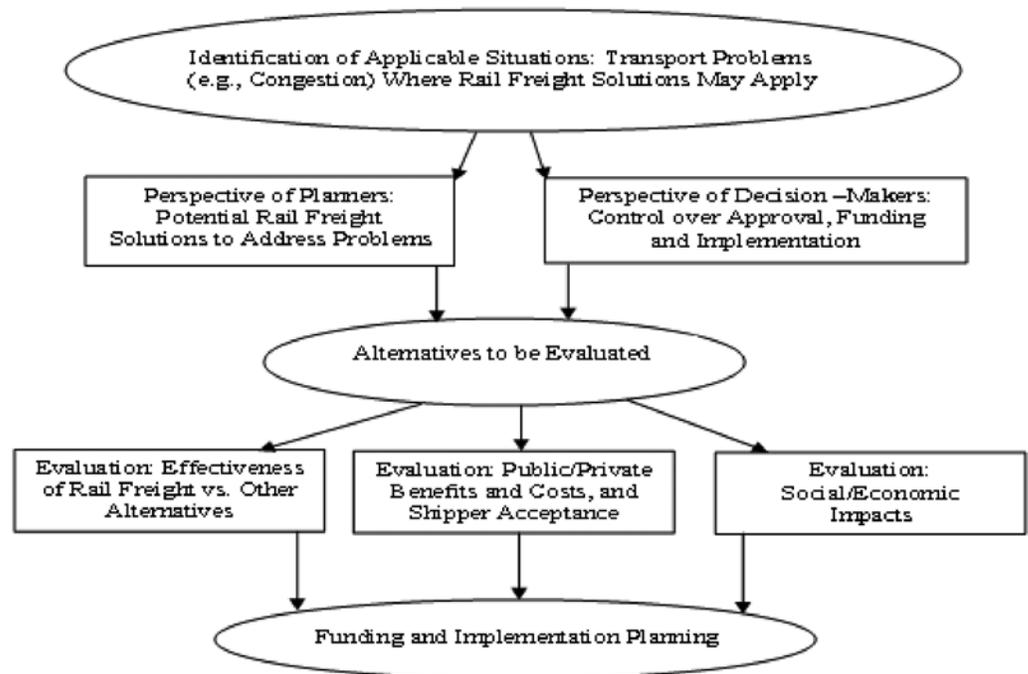


Exhibit 1-2. Decision-Making Process for Rail Freight Investment.

together with public-private dialogue to consider the perspectives of all parties that need to be involved in implementing rail freight solutions.

Topics Covered

This document is designed to provide three types of guidance:

- **Planning Process Guidance.** Guidelines for planners to identify the types of situations where rail freight is potentially relevant as a consideration for addressing roadway congestion and the types of organizations and factors that need to be considered;
- **Analysis Guidance.** Guidelines for assessing the effectiveness of potential rail freight alternatives as solutions to transportation problems and a description of available analysis methods that can be used to assess the benefits and costs from public- and private-sector perspectives.
- **Implementation Guidance.** Guidelines for determining (1) the types of public- and private-sector involvement most appropriate or likely for implementing rail freight alternatives and (2) approaches for implementing effective public-private cooperation for developing, funding, and implementing various forms of rail freight solutions.

Different Levels of Users, Needs, and Project Complexity

The guide is intended to provide useful reference material for a wide range of users, who may then tailor the material to meet their needs. The users and their needs can differ in several ways:

- **Levels of Technical Expertise.** The guide can provide planners who are novices to this analysis topic with a straightforward sequence of five steps they can use to identify rail freight options, initiate discussion with relevant parties, and conduct screenings of them for potential feasibility. At another level, it offers a description of more detailed methods that can be used by experienced professionals to conduct more advanced evaluation applicable for planning and policy analysis.
- **Level of Analytical Detail.** The guide describes a “sketch planning” level of analysis that can be efficiently completed with limited information and spreadsheets to establish a rough estimate of the potential range of costs and impacts associated with rail freight options to reduce road congestion. The guide’s later chapters then describe more comprehensive analytical methods designed to provide detailed estimates on the basis of additional information collection.
- **Level of Project Complexity.** The guide has sections to walk readers through a wide range of public- and private-sector actors, their concerns, and constraints. It is designed to provide a platform for identifying and engaging relevant parties in discussion of proposals for both simple and complex projects.

Because this guide seeks to be useful for different types of users facing different types of situations, it is not presented as a textbook that just teaches readers how to follow a single set of procedures. Rather, it is designed as a reference tool that provides analysts with the foundation for exploring the many facets of rail freight solutions to traffic congestion. This includes separate sections on screening of opportunities, creating public-private dialogue, and conducting benefit/cost analysis of alternatives.

Organization of this Guide

This guide is designed as a set of sections that readers can consult or ignore as appropriate for their particular situations. The sections can be considered in the following groups:

Initial Grounding. Chapters 1 and 2 provide a basic grounding in freight analysis issues.

- *Chapter 1 (Introduction)* defines the coverage of this guide. It classifies the types of situations, issues, and solutions that can be considered in planning and evaluation of rail freight solutions to traffic congestion.
- *Chapter 2 (Background: Context)* provides information for readers who are not already experts on rail freight planning. It discusses the process of rail freight planning and factors affecting rail/truck diversion.

General Guidance. Chapters 3 and 4 provide basic guidance on technical analysis and discussions to ascertain the potential for rail freight to help reduce traffic congestion growth.

- *Chapter 3 (Guidance for Evaluation of Alternatives)* outlines a series of five basic analytical steps that can be conducted by planners at relatively low cost to screen available rail freight options for reducing congestion and identify when further discussion and analysis is warranted.
- *Chapter 4 (Guidance for Public-Private Dialogue)* discusses needs, uses, and procedures for bringing highway and freight planners in discussion with representatives of institutional players and private-sector freight operators, in order to design cooperative strategies that can be acceptable to key parties.

Technical Analysis Methods. The final section provides material for advanced use in analyzing options and presenting results in ways that can gain support among diverse parties.

- *Chapter 5 (Detailed Analysis Methods)* describes the availability and application of various analytical tools, methods, and data sources for assessing road and rail options, diversion between them, and the relative benefits and costs involved.
- *Additional Resources* summarizes additional sources that readers may consult for further information on evaluation and analysis issues.

Background: Context for Rail Freight Planning

This chapter provides information for readers seeking an introduction to rail freight planning. It first discusses the process of rail freight planning, and associated planning and policy issues. It then discusses the various negative factors (constraints) and positive factors (levers) affecting rail/truck diversion. Finally, it provides examples of projects that enabled rail to handle a greater share of freight, including discussion of the different ways in which these projects were justified in terms of their potential public benefits.

2.1 Rail Freight Planning and Policy Issues

Underlying Planning and Policy Themes

A central theme in the public discussion of freight transportation today is the adequacy of capacity. For much of the past half century, this was not a major concern. The U.S. railroad network underwent prolonged rationalization, and public agencies were more concerned with preserving than with expanding rail lines and service. In highway planning, the construction of new roads and lanes could be counted on, and freight largely could be left to look after itself. In recent years, this began to change. Three things occurred in the highway sphere:

- **Emergence of Freight Planning.** The effective ability to build more road capacity was reduced, while congestion mounted steadily. Highway planners started to consider what this meant for the components of stalled traffic and whether they required a differential response. Since the needs and options for freight stand apart from other traffic and present distinct consequences when mobility declines, it is productive for freight to be treated differently, and this began to happen.
- **Logistics Technology Development.** The movement of American industry to fast-cycle systems of logistics over the previous quarter century replaced inventory with information and high-performance transportation. This was a beneficial trend for the competitiveness of industry, the globalization of supply chains, and the cost of goods. Enabled by the digital revolution and advances in mobile communications, it created great dependency on the reliability and speed of the transportation network. This dependency then came into inexorable conflict with the spread of congestion. While freight operations can manage to work around sluggishness in the network, this is done by accepting a loss of efficiency, and congestion gradually is threatening to compromise the new logistics systems.
- **Concern about Truck Roles in Congestion.** The resounding success of motor carriage as the preferred mode of freight transportation was facilitated by erection of the national highway network, and yet to a large extent this infrastructure was designed for a lesser proportion of truck traffic than it now bears. Higher volumes of truck traffic are a serious concern to the traveling public. Real or perceived, the discomfort produced by unavoidable proximity to

large, heavy vehicles engenders animosity toward truck transportation and limits citizens' support for investments that would increase truck traffic.

Role of Railroads in Freight Planning

Rail transportation, as an alternate form of freight capacity, offers a potential means of mitigating roadway congestion. The rail system already carries a significant part of the nation's goods, especially those heavy loading commodities that travel long distances. To the degree that those goods would otherwise travel by highway, rail transportation limits congestion and highway maintenance, as well as the traffic tie-ups that highway maintenance imposes. Growth in rail can slow the advance of congestion, and, in given localities, directly relieve it, by diverting freight from the road system. When rail succeeds in winning new traffic, it does so with service that suits the competitive requirements of shipper supply chains and that boosts the efficiency of motor carriers who can employ it. Truck lines hemmed in by labor shortages, by power utilization dragged down by congestion, and by mounting fuel prices may find a reprieve through rail. Rail usage furthermore diminishes the interaction between trucks and automobiles by moving freight onto the naturally separated rail right of way. Apprehension about the safety of shared roadways thus finds a remedy in rail, and roads that are becoming truck-dominated routes may be helped to avoid or postpone that destiny.

Finally, freight rail promises a series of public benefits beyond its effect on overloaded highways. Maintenance and security costs, for example, are borne by the public for highway freight and are privately provided on rail. The environmental advantage and fuel efficiency of the railroad motive system accrue to the public welfare, and their value may be more acutely felt as the 21st Century progresses. Economic development and competitiveness are a common justification for public rail investments, especially in seaport and hub markets where traffic is dense and service extensive. Benefits of this sort imply that congestion relief does not have to be sufficient grounds for a rail project in order to be an attainable result, because projects justified by other objectives can reduce road volumes as well.

Public Policy Issues

The public interest in transport capacity is bigger than freight. Passenger mobility is the need uppermost in the minds of average citizens, which rail can aid by stemming the growth of commercial traffic on roads, removing some of the current truck volume, and preventing the diversion of rail freight. Since the handling characteristics of trucks as well as their size give them an exaggerated footprint on the highway, a reduction in trucks has a magnified influence on passenger traffic flow. Moreover, there is a second magnification at the margins, because incremental traffic is a greater detriment to system performance in already congested networks. This implies that the diversion or heading off of additional trucks is more productive as congestion worsens, and rail alternatives will be worth more in the future. Even so, the greatest transportation capacity benefits offered by the freight rail network are for the movement of goods. This is important in the public valuation of rail options, because their effect on goods movement capacity can be substantial even while their effect on highway passenger capacity may be less substantial. This means that the more freight is accorded independent importance in public planning, the more useful the rail options will appear.

The rail industry also requires continuing investment in equipment and facilities in order to handle the projected growth in freight traffic. For much of the 20th century, the rail system underwent rationalization that resulted in a smaller network with higher density mainlines, fewer branchlines, larger and more efficient classification yards, and new facilities for handling bulk and especially intermodal traffic. For most of this period, advances in rail technology provided

tremendous boosts to capacity by allowing heavier cars and longer trains. However, beginning in the mid-1990s, the rail system began to experience congestion, to which the industry responded with a combination of demand management and investments within its resources. Additional track and facilities were constructed to handle the extra train traffic, particularly in parts of the network where growth in coal and intermodal was strongest.

Given that railroads are private companies, they must be able to earn enough to cover their cost of capital if they are to continue to make capacity investments. They also have strong incentives to invest for traffic classes where the return is the greatest, which tends to be bulk, long-distance, or high-volume traffic. Since capital is limited, they do not necessarily have the ability, even if they have the desire, to provide capacity for shorter-haul traffic that is susceptible to diversion from truck. These limits can be expanded with public contribution, which acts as leverage on the railroads' capital by lowering their blended cost of funds and further improving returns. Better returns then attract more interest in rail from the capital markets, but, just as important, because it is profitable growth that the markets reward most, public investment helps to stimulate such growth.

These conditions create a convergence of interests between railroads and the public sector. For the public, it is attractive to supply capacity in any productive way, and rail is the most prominent of the multimodal alternatives. For railroads, there is new receptivity to public investment as a way to ease the rationing of capacity and to open the doors wider to growth. This is a sound basis for public-private partnerships formed in response to common needs. Both railroads and local and state governments are interested in specific changes to local and regional rail systems that will provide more efficient and more profitable operations for the railroads and their customers and achieve better environmental, land use, and mobility benefits for the public. Some of these changes can produce network-level effects that elevate railroad performance widely and have national import, and some can be coordinated among local jurisdictions to produce regional benefits. Capacity alternatives can be pursued jointly for local purposes or amplified and organized for broader results, even if countrywide investments are not undertaken.

Public-Private Cooperation

Public investment in rail is little different from the public-private partnerships devoted to roadway projects visible around the nation, with the active support of government policy and legislation. Both kinds of partnership—rail and road—are motivated by a desire to use capital for the expansion of capacity and by the recognition that conventional sources of funds and capacity are not satisfying traffic demand. There are public goals and legal requirements to be met in both cases, service commitments to be assured, and private returns on investment to be realized. The conditions of infrastructure ownership between road and rail are divergent to begin with, but this divergence is contracting because the roadway options today extend to long-term leases and agreements with a private responsibility to build, own, and operate. The pressure to find and fund capacity is transforming the way the public sector is willing to do business.

The catalyst for partnership is public capital justified by public benefits. By the public shouldering part of the capital burden, the high capital expense to railroads is reduced, and returns on the carrier portion of investment are rendered more competitive for internal and other private funds. Carriers then are enabled or induced to pursue business that is attractive but below hurdle rates, business development is made possible that rail carriers could not justify on their own, and they can address more projects with public benefits. The policy rationale for doing this is that public benefits normally do not invite private capital, but are a proper use of government revenue and deserving rail projects may realize certain of these benefits better than other uses of government money. Public advantages—including road relief—in this way can be brought within reach.

Railroads and public agencies will approach joint projects with different objectives in mind, and reasons for conflict will be mingled with reasons for cooperation. The development of relationships among people and institutions in the two spheres will therefore be critical. Traditionally, public agencies have given scant attention to rail freight, and carriers have been guarded with the public, resulting in little experience with and limited expectations for cooperative projects. Complicating this picture is the multitude of public agencies with minimal obligation to work together. Moreover, public agencies responsible for rail are unlikely to have much familiarity with options for expanding the capacity of the rail freight system, which involves much different issues than arise in dealing with light-density lines, abandonments, and passenger service. Similarly, the customary railway government affairs department was restricted, dealing with such things as line reduction, safety, and taxation; they were not called on to work with public agencies to nurture new investment opportunities. Now both groups are changing, and there is ample motivation for relationships to be woven by a rail industry that needs to grow and a public sector that wants this to happen.

Partnerships in rail are appropriate, realistic, and increasingly valuable for the two parties. Rail will not stop road congestion, but it can blunt it. Rail is not always a remedy for freight capacity, but in fitting conditions it is competitive and effective. Public money is not the whole answer for railroad growth, but it is part of the answer in an era when needs and opportunities are ripe. The questions of when rail partnerships are useful, of evaluating and making the case for them, and of treating barriers to rail effectiveness are some of the matters for which this book is a guide. To the basic questions of whether the public should look to the private rail system for capacity, and whether that can work, the response should be yes. If public investment in private infrastructure produces a public benefit, making the investment ought to be a straightforward proposition. There are institutional obstacles at many levels of government, but there are solutions as well, just as solutions have been found for roadway partnerships. When public funds moderate the capital intensity of railroading, new services become possible at a lower cost. When the new services are competitive with highway transport—as many can be—their cost position creates a persuasive advantage and rail wins traffic. In short, good service at a lower cost wins freight business, public funds used with discrimination can help that to happen on rail, public benefits can result, and railroads can grow.

Directions for Incorporating Rail Planning with Highway Planning

What is the place for rail freight in public planning? From the conventional standpoint of highway stewardship, public agencies care about rail for its influence on road conditions. The preservation of rail traffic, the diversion of trucks, and the moderation of their growth all help to combat road congestion and maintain mobility. However, beneath the stress of capacity and fiscal constraints, the conventions are being transformed. The resort to public-private partnerships in the highway sphere is an indication of this, and railways are another multimodal example. The primary foundation for partnership between the railroads and the public sector is created by intersecting needs, and the catalyst for their partnership is capital: each party gains advantage from the other's contribution, and together they are able to sustain growth. While maturation of their institutional relationships is necessary in order to build on this foundation, the recourse to rail for transportation capacity will be better accepted as freight is valued more in public planning. The crucial place of logistics in the global economy, its vulnerability to network degradation, and emerging concerns about mixed-use facilities underscore the independent requirements of the freight system. This system will benefit from local rail projects pursued for conventional motivations. It will benefit more from many such projects, orchestrated by regional strategies of network improvement and public advantages, which are backed by sustained programs of investment—even moderate investment. This makes bigger objectives

achievable over time and marks the transition to more purposeful applications of public-private partnership in the production of freight capacity. Limited investments with parochial justification and major initiatives both fit into a framework of this sort, because it allows a methodical but variable way of capitalizing on the joint possibilities for rail.

Relevance of this Guide

This guidebook develops these possibilities. It is designed for public and private planners whose interests range from the local, to the coordinated, to the larger scale employment of freight rail partnerships. It supplies basic analytical tools to novices who are uncertain about the role of rail, and systematic techniques and approaches for sophisticated users. Its methods facilitate the use of freight rail in answering the nation's need for transportation capacity and for reining in the progress of congestion.

2.2 Diversion Obstacles

The diversion of freight traffic from highway to rail is a basic objective in congestion relief projects. Diversion is restrained by a series of obstacles that can be overcome, but only if they are recognized and addressed. They can be encapsulated in eleven types of barriers which relate to market viability factors, institutional readiness factors, and public issues inhibiting modal shift. These categories of factors are discussed below (see also Exhibit 2-1).

Market Viability Constraints

Market viability factors affect the acceptability, competitiveness, and logistical efficiency of rail service for the customers. The major diversion barriers are four, and reflect on the immediate practicality of projects for planners:

1. *Equivalent Service* is the comparability of the rail product to over-the-road alternatives with respect to the requirements of supply chains. Comparability of service is measured from the shipper's door to the receiver's door and encompasses many factors, including (1) trip times and reliability; (2) the typical yet not universal perception of rail as an inferior good; and (3) the ability of rail to meet the explicit delivery windows required by customers.
2. *Access Limitation* concerns the requirement for rail-truck intermodal operations or for transloading and drayage of carload freight, when direct rail service door-to-door is unavailable. Access limitations relate to the need and specifications for transfer facilities; the length, efficiency and circuitry of truck pickup and delivery; the time and cost penalties associated with these elements; and the urban problem. The urban problem refers to the fact that metropolitan roadways are especially vexed by congestion, yet if railroad access occurs primarily via truck drayage, then it is precisely the urban areas that railways will find most difficult to relieve.
3. *Interoperability* is the ability of rail to interchange smoothly with marine and motor carriage for either transload or intermodal operations. It embraces particularly the compatibility of

Market Viability	Institutional Readiness	Public Barriers
1. Equivalent Service	1. Capacity	1. Public Acceptance
2. Access Limitation	2. Capital	2. Competitive Reckoning
3. Interoperability	3. Institutional Commitment	
4. Density	4. Institutional Structure	
	5. Sustained Performance	

Exhibit 2-1. Diversion Obstacles.

equipment, the domestic appeal of service, the breadth of the addressable market, and the integration of rail in the operating networks of ship and truck lines.

4. *Density* is the concentration of traffic volume in specific corridors or lanes; its influence shapes the frequency of service and the productivity of assets. Traffic density is the critical factor in determining if a given traffic flow will support trainload operations, require or avoid intermediate staging, or permit the production of service economies. As a result, it has profound effects on competitive performance and the sustainability of service.

Institutional Readiness Constraints

Institutional readiness describes the capability of railroads in physical, financial, and organizational terms to attract and retain additional volume from highways. There are five prominent barriers to diversion:

1. *Capacity* is the magnitude of line, terminal, and siding infrastructure for the physical and functional accommodation of train operations, including factors like signaling, clearances, and weight limits. It is a tangled consideration in networks, and it has become a significant hindrance to railroad growth. Labor, power, and carrying stock also are components of capacity; shortages of qualified manpower are common in much of the freight industry and increasingly are a challenge in rail.

An instructive example of the intricate nature of capacity and its interference with diversion comes from a Class I railroad in 2004. A premium intermodal train for a major motor carrier, designed to produce highly competitive 3 to 4 day transcontinental service, created system congestion and delays for other trains. Limitations of track, siding, signaling, and labor capacity, coupled with the need to create headroom (a clear lane) for the much faster intermodal train, created cascading disruption for other operations, which lasted up to a week.

2. *Capital* is the constraint of funds for investment in capacity and new services, which leaves railroad networks undersized and divertible traffic on the roads. Because rationing of capital pushes internal hurdle rates to high levels, there are important consequences for retention of operations and prioritization of projects: profitable opportunities may not be profitable enough, new business can drive out old, and capacity can be subject to allocation.
3. *Institutional Commitment* is the in-place investment of financial and human resources in a course of action or way of doing business. It causes change to be encumbered and new ways of operating to face higher asset costs and fewer network benefits than continuance of the old. Partly, it manifests the business franchise that companies build up through the years, with their customer relationships and interlinked traffic and asset deployments; and partly, it depicts the engrained implications of capacity and capital restraints.
4. *Institutional Structure* acts as a barrier when company and industry organization cause the railroad network to function in balkanized segments, instead of an integrated whole. Due to service and efficiency benefits, railroad market shareⁱ tends to be materially higher in territory where carriers offer single-line service, and this can discourage some interline operations. There are motivational aspects as well: railroads interchanging traffic have shorter hauls than if they handled the traffic themselves, and they must divide profit contributions. This pro-

ⁱThe authors of this report conducted private studies in the mid-90's that showed this, and are aware of others also done privately that produced the same conclusion.

duces the under-served markets of the so-called watershed areas, that straddle the territories of two rail systems,ⁱⁱ and it has an influence on the opportunities and relationships between short line and Class I railroads.

The Alameda Corridor offers another perspective on the motivational component. There, the local authority purchased the right of way to be upgraded, and it bought out all of the competing routes, so as to ensure that the user railroads would not favor their own track ahead of the public facility.

5. *Sustained Performance* is a cross over issue between the categories of viability and readiness. If a railroad can introduce but not maintain competitive service, or if it withdraws service in favor of another use for its assets, then traffic diversions are lost. Sustained performance touches on market viability in that the projected demand for a service may not fully materialize, or there may be institutional dynamics and economic incentives at work that depress the volume of business.

Start-up risk is a specific and important instance of this barrier at work. Departments of operations frequently are cost centers for railroads and other freight carriers alike. Start-up services impose most of their costs long before they generate most of their revenue. Customer utilization of new services builds and matures through time (following a typical product life-cycle curve), and traffic shifts do not reach their peak for a long while after a competitive operation commences. Moreover, traffic activity rarely is consistent day to day, and train starts have a high fixed cost. There is a powerful daily incentive in operating departments to delay or consolidate line haul departures for the sake of more volume, and this normally means a penalty for on-time performance. Unreliable service then undermines the retention of new business, creating more reason to hold departures for volume, and in time the start-up is killed entirely for lack of traffic. This vicious cycle can be overcome with discipline and financing, but it is a frequent problem in freight transportation, not just at the lane level, but companywide when there is an organizational movement to raise performance. New ventures consequently may have to run at a loss until they earn customer confidence and attract adequate business, and their operating expenses should be treated essentially as investments.

Public Barriers

While public obstacles to the use and support of freight rail appear elsewhere in this guide, two public barriers will be cited here for emphasis, because they exacerbate the challenges of readiness and viability that this section has discussed.

1. *Public Acceptance* is the first obstacle. For almost any kind of freight, the reluctance to accept traffic in populated districts seems to be widespread, and there is a preference for “out of sight, out of mind.” Citizens want fewer trucks on the road but not more trains, and the construction of new lines as well as new facilities face local as well as environmental concerns,ⁱⁱⁱ with delays stretching into years. This has caused some railroads to view facility capacity as fixed. The crucial difficulty is that this not only prevents acceptance of substantial new volumes, it also spurs the process by which the railroad traffic mix is culled for only the most profitable traffic. The public and the carrier financial interests are not necessarily aligned in these conditions.

ⁱⁱThe lane between Nashville TN and Dallas TX is one of many examples. The 660-mile total distance is a haul length where railroads are active, yet the lane crosses between the service regions of eastern and western rail systems. With a 210 mile run in the east and 450 miles in the west, the business opportunity is less appealing to both carriers.

ⁱⁱⁱFor example, the break-up of Conrail saw great resistance to higher train volume through Cleveland, OH. In Virginia’s I-81 study, the construction of certain routes was ruled out by the state, because of citizen resistance in well-healed rural areas.

2. *Competitive Reckoning* is the second barrier. Diversion is two-sided because it involves competitive interaction, and competition is about *relative* position. While the competitive repercussions of rail projects can be mitigated by the ability of motor carriers to use rail for their own benefit, in the reciprocal case, there is little mitigation. The consequences of public road projects for rail are typically subtle, but detrimental and cumulative, and, with some exceptions, public planning does not consider these consequences. It seems improbable that this behavior will change, yet the failure to take into account the competitive effects of highway projects is an entrenched barrier to rail diversion.

2.3 Diversion Levers

The countering case against barriers to diversion is found in the levers that aid diversion. This section introduces a selection of five public levers, some of them commonplace and some not. The selection is more illustrative than comprehensive, and it does not treat the many commercial options available to railroads for attracting traffic.

1. In light of the discussion of competitive reckoning, the most obvious lever is the **two-sided character** of diversion. Actions or inaction that influence the efficiency or service quality of motor carriage affect the competitive balance with rail. It is not in the public interest to interfere with the performance of truck transportation when it is the way most goods travel to market, including a large number that travel part of the distance by air, water, or rail. Conversely, there are initiatives that on balance may be judged to be in the public interest, but nevertheless impose a penalty on truck lines. Tolling of roads is an example of this. Another was the modification of federal hours of service regulations for truck drivers.^{iv} This was designed to improve road safety, but it also reduced labor productivity for some classes of truck shipments and probably produced a benefit for rail.
2. **Public financing** is another obvious mechanism, suited to the equally plain purpose of removing capital and capacity constraints. The issues surrounding its use are presented elsewhere in this guide. However, in this section's consideration of barriers and levers, there are two points to underscore:
 - Funds can be used to elicit a quid pro quo from the recipient. Therefore, financing agreements can be linked to steps that reduce the barriers of interoperability and institutional commitment and thus widen the market to which publicly backed rail services may appeal.
 - Start-up risk can be mitigated with limited-duration operating subsidies, protected by performance and marketing covenants. Alternately, to avoid public absorption of operating expense, a combination of project-related equipment financing, and tax credits for fuel and possibly labor could be applied to accomplish the same objective.
3. **Market strategy** is a lever not normally associated with the public sector, which nevertheless can be part of comprehensive statewide and regional plans. For instance, DOTs who support the pursuit of bulk traffic by their shortline railways are keeping the heaviest trucks off the roads and shortlines healthy, but they are also pursuing a vertical market strategy that specializes in the bulk industry. An example of a geographic market strategy favoring intermodal diversion would be the support of enlarged breadth and depth for terminal coverage throughout a geographic region. Its repercussions would fall on the load availability experienced by motor carriers and could induce their consideration of rail alternatives. A depiction of how this dynamic has worked historically appears in the accompanying box.

^{iv}Initiated by the Federal Motor Carrier Safety Administration in 2004.

Prior to the advent of fast-stack train service from the west coast to the interior of the country, those lanes were a long-haul truck market. When stack trains arrived, the traffic they captured substantially reduced the number of loads available to motor carriers delivering on the coast to return their trucks inland. Regional work could be found, but a truck that came from Chicago could not get back to Chicago, nor to anywhere close.

The difficulty was not that the railroad took all of the business, but that it took enough of it for the remaining loads to be fewer and further between. This resulted in trucks laying over longer while they awaited their next load and traveling a greater distance to find one. The coastal geography – with mountains and rural areas for hundreds of miles eastward – acted like a peninsula to trap truck fleets along the Pacific.

Layovers and empty miles meant declining utilization, and coupled with rates dropping toward the railroad price points, the business was no longer profitable. Many motor carriers withdrew from the west coast market, ceding it to the railroads and to the first truckload lines to seriously adopt rail intermodal as a strategic alternative. Trucks flowed and still flow over the road, especially for time-sensitive traffic like California produce, yet the railroads effectively took the market and kept it.

The critical ingredients in the historical example were good quality rail service, its coverage of all the important lanes (which were long, busy, and few), and the peninsular conditions that prevented truck lines from easily finding their loads elsewhere. These conditions can be reproduced in open geography by a terminal network whose coverage areas densely overlap, so long as service levels are competitive and extend to enough of the major lanes. The diversion dynamic is that reduction of a significant portion of available market loads, and elimination of nearby alternatives, disturbs truck use to the point that rail options have to be considered.

The effect will be strongest in the most concentrated part of the network, motor carriers actually can be allies in bringing it about, and it is not necessary to serve all lanes in order to have a noticeable influence on load availability. As a potential public strategy to encourage rail traffic, the key elements are the number, serving radii, and overlap of terminals (which may have to be determined from gate surveys), and the proportion of large lanes these terminals operate with competitive service. The lever is public investment in terminals and other capacity. Since the diversion effect is produced regionally, the strategy works best with multi-state coordination, although geographic barriers can fortify it.

4. **Manipulation of density** can be undertaken from vectors and points. Inland ports and forward distribution programs transfer the location from which traffic is dispersed, from a gateway or production region to a spot closer to the consuming markets. The lane from that production or gateway region to the new dispersal center consolidates traffic into a dense vector, which may support trainload operations and non-stop service. Both kinds of program are active in the public (and private) sector; the Port Inland Distribution Network sponsored by the Port Authority of New York and New Jersey is one of many examples.

Point density, which affects pickup and delivery efficiency, is produced overtly by public terminals or land development concepts like the freight village; however, purposeful city planning and zoning can lead with a lighter hand to a comparable result. The operative dynamic is concentration of multiple shippers in a geographic pocket. The pocket then may become

served with good access routes and with rail spurs or facilities, and the proximity of shippers improves the cost and quality of direct or drayage service.^v

5. Finally, the **intrinsic appeal** of railroading as a separated right of way can be wielded more aggressively to attract public support to rail projects. On the theory that citizen objections to freight are rooted in the visceral experience of driving alongside heavy trucks, the more segregated and less visible rail mode is an answer. A tactical approach that routinely sought grade separation as a way to reinforce the segregation of rail and then emphasized the railroad's sequestered character as an additional benefit in projects motivated by factors like congestion relief could foster a public consensus in regular support of freight rail programs. Such a receptive environment could smooth and simplify the production of diversions by making programs easier to pursue and faster to accomplish.

2.4 Examples of Rail Freight Solutions

Categories of Examples

Examples of built projects and approved plans that enhance and support the growth of rail freight services as an alternative to reliance on congested roads exist. Examples found by the preparers of this Guide generally fall into four categories:

1. *Enhancement of rail freight capacity and service for intercity corridors* (e.g., Pennsylvania Double Stack Clearance Project, Virginia I-81 Marketing Project, Netherlands Betuweroute);
2. *Enhancement of rail capacity and service along urban corridors* (e.g., California Alameda Corridor Project, Kansas City Sheffield Flyover);
3. *Plans to enhance throughput and capacity of regional rail freight system* (e.g., Vancouver MCTS Plan, Chicago Rail Futures Plan); and
4. *Enhancement of rail freight options for service to ports/terminals* (e.g., State rail access programs and Inland Ports).

Selected examples are summarized below. More details are provided in the separate research report document.

- **Pennsylvania Double-Stack Clearance Project**—Pennsylvania DOT coordinated the work of the railroads and contractors, who “cleared” 163 obstacles so that double-stack container trains could serve the Port of Philadelphia. This involved a combination of undercutting rail rights-of-way and raising vertical clearances on railroad bridges and tunnels as well as highway and township road bridges. The project covered Conrail’s east-west route from the Ohio border to the port, and Canadian Pacific’s north-south route from the New York border to the port. In addition, the project improved horizontal clearances in order to accommodate dimensional movements from Wilkes-Barre to the Port of Philadelphia. The project benefits were (1) reduced shipping cost and improved service for the region’s shippers, (2) some newly viable competitive rail alternatives where none had previously existed, (3) gain of dimensional traffic for the port and gain of intermodal traffic for the railroads, and (4) a dramatic increase of trucking and warehousing employment in the area.
- **Virginia Interstate 81 Marketing Study**—The Virginia Department of Rail and Public Transportation studied the potential for new railroad freight services to attract truck traffic from Commonwealth highways for the alleviation of roadway congestion and improvement of safety. The project employed market research, competitive and operational analysis, diversion modeling with traffic data, and cooperative planning with railroad officials to establish the

^vAn example of this strategy as pursued by railroads is the “logistics hub,” described in a trafficWORLD article “Logistics Hubs’ Promise,” 4/5/04, page 21.

product features and attendant costs and investments that would be required to shift varying levels of highway volume to rail. Earlier studies had determined that the direct benefits of freight modal diversion along I-81 were significant and included improvements in highway user, safety, and pavement maintenance costs, as well as in air quality. The project identified public investment needed to upgrade right-of-way and expand or develop terminals to allow the introduction of new intermodal trains, raise their performance characteristics, and reduce their cost of operation to the point where it would shift the competitive modal balance.

- **Betuweroute Freight Line**—The Netherlands Ministry of Transport and the NS Railinfrabeheer Railroad partnered to develop a 160-km, U.S. \$5 billion freight-only rail line from the Port of Rotterdam to the German border, linking with the German rail network. The project included five tunnels with a total length of 18 km and 130 bridges and viaducts with a total length of 12 km, all electrified and built to accommodate double-stack trains operating at a speed of 120 km/h, with up to ten trains per hour in each direction. The nearly completed project was designed to expand freight rail capacity and protect the competitive trade position of the Netherlands and its major port. It is one of the 14 priority infrastructure projects supported by the European Commission as part of its effort to discourage road haulage in favor of rail freight across Europe. As such, the Betuweroute is expected to reduce roadway congestion and yield environmental benefits, which are prominent policy goals of the EC.
- **Alameda Corridor**—The State of California and Los Angeles County MTA provided major support for a new freight rail expressway connecting on-dock and terminal rail facilities at the San Pedro Bay (Los Angeles and Long Beach) ports to inland terminals and the continental rail network. The current corridor consists of 20 miles of public, multi-track rail line, half of it grade-separated in a sub-street trench. The \$2.4 billion project consolidates access to the country's top international container port by its two serving Class I railroads, with capacity for one hundred trains per day at speeds of 40 mph, in an urban environment. As part of the project, two hundred grade crossings were eliminated by rebuilding the right-of-way and by redirection of traffic to a consolidated route. This was estimated to remove 15,000 daily hours of vehicle delay from Los Angeles roads. At the same time, the street parallel to the rail corridor was widened and improved as part of the right-of-way reconstruction, leading to better traffic flow. The corridor is expected to substantially reduce the growth in truck trips associated with port container activity expansion. A planned second phase would extend the route to downtown operations and a huge goods distribution complex at the rim of the metropolitan region. If finished, the second stage would produce a 55-mile trans-urban rail corridor.
- **Kansas City Sheffield Flyover**—A public-private partnership of railroads and Missouri DOT funded development of 3 miles of elevated tracks in Kansas City to increase the capacity and improve the performance of a major bottleneck in the rail network. At-grade crossing of high-density rail routes had led to train backups and caused extensive delays to highway traffic when trains blocked local streets. The resulting delays were especially difficult for trucks seeking to enter or exit a major industrial area hemmed in between the main lines. By double-tracking the flyover and keeping the existing tracks, it was possible to greatly increase the capacity of the intersection, improving flow of through trains and allowing better service to local rail customers. The project eliminated rail and highway delays associated with train interference at the rail crossovers.
- **The Major Commercial Transportation System (MCTS)**—This project for the Vancouver region of British Columbia is a system of key transportation facilities and routes planned to improve both rail and highway connections to the region's external gateways and major commercial activity centers. The MCTS planning process identified a set of surface transportation projects designed to support a balanced flow of rail and truck movements. They were intended to minimize local traffic congestion, while maximizing the economic health of the region's international gateway function—which is the flow of people and cargo to and from marine

port, airport, and international border crossing facilities. The “Current and Planned Infrastructure List” makes the case for 17 major new investments, comprising highway upgrades, rail links, new road and rail river crossings, a new rapid transit line, and an additional harbor crossing, with a cost of Can \$6 to \$7 billion.

- **Chicago Freight Rail Futures**—Chicago’s undeniable stature as the nation’s rail freight hub has immersed that city in the issues of multi-modal policy development. At present, nearly 60 percent of all U.S. rail intermodal traffic and one-third of all U.S. rail traffic flows through the Chicago region. As overall rail traffic volumes have grown and mergers have concentrated volumes on fewer and fewer traffic corridors, the region has faced a growing rail congestion problem. Although trains can make the trip from the West Coast to Chicago in a truck-competitive 2 days, once they get to Chicago they can take 3 more days just to move across town by truck. This adds to urban congestion, especially with 600 at-grade rail crossings in Chicago. The City of Chicago DOT, along with the Chicago Metropolis 2020 organization and the Chicago Coordinating Committee of the railroads have each studied needs for improving freight service and movement through the city. The proposed \$1.5 billion CREATE (Chicago Regional Environmental And Transportation Efficiency) Project, envisioned as a public-private partnership, would maximize the use of five rail corridors, create grade separations at 25 road-rail crossings, and create six rail-to-rail “flyovers”—overpasses separating passenger trains from freight trains. The project has not yet been developed, as public funding is still pending.
- **State Rail Access Programs**—Many states have local transportation grant programs designed to help fund local rail and/or highway projects that are needed to help attract and expand industry in the state. Several of these states operate separate rail grant funding programs that are specifically focused on supporting local projects that address these economic development objectives. Among them, Maine’s Industrial Rail Access Program and Ohio’s Rail Economic Development Program offer particularly interesting examples of rail economic development programs, since programs in those states have documented how their projects have explicitly served to reduce highway demand and associated needs for highway-related investment. In both states, most projects are new or rehabilitated rail sidings and spur lines, although the eligible projects can include transload facilities, bridges, rail/roadway crossings, track interchanges, and rail yards.
- **Inland Ports**—A true “Inland Port” is a remote freight-processing facility and connecting infrastructure that provides advanced logistics for ground, rail, and marine cargo movements outside the normal boundaries of marine ports. In effect, it extends a marine port to an off-site, inland location by providing a remote, inland multimodal distribution center for marine/rail and marine/truck transfers, with a direct rail or barge shuttle that moves cargo between ocean-going vessels at the main port and the intermodal transfer site on a frequent basis. By relocating the truck and rail distribution facilities away from the main port site, the inland port facility can reduce congestion from truck traffic in the area of the main port, reduce rail/roadway intersection delays, and remove constraints on port expansion that are attributable to truck capacity limitations. Examples include the Virginia Inland Port (VIP), the European Container Terminal (ECT) in the Netherlands, Nilai Inland Port (NIP) in Malaysia, and New York’s Port Inland Distribution Network (PIDN).

Motivations

Exhibit 2-2 shows the motivation for each of these examples. All of these cases create solutions to roadway congestion, but, in most cases, this was not the primary stated motivation for the project. The most common impetus claimed for these projects was economic development or the related matters of port or regional competitiveness. Viewed from the perspective of how proj-

Project Type	Case Illustration	Motivation
1. Intercity Corridor	1) PA Doublestack Clearance 2) VA I-81 Marketing 3) Betuweroute Freight Line	Port/Regional Competition Safety and Congestion Port/National Competition
2. Urban Corridor	4) Alameda Corridor 5) Sheffield (KC) Flyover	Port Capacity & Competition Hub Capacity
3. Metropolitan Citywide	6) Vancouver Gateway 7) Chicago Rail Futures	Gateway Competition Economic Development
4. Facility	8) State Rail Access Plan 9) Inland Port Plans	Economic Development Port/Regional Competition

Exhibit 2-2. Examples of Projects and Plans to Implement Rail Freight Solutions.

ects attract political support and financial backing, these illustrations suggest that the economic card is a strong one to play and can win relief for roadways where a program based on congestion happens not to suffice. Even so, reduction in road congestion formed an important part of project justification in every instance, and crowded roads are linked to the question of competitiveness. Congestion was a particularly resonant issue where the relief was obvious—as in grade crossing improvements—or was bound up with safety perceptions. Finally, as truck volumes continue to grow and capacity strains increasingly turn acute, congestion may drive more projects, because of the logistical effect on economic performance and public frustration with deteriorating highway levels of service.



CHAPTER 3

Guidelines for Preliminary Evaluation of Alternatives

This chapter outlines a series of three phases involved in moving from a preliminary assessment of potential feasibility to a detailed benefit/cost analysis of rail freight solutions. It then provides details for new analysts on how to complete a five-step initial screening process. This approach also forms a foundation for more complex analysis using other analytical models and tools described later.

3.1 The Three Phase Approach

Evaluating Potential Projects and Programs

While the guide is intended to work for different types of projects, an underlying set of three phases applies to essentially all analysis and decision-making processes. These phases are shown in Exhibit 3-1 and explained in the text that follows.

Phase 1 – Initial Screening. In general, public agencies are looking for particular rail projects or programs that can help to relieve highway congestion. As such, there is a need for guidance in identifying the types of situations where rail might help; expected benefits associated with congestion relief; and the specific types of projects or programs that might be appropriate given local conditions. These assessments are part of the first phase of the analysis, which focuses on determining whether there is a reasonable chance that the costs of rail projects or programs can be justified in terms of their contribution to congestion relief. This phase involves carrying out five steps to (1) screen for relevancy of rail freight solutions, (2) gauge the magnitude of the road congestion problem, (3) characterize the local pattern of freight shipping, (4) characterize available rail resources, and (5) use “sketch planning” approaches to assess the potential viability (benefit and cost) of available options.

Phase 2 – Detailed Analysis. Only if there seems to be potential for a particular project or program, should an agency proceed to Phase 2 for a more detailed analysis of the proposed options. The logical place to begin is by looking at specific rail investment options and estimating how they could affect cost or any of the service factors that influence total logistics costs. The next step is to use a logistics cost or mode-split model to determine whether service improvements, if obtained, would be likely to affect road/rail choices and, if so, to estimate how many trucks might be diverted to rail. Given the potential diversion, it would then be possible to estimate the effects on highway performance using various highway models. The changes in highway performance can then be compared to the costs associated with the rail initiatives to see if further consideration is warranted. Thus, Phase 2 makes use of (1) rail cost or performance analysis, (2) logistics cost or mode-split analysis, (3) highway performance analysis, and (4) economic and financial evaluation.

Phase	Major Activities	Main Question & Desired Outcome	Methodology
1	Preliminary assessment: situations where rail solutions appear feasible	<ul style="list-style-type: none"> -Can rail help relieve highway congestion by handling more freight? -<i>Identification of promising rail projects or programs aimed at specific solutions to congestion problems</i> 	<ul style="list-style-type: none"> -Review information on freight facilities & traffic flows -Use framework to identify problems & potential solutions -Use simple models to estimate costs & benefits of potential solutions
2	Detailed analysis: evaluation of rail options	<ul style="list-style-type: none"> -Do benefits of proposed actions justify their costs? -<i>Analysis of costs & benefits of rail solutions, including economic & environmental factors.</i> 	<ul style="list-style-type: none"> -Estimate project costs and impacts on rail service -Traffic diversion study -Benefits analysis
3	Decision-making: multi-criteria & Benefit-cost analysis	<ul style="list-style-type: none"> -Is this project or program as good as or better than other approaches? -<i>Comparative analysis of major alternatives</i> 	<ul style="list-style-type: none"> -Consider alternatives including rail, highway investments and public policy regarding taxation & finance.

Exhibit 3-1. Major Phases of the Decision-Making Process.

Phase 3 – Decision-making Support. The final phase puts results in the context of decision choices. First, findings must be placed in the context of other options, such as doing nothing and living with congestion; building more highways; expanding the capacity of existing highways; or using tolls, fees, or regulations to restrict traffic flows. Second, each option must be considered from the perspective of its economic, political, and practical feasibility for the various participants. This includes consideration of the levels and types of benefits that might accrue to each party and confirmation of the sufficiency of benefits for shippers to accept a change of mode. It requires direct interaction with the shipping community in any of several ways and an assortment of steps for the assurance of traffic volumes. Third, for the public evaluation component, additional analysis of social and broader economic impacts might be needed. Thus, Phase 3 makes use of procedures for comparing alternatives in a broader context that may include regional economic models and/or multi-criteria assessment tools.

3.2 The Five Steps for Preliminary Screening

Organization of this Chapter

The remainder of this Chapter guides readers through the five steps of the Phase 1 assessment. These steps are illustrated in Exhibit 3-2. Each of these steps is discussed in terms of the types of information and analysis needed, the tools that can be used, and the ways in which findings can be presented and used. Chapters 4 and 5 then provide guidance on public-private institutional considerations and available analytical tools for carrying out Phases 2 and 3.

Step 1. Screening for Relevancy

The first step is to conduct a three-part screening process to clarify the local situation, available alternatives, and public policy levers. The three parts are

1. **Screening the Situation**—whether the local situation matches prototype situations where multi-modal freight planning is most appropriate;
2. **Screening Available Actions**—whether potentially available local actions match any of the prototype action categories for promoting rail freight use; and

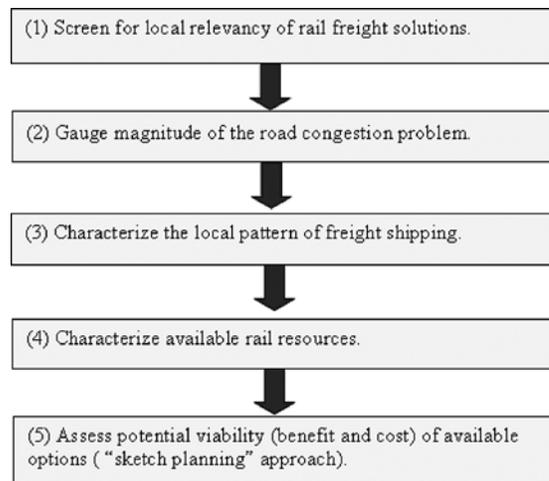


Exhibit 3-2. Five Steps in the Initial Assessment Process.

3. **Screening Available Policies**—whether public agencies and policies exist to implement relevant actions.

Part 1 – Screening the Situation. The first screening assesses whether the local situation matches any model situations where rail freight can be relevant to reducing highway congestion. The goal is to identify situations where there is a need and opportunity for achieving greater use of rail. Exhibit 3-3 lists the six categories of situations that are the potentially most promising situations for rail freight solutions. In the text that follows, each situation is described in terms of the type of context in which they might be particularly applicable and examples where rail projects or programs have taken advantage of these opportunities. The user of this guide must determine whether the local situation matches any of these six categories. In general, judgments concerning the local relevance of these types of situations can be addressed and answered by a group of knowledgeable public officials, railway officials, and customers. Only in promising situations is it reasonable to encourage further analysis of rail solutions for roadway congestion.

Exhibit 3-4 shows factors to consider in characterizing the local context and type of congestion conditions and using that information to define the form of congestion and conformity to any of six types of prototype situations described as follows.

- Situation 1, *where severe congestion seems to require extensive investment in highways*, can be found in two contexts: (1) congested highways with high truck volumes and (2) local congestion related to delays at grade crossings. Examples of the first include I-5 between Portland, Tacoma, and Seattle, where Northwest Container Services has taken 100,000 trucks off the interstate in order to reduce congestion; and I-95, where the I-95 Coalition is promoting

1. Severe congestion seems to require extensive investment in highways
2. Over-reliance on trucks leads to severe local problems
3. Problems with the network structure restricts role of rail
4. Rail network structure restricts performance of highways
5. Freight users are too small or too scattered for efficient use of rail
6. Regional economic growth is threatened by lack of goods movement capacity

Exhibit 3-3. Situations Where Multi-Modal Freight Planning Is Most Needed.

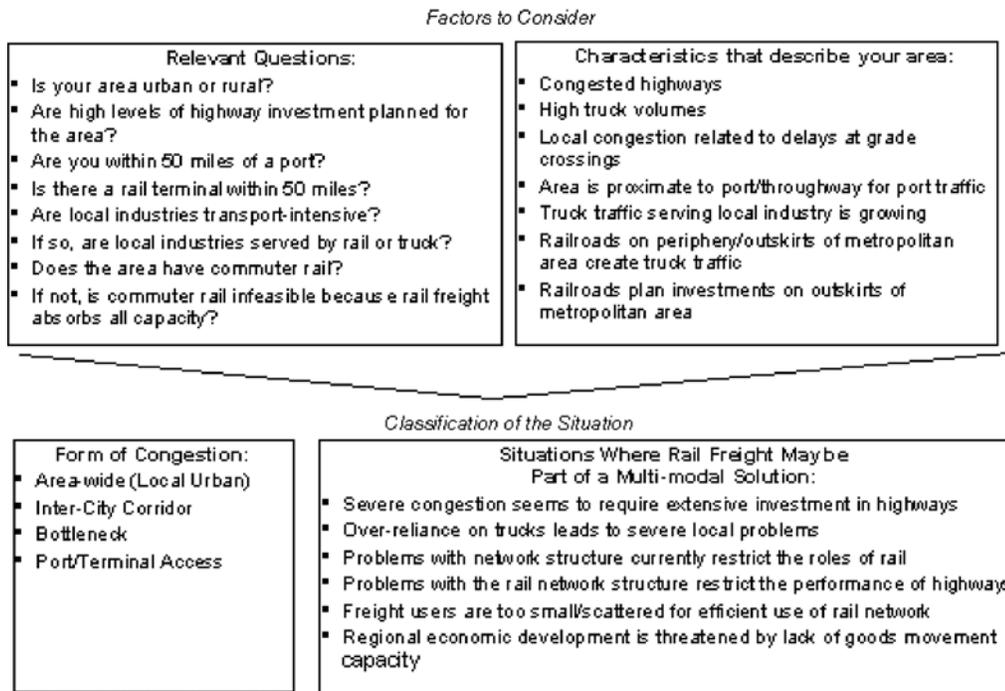


Exhibit 3-4. Situation Screening Process.

greater use of rail as a way to remove trucks from this heavily traveled highway. Examples of the second include the Alameda Corridor Project (a very large grade separation project, among other things) and numerous smaller efforts around the county to close rail-highway grade crossing or to replace them with bridges.

- Situation 2, *where over-reliance on trucks leads to severe local congestion*, has two primary contexts: (1) truck traffic moving to and from ports causes severe congestion along the major access routes; and (2) truck traffic serving local industry (or agriculture or mines) is growing, causing rapidly escalating maintenance costs for and congestion on local street networks. Examples of the first include the series of projects in New Jersey undertaken by The Port Authority of NY/NJ to promote the use of rail for containers moving to and from the port. Examples of the second abound, especially in locations with recent investments in major industrial facilities that rely on large, frequent deliveries of supplies, such as automotive assembly plants and distribution centers.
- Situation 3, *where the rail network structure restricts performance of highways*, occurs when rail facilities block logical development of the metropolitan area or disrupt the flow of local street traffic. For example, Crystal City, a major development project opposite Washington National Airport, was made possible by the closure and redevelopment of Potomac Yard. The Kansas City Flyover eliminated train delays associated with two very busy rail-rail crossings, thereby relieving very extensive congestion in nearby neighborhoods. Another example of rail infrastructure restricting highway performance involves substandard roadway clearances at railroad underpasses, which is not an uncommon problem where such underpasses were constructed as part of grade separation projects undertaken prior to WWII. In Chicago, this is sometimes referred to as the “viaduct problem.” There is little railroad benefit from solving this problem, which would entail significant reconstruction costs as well as disruption to the transportation system.
- Situation 4, *where the rail network structure restricts the role of rail*, can occur when railroad investments in intermodal terminal capacity at the outskirts of metropolitan areas are increasing local

truck traffic within the region. In Atlanta and other metropolitan areas, new intermodal terminals have been located on the fringe of the city. In Chicago, conversion of the Joliet Arsenal into an intermodal freight facility is an attempt to use “brownfield” sites at the fringe of the region for serving metropolitan rail freight operations. Also in Chicago, extensive freight and commuter operations strain network capacity, leading to conflict between commuter and freight operations. The CREATE (Chicago Region Environmental and Transportation Efficiency) Program was developed by railroads and regional agencies in Chicago to reduce rail-rail and rail-highway conflicts.

- Situation 5, *where freight users are too small or too scattered for efficient use of rail*, occurs in many contexts including cases where local companies lack access to the rail network or there are untapped opportunities for regional warehouses or distribution centers at locations served by rail. Investments aimed at addressing the first include the many efforts to make intermodal transport cheaper, more reliable, or more accessible, all of which make rail service more convenient to shippers who lack sidings; state programs such as those in Ohio and Maine that help fund construction of rail sidings; and state programs such as those in New York and Pennsylvania that help improve the track structure or increase clearances to allow taller, longer, or heavier cars. Investments aimed at addressing the second include public investments by the state of Maine in a transload facility that eliminated 100,000 to 150,000 truck trips per year to the port. An example of a private-sector investment to promote effective use of rail would be UPS’s development of sorting facilities next to new or renovated intermodal rail yards in Chicago and Jacksonville.
- Situation 6, *where regional economic development is threatened by lack of goods movement capacity*, is most often associated with the following contexts: (1) a region’s economy is based to a significant degree on a city’s role as an international port or border gateway and growing roadway congestion threatens the continued viability and competitiveness of that economic function; and (2) a region’s infrastructure and location make it ideal for locating intermodal interchange facilities or bypass routes and regional officials see this as an opportunity to spur economic growth in the area. Examples of the first include Vancouver, BC, where forecasts of traffic growth indicated congestion barriers to goods movement at ports and border crossings, factors that could significantly reduce regional economic competitiveness and growth; and the I-5 corridor through Portland, OR, and Seattle, WA, where congestion threatened the portions of the region’s economy that are based on international trade. Examples of the second include efforts by communities in Pennsylvania, New Jersey, and Connecticut to develop inland or satellite port facilities that can accept truck shipments and transfer them by rail or barge to the Port of NY/NJ for overseas shipment. These efforts were aimed at helping economically depressed communities take on a new transportation function while also relieving congestion in New York City.

Part 2 – Screening Available Actions. Having characterized the local situation, a user of this guide will have a basis for identifying the possible types of local actions that might succeed in improving the performance of the rail system. Exhibit 3-5 lists five classes of actions that can increase the role of rail freight in controlling road congestion. In the text that follows, each action

1. Rationalize the center city rail network
2. Reduce conflicts among traffic flows
3. Increase use of rail/truck intermodal transportation
4. Improve rail service to industry
5. Upgrade facilities to handle heavier/higher cars

Exhibit 3-5. Range of Actions to Promote Greater Use of Rail.

category is followed by examples. The user of this guide must determine which (if any) of the five classes of actions appear relevant in the local context and potentially useful as a way to shift freight traffic from highway to railway.

- Action 1—*Rationalization of the center city rail network* is the most complex and the most costly, but can sometimes be the most valuable. Built for land use patterns and transportation technologies of the 19th century, urban rail networks are seldom well structured for the needs and competitive environment of the 21st century. There are likely to be too many small terminals, too many low-capacity track segments, poor integration with other modes, and excessive conflicts among transport flows. The public may also be concerned about the risks or environmental impacts associated with the rail system, as reflected in the District of Columbia's attempt to restrict the flow of hazardous material through the city.
- Action 2—*Reducing conflicts among traffic flows* is another aspect of rationalizing urban rail systems. Conflicts include competition among passenger trains and various kinds of freight trains for space on the major routes, as well as conflicts at rail-highway grade crossings and where rail mainlines cross each other at grade. Possible solutions include adding capacity to the mainlines so they can handle more trains, eliminating grade crossings, and constructing flyovers.
- Action 3—*Increase use of rail/truck intermodal transportation*—this is the most rapidly growing rail service and is also a form of service where it is often difficult for railroads to add capacity. Railroads have already started to locate major terminals well outside of cities, which means that local shipments will still need to use the metropolitan highway network, even if they are destined to move on an intermodal train. From a public perspective, air quality and congestion benefits could accrue from having multiple intermodal terminals throughout the metropolitan area, rather than a single large terminal on the edge of the region. Another approach would be public support to promote short-haul intermodal service, either through investment in facilities or through operating subsidies. Forms of short-haul service could include shuttles between ports and inland terminals or special services designed to move highway truck traffic through metropolitan areas.
- Action 4—*Improving rail service to industry*, a strategy aimed at customers rather than railroads, can be a key way to encourage carload traffic. Several states have provided support for constructing rail sidings as an incentive for industrial development or as an incentive for using rail. Another approach is to support warehouses or distribution centers that could be served by rail, perhaps within a freight village or industrial park development.
- Action 5—*Upgrading facilities to handle heavier/higher cars* is a strategy that relates to two situations. The first is the rail industry's decision in 1990 to increase axle loads so as to reduce the total costs of bulk transportation. The standard maximum weight for rail cars rose from 263,000 to 286,000 pounds, allowing some efficiencies in transport costs, but only if the track structure can bear the heavier cars. On high-density lines, the costs of upgrading the track and of strengthening the bridges can be justified by operating savings. However, on light-density lines, especially lines operated by shortline railroads, it is difficult to justify the initial capital expenditures. Given that the industry as a whole is moving toward the heavier cars, the location of industrial activity will depend in part on which locations can originate or receive the heavier cars. Public interests in maintaining efficient rail service, in retaining employment, or in industrial development might, therefore, lead to support for upgrading some of these light-density lines. The second situation is where lateral or overhead clearances restrict the movement of double-stack container cars or other large cars. Limited clearances are mainly a problem encountered in the east. Railroads have pursued clearance projects with public support, for example, to improve intermodal service for the sake of the competitiveness of ports.

Individual projects fitting any of these five action categories do not necessarily have to be complex, costly, or time-consuming efforts that require cooperation among multiple

railroads and public agencies. They can be as simple as expanding intermodal facilities, sidings, and road/rail crossings, although they can also involve regional efforts to reorganize rail yards or subsidize costs for new services. In any case, the same basic analytical steps must be completed.

Part 3 – Screening Potentially Relevant Programs and Policies. Having characterized potentially relevant actions, a user of this guide will have a basis for identifying specific types of programs or strategies that public agencies can use to maintain, improve, or promote the use of rail. Exhibit 3-6 lists six classes of public programs that are most often used for this purpose. These programs and strategies deal with rail finances and industrial development issues, as well as with particular kinds of investments in rail technologies.

- Policy 1—*Project finance* programs are an option to put public money into cooperative rail projects that add capacity and divert trucks.
- Policy 2—*Public ownership of the railway right-of-way* is another option sometimes used to keep a light-density route open for rail service. Purchase and lease-back of rail lines can also be used to promote the economic health of railroads serving a region.
- Policy 3—*Redevelopment of rail facilities* refers to selective closure and shifts in usage of various parts of the urban rail network to improve rail service. This can also provide an opportunity for better uses of the land occupied by some rail yards. It might be possible to use the development potential of the land to help fund relocation of rail facilities to equivalent or superior sites.
- Policy 4—*Taxation* is a strategy that can affect the general costs of doing business for railroads and their competitors. Tax policies have historically been important aspects of transportation policy. Some, but not all, states have granted property tax relief for certain rail properties. The federal government has from time to time offered investment tax credits for railroads and other industries facing financial difficulties. Tax policy provides a way of encouraging investments in particular industries or activities to further various public interests in the services provided by those industries.
- Policy 5—*Financial reform* is another approach that seeks equitable treatment of the various modes. The taxes and fees charged to heavy trucks, fuel taxes, toll charges, and other aspects of highway financing affect the competitive boundary between rail and truck.
- Policy 6—*Land grants* were a major incentive used in the United States and elsewhere to help finance the construction of early railroads. More recently, there have been specific instances where land grants facilitate the construction of a new rail link or bridge (e.g., the donation of small bits of land to allow construction of a flyover, as in Kansas City). Land grants and land swaps might be needed in order to be able to locate intermodal terminals where they can be most effective in attracting traffic off the highways.
- Policy 7—*Light-density line programs* include public purchase or subsidy of rail lines in order to maintain rail operations, as well as investment in low-volume lines in order to improve the ability to serve customers.

1. Project finance
2. Public ownership of the right-of-way
3. Redevelopment of rail facilities
4. Taxation
5. Financial reform
6. Land grants and land swaps
7. Light-density line programs

Exhibit 3-6. Public Programs and Policies Related to Rail Freight.

This list of policy directions is not an endorsement of any of them, as this is not the place to judge the extent to which such strategies have been effective in the past. The intent is simply to encourage public agencies to consider the full range of options open to them. The success of any project or of any program will depend on local conditions and the particulars of implementation.

Step 2. Estimating the Magnitude of the Problem

Having classified the local situation and identified potentially relevant actions and policies, the second step has two parts. The two parts are to develop

1. *A representation of current and projected future traffic conditions;* and
2. *Measures of the level of congestion, its location, and the extent to which truck traffic contributes to its severity so that such information can be used to compare scenarios and assess the magnitude of their congestion reduction benefits.*

Part 1 – Representation of Traffic Conditions. This typically requires some representation of regional or corridor highway demand and performance characteristics in terms of current and future vehicle trips, distances, and speeds. By estimating traffic volumes and congestion conditions under alternative scenarios, it is possible to identify the magnitude of the future congestion problem under base case conditions that assume no diversion to rail freight (and later under alternative scenarios that create some diversion to rail freight).

Most metropolitan areas have some type of road network and traffic model that can be used to represent current conditions and project expected future conditions in terms of the flow of vehicle trips, distances, and speeds. Typically, these models start with a forecast of truck and car *trip generation by zone* (including detailed zones internal to the region and larger zones representing areas or directions outside the region that are ultimate origins or destinations). They then provide a forecast of *trip assignment* between origins and destinations based on current traffic levels and expected future changes in employment and population location patterns. Finally, they provide a forecast of *trip distribution* among particular links and nodes, based on a “least time” or “least cost” path for future traffic. This process can forecast shifts in traffic as travel times slow for those links and nodes forecast to have high volume-to-capacity ratios. The results are some measures of vehicles, link speeds, and trip distances.

Those measures, in turn, are used to calculate the amount of total daily traffic measured as vehicle-miles of travel (VMT) and total time spent traveling measured as vehicle-hours of travel (VHT). Generally, these models are accompanied by some data concerning the portion of vehicle trips made by trucks. Many states also have statewide models used for major highway corridors; that data can similarly be applied to calculate current and future VMT, VHT, and truck volumes on those routes. This information provides a basis for calculating current and expected future congestion for areas and corridors under base case conditions, which assume no diversion of any freight movements to rail.

Later steps will provide estimates of the potential freight diversion to rail that might be possible or expected in an alternative (future project) scenario. Then, this same process of traffic analysis can be reapplied to calculate the changes in traffic volumes, VMT, and VHT expected to occur under that future scenario. Most road network models will forecast how a reduction in freight-related truck traffic (due to rail diversion) will lead to shifts in the spatial distribution of vehicles on various road links throughout the road network, and then calculate the implications for overall VMT and VHT levels on a regional basis.

Part 2 – Measures of Congestion Problems and Benefits. The traffic modeling analysis, and its findings of changes in traffic conditions, can be used to develop a number of different measures of congestion growth and the additional cost of congestion for freight and passenger travel.

The issue of measuring congestion and its costs is addressed in NCHRP Study 2-21 (*NCHRP Report 463*),ⁱ which examined the economic impacts of road congestion. It notes that “a great deal of attention has been devoted to the definition and measurement of congestion in existing research, and is reflected in the development of congestion management systems. Indicators of congestion are available for urban areas and are reported in FHWA’s Highway Statistics and BTS’s National Transportation Statistics.”

Exhibit 3-7 lists the seven most common measures of road traffic congestion. The use of each measure and its advantages and disadvantages is discussed below.

*Summary of Congestion Measures:*ⁱⁱ

- **Time Delay (aggregate VHT by vehicle type).** Generally, the measure of travel time delay is most appropriate for this study. This is the most widely used measure of congestion delay. Road network models can be used to forecast differences in total aggregate travel time delay associated with allowing congestion to worsen, compared to taking actions to reduce vehicles on the road (as could occur if rail freight growth replaced some of the future truck volume growth). The values of total delay (increase in VHT) can be used along with business “value of time” factors to calculate the total cost of freight congestion.
- **Accessibility or Travel Time Contours.** The travel time contours from a single point to/from multiple destinations/origins can be plotted on a map showing times in discrete intervals (e.g., 5 or 10 minutes at a time). These are most useful for studying travel to a major employment center such as the port, airport, border, rail intermodal facilities, Central Business District, or industrial zone of a city.
- **Percentage of Time Average Speed is Below Threshold Value.** This spot-speed measure uses information collected from automated speed monitoring equipment. The measure uses data that can be collected in a completely automated fashion, with an increase in the value of this measure corresponding unambiguously to an increase in the degree of congestion. This measure would appear to be practical as long as the threshold speed is set at 20 or 25 mph or higher due to potential equipment inaccuracies at lower speeds.
- **Volume-to-Capacity Ratio.** The FHWA’s HPMS (Highway Performance Monitoring System) dataset includes peak-period volume-to-capacity ratio (V/C) as a data item. Also, the distribution of total traffic by V/C can be estimated using the HPMS data items, annual average daily traffic volume (AADT) and capacity, together with tables showing the distribution of traffic by V/C for different values of AADT. V/C ratios are used as the basis for estimating network link speeds in traffic assignment models, in a function known as the BPR (Bureau of Public Roads) curve.
- **Congestion Indices.** Much of the research on congestion indices has facilitated comparisons of relative levels of congestion among U.S. cities. These are valuable tools for estimating overall levels of congestion but might not be applicable at the regional level and across multiple

1. Average Time Delay
2. Accessibility or Travel Time Contour
3. Percent of Time that Average Speed is Below Threshold Value
4. Volume to Capacity Ratio
5. Congestion Indices
6. Delay Indices

Exhibit 3-7. Summary of Congestion Measures.

ⁱEconomic Implications of Road Congestion, Weisbrod, G., D. Vary and G. Treyz. National Cooperative Highway Research Program, Report 463, National Academy Press, 2001.

ⁱⁱText is drawn from NCHRP Report #463; op cit.

modes of travel. To expand on the work done in the past, the Texas Transportation Institute (TTI) developed an index that takes all modes of transport into account and is based on a measure called Volume/Acceptable Flow Rate. The flow rate deemed acceptable by local officials is calculated based on various local roadway classification characteristics.

- **Delay Measures.** Delays of any type increase travel time and reduce travel speeds. As such, measures of delay are closely tied to time-related measures. By focusing on delay as a performance measure, specific problem locations can be identified. A number of recent studies, focused on non-recurring congestion, have demonstrated the importance of incident-related delays and the benefits that can be derived from their reduction. *Minute Miles of Delay* is the product of the length of a roadway segment and the difference between an acceptable travel rate and the actual travel ratio (where the actual travel ratio is equivalent to 60 minutes divided by the speed on the segment). This measure combines the effects of lower speeds on congested highways and the distance that must be traveled on congested highways. *Level-of-Service (LOS)* classifications are derived from other performance measures and merely represent a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers (TRB, 1985).

Any of these measures can be used to characterize the severity of congestion and qualitatively assess the extent to which it presents a problem for various types of goods movement. For purposes of benefit-cost analysis, the *travel-time delay* measures offer the simplest means for quantifying the total business costs of future congestion. This can be done by multiplying total delay hours times various values of time for specific types of vehicles, trips, and commodities. Value of time factors are discussed later in this guide.

Other measures can also be useful for evaluating the effect of congestion on goods movement. For instance, the measurement of congestion impacts on *travel time contours* can be particularly important if congestion disproportionately affects throughput and accessibility to ports, borders, or particular industrial areas. The *V/C* and related *congestion index* can be used to identify conditions in which there will be a disproportionately higher rate of traffic incidents and hence reduction in reliability of travel time. That consideration can be especially important if just-in-time production and logistics scheduling are a major factor for area businesses. For that reason, it can also be important to distinguish “recurring delays” (due to speed slowdown) from “non-recurring delays” (due to traffic incidents). The latter can be particularly significant because traffic incident delays can cause businesses to incur high costs as they pad their schedules (in effect, anticipating incidents) in order to avoid being unduly hurt by them.

Note on Handling of Induced Demand. Often, projects that add to the effective capacity of roads lead to less-than-expected congestion reduction benefits on those routes due to shifts in regional traffic patterns. Some of the changes, such as a tendency for traffic to shift from other congested parallel routes to the now less-congested route, can still lead to overall system-wide savings in both VMT and VHT. However, sometimes the net reduction in congestion and area-wide time savings is less than expected because longer and/or more frequent trips occur when travel times shorten. For instance, delivery services may respond to a reduction in congestion by expanding the frequency of deliveries or the distance of their delivery areas. Individuals may make shopping or recreation trips to more distant destinations. The net result is more vehicle-miles of travel and fewer vehicle-hours of time savings than would otherwise be expected from the new capacity. This effect is referred to as “induced demand growth.” It may reduce or offset the congestion reduction that would otherwise occur from rail or roadway improvements.

The more sophisticated traffic studies for congested urban areas and highway corridors are now accounting for induced demand in their forecasts of long-term impacts. From the viewpoint of traffic engineering, this consideration is an important step in making more realistic traffic

forecasts. However, from the viewpoint of benefit-cost analysis, care must be taken in the treatment of induced demand. After all, no traveler or shipper would change the frequency or length of trips unless there was some benefit in doing so. So it would be wrong to merely assume that the induced demand is a reduction in the economic benefit of congestion reduction.

Step 3. Characterizing Freight Patterns

Having assessed the magnitude of congestion problems in Step 2, the third step is to identify what is being delayed—i.e., the extent of delay for goods movement and the characteristics of the freight flows that are affected—and what might be diverted. This step involves four parts:

1. Develop a *representation of local freight shipping patterns* in terms of flow volumes, their spatial patterns, and commodity mix;
2. Conduct a *macro analysis* of the extent to which truck trips contribute to current and expected future congestion conditions;
3. If part 2 establishes that truck trips are a major contributor to congestion, then conduct a *micro analysis* which examines the types of goods being shipped, the potential for truck-to-rail diversion, and the types of investments required to support such diversion; and
4. If part 3 determines that some commodities could be shifted to rail freight, then conduct a *geographic analysis* which examines the origins and destinations of truck freight flows in the study area.

The involvement of private-sector entities during this step of analysis is initially useful and ultimately essential. The following chapter on “Public-Private Dialogue” begins with the importance and methods of engaging such entities. For preliminary screening, they can assist with data and expert information, provide practical guidance, and offer realistic assessments of whether and why a project aimed at traffic diversion should or should not succeed in the market.

Part 1—Representation of Local Freight Shipping Patterns. It is necessary to develop a profile of the pattern of freight flows by truck and by rail currently flowing through the region or corridor in order to identify their spatial pattern and the composition of goods movement. This will allow the analyst to begin to assess the potential for freight diversion from truck to rail. Exhibit 3-8 lists the relevant characteristics of freight flows that should be assessed.

Information on *volume of truck freight* is important for determining whether freight truck traffic is a significant contributor to congestion in the study area. Freight flow *directions* and *commodity information* are important because they directly affect the viability of rail freight as an alternative to trucking: some commodities moving by truck could potentially be shipped by rail, while rail might be impractical for commodities that are more fragile or time sensitive. The internal/external split of *trip end locations* is important as it is an indicator of the contribution of local freight movements to congestion and also as it reflects trip length which influences potential demand for local intermodal

1. *Volume of freight* – To what extent is truck freight contributing to local congestion?
2. *Direction of affected freight flows* – What are the specific corridors affected by congestion? Where are the markets currently served by truck freight?
3. *Commodities affected* – Which commodities are currently shipped by truck? For which of these is rail a technically feasible option?
4. *Location of trip ends* – How much of the freight traffic can be characterized as internal trips (within the region), external trips (passing through the region), and internal-external trips (with one trip end at a business within the region and the other trip end outside the region)?

Exhibit 3-8. Freight Flow Characteristics to be Measured.

loading facilities. Information on time of day or day of week, if available, could also be useful in determining the extent to which the truck freight flows affect peak-period congestion.

This information on characteristics of freight movements will be needed in Step 4 to assess the potential for freight diversion to rail and in Step 5 to assess particular types of rail investments that could relieve congestion. In addition, the economic costs of congestion vary by type of business, so knowing the types of commodities is also important for that reason. These business costs of delay can be substantially greater than the cost of driver time and vehicle operating time alone. For some businesses, there can also be implications for revenues and costs related to the size of the business market and/or service areas; to business inventory and logistics costs; to just-in-time production costs; and to workforce attraction.

Part 2—Macro Analysis. A macro analysis of shipping patterns answers two general questions, as shown in Exhibit 3-9.

The first question is whether or not rail investments are a feasible way to reduce local congestion. There are three types of truck freight movements: those that begin in the study area (“origin”); those that end in the study area (“destination”); and those that pass through the local area (“overhead traffic”). The greatest potential for diversion to rail within local control are trips with a local origin or destination, because shippers and receivers decide on mode choice options and make the mode choice decisions, so they are strongly influenced by the cost and quality of rail service and congestion costs in the areas served. In addition, because the customers are located in and around the study area, it is possible to involve them in planning and public meetings regarding rail investments. Diversions to rail of “destination” movements are likely to be strongly influenced by changes in cost and service in the locations in which the trip originates, although destination conditions certainly affect them, especially if the receiving business has control of the carrier selection (as will happen with automobile plants and large retailers, among others). “Overhead” trips are less directly influenced by rail cost or service in the study area, unless the region acts as an interchange point or hub.

The second question is concerned with future levels of truck freight trips. In cases where truck traffic is not currently a major source of congestion, but could be in the future, or where already heavy traffic promises to become very much heavier, this question is especially pertinent for purposes of long-term infrastructure planning. To assess the proportion of current congestion related to freight truck trips originating in the study area, it is necessary to examine the composition of current traffic. Unfortunately, there is no one public source that decomposes freight traffic by origin, destination, and overhead, and most sources are several years old. However, as noted in Step 2, most metropolitan areas have highway models, which can be used to estimate the contribution of trucks to overall congestion levels. State DOTs will often collect information on the volume of truck traffic in a state or locale; federal sources, including the U.S. Bureau of Census’s Commodity Freight Survey (CFS) and the FHWA’s Freight Analysis Framework (FAF), collect information on freight movements by origin and/or destination and commercial sources offer relevant information for sale. In addition, material from partners and stakeholders is a common and often highly pertinent source of traffic information in projects. (Data sources are

1. *Role of Local Origin Traffic* - How much of current congestion is related to (freight) truck trips originating in the study area?
2. *Role of Truck Traffic* - Given existing trends in freight movements, how much congestion will be created in the future by (freight) truck trips originating in the area?

Exhibit 3-9. Macro Analysis Issues.

discussed in more detail in the next section.) Using these data, an analyst can estimate the total portion of truck traffic with an origin and/or destination within the study area.

If the macro analysis reveals that truck freight traffic is composed largely of “overhead” freight movements, it is unlikely that local rail investments by themselves can divert freight traffic. In these cases, a multi-jurisdictional approach with coordinated investment is required, pursued by the public agency either on a regional or corridor basis. Barring that, other solutions to congestion problems should be pursued. Multi-jurisdictional groups, and areas with freight truck traffic that can be traced to trips with origins or destinations within the study zone, should proceed with micro analysis.

Data for Macro Analysis: CFS data are available on the national, state, and sub-state levels. (Sub-state data include information on each large metropolitan area in a state, as well as the “remainder of state,” i.e., non-metropolitan area totals.) Aggregate data include the shipments by mode (expressed in tons, values, or ton-miles) and the percentage of shipments (expressed in tons, values, or ton-miles) carried by each mode for each survey year, which include 1997 and 2002. CFS reports also include comparisons of modal breakdown for 1997 and 2002. The availability of 1997 and 2002 data allows for estimation of recent growth in freight shipments by mode, trends that could be extrapolated to determine the extent to which truck freight shipments are likely to be a source of congestion in the future. Many of the data from the 2002 CFS are available on line in ASCII and spreadsheet formats.ⁱⁱⁱ FAF data can also be used to determine the contribution of current and future role of freight shipments to congestion levels. FAF1 data include state profiles, which include tons and value of originating and terminating shipments by mode for each state for 1998 with projections for 2010 and 2020.^{iv} These profiles can be used to assess whether freight shipments currently contribute to congestion problems in the study area or will in the future. FAF2 data are expected to offer comparable information for more current time frames. In addition, detailed maps (but not data) of truck freight flows are available from FAF; specific data on truck freight flows can be purchased from private sources, such as Global Insight’s former Reebie group. Other tools for more detailed analysis include FHWA’s Geofreight^v tool, which can analyze freight flows on particular highway segments, including estimates of origin, destination, and overhead traffic.

Part 3—Micro Analysis. If Part 2 analysis indicates that truck freight movements are a major cause of congestion or are likely to be so in the future, then a “micro analysis” is warranted to profile the types of goods and likely trends in the characteristics of goods that are moved within the study area. Micro analysis is important because technical feasibility and cost of diversion from truck to rail will be strongly influenced by characteristics of the goods being shipped. Thus, micro analysis contributes to three analytic needs: (1) estimation of the potential size of truck-rail freight diversions (used in Step 5); (2) assessment of the feasibility of current rail resources to absorb a portion of current or future freight shipping needs (used in Step 4); and (3) determination of the types of rail investments and service offerings that would be required to divert current or anticipated freight from rail to truck given current rail resources.

To get a first-order estimate of the potential for truck-to-rail diversions, it is necessary to assess the composition of commodities that are currently moved by truck or will be in the future. The types of information required for micro analysis can be gathered from metropolitan planning agencies, state DOTs, the CFS, and private sources and by gathering information from surveys or interviews aimed at understanding current and likely future shipping needs. For metropolitan areas, CFS data include information on ton, value, and ton-mile shipments by mode for 10

ⁱⁱⁱ<http://www.census.gov/svsd/www/02CFSdata.html>

^{iv}http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/state_profiles.htm

^vGeofreight Intermodal Display Tool, <http://www.fhwa.dot.gov/freightplanning/geofreight.htm>

general commodity classes. Unfortunately, these data are available only for the 50 largest metropolitan areas in the United States and thus do not provide broad geographic coverage. For states, CFS provides detailed data on shipments by mode for 43 commodity classes.

Both metropolitan and state data are available for 1997 and 2002, as well as for select earlier years, and include information on origin and destination of shipments. With these data, analysts can characterize freight shipments in an area by origin and destination by commodity. These data can also be used to project future shipping needs, either by extrapolating from 1997–2002 CFS trends or by using forecasts of economic activity by industry to estimate future commodity shipments by mode in large metropolitan areas and states. Such calculations would provide a rough estimate of likely future commodity freight demand by type of carriage and can be calculated for any future year, though estimates are likely to be less accurate in later years. (Basing forecasts on extrapolation of current trends assumes that commodity and modal freight patterns will continue to develop in the future as they have in the recent past. This assumption, of course, will not hold if there are significant changes underway in transportation systems or in local industrial structures.) Analysts also can use forecasts of freight movements by mode from FHWA. As of this writing, these forecasts are available for all states for the years 2010 and 2020 and can be used as an estimate of future modal demand or as a check against forecasts developed by extrapolating from CFS data.^{vi} However, based on 1998 data and a pre-9/11 outlook, the projections are less useful than previously; updated forecasts will become available from FHWA or can be procured from private sources.

After compiling information on the commodity composition of freight moved by trucks, an estimate of the potential diversion must be made. There are two ways to calculate a first-order estimate of potential diversion of each commodity. The first is to use a “rule-of-thumb” regarding the proportion of freight shipments that is “modally competitive,” i.e., “fall(s) within normal distance and service characteristics of both truck and rail.”^{vii} Forkenbrock (2001) suggests that approximately 40 percent of long-haul truck freight shipments could be moved by rail. A second method involves examining the types of commodities being shipped locally and inferring potential diversion from commodity composition. This approach requires examining current modal patterns, particularly the proportions of each commodity moved by truck and rail, and inferring potential diversion for each commodity based on these proportions.

To illustrate the second method, we can begin by making the following assumptions:

- For commodities for which no freight is currently moved by rail, such as live fish and animals, it is assumed that there is no potential diversion.
- For commodities for which only a very small proportion of freight (less than 5 percent) is moved by either truck or rail or the amount moved by truck dwarfs the amount moved by rail, it is assumed that potential diversion is small.
- For commodities for which the proportion of freight moved by rail and by truck is at least 5 percent, but the proportion moved by rail is still smaller than the proportion moved by truck, it is assumed that potential diversion is significant but not large.
- For commodities for which the proportions moved by rail and truck are large and relatively equal, it can be assumed that potential diversion is large.

Using these assumptions and 2002 CFS data for the United States, classifications of potential diversion for each of the 40 commodity classes were developed for this study. These are shown in Exhibit 3-10.

^{vi}http://ops.fhwa.dot.gov/freight/freight_analysis/state_info/state_profiles.htm

^{vii}Forkenbrock, David J., 2001. “Comparison of external costs of rail and truck freight transportation,” Transportation Research Part A; p. 322.

SCTG				Potential
Code	Product	% Rail	% Truck	Diversion
1	Live animals and live fish	--	93%	ZERO
2	Cereal grains	54%	9%	SIGNIFICANT
3	Other agricultural products	23%	43%	LARGE
4	Animal feed and products of animal origin, n.e.c	30%	52%	LARGE
5	Meat, fish, seafood, and their preparations	2%	96%	SMALL
6	Milled grain products and preparations, bakery products	25%	67%	SIGNIFICANT
7	Other prepared foodstuffs and fats and oils	25%	68%	SIGNIFICANT
8	Alcoholic beverages	25%	67%	SIGNIFICANT
9	Tobacco products	--	67%	ZERO
10	Monumental or building stone	--	92%	ZERO
11	Natural sands	23%	70%	SIGNIFICANT
12	Gravel and crushed stone	27%	48%	LARGE
13	Nonmetallic minerals, n.e.c	48%	46%	LARGE
14	Metallic ores and concentrates	21%	5%	SMALL
15	Coal	86%	2%	SMALL
17	Gasoline and aviation turbine fuel	3%	31%	SMALL
18	Fuel oils	6%	35%	SIGNIFICANT
19	Coal and petroleum products, n.e.c	39%	23%	LARGE
20	Basic chemicals	49%	27%	LARGE
21	Pharmaceutical products	--	61%	ZERO
22	Fertilizers	40%	50%	LARGE
23	Chemical products and preparations, n.e.c	13%	80%	SMALL
24	Plastics and rubber	30%	65%	SIGNIFICANT
25	Logs and other wood in the rough	11%	80%	SMALL
26	Wood products	42%	53%	LARGE
27	Pulp, newsprint, paper, and paperboard	40%	56%	LARGE
28	Paper or paperboard articles	4%	88%	SMALL
29	Printed products	--	76%	ZERO
30	Textiles, leather, and articles of textiles or leather	1%	75%	SMALL
31	Nonmetallic mineral products	19%	75%	SMALL
32	Base metal in primary or semifinished forms & in finished	25%	61%	SIGNIFICANT
33	Articles of base metal	13%	79%	SMALL
34	Machinery	5%	83%	SMALL
35	Electronic & other electrical equipment, components, etc.	2%	79%	SMALL
36	Motorized and other vehicles (including parts)	21%	67%	SIGNIFICANT
37	Transportation equipment, n.e.c	--	45%	ZERO
38	Precision instruments and apparatus	--	76%	ZERO
39	Furniture, mattresses and mattress supports, lamps, etc.	1%	93%	SMALL
40	Miscellaneous manufactured products	2%	81%	SMALL
41	Waste and scrap	33%	36%	LARGE
43	Mixed freight	3%	89%	SMALL

Exhibit 3-10. Examples of Truck to Rail Diversion Potential by Commodity.

These classifications were then translated into estimates of the percentage of freight that can be diverted. Values used in this illustrative analysis are: 0 percent for “zero or negligible,” 20 percent for “small,” 40 percent for “significant,” and 80 percent for “large.” However, actual values used should be tailored to each analysis based on knowledge of local conditions: actual diversion potential will be strongly influenced by local factors such as local infrastructure and average trip length. In all cases, local knowledge about these factors should be used in lieu of the default classifications and values presented here. After potential diversion values have been finalized, the values can then be multiplied by the current amount of each commodity shipped by truck to estimate total potential diversion for all commodities. A sample calculation of 2002 CFS data is presented in Exhibit 3-11. Using the default values discussed above, it shows that much of the truck freight (61%) is not divertible, but that also means that up to 39 percent could potentially be diverted to rail.

Part 4—Geographic Analysis. A geographic analysis can be used to examine the geographic patterns of truck freight flows. This information can be used to estimate the amount and direction of

SCT G Code	Diversion Classification	Diversion Value	CURRENT		POTENTIALLY DIVERTED	
			Rail Freight ('000 tons)	Rail Freight (M ton-miles)	Rail Freight ('000 tons)	Rail Freight (M ton-miles)
1	ZERO	0%	94.13	25.32	-	-
2	SIGNIFICANT	40%	89.44	23.14	35.78	9.26
3	LARGE	80%	63.27	10.13	50.62	8.11
4	LARGE	80%	29.51	7.74	23.61	6.19
5	SMALL	20%	33.48	2.35	6.70	0.47
6	SIGNIFICANT	40%	15.12	10.18	6.05	4.07
7	SIGNIFICANT	40%	5.50	2.28	2.20	0.91
8	SIGNIFICANT	40%	3.70	1.71	1.48	0.68
9	ZERO	0%	0.31	0.11	-	-
10	ZERO	0%	1.49	0.46	-	-
11	SIGNIFICANT	40%	0.03	0.05	0.01	0.02
12	LARGE	80%	5.53	2.42	4.42	1.94
13	LARGE	80%	1.75	1.82	1.40	1.46
14	SMALL	20%	0.21	0.15	0.04	0.03
15	SMALL	20%	0.35	0.37	0.07	0.07
17	SMALL	20%	0.19	0.26	0.04	0.05
18	SIGNIFICANT	40%	0.85	0.93	0.34	0.37
19	LARGE	80%	0.16	0.11	0.13	0.09
20	LARGE	80%	2.94	0.36	2.35	0.29
21	ZERO	0%	0.05	0.01	-	-
22	LARGE	80%	0.05	0.01	0.04	0.01
23	SMALL	20%	0.05	0.01	0.01	0.00
24	SIGNIFICANT	40%	0.02	0.01	0.01	0.00
25	SMALL	20%	0.03	0.01	0.01	0.00
26	LARGE	80%	4.53	2.13	3.62	1.71
27	LARGE	80%	4.34	2.01	3.47	1.61
28	SMALL	20%	1.69	0.18	0.34	0.04
29	ZERO	0%	1.12	0.14	-	-
30	SMALL	20%	0.57	0.04	0.11	0.01
31	SMALL	20%	1.39	1.14	0.28	0.23
32	SIGNIFICANT	40%	1.26	0.68	0.50	0.27
33	SMALL	20%	0.65	0.66	0.13	0.13
34	SMALL	20%	0.69	0.57	0.14	0.11
35	SMALL	20%	0.59	0.02	0.12	0.00
36	SIGNIFICANT	40%	0.98	0.09	0.39	0.04
37	ZERO	0%	0.02	0.01	-	-
38	ZERO	0%	0.02	0.01	-	-
39	SMALL	20%	0.02	0.01	0.00	0.00
40	SMALL	20%	0.04	0.02	0.01	0.00
41	LARGE	80%	0.03	0.02	0.03	0.02
43	SMALL	20%	1.51	1.07	0.30	0.21
TOTALS			367.6	98.7	144.7	38.4

Exhibit 3-11. Sample Calculation of Potential Freight Diversion by Commodity.

truck freight originating in a study area; the amount and direction of truck freight destined for a study area; and in some cases, an estimation of overhead traffic. At the most general level, analysis will focus on the amount and direction of truck freight originating in or destined for the study area. These data will provide a snapshot of the direction of truck freight flows to and from the study area and will be used in Step 4 to determine whether the broad characteristics of truck freight flows make it possible for large-scale diversion to rail. The geographic analysis might indicate, for example, that truck freight flows are generally north-south while rail infrastructure goes east-west, in which case, diversion to rail would be difficult; or that truck freight flows are concentrated in two or three states currently connected to the study area by rail, in which case diversion to rail is technically feasible. An example of analysis using 2002 CFS data for Illinois and Montana is presented in Exhibit 3-12.

TRUCK FREIGHT BY STATE OF ORIGIN					
	% of All Out-going Truck Freight Tons	% of Non-MT Out-going Truck Freight Tons		% of All Out-going Truck Freight Tons	% of Non-IL Out-going Truck Freight Tons
Montana			Illinois		
Montana	77%	--	Illinois	75%	--
Wyoming	4%	17%	Indiana	5%	18%
Idaho	4%	16%	Wisconsin	4%	16%
Utah	2%	10%	Missouri	2%	8%
California	2%	9%	Ohio	2%	7%
Washington	2%	7%	Michigan	2%	7%
North Dakota	1%	6%	Iowa	2%	6%
South Dakota	1%	5%	Pennsylvania	1%	4%
Colorado	1%	3%	Kentucky	1%	4%
Minnesota	1%	3%	Texas	1%	3%
Illinois	0%	2%	Minnesota	1%	3%
TOP 5	89%	59%	TOP 5	87%	55%
TOP 10 + MT	95%	78%	TOP 10 + IL	94%	76%
TRUCK FREIGHT BY STATE OF DESTINATION					
	% of All Out-going Truck Freight Tons	% of Non-MT Out-going Truck Freight Tons		% of All Out-going Truck Freight Tons	% of Non-IL Out-going Truck Freight Tons
Montana			Illinois		
Montana	73%	--	Illinois	77%	--
Washington	4%	13%	Indiana	4%	17%
Idaho	3%	10%	Wisconsin	3%	14%
Utah	3%	10%	Missouri	3%	12%
Wyoming	2%	8%	Iowa	2%	10%
Texas	2%	6%	Ohio	1%	6%
Oregon	1%	4%	Michigan	1%	5%
North Dakota	1%	3%	Kentucky	1%	4%
Iowa	1%	2%	Pennsylvania	1%	3%
Illinois	0%	2%	Minnesota	1%	3%
Nevada	0%	1%	Texas	0%	2%
TOP 5	84%	47%	TOP 5	89%	59%
TOP 10 + MT	89%	60%	TOP 10 + IL	95%	76%

Exhibit 3-12. Truck Freight Flows by State of Origin.

These data show that about three-quarters of all truck freight flows (origin and destination) stay within each state. For truck freight that leaves Montana, almost 60 percent goes to one of five states (i.e., Wyoming, Idaho, Utah, California, and Washington), a pattern similar to Illinois'. This concentration suggests that in both states, better or cheaper rail service to a handful of states could result in large diversions of truck freight. Truck freight coming into Montana, however, tends to be more dispersed, with the five largest (origin) states accounting for less than half of all truck freight coming into Montana. For Illinois, on the other hand, almost 60 percent of all incoming truck freight originates in one of five states. It is possible as well to perform state-to-state freight flow analyses by 2-digit commodity, allowing analysts to combine the findings of the micro analysis with a geographic analysis. This would be particularly useful where a few commodities account for a large portion of truck freight. This could also be useful for interstate highway corridor projects, where it is important to determine the benefit to participant and non-participant states from infrastructure investment in each of the participant states in order to allocate costs appropriately.

Alternate Method for Intermodal Analysis. For intermodal services, a conventional commodity-based approach to preliminary diversion assessment is limited by the source data. The Commodity Flow Survey does not sample import shipments, which account for about half of the

intermodal business, and this depresses the apparent participation of rail in commodity carriage. There also are questions as to the completeness with which the Survey can recognize intermodal activity, since respondents see their pickups made by truck and are not always aware of the line haul mode. The Carload Waybill Sample offers a more inclusive picture on both accounts, but most of its commodity identification for intermodal shipments is with the catch-all category FAK, for “freight all kinds,” and specific detail is not available.

An alternate approach begins with the consideration that the great majority of rail intermodal transportation involves “containerizable” goods of the sort hauled in dry van trailers on the road. A commodity list can be screened for containerizable goods; the classification of many (e.g., paper products) will be straightforward, yet some (e.g., various forms of chemicals) will be divided between dry vans and other equipment types, and an allowance has to be made for the mixture. More readily, the preponderance of truck traffic moves in dry vans can be employed in a simple estimation. Dry vans account for approximately 66 percent of the truck traffic over 200 miles and 70 percent of the traffic at or under 200 miles. Applying these percentages to truck flow data produces a first approximation of the traffic volume compatible with intermodal transport.

An intermodal capture rate can be estimated by means of a market share matrix, as shown in Exhibit 3-13. The matrix displays the average penetration rate for rail intermodal service within the market for dry van carriage. It is organized by the distance and density of traffic lanes, based on flows between metropolitan markets. It can be used in conjunction with traffic flow data from a source such as the CFS, to benchmark intermodal participation and potential diversion. Several points affect the analysis:

- If data are no finer than state-to-state lanes, they will be too broad to establish lane density but can offer a general picture of distance. The length of haul totals to the right of the matrix would then be used, although further interpretation could be gleaned from density figures for state lanes with obviously huge or small volumes.
- If traffic is denominated in numbers of trucks, it can be converted to tonnage for correspondence to the matrix by multiplying the number of trucks by 15 tons per load, which is a rule

MODAL MARKET SHARE BY LANE DENSITY & DISTANCE								
RAIL INTERMODAL (IMX) Vs OVER-THE-ROAD (OTR) DRY VAN TRUCK								
Source: TRANSEARCH 2000								
HIGHWAY MILES	LANE DENSITY (Annual Tons [000] by IMX+OTR)							
	< 100		100 - 400		> 400		Total	
	IMX	OTR	IMX	OTR	IMX	OTR	IMX	OTR
1-100	0.1%	99.9%	0.1%	99.9%	0.4%	99.6%	0.4%	99.6%
100 - 299	0.3%	99.7%	1.1%	98.9%	1.4%	98.6%	1.3%	98.7%
300 - 499	0.8%	99.2%	2.3%	97.7%	3.6%	96.4%	3.0%	97.0%
500 - 699	1.3%	98.7%	5.8%	94.2%	11.1%	88.9%	6.6%	93.4%
700 - 999	1.3%	98.7%	8.3%	91.7%	27.2%	72.8%	12.6%	87.4%
1000 - 1499	2.6%	97.4%	8.7%	91.3%	28.1%	71.9%	11.4%	88.6%
>1500	7.3%	92.7%	24.8%	75.2%	62.0%	38.0%	37.1%	62.9%
Total	2.4%	97.6%	6.6%	93.4%	8.2%	91.8%	7.0%	93.0%
Total > 500	3.0%	97.0%	10.8%	89.2%	33.8%	66.2%	16.8%	83.2%
Total < 500	0.6%	99.4%	1.5%	98.5%	1.5%	98.5%	1.4%	98.6%

MARKET SHARE KEY:

OTR TRUCK ≥ 80%
BOTH < 80%
IMX RAIL ≥ 80%

Exhibit 3-13. Example of an Intermodal Matrix.

of thumb used by rail and motor carriers for a typical dry van payload on the road. Some commodity groups will have significantly higher or lower tons per load figure, so the actual tons per load by STCC code may be needed if traffic is concentrated in a few commodity groups. Ton-miles can be calculated from tons by factoring in an average lane distance.

- Benchmarking against modal share should take into account the existing intermodal penetration. This can be derived by joining truck data to intermodal information from the Carload Waybill Sample—a source all states may tap and to which MPOs may request access through their state DOT.
- Intermodal traffic gains assume access to rail transfer terminals and the provision of lane service and pricing competitive with over-the-road trucks. These need to be in place or in prospect for any preview of possible diversion to be valid.

Beyond these points, application of the matrix is a clear-cut exercise of multiplying rail percentages against total traffic, with the difference between current and benchmark penetration indicating the diversion potential. For well-developed intermodal lanes or where new rail services are expected to be especially competitive, the matrix values from adjacent cells can be used to suggest upside traffic gains. The whole procedure produces a preliminary evaluation of possible traffic capture, helpful at a sketch planning level but requiring more rigorous analysis for project assessment, as will be described in later steps.

Step 4. Characterize Available Rail Resources

Having assessed the pattern of truck and rail freight flows in Step 3, the fourth step is to identify the nature of rail lines and supporting facilities available to serve freight movements. The determination of these rail resources will make it possible to get a first-order estimate of the portion of current truck flows for which rail freight can potentially be a viable option. In other words, just by screening the direction of railroad lines, location of intermodal facilities and type of services offered, it will be possible to identify the portion of truck freight movements that involve commodities, origins and destinations that can be serviced by existing rail services. This step involves three parts:

1. Determination of the *geographic areas and markets served by the existing rail* configuration;
2. Assessment of the current *availability of various classes of rail service*; and
3. The match of *rail services to types of transport services needed* for diversion of truck freight to rail.

Part 1—Geographic Areas and Markets Served by Rail. The best source of information on the current rail services offered is the local railroads, who will have the best understanding of (1) current operational capacity; (2) operational constraints; and (3) the types of demand (i.e., geographic and commodity characteristics) they can readily absorb; as well as (4) any issues related to terminal or service availability. However, it must be noted that issues related to railroad capacity are complex and can involve proprietary data, so obtaining such information would require close contact with carriers.

Material gathered from the railroads can then be compared to information previously collected on the geographic pattern of existing truck freight flows, as assembled for Step 3, part 3 (and also illustrated previously in Exhibit 3-12). This comparison provides a basis to determine whether existing patterns of demand for freight movements could be filled using existing rail resources.

Part 2—Availability of Various Classes of Rail Service. The second part of the characterization of rail resources focuses on the availability of rail operations by three classes: (1) unit train, (2) carload, and (3) intermodal services. This typology of rail service into three classes is intended as an overview of the major railroad business groups and is functional as such. Key aspects of the

RAIL FREIGHT TYPOLOGY				
DIMENSION	ELEMENT	UNIT TRAIN	CARLOAD	INTERMODAL
Markets	Commodities	Coal, grain, minerals	Chemicals, forest, bulk food, metals, waste, auto parts	Merchandise, automobiles
	Competitive dynamic	Rail dominion	Eroded dominion	Competitive, divertable
	Intermodality	Water; truck gathering	Truck (bulk transfer, breakbulk)	Marine & truck
	Service requirement	Equipment turnaround	Equipment supply	Speed & reliability
	Captivity	Some	Some	Little or none
Economics	ASPECT	UNIT TRAIN	CARLOAD	INTERMODAL
	High empty return	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	No (but imbalance affects)
	Private/Sequestered equipment	<input checked="" type="checkbox"/> (not grain)	<input checked="" type="checkbox"/>	Box, not car
	Heavy, periodic eqpt. demand	<input checked="" type="checkbox"/>	No	International marine
	Long haul	Mixed	Mixed	<input checked="" type="checkbox"/>
	High lane density	<input checked="" type="checkbox"/>	No	<input checked="" type="checkbox"/>
	Heavy axle loads	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	No
	Serves commodity business	<input checked="" type="checkbox"/>	Usually	No (but transport a commodity)
	Operational	Door-to-door	Door-to-door	Ramp-to-ramp
	Capital	Non-stop Self-funded Traditional Baseload (sine qua non)	Intermediate switch & Interchange Mainly unfunded	Intermediate mixing & interchange Under-funded New Baseload
Public Benefits	BENEFIT	UNIT TRAIN	CARLOAD	INTERMODAL
	Bridges & pavements (heavy axle loads)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	No
	Congestion & capacity	Avoided traffic	No (but rail is door-to-door)	Avoidable traffic (highway relief)
	Private maintenance & security (pertinent if public investment)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Economic development	Cost of production Viability of plant	Production costs Rural communication	Supply chain efficiency
	Defense	<input checked="" type="checkbox"/>	minor	<input checked="" type="checkbox"/>
	Emissions	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Fuel efficiency (today, a national security benefit)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Safety (truck perception; freight separation)	Avoided trucks	Hazmats: positive record	Avoidable trucks	

Exhibit 3-14. Rail Freight Typology.

economic and market issues that distinguish these three classes are shown in Exhibit 3-14. The most useful aspect of this typology is the linking of commodities with class or type of service. These are as follows:

- The *unit train* business handles high-volume bulks like coal and grain in trainload quantities. Dedicated operations make time performance fairly good, and the emphasis of service principally is the turnaround time of equipment to keep shippers resupplied. Dense, non-stop, door-to-door transportation in imbalanced lanes conforms to railroad strengths, and this is the traditional baseload of the industry.
- The *carload group* carries industrial goods, chiefly for further processing, in mixed train consists that require intermediate switches (which is essentially a kind of hubbing). Multi-car shipments are an important component of this category. Shippers who can use carload or multi-carload service typically are focused on equipment supply and low-cost transportation for higher lading weights, because performance can be slow and irregular. The time and cost challenges of handling carload traffic cars has caused this historical traffic of the railroads to contract steadily relative to unit trains and intermodal. Another factor contributing to the relative decline in carload traffic is that heavy manufacturing—typically involving major carload customers—has diminished in the American economy and, in some cases, relocated along interstate highway corridors, with no rail sidings. On the other hand, carload service is much cheaper than truck service, and there is a potential for replacing three to five trucks with a single carload movement. Rail carload service can also involve a service to a transload facility, where the freight is transloaded to trailers or containers for delivery to the customer.

- The *intermodal business* moves consumer goods and general merchandise, half of it imports and exports, primarily in solid trains with some intermediate hubbing. Service is among the railroads' best, and although it is mostly slower than highway, on premium trains or in well-developed lanes like Los Angeles–Chicago, it is fully the equivalent of over-the-road. Intermodal trains run in a smaller, more concentrated network than carload traffic, but in these markets they are at the front of modal competition between highway and rail. The intermodal business became the top source of Class I revenue in 2003, surpassing coal and in some ways rendering itself the new base-load of the industry. *Because it is the class of service most similar to standard truck service, intermodal is the type most likely to divert highway traffic on a large scale.*

Data on class of service offered by railroads can be assembled from sources like the Carload Waybill Sample, public information like the federal Commodity Flow Survey, commercial databases, traffic surveys, or directly from the railroads themselves. Linking class of service and demand by commodity supplies a basis for understanding potential diversion based on existing railroad resources, as well as the types and significance of barriers to diversion and opportunities to reduce them.

Part 3—Match of Rail Services to Demand for Transport Services. With the information collected in Parts 1 and 2, the analyst can develop a spreadsheet to show how the available classes of rail service (collected here) match with the potentials for diversion by commodity class previously assembled in Task 3 (and shown in Exhibit 3-11). A sample spreadsheet with hypothetical data is presented in Exhibit 3-15. (For intermodal transportation, the alternative method described in Step 3 can also be used.) This spreadsheet provides an estimate of the demand for (new) freight ton-miles for each class of rail service.

The results from the above table can then be compared to an estimate of the availability of rail capacity, as illustrated in Exhibit 3-16. This organizes information for determining whether or not existing rail infrastructure is sufficient to capture freight diverted from truck. It represents a first-order approximation of the amount of potential freight diversion, given current demand and supply conditions. If existing rail service is not sufficient for diversion to occur, this table will provide a basis for analysis of the types and level of investments that would have to be made in order to divert rail (used later, in Step 5).

SCTG Code	Commodity	Potential Diversion (M ton miles)	Class of Service
3	Other agricultural products	8.1	Unit train
2	Cereal grains	9.3	Unit train
4	Animal feed and products of animal origin, n.e.c	6.2	Unit train
6	Milled grain products and preparations, bakery products	4.1	Carload
12	Gravel and crushed stone	1.9	Unit train
5	Meat, fish, seafood, and their preparations	0.5	Intermodal
26	Wood products	1.7	Carload
27	Pulp, newsprint, paper, and paperboard	0.6	Carload
27	Pulp, newsprint, paper, and paperboard	1.0	Intermodal
20	Basic chemicals	0.3	Carload
	TOTAL--UNIT TRAIN	25.5	
	TOTAL--CARLOAD	6.7	
	TOTAL--INTERMODAL	1.5	
	TOTAL--Largest Commodity Classes	33.6	
	Total--Potential Diversion	38.4	
	Largest Commodity Classes as % of Total Potential Diversion	88%	

Exhibit 3-15. Demand for Rail by Class of Service.

Factor	% of Potential Diversion	Available Rail Capacity
<i>Demand by State X</i>		
State X	75%	YES
Indiana	5%	YES
Wisconsin	4%	NO
Missouri	2%	YES
Ohio	2%	YES
Michigan	2%	YES
Iowa	2%	YES
Pennsylvania	1%	NO
Kentucky	1%	YES
Texas	1%	YES
Minnesota	1%	NO
% OF STATE DEMAND THAT CAN BE MET (A)	90%	
<i>By Class of Service</i>		
	<i>Demand</i>	<i>Availability</i>
TOTAL-UNIT TRAIN	25.5	13.0
TOTAL-CARLOAD	6.7	4.0
TOTAL-INTERMODAL	1.5	1.8
TOTAL-ALL CLASSES	33.6	18.8
% OF CLASS OF SERVICE DEMAND THAT CAN BE MET (B)	56%	
POTENTIAL FREIGHT DEMAND THAT CAN BE MET (A x B)	50%	
TOTAL POTENTIAL FREIGHT DIVERSION (M ton miles)	38.4	
POTENTIAL FREIGHT DIVERSION (M ton miles) GIVEN RAIL RESOURCES	19.2	

Exhibit 3-16. Hypothetical Example of Potential Freight Diversion Given Rail Capacity.

As Exhibit 3-16 shows, two pieces of information are needed for this calculation:

- The first is the *current geographic configuration of rail capacity* (from Part 1), which is needed to determine the extent of the overlap between the markets served by truck freight and the markets served by the current rail configuration. If, for instance, all of the current or projected future truck freight moves east to west and rail capacity is only available north to south, the potential for diversion would be zero. In general, the exercise is aimed at estimating the portion of truck freight that could be diverted to rail, given the geographic characteristics of truck freight movements and the geographic configuration of rail capacity. In the hypothetical example in Exhibit 3-16, this portion is estimated to be 90 percent.
- The second is the *current availability of various classes of rail services* to which the demand for freight movements can be compared. For this calculation, it is necessary to obtain indications of available rail capacity. Information on terminal and service availability usually must be obtained directly from the railroads and probably will be expressed in terms of the possible numbers and types of additional trains that might be accommodated. In the example in Exhibit 3-16, it is estimated that 56 percent of demand can be met with existing rail capacity and that, overall, the current terminal and service availability at the railroads is sufficient to satisfy 50 percent of potential freight diversion.

The sample calculation in Exhibit 3-16 greatly simplifies the factors that will shape the capacity of existing rail resources to capture and serve existing freight traffic, so it is imperative to utilize information obtained from the railroads themselves about local conditions in this calculation. For areas in which short rail freight movements are unusual or unlikely, an analyst might assume that available rail resources cannot be used for intra-state movements, in which case assumptions about the percent of state demand that can be met with existing resources would be much lower. If information about local conditions is utilized properly, the general logic in Exhibit 3-15 is sound; the ability of existing supply to meet demand will depend on the intersection of the characteristics of freight traffic with the characteristics of existing rail resources.

Step 5. Initial Assessment of Benefit and Cost

This step is the culmination of the Preliminary Assessment. It builds on information assembled in Tasks 1 through 4 to provide an initial assessment of the possible viability of rail freight solutions. This is sometimes referred to as “sketch planning” because it relies on relatively simple models that can be performed to make strategic-level decisions about the value of spending more time and resources on a detailed analysis. Methods for more detailed analysis and application of more sophisticated analytical tools are then described in the final chapter of this guide.

Taken together, Steps 1 through 4 provided answers to two questions: (1) How much congestion is related to freight movements by trucks? and (2) How much of the truck freight movements could be diverted to rail? Through use of a spreadsheet model containing rules of thumb for the value of reduced congestion and other factors, Step 5 addresses a third question: (3) What is the maximum investment that could be justified, given the external benefits associated with the potential freight diversion?

A sketch planning calculation relies on rule-of-thumb benefit valuations to provide a simple, first-order assessment of the magnitude of the possible benefits from rail diversion. At this juncture, it is not necessary to have specified projects and costs—only the potential magnitude of the congestion problem, possible diversion, and benefits from such diversion are being assessed. However, this preliminary assessment does provide a screening to determine whether or not there is a potential to substantially reduce roadway congestion. Utilizing the first-order estimate of the potential benefits of rail investments, it is straightforward to set a corresponding maximum level of expenditures that could be justified to bring about congestion reduction. The basic logical flow of the sketch planning calculations is shown in Exhibit 3-17.

For instance, the components of Exhibit 3-18 show alternative estimates of the marginal external (i.e., non-private) costs associated with reduction of truck usage and the average private and external costs of truck and rail freight modes. The estimates differ in the following ways:

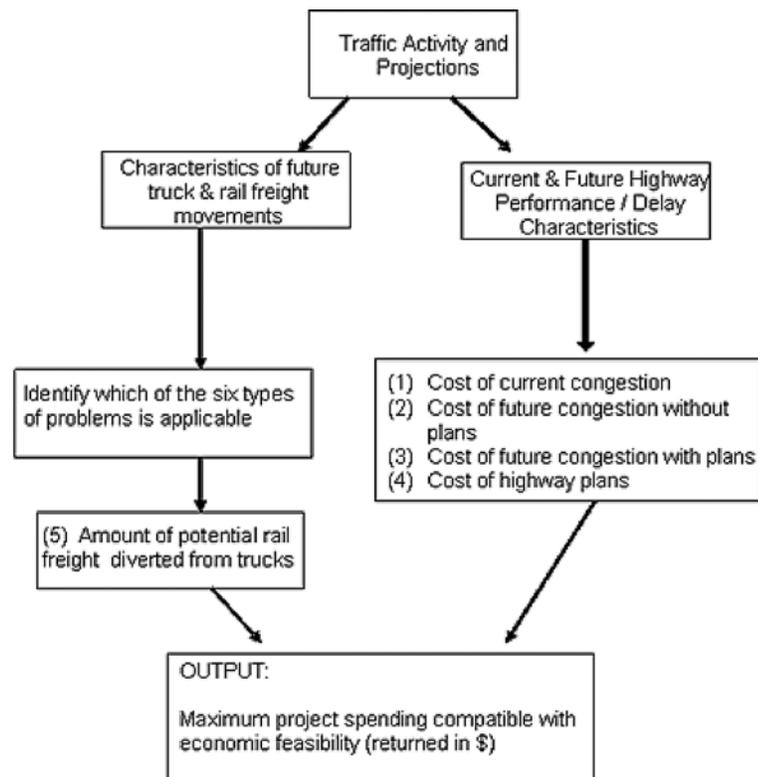


Exhibit 3-17. Sketch Planning Calculation.

- Exhibit 3-18a shows the marginal public cost of highway use by trucks in terms of cents per vehicle-mile. A reduction in vehicle-miles of truck travel means a reduction in those public costs.
- Exhibit 3-18b shows the marginal public cost of highway use by trucks in terms of cents per ton-mile. A reduction in ton-miles of trucks similarly translates to a reduction in those public costs.
- Exhibit 3-18c shows the average private and public cost of moving freight (per ton-mile) via trucks and via rail. However, it does not include congestion costs, which account for roughly

Cents per Mile (2000)

Vehicle Class/ Highway Class	Pavement	Congestion	Crash	Air Pollution	Noise	Total
<i>Urban</i>						
40 kip 4-axle S.U. Truck/Urban Interstate	3.1	24.48	0.86	4.49	1.5	34.43
60 kip 4-axle S.U. Truck/Urban Interstate	18.1	32.64	0.86	4.49	1.68	57.77
60 kip 5-axle Comb/Urban Interstate	10.5	18.39	1.15	4.49	2.75	37.28
80 kip 5-axle Comb/Urban Interstate	40.9	20.06	1.15	4.49	3.04	69.64
<i>Rural</i>						
40 kip 4-axle S.U. Truck/Rural Interstate	1	2.45	0.47	3.85	0.09	7.86
60 kip 4-axle S.U. Truck/Rural Interstate	5.6	3.27	0.47	3.85	0.11	13.3
60 kip 5-axle Comb/Rural Interstate	3.3	1.88	0.88	3.85	0.17	10.08
80 kip 5-axle Comb/Rural Interstate	12.7	2.23	0.88	3.85	0.19	19.85

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Source: Reproduced in part from *Addendum to the 1997 Federal Highway Cost Allocation Study Final Report*; U.S. Department of Transportation Federal Highway Administration, May 2000, Table 13.

Exhibit 3-18a. Marginal Cost of Highway Use by Trucks.**Cents per Mile (2000)**

Vehicle Class/ Highway Class	Pavement	Congestion	Crash	Air Pollution	Noise	Total
<i>Urban</i>						
40 kip 4-axle S.U. Truck/Urban Interstate	0.21	1.65	0.06	0.30	0.10	2.32
60 kip 4-axle S.U. Truck/Urban Interstate	1.22	2.21	0.06	0.30	0.11	3.90
60 kip 5-axle Comb/Urban Interstate	0.71	1.24	0.08	0.30	0.19	2.52
80 kip 5-axle Comb/Urban Interstate	2.76	1.36	0.08	0.30	0.21	4.71
<i>Rural</i>						
40 kip 4-axle S.U. Truck/Rural Interstate	0.07	0.17	0.03	0.26	0.01	0.54
60 kip 4-axle S.U. Truck/Rural Interstate	0.38	0.22	0.03	0.26	0.01	0.90
60 kip 5-axle Comb/Rural Interstate	0.22	0.13	0.06	0.26	0.01	0.68
80 kip 5-axle Comb/Rural Interstate	0.86	0.15	0.06	0.26	0.01	1.34

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Source: Calculated by the authors using data from Exhibit 3-16a and assuming average truck load of 14.8 tons

Exhibit 3-18b. Marginal Costs of Highway Use by Trucks (Cents per Ton-Mile).

(Cents per ton-mile, 1994)	Truckload	Mixed Freight	Inter-Modal	Double-Stack
Private Vehicle & Driver Cost	8.42	1.20	2.68	1.06
External Cost	0.86	0.24	0.25	0.24
Accidents	0.59	0.17	0.17	0.17
Air Pollution	0.08	0.01	0.02	0.01
Greenhouse Gases	0.15	0.02	0.02	0.02
Noise	0.04	0.04	0.04	0.04

Source: *Forkenbrock, David, 2001.* "Comparison of external costs of rail and truck freight transportation," *Transportation Research Part A*, Vol. 35, p. 334.

Exhibit 3-18c. Average Private and External Costs of Truck and Rail Freight.

30 to 70 percent of public costs in urban areas and 10 to 30 percent of public costs in rural areas. Taken together, the data in these tables paint a reasonably consistent picture in which public costs of truck freight movements (in today's dollars) are roughly in the range of 2 to 5 cents per ton-mile in urban areas and 0.5 to 1.5 cents per mile in rural areas.

Four factors are worth noting.

- The derivation in Exhibit 3-18b of cost per ton-mile was calculated assuming an average ton load of 14.8 tons (Forckenbrock, 1999; p.509).^{viii} This represents the average weight of truckload (TL) general freight. If freight is diverted from less-than-truck-load (LTL) movements or if the average weight of truckload is lower, marginal external costs per mile will be higher.
- The value of external costs varies greatly, depending on truck characteristics: an 80 kip 5-axle combination truck will generate roughly twice the social costs as a 40 kip 4-axle single-unit truck. Thus, characteristics of the local truck fleet will affect average and total external costs.
- The benefits associated with reduction in truck traffic will be partially offset by the increase in external costs associated with increased rail freight. As the data in Exhibit 3-18c suggest, the offset ratio is roughly 4:1, i.e., each \$1.00 in benefits from reduced truck freight is accompanied by an increase in external costs of rail freight of roughly \$0.25.
- These benefits represent only public benefits associated with reductions in congestion, noise, pavement costs, and air pollution. They do not include other public benefits (e.g., economic development and security) or other private benefits (e.g., lower prices, better service, or larger delivery markets). While they are *not* included in this sketch planning phase, they can be addressed in a more detailed evaluation as described in the final chapter.

For sketch planning purposes, the following *gross* numbers can be used as the basis for estimating benefits of truck diversion: 4 cents per ton-mile in urban areas and 1 cent per ton-mile in rural areas. These estimates are taken from the high range of the values presented in Exhibits 3-18b and 3-18c. (To determine whether or not rail investments might be an economically feasible way to reduce congestion, high-end estimates should be used. If high-end estimates of benefits from rail investments are not economically feasible, then it is unlikely that any rail investments would be an economically efficient means of reducing congestion costs.) For the actual calculations, *net* benefits (which include the offsetting increase in external costs associated with increased rail freight traffic) should be used: these are roughly 3 cents per ton-mile in urban areas and 0.75 cent per ton-mile in rural areas. Chapter 5 provides more detailed discussion on the range of estimates associated with truck diversion.

A sample sketch planning calculation is presented in Exhibit 3-19. The first number entered is the estimate of potential freight diversion, given rail resources from Step 4 (Exhibit 3-15), which in this example is 19.2 million ton-miles. Assumptions about the net external benefit of truck diversion for urban and rural areas are then entered. In this example, the default values of 3 cents and 0.75 cents are used. (See above for derivation of these estimates.) If data are available, information on highway investment plans in the study area—including expected public benefits in the first decade after investment—is then entered. The latter numbers are used to calculate maximum rail project spending that could match the return on investment (ROI) associated with highway investments, given the expected change in the factors listed in Exhibit 3-18b (e.g., congestion and noise).

^{viii}Forckenbrock, David J., 1999. "External costs of intercity truck freight transportation," Transportation Research Part A; Volume 33, pp. 505–526.

Input	Value
Truck freight diverted (M ton-miles)	19.2
Net external benefit of urban diversion (cents/ton mile)	0.03
Net external benefit of rural diversion (cents/ton mile)	0.0075
<i>If known:</i>	
Cost of this year's highway investments	2,500,000
Cost of congestion, noise, etc. without this year's highway investments (over next 10 years)	7,000,000
Cost of congestion, noise, etc. with this year's highway investments (over next 10 years)	4,000,000
Output	
<i>Urban:</i>	
Maximum project spending compatible with positive ROI	5,060,798
Maximum project spending to meet highway ROI	4,800,000
Maximum project spending compatible with 7% ROI	2,572,653
<i>Rural:</i>	
Maximum project spending compatible with positive ROI	1,265,199
Maximum project spending to meet highway ROI	1,200,000
Maximum project spending compatible with 7% ROI	643,163

Exhibit 3-19. Estimating Maximum Justifiable Spending.

To complete this table, three sets of calculations must be performed.

- In the first set, the external benefits of freight diversion in rural and urban areas are quantified for the first 10 years after investment. These are calculated in terms of net present value (NPV) and summed for the 10-year period.
- In the second set, the first decade of benefits associated with highway investments (if known) is calculated in terms of NPV and compared to the cost of highway investments to determine the ROI of highway spending.
- The third set of calculations compares the benefits of freight diversion to three financial benchmarks to estimate the maximum investment that can be justified on the following grounds: (1) obtaining a positive ROI for the project, which is defined as \$1 more than the break-even point; (2) matching the ROI of existing highway plans; and (3) achieving a 7-percent ROI, which is widely used as the opportunity cost for public investments. This third set of calculations is the basis for the output section of Exhibit 3-19.

3.3 Further Steps for More Detailed Assessment

Results of this preliminary assessment make it possible to screen situations and determine whether or not rail freight is an available and potentially feasible option to consider for highway congestion relief in that local context. The preliminary assessment furthermore makes it possible to identify the specific freight market segments that may be applicable and the types of projects or programs worthy of further consideration. (In the example shown earlier, analysts would consider the potential costs in Exhibit 3-19 and the given rail resources and then determine whether or not an investment of roughly \$2.5 to \$5.0 million in rail investments could be sufficient to support the level of freight diversion implied by Exhibit 3-16.)

This screening is most important because rail freight options may be unrealistic or have limited applicability in many situations, and the screening can save planners the time and cost of further analysis (as well as the time and cost of further public-private discussion about such options). On the other hand, the screening can serve to identify the particular situations and types of projects where rail freight can be most viable and useful in addressing congestion. For those situations, it can provide a basis for defining

1. Project options that are worth discussing further in a public-private dialogue about organizational and institutional feasibility (using the Chapter 4 guide to public-private dialogue that appears next), and

2. Proposed project options that can be subject to more formal and detailed analysis of project costs and formal and detailed modeling of their freight modal choice impacts (using more detailed analytical methods that appear in the final chapter of this guide).

The project options identified by this screening process can be any of the 15 key types of actions identified back in Chapter 1 (Exhibit 1-1) or they may be any combination of those actions.

Guidelines for Public-Private Dialogue

This chapter discusses needs, uses, and procedures for bringing highway and freight planners together with private-sector freight operators and other institutional players and lays out the types of actions and cooperative strategies that can be effective in cultivating relationships and forging partnerships between public- and private-sector entities. This chapter first focuses on three types of actions that can aid the development of relationships—the establishment of cooperation, the positive techniques of conflict resolution, and the distribution of labor. It then prescribes six elements for the development of institutions: stable funding, organizational strategies, professional development, the promulgation of standards, multi-jurisdictional techniques, and land use actions. The design of transactions is described next in terms of two major categories of initiative: progress improvements and new market improvements. Topics include expediting projects, taking care of the community, and traffic assurance. The chapter concludes with methods for winning project support by addressing program priority and forming multi-party coalitions.

4.1 Cooperation First

Many planners believe that the establishment of mutual cooperation in a public rail program must come before any serious investment in technical analysis. This is meant to prevent conflict, but it presents practical challenges. Railroads have few resources specially assigned to public interaction, and those they have are dwarfed by the number and variety of agencies. Most rail personnel have other duties, cannot devote time to the nurture of relationships for their own sake, and require specific proposals to win their attention. Similarly, it is common for public organizations to have few resources devoted to freight, and fewer yet to consider railroad options.

Moreover, relationships progress along an evolutionary path. Because public rail partnerships often are new endeavors, most agencies are at the start of the path; they cannot count on a mature rapport or appreciation of rail behavior to guide them in their dealings. Their railroad counterparts frequently are in a comparable position, knowing their own business well and the public process less well, especially in its diversity around the country. While it is easier to form a limited partnership around the particulars of a project and see whether a lasting relationship results, it is better to lay a foundation of understanding and shared purpose. This helps ensure that the right projects are proposed—ones that will fit the strategic focus and network priorities for both groups.

Four steps can be taken to create cooperation: (1) initiation of advisory discussions; (2) provision of leadership and high-level contact; (3) application of freight advisory councils; and (4) situational adjustment.

Advisory Discussions

Advisory discussions are a productive way to clarify the overarching goals and structural requirements of both public and private stakeholders. Such discussions should be considered by (1) public agencies whose relationships with their rail carriers are still maturing; (2) agencies that are further along, but want to improve their railroad dealings; and (3) railroads interested in public partnerships. The purpose of these discussions, preceding evaluation of any specific investment proposals, is to develop a foundation for proposals to succeed. It may be necessary for the parties to have one or more projects in view in order to justify the allocation of time and instill focus to the meetings, but even so, their deeper aim should be to reach an understanding of needs and to instill mutual regard. To reduce the ratio of public representatives seeking railroad time to the number of railroad personnel, it can be desirable for states to organize these meetings jointly for their MPOs and themselves. Senior DOT officials reaching out to senior rail executives will be an expeditious way of causing the discussions to happen, and it will give such meetings an aura of importance. Finally, in the treatment of procedures for conflict resolution presented later in this chapter, there are precepts for bilateral decision-making that will be helpful for managing advisory discussions and reducing the likelihood of disagreements.

The objectives for these meetings would include

- Acknowledgement by both sides that the venture into mixed rail investment may be breaking new ground and should be developed together. Neither public agencies nor freight carriers have the leverage to force change on the other.
- A clear understanding of the priorities and processes that drive public and private investment allocations and of the assumptions about what will constitute success. The following chart gives examples of how perspectives can differ in each sector's approach to projects and the factors associated with them.
- Understanding and documentation by public agencies of the issues of greatest concern to private rail interests. Such issues may include taxation, liability, open access, capacity allocation, and management of core assets. Resolution of such issues may, in some cases, be a prerequisite for moving forward on collaborative investment proposals.
- Comprehension and acknowledgement by rail carriers of the public accountability required for use of taxpayer-supported funds. Rail carriers need a good grasp, for example, of how the

Planning Element	Public Perspective	Private Perspective
Financial Performance	Public rail investment vs. highway cost avoidance and other public benefits	Return on private investment
Access to System	Broadest possible for all freight shippers	Selective access to maximize returns
Public Involvement	Broad education to support political agenda	Minimized; defensive to avoid taxation and liability proposals
Environment	System or corridor focus; net impact on all modes	Adherence to statutory or regulatory limits
Asset Tracking	Public contribution easily identified and tracked	Asset integration to promote efficiency
Capital Planning	Incorporated into formal long-term plans with broad public input	Revised annually to reflect funds availability and ranking with other projects system-wide
Passenger Travel	Impact on passenger rail operations and highway congestion for passenger travel	Impact of passenger rail on freight operations; potential for passenger-driven capacity expansion
Benefit-Cost Analysis	Architecture described by federal funding programs	Proprietary to each carrier, geared to investor expectations

Exhibit 4-1. Public and Private Perspectives.

benefits from public rail investment must be tracked in order to compete with other modes for infrastructure spending.

- Agreement on a shared process to better track and publicize the benefits of rail transportation to key decision makers and the public at large. A specific public information program jointly supported by public agencies and the private freight carriers would provide an additional platform to build confidence and prove the value of public engagement to the carrier community.

A specific product such as the public information and rail impact-tracking program described above may serve as an inducement for serious, early engagement by the private freight carriers. The overall goal is establish joint ownership of the targeted projects rather than to have either the public agency or carrier in the position of selling the merits of an initiative to the other side.

The budget, level of staff, and rail knowledge of public-sector players can prove crucial to gaining the degree of carrier engagement that brings success to a public rail program. Carriers will commit resources when given a prospect of real deliverables and a serious, long-term commitment by a state or other agency to fund attractive projects. States whose programs are seen as effective by peers have a history of substantive rail funding and staffs that understand the complexity of railway operations.

Leadership and High-Level Contact

Delivery of developmental objectives like those outlined above depends in large measure on having the right kind and level of people participating. Since new ways of doing business may be devised, those present at such meetings should have the power to work from organizational needs, rather than public policy positions or company protocol. To that end, the following actions will be useful:

- Foster high-level contacts between top railway and public agency executives if rail initiatives are expected to become a major element in local programs. States that have done this single it out as a key reason for their success in gaining carrier cooperation and in executing projects on the ground. Such contacts also establish a relief channel to get discussions moving if parallel (and more frequent) lower level talks break down. A DOT secretary, top lieutenant, or mayor working with a railroad CEO or senior vice president typically is the right kind of contact, provided the parties have a more than superficial commitment to the value of partnership.
- Provide initial leadership by state officials. Many rail projects have significance at the state, if not the regional level, even if they may be led by MPO or other local units of government. State leaders also are better positioned to address the broader non-transportation issues (such as liability or taxation) that may surround a carrier's willingness to consider alternate ways of doing business.
- Consider professional facilitation. Described at greater length under Section 4.2, Conflict Resolution, professional facilitation may be required to ensure that foundational issues remain the focus of the advisory meetings. Planning and carrier officials both may leap to specific scenarios and potential projects before detailing and documenting the full context into which such projects must be launched.
- Limit stakeholder attendance at advisory meetings to a handful of public and railway officials. Private firms are wary of large-scale meetings that may serve as a platform for airing of grievances by interest groups.

Freight Advisory Councils

Support for public rail funding ultimately relies on a broader set of interests than those represented in the rail carrier community. Shipper groups, motor carriers, MPOs, environmental

groups, land use planners, and economic development interests all have a stake in efficient, balanced transportation investment.

Freight advisory councils (FACs) are used by many states and urban areas to gather input on stakeholder concerns and provide policy input to public agencies on transportation priorities. Usually FACs are not convened expressly to treat rail issues, but railroads and their potential customers commonly are members, and the councils can be well placed to step into this role. Such groups typically are facilitated by public agencies, but should include sufficient private-sector leadership to be credible in the eyes of citizens and legislators, when it comes to the economic rationale for investment of tax dollars. Councils also can perform the crucial function of delivering an early reality check on the commercial attractiveness of proposals to develop or enhance rail facilities and the ability to divert highway traffic such as FAC members themselves may manage.

Councils should be called on critically, but not constantly. The limited time available to members of advisory groups means that a specific list of possible rail policies and projects should first be developed by the sponsoring agencies. A draft description of the project assessment principles to be employed should be brought before this group early on to preempt concerns over the fairness of the capital allocation process.

Agencies in states with active FACs should draw them into freight rail issues, if they are not already engaged. Others should urge their formation. There are many examples of how to proceed with this; one from the State of Florida is discussed in the inset box.

Freight Advisory Council: Florida

The **Statewide Intermodal Transportation Advisory Council (SITAC)** was created by the 2003 Florida Legislature to advise and make recommendations to the Legislature and the Florida Department of Transportation on policies, planning, and funding of intermodal transportation projects. Initial responsibilities of the SITAC are to coordinate with the Florida Transportation Commission on the development of a mandated assessment of regional transportation in Florida and to supply input on the initial draft strategic plan for the Florida Strategic Intermodal System.

The FDOT Office of Policy Planning (OPP) gives administrative support for the SITAC. The OPP also provides project management for development of the SIS strategic plan. The FDOT Seaport Office, part of the Public Transportation Office, is responsible for programs relating to seaports, intermodal development, and planning for freight movement/intermodal connections.

The SITAC meets on a monthly schedule. The members are appointed by the Governor (5), Senate President (3), and Speaker of the House (3). The current members include representatives from each of the modes, as well as the Florida Space Authority and various port interests.

Situational Adjustment

Freight carriers always care about operational improvements and cost reductions, and railroad capital programs normally have projects underway of this type. Some railroads also care for network and business expansion and their interest is particular to their own circumstances and the locality. Public planners should evaluate how the projects they are contemplating match with

the situation and behavior of the carriers. For instance, a railway's financial condition plainly will shape its motivations, so that a company whose position is straitened will be acutely concerned for the near term and not very much for the long. Similarly, its planning horizon may be foreshortened if it is preparing itself for a possible merger or trying to demonstrate immediate returns to Wall Street. Operational improvements—and there are many examples of operationally oriented projects with significant public benefits—may win the support of these carriers, where new traffic development may not. Carriers intent on expansion will reveal this by their public pronouncements, the programs they support, and the level at which they support them. They may be able to tackle only a few at a time, and fewer than their many public jurisdictions may wish, but they will be committed partners for both operationally driven and development-driven initiatives. In short, public planners should adjust their proposals to railroad motivations and should seek to understand those motivations. By doing so, planners may be able to reach a project-based consensus with the carrier, regardless of whether they can reach consensus on other issues between them—and this may be sufficient to the purpose.

For the carrier's part, public proposals should be viewed with flexibility, because there is a range of ways for the railroad to participate. At one extreme, carriers can facilitate corridor access and the development of specialized rail services that would operate with substantial autonomy and little management interaction with the main carrier. This option (which is just short of line sales) may be appropriate for railroads with limited planning horizons. It may allow them to derive revenue when they otherwise would not, particularly at times or in locations where capacity is slack or where the public sector helps to enlarge it. Use of this option can be seen today in the short-haul intermodal market. At the opposite end of the spectrum is a full service-integration model, where the railroad mingles a new service offering with existing traffic, while accepting public contributions of capital for track capacity, rolling stock, or terminals.

Even when projects and participants are in harmony, conflicts will arise. Some of them may derive from the everyday interaction of the railroad with the community—carriers who keep a clean house with regard to this may find it easier to focus on larger opportunities and diminish opposition to rail investment schemes. (Similarly, numerous projects that have actively treated community concerns count this among the reasons for their success.) Other disputes may be addressed by broadening the terms of discussion from a narrow point of complaint to the more systematic matter it may manifest. Examples of how this may be done appear in Exhibit 4-2. Finally, challenging conflicts may be encountered because of entrenched positions, adversarial histories, competitive apprehensions, or the sheer stakes of a project. Organized methods of contending with them, including techniques for improving the general process of public-private decision-making, are presented next.

Initial Issue	Broader Issue	Potential Resolution
Whistle Blowing	Grade crossing safety	Quiet zone improvements or grade separations
Line Abandonment	Job loss, economic development potential	Short line or public rehab assistance; targeted economic development
Disrupted Freight Rail Service	Terminal or line congestion issues	Corridor capacity or terminal configuration assessment and improvements
Commuter Rail Service	Shared Corridor Dispatch Arrangements	New or shared dispatch facility arrangements; interlocking or signal upgrades
Hazmat Transit Concerns	Obsolete urban freight main alignments.	Long-term urban rail relocation planning

Exhibit 4-2. Underlying Issues and Their Resolution.

4.2 Conflict Resolution

The convergence of interests between the private and public sector is a prime force behind the growing interest in freight rail. Even so, for various reasons, the achievement of cooperative partnerships between public agencies and rail firms may be impeded or thwarted by conflicts, and methods for resolving them, therefore, are an important part of practice. Some conflicts stem from divergent motivations and priorities, and others are conflicts within sectors: jurisdictional and funding barriers can divide public agencies, just as competition can divide railroads, so that groups with shared needs may struggle to act in concert.

There are three broad ways by which parties in disagreement can be brought to cooperate:

- *Common Interests* means the uncovering of shared objectives, whose influence brings dissenting parties away from fixed positions and toward areas of accord. The techniques associated with interest-based negotiation are central to the current practice of conflict resolution and are likely to be the most productive in everyday use. They are treated in greater detail below.
- *Appeal to Higher Order Objectives* means the invocation of deeper purposes that override the specific factors in conflict and cause the parties to negotiate a compromise. Higher order objectives might be (1) social values, like the competitiveness of industry during a period of economic stress; (2) an ideal, like the pursuit of a world-class transportation system; or (3) a political aim, like diminishment of road traffic because of demands from voters. Such appeals normally are initiated by persons in a position of leadership who can stand above the fray, are custodians of organizational values, and present their appeal to counterparts. The nurturing of top-level relationships, such as those between a DOT Commissioner and chief railroad executives (as cited above), maintains a communication link through which higher order appeals may be made. It also is possible for a less well-placed individual to stand forward in a personal exercise of leadership and call on others to reach for the common good. Such natural leadership has less organizational force behind it, but it is by no means without precedent or effect.
- *Coercion* is the use of force in some manner or degree. In its baldest form, it employs compulsion—sanctions, fines, takings, or threats—yet the compliance this engenders is no basis for partnership and creates hostility instead. While there is a place for raw force when the stakes are high, options few, and adverse consequences less important, it is mainly a last resort and its benefits can be impermanent. The milder forms of coercion are more common and typically more productive. One is the shutting off of alternatives, so that the choices parties have before them are restricted to certain channels. Another is the buyout of interests, whereby public funds are traded for control or are used to create incentives toward a desired result. Fines can be replaced with user fees, which ideally have an economic rationale, but are also a method for shaping behavior. (The Alameda Corridor in fact employed all these methods: purchasing railroad lines so that the local authority held sway, reducing port access to a single rail route, and then charging fees whether rails are used for access or not.) Finally and familiarly is the exercise of hierarchical authority. In this case, an agreement is reached because an officer in charge orders it done or because disputants face the risk that decisions will be taken out of their hands.

Six-Point Framework

Formal structures for conflict resolution have evolved over the last several decades. They are used by courts around the nation and have surfaced in the planning arena in connection with interagency disagreements and public involvement.¹ The keystone in these structures is the tech-

¹For example, the Florida High Speed Rail Authority was mandated by state statute to implement a conflict resolution process to handle disputes with environmental and growth management agencies, and with citizens. Florida governmental entities as a whole are encouraged by the legislature to utilize such processes, and several MPOs have adopted programs.

nique of interest-based negotiation; some classes of conflict may not be susceptible to it, but most are. In this technique, the fixed positions staked out by the parties to an argument are reformulated in terms of their underlying interests. Because multiple positions may be compatible with these interests, this helps the negotiation to become fluid instead of fixed. (To clarify the terms, a position “is something you have decided upon; your interests are what caused you so to decide.”ⁱⁱ) The process of defining interests tends to soften positions, uncover zones of existing agreement, and produce shifts in the conception of the problem. From this, issues can be reframed in different terms; for instance, they might transform a network question from being about who controls a line to being about how to expand capacity. Like product repositioning in the world of business, this approach can open up whole new classes of solution. In fact, one of the benefits asserted for these methods is that they improve the quality of decision-making overall, because of the conceptual change they introduce.

A six-point framework has been put forward by a group of experts in conflict resolution,ⁱⁱⁱ which is representative of the major elements of technique recommended currently in the field.

**6 Point Framework for
Collaborative Dispute Resolution**

1. Identify and pursue interests, not solely positions
2. Frame issues for constructive negotiation and management of differences
3. Use objective criteria
4. Generate options
5. Develop a sense of the realities
6. Be cognizant of relationships

Source: Bloustein School, Rutgers

The framework is summarized in the accompanying box and offers an overview for practitioners about how to respond to contentious situations. Beginning with the interest-based method and the purposeful reframing of issues in constructive terms, it also emphasizes

- *Insistence on objective measures*, because they (1) are visible to both sides and reduce the opportunity for disagreement; (2) encourage participants to rationally evaluate their own positions for consistency with the facts; and (3) afford evidence by which negotiated outcomes can be sold to superiors overseeing each side, as well as to other concerned parties and to the public. Joint fact-finding is a specific procedure for establishing objective information and simultaneously is an exercise in collaboration for the parties; for example, a railroad and an agency might pool resources for a gate survey to determine lane densities for a port service.
- *Generation of options* is a creative routine that serves at least three purposes. First, it explores the range and combination of ways through which solutions can be reached. Some of these may be new or overlooked, and the result is to enlarge the scope for action. Second, the act of probing for solutions in itself can draw participants out of their corners and into more vigorous give and take. Third, if superior alternatives to those originally under discussion fail to surface, the implication is that the best prospect for settlement is already on the table.

ⁱⁱRoger Fisher and William Ury, “Getting to Yes: Negotiating Agreement Without Giving In,” Penguin Books, 1983, pg. 42.

ⁱⁱⁱCenter for Negotiation and Conflict Resolution, Bloustein School for Planning and Public Policy, Rutgers, The State University of New Jersey. The framework is courtesy of the Center’s Co-Directors Linda Stamato and Sanford Jaffe, whose advice and assistance in this section of research the authors gratefully acknowledge.

- *Development of a sense for realities* is about recognizing what happens if negotiations collapse. Examining consequences in a clear-eyed fashion may be enough to bring recalcitrant parties back into discussions or may show that the incentives for settlement are insufficient. A common formulation of this concept is called BATNA: the Best Alternative To a Negotiated Agreement. This holds that the probable outcomes of negotiation should be compared to the best available course of action if no agreement is reached. The relative attractiveness of the BATNA for each party will suggest the power of their position and the strength of their urge to settle, and focusing on it can help bring matters to a head. A corollary is that actions or events that affect the BATNA have a direct bearing on the negotiation.
- *Cognizance of relationships functions at several levels.* Relationships can be essential to the implementation of an agreement, so that when care is taken with them, it aids the ultimate goals. Relationships may be recurrent, implying that the events of one transaction will affect the next. Similarly, they may have a history that assists or impedes their progress and that should be utilized or addressed. The nature of relationships also contributes to the level of trust. Trust will speed the development of agreement and can be especially helpful if discussions shift to higher order objectives. Finally, relationships may be implicit. Buying a gallon of milk, for example, is a routine transaction on the surface. Nevertheless, the commercial branding by the manufacturer creates trust in the integrity of the product and is a surrogate for a relationship with the buyer. One way this becomes significant is when the reputation of a railroad or a public agency as a reliable or unreliable partner influences the behavior of parties who have no experience of their own.

Two-Step Implementation

Understanding the techniques for conflict resolution does not guarantee an ability to employ them skillfully. Acquisition of this skill calls for a dual course of action. The carrier or public agency should import the expertise and, simultaneously, should develop it internally in strategic locations that can support a network of planners.

Step 1: Import—Centers for the study and improvement of conflict resolution have arisen at universities around the United States, with enough dispersion that one or more will exist in most regions of the country.^{iv} These centers are sources for teams of professionals who may be hired individually or in groups, to assist the solution of a particular dispute. There will be experts in private practice as well, working in service to business or the courts.

Such experts usually are styled as professional mediators, although the title “facilitator” is used too, as a way to emphasize that their role is not to produce the solution, but to help the disputing parties to produce it themselves. This last point is important in view of the slight transportation industry and planning knowledge that some facilitators will possess today. However, if the disputants are the real source of resolutions, then the critical skills lie in process management and not subject matter—and knowledge can be a cause of perceived bias as well. Familiarity with the industry is going to be preferable, but conflict resolution still can move forward while facilitators accumulate experience. On the other hand, railroads contending with planners and moderators who are both industry neophytes should anticipate some frustration. Railroads moreover may instinctively resist mediation, comparing it to the arbitration in labor conflicts and guarding their freedom of action. The way to counter railroad wariness is to show that collaborative dispute resolution is a voluntary procedure, with participants who are independent and act accordingly. The facilitators work to breed cooperation and to improve the joint structuring of decisions; they do not impose settlement on the parties.

^{iv}A partial list of university centers and consortia: University of Colorado, Florida State, Harvard, Michigan, Minnesota, Northwestern, Penn State, Rutgers, Stanford, and Wisconsin.

The institutional action that needs to be taken is to provide and position expert support where planners can call on it as needed. An indefinite quantities contract, sponsored by the DOT with MPO support and let to one or more consortia, is a logical method (and some states may have services on call now). Its advantages are that (1) it establishes an accessible and variable budget; (2) the qualification of facilitators takes place in a deliberate fashion away from the time pressures of specific negotiations, and contracting mechanisms are put in place beforehand; and (3) the expert resource can be shared among multiple user groups and needs—perhaps improving vendor negotiations or the handling of land use conflicts—and thus the procurement does not have to be justified by rail issues alone. An additional advantage is that the availability of mediation tends to spur parties to reach a settlement, so that they can avoid the more formal process.

Step 2: Develop—Courses of professional instruction for public freight planners, or for railroad officials expected to manage public partnerships, should include conflict resolution in the curriculum. At a minimum, this would provide instruction in basic techniques and prepare practitioners to engage in facilitated transactions at a more sophisticated level. Moving beyond basics into a more ambitious program of development, at least two further steps can be taken. First, a series of short training workshops, expressly devoted to resolving differences in public-private partnerships, can be launched toward a mixed target audience of planners and industry officials. The series would be designed to initiate partnership improvement, instill elementary expertise more rapidly, fortify relationships, and foster belief in the potential for success. There is no point in such workshops if there is not also an understanding among participants that rail partnerships will be implemented—in other words, there will be no interest in making them better if there is no mechanism to make them happen at all. Given that, the series could be established as an additional scope element in the indefinite quantities contracts for expert support, with attendees defraying some of the cost through fees. Or, a phased approach could begin with an orientation to methods of dispute resolution at a national or large regional gathering, using the associations and conferences of TRB, AASHTO, or AMPO, or as an addition to FHWA programs.

Second, individuals or organizations could be selected by DOTs, acting alone or in groups, to be developed as internal experts in collaborative dispute resolution and designated to serve a subsidiary network of planners with guidance and intervention as needed. While outside experts are needed initially and may be best long term for regions whose partnership opportunities will be infrequent, more active regions could want a high degree of institutional skill. For them, the use of external capacity initiates a process of knowledge transfer that builds into long-range, in-house capability through training and experience. By concentrating this development on select recipients who then serve others, the program can avoid creating planners whose skills are insufficient because they handle disputes infrequently. These specialists then may be attached to dedicated institutions like joint powers authorities, whose value in the management of rail partnerships is discussed elsewhere in this guide.

Conflicts between the public and private sector are inherent in their distinct objectives and structures and may arise whatever the qualities of a project. Such conflicts do not need to stymie partnership or prevent action and, in some ways conflicts can be welcomed, because they bring into the open forces that need to be reconciled. Collaborative dispute resolution is a productive method for contending with these forces and can be developed into a readily available tool for public and private planners.

4.3 Distribution of Labor

Public-private rail partnerships can consume substantial staff time and effort, given their unfamiliarity. All stakeholders must acknowledge the burden of coordination with other groups, but assumption of leadership for certain categories of effort will lessen the staff resources required. This can be done by organizing the distribution of labor.

Element	Leadership	Support
Rail capacity limits	Rail Carriers	
Rail capacity investment needs	Rail Carriers	Public Agency
Freight market projections	FAC & Public Agency	Rail Carriers
Trans-modal effects of investment scenarios	Public Agency	Rail Carriers
New market assessments	Public Agency	FAC & Rail Carriers
Public education	Public Agency	Freight Advisory Council
Environment	Public Agency	
Multi-jurisdiction coordination	Rail Carriers	Public Agency
Media coordination	Public Agency	FAC & Rail Carriers

Exhibit 4-3. Elements of Leadership and Support for Various Project Elements.

Labor distribution may be difficult to realize when parties are not well known to each other, but such distribution reduces the time and complexity associated with partnership planning, needs assessment, and funding of capital projects. In the current environment, rail carriers could be better positioned than public agencies to take the wide view on freight transportation corridors that cross dozens of MPOs and states. Railroads conversely have important needs—quite apart from capital funding—that their public partners are better or uniquely able to satisfy. Streamlining of process and acceleration of approvals are one kind of aid; running interference with citizen groups and provision of political assistance are others. These things can have a great effect on the efficiency and diplomacy with which railroads can function in the public sphere, and they especially help to answer the challenge of a handful of Class I carriers interacting with hundreds of distinct public entities. Distribution of labor bears with it the seeds of real partnership, because as relationships mature and parties come to rely on one another, they acquire roles and perform like the members of a team.

Freight shippers and receivers, third-party logistics firms, and motor carriers also have an important stake in the success of freight planning and should likewise be engaged in the public process. Their input could be coordinated through a FAC, as earlier described.

Leadership roles under a shared agenda are illustrated in the Exhibit 4-3. Individual positions should be modified for local circumstances and are not hard and fast; the primary purpose of this exhibit is to suggest how responsibilities can be distributed and show the inter-reliance of parties.

Developing relationships means finding the right personalities and leadership to address issues in a broad fashion and forge a partnership based on needs, shared resource burdens, and emerging trust. An initial consensus limited to projects and supported by the methods of collaborative dispute resolution can mature into long-term relationships with efficient, inter-reliant roles. The broad perspective also is necessary to cultivate the stakeholder groups required to cement a political coalition favoring local and state contributions to rail projects.

4.4 Institutional Development

A successful project solves an immediate problem. An institutionalized system solves many problems through common channels and transforms cooperating parties into continuing partnerships. A well-designed and easily understood institutional framework for rail projects also makes the public-private interaction more efficient—organizing priorities for the two sides, normalizing and speeding up the identification and funding of beneficial improvements, and forming rules for the interaction that encourage the commitment of both parties.

Six steps can be taken by or alongside the public sector to foster stronger institutions: introducing stable funding, use of organizational strategies, provision for professional development, adoption of standards, cooperation across jurisdictions, and land use actions. Some are steps that few users of this guide will have direct power to take, unless they stand in a position of authority or influence. However, development is something many members of an institution participate in, and each can call for appropriate actions from time to time, support their introduction, and capitalize on them once in place.

Institutional Development

1. Stable Funding
2. Organizational Strategies
3. Professional Development
4. Standards
5. Multi-jurisdictional Techniques
6. Land Use Actions

Stable Funding

Dedicated, predictable sources of funds add credibility to rail planning efforts and are strong motivations for private-sector participants to engage fully in planning discussions. Railroads are used to a very long asset replacement cycle for major investments. A concern for carriers, then, is the reliability of public-sector funding as part of any long-term partnership. Many DOTs, if they can use state money directly for rail projects at all, must rely on bonds, appropriations, and their general funds, which are improvised and variable. In several states with well-established rail programs, however, there are standing budgets that are modest by highway standards, but are continuous and can supply a program through time. New Jersey has been able to support rail from its Transportation Trust Fund, and Virginia has created a Rail Enhancement Fund within its Transportation Trust. Where trusts are off limits to rail (as is often the case), there are other approaches. Indiana devotes some of its state sales tax to rail; in Oregon, a portion of lottery proceeds are set aside for non-highway transport, of which freight rail receives a segment and is eligible for more. These designated streams of revenue have the virtue of being sequestered, and this protects them, even if they are not transportation derived. The key point is that states have found various ways to create dependable annual funding for rail, which strengthens the standing of their rail divisions, enlarges their range for action, and cements their partnership with carriers.

Larger ambitions demand larger budgets. Rail projects with network-level benefits have cost from tens of millions to billions of dollars. Apart from infrequent federal earmarks, the bigger projects require funding packages assembled from a combination of federal programs, state and possibly local money, private contributions, and ad hoc sources such as project bonds. Qualification under multiple federal programs (and federal flexibility in administering them) is a practical tactic that has led to successful completion of capital packages, even for efforts of moderate size.

Project-driven financing is inevitable for the biggest initiatives, but to move rail investment toward systematic highway relief calls for a steady and growing program at the base. For most users of this guide, fostering a commitment to effectual and sustained funding by states is the right focus, and some form of sequestered revenue is a desirable way to produce this. Two further elements can be very helpful for building up funding amounts:

- If state money can be safely banked from year to year, then unused or purposefully deferred program money can be accumulated toward the provision for major projects.

- If neighboring states each have underwritten substantial rail program budgets, their ability to jointly fund network initiatives that cross jurisdictional borders will rise.

Ultimately, for states and other public agencies, a public commitment to shared-investment rail capacity should be supported with a public funding structure that is robust and stable, in order to gain the full measure of private-sector participation.

Organizational Strategies

Many states have statutes or even constitutional prohibitions against use of certain revenue sources for rail improvements. In still other states, a blanket prohibition on investment of public money in private businesses effectively precludes consideration of public investment in rail.

Some obstacles can be dealt with by using the general fund or accessing particular and non-restricted state income, like the lottery revenue mentioned earlier. Beyond this, joint powers authorities, due to their special taxing and bonding capabilities, have proven to be a pragmatic instrument for bypassing some statutory limitations. Constituted as government corporations or as similar enterprises outside of the normal state structure, the authorities are controlled by two or more public agencies but enjoy independent status. They are endowed with powers like fund raising and tax abatement that enable them to secure, assign, and manage public money in venues that might otherwise be prohibited. Usually they are associated with a single project and not with management of a portfolio, yet at a minimum their organization, systems, and perhaps personnel could be duplicated for successive applications. An entity of this type may be the most sensible way to govern multi-state initiatives, although working instances of this are not fully in evidence and could require legal crafting.

Joint powers authorities offer a way around statutory obstacles to public rail investment. They also may fit into the wider role of a dedicated institution assigned to the management and implementation of a major rail proposal.

Large projects that take years to bring to fruition can consume staff and resources to a degree that is either disruptive to the typical public agency or falls short of the needs of the project. Dedicated institutions provide a way to obtain personnel and functions and devote them to a major initiative. This can be a mark of commitment to partners—it gives them a single point of contact and is a practical way to get work done. As fairly independent repositories of professional expertise, authorities also can act as interested intermediaries in collaborative dispute resolution, as discussed earlier in this chapter. Dedicated institutions, therefore, become effective mechanisms to access funds, assess needs and priorities for funds application, treat conflicts, ensure project activation, and monitor and manage results.

An organizational approach that is less sharply delineated, but more suited to rail coordination on an ordinary scale, is for the state DOT to assume formal or informal leadership for all public rail planning, analysis, and funding in its region. States with dedicated rail groups of any size aim to do this now, and this approach responds to the freight carriers' manpower limitation for dealing with multiple and overlapping public agencies. Individual cities, counties, or MPOs all have specific rail needs or interests, but these can be coordinated through the state group or through a sharing of professional staff and costs—and MPOs seldom can specialize on their own. State leadership also ensures that any rail project, even if sponsored by an MPO or city, is developed through an analytical framework with which carriers are familiar.

The quality of the relationship between State DOTs and their MPOs will contribute to the ease or difficulty of reaching agreement on the structure of rail planning efforts. At a minimum, the states and MPOs should, with the encouragement of carriers, agree on common definitions and measurement tools for evaluating rail investment proposals. Still, this does not mean that the weighting

of factors used to evaluate a project must be the same for all locations in a state. Highway congestion and air quality, for example, normally play a more prominent role in the selection process for urban rail corridors than for those that traverse rural areas. Specific timetables and products should be insisted on as well, even if the early products are just policy statements or standards. Carriers are leery of an open-ended time commitment, without some schedule for deliverables.

At least some of the state rail section personnel should be knowledgeable about the commercial, operational, and engineering practices that govern rail functions—ideally some should have private rail experience. The eventual goal should be to develop specialized in-house planners, able to provide continuity in the evaluation of rail proposals and competence in the eyes of prospective partners. To this end, a program of professional development is a necessary step.

Professional Development

The rail section of the typical DOT is not prepared to handle a growing public role for rail investment, and MPOs are even less so. DOTs and MPOs can enhance their capabilities by using contractors, but training and development programs are the best way to equip public officials to deal with the issues. Carriers cannot carry out staff education each time a public-sector rail initiative is put forward for discussion. Carriers might, however, be willing to participate in a more broadly based rail education effort, and their own staff may learn from the process. Professional development also makes it easier for public agencies to attract appropriate rail representatives to the table:

- Carriers will come to see public rail staff as knowledgeable and influential allies in raising awareness of rail sector benefits and building sympathy for rail-friendly policies.
- Carrier time will be spent more efficiently because public staff will be working from a solid understanding of the freight rail environment.
- The levels and positions of carrier representatives who attend meetings may be elevated, so that officers with decision-making authority become involved.

Development and implementation of a training program should be organized by state DOTs, or more efficiently by a coalition of interested states and like-minded MPOs. Impetus could start from a source like the rail committee of AASHTO (known as SCORT) and proceed with the collaboration of such industry groups as the Association of American Railroads (AAR) or the American Short Line and Regional Railroads Association (ASLRRA). Alternately, the freight professional development program of the FHWA could be adapted to the purpose. Its rail content should be reviewed by a competent body of users (SCORT again is a reasonable choice), and recommended for acceptance or modification. Key considerations for the design of the program are its breadth and duration. There are practical bounds to the time available from course providers and recipients, but prepared professionals will not emerge from a 2-day intensive program. A solution would be basic instruction managed nationally, then supplemented by a longer regional course, backed by states and perhaps run through universities.

The program curriculum should feature a general orientation on essential issues that influence freight railroad services, including operational, economic, and market factors. This guidebook and its supporting report can serve as a survey of content or could function as texts. The course should be targeted to state and MPO planners, but should have features or versions to attract railroad personnel. Certainly railroad officials can benefit from a richer and balanced comprehension of public planning, and the opportunity for mixed public-private participation in course work would be an understated way to cultivate partnerships.

Standards

Public funding of rail projects can best proceed from a transparent, well-reasoned, and visibly fair accounting of public costs and benefits. Carriers and states alike have an interest in

acquiring standards that organize the assessment process. Carriers in particular have no appetite for learning new evaluation methods for every public partner in the many states of their networks. The procedures presented in this guidebook are intended to form such a core system of standards. By adopting common rules, participants can concentrate on participation instead of adjustments. Participants can combine efforts across jurisdictions because of shared principles and can expect generally equal treatment around the country. Moving from a guide to an active system, of course, requires the acceptance of major railroads and public associations, promulgation through professional development programs, and successful use in the field.

Multi-Jurisdictional Techniques

Many proposals simply are not local. Rail networks cross jurisdictions, freight markets ignore boundaries, and trucks move everywhere. A project undertaken in one place frequently has influence in another, even if it can be completed in a single spot. The public sector's institutional difficulty in responding to this is a built-in problem affecting freight initiatives of all sorts, and not just in rail; the difficulty derives from barriers based in the system of government and the ways federal money is distributed. A related predicament is benefit-cost imbalance, which arises when the costs of a project fall in one jurisdiction, and the preponderance of its benefits fall elsewhere. Railroads seeking to work with the public sector wrestle with these things and sometimes prefer locally contained projects for their lack of jurisdictional complexity, even when the strategic needs are larger.

This section has discussed steps and devices to make multi-jurisdictional programs more feasible. None of them remove the root problem of political and fiscal structure, yet taken together they may reduce the degree of difficulty.

- Common rules for evaluating proposals make it easier for public agencies to collaborate and may end up fostering common goals. Railroads, with their interstate perspective, can act as intermediaries to bring these goals into focus.
- The spread of professional development programs in freight rail will support these same purposes by creating more responsive officials with comparable viewpoints in multiple agencies.
- Standing budgets committed to rail, especially those with reliable revenue sources, make rail programs more practical. Budgets committed in adjoining states give neighbors a basis for coordination over an extended time.
- Joint powers authorities offer a formal way to manage cross-jurisdictional projects, provided they can be fashioned to conform to the laws of participating states. They may be able to support cost sharing to offset imbalanced benefits, and they have the additional virtue of dedicating resources to the complicated process of interstate cooperation. Corridor coalitions are a variant on this approach and are seeing use in freight applications for highway and rail.

Finally, there is the designation of sequential projects in line with an overall strategy. The concept is that multiple improvements in different districts all can be pointed at a general increase in service for a corridor or region. The affected agencies agree to the program, yet the components are executed according to individual budgets and time frames. This is not an ideal approach, because program elements can be interdependent, and strategies with a culminating purpose (like the inauguration of new corridor trains) are made to wait until the necessary pieces are in place. Nevertheless, in the absence of consolidated financing, it is a pragmatic way to create incremental improvements, and for projects particularly with stand-alone components, it is a sensible way to proceed. The maxim “plan regionally, act locally” is a phrase that comes from practitioners in multi-jurisdictional program management, and it expresses the same kind of realism.

Land Use Actions

Land use represents a different kind of institutional issue. Some planners argue that there are ways in which congestion is not a transportation matter at all and that it results from policies shaping where and how densely the population lives, how industry is encouraged and zoned to locate, the mixture of activities permitted to come about, and other factors often concerned with the use of land. Transportation agencies normally influence, but do not determine, these policies. However, their use of institutional influence—with economic development commissions, zoning boards, and others—is important to the success of rail investment. Siting decisions and procedures affect rail's integration with other parts of the transportation network, its fit with the community, its popularity with citizens, and the willingness of carriers to accept development time frames. Proactive cooperation, by the railroads with the transport planners and by the planners with land control groups, can make rail ventures more productive in relief of the highway system.

Collaborative steps that can be taken by carriers and public agencies include these:

- States can offer incentives to local communities (such as infrastructure grants or tax incentives) to help carriers overcome the not-in-my-backyard issues that surround development of truck-generating nodes like intermodal terminals.
- The geographic perspective of state agencies (versus MPOs or local communities) permits a more reasoned trade-off between the challenges of freight flow concentration and reduced overall truck-miles on a state's highway network.
- Carriers can (and do) provide incentives to develop client clusters where a large number of carload rail customers can receive regular switching service in proximity to a terminal. Such concentration improves service reliability by supporting more frequent service and keeps down travel distances to the client sites.
- Public officials can facilitate the organization of client clusters through supportive zoning and roadway planning. Urban brownfield sites situated near rail terminals can be particularly attractive for such use because of the decontamination costs associated with retail or residential redevelopment of the land.

The evolution of institutions is one of the primary means by which maturation of public-private partnerships in rail will occur. The six steps outlined in this section can lead to stronger organizations and more vigorous and better sustained programs of activity. They extend and reinforce the framework wherein transactions are designed, which move these programs to implementation.

4.5 Designing Transactions

Transactions are the commercial structures for projects. They reflect the project's principles and the agreement between its participants. Ultimately, they will be reduced to contracts, but this discussion will focus earlier in the process and discuss the factors and considerations that affect the principles and shape the agreement.

It is useful to distinguish between two categories of public rail projects, because they establish different areas of emphasis. The first category is network improvements that accommodate the current progress of rail operations, including indigenous growth; the second category is improvements that stimulate greater traffic growth by opening new markets. First-category projects augment the present service offerings and conform to the regular market focus of carriers. Their familiarity makes them simpler to sell and execute, although their difficulty becomes greater with size and with jurisdictional and participatory scope. Second-category projects have

a larger measure of uncertainty. They aim for new business and may require changes in the configuration of service, such as higher train speeds or service frequency. These features make them more challenging to develop, but they are attractive to some carriers in some places, and at times strongly so. The public interest lies with both types, because both influence capacity and the contribution of truck traffic to congestion.

The two categories are presented separately in this section. More of the common elements for the design of transactions are listed with the first group, but shared factors appear in each. For example, the assurance of traffic volumes is critical for any initiative, yet because there is more uncertainty surrounding it in second-category projects, it is discussed under group two. The elements are summarized in Exhibit 4-4.

Category 1: Progress Improvements

First-category projects support conventional markets by adding capacity or lifting operating constraints. Their significance may be local or widespread if they treat bottlenecks at the top of the network like hubs, ports, or mainline connections. Investor risk is moderated because the initiatives build on existing traffic, but the growth they accommodate and the roadway volumes they avert can be major. Development of public-private transactions for such projects should incorporate the following practical steps:

- **Identify Potential Beneficiaries.** A broad range of stakeholders in the success of the project should be identified. Benefits accruing to these groups should be quantified and then translated for easy comprehension by lay audiences. Similarly, the parties to the transaction need to understand their effect on one another. For example, the contribution of public capital can reorder a railroad’s resource priorities. Identifying the carrier’s internal incentives will help to cement their commitment to the public process.
- **Build a Broad Political Structure** to organize stakeholder involvement and to address the embedded limitations of public programs. The support of the local freight interests is essential, and the influence of beneficiaries must be harnessed. For example, special corporations can be formed to overcome prohibitions on public funding of rail, provided there is a mobilized will to do so. Also, once a coalition is formed to identify, finance, and implement projects that fulfill clear needs, that coalition can quickly move to additional projects.
- **Carefully Consider Scale** in a project. The scope should be large enough to achieve a critical mass of benefits, supporters, and operating volume, but will grow in complexity as the number of political jurisdictions grows. Participants can favor single-jurisdiction projects until funding and management solutions mature for the wider programs.

1: Progress Improvements	2: New Market Improvements
Identify Potential Beneficiaries	Traffic Assurance
Build a Broad Political Structure	Understand Motivations
Carefully Consider Scale	Engage Buyers
Utilize Network Strategy	Hedge Risk
Adjust for Benefits	
Take Care of the Community	General Steps
Seek Balance	Respect Management Prerogatives
Ensure Role Clarity	Examine Unconventional Solutions
Ensure Equity	Tailor Investment to Diversion
Expedite	Allow for Interoperability
Plan for Tolls	Encourage Carload Freight
Utilize Variable Compensation	Manage Expectations
Employ Performance Measures	

Exhibit 4-4. Transaction Factors and Considerations.

- **Consider Network Strategy.** Network strategy may determine the value of a project for rail carriers and can enlarge its value for the public. In a network business like railroading, the productivity of an improvement can depend on or be enhanced by conditions and parallel actions in other localities, and beneficiaries can be well outside the immediate geographic limits of the project. Railroads will have a strategy for this and states should consider preparing one, because it establishes a context for projects, helps identify initiatives where the benefits and traffic attraction are broader, and supplies a systems approach to development of infrastructure. This implies that public authorities should examine harmonization of their efforts with external jurisdictions. Although they cannot become hostage to an external set of political approvals, coordinated parallel development is another method for agencies to treat project scale.
- **Adjust for Benefits.** Incorporation of public benefits should cause the revision of some private plans for freight investment. Railroads ordinarily will invest in equipment and facilities based on a financial analysis that includes costs and benefits to themselves and their customers. They do not ordinarily consider the effects (either way) of their decisions on congestion, the environment, communities, or regional economic development. Adding in these public benefits could result in different sizes and locations of terminals, different routings of through traffic across cities, higher capacity mainlines, and further rationalization of the rail network in metropolitan areas. The public contribution to investment should consider the cost of these additions.
- **Take Care of the Community.** Well-designed rail projects give advantages to surrounding communities that do not depend just on freight shipping factors. Commuter rail improvements, grade crossing safety, and community re-development opportunities help gain acceptance for a freight mobility program. Transit and passenger rail authorities often enjoy deeper or different political support within a metropolitan area than do freight stakeholders, which can strengthen a freight coalition. Segregation of freight traffic from neighborhoods—through grade separation or route arrangement—produces benefits by improving popular perceptions of safety, reducing congestion, and softening community impacts. Minimizing the detrimental effect of construction also is important. One project did this by (1) preserving the historical character of improvements; (2) smoothly handling problems and concerns as they came up; and (3) closely coordinating between agencies so that improvements were accelerated.
- **Seek Balance.** The willingness of various railroads to work together and to negotiate ways to distribute costs is essential in a project with multiple entities. Competitive concerns between rail carriers, or between motor carrier and rail interests, can stymie a project and should be addressed in its design. The organizing agency should have the scope to attend to these concerns, and it can tackle them by devising a program of improvements that benefits multiple groups. For instance, multiple projects or separate phases of a project can be packaged to deliver investment opportunities for different parts of the surface transportation network and for different stakeholders in turn. Third-party rail operators can provide balance at joint facilities whose operation is important to more than one carrier. Shortline railways and switching roads supply a neutral and often lower cost form of common access to many ports and terminal areas today. They can be a satisfactory solution for managing infrastructure whose function is vital to the public and where there is a need to support rival rail networks.
- **Ensure Role Clarity.** For the sake of efficiency and accurate expectations, the roles of public- and private-sector participants require clarity from the beginning of a project. To that end, full responsibility for certain categories of capital and expense items should be allocated to specific participants, as distinct from cost-sharing schemes that would entail complex reconciliation of public and private financial accounts. As an example, public agencies could take on the financing role for specific net additions to line capacity in a given location, while the railroad would be responsible for replacement in kind of existing capacity, as well as capital renewals going forward.

- **Ensure Equity.** The contributions from each party to a project should be scaled to its benefits, in order to relate investment to return. This may not be strictly practicable if the parties are operating under resource constraints, and it is reasonable for one to supply funds that another reimburses. However, no party should be expected to pay for advantages it does not seek, all should be satisfied that their results are worth their investment, and contributions need not and will not be all financial.
- **Expedite.** The long ripening time of projects in the public sector and the sometimes byzantine approval process are recognized obstacles to investment for railroads, whether they proceed alone or in partnership. Fast-track procedures, go-between services, cushioning with citizenry, and political cover for nailing down agreements are ways that public agencies can simplify and expedite requirements for their rail counterparts. These steps raise efficiency, and they also make public collaboration more attractive to railroads as a means of doing business.
- **Plan for Tolls.** Plans for road pricing are intensifying in the United States, with a particular emphasis on truck tolling. Truck traffic that seeks to avoid these charges will move to alternate highways or secondary roads, and some may be picked up by rail. In Europe, road pricing is used in conjunction with rail programs to encourage their success. It is improbable that this would develop in the United States, but it is appropriate for U.S. agencies to anticipate the effect of road pricing on rail capacity requirements and build into project designs the recognition that road tolls are a stimulus to rail.
- **Utilize Variable Compensation** schemes with carriers. Financing systems will be attractive to railways that replace up-front capital investment with contributions linked to use, essentially turning fixed costs into variable costs. In some projects arranged this way, rail carriers found their direct operating cost savings *on existing traffic* were sufficient to cover the usage charges, which compensated the public for new or improved facilities. The repayments from this method of financing also can be placed in trust, replenishing the public fund for development of further rail system improvements as volumes grow.
- **Employ Performance Measures.** Freight performance measures are being introduced generally in statewide plans, for the rail and the highway modes. Rail measures can reveal the fitness of carriers to attract new volume and the sections of the network requiring improvement, and thus suggest market and investment opportunities. For project applications, performance tracking is a vital part of sound and sustained investment. Because railroading is a service, investments in plant have to be protected with competitive operations sustained through time. Thus, it is important to know not only the volume change across a facility versus the investment plan, but also whether it is being operated according to the service plan and will continue to fulfill its purpose. Public-private initiatives can be judged to have been successful when (1) the public investment or support is sufficient for the private carriers and customers to justify greater use of rail and less use of highway transport; (2) the public benefits are sufficient to justify the public portion of the investment; and (3) there were no clearly superior means of achieving similar results. Performance measures are critical to determine this success and earn the continuance of funds. They should be integrated in the project undertaking and expressed in covenants between the parties.

Category 2: New Market Improvements

Second-category projects pursue the diversion of truck traffic from new lanes and markets. They may offer standard services for new places and customers, but typically they draw on higher performance, expanded capacity, better routes, fresh equipment, or other improvements to attract business. The standards for cost, speed, and reliability in these markets are set by motor carriage, and they have to be matched. This will be done most often, but not exclusively, with intermodal service.

There must be room—available or feasible physically—for the new traffic; it must fit with other operations on the network; and it must be more attractive than alternatives. Then, the key dynamic in traffic diversion is an investment that supports the introduction of new train service with competitive performance characteristics and costs of operation reduced to the point where the modal balance shifts. Because the performance is unproven and the traffic must be captured, there is significant uncertainty for the railroad and other investors. Railroads accept this risk selectively, with projects small and large. However, it is a normal business risk; it is the way that a business grows and the way that roadway relief will grow. Development of public-private transactions for these projects should begin with traffic assurance, and proceed from there with a series of general steps.

Traffic Assurance

No traffic diverts without a change to stimulate it, and new rail services introduce this change. Adequate use of new services by transportation buyers is one of the central concerns for second-category project investments. Transactions that create these investments can attack this concern in three ways:

- **Understand motivations to begin with.** For intermodal products particularly, there are several kinds of buyers with different sets of needs.
 - Shippers want on-time performance in specified transit windows, competitive costs door-to-door, and shipment visibility. So long as carrier performance reaches a threshold level of service, cost is the primary issue.
 - Ocean container lines want capacity at an aggressive price point. Service times are important but less crucial; the key factor is that inland transportation typically is embedded in a commoditized international price, and the objective is to get it done very economically in shipload volumes.
 - Motor carriers with national fleets and a serious interest in intermodal products want two things. First, intermodal linehaul is more profitable than highway, provided service will satisfy shippers and charges remain competitive. In this respect, their specifications are like the shippers, but what truck lines want is more business and a bigger, high-service rail network to carry it. Second, rail allows more truck shipments to be handled per unit of manned motive power. Since tractors are expensive and drivers perennially in short supply, motor carriers want the higher use of resources that intermodal linehaul allows.
- **Engage buyers in face-to-face discussion.** Preference surveys and similar marketing devices are sensible ways to gauge the general demand for new services. However, the deeper questions—about how the service should be constructed, where the tipping points lie, how long conversion may take, and how to address the buyer’s reservations—are best answered in a probing, interactive format that is not tightly time-limited. Focus groups and in-depth interviews, conducted in person, are the best methods for this; public forums are less productive because information is not confidential and the venue attracts posturing. FACs also are effective in this role, if their discussions are directed in the structured fashion of a focus group. They can be conduits for the recruitment of interview prospects, particularly those who are not local, and councils have the additional virtue that their viewpoints can be sought at successive stages of a project. In this sense, they may serve in the manner of an independent Board of Directors to a project.
- **Hedge Risk from three directions:**
 - Appoint a Devil’s Advocate. Recognition of risk is the starting point for treating it. An old and promising method for doing this well is the appointment of a Devil’s Advocate. This is meant in the original sense of a kind of lawyer for the opposition, who is attached to the project staff with the formal charge of uncovering defects. Planners may step into this function informally, and it is an easy precaution to take.

- Secure a Baseload. For volume risk, the usual answer is to secure a baseload. First-category projects have one in place; if existing traffic is to be rerouted or upgraded in service, a ready baseload can be available in the second category as well. Without this, volume for the project launch has to be assembled from a group of buyers. Ship lines, large motor carriers, and Fortune 500 companies are possible candidates. Railroads and advisory councils should identify them, although prominent local industries should be obvious to planners. Buyers with a firm interest in new service should be able to quantify the business they would consider tendering, but they should not be expected to offer a definitive commitment unless they are investors in the project or special beneficiaries of a segment of construction. The strongest response that is reasonable to seek is a non-binding letter of buyer support, akin to the instruments that railways secure to buttress a merger application. Even so, refusal to provide a letter is not proof of negative intention, because buyers can be cautious of public pronouncements or unwilling to reveal traffic information.
- Establish Covenants. A competitive service that (1) performs as promised, (2) is offered at a compelling price, and (3) makes economic sense to begin with is going to win traffic. Given a good product design and free market pricing, the risk lies in the performance, and covenants associated with financing are a reasonable remedy. In exchange for public money, these are binding commitments by the railroad to provide service of some minimum frequency and configuration for a minimum period of time. Service incentives can be incorporated as well. A critical railway concern is the obligation to run trains despite inadequate volume; the public concern should be that compromise of service will prevent volume from growing. This is the common problem of start-up risk. Some solutions to it are (1) a public guarantee of minimum rail revenue or outright purchase of train starts; (2) a public investment in such train assets as locomotives, aimed at reducing the railroad's financial exposure; and (3) investment in train starts by independent third parties (discussed below in the section on Winning Support).

General Steps

Several further steps should be taken in designing transactions for new market improvements:

- **Respect the Management Prerogatives** of railroads to select clients and manage their franchises as they see fit. Carriers will not be convinced to compete for new markets or service low-margin business because of public benefit objectives. What will convince them is public investment that changes their margins.
A related dilemma is the allocation of added capacity, because the expense of successive additions frequently will climb, and this opens the question of which users should be expected to pay for each. For joint facilities, or facilities shared between passenger and freight activity, the prerogatives of individual players can come into conflict, and the difficulties posed need a clear and collaborative resolution early in the project.
- **Examine Unconventional Solutions and Structures.** Rail service applications to certain markets may not fit the business priorities and service design of standard carrier operations. Partnership with carriers can adjust to this by taking various forms:
 - In a condominium approach the public purchases an easement to build and operate rail service that is physically and operationally separate from that of the existing carrier. This method, while expensive, can be used to create new services and to control the quality of a corridor-specific operation. Ongoing involvement by the railroad is minimized, but the public becomes a carrier, or contracts with one. (The Alameda Corridor followed this form.)
 - In an apartment approach specific units of service capacity are leased or bought from a carrier to serve a given market under specified terms and conditions. The public agency negotiates a slate of capital or expense contributions to support the service. Traditional and new

train operations take place under an integrated structure, but the railroad exits certain responsibilities such as supply of rolling stock, terminals or administrative support.

- In an REIT approach the public is an investor in railroad development. It contributes funds or incentives that the railroad uses to build new capacity, or otherwise cover the capital requirements for serving new business. Public money becomes part of the overall capital structure of the carrier. The public interest is in project performance instead of functional management, and the railway retains traditional roles in marketing, service quality and operating control. This approach imposes less disruption on existing carrier practices but requires accountability to the public investor, and the demonstration of benefits the investor expects.
- **Tailor Investment to Diversion.** The dominant components of rail operating costs vary by length of haul. For intermodal freight services, the majority of costs at distances below about 900 miles are taken up by terminal expense and drayage – in other words, by transloading, and the pickup and delivery operation. As mileage climbs, the balance shifts toward the costs for line and for operation of trains. Tailoring of public investment toward the sensitive cost factors, according to the profile of traffic lanes in a project, is a sensible way to support its truck diversion objectives. For example, tax incentives for drayage could make sense at the medium and short haul end, as could investment in transload facilities. Time elements, too, become more sensitive as linehaul distance declines, so that reduction of crossing delays can be an appropriate way to aid diversion in the lower mileage ranges.
- **Allow for Interoperability.** The free flow of intermodal shipments between rail and non-rail operations creates efficiency and a larger effective network. Compatible equipment is a necessary component of this interoperability, which is well developed between railroads and marine container lines, but much less so with domestic trucking. The rail intermodal business has emphasized stack containers over domestic trailer service for many valid reasons, including better capacity utilization; however, it is domestic trailers that fill the highways. The result is that motor carriers using rail are encouraged to do so with a specialized container operation, while the trailer fleets cannot make rail a broad extension of their over-the-road networks. This produces a robust international intermodal system and a smaller effective domestic system. For public planning, the useful step is to allow for interoperability in project design. If the goal is to appeal to international shipping, capacity for container trains will suffice. If the goal includes domestic truck diversion, containers will capture some, but the interoperability of motor carriage with rail will become a consideration, and added capacity for trailer service may be desirable.
- **Encourage Carload Freight.** General merchandise carload freight is not the engine for rail industry growth that the intermodal business may be, but it is a valuable part of the rail portfolio for public planning. Rail retention of carload traffic keeps heavy-loading goods off the highways, and, when new traffic is captured, it often is done with direct-to-door service at one or both ends of the journey—in other words, no drayage truck is involved. Diversion effects on local roads can be quite significant when an industrial plant shifts volume to direct rail, and the shortline sector tries to specialize in this kind of conversion. Apart from proactive inclusion of carload freight in rail programs and partnerships, many of the key steps for government are in complementary land use and zoning regimes at the city or MPO level. The encouragement and retention of sidings, the provision of rail spurs into new commercial sites, industrial development in proximity to rail lines, and financial mechanisms to support these things are some steps to improve carload access. Joint investment or just local approvals for bulk or breakbulk transload facilities are appropriate when direct service is impractical.
- **Manage Expectations.** The success of any project is shaped by what its constituents expect it to do. Careful forming of those expectations is important in first-category projects and more so in the second, where citizens may be hoping to see fewer trucks in their daily travel. The fact may be that even large diversions of truck volume will be overwhelmed by the overall growth

in freight. Transit advocates face a similar dilemma in selling their projects. Their argument is that a parallel system like transit guarantees people a certain minimum threshold of mobility in the face of worsening roadway congestion. Freight rail can argue (and has) that it slows the growth of congestion or retards the rising incidence of trucks or that it guarantees mobility to supply chains by offering a parallel system in freight. The point is to consider the popular perceptions of a project's objectives and direct those perceptions toward what the project can finally accomplish.

Transaction design thus solidifies the approach to projects and the roles of participants. It is concerned to assure their success, and the way that success will be determined.

4.6 Winning Support

Drawing support to public freight rail projects organizationally, politically, and financially is vital to their likelihood of implementation. Two avenues for doing this are explored in this section: methods of influencing program priority and utilization of multi-party coalitions.

Program Priority

The program priorities for multimodal projects in the public sphere can be heavily governed by their ability to delay or eliminate the need for new road capacity. Rail projects answer well to this requirement when diversion is concentrated on particular roads due to high-volume shippers or confluent traffic, but, in other locations, the same diversion effect can be diluted across the road network. To contend with this, the value of rail can be asserted for program prioritization in three ways:

1. **Reformulation.** First, it should be questioned whether the effects on the passenger-driven highway spending program are the right way to judge freight projects. When the capacity problem is reformulated as congestion specifically affecting the freight system, the rail solutions become more potent because they address it directly. For example, if highway conditions determine the advantage of diversion, then results for the class of traffic which departs the highway are excluded, yet this traffic should experience the greatest benefit from a rail project. Reformulation of conditions in terms of the system for freight, and including all affected commercial traffic because the modes are interactive, is a more relevant method of deciding program priority.
2. **Containment.** Second, the utility of rail should be stressed for managing congestion as a worsening and generalizing condition. For example, intercity lanes represent the new zones of congestion in the decades ahead. Exhibit 4-5 is a projection of this. It depicts highway level of service deterioration spreading through the years, until the corridors linking major cities degrade to the most congested rank almost end to end. Even if they are focused at greater lengths of haul, rail options help to respond to congestion because of its proliferation.
3. **Broader Criteria.** Third, rail benefits that resonate with the voting public should be advanced as additional program criteria, focusing especially on economic competitiveness and safety in the form of traffic separation. For instance, in the major hub center of Chicago, rail freight has been shown to be worth whole points of gross regional economic product. While the influence of rail in more typical locations will be less, this large-scale example shows the strength of the connection to economic well-being, with its implication of jobs, income, and political interest. Other advantages from rail can act in a comparable role: in Europe, railroad environmental performance wins preference at the policy and program level, and some American communities may choose to act similarly, because of air quality non-attainment, climate concerns, or local opinion.

fer those who bring assets to the table and favor them when capacity is tight. Commitment of assets also produces a vested interest in the rail operation and usually in the quality of service, since service affects the use of equipment and therefore its return on capital. When the volume or operational requirements of the asset owner begin to warrant investment in trains or terminals, this interest can become compelling and create an additional full partner for a cooperative relationship.

Railroads can have misgivings when a private partner begins to look like a private operator. When purchasers of trainload intermodal services have resold space on trains, railroads have asked whether they are competing with themselves. The dilemma is like that of ocean lines with Non-Vessel-Operating Common Carriers (NVOCCs), who improve the use of ship capacity yet are rivals with the lines for some business. Nevertheless, while railroads prefer to retain full control of trains, they are apt to prefer profits more and can reach an accommodation with private players who will not severely commoditize rail service.

A multi-party approach to public-private partnership brings a clear set of advantages to rail projects.

- **Traffic Assurance.** Truck lines, ship lines, and shippers all command volume they can tender to railroads, and this brings assurance to project traffic levels. Even if quantities fluctuate, their existence reduces project risk and makes railroad and public money safer to invest.
- **Public Relations.** The influence of alliance members on public relations and the courting of public favor is a second advantage. When the pairing of railroad and government expands to take in transportation users, the partnership begins to have evident market support, and if the users are well known to the community or prominent in the industry, it can take on the aspect of a grand coalition. This establishes an impression of solidity and prestige that is beneficial to a project, by helping to sway decisions for it in a political environment.
- **Capital.** The most obvious advantage is the enlargement of sources of capital. The funding minimums required to make new projects operational become easier to reach, more projects reach fruition, and the money available from public and railroad coffers goes further. The new partners will have characteristic inclinations, derived from their own business functions, which tend to slot them into certain roles: for example, a motor carrier will commit fleet equipment but is not likely to invest in track. While seemingly restrictive, these roles can be complementary to the public interest, so that taken together, the parties may fund a rail initiative more completely than any would alone. How this could function is discussed next.

Funding Roles

The funding roles that the parties in a coalition may play are pictured in Exhibit 4-6. It shows in a general way the rail cost composition of intermodal service and each partner's area of involvement and potential contribution.

- Public-sector actors normally will make rail investments in infrastructure, mirroring their function on the highway side. Specifically, they will contribute toward track and right-of-way (ROW), yards, terminals and access, and potentially terminal transloading (lift) equipment.
- Private-sector actors invest principally in payload equipment: trailer/container units or railcars. Some may be brought into terminal investment, perhaps on a shared basis with a railroad or public agency (as shown in Exhibit 4-6). While this is not normally done today, ship lines with on-dock rail or industries with private spurs are stepping in this direction, and motor carrier-owned terminals outside of the rail sphere are commonplace.
- Train starts are possible targets of investment for both public and private players, individually or on a shared footing. A train start is a commitment of crew, locomotives, and

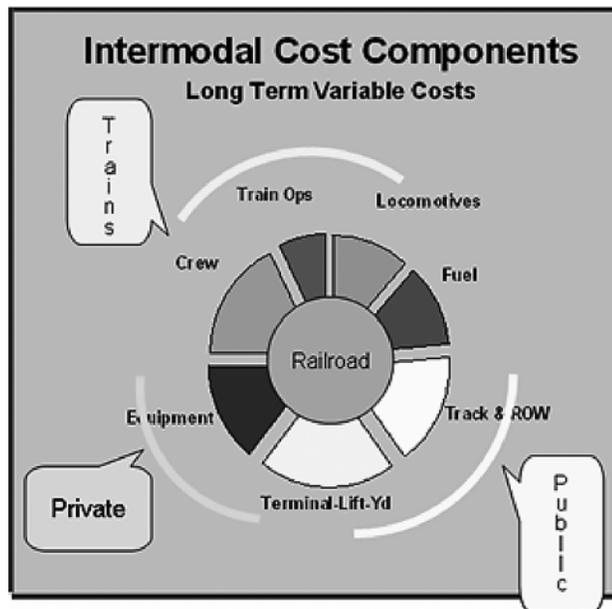


Exhibit 4-6. Illustration of Funding Roles.

operating resources on a set schedule. Although it is not a capital commitment per se, it imposes a material fixed cost that railroads approach with care, and a purchaser of train-load services can defray it. Shippers, container lines, independent operators, and public agencies all have undertaken this to varying degrees, and motor carriers have now begun to do so. The party that is best able to accept the train start risk is the one who controls enough traffic to support the train. The public agency function can be to bring several private entities together to reach a volume threshold or to guarantee against a volume shortfall as an inducement to the cooperation of others, especially during the ramp-up phase of a project.

- Railroads invest everywhere, sustaining the system—the network, fleet, personnel, controls, transactions, and organization—that makes contributions by others effective. A public investment in track, for instance, represents a subset of the hundreds of miles of track that trains may travel in providing service to that investment. Similarly, a train start draws on a pool of qualified labor and a string of locomotives maintained and positioned in the right district by the carrier.

The relative significance of roles in the cost composition of intermodal rail service is illustrated somewhat better by the graph in the following Exhibit 4-7.^v The previous pie chart displays the distribution of expenses for a mixture of longer and shorter haul traffic, with a weighted average of around 1,000 miles. The graph depicts how this distribution changes with distance. A conse-

^vThe costs presented in both graphics are long-term variable costs, which contain major capital components. When some components fluctuate in price, they affect the weight of other factors. (Fuel is a key example; the graphics represent fuel prices in 2003–2004.) Numbers are calculated per shipment for typical train sizes, implying for instance that atypically short trains would bear a greater locomotive expense, allocated over fewer shipments. Finally, the costs are for a shipment across its entire rail journey (pickup and delivery drayage is excluded). Thus, it will pass through at least two terminals and cross many miles of track. A normal rail project will contribute a portion of such expenses but not all of them, although it will do so for many shipments. As a result, where the chart shows public investment in track and terminals affecting costs that account for 37% of the total, it means that those areas of contribution are substantial in the railroad cost structure, and it does not mean that the public is covering all of those costs. Source: Global Insight, based on the Surface Transportation Board Uniform Rail Costing System.

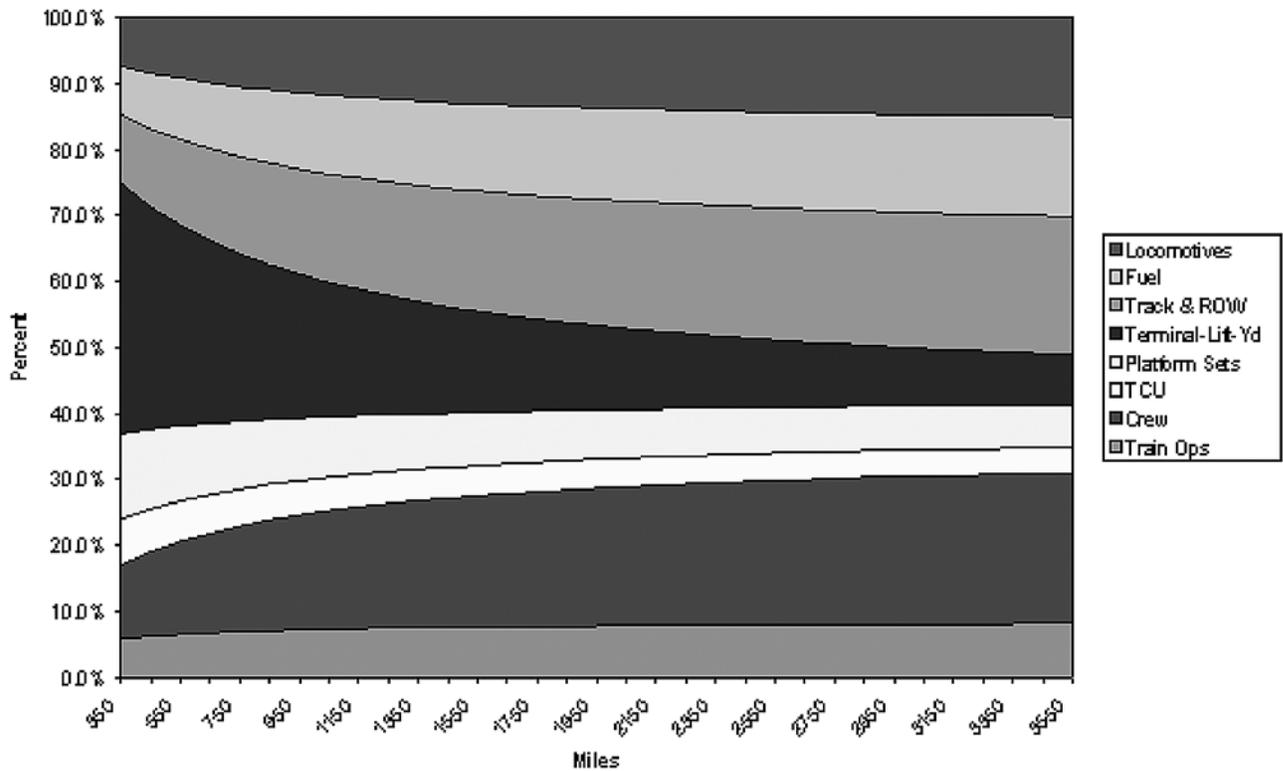


Exhibit 4-7. Distribution of Intermodal Rail Costs by Mileage.

quential point for public planning is how important the terminal and equipment components are at the lesser lengths of haul, encompassing half the costs under 500 miles. Since terminals and equipment also are the nexus where private non-rail and public roles meet (as shown in the pie chart), it stresses how helpful, and even critical, a multi-party alliance can be, at the distance ranges where railroads traditionally have not competed. In addition, the chart reinforces the notion advanced earlier that investment can be targeted to sensitive components in order to divert a given traffic mix.

As the exhibits suggest, the roles that the parties tend to fall into are complementary and mutually supportive. They are not limiting roles, so that a public agency could act differently—perhaps by purchasing locomotives to ensure a project’s power supply. However, they are essentially natural parts for each actor to play, delineating a partnership structure that can be followed, and diluting the capital demands of railroading by spreading them according to segmented interests.

Winning support for projects concludes the process of public-private dialogue in the development of rail responses to road congestion. Detailed steps of analysis should be conducted in parallel with this process in order to demonstrate the viability and value of rail initiatives and their preferability as a use of public resources. Those steps form the subject of the next chapter.

Methods for Detailed Analysis

This chapter describes methods that can be used for more detailed analysis of project cost, benefits, and feasibility, beyond the sketch planning approach for preliminary screening that was described in Chapter 3. The methods described here encompass six major steps that can be part of a more detailed analysis:

1. **Assess Congestion Levels and Reduction Needs.** Section 5.1 describes methods for determining the severity of traffic congestion and the relative contribution of truck traffic to that problem.
2. **Analyze Shipping Cost and Service Features.** Section 5.2 describes methods for assessing differences in freight carrier cost and service levels associated with truck and rail freight options.
3. **Analyze Overall Logistics Costs.** Section 5.3 describes methods for assessing the overall logistics cost factors considered by freight shippers (users of freight transportation) when deciding between truck and rail freight options.
4. **Calculate Truck to Rail Modal Diversion.** Section 5.4 describes methods for estimating the impact of proposed project alternatives on diversion of freight from truck to rail along congested corridors.
5. **Calculate Traffic and Economic Impacts.** Section 5.5 describes methods for calculating impacts on transportation system efficiency (cost to carriers), benefit for freight system users (shippers), and broader impacts for other businesses (regional and national economy).
6. **Present and Summarize Benefit-Cost Findings.** Section 5.6 describes methods for portraying project benefits and costs from various perspectives that may be useful for public discussion and decision-making.

For each element, this guide describes (1) an overview of the analysis step, (2) components of the analysis, (3) background considerations, (4) factors to be considered, (5) alternative methods for analysis and (6) resources required.

5.1 Assess Congestion Levels and Reduction Needs

5.1.1 Overview

The first step is to estimate levels of current and projected future traffic congestion within the study area or along the highway corridor and the extent to which truck traffic contributes to that congestion. This is necessary to establish the potential benefit that could be achieved if some portion of the truck traffic could be shifted to rail freight alternatives.

5.1.2 Components

Three factors should be considered in evaluating current congestion and forecasting future congestion levels. They are

- The *measurement* used for monitoring congestion levels and estimating future levels;
- The process of *modeling of traffic growth* in target areas and corridors; and
- The handling of *reliability effects* resulting from sporadic delays known to increase in incidence as traffic volumes approach the design capacity of highways.

5.1.3 Background

Traffic congestion refers to the slowdown in travel speeds and increase in incidence of traffic backups that grow exponentially as the volume of traffic approaches the design capacity of a road, bridge, or intersection. Traffic congestion increases the travel time, operating expense, and safety costs of travel. With limited capability to further expand many highways in the future, it becomes particularly important to forecast the expected growth of congestion so that actions can be taken to mitigate negative effects.

However, the costs of congestion are often under-estimated because state and regional travel demand and road network models typically focus on average daily traffic conditions and report them for large areas. Unless the analyst requests special reports for small areas, the extent of severe localized congestion will also be missed. Yet even if the analyst requests a report for a specific area or corridor, the measurement of daily average traffic volumes over a 24-hour period will tend to show moderate average volume/capacity ratios and travel speeds, while failing to identify the extent of peak period over-capacity conditions and delays in that area. This makes it particularly important to apply methods that can assess the extent of time-specific and location-specific congestion conditions.

In addition, many state and regional travel network models count only total vehicles and do not track differences in car/bus/truck vehicle mix for specific areas and corridors. That can also lead to an under-estimation of the costs of congestion for two reasons: (1) trucks contribute more to congestion because they take up more road space and require broader separation than cars and (2) the business costs associated with truck delay can be substantially greater than the economic value of passenger car delay. In addition, options for shifting truck traffic to other modes (such as rail) can be quite different from the options available for shifting car traffic. This makes it particularly important to assess the vehicle mix in congested areas and identify the extent to which trucks contribute to that congestion.

5.1.4 Factors

The analysis of congestion levels considers four dimensions:

- The *spatial pattern* of traffic congestion; delays can be area-wide or location-specific;
- The *temporal pattern* of traffic congestion; delays can occur during morning or afternoon peak periods or during off-peak periods;
- The *stochastic element* of congestion; delays can be predictable or occur sporadically as a result of traffic incidents (that rise exponentially as volume/capacity ratios increase); and
- The *mix* of vehicles and traffic classes affected; vehicles include cars, buses, and various categories of trucks, while traffic classes include local and through traffic.

5.1.5 Methods

Element 1 – Measurement of Congestion Levels

Congestion measurement can be grouped into four broad classes, which portray congestion levels on the basis of

- A *congestion index* related to the rate of travel delay (reflecting average speed);
- An *excess delay* measure for urban areas that is tied to total vehicles and minutes spent on facilities operating below a certain level-of-service; or
- The *percentage of time at a given point* on a highway system that average speed drops below some threshold value.

Exhibit 5-1 provides a more detailed list of the various measures used to assess the severity of congestion in a given area. These various congestion measures can be derived from direct observation (discussed here) or application of a travel demand and network models (discussed in the subsection that follows).

A growing number of agencies are monitoring congestion levels via direct observation. Examples of alternative data collection approaches for direct observation are Houston's Real-Time Traffic Information System (which uses cellular telephone reporting and automatic vehicle identification techniques to record travel times); the TRANSCOMM Electric Toll and Traffic Management Project in New Jersey (which monitors the travel times of specially tagged vehicles); and the ADVANTAGE project in Chicago (which uses satellite global positioning systems and probe vehicles to record travel times).

NCHRP Report 463: Economic Implications of Congestion provided a full discussion of the elements of traffic congestion and alternative ways of measuring it. It can be accessed in two volumes at:

Time-Related Measures
Average Travel Speed
Average Travel Time
Average Travel Rate
Travel Time Contours
Origin-Destination Travel Time
Percent Travel Time Under Delay Conditions
Percent of Time Average Speed is Below Threshold Value
Volume Measures
VMT/Lane Mile
Traffic Volume
Congestion Indices
Congestion Index
Roadway Congestion Index
TTI's Suggested Congestion Index
Excess Delay
Delay Measures
Delay/Trip
Delay/VMT
Minute-miles of delay
Delay due to construction/incidents
Level of Service Measures
Lane-miles at/of Level of Service Rating "D" or "F"
VHT/VMT at/of Level of Service Rating "D" or "F"
Predominant Intersection Level of Service Rating
Number of Congested Intersection

FHWA: Analytical Procedures to Support a Congestion Management System; Technical Memorandum 1; prepared by Cambridge Systematics; February 1994.

Exhibit 5-1. Measures of Traffic Congestion.

http://gulliver.trb.org/publications/nchrp/nchrp_rpt_463-a.pdf

http://gulliver.trb.org/publications/nchrp/nchrp_rpt_463-b.pdf

To avoid redundancy, readers of this guide are referred to that document for a more complete discussion of congestion measurement.

Element 2 – Modeling of Traffic Growth

The availability of data on actual congestion levels varies from one metropolitan area to another. Data may or may not be available at the level of detail desired, and data may or may not be updated regularly. Highway travel demand models are therefore frequently used to estimate traffic flows and congestion for specific facilities or for metropolitan road networks. Such models also provide a way to forecast future growth in traffic volumes and associated congestion levels. The traditional form of travel demand modeling is the four-step model process of trip generation, trip distribution, mode choice, and trip assignment via computer simulation models. There are also simpler sketch-planning spreadsheet-based models, sometimes using an approach known as “pivot-point analysis,” to estimate future changes based on the application of growth rates to existing conditions. In general, these modeling methods yield estimates of highway system travel performance metrics in terms of highway volumes, speeds, travel time saved, operating cost changes, and safety effects.

Travel demand models can be used to forecast the implications of alternative future conditions, by changing the assumptions about traffic growth. Thus, they can forecast how a reduction in truck traffic will lead to reduced congestion delays compared to what would otherwise be expected. They also provide a measure of the delay reduction benefit to remaining automobile travelers and truck carriers on the affected highways. However, the usefulness of travel demand models for truck reduction scenarios depends on two factors that are not always considered in statewide or regional travel demand modeling systems:

1. **The ability of the modeling system to distinguish truck and car traffic changes.** This is important since many regional and statewide highway network models assume a fixed truck/car ratio for all road segments and cannot distinguish the greater congestion reduction benefit that comes from reducing truck traffic.
2. **The ability of the modeling system to distinguish concentrations of congestion at particular times and places.** This is important since the severity of congestion delays rises more than linearly as traffic volumes rise, so a system that can hone in on particular locations and peak periods will find greater overall regional congestion than one that only considers daily average regionwide levels.

Since the truck percentage of vehicles on a highway can vary widely (from 2 to 10 percent or more), it can be particularly useful to observe the current truck share for specific congested areas and corridors and then be sure that the travel demand forecasts can be used to generate car/truck shares or to forecast future traffic. In addition, since congestion can vary by time of day, it can also be useful to observe the current ratio of peak traffic to daily average and then be sure that the travel demand model can be used to generate peak-period forecasts for the specific areas and corridors of interest.

The FHWA’s Office of Operations has produced a web-based report called the *Traffic Analysis Toolbox*, which discusses and describes all the different types of travel demand, traffic forecasting and sketch planning models. It can be accessed at <http://ops.fhwa.dot.gov/trafficanalysistools/index.htm>. To avoid redundancy, readers of this guide are referred to that document for a more complete discussion of the available options for traffic analysis tools.

Regional travel demand models can also be supplemented with corridor-specific peak congestion measurements and truck congestion measurements in order to address the previously cited concerns about limitations of regionwide models. An example of that additional modeling is provided in the 2005 study, *The Cost of Congestion to the Portland Region*, available at http://www.portlandalliance.com/pdf/Congestion_Report.pdf.

Element 3 – Handling of Reliability Effects

As the volume of traffic rises beyond 80 percent and toward 100 percent of the facility design capacity, there tends to be an exponential increase in the incidence and severity of delays due to non-recurring and unpredicted events such as accidents, mechanical breakdowns, special events, or hazardous materials spills. Various studies have found that such incidents account for over half of total congestion delays on both freeways and arterial roadways. Various other studies have shown that diminishing reliability (increasing variation) in travel time has a particularly high cost for truck traffic, since it affects vehicle delivery schedules. Penalty factors have been developed for application to average time delays in situations where travel time reliability also degrades. Those factors can be used with travel demand models to effectively increase the valuation of time savings benefits for congestion reduction scenarios that also improve travel time reliability.

There is a full discussion of the measurement and modeling of travel time reliability, its valuation, and application with travel demand models, in the previously cited *NCHRP Report 463: Economic Implications of Congestion*. To avoid redundancy, readers of this guide are referred to that document for a more complete discussion of methods to account for reliability impacts of congestion. Readers are also referred to the previously cited Portland report for case study examples of the impact of congestion-induced travel time reliability degradation on business scheduling costs.

5.1.6 Required Resources

In general, travel demand models involve data such as

- Forecasts of trip generation rates by households and businesses;
- Forecasts of car/truck/bus/rail mode split;
- Model specification of road system links and nodes;
- Model specification of traffic control data at intersections and junctions;
- Observed traffic volumes (counts) on road links (daily or peak/off-peak);
- Observed travel time and speed data; and
- Observed traffic delay and queue data.

When considering rail freight solutions for traffic congestion, it becomes particularly important to be able to distinguish truck shares of traffic on the key congested areas and corridors and to forecast changes in congestion during peak periods for those areas and corridors.

5.2 Identify Carrier Cost and Service Levels

5.2.1 Overview

This step identifies the carrier costs and service capabilities of rail, truck, and intermodal options for moving freight. An understanding of carrier costs is necessary to understand how new projects and facility investments, changes in operations, or new public policies can affect carrier costs. The outcome of this step is then used later to calculate the broader logistics cost associated with use of truck and rail alternatives by freight system users (shippers).

5.2.2 Components

The analysis of carrier costs and service features is based on a classification of different types of freight carriage, each of which has its own set of cost and service features. The classes are

- Truckload freight service;
- Intermodal (rail/truck) freight service;

- Unit train freight service; and
- General rail freight services.

5.2.3 Background

An understanding of relative costs and prices of the various transport options is essential for anyone trying to identify useful projects. In recent years, cost and service models have been developed at many different levels of detail. Many of the costs shown in this section were originally developed as estimates of transportation costs and/or rates as of the year 2000 or earlier. Costs are somewhat higher as of the year 2006 and will likely increase in future years. Rough estimates of costs, operations, and resource utilization can be extremely helpful in initial planning studies. These estimates are not intended to be used for any specific shipment, and they certainly should not be used as indications of future cost or price levels.

5.2.4 Factors

The carrier cost and service features are very different for the various classes of truck and rail options, and those differences are reflected in both the rules-of-thumb methods and the more sophisticated costing model methods discussed next. However, all of these methods key off of common factors that serve to distinguish the various freight transportation options. Those factors are

- Length of the average shipment (miles or km);
- Per mile line haul operating costs;
- Size of the average shipment (whether it is truckload or less than a truckload, a full train or less than a full train);
- Additional terminal or transfer costs associated with less than truckload or less than trainload shipments; and
- Frequency and speed of shipment.

5.2.5 Methods

Element 1 – Truckload Freight Movement

Many different kinds of trucks are to be seen on the highways, but only the largest carry freight that might be divertible to rail. Tractor-trailer combinations that can carry 20 or more tons of freight are commonly used for long-distance trucking. Specialized trucks are used for moving automobiles, chemicals, bulk commodities, and other heavy products that might also be rail competitive. The routes taken and the miles traveled by smaller trucks might relate to the location of industrial plants, warehouses, and retail establishments, so there could be a long-term relationship between the use of rail, the location of such facilities, and the nature of local truck movements. However, discussions of diverting freight to rail must focus on the larger trucks.

Large trucks might be carrying freight to a single customer (truckload or TL) or freight destined to multiple customers (less-than-truckload or LTL). Both TL and LTL are divertible to intermodal and possibly to rail carload services. For LTL movements, railroads can be involved in the movement of a trailer or container of consolidated shipments from one trucking terminal to another; railroads are no longer competitive in terms of the pickup and delivery of the individual LTL shipments. The truck traffic of interest is therefore either TL or the linehaul portion of LTL.

Approach 1 – Overall Rules of Thumb. Distance is an important cost factor. For bulk traffic, as discussed above, railroads can handle even very short trips using a very efficient mini-train.

For general merchandise traffic, rail is competitive only for hauls of at least a couple of hundred miles. For these rail-competitive movements, the trucking operation is straightforward: drive to the customer's loading dock, load the truck, drive to the destination, and unload the truck.

While costs also vary with the specifics of the journey, trucking costs per mile are predictable. For many years, they have been on the order of \$1 to \$1.35 per mile¹ for general freight moving in standard equipment for distances over 300 to 400 miles. Costs for shorter haul movements depend to a great extent on the time required to load and unload and the average speed of the highway trip. These factors determine the number of loads per day that can be handled by a truck driver—this is a more important measure than distance for truckload costs. Interviews with truckers indicated that they need to charge a total of about \$500 to 525 per day to cover their costs in short-haul service.

The trucking market is highly competitive; prices were deregulated in 1980; and prices have been close to costs ever since. For the preliminary analysis, it is probably sufficient to assume that truck costs for a standard tractor-trailer combination range from \$1 to 1.35. However, truck rates have recently been rising, and somewhat higher costs may be needed in future studies.

For specialized trucking, a recent study estimated costs of \$1.35 per mile for system loads and \$2.60 for restricted loads. These costs were obtained from a larger, efficient tank carrier in 2003. System loads were shipments where the company would be able to reload the truck because (1) commodities did not contaminate the trailer and limit its next use and (2) the length of haul was long enough to make it worth seeking a back-haul load. Restricted loads were the opposite: the nature of the commodity limited reuse or the distance was too short to do other than return empty to base. The distance limit was defined by what a driver could do in an out-and-back run, which was about 250 miles each way. Thus, the cost of tank shipments under favorable reload conditions could also be on the order to \$1.35 per mile, but would likely be considerably higher.

Approach 2 – Modeling Cost Components. More precise estimates of trucking costs can be obtained with further knowledge of operating conditions and current costs. The major components of trucking costs fall into the following categories:

- *Truck driver costs* are on the order of \$0.35 to \$0.40 per mile for long-distance, non-unionized truck drivers who drive in excess of 100,000 miles per year; \$40,000 or more per year applies for unionized truck drivers, who are typically involved in LTL or specialized operations. Both costs have been rising in recent years and are expected to rise higher than the historical rate in order to attract and retain drivers.
- *Ownership costs* for the tractor-trailer combination are on the order of \$100,000; the tractor might have a useful life in long-haul service of 5 or more years and the trailer should last 10 or more years. Operators of big fleets typically will sell equipment before the end of its useful life. It is an advantage to them to sell tractors after 3 to 4 years, i.e. before the normal 400,000-mile engine warranty expires. Costs are higher and also rising for specialized equipment, such as refrigerated units or tank-trailers.

The purchase prices can be transformed into a cost per trip as follows:

- Calculate the equivalent annual ownership cost over the expected life of the vehicle, assuming a reasonable discount rate (e.g., the weighted average cost of capital for the trucking industry);
- Estimate the number of days per year that the equipment will be used;
- Divide the equivalent annual ownership cost by the expected number of days the equipment will be used to get the daily cost of the equipment;

¹These figures include fuel costs, but could be significantly higher during periods of fuel price spikes.

- Divide by the typical number of hours used per day to get hourly cost; and
- Estimate the cycle time, which is time required for the trip, taking into account the hours available for working each day (which can be as high as 10 to 11 hours per day for 6 days per week) and the time required for each activity.

Note 1: Positioning the equipment for loading: For most TL traffic, empty repositioning is small, on the order of 10 percent of total miles. For efficient bulk operations, large trucks cycle between a given origin and a given destination, and the empty miles equal the loaded miles. For general freight, it may be necessary to travel empty 50 to 75 miles to pick up the next load, independent of the length of haul. Empty mileage tends to be higher for specialized equipment.

Note 2: Loading, Loaded movement and Unloading: Allocate costs to a particular trip by multiplying the hourly or daily cost by the hours or days required.

- *Maintenance costs for equipment.* Some maintenance costs will vary with time, others with mileage.
- *Fuel:* Large trucks typically achieve 5 to 7 mpg (as of the year 2005). Fuel can be allocated on a per-mile basis along with maintenance.
- *Tolls* can be allocated on a per-mile basis using typical values for a generic trip or actual tolls for a specific route.
- *Fees and taxes* will vary by state; most can be included in daily equipment costs.
- *Insurance* costs have driven some smaller fleets out of business.

Some modifications to truck costs can be considered. The rate/ton-mile is what is important relative to mode split, and this can be estimated by dividing the rate by the shipment size or typical payload of the truck. (The 15 tons/load figure cited above is a good factor for general merchandise, but payloads will be higher for commodities that have higher density.) In most states, it is possible to use multiple trailers of various kinds, which will reduce the cost per ton on the order of 10 to 20 percent.

The service provided by rail-competitive trucks is also easy to estimate, since most long-distance trucking uses the interstate system. A trip of up to 500 miles can be done overnight. A trip of 1,000 miles can be done in 2 days. Faster service (1,000 or more miles per day) can be provided by using two drivers. Long-distance trucking is very reliable compared to rail, so it is usually not necessary to worry about the distribution of trip times.

Low empty mileage and efficient equipment utilization are the keys to low operating costs. In order to maximize loaded-miles and the total weight carried, carriers will sometimes consolidate several loads, often from one origin to several destinations or from multiple origins to a single destination. Congestion is a major concern for truckers, because congestion increases travel time, reduces utilization, and limits the amount of work that can be completed in a day. On a very short-run basis, costs of drivers and fuel are the most important, as the cost of equipment is not a day-to-day issue.

Element 2 – Intermodal Freight Movement

Intermodal freight involves a combination of trucking for the pickup and delivery ends (drayage), transferring at an intermodal terminal for rail movement for the longer distance linehaul travel. In general, intermodal is faster and more reliable than general rail service and cheaper than truckload service. Intermodal service levels are generally similar to those for truck. Additional time is required in the terminals, but trains generally can move traffic further in a day than can trucks. For long hauls, therefore, intermodal can be faster than truck, while for shorter hauls, trucks can be faster than intermodal service. The differences are likely to be on the order of hours, not days. Truck operations also tend to be more reliable, and pickup and delivery times are more flexible—two aspects of service that can be important to some customers.

To evaluate the relative cost of intermodal freight compared to other options, it is necessary to separately consider the three distinct elements of intermodal service: (1) drayage, (2) terminals/hubs, and (3) linehaul.

- **Drayage.** Costs of drayage consist largely of the costs related to the driver and the tractor, both of which are largely proportional to the time required per dray. Hence, draymen focus on the number of trips per day that they can make, and they are concerned about taking excessive time to pick up or deliver a container. In addition, there are public concerns with traffic congestion near the intermodal terminal, vehicle-miles traveled within the congested area, and the related effects on noise, air quality, and quality of life along the routes used to access the terminal. Drayage costs can be below \$50 for short hauls, but up to \$500 or more for trips more than 200 miles from the terminal; \$150 per trailer or container is a typical figure. Drayage costs can be modeled in detail using the same approach described in the previous section for trucking costs.
- **Terminals/Hubs.** Terminal costs include the costs related to the gate operation, lifting containers and trailers on and off the trains, storage of containers, and management of empty equipment. There are economies of scale in intermodal terminals, so that railroads and terminal operators try to concentrate the workload at a few high-volume facilities rather than at more, smaller volume but perhaps better located facilities. Depending on the nature and size of the operation, terminal costs can be \$50 to \$150 per lift. Some intermodal terminals also act as hubs where intermodal traffic is transferred between trains. The transfer operation adds to operating costs, but using hubs makes it easier to consolidate traffic and increase train frequencies in key lanes.
- **Linehaul.** Variable linehaul costs include the costs of operating the train, the equipment costs for locomotives and freight cars, maintenance costs for the right-of-way, and costs related to communications and control. As of the year 2005, these costs range from \$0.70 to \$0.80 per container-mile or trailer-mile for TOFC (truck on flatcar) or COFC (container on flatcar), but only \$0.40 to 0.50 per mile for double-stack trains. This compares to trucking costs of \$1.00 to 1.35 for TL or the linehaul portion of LTL.

Many of the basic concepts of the competition between truckload and intermodal freight options can be understood in terms of a very simple cost comparison:

$$\begin{aligned} \text{Intermodal} - \text{Truck Cost} &= \text{Drayage} + \text{Terminal} + \text{Intermodal Linehaul} - \text{Truck Linehaul} \\ &= \text{Drayage} + \text{Terminal} + (\text{Trk}\$/\text{mile} - \text{Int}\$/\text{mile} \times (1 + \text{circuitry})) \times \text{Distance} \end{aligned}$$

Since the linehaul costs are fairly constant for competitive distance, the basic question is whether or not the intermodal savings per mile are sufficient to offset the added costs for drayage and terminal costs. Generally, the trip must be several hundred miles before the linehaul savings from intermodal shipment becomes larger than the added costs associated with drayage and terminals.

Factors Affecting Carrier Costs. Lane density is also an important consideration for intermodal operations. The higher the density, the easier it is to provide frequent service to customers and the easier it is to fill up trains. The geography of the region and the location of the intermodal terminals in respect to the lane also are significant cost factors. A substantial drayage of a hundred miles or more is not necessarily a problem, so long as it is in the general direction that the shipment is moving; the distance-related portion of drayage costs would not be much different than if the move were the first portion of a TL move. If the drayage required backtracking a hundred miles or more, then the drayage costs would be a much more significant burden in competing with the direct TL move.

Double-stack has grown dramatically because the linehaul savings are so much greater than they are with TOFC. Instead of a linehaul service that offers a modest saving over TL, double-stack

cuts the linehaul costs to less than half of truck costs. Railroads and, in some cases, public agencies have invested in increasing clearances along the right-of-way in order allow operation of double-stack trains.

Other technological changes are further reducing intermodal costs or flexibility. The Road-Railer technology allows specialized trailers or containers to be hauled in very efficient trains that can be assembled in small terminals without using expensive equipment. Two primary concepts have been used in specialized services. The original concept was to use trailers that had a rail axle as well as the traditional highway axles; the axles could be lowered or raised hydraulically in order to assemble and disassemble trains. The extra weight of the rail axle proved to be a competitive burden, as it reduced the load that could be carried on the highways. The newer concept was to use rail “cars” that were basically a pair of axles with a shelf that could hold up a trailer. A forklift could move these bogies around to facilitate train assembly, and the trailers would not have the extra weight of the wheels. A RoadRailer train is remarkable for its low wind resistance, which improves fuel efficiency at higher speeds, and for its very low loss and damage rate. This type of equipment is not quite as efficient as double-stack trains, so it has been used in specialized traffic lanes that lack the volume to support double-stack service.

Other innovations that may also change intermodal costs are the Expressway and Rolling Highway classes of equipment and similar rail systems. These provide what is effectively a long, articulated platform for hauling any kind of trailers, containers, or even tractor-trailer combinations. Like the RoadRailer technology, no specialized terminal lift equipment is necessary and very little space is needed for loading or unloading. This type of technology has been used in Canada for tank and flatbed highway trailers as well as vans, and for many years in Europe to shuttle trucks through tunnels in the Alps. The ability to carry tractor-trailer combinations means that this technology could support other kinds of shuttle services that take highway trucks off the road for movement through metropolitan areas. For example, Chicago Metropolis 2020 has recently recommended that “intermodal bypass service should be developed to shuttle trucks 100 to 400 miles through and around the region.”ⁱⁱ

Element 3 – Unit Train Freight Movement

Unit train costs are straightforward. The main cost elements are (1) equipment, (2) operations, and (3) track maintenance.

- *Equipment costs* are generally considered to be the cost of ownership and maintenance, and they are allocated based on time (for ownership and some maintenance) or distance traveled (for most maintenance). Equipment costs can be allocated to a shipment based on the cycle time required for the trip and the distance traveled. The modeling approach is the same as described above for TL operations.
- *Operating costs* include the costs of the crew, fuel, and communications and control. Crew and fuel costs are most important. Crew costs are determined by complex labor agreements, but, for most unit train services, they will be approximately proportional to train-miles. Fuel costs vary with gross tonnage and the terrain. Track maintenance includes the costs of installing, inspecting, and maintaining rail, ties, ballast, and structures. These costs generally vary with the gross tonnage carried. Costs will be somewhat higher if axle loads or operating speeds are higher.

Administrative costs and most other costs are commonly assumed to be fixed costs that can be allocated on the basis of tonnage or shipments.

Unit train service is generally easy to understand, as it operates similarly to truckload service. The train operates on a continuous cycle between a shipper and a receiver, making 5 to 10 or

ⁱⁱ“The Metropolis Freight Plan: Delivering the Goods,” Chicago Metropolis 2020, 2004, p. 28

more cycles per month depending on the distance and the time required to load and unload the train. While average speed might only be 20 mph, this allows unit trains to travel on the order of 500 miles per day, which is competitive with trucks for longer distances. Since terminals are usually bypassed, unit train service is reasonably reliable.

Element 4 – General Freight Train Movement

General freight service is used when a shipper uses one or more railcars but less than a full train. The resulting service is more complicated to operate than intermodal or unit train service. The main difference is that freight must go through a series of rail yards; at each yard, freight cars are sorted and assembled into trains.

The variable costs of yard operations are on the order of \$25 to \$100, depending on the size of the facility, the complexity of the operation, and the amount of traffic. There are economies of scale and of density, and railroads have long attempted to expand the geographic coverage of their networks while consolidating switching operations into fewer, larger yards.

General freight service requires the railroad to serve the customer directly. Placement of an empty car for loading, picking up the loaded car, delivering the load, and picking up the empty car tend to be time-consuming operations performed by crews handling short trains on light-density lines or in terminal areas. Important trade-offs are embodied in two fundamental decisions: how often to provide service on a branch line and how well to maintain the branch line. Higher frequency of service increases crew costs, but lower frequency service leaves cars at customers' sidings for extra days and increases car costs. Lower quality maintenance reduces train speeds and adds to the time required for switching, but better maintenance can greatly increase costs if there is only a small amount of traffic using the line. The trend since the 1920s has been for railroads to reduce the number of branch lines in order to avoid the high costs of operations and maintenance.

The size of the shipment is a key factor for general freight service. A rail car can typically carry 3 to 5 times as much freight as a truck, yet the linehaul costs will be similar (i.e., on the order of \$1 per mile for boxcar service). Even with the added costs associated with terminals and branch-line operations, costs per ton can therefore be much lower than for TL or intermodal. However, the costs are very situation specific: a move involving many terminals and very light-density branch lines can easily be more expensive than going by truck. Also, a move involving shortline railroads can be cheaper than an equivalent move involving one of the larger railroads, because they may have a much different cost structure related to train crews, track maintenance, and other cost factors.

While low cost is a benefit for merchandise traffic, service quality is a major problem. It takes approximately a day for each terminal, and there is a chance of missing a connection at each terminal because of delays or lack of room on the outbound train. As a result, service is slow and unreliable; the typical 600-mile trip takes 6 to 8 days, which is much longer and far less reliable than truck service. During congested periods, service deteriorates dramatically.

Additional Rail Performance Models

Besides the rules-of-thumb estimation approaches and more detailed cost component approaches discussed in the preceding text, computer models also can be used for rail system cost, performance, and supply adequacy. They include

- **Train performance calculators.** A TPC calculates train performance (speed and energy consumption) as a function of train and route characteristics.
- **Dispatching models.** These models predict the movement of trains along a route, taking into account the need for trains to use passing sidings on single-track routes, and the need to allow

high-priority, fast trains (passenger or intermodal) to overtake slower trains. These models can include disruptions related to weather or maintenance; similar models are used by some railroads to assist in real-time dispatching of trains.

- **Train scheduling models.** These models are similar to dispatching models in that they create a schedule for trains operating over a route, given the scheduled departure times, route characteristics, and train priorities.
- **Terminal performance models.** Simple models estimate terminal processing time and cost requirements as functions of traffic volumes, schedules, and processing capabilities; more complex simulation models can analyze the effects of changes in layout or processing capabilities on performance.
- **Track maintenance models.** These models predict maintenance requirements as a function of the traffic mix and volume, equipment characteristics, track components, and maintenance strategies.
- **Network simulation models.** These models can simulate the operation of a terminal area, a region, or an entire system.
- **Rail cost models.** Service unit costing is commonly used to estimate rail costs; this technique is an example of what is currently called “activity-based costing,” as it relates costs to activities or service units such as train-miles, car-miles, cars handled at yards, and ton-miles.
- **Rail service models.** These models relate trip times and reliability to schedules, terminal capabilities, and traffic volumes.
- **Equipment utilization models.** These models predict cycle times for freight cars (which is the number of freight car-days required to move a load and to reposition the car for its next load). Fleet sizing, empty car distribution, and fleet management are very important matters for achieving efficient rail service; equipment costs can be very critical for some market segments.

5.2.6 Required Resources

The various types of truck and rail carrier cost estimation methods all require data (or assumptions) about factors such as

- Typical travel distance;
- Vehicle fuel use rate and associated distance-based costs;
- Typical travel times and speeds;
- Crew or driver time-based costs;
- Typical terminal requirements;
- Terminal time and expense costs;
- Typical vehicle (truck or train car) requirements;
- Vehicle ownership and maintenance costs; and
- Typical taxes, tolls, and fees collected by agencies.

Realistic data are required to ensure appropriate comparisons of the rail and truck costs for various different classes of freight travel.

5.3 Analyze Overall Logistics Costs

5.3.1 Overview

This step develops estimates of the direct shipping cost and overall logistics cost considerations as viewed by shippers involved in evaluating rail and truck alternatives. The basic concept is that if a project can improve rail service or operating efficiency, then it can reduce logistics costs sufficiently to induce some customers to shift from truck to rail. Alternately, if service is attractive but capacity-constrained, a project could allow utilization of rail by customers in

greater volume. However, before modal diversion can be estimated, it is first necessary to develop measures of the logistics cost and service features associated with rail and truck alternatives.

5.3.2 Components

The analysis of logistics costs involves two elements:

- *Logistics Cost Analysis* to estimate the total cost of shipping via applicable truck and rail freight shipping options; and
- *Service Features Analysis* to identify differences in capacity, reliability, and other features that also affect the freight mode decisions of shippers.

5.3.3 Background

Freight flows result from the interaction of many thousands of customers seeking sources for their raw materials and markets for their outputs and many hundreds of carriers offering transportation services. It is therefore useful to view freight transportation as a component of a broader logistics system that includes warehousing, location of factories, choice of suppliers, and selection of markets.

Freight shippers and their customers are not necessarily looking for the cheapest or the fastest transportation, but the transportation that best fits their overall logistics objectives. A shipper interested in minimizing total logistics costs will be concerned with various aspects of the services that carriers offer: (1) shipping rate charged, (2) shipment trip time and reliability, (3) size of the shipment, (4) costs to the customer for ordering and paying for a shipment, and (5) costs to the customer for loading and unloading the shipment

Therefore, to understand logistics decisions, it is necessary to understand elements of the service provided by the carriers. For shippers of bulk products, the transportation rate per ton might be the dominant concern. For high-value commodities, where inventory costs are important, customers will also be very interested in shipment sizes, trip times, and reliability. For many situations, ordering costs or loading/unloading costs will be critical. In general, to understand why freight flows on particular modes, it is useful to understand how each carrier's costs and service affect the logistics costs of potential freight shippers.

5.3.4 Factors

Freight mode choice decisions are based to a large extent on logistics costs, which include ordering costs, inventory costs, loading and unloading costs, and loss and damage, as well as the rate charged by the freight carrier (Exhibit 5-2 illustrates this).

Exhibit 5-3 portrays the factors covered in the preceding exhibit into three categories: commodity, customer, and transport characteristics. These factors can be used to estimate the logistics costs for a particular shipment by each of the available modes. Depending on the situation, options could include express package, air freight, truckload (TL), less-than-truckload (LTL), rail-truck intermodal, rail carload, rail multi-car, rail unit train, and barge. Within each of these modes, there could be multiple options regarding shipment size or service quality. For any particular shipment, the choices can quickly be narrowed down to two or three of the most relevant modes.

5.3.5 Methods

The logic for logistics cost analysis might be straightforward, but the differing factors and information requirements can be overwhelming, especially when there can be thousands of different types of shipments that might be moving along a congested highway. Clearly, a sound

<p>Transport Cost - The amount charged by the carrier(s) for transporting the shipment plus the costs related to any equipment owned by the customer</p> <p>Ordering Cost - The customer's cost associated with arranging and paying for the shipment, which will be a fixed cost for each mode and class of service</p> <p>Loss & Damage - The expected costs related to either losing or damaging some or all of the shipment, which can be expressed as a percentage of the value of the shipment</p> <p>Perishability - The potential for loss of value of the shipment caused by deterioration of the commodity (e.g. fresh fruits & vegetables) or delays in reaching the market (e.g. greeting cards being distributed to retailers for a holiday season); perishability can be expressed as a function that increases rapidly with transportation delays; perishable products might require specialized equipment or warehousing</p> <p>Inventory Costs - Costs associated with holding inventory can include warehousing, insurance, and capital costs; these costs are commonly expressed as a percentage of value of the commodity, e.g. 10-20% of the value of the commodity per year</p> <ul style="list-style-type: none"> - <i>Origin</i> - Inventory held at the origin until there is enough available to ship to the destination. If production and shipments are uniform throughout the year, then the average amount of inventory at the origin will be ½ of the shipment size. - <i>In-transit</i> - The capital carrying costs associated with the shipment while it is in transit - <i>Destination</i> - Inventory held at the destination until it is used. If shipments and usage are uniform throughout the year, then the average inventory will be ½ the shipment size. - <i>Safety Stock</i> - Additional inventory will be kept to protect against higher-than-expected demand or delays in producing, ordering, shipping, or transporting shipments. The more variable the time between ordering and delivery, the higher the safety stock must be to protect against stock-outs.

Exhibit 5-2. Elements of Logistics Cost.

methodology and some simplifying assumptions are needed for dealing with the data problems. In fact, there are four approaches to assembling inputs for a logistics analysis:

Approach 1 – Use Rules-Of-Thumb Values Prepared by Experts for Prior Studies

The crudest form of logistics cost analysis is to ignore differences among commodities and merely identify the average costs of rail and truck alternatives. For example, rail unit trains generally have

Factor	Elements Affected
Commodity Characteristics	
Value per unit weight	Inventory, perishability, and loss & damage costs
Density	Shipment size and inventory costs
Shelf life	Perishability
Customer Characteristics	
Annual volume shipped from one origin to a particular destination	Inventory costs (since the average inventory is ½ the shipment size, this fixed cost will be spread over the total annual shipments)
Inventory carrying costs	Inventory costs
Distance (origin-to-destination)	Transportation costs
Mode Characteristics	
Cost per shipment (transport rate)	Transportation costs
Capacity (weight)	Shipment size and therefore inventory costs
Capacity (space)	Shipment size and therefore inventory costs
Trip time	Inventory costs
Reliability	Stock-out costs
Loss & damage probability	Loss & damage costs
Loading & unloading capabilities (manpower, equipment, time required)	Loading and unloading costs

Exhibit 5-3. Factors Influencing Logistics Costs.

a cost of about \$0.01 per ton-mile compared to \$0.025 for general freight service or \$0.05 for heavy trucks. These costs can then be compared to differences in delivery schedule and reliability needed for shipping of the relevant commodities in order to derive cost-delivery tradeoffs. The limitation of this approach is that it ignores delivery schedule and reliability requirements that are vastly different among various commodities, so it is most useful only when an area's freight shipments are dominated by one or two commodities (e.g., incoming wood and outgoing lumber or paper products).

The additional importance of delivery schedule reliability for products that commonly move by truck is demonstrated by findings of NCHRP Study 2-18 (*Development of an Innovative Highway User-Cost Estimation Procedure*), which surveyed trucking companies and confirmed findings of prior studies that they place a value on freight transit time savings that is far beyond the equivalent hourly driver wage rate alone. A compendium of value placed on avoiding time delay for truck deliveries is also provided in findings from *NCHRP Report 463: Economic Implications of Congestion* (2001).

Approach 2 – Use Commodity-Specific Logistic Factors Prepared by Experts

Many studies have been conducted concerning all aspects of logistics analysis for specific commodities. Reports have compiled the characteristics of thousands of individual commodities, giving typical density, shelf life, and value. Studies have documented customer characteristics for many different industries, and the basic parameters of mode performance are well understood. Many prior studies have used general concepts, such as “high,” “medium,” or “low-value” commodities, and coarse characterizations are likely to be sufficient, at least for preliminary analysis. Therefore it is possible to identify and to use typical values for all of the factors required. Care is required in selecting typical values, so this is a task that should be assigned to someone with considerable prior experience.

Approach 3 – Use Values from Experts Familiar with the Present Study

The next level of effort is to assemble an advisory group for a particular study; the group should include carrier officials, customer representatives, planners, and consultants. The members of the advisory group might be able to provide guidance concerning what ranges of values to consider for many or all of the various factors required.

Approach 4 – Conduct a Survey of Customers and Carriers Involved in the Present Study

Potentially affected carriers and shippers can be surveyed to determine whether the cost and service changes associated with an investment project are likely to influence their modal choices. For example, a study of freight investments in Chicago involved surveys of rail users to estimate expected changes in shipping costs associated with changes in the quality of freight survey (Reebie and EDRG, 2003). These data were used to estimate how costs associated with different investment alternatives were likely to fall on each industry group. These costs were then entered into an economic simulation model as changes in the cost of doing business by industrial group. Because businesses were directly asked about how investment scenarios would affect overall costs, the approach implicitly allows for the possibility of modal substitution. Unlike the traditional approach (which focuses only on carriers), this approach captures the different sensitivities of individual sectors to changes in cost structures (i.e., different effects on output and employment depending on competitiveness of market). By assigning cost reductions across industry groups, this approach also reflects that many firms have in-house trucking services and therefore do not outsource or outsource only a portion of their transportation requirements to carriers. The downside of this approach, however, is the cost and difficulty of obtaining data on

shipper responses to changes in freight cost and service, which can only be gathered using survey techniques.

Considerations for All Approaches

Whichever approach is used, it is important to focus on the customers and commodities that are most relevant. When seeking rail solutions for highway congestion, it is only necessary to consider those shipments for which rail and truck are both reasonable options. There are two broad categories of shipments of interest. First, there is a range of containerizable shipments for which rail, truck, and intermodal options are the major choices. Containerizable commodities include general merchandise and many other commodities that could move in a boxcar, an intermodal container, or a (normally dry van) trailer. Within this group of potential shipments, rail and intermodal become more attractive as distances increase and as costs become more important to customers than service. The second category of shipments is bulk commodities, with rail increasingly favored over truck as distances increase. Rail options, whether for bulk or for containerizable shipments, become more attractive as annual volumes increase; with higher volumes, inventory costs become less important and the large shipment sizes offered by rail can be used effectively.

Since most freight customers are concerned with minimizing total logistics costs, it is possible to develop a simple mode-split model based on the factors and relationships shown in Exhibits 5-2 and 5-3. A spreadsheet can be used to compute total logistics costs as a function of the commodity, customer, and mode characteristics. The shipment size, which in theory could be continuously variable, in practice will be determined by the characteristics of the equipment. Bulk shipments will fill the truck or rail car to limits imposed by space or axle loads. General merchandise shipments that are rail competitive will generally either be truckload or carload, with loads limited by either space or axle loadings. The economic order quantity (EOQ) can also be used to determine if a smaller shipment size is justifiable because of inventory savings.

In a head-to-head comparison of intermodal rail against over-the-road truck service, many logistics features will be comparable in the eyes of shippers and can be canceled out of the calculation because they have an equivalent effect on both sides. Equipment types, order sizes, handling characteristics, and even loss and damage can be negligibly different between the truck and intermodal modes. The logistics factors then simplify down to trip time, reliability, and transport costs. In high-service intermodal lanes, the time and reliability differences also may become less important, allowing for an even greater simplification of the analysis down to cost considerations.

5.3.6 Required Resources

To study the relative costs (and characteristics) of shipping by truck or rail freight, it is necessary to develop data for typical shippers who move freight over a corridor, through a city, or within a region. The database needs to have customer, commodity, and carrier characteristics for a representative set of movements. Using such data, the logistics costs can be estimated for each mode used, and it will be possible to identify movements where rail can be a viable alternative to truck. The effects of a proposed project, change in operations, or new pricing strategy must then be translated into changes in the commodity, customer, or carrier characteristics, so that the logistics costs can be re-estimated.

Carriers seldom have access to detailed information concerning the total logistics costs for particular types of shipment. Moreover, they are likely to be thinking in terms of “shipping lanes,” e.g., New York City to Chicago or Atlanta to Jacksonville. Each lane is made up of many different kinds of shipments from many different types of customers. Lanes are relevant to carriers, because they relate to how they organize and manage their operations and their networks.

Shippers can provide information on the cost and schedule reliability characteristics of their shipping services. If data can be collected or estimated for a typical group of shippers, then a logistics cost model can be used to estimate the cost and service characteristics of the competing modes, and that information can be applied to estimate resulting changes in mode shares.

The database can include actual and/or hypothetical data. The advantage of using actual data is that the study will be more realistic and more believable; the disadvantage is that it may be very time-consuming and costly to collect the data. The advantage of using hypothetical data for typical cases is that the study can produce some results very quickly; the disadvantage is that it may be difficult to ensure that the typical case is truly representative of actual conditions.

For bulk shippers, it may be possible to identify a small number of customers currently using truck who would be excellent candidates for using mini-unit trains. If the shippers cooperate, it will not be difficult to obtain the relevant information concerning the commodity, the customer, and the modal options. For containerizable freight, there will be many more potential customers, and a survey will be more difficult.

5.4 Estimate Truck to Rail Diversion

5.4.1 Overview

This step estimates project effects on freight traffic diversion, i.e., the expected level of freight movement likely to be shifted from congested roads to new, better, or expanded rail services. It builds on the analysis of logistics cost and service quality features and tradeoffs identified in the preceding step to identify the potential for a project to allow some customers to save cost by shifting from truck to rail.

5.4.2 Components

The analysis of freight modal diversion involves two elements:

- *Mode Choice and Modal Share Analysis* to estimate changes in rail and truck modal shares associated with proposed project investments; and
- *Sensitivity Analysis* to estimate the extent to which small refinements in the proposed project can make rail more attractive than trucks.

5.4.3 Background

The rail and truck shares of freight trips are the result of decisions by many different shippers. Even within a single company, there may be different transportation requirements for various shipments involving different origins and destinations. For some of these shipments, rail or intermodal could be the obvious choice, but for others, truckload or LTL could be preferred. Hence, shippers and their customers are likely to select multiple freight modes. Policies can be established regarding when it is appropriate to use each mode. There may even be traffic managers who do not ship by rail because of bad experiences, no matter how long ago and no matter how compelling the economics of using rail. Over time, customers' overall use of rail often changes, partly in response to changes in freight service, but also in response to changes in how they manage their supply chains. Generally, modal choice models work on an aggregate level that ignores the idiosyncrasies of individual firm decisions. Instead, such models work by estimating the impact of cost and other shipping changes on the overall share of shipments moving by each mode, given a particular commodity mix.

5.4.4 Factors

Any analysis of existing freight mode split or future freight modal diversion is necessarily based on consideration of six key factors as follows:

- The mix of commodities moving to, from, or through the study area or corridor;
- Existing rail and truck mode shares for those commodities and industries;
- The availability of rail options for commodities now traveling to/from the area by truck;
- Carrier service and cost features for rail and truck options (discussed in Section 5.2);
- User logistics costs associated with rail or truck options (discussed in Section 5.3); and
- Additional taxes, fees, or subsidies that affect decisions about rail or truck choices.

5.4.5 Methods

The analysis of modal diversion can be viewed from two perspectives: (1) from an individual case perspective, in which a *mode choice* model identifies the best and most likely mode choice for a given type of business, commodity, and origin-destination combination, or (2) from an aggregate perspective, in which a *modal share* model estimates the overall portion of shipments moving by each mode, given a mix of business types, commodity types, and origin-destination characteristics. In fact, a common approach spans both perspectives by applying a mode choice model for a representative set of individual cases and then developing a weighted sum of those cases to estimate aggregate mode shares.

In most individual situations, one mode will clearly be the best, so it will be expected to capture all of the freight. Still, in many situations, two or more of these models will be close. For policy analysis, it is generally more realistic and more informative to assume a mode will get some of the freight if its total logistics costs are close to the other modes. The modal shares for these cases can be estimated by comparing the total logistics costs for rail, rail-truck intermodal, and truck. Various techniques can be used to estimate modal shares given the total logistics costs for each mode. The math can become complicated, but the logic is simple: if the total logistics costs are about equal, then the two modes should be predicted to each get about half the freight; as the total logistics costs for one mode increase, then its share should go down; if the total logistics costs for one mode are much higher, then it should not be expected to carry any of the freight. Two approaches are commonly used to calculate these shares and the effect of proposed projects on them. They are discussed below.

Approach 1: Use Logit Models of Discrete Choice Decisions

Logit models, which have been extensively used in modeling mode choice for commuters, are statistical models that allocate mode shares based on a comparison of the “utility” (estimated overall benefit) of each available mode of transportation. The basic form is as follows:

$$\text{Mode share (A)} = e^{-U(a)} / \sum(e^{-U(i)}), \text{ for all modes } i$$

In this equation, $U(i)$ is the utility associated with mode i . For freight analysis, the total logistics cost has most commonly been used as the predominant measure of utility, so that this formulation can easily be used with the logistics cost model.

Approach 2: Use Statistical Analysis of Logistics Cost Variation

A second approach is to assume that the estimates of total logistics costs are the expected values of a random variable that is normally distributed with a known variance. The mode split can then be thought of as being the probability that the logistics costs of the mode are in fact lower than the logistics costs of the other options. If the estimates of logistics costs are very good and if the analysis includes all of the variables used by the shipper, then the standard deviation of the total logistics costs

will be small (this is the kind of analysis that a shipper will perform—identify the best option and use it). If the estimates of logistics cost are less precise and if it is unclear that all important elements have been properly included, then the standard deviation of the total logistics costs will be larger (this is the more usual case for a researcher or a planner). The difference in the estimated costs can be compared to the standard deviation of the costs in order to estimate the probability that one cost will be lower than the other. While this requires complex mathematics, spreadsheets typically have a function that will return the probability that a is less than b, under the assumption that a and b are the expected values of normally distributed random variables with a known standard deviation s (in Microsoft Excel, the desired probability is calculated as $\text{NORMDIST}((a-b)/s,0,1,\text{true})$).

Policy Analysis

Policy analysis involves re-estimating the truck and rail mode shares, using either of the above-cited techniques, while varying the assumed values of costs and service levels associated with those alternatives. This tests the sensitivity of the results to variations in the assumptions. It is useful to show how changes in mode characteristics (e.g., rates or service quality) will affect the split of mode shares.

For example, public subsidies of or investments in rail could be reflected as a change in service, a change in rates, or a change in loading/unloading costs, depending on the investment. Public investment in rail-truck intermodal could be represented by adding an intermodal option or by changing the characteristics of the intermodal option. Public actions that increase costs to highway users (such as tolls) could be reflected in the truck characteristics.

To conduct this type of policy analysis, it is necessary to create a database to represent the profile or mix of shippers and shipments that move freight over a corridor, through a city, or within a region. The database needs to have information related to a sample of origin/destination movements to which the logistics cost model can be applied. The database will therefore need to have customer, commodity, and carrier characteristics for a representative set of movements. Using these data, the logistics costs and then the mode share can be estimated. The effects of a proposed project, change in operations, or a new pricing strategy must be translated into changes in the commodity, customer, or carrier characteristics, so that the logistics costs and estimated mode shares can be re-estimated.

Two types of studies can be done, one using actual data and the other using representative but hypothetical data. The advantage of using actual data is that the study will be more realistic and more believable; the disadvantage is that it can be very time-consuming and costly to collect the data. The advantage of using hypothetical data is that the study can produce some results very quickly; the disadvantage is that it can be difficult to ensure that the hypothetical data are completely realistic. Examples of both approaches are provided in the collection of Project Resources, cited in Chapter 6.

For bulk shippers, it might be possible to identify a small number of customers who are currently using truck and who would be excellent candidates for using mini-unit trains. If the shippers cooperate, it will not be difficult to obtain the relevant information concerning the commodity, the customer, and the modal options. For containerizable freight, there will be many more potential customers, but it will still be possible to conduct a survey to obtain representative information concerning commodity, customer, and modal characteristics. For either situation, it will also be possible to use data representing a hypothetical set of customers. This approach can be useful because it allows rapid assessment of the relative merit of various changes in the freight system.

5.4.6 Required Resources

To study the potential for freight traffic diversion, it is necessary to develop profiles of commodity mix, shipper/customer types, and carrier price and service characteristics. Then a modal

choice or market share model can estimate the shift in truck and rail shares that would result from changes in logistics costs and service levels available from alternative modal options. However, all such models depend on assumptions regarding the mix of customers, shipments, and available carriers. It will normally be much too difficult to attempt a comprehensive analysis of thousands of individual shipments. Instead, it is more realistic to use statistical models with assumptions about a given mix or representative set of shippers and shipments.

5.5 Calculate Traffic & Economic Benefits

5.5.1 Overview

This step evaluates the benefits of projects and policies that reduce traffic congestion by reducing truck traffic in those areas and shifting it to rail freight services. There are four distinct perspectives for viewing their impacts and benefits: (1) transportation system efficiency, (2) user benefit, (3) economic growth benefit, and (4) total societal benefit.

5.5.2 Components

Different analysis methods are required for analysis of benefits as viewed by each perspective. Accordingly, the analysis approaches are discussed separately for each of these four views:

- *Transportation system efficiency benefit*, in terms of improved traffic flow and reduced cost for carriers;
- *User benefit*, in terms of reduced total logistics cost for freight shippers;
- *Economic growth benefit*, in terms of resulting increase in jobs and income in a local, regional, or national economy; and
- *Total societal benefit*, including the value of environmental improvements that may be over-and-above any economic benefits.

5.5.3 Background

Direct *travel benefits* associated with transportation investments include out-of-pocket operating cost savings and the value of time savings and safety benefits. These travel benefits are also referred to as *transportation system efficiency benefits* since they reflect performance characteristics of the transportation system. In urban planning contexts, these benefits are sometimes also referred to as *user benefits*, based on the notion that the vehicle drivers and passengers are the parties using the transportation system and hence benefiting from its improvement. However, freight studies may separately define the full user benefit of freight transportation system changes as the total logistics cost benefits accruing to shippers (rather than just the change in vehicle cost and staff time for the carrier).

Analysts sometimes disagree about the value of measuring benefits as carriers' cost changes (here referred to as *freight travel benefits*) versus measuring benefits as shippers' total logistics cost changes (here referred to as *freight user benefit*). Both measures can be useful, and they can be seen as different perspectives for viewing the benefits of rail freight projects and programs. The freight user cost impact is more complete in its coverage and is particularly important for calculating truck/rail modal diversion effects and impacts on economic growth.

Freight user benefits, in turn, can have significant impacts on *economic activity*. The diversion of some freight to rail can save operating and safety costs for all affected groups: (1) freight shippers making the switch from truck to rail, (2) freight shippers still relying on trucks using the affected highways, and (3) passenger car and bus travelers who also use the affected highways.

The latter two groups benefit insofar as the highways remain less congested than they would have been without any modal diversion.

The benefits for shippers using both rail and truck modes can lead to increased *business productivity* (which is the level of economic activity that can be generated per dollar of labor and materials). That, in turn, can enhance the cost competitiveness, profitability, and economic expansion of directly affected shippers and indirectly affected firms that are their suppliers and customers. Of course, the extent of these broader economic benefits will depend on the extent to which benefiting shippers, suppliers, and customers are locally based in the affected region. To calculate those effects, a regional economic model is necessary.

In the end, the economic expansion of benefiting firms can expand *employment* opportunities and *income* levels for workers throughout the affected region. In addition, the local communities and states in which investments are made can become more attractive sites for business activity, leading to growth of existing firms and, in some cases, greater attraction of new or expanding businesses. Changes in economic activity levels, then, generate *fiscal impacts* on government revenues and costs at the local, state, and national levels.

5.5.4 Factors

The various benefits of encouraging rail freight options in congested highway segments come as a consequence of the following factors:

- Rail and truck cost and delivery performance changes,
- Overall vehicles and total ton-miles of diverted freight,
- Production cost and market access changes,
- Regional job and income generation by affected industries, and
- Air quality and other environmental impacts of traffic congestion reduction.

Each of the methods discussed below relies on some subset of these factors to calculate benefits from a particular perspective.

5.5.5 Methods

Element 1 – Transportation System Efficiency (Carrier Benefit)

Traditionally, transportation system efficiency benefits have been calculated as the sum of traveler savings in out-of-pocket operating costs, time savings, and safety costs (i.e., costs associated with fatal and non-fatal accidents). We can refer to the value of these three types of savings as the overall savings for travelers. Ideally, analyses should capture benefits to all classes of travelers, including (1) existing travelers, (2) “modal diversion” travel changes associated with modal switching and (3) “induced” travel changes associated with changes in length and frequency of travel.ⁱⁱⁱ

The transportation system efficiency benefits can include travel savings impacts for both highway system travelers and rail system travelers. For analysis of rail freight solutions to highway congestion, though, the main emphasis is on benefits from reduced highway congestion that accrue to existing highway system travelers. However, some rail improvement projects may also bring added benefit for existing rail system travelers. For analysis of passenger-oriented rail projects, such as introduction of high-speed rail, benefits to “diverted” and “induced” users also become important for estimating total travel-related benefits. Focusing only on the benefits of

ⁱⁱⁱWeisbrod and Weisbrod, p.20.

congestion reduction that accrue to existing highway travelers will provide a conservative estimate of total transportation efficiency benefits.

Calculation of Traveler Benefit. A shift of some truck traffic to rail freight can reduce traffic congestion and improve travel times for all (car and truck) travelers who remain highway users. The value of the highway traveler benefit for *all car and truck travelers who remain highway users* is calculated as the difference between the higher travel time and expense incurred if no changes were made and the lower time and expense incurred if the project is instituted and congestion is reduced. It can be represented as follows:

$$\begin{aligned} &[(\text{highway travel time value and expense}_{\text{without investment}}) \\ &- (\text{highway travel time value and expense}_{\text{with investment}})] \end{aligned}$$

If we focus instead on the benefit for all freight travelers (carriers), including trucking and rail carriers, then the value of the traveler benefit is calculated using information on expected cost changes for rail and truck freight and expected changes in modal share. The total expected savings for existing freight carriers can be calculated as follows:

$$\begin{aligned} &[(\text{truck freight cost}_{\text{without investment}} \times \text{truck share}_{\text{without investment}}) + (\text{rail freight cost}_{\text{without investment}} \times \text{rail share}_{\text{without investment}})] \\ &- [(\text{truck freight cost}_{\text{with investment}} \times \text{truck share}_{\text{with investment}}) + (\text{rail freight cost}_{\text{with investment}} \times \text{rail share}_{\text{with investment}})] \end{aligned}$$

This, however, only captures the benefits that accrue for current freight travel. For some projects, including large, long-range projects that might take 5 or 10 years to complete, it will be important to capture benefits that will accrue to all future users, i.e., current and expected new users. The impacts of the project on all future users can be estimated as follows:

$$\begin{aligned} &[(\text{projected truck freight cost}_{\text{without investment}} \times \text{projected truck share}_{\text{without investment}}) + (\text{projected rail freight cost}_{\text{without investment}} \times \text{projected rail share}_{\text{without investment}})] \\ &- [(\text{projected truck freight cost}_{\text{with investment}} \times \text{projected truck share}_{\text{with investment}}) + (\text{projected rail freight cost}_{\text{with investment}} \times \text{projected rail share}_{\text{with investment}})] \end{aligned}$$

Available Modeling Tools. Modeling tools can be used to represent transportation system performance and then calculate the total savings in delivery times, operating expenses, and accident rates resulting from freight transportation projects. Available models are discussed in the Caltrans Benefit-Cost website (http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/models/index.html).

Most of the available tools focus exclusively on highway user benefits, although a few also address rail user benefits. Examples of available options are noted below:

- STEAM is a well-known modeling tool for urban transportation planning that calculates traveler benefits at the regional or corridor levels and distinguishes peak and off-peak impacts. It then calculates the economic value of those benefits. It can also account for air quality benefits.
- State or regional highway network models use more sophisticated network simulation techniques to calculate the highway system benefits of proposed projects, and they can also capture small area changes affecting highway network connectivity and additional benefits of projects affecting connections between highways and special generators, such as ports or intermodal rail terminals. Results of highway models can be translated into dollar values, using values as shown in the AASHTO Red Book or using broader factors discussed more fully in the Caltrans Benefit Cost Guide at http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/index.html. It is also possible to perform these calculations automatically using a highway-oriented economic analysis tool such as StratBENCOST or Cal-B/C or NET_BC.

- For rail system benefits of proposed projects, the time and cost impacts on carriers and shippers can be calculated based on rail carrier cost and service models as discussed in Section 5.2. Detailed examples are provided in the collection of Project Resources cited in Chapter 6. A rail-oriented economic analysis tool, such as RAILDEC^{iv}, can then be used to calculate and assess the relative benefit of alternative rail projects.

It is also possible to allocate freight carrier benefits to industries using them. The most direct way is to use the U.S. DOT's Freight Analysis Framework (FAF) data that profiles the industries and commodities moving through large regions and along major corridors. The alternative, particularly applicable for urban freight cases, is to use the U.S. Bureau of Economic Analysis' Transportation Satellite Accounts (TSA) data, which estimate spending by mode per dollar of output and multiply it by the actual local profile of business output by industry. The product of these two vectors will yield an estimate of total local spending by mode by industry, which can be used to apportion total carrier benefits to individual shipping industries.

Element 2 – Additional Freight User Impact (Shipper Benefit)

The preceding calculations capture total cost savings for truck and rail carriers. Recent research describes the sequence by which transportation investments can translate into economic efficiency benefits on shippers, who are the true “users” of freight transportation services. By introducing, improving, or reducing freight costs in one or more transportation modes, transportation investments can lower logistics, loading, warehousing, and production costs and potentially also provide economies of scale by increasing market delivery areas. So although cost reductions at carriers may be fully passed on as price reductions for shippers (the long-term trend in the transportation industry), the changes in service levels associated with decreased congestion and improved reliability can also lead to changes in operating costs, market opportunities, and behavior at the shipping firms. It has been estimated that the traditional transportation efficiency measure of benefit, which examines only impacts on carriers, underestimates the total value of benefits for freight travel by 10 to 40 percent because it neglects additional shipper benefits (FHWA, 2004).^v As laid out in the FHWA Freight Benefit-Cost Study (ICF and HLB, 2002),^{vi} benefits to shippers can be thought of as occurring in three stages:

- In the first stage (i.e., “short term”),^{vii} shippers incur changes in direct transportation (carrier) costs as a result of new transportation projects. Any realized increase in transportation speed and reliability and decline in transportation costs does not affect the amounts of each type of transportation and logistics service purchased by firms (e.g., rail, truck, marine, inventory, warehousing, administration, and customer interactions) but only the prices that they pay for outside transportation services or costs they incur for self-transportation. In this stage, shippers benefit from the reduction in transportation costs but do not change their production or distribution processes—they merely realize a savings on the basket of

^{iv}RAILDEC is a family of software programs designed to evaluate the economic benefits from rail-related infrastructure benefits. It is available from the Federal Railroad Administration.

^vFreight Transportation: Improvements and the Economy. US Department of Transportation, FHWA, Washington, DC; June 2004.

^{vi}Economics Effects of Transportation: The Freight Story. Final Report. ICF Consulting and HLB Decision Economics; January, 2002. Appears as Appendix A in FHWA, 2004, op cit.

^{vii}“Short-term” refers to a time period that is short enough that firms do not have a chance to change any factors of production, i.e., cannot change the “recipe” they use to produce and distribute goods. The “long-term” refers to a time period of sufficient length that all factors of production can be changed. The “medium-term” here is used to capture that period that is long enough that some factors of production can be changed (e.g., less warehousing and more frequent deliveries) but too short for all factors to be changed (e.g., changes in capital and labor mix and utilization associated with adoption of just-in-time production schemes). Note that “short-,” “medium-” and “long-term” are not used in the ICF/HLB (2002) report, but are introduced here.

logistics-related services they already purchase. These savings have been termed “first-order benefits” (ICF/HLB, p.A-12).^{viii}

- In the second stage (“medium term”), firms shift the relative proportions of modal inputs to take advantage of the price reduction in one or more modes. That is, an increase in service quality and decline in costs in one transportation mode can lead firms to substitute spending on this mode for other transportation modes (e.g., more rail and less trucking). The logistics models discussed above and other mode choice models capture inter-modal substitutions, i.e., freight diversion. These savings are the first component of what have been termed “second-order benefits” (ICF/HLB, p.A-12).^{ix} Preliminary research suggests that, to account for second stage (i.e., substitution) impacts, “the benefits found in current benefit-cost models should be increased by about 15 percent to account for these newly measured [i.e., shipper] effects” (FHWA, 2004; p.8).^x Diversion will account for most, but not all, of these effects, which can include gains from modal shifts (i.e., diversion) as well as substitution of (newly improved) logistics services for other inputs.
- In the third stage (“long term”),^{xi} firms can reorganize their entire distribution systems around the availability of better or cheaper transportation services, leading to shifts among the types of logistics-related services purchased (e.g., more reliance on trucking and less on warehousing). Case studies also show that better freight transportation services can eventually spur firms to reorganize their entire distribution process, including (but by no means limited to) introduction of just-in-time systems. This can occur as, for example, a firm that relies increasingly on direct shipment to customers ends up adding investment and staff in computerized tracking systems while reducing warehouse-related labor, inventory, and insurance (FHWA, 2004; pp. 6, A-9, A-10).^{xii} Although logistics models generally capture inter-modal substitutions, none has been identified that explicitly models substitutions between transportation and other logistics services. Survey approaches that capture both intermodal substitution and substitution between transportation and other logistics services could be designed.

These savings are second-order benefits. The benefits associated with reorganization of distribution will vary according to the size of the transportation cost reduction, but can be substantial. Prior studies suggest that when transportation cost reductions are less than 2 percent, there is little or no measurable impact on shipper benefits, but that at transport cost reduction levels of 20 percent, reorganization effects can add an additional 9 percent in benefits (ICF/HLB, p. A-14).^{xiii} Other potential benefits include additional adjustments in operations due to the reduced need for schedule padding to allow for uncertainty in delivery times.

Related work has identified additional stages related to shipper response to reduced cost of transportation and logistics services. In particular, firms that have reorganized their distribution systems can also reorganize their production systems. For example, firms that develop just-in-time distribution systems can use this change as an entrée to introduce just-in-time production systems. Case studies indicate that savings from introduction of JIT manufacturing methods can create large savings on the assembly line.^{xiv} However, it is very difficult to predict whether or not and which firms will reorganize their production systems in advance of transportation investments. To do so would require analysts or firms themselves to be able to predict the types of broad reorganization

^{viii}Op cit.

^{ix}Op cit.

^xOp cit.

^{xi}The third stage (or “phase”, which ICF/HRB use) is marked by a shift in shippers’ demand curves in response to new prices and services at carriers.

^{xii}Op cit.

^{xiii}Op cit.

^{xiv}Economic Implications of Road Congestion. Weisbrod, G., D. Vary and G. Treyz. 2001. National Cooperative Highway Research Program, Report 463, National Academy Press.

that could be undertaken years down the road and to predict how competitors and other related actors (e.g., carriers, suppliers, and customers) would respond. For these reasons, these effects are usually not considered in economic impact studies for major projects.

Calculation of Freight User (Shipper) Benefit. The simplest approach for estimating the total freight transportation user benefit is to start with the measure of freight carrier benefit previously defined and multiply it by a factor that accounts for the shipper benefits that are beyond carrier cost savings. Based on the cited literature, this would mean adding roughly 15 percent to account for second-stage effects and 0 to 10 percent to account for potential third-stage effects (depending on the size of the transportation cost reduction). Although this approach would yield only a rough estimate of total user benefits and would yield little information on user impacts by industry, it is less data-intensive than methods that rely on surveys of shippers and/or additional analyses of likely second- and third-stage effects.

A second approach relies on estimating directly the impacts of transportation improvements on shippers using survey methods. Surveys can be designed to capture estimates of first, second- and even third-stage cost reductions. Two survey approaches are possible. For the first approach, industry users would be surveyed about the likely cost changes associated with investments and the results directly used to capture shipper benefits. For the second approach, industries would be surveyed about transportation, modal dependence, and transportation substitution possibilities to estimate the *relative* benefits likely to accrue to each industry. The relative measures can then be used to apportion total expected user benefits to individual industries. This method was used in the study of freight investments in Chicago (Reebie and EDRG, 2003).

A practical reason to prefer the direct approach is to confirm the sufficiency of benefits to induce modal shift. The previous chapter section, Designing Transactions, prescribed steps for the assurance of traffic volumes. They were founded on the engagement of shippers in first-hand discussions, which ought to begin in the early stages of a project—if for no other reason than information gathering—and should certainly take place before an evaluation is fully developed in order to demonstrate market acceptance. Quantitative methods of diversion analysis are derived from and are meant to model shipper behavior; however, they should not replace the direct affirmation by transportation purchasers that a particular service will win their business. Realistically, this can be done just as well during the estimation of diversion as during the calculation of benefits, and at either time can satisfy both purposes. The key thing is for shippers to agree with what the models represent and ultimately be willing to commit traffic.

Element 3 – Broader Economic Impacts

Three general types of economic impacts are associated with transportation projects: (1) productivity, (2) location, and (3) fiscal impacts.

Economic productivity benefits are those that raise the level of economic output produced per unit of labor and material cost. These come about in two general ways. First, the reduction in the cost of (freight and passenger) transport allows businesses to reduce the cost of inputs required to produce a given level of output or, conversely, to increase the amount of output for a given dollar level of inputs. Second, transportation improvements provide businesses access to larger labor, supplier, and customer markets, which results in better cost and quality in terms of inputs and greater economies of scale in production of outputs. Both raise the productivity of economic activity in the affected area and (to a much smaller degree) in the national economy.

Location of economic activity can also be affected by transportation projects. The reduction in costs and increase in productivity in project areas can result in a shift in business activity toward those areas. Some national productivity gain is associated with such shifts because

businesses that relocate due to transportation improvements do so in order to experience higher productivity than they otherwise would in their original location (otherwise they would not be moving). However, the impact at a larger national level can be mostly distributive, as a major portion of the gain at the new location occurs as a transfer of activity from another (non-project) area.

Shifts in business location patterns can be viewed as a net national social benefit under two conditions: (1) if the areas that gain growth opportunities have been identified by state or federal agencies as targets for economic development; or (2) if shifts in business location or increased output associated with projects represent net national gains in economic activity. For example, some portion of new economic output and employment in affected areas will be the result of increased exports to foreign markets that come at the expense of foreign rather than other U.S. producers. Similarly, a portion of business location shifts will reflect foreign investors taking advantage of better productive conditions in the project areas. Although some of the foreign direct investment (FDI) stimulated by a project will come at the expense of other U.S. locations, a portion could come at the expense of foreign (i.e., non-U.S.) locations. Thus, where transportation projects stimulate exports and/or FDI, it is likely that some of this increase in output and employment reflects a net national economic benefit.

Fiscal impacts on government revenues and costs can also occur at the local, state, and national levels as a result of various business efficiency and location impacts. Fiscal impacts can be traced to capital, operating, and maintenance expenses associated with transportation investments, and changes in tax revenues from output and employment effects. Input-output and economic simulation models can provide estimates of fiscal impacts associated with user and economic benefits.

Calculation of Economic Impacts. Depending on project budget and the degree of confidence in results that is required, analysts can use different techniques and models to estimate economic impacts:

- If estimates of output impacts from carrier and/or shipper cost savings are available, input-output models (which can be relatively inexpensive) can be used to estimate total employment, output, and fiscal impacts.
- If only estimates of cost savings by carriers and/or shippers are available, economic simulation models can be used to estimate total employment, output, export, fiscal, and other impacts.
- Neither input-output nor economic simulation models can capture likely business attraction effects, which must be estimated using a business attraction model or if resources are constrained, estimated based on information gathered from local and state economic development agencies.

Regional Economic Impact Models. Economic impact models are frequently used to convert direct cost savings, market access, and productivity effects into broader regional/macroeconomic impacts on measures such as employment by industry, gross regional/state product, and personal income. A listing of economic impact models, with links for further information about them, is provided on the website of the TRB Committee on Transportation and Economic Development (www.tedcommittee.com). The most commonly used types of tools are summarized below:

- **Regional Economic Models.** For cases where the primary impact is on changing business costs, the most frequently used models are regional economic simulation models such as REMI, Global Insight, or TREDIS-REDYN models. Sometimes, static input-output models such as IMPLAN and RIMS II are also applied in conjunction with price elasticity response calculations to estimate the full industry impacts of projects. Application of these models for highway and rail

transportation projects are summarized in *NCHRP Synthesis of Highway Practice 290*^{xv} and more recent experiences are discussed in Weisbrod (2006).^{xvi}

- **Business Attraction Models.** Sometimes, economic impacts accrue from changes in market access as much as from changes in cost. Methods for evaluating those market access effects are discussed in *NCHRP Report 456: Guide for Assessing Social and Economic Effects of Transportation Projects*^{xvii} and *NCHRP Report 463: Economic Implications of Road Congestion*.^{xviii} Those market access impact methods are also embedded in business attraction models such as ARC-Opps and EDR-LEAP (now also part of TREDIS). Their impacts can then also be fed into the regional economic analysis tools noted in the prior bullet item.

Element 4 – Total Societal Benefits

Transportation planners often think of “social benefits” in the context of environmental impact studies, where the term can refer to the non-economic side of “socio-economic” impacts. However, to economists, the term “social benefits” refers to all benefits to society, including time, money, environment, and quality of life factors. To avoid confusion here, we also refer to these total benefits as “societal benefits.”

Rail investments can reduce truck freight movements and thus reduce congestion, maintenance, environmental, and other costs associated with truck traffic. These societal benefits of reduced highway congestion can accrue to highway users (crash and congestion costs), non-users (air pollution and noise costs) and government (highway maintenance costs).

The value of societal benefits associated with truck diversion will vary greatly depending on local conditions (“where”), the types of trucks diverted (“what”), and the time of day the diverted freight movement would have occurred (“when”). For example, areas with significant existing congestion or air pollution problems will benefit more from truck diversion than uncongested or less polluted areas; benefits are higher when diverted trips take place during high traffic time slots; and in general, the overall value of truck diversion is much higher in urban than rural areas because of congestion costs. Characteristics of trucks also matter: combination trucks are associated with higher maintenance, congestion, and safety costs than single-unit trucks; larger trucks tend to create higher maintenance costs than smaller trucks; and 5-axle trucks create greater pavement and safety costs but contribute less to congestion than 4-axle trucks.

Calculation of Societal Benefits. An FHWA report (2000) has shown how the public costs associated with each additional highway vehicle-mile traveled can vary by type of trucks.^{xix} These marginal costs were presented in Step 4 and are reproduced in Exhibit 3-19. As the data in that table show, social costs associated with truck movements can be as high as almost 70 cents per mile for an 80 kip 5-axle combination truck driving in an urban area. In general, diverting a truck mile of freight will reduce social costs by 8 to 20 cents in rural areas and 34 to 70 cents in urban areas.

^{xv}Current Practices for Assessing Economic Development Impacts from Transportation Investments, NCHRP Synthesis 290, TRB, 2000.

^{xvi}Weisbrod, Glen: Evolution of Methods for Assessing Economic Development Impacts of Proposed Transportation Projects, paper presented at International Conference on Transportation and Economic Development, 2006.

^{xvii}Guidebook for Assessing Social & Economic Effects of Transportation Projects, Forkenbrock, D. and G. Weisbrod. NCHRP Report 456, National Academy Press. 2001. (see Chapter 8)

^{xviii}Economic Implications of Road Congestion, Weisbrod, G., D. Vary and G. Treyz. 2001. National Cooperative Highway Research Program, Report 463, National Academy Press.

^{xix}Addendum to the 1997 Federal Highway Cost Allocation Study Final Report. U.S. Department of Transportation; Federal Highway Administration, May 2000.

Cents per Mile						
Vehicle Class/ Highway Class	Pavement	Congestion	Crash	Air Pollution	Noise	Total
<i>Urban</i>						
40 kip 4-axle S.U. Truck/Urban Interstate	3.1	24.48	0.86	4.49	1.5	34.43
60 kip 4-axle S.U. Truck/Urban Interstate	18.1	32.64	0.86	4.49	1.68	57.77
60 kip 5-axle Comb/Urban Interstate	10.5	18.39	1.15	4.49	2.75	37.28
80 kip 5-axle Comb/Urban Interstate	40.9	20.06	1.15	4.49	3.04	69.64
<i>Rural</i>						
40 kip 4-axle S.U. Truck/Rural Interstate	1	2.45	0.47	3.85	0.09	7.86
60 kip 4-axle S.U. Truck/Rural Interstate	5.6	3.27	0.47	3.85	0.11	13.3
60 kip 5-axle Comb/Rural Interstate	3.3	1.88	0.88	3.85	0.17	10.08
80 kip 5-axle Comb/Rural Interstate	12.7	2.23	0.88	3.85	0.19	19.85

NOTE: S.U. = Single Unit, Comb. = Combination; Air pollution costs are averages of costs of travel on all rural and urban highway classes, not just Interstate. Available data do not allow differences in air pollution costs for heavy truck classes to be distinguished.

Source: Reproduced in part from *Addendum to the 1997 Federal Highway Cost Allocation Study Final Report*; U.S. Department of Transportation Federal Highway Administration, May 2000, Table 13.

Exhibit 5-4. Marginal Costs of Highway Use by Trucks, 2000 (Cents per Mile).

The costs presented in Exhibit 5-4 provide only an approximation of the type and magnitude of social cost savings that can be expected from truck diversions. The estimates of unit values presented in that table can be applicable when combined with additional information about rail mode alternatives as shown earlier in Exhibit 3-16. However, care must be taken to avoid combining disparate information that compares costs per vehicle-mile and costs per ton-mile, since analytical findings can vary depending on specific size and weight restrictions on trucks and rail cars in various states.

In addition, actual societal cost savings will depend heavily on a number of factors, including local conditions; truck and trip characteristics; and expected increases in costs associated with greater freight movements by rail. Thus, the estimates below provide only rules of thumb regarding the expected changes in social cost associated with diversion of freight from truck to rail. In situations where local conditions or truck or rail characteristics are atypical or when the analysis must provide detailed, high-confidence estimates, a separate analysis of social costs should be undertaken using more sophisticated models, such as network optimization and highway capacity models.

Underlying Logic of Societal Impacts. To illustrate calculations and reporting of user and economic costs and benefits, Exhibit 5-5 provides an outline of the logic underlying the estimation of project benefits. There are multiple ways to estimate benefits from freight diversion: in the exhibit, “Level 1” refers to methodologies that are generally less time- and resource-consuming than “Level 2” options. Included among Level 1 methodologies are logistics models and marginal cost factors. Level 2 methodologies include surveys of carriers and users, to forecast shifts in mode choice, and diversion, network optimization, and highway capacity models, which can be used to estimate the impact of truck diversion on the highway transportation system. The latter models are complex, but are useful in situations where the marginal benefits of truck diversion are high. In these cases, small amounts of truck diversion could have large effects on congestion and social costs because of network configuration or other local conditions (e.g., proximity to an international port). Social equity may also be a factor. Diverting traffic from one congested corridor to a less congested corridor, whether by truck or to rail, may increase traffic, noise, and grade crossing incidents in other areas.

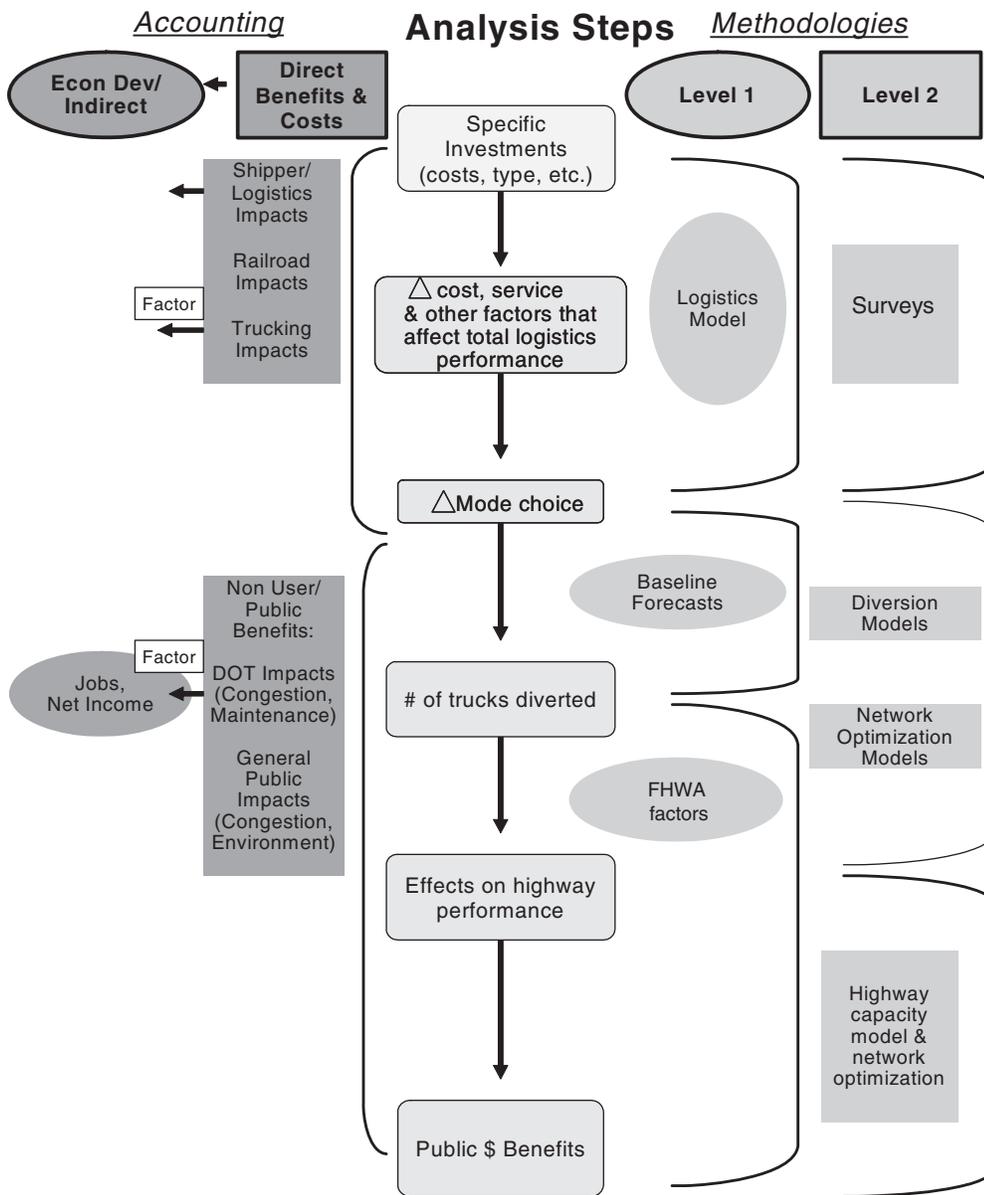


Exhibit 5-5. Elements of the Calculation of Total Project Benefits.

For all analyses, the reduction in social costs associated with diverted truck traffic must be compared to any costs (e.g., environmental, noise, and safety) associated with increased rail freight. In general, railroads should be a good source of information on expected increases in the factors that contribute to these social costs (e.g., crashes and emissions).

Air Pollution Impacts. Special attention should be given to air pollution costs when the proposed investment is to take place in an area designated by EPA as not in attainment with national air quality standards^{xx} or when the investment will be in a rural area. In non-attainment areas, rail projects that divert truck traffic can have much larger societal cost reductions than the averages. In rural areas, air pollution costs account for 20 to 50 percent of total societal costs; in these cases,

^{xx}To determine the ozone and particulate matter non-attainment status of counties potentially affected by rail projects, go to www.epa.gov/ozonedenignations and www.epa.gov/pmdesignations.

the accuracy of estimates of social costs will depend strongly on the accuracy of air pollution cost reduction estimates.

In general, freight movements that involve rail are understood to generate less air pollution than those that rely wholly on trucks. The U.S. EPA recently concluded that “For shipments over 1000 miles, using intermodal transport cuts fuel use and greenhouse gas emissions by 65%, relative to truck transport, alone.”^{xxi} A 2004 study reported that “per ton-mile, trucks emit three times more nitrogen oxide and particulate matter than a locomotive does” and that despite new regulations on trucks emissions that will be in place by 2007, “for the foreseeable future, freight trains should be considered cleaner and more efficient than tractor-trailer trucks on a per-ton-mile basis.”^{xxii}

5.5.6 Required Resources

The calculation of total project benefits can be data and model intensive, especially as the scope of benefits and the scale of analysis is expanded. The types of information and models that may be required are enumerated below. However, an elaborate analysis of every element is by no means always necessary, and it is possible to mix a detailed evaluation of one facet with an estimate of another, if practical conditions require it.^{xxiii}

Data needs include

- Rail carrier costs per unit of freight movement,
- Truck carrier costs per unit of freight movement,
- Total shipper logistics costs per unit of freight movement,
- Commodity mix and trip distance profile,
- Regional economic profile, and
- Regional air quality conditions.

Models include

- Modal Diversion Model—Forecast of total ton-miles of diverted freight and resulting change in truck and rail vehicle volumes;
- User Benefit Model—Calculation of shipper cost savings and market access changes;
- Economic Benefit Model—Productivity benefit due to cost savings and scale economies from production and market access changes;
- Regional Economic Impact Model—Job and income generation from freight-dependent industries, their customers, and suppliers (as viewed from local or national levels);
- Environmental Impact Model—Air quality impacts of reductions in traffic congestion; and
- Government Fiscal Impacts Model—Changes in public agency revenues and expenditures as a result of regional economic changes.

^{xxi}“A Glance at Clean Freight Strategies,” www.epa.gov/smartway/documents/intermodal%20shipping.pdf

^{xxii}Investing in Mobility, Environmental Defense Fund, 2004; p. 40.

^{xxiii}For example, under Element #2, above, was an FHWA citation to the effect that shipper benefits represent a 10–40% increase over carrier benefits. Thus, in the absence of better information, a detailed analysis of carrier benefits could be multiplied by this factor to yield an estimated range of the benefits to shippers.

5.6 Representation of Benefit-Cost Findings

5.6.1 Overview

The previous step calculated various measures of carrier, shipper, economic, and societal benefits associated with rail freight investments. This final step discusses how these measures can be compared to project or program costs and portrayed in ways that are relevant to the perspective of different affected groups.

5.6.2 Components

Four general approaches are most commonly used to assess and compare the relative benefits and costs of proposed transportation projects. They are

1. Cost-benefit analysis,
2. Cost-effectiveness analysis,
3. Data envelopment analysis, and
4. Multi-criteria assessment analysis.

These four types of analysis are discussed here as alternative methods, although they are not mutually exclusive, and each of these analysis approaches can be applicable for a different type of situation.

5.6.3 Background

The cost of implementing rail freight solutions and the various categories of benefit from doing so are not always simple to compare. Exhibit 5-6 can be viewed as a “checklist” of information the analyst may need to represent the full benefits of rail freight projects.

The difficulties presented by these various cost and benefit considerations are that

- Some of these factors can be measured in quantifiable numbers more easily than others,
- Some of these factors can be monetized in dollar terms more easily than others, and
- The incidence of cost and benefits for various parties can be politically sensitive.

These difficulties are the major reason why four different approaches are discussed here for comparing the relative benefits and costs of rail freight projects and policies.

Benefit Category	Trucking				
	Railroads	Companies	Shippers	Government	Public
Operating Costs	X	X	X	X	
Productivity	X	X			
Breakage			X		
Congestion					X
Environmental Quality					X
Safety & Security	X	X	X	X	X
Tax Revenue				X	
Scheduling/Reliability	X	X	X		
Economic Development				X	X
Facility Capital Costs	X			X	
Facility Maintenance Costs	X			X	

Exhibit 5-6. Categories of Potential Project Benefits and Costs.

5.6.4 Factors

The overall value and usefulness of implementing rail freight solutions to road congestion depends on a set of common factors:

- The magnitude of *congestion reduction* that it achieves and the value of that impact;
- The effect that it will have on *freight transportation cost or service quality* for carriers and shippers, and the relative value of the impact on those parties;
- The value of *environmental and quality of life impacts* on the general public;
- The *cost of implementing* the project or policy and the incidence of those costs for various public agencies, private organizations, and the general public.

All of these factors are considered in the four alternative methods presented here.

5.6.5 Methods

Alternative 1 – Benefit-Cost Analysis (BCA)

BCA is the traditional method used by economists for assessing the social value of investments. (It is sometimes also referred to as Cost-Benefit Analysis or CBA.) It examines the benefits and costs associated with a particular project and reports results in terms of two measures:

Net Benefit = Gross Benefit – Gross Cost

Benefit/Cost Ratio = Gross Benefit/Gross Cost

Thus, a benefit-cost (B/C) ratio of 1.5 implies that each \$1.00 of project investment will yield benefits valued at \$1.50. Benefit-cost analyses are used in two general ways: (1) to determine whether or not the benefits associated with a project are sufficient to justify project spending (i.e., the B/C ratio is greater than 1.0); and (2) to rank proposed projects in terms of their return on investment (e.g., a project with a B/C ratio of 1.5 has a higher return per dollar invested than a project with a B-C ratio of 1.4 and a lower return than a project with a B-C ratio of 1.6).

Benefit-cost studies, however, are limited by the requirement that only costs and benefits that can be monetized can be included in analysis. This creates two fundamental limitations. First, a number of important benefits associated with transportation investments either cannot be monetized (e.g., the social benefit of economic development in low-income areas) or are very difficult to monetize (e.g., more frequent rail stops). Second, results from BCAs are sensitive to judgments about valuation of different benefits. For example, historically EPA and DOT have used different valuations of the expenditures that can be justified by the expected elimination of a premature death, with EPA using \$4.8 million and DOT using \$2.6 million (DOT, 2000). In general, there is no consensus on “correct” valuation of such benefits and evaluation of projects will be sensitive to analysts’ decisions about the proper valuation.

There are two basic shortcomings in the use of BCA for evaluation of rail freight projects. The first is that BCA is designed to aggregate all benefits and all costs for society, without regard to their incidence. In the case of integrating highway and rail investment, the different roles of public agency investment for roads and private investment in railroad functions should be recognized and considered in evaluating opportunities for “win-win” propositions in public-private partnerships.

BCA tools for highway-oriented projects include STEAM, StratBENCOST, Cal-B/C, NET_BC and MicroBenCost. Available tools for BCA of rail-oriented projects include RAILDEC. A more general BCA framework that covers both rail and highway projects is the newer TREDIS system.

Further details on BCA tools and methods are available from existing documents that are widely available:

- Caltrans Transportation Benefit-Cost Analysis web site
http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/index.html
- FHWA Cost-Benefit Forecasting Toolbox web site
http://www.fhwa.dot.gov/planning/toolbox/costbenefit_forecasting.htm
- Transport Canada Guide to Benefit-Cost Analysis
<http://www.tc.gc.ca/finance/bca/en/bca.pdf>
- FHWA Asset Management: Economic Analysis Primer
<http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer.htm>

Alternative 2 – Cost-Effectiveness Analysis (CEA)

CEA differs from BCA in that it does not seek to evaluate all positive and negative impacts simultaneously, and it does not require that all positive and negative effects be boiled down to a common measure of dollars. Rather, CEA compares the effectiveness of project alternatives in achieving various individual indicators of desired benefits. For example, CEA can portray the cost per ton of emissions reduction or the cost per thousand passengers carried.

If most of the costs can be expressed in monetary terms and if most of the benefits can be quantified at least in non-monetary terms, then it is possible to use measures of cost-effectiveness that show the cost per unit benefit. This makes it possible to compare different designs and entirely different approaches to achieving quantitative, non-financial goals such as improving air quality and reducing congestion. However, CEA is limited because it examines single dimensions of impact that may affect different parties (e.g., shippers or transportation providers) and it still does not differentiate the coincidence of costs.

In the context of this guide, CEA can be applicable if the primary goals of rail freight solutions are focused solely on reducing aggregate vehicle-time or reducing emissions. However, if the analysis seeks to examine broader impacts on carriers, shippers, and the general public, then the other methods are more applicable.

Alternative 3 – Data Envelopment Analysis (DEA)

DEA is related to CEA in that it attempts to compare the effectiveness of alternative projects or programs in achieving results that can be measured, but not in monetary terms. Basically, DEA is a form of graphical analysis that simultaneously displays the effectiveness of alternatives in achieving multiple criteria. This makes it possible to identify alternatives that are clearly superior to other alternatives at all spending levels, those that can provide greater benefits along all dimensions per dollar of spending at certain levels of implementation, and those alternatives that provide tradeoffs in results.

In public funding of transportation projects, it is seldom possible to reduce the analysis to financial terms, and it will even be difficult to quantify some of the costs and benefits. Therefore, a more elaborate scheme is needed to allow rating of multiple criteria with attention to incidence.

Alternative 4 – Multi-Criteria Analysis (MCA)

The shortcomings of BCA have led to the creation of methodologies that can more easily accommodate and evaluate a range of monetizable and non-monetizable benefits. Chief among these newer methodologies is multi-criteria analysis (MCA), which attempts to consider all benefits associated with a project and weight them according to their importance. This approach is aimed at producing a comprehensive assessment of project benefits. Employing MCA requires that analysts identify all benefits—including those which can be monetized (e.g., reduction in air pollution control costs), those that cannot be monetized but can be expressed with quantitative metrics (e.g., the number of jobs that relocate from high- to lower income areas), and those that cannot be expressed with quantitative measures (e.g., civic pride associated with state-of-the-art transportation infrastructure)—and a ranking to weight benefits according to their relative

	Values:		Weighting Scheme :	
	Project 1	Project 2	Project 1	Project 2
Benefits				
<i>Monetizable</i>				
Tax revenues (\$M)	2	5	3	3
Air pollution reductions (\$M)	10	5	1	3
Personal Income	6	10	1	1
<i>Quantifiable</i>				
Jobs Created ('000s)	3	1	0	3
Jobs Created in Low-Income Areas ('000s)	1	0	0	3
<i>Qualitative</i>				
Civic Pride	YES	NO	1	1
Assessment				
<i>Quantitative</i>				
Weighting 1	22	30		
Weighting 2	54	43		
<i>Qualitative</i>				
Factors	Civic Pride	None		

Exhibit 5-7. Using Multi-Criteria Analysis (MCA): An Example.

importance. A key example of this last kind of measure is the safety risk perceived by motorists who share the road with large trucks, especially when trucks form a material component of the traffic stream. Quite apart from actual safety performance, these perceptions carry weight in public opinion. MCA has become increasingly popular for transportation “project appraisal” by transportation agencies in Europe and by the World Bank, because of its ability to account for broader societal impacts that cannot be monetized.

Exhibit 5-7 provides an example that uses hypothetical data to illustrate how MCA is operationalized. Three aspects are worth noting.

- First, MCA allows inclusion of variables not normally considered in BCA, such as the job creation and civic pride dimensions just noted.
- Second, project rankings will depend on the weights (i.e., importance) attached to different variables. In the example in Exhibit 5-7, Project 1 yields large reductions in air pollution and high levels of job creation, while Project 2 generates significant growth in personal income and tax revenues. Thus, in the first weighting scheme, which gives the highest weighting to tax revenues, Project 2 is the preferred project. Under weighting Scheme 2, however, where job creation and air pollution reductions are valued as highly as tax revenues, Project 1 scores higher.
- Third, variables such as civic pride, for which it is difficult to assign a quantitative value, might (as they are in the example) be reported but not used in calculating project scores. Including these variables in the reporting framework, however, could be important to decision makers in cases where competing projects have similar or identical assessment values.

Like BCA, MCA has its limitations. For example, although it provides a more comprehensive way of ranking the benefits of alternative projects, it does not (by design) yield an estimate of the monetary value of a project’s benefits. As such, it cannot be used to address whether a particular project has a B/C ratio of greater than one, or an adequate financial return on investment.

It is possible, however, to use both BCA and MCA for project assessment. For example, an analyst could use BCA to determine which of a set of projects has a B/C ratio of greater than 1.0

and thus, can be justified based on quantifiable benefits and costs. After BCA is used to identify economically feasible/attractive projects, MCA could be used to select the project likely to yield the highest total (monetizable and non-monetizable) benefits.

TransDec (Transportation Decision Analysis Software) was developed as part of NCHRP Project 20-29 (2) to assist public officials in implementing multi-criteria analysis for multi-modal transportation investment decisions. It also specifically distinguishes freight from passenger transportation effects. It is designed for evaluating transportation investments on the basis of multiple goals tied to specific objectives and values. The following types of goals might be considered: improve mobility, improve connectivity, increase cost-effectiveness, increase energy efficiency, improve air quality, reduce resource impact, reduce noise impact, improve accessibility, reduce neighborhood impact, and improve the economy.^{xxiv}

Assessing the Distribution of Benefit and Cost Results

Methods described above provide guidance on how to evaluate the overall costs and benefits associated with projects. For many rail freight or other transportation projects, however, a set of related questions is just as significant: namely the proportion of costs and benefits that accrue to different groups. This is especially important where private interests, such as railroads, are seeking public funds for investments; where local or state governments are seeking federal funds; or where private, local, state, and federal interests are trying to determine the appropriate alloca-

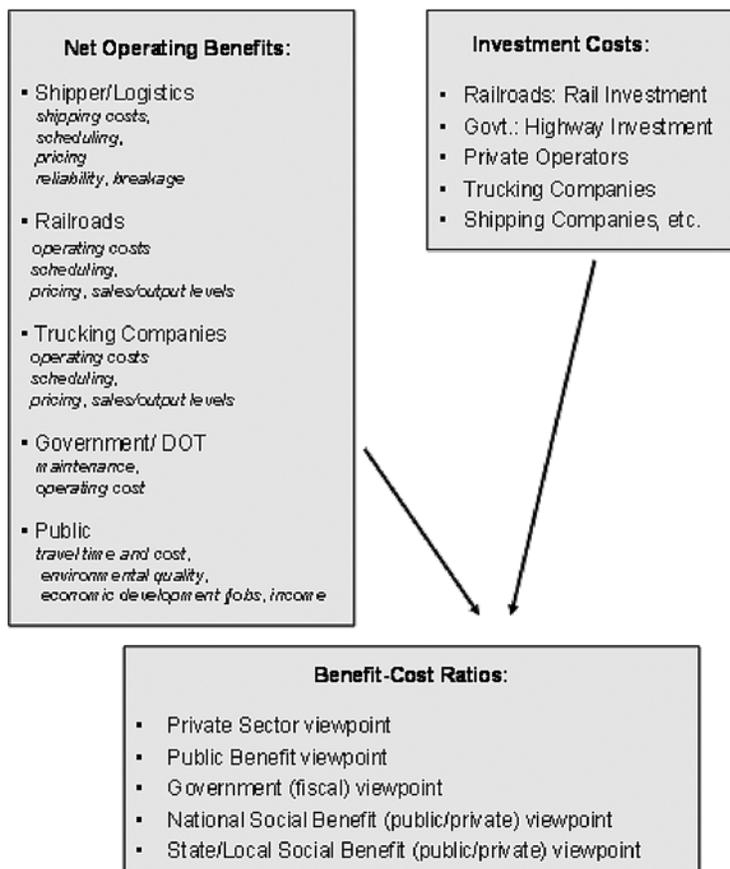


Exhibit 5-8. Cost-Benefit Accounting.

^{xxiv}NCHRP Research Results Digest 258.

tion of project costs. In these cases, there are multiple benefit-cost ratios, each of which describes a different perspective or viewpoint.

This is presented schematically in Exhibit 5-8, which portrays the different types of operating benefits and capital costs associated with rail freight projects, as well as the benefit-cost viewpoints that can be relevant for project assessment. Five viewpoints are relevant—private sector, government, public, national social benefit, and state/regional social benefit. These can be measured in the following ways:

- **Private Sector.** For rail freight projects, the relevant private sectors include railroads, trucking companies, and shippers. Private sector benefits include reduction in operating costs and increased revenue. Ideally, change in profit levels (which captures changes in both output and revenue per unit of output) will be used and compared to investment costs to yield an estimate of return on investment (ROI). The ROI, when annualized, should be greater than the current interest rate, which proxies for cost of capital as well as the return on capital if it were invested in a no-risk asset (e.g., certificates of deposit).

In cases where effect on profits is difficult to estimate or where railroads, trucking companies, and shippers have objectives other than profit maximization, then the other metrics above might be more useful. Common objectives for private actors include maximizing sales or gaining market share when establishing a new market or product line. In the highly competitive rail sector, sales growth is often an important objective. In these cases, the appropriate measure could be volume or market share.

Private sector costs are the investments made by railroads, trucking companies, shippers, and private operators in the project itself or in accessing the project benefits.

- **Government.** The direct benefits to government are the highway maintenance and operating cost reductions associated with reduced congestion; the reduction, avoidance, or deferral of new highway lane construction; and the increased tax revenues from increased business output and personal income. The costs are the government portion of the project investment costs. Depending on the funding scheme for a project, analysis of more than one level of government (e.g., local, state, and federal) could be required. In all cases, it is important to compare investment costs by level of government with benefits that accrue to that level of government. This could require, for example, estimating the portion of maintenance and operating costs paid by state and federal DOTs and estimating local, state, and federal tax impacts.

Costs to government are generally confined to project costs and, if relevant, any increase in operations and maintenance of transportation infrastructure. In multi-jurisdictional projects, the distribution of costs can differ from the distribution of benefits, which is important for the managing agency to recognize.

- **Public.** Public benefits can be defined narrowly or broadly, depending on the needs of the analysis. The narrow definition includes the value of changes in congestion, environmental quality, and other quality-of-life considerations (e.g., noise). The broad definition of public recognizes also the costs and benefits that accrue to taxpayers and includes the effects of transportation investments on tax revenues and government spending. For projects that involve more than one level of government (e.g., state and federal) public costs and benefits can be calculated for the state and national levels.

Under narrow definitions, there are few, if any, public-sector costs (perhaps, for example, the inconvenience and noise associated with large-scale transportation projects). Under the broader definition, public-sector costs would include costs to local, state, and/or federal governments for project investment and, if relevant, any increase in operations and maintenance of transportation infrastructure.

- **Societal Benefits (National).** The national societal benefit is defined as the sum of the social benefits (congestion, safety, air pollution, and noise) and the net national economic and fiscal

impacts. To estimate net national economic impacts (as described above), the user should include only those benefits that can be tied to increases in productivity and should ignore economic impacts that are the result of shifts in business location to the affected project area from other parts of the United States. A portion of economic impacts associated with increased trade and foreign direct investment can also be considered as net national impacts. Unfortunately, it is difficult to estimate the portion of new trade and investment activity in the project area that represents new activity in the United States, rather than a shift from other parts of the country, and the types of macroeconomic models that are otherwise useful for transportation analysis offer little guidance. As such, analysts will likely have to estimate this portion or survey local businesses to assess the proportions of their competition that are national and international. National social costs would include all private and government spending on project investment and, if relevant, any increase in the costs of construction, operation, and maintenance of transportation infrastructure.

- **Societal (State or Local).** The state (or local) social benefit includes all social, economic, and fiscal benefits that accrue to the state. Unlike calculations for assessment of national social benefits, the analyst does not need to be concerned with economic benefits that represent shifts in activity from the rest of the United States. From the perspective of the state, all new economic activity is a gain, regardless of whether it decreases activity in other parts of the United States.

State or local social costs would include spending on project investment by local/state firms and the local/state government, as well as any increase in operations and maintenance of transportation infrastructure paid for by local/state governments.

Portraying Cost and Benefit Incidence

The basic format for measuring and portraying benefits and costs is as shown in Exhibit 5-9. This format shows the incidence of various time, cost, safety, and production-related benefits for carriers (“transportation system efficiency”), users (“user cost savings benefit”), and society (“total benefit”). This format is most useful when a breakdown of costs and benefits by general category is needed.

There are cases where it is also important that costs and benefits be presented in a way that contributes to negotiations and decisions regarding which affected parties should bear the costs. In these cases, a more detailed format, like the one presented in Exhibit 5-10, may be warranted. This table reports costs and benefits by group (e.g., public versus private) and type of benefit

(A) Target Year Benefit

Mode	(A) Cost of Transport	(B) Cost of Time	(C) Cost of Accidents	(D) Cost of User Operations	(E) Social & Environ
Truck Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx
Rail Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx

(B) Net Present Value of Benefit Stream

Mode	(A) Cost of Transport	(B) Cost of Time	(C) Cost of Accidents	(D) Cost of User Operations	(E) Social & Environ
Truck Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx
Rail Freight	xxxxx	xxxxx	xxxxx	xxxxx	Xxxxx

(C) Benefit Perspectives

Category	Definition	Design Year	Net Present Value of Stream
Transport System Efficiency	= A+B+C	xxxxx	Xxxxx
User Cost Savings Benefit	= A+B+C+D	xxxxx	Xxxxx
Total Benefit	= A+B+C+D+E	xxxxx	Xxxxx

Exhibit 5-9. Summary of Benefits and Costs at a Societal Level.

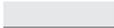
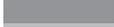
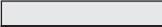
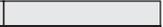
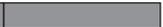
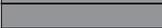
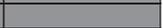
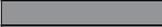
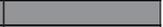
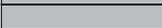
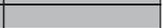
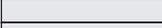
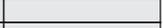
Project Benefits	First Year Benefit (\$)	Net Present Value (\$)	KEY			
TRANSPORT CARRIERS				Private costs/benefits		
				Public (non-Gov't) C/B		
				Public (Gov't) C/B		
Rail Net Revenue			B - C	BENEFIT		
Truck Net Revenue					Private	
Intermodal Net Revenue						Public
Shipper/Logistics Net Revenue						
INDUSTRY SHIPPERS & RECEIVERS			Social			
Industry						
• Transport Costs						
• Logistics Costs						
• Production Costs						
Consumers						
• Prices/Consumer Surplus						
EXTERNALITIES (IMPACTS ON NON-FREIGHT)						
Congestion						
• Personal Travel--vehicle time						
• Business--vehicle time						
• Personal Travel--operating cost						
• Business--operating costs						
Emissions (\$ value of tons/year)						
Safety/Accidents (\$ value)						
ECONOMIC DEVELOPMENT						
Income in Transportation Sectors						
Income in Non-transport Sectors						
Total sales (D,I) in Trans Sector						
Total sales in Non-trans sector						
GOVERNMENT						
Construction and Maintenance						
Operating Costs						
Tax Revenue						
Project Costs						
	Cost Per Yr	Net Pres Val				
Government						
Railroads						
Trucking Companies						
Shippers/Logistics						
Other						

Exhibit 5-10. Breakdown of Benefit and Cost Incidence Among Various Parties.

(e.g., environmental versus economic development). The latter can be useful if public funding may come from multiple governmental agencies, in which case, information about the contribution of a project to different agencies' missions could be useful in negotiations. Getting parties to agree on risk sharing is also important.

A common problem in benefit-cost estimation and accounting is double-counting of benefits. Two potential sources of double-counting are as follows:

- **Change in costs.** All costs reductions at carriers are realized as either increased profits for the carriers or price reductions for shippers. Research to date has not been able to establish definitively the likely split between profits and prices from cost changes, and it will vary with market conditions. Cost reductions in the rail and trucking freight sectors often get translated into price reductions for shippers, but the extent to which that occurs depends on the commodity and competitiveness of specific routes (General Accounting Office, 2002). When modeling impacts, it is important not to double-count the impacts of cost reductions. As such, the analyst should

model cost reductions by reducing the cost of doing business at carriers or by reducing the cost of doing business for shippers in an economic simulation model. When cost reductions are modeled as a change to carriers' cost-of-doing-business, the model will estimate some increase in demand for carrier services. When cost reductions are modeled as a change to shippers' cost-of-doing-business, the model will estimate impacts on shipper output as well as the change in goods and services purchased to meet new output demands. Transportation is one of the goods and services purchased by shippers.

- **Regional versus national economic impacts.** As discussed earlier, some of the growth in economic activity in areas with improved infrastructure investment will represent a shift in business activities (e.g., sales and output) from other parts of the United States. These generally should not be considered in estimates of national economic gains from transportation investment. Typically, analysts will have to estimate using whatever local information is available the portion of activity that likely represents a shift in national activity, rather than a net gain. For the portion of new business activity realized by increases in international trade or foreign direct investment, a larger portion can be considered as new national activity.

5.6.6 Required Resources

Portraying incidence of benefits and costs associated with rail freight solutions can go far beyond the direct project cost and the direct effect on congestion levels. It can be shown at many levels, ranging from an overall benefit/cost ratio to a detailed breakdown of the incidence of who pays the various costs and who receives the various elements of benefit. The choice of how to measure and portray these impacts will depend on the particular project situation and the parties involved. At the simplest level, a spreadsheet process may suffice. At the other extreme, a series of rail performance and highway network simulation models could be used and linked to a regional economic model to calculate overall impacts, and the results then put into a separate benefit/cost analysis system to calculate the net present value of benefits and costs.



CHAPTER 6

Additional Resources

Additional resources developed as part of NCHRP Project 8-42 are provided in the Final Report which constitutes the first part of *NCHRP Report 586*. Those using this guidebook may find it useful to consult that material, particularly

1. Literature Review of Truck, Rail, Freight and Congestion Issues
2. Detailed Case Studies of Rail Freight Solutions to Traffic Congestion
3. Shipper Needs & Structural Factors Affecting Road-to-Rail Diversion
4. Trends Affecting Traffic Congestion and Reliance on Rail Freight
5. Data Sources for Measuring Truck and Rail Freight Characteristics

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation