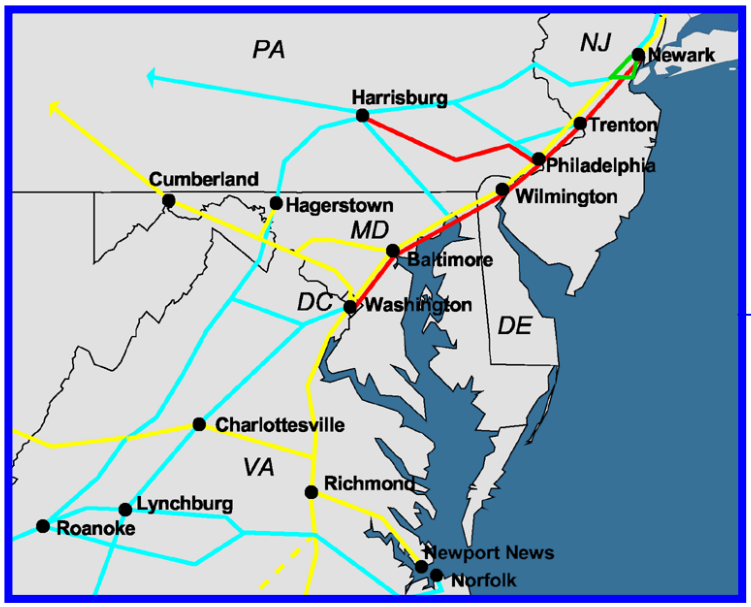

I-95 Corridor Coalition

Mid-Atlantic Rail Operations Study

Interim Benefits Assessment

I-95 CORRIDOR COALITION

March 2004

Mid-Atlantic Rail Operations Study
Interim Benefits Assessment

Prepared for:

I-95 Corridor Coalition

Sponsored by:

New Jersey Department of Transportation
Delaware Department of Transportation
Maryland Department of Transportation
Pennsylvania Department of Transportation
Virginia Department of Transportation Amtrak

I-95 Corridor Coalition

CSX Transportation
Norfolk Southern

Prepared by:

Cambridge Systematics, Inc.

March 2004

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Executive Summary

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The MAROps Summary Report[1] (the Report) and its Appendices documented existing conditions in the study area (e.g., demographics, economic conditions, transportation facilities, passenger and freight flows, etc.) and defined a three-phased program of improvements to eliminate key rail choke points across the five-state study region. The Report also presented order-of-magnitude cost estimates for the projects. Finally, the Report identified a number of types of anticipated benefits, including:

- Transportation benefits from the reduced need for highway travel by trucks and automobiles;
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Mid-Atlantic Rail Program Initial Benefits Assessment

As the MAROps program continues to evolve and advance, it is important to quantify these benefits. This Initial Benefit Assessment is designed to provide a first approximation of the program's benefits. The information will support ongoing policy and planning discussions. The Initial Benefits Assessment is an approximation because comprehensive,

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As a starting point, two alternative futures were defined for the Initial Benefit Assessment:

1. *Without MAROps* 2025 scenario assumes that rail maintains its current overall volume, but does not grow its business. Rail grows its volume in certain commodity lanes, but "de-markets" in others, resulting in little or no growth in overall rail tonnage. Total rail tonnage in the *Without MAROps* 2025 scenario is significantly below the unconstrained 2025 base-case forecast. Trucking continues to grow and absorbs traffic that "wanted" to stay on rail but cannot.

2. *With MAROps* 2025 scenario assumes that rail maintains its current overall market share (as a percentage of total freight tonnage). But the scenario also assumes that rail increases its share of intermodal traffic relative to trucking. It assumes that up to 10 percent by tonnage of dry van commodities and automobiles moving 400 miles or more by truck shifts to rail intermodal.

The freight tonnage and vehicle miles of travel (VMT) associated with these scenarios was determined using the TRANSEARCH dataset, a commercial database product developed by Reebie Associates. The *With MAROps* scenario reduces 2025 truck VMT by 3.6 billion miles across the National Highway System. As determined by this analysis, 33 percent of this reduction is within the five-state MAROps region.

The dollar benefits of this VMT reduction were estimated in three ways:

1. By calculating the direct cost savings to freight shippers, based on differences in truck and rail freight rates, with appropriate discount factors.

2. By calculating the direct cost savings to highway users (e.g., truckers and automobile drivers making work trips and non-work trips) using the Highway Economic Requirements System (HERS). HERS is computer simulation model that estimates the benefits and costs of highway investments and changes in VMT on the Federal-aid highway system.

3. By using an input-output (I/O) model of the economies of the five MAROps states, leased from Regional Economic Models, Inc. (REMI), to estimate how changes in transportation costs translate into increases in productivity and reductions in the cost of doing business, generating "multiplier" benefits throughout the economy.

The benefits from the MAROps program improvements are estimated at $12.8 billion. These benefits are cumulative benefits for the period from 2005 (when the initial MAROps improvements are finished) through 2025 (when the final MAROps improvements are completed). The benefits accrue to the five-state MAROps region only. Additional

benefits will accrue to regions and states outside the Mid-Atlantic region, but were not estimated as part of this Initial Benefits Assessment.

Two groups benefit from the MAROps improvements that shift freight from truck to rail and reduce truck VMT on the highways. Shippers—especially those shipping long distances, who will pay less to move freight by rail than they did by truck—benefit by an estimated $6.1 billion. Highway users benefit by an estimated $6.7 billion. Of the $6.7 billion of highway user benefits, automobile drivers making non-work-related trips get $4.8 billion; auto drivers making work-related trips get $0.9 billion; and truckers continuing to use the highways get about $1.0 billion.

Of the total $12.8 billion benefits, $9.1 billion are direct benefits to automobile drivers, shippers, and truckers. The remaining $3.7 billion are indirect economic benefits, the result of lower transportation costs for businesses. The benefits are summarized in Table ES.1.

Table ES.1 Summary of Estimated Benefits to the MAROps Region from MAROps Improvements, 2005-2025

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

The estimated $12.8 billion benefit of the MAROps program is significantly larger than the estimated $6.2 billion cost of the program, suggesting a positive benefit/cost ratio. However, the full net present value of the benefits and the costs must be estimated before an accurate benefit/cost ratio can be calculated. Nevertheless, the Initial Benefits Assessment supports a preliminary conclusion that the MAROps program could return positive benefits and that more detailed development is warranted.

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Mid-Atlantic Rail Operations Study
Initial Benefits Assessment

1.0 Introduction

The Mid-Atlantic Rail Operations Study (MAROps) is a joint initiative of the I-95 Corridor Coalition, five member states (New Jersey, Pennsylvania, Delaware, Maryland, and Virginia), and three railroads (Amtrak, CSX, and Norfolk Southern [NS]). The Federal Railroad Administration (FRA) and Federal Highway Administration (FHWA) participate as advisors. Over a two-year period, the MAROps participants crafted a 20-year, $6.2 billion program of rail improvements aimed at improving north-south rail transportation for both passengers and freight in the Mid-Atlantic region and helping reduce truck traffic on the region's overburdened highway system.

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The Initial Benefits Assessment report has the following sections:

1. Introduction;
2. Scope of Work;
3. Overview of the MAROps Program;
4. Current and Future Freight Flows in the MAROps Region;
5. Service and Market Impacts of MAROps Program Improvements;
6. Business Benefits of MAROps Improvements to Freight Shippers;
7. Highway User and System Benefits of MAROps Improvements Calculated from Highway Economic Requirement System (HERS) Model;
8. Regional Economic Benefits of MAROps Improvements Calculated from Regional Economic Models, Inc. (REMI) Model; and
9. Summary of Benefits.

2.0 Scope of Work

2.1 Objective

The objective of the Initial Benefits Assessment is to develop a quantitative estimate of selected transportation and economic benefits of the 20-year regional rail improvement program recommended in the MAROps Report.

2.2 Methodology

The Initial Benefits Assessment was performed by Cambridge Systematics, Inc. The general methodology was adapted from the technical approach developed by Cambridge Systematics in the American Association of State Highway and Transportation Officials (AASHTO) *Freight-Rail Bottom-Line Report* (FRBL Report) to assess the benefits of national

rail system improvements.[3] The FRBL Report approach estimated the current and future demand for freight transportation by all modes, forecast the tonnage of freight that could be shifted from truck to rail if improvements were made to the rail system, and then applied the HERS model to quantify the highway-related benefits of reducing truck traffic on the highways.

This Initial Benefits Assessment extends the FRBL Report methodology in two important ways:

- First, it focuses on the major freight lanes within and through the MAROps region; and

- Second, it applies an economic input-output (I/O) model, leased from REMI, to estimate the economic impacts of the improvements.

2.3 Work Plan

The work plan had five tasks:

- **Task 1. Identify current and future freight volumes for the MAROps region.** Cambridge Systematics reviewed available data on current and future freight volumes moving along the major highway and rail freight lanes in the MAROps region. The data sources included the FHWA's Freight Analysis Framework database, which has a 1998 benchmark year and 2010 and 2020 forecast years; state automobile and truck traffic counts reported in the FHWA's Highway Performance Monitoring System (HPMS); railroad data; and TRANSEARCH/Insight commodity flow and forecast data available from Reebie Associates and Global Insight. The primary source of data used for the Initial Benefits Assessment was the TRANSEARCH/Insight database. The benchmark year for the freight flow data was 2001 (the most recent available) and the forecast year was 2025.[4]

- **Task 2. Estimate service and market impacts of rail improvements.** Cambridge Systematics worked with senior staff from the CSX and NS railroads to develop "most likely" scenarios regarding future rail-freight volumes, commodities, and routings. These estimates were used to develop two scenarios for the regional rail system: a *Without MAROps* 2025 improvements scenario, and a *With MAROps* 2025 improvements scenario.

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[3] See AASHTO's Freight web page at http://freight.transportation.org/. A PDF version of the AASHTO *Freight-Rail Bottom-Line Report* is available at http://freight.transportation.org/doc/FreightRailReport.pdf.

[4] The forecasts do not make specific adjustments for the impact of 9/11 on freight movement and economic activity in the region. From a national perspective, the economic effects of 9/11 were short term; there was no major relocation of population, jobs, or production that would markedly change freight patterns over the 20-year forecast period.

- **Task 3. Estimate highway system costs and highway user benefits using the HERS model.** HERS is a simulation model that estimates the benefits and costs of highway investments in the Federal-aid highway system, currently the 958,000 miles of roadways that serve most of the nation's truck-freight traffic. HERS was developed by Cambridge Systematics staff for the FHWA and is used by the U.S. Department of Transportation (DOT) as the basis for its reports to the U.S. Congress on highway investment needs. HERS utilizes HPMS data prepared by the states. The HPMS data include information on current highway conditions, capacity, and vehicle miles of travel (VMT), and forecasts of future highway conditions, capacity, and VMT. Cambridge Systematics ran the HERS model for the "*Without MAROps*" and "*With MAROps*" scenarios, estimating the effects of reducing truck traffic by shifting freight from trucks to rail. The HERS model generated estimates of the costs and benefits to highway users (e.g., to all automobile and truck drivers remaining on the highways) and the highway system (e.g., to the transportation agencies charged with maintaining and improving the highways). The difference in costs and benefits between the two model runs was attributed to the MAROps improvements.

- **Task 4. Estimate regional economic impacts using a REMI model.** The changes in highway user and highway agency costs and benefits, as calculated by the HERS model, were input to a dynamic I/O model, leased from REMI, to estimate the economic impacts of the improvements. The REMI model estimates how the MAROps benefits would cascade through the economy to benefit specific industries and regions. Shipper cost benefits for each scenario (e.g., the savings accruing to shippers who shift freight from higher-cost truck service to lower-cost rail service because of the MAROps improvements) were calculated manually and input to the REMI model. The output of the task was an estimate of the economic benefits of the 20-year MAROps program measured as an increase the Gross Regional Product (GRP) for the MAROps region.[5]

- **Task 5. Report findings and conclusions.** A preliminary report on the findings of the Initial Benefits Assessment was prepared as a PowerPoint presentation in September 2003. The preliminary findings were subsequently reviewed and adjustments made to improve the methodology. This Initial Benefit Assessment report presents the updated findings and conclusions, and documents the methodology.

[5] Highway construction costs were held constant between the *With MAROps* and *Without MAROps* scenarios. Rail improvement construction expenditures were not input to the REMI model for this initial assessment, but could be calculated and added in a subsequent, more detailed study of MAROps program benefits.

3.0 Overview of the MAROps Program

3.1 Vision

Over the last two decades, passenger and freight movements over the nation's transportation system have increased dramatically. VMT by passenger cars and trucks grew 72 percent while road-lane-miles grew only one percent.[6] Over the same period, ton-miles of freight moving over the nation's railroads increased 55 percent while system mileage actually declined.[7] Some of this growth has been accommodated by actions that improved the efficiency of the existing transportation system.

Within the public sector, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) returned transportation decision-making to the states and metropolitan regions, promoted improved intermodal connections among transportation modes, and funded aggressive use of intelligent transportation system (ITS) technologies. The Transportation Equity Act for the 21st Century (TEA-21, 1998) reinforced these initiatives, paid for better maintenance and more infrastructure improvements, and emphasized the need to re-link transportation investment to economic development and trade strategies.

Within the private sector, an expanding economy and economic deregulation of the trucking, railroad, airline, and ocean shipping industries triggered explosive growth in freight transportation productivity. Competition increased; firms were consolidated, merged, and restructured; investments were made in larger trucks, double-stack trains, bigger containerships, and modern terminal facilities; and new and better coordinated services were introduced.

However, the transportation productivity returns from these initiatives are diminishing. Capacity and congestion problems today are eroding the productivity of the transportation system. Travel time and cost are increasing, service reliability is decreasing, and the ability of the system to recover from emergencies and disruptions of service is severely taxed. The capacity and congestion problems are apparent at international freight gateways, across metropolitan regions, and along national transportation routes.

Layered on top of these concerns is a renewed mandate for contingency planning that will protect the freight and passenger transportation systems from terrorism as well as natural disasters and criminal activity. The public and private sectors have just begun to address the issue of how to balance the need for open, cost-effective transportation flows to encourage economic development and trade against the need for closely controlled flows and redundant transportation infrastructure to ensure national security and public safety.

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[6] FHWA data.

[7] Eno Foundation data.

Addressing these problems in the coming decade requires a willingness to plan and fund transportation system improvements across boundaries—across the jurisdictional boundaries between states and cities, across the interest boundaries between the public agencies and private firms, and across the financial boundaries between the highway and rail systems. The MAROps Study begins to address these barriers.

3.2 Key Findings and Conclusions of the MAROps Summary Report

The key findings and conclusions of the MAROps Report were as follows.

The Mid-Atlantic region is a vital intermodal transportation crossroads for the nation.

The transportation network in the Mid-Atlantic region serves and connects the nation's political capital, its financial capital, and 47 million people—33 million in the five Mid-Atlantic states and another 14 million in the New York City metropolitan area. The Mid-Atlantic is the nation's largest producing and consuming market.

About half of the region's interstate truck tonnage and nearly all of its freight-rail tonnage moves to and from states outside the region, which means that transportation conditions in the Mid-Atlantic affect business and transportation decisions throughout the country.

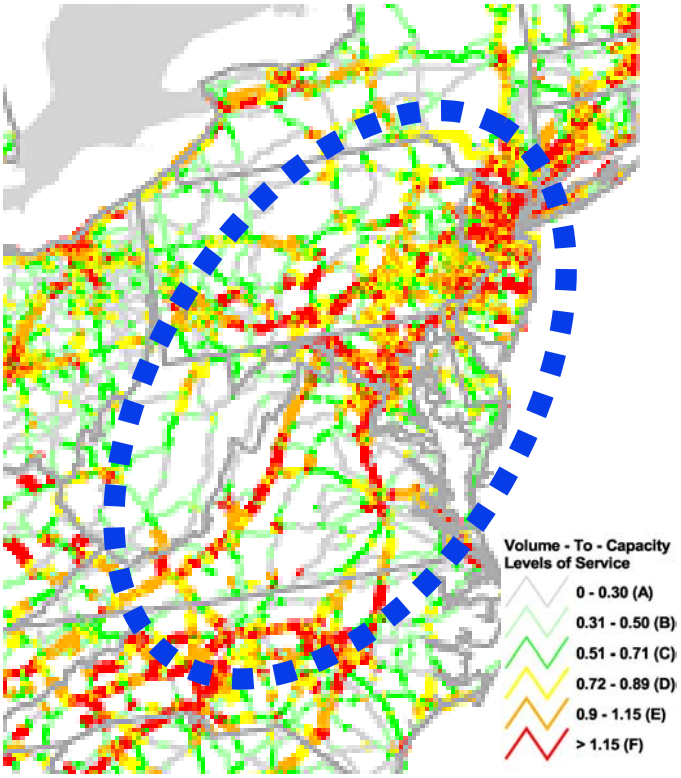
The Mid-Atlantic also is a national gateway to European, South American, and Asian markets through its international seaports—Hampton Roads, Baltimore, Wilmington, Philadelphia, and South Jersey, and the Port of New York and New Jersey—and its "landbridge" rail terminals.

The Mid-Atlantic's transportation infrastructure—particularly its highway system—is severely constrained.

I-95 is one of our nation's preeminent freight corridors, carrying more than 10,000 trucks per day. Trucks represent 10 to 20 percent of all vehicles on I-95. Although I-81 carries fewer trucks than I-95, trucks on I-81 represent an even higher share of total vehicle traffic—20 to 30 percent on a daily basis with peak-period volumes of up to 60 percent.

The FHWA's Freight Analysis Framework project estimated that the tonnage of truck and rail freight moving in the region will increase by 79 percent (about 2.5 percent annually) by 2020, putting more trucks and trains on transportation system. Level-of-service measures show that major segments of I-95 and I-81 are already at or near capacity. The situation will only deteriorate further with growth in freight and passenger movement. Figure 1 shows the projected peak-period highway levels of service in 2020. The highway segments shown in red indicate highly congested, stop-and-go traffic conditions.

Figure 1. Mid-Atlantic Highway Network Showing Projected Peak-Period Congestion, 2020

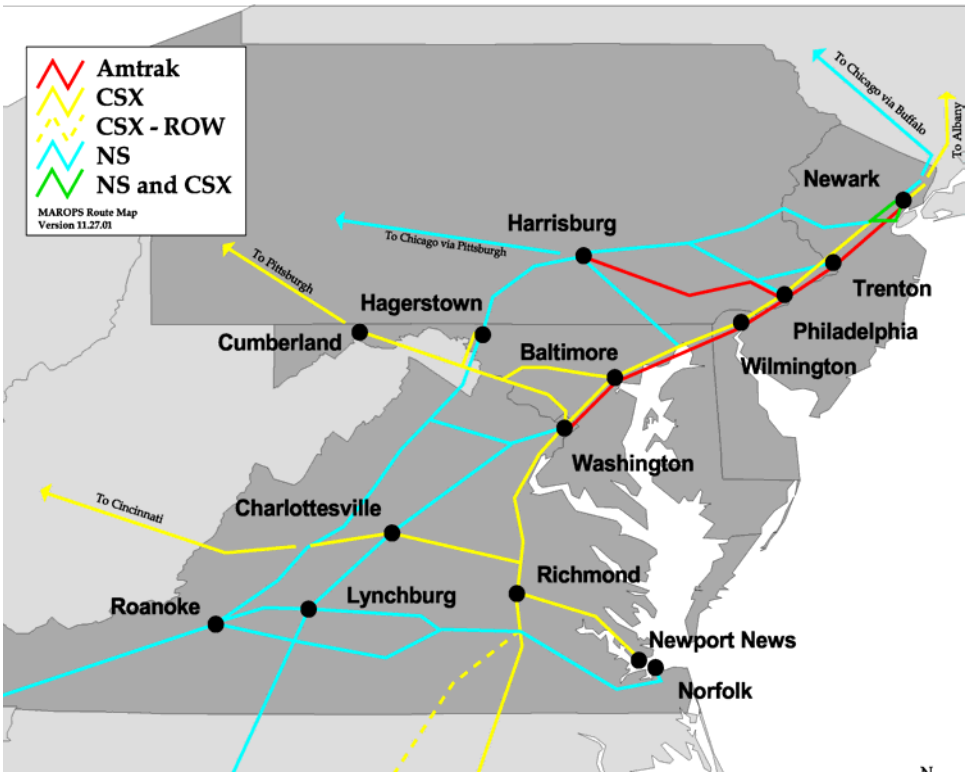


Source: FHWA Freight Analysis Framework Project.

The Mid-Atlantic rail system is an essential part of the region's transportation infrastructure.

The Mid-Atlantic rail system, shown in Figure 2, includes an intercity railroad operating as a for-profit enterprise (Amtrak) and five commuter rail services (NJ TRANSIT, Southeastern Pennsylvania Transportation Authority [SEPTA], MARC, Delaware DOT's contracted services with SEPTA, and the Virginia Railway Express [VRE]). Amtrak's Northeast Corridor (NEC) service, serving the Washington, D.C., New York, and Boston markets, is its most profitable service, carrying more than 13 million riders per year. Amtrak runs more than 80 trains per day in the Mid-Atlantic section of the NEC between Washington and New York. The commuter railroads operate upwards of 250 trains per day over the high-volume segments of the rail network and collectively carry more than 100 million riders per year over their systems.

Figure 2. Mid-Atlantic Rail Network Showing Major Rail Lines and Ownership



Source: MAROps Summary Report.

The system also includes two Class I freight railroads—CSX and NS—and numerous short-line railroads that provide vital "last-mile" service, connecting shippers to the trans-continental Class I railroads. On an annual basis, the freight railroads move more than 250 million tons of intermodal (containerized) and non-containerized goods into and out of the region and carry an additional 100 million tons through the region. The Mid-Atlantic rail freight system carries more east-west traffic than north-south traffic, but the freight railroads run up to 27 trains per day on their busiest north-south segments—in many cases, threading their way through higher-priority intercity and commuter rail passenger traffic, with which they share trackage.

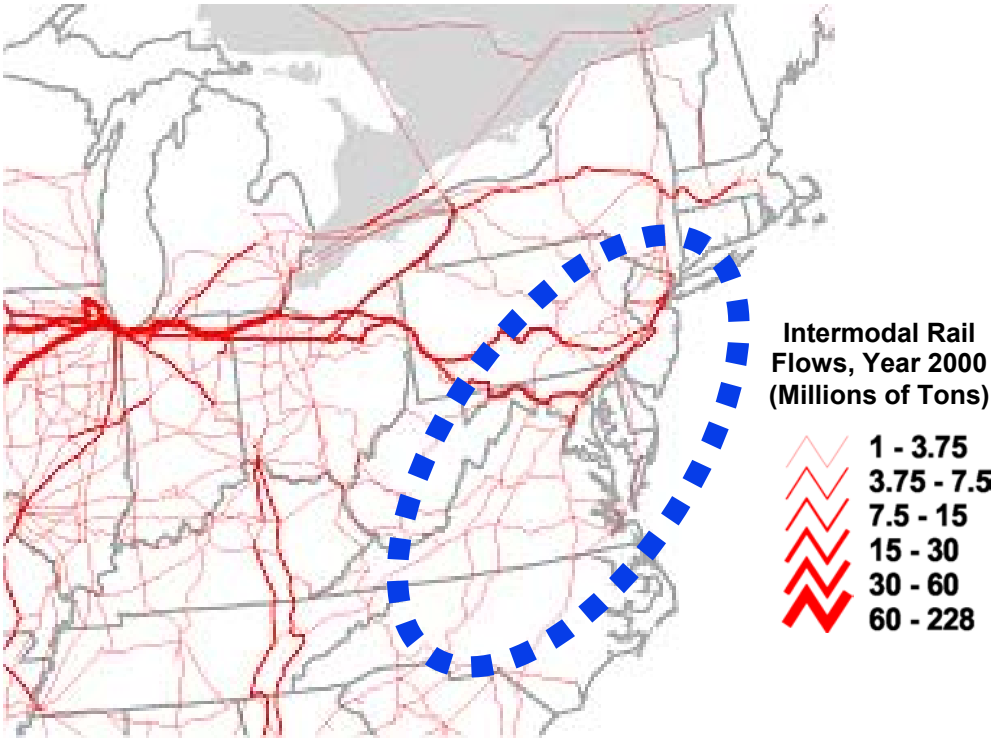
The Mid-Atlantic rail system is not operating at its full potential, especially north-south. Many segments are capable of handling higher volumes of passenger and freight traffic, but these volumes cannot be accommodated because of critical choke points in the rail system. Rail has the potential to carry an increased share of freight and passenger traffic, helping ease the burden on the highways, if these critical chokepoints are relieved.

The choke points include:

- Antiquated and undersized bridges and tunnels;
- Lack of mainline capacity on critical segments of freight and passenger lines;
- Inadequate vertical clearances for double-stack container traffic on freight mainlines;
- Inadequate connections between rail lines; and
- Outmoded and inadequate information and control systems.

Figure 3 shows the density (in tons) of intermodal rail flows in 2000. The Mid-Atlantic rail network supports high-density east-west rail flows, but not north-south flows. North-south freight must move by truck today because the rail system does not have the capacity to provide service that is competitive with trucking.

Figure 3. Intermodal Rail Flows in the MAROps Region



Source: AASHTO *Freight-Rail Bottom-Line Report*.

3.3 The MAROps Program

To address these choke points, the I-95 Coalition, the participating states, and the railroads worked closely and cooperatively in a process that crossed jurisdictional, modal, and

public-private boundaries. Together, they developed a consensus program of 71 infrastructure and information technology improvements to be implemented over 20 years. The initial order-of-magnitude cost estimate for the improvements (not based on detailed engineering) was $6.2 billion.

The states and the railroads have continued to meet regularly, and the list of improvements has undergone refinement. However, the states and the railroads agreed that the Initial Benefits Assessment should work with the set of improvements recommended in the FRBL Report. Those improvements are summarized below, grouped according to the length of time it will take to implement them: near-term projects that can be completed within five years; medium-term projects that can be completed within 10 years; and long-term projects that can be completed within 20 years.

Near-Term Program ($2.4 Billion Dollars, Within Five Years)

- **New Jersey:** Highway grade separation at the NS Croxton Yard; second main track and 11 related projects on the two Shared Assets mainlines; and second main track on CSX from Manville to Trenton.

- **Pennsylvania:** Clearance improvements (33 locations) on the CSX between Philadelphia and Trenton; clearance improvements (11 locations) on CSX in the Philadelphia area; second main track on CSX in the Philadelphia area; connection on NS Lurgen Branch at Harrisburg for yard access; and second main track on NS line from Harrisburg to the Pennsylvania/Maryland state line.

- **Delaware:** Clearance improvements (eight locations) on CSX; restored Shellpot Connection to eliminate NS/passenger train conflicts and serve the Port of Wilmington; and dedicated freight track to eliminate NS/passenger trains conflicts from Wilmington to Perryville, Maryland.

- **Maryland:** Design for reconstruction of the Howard Street Tunnel and approaches on CSX; connection between Amtrak Penn Line and CSX Camden Line to serve MARC; second and third main track on CSX from West Baltimore to Washington; clearance projects (17 locations) on CSX north from Baltimore; rehabilitation of Amtrak's Gunpowder, Susquehanna, and Bush River bridges; design for reconstruction of Amtrak's Union Tunnels and B&P Tunnel; dedicated freight track to eliminate NS/passenger train conflicts between Perryville and Baltimore, Maryland; and second main track on NS from the Pennsylvania/Maryland state line to Berryville, Virginia.

- **Washington, D.C.:** Virginia Avenue Tunnel reconstruction and related projects on CSX; design for second track to serve the VRE L'Enfant Plaza Station and third track to eliminate CSX/passenger conflict; and studies for a new rail bridge over the Potomac adjoining the CSX Long Bridge to eliminate train conflicts.

- **Virginia:** Various capacity projects (second and third main track segments, crossover, and pedestrian bridge) on CSX south of Alexandria; crossovers on CSX at Rose and South Anna to eliminate CSX/passenger train conflicts; third main track on CSX from Alexandria to Crossroads to eliminate CSX/passenger train conflict; Manassas area

improvements; second main track on NS from Berryville, Virginia, to Front Royal; and upgrade of NS interlocking at Front Royal (Riverton).

- **Systemwide:** Develop a regional Advanced Traffic Information System (Regional Rail ATIS) to exchange information electronically among the freight and passenger railroad dispatch and control systems in real time, thereby allowing the railroads to monitor the status and location of all traffic on the rail network, anticipate and compensate for traffic delays, and respond quickly to emergencies. Undertake feasibility studies of other advanced technology and information applications to achieve maximum efficiency from the rail infrastructure.

Medium-Term Program ($1.9 Billion Dollars, Five to 10 Years)

- **New Jersey:** Third main track on Shared Assets line; and various improvements (additional tracks, bridge rehabilitation, crossovers, etc.) on NS Lehigh line from Manville to Phillipsburg.

- **Pennsylvania:** Second main track on CSX from Philadelphia to Trenton; and second main track on CSX south of Philadelphia to the Pennsylvania/Delaware state line.

- **Delaware:** Second main track on CSX from the Pennsylvania/Delaware state line to the Delaware/Maryland state line; and relocate the Delaware DOT's Newark station to reduce NS/passenger train conflicts.

- **Maryland:** Second main track on CSX from the Delaware/Maryland state line to Baltimore; reconstruct the Howard Street Tunnel and approaches on CSX; construct new freight bridges over the Gunpowder, Susquehanna, and Bush rivers to eliminate NS/passenger conflict; and reconstruct Amtrak's Union Tunnels and B&P Tunnel.

- **Washington, D.C.:** Siding on CSX Capital Subdivision and crossovers to Northeast Corridor to improve operations and reduce CSX/passenger conflicts; clearance projects (five locations) on CSX; and second track to serve VRE's L'Enfant Plaza Station and third track to eliminate CSX/passenger conflict.

- **Virginia:** Highway/rail grade crossings and track speed improvements on CSX north of Richmond; various upgrades to tracks, signals, and highway grade crossings on CSX to serve VRE from Fredericksburg to Washington; sections of third track; and clearance projects (11 locations) on CSX south of Washington.

- **Systemwide:** Implement recommended improvements to be identified in feasibility study.

Long-Term Program ($1.9 Billion Dollars, 10 to 20 Years)

- **New Jersey:** Improvements to Bergen and Waldo tunnels in Shared Asset region.

- **Pennsylvania:** Various improvements (additional track, rehabilitation/replacement of bridges, crossovers, etc.) on multiple segments of NS Reading Line; clearance projects (four locations) on NS Reading Line in Reading; grade crossing elimination projects

(13 crossings) at Lebanon on NS Harrisburg Line; improve Amtrak's Phil Interlocking to allow more frequent SEPTA service to Philadelphia International Airport; provide connection between Amtrak's north-south line and east-west line at Zoo Interlocking; second main track on NS from Norristown to Morrisville; add dispatcher signal control in both directions for 10 miles on NS Harrisburg line; and add separate freight track from Philadelphia to Wilmington to eliminate NS/passenger conflict.

- **Delaware:** Various improvements (track reconfiguration, interlockings, and overhead structures) on Amtrak in Wilmington to reduce passenger train congestion.

- **Maryland:** Reconfigure existing tracks on Amtrak from West Baltimore to Baltimore Washington International Airport (BWI); construct new passenger station at BWI; and construct fourth main track from Halethorpe to Landover to eliminate freight/ passenger train conflicts.

- **Washington, D.C.:** New rail bridge over the Potomac adjoining the CSX Long Bridge to eliminate train conflicts; and third and fourth main track on CSX feeding into new rail bridge to eliminate train conflicts.

- **Virginia:** Third main track on CSX from Crossroads to Richmond and Centralia to eliminate CSX/passenger conflict; and additional highway grade crossings and track speed improvements on CSX north of Richmond.

- **Systemwide:** Implement recommended improvements to be identified in feasibility study.

3.4 Anticipated Benefits

The projects recommended in the MAROps Report were selected because they provide local and systemwide benefits. Each project contributes to improvement in the overall performance of the Mid-Atlantic rail network, but each project can be built and benefits realized regardless of whether the other projects are implemented. However, the greatest benefits are realized if all the projects are implemented so that the major freight lanes are cleared and choke points are not simply moved upstream or downstream a few miles. Eliminating tunnel-clearance impediments in Maryland, for example, will provide local benefits as well as regional and national benefits, but only if there is sufficient capacity and good performance over the entire north-south route using the tunnel. This requires a coordinated program of improvements, not just a patchwork of stand-alone projects.

Coordinated, systemwide improvements to those portions of the rail network used by Amtrak and the commuter railroads will provide significant benefits to the public, including:

- Increased passenger capacity, helping offset the burden on congested air and highway systems;
- Enhanced safety, reliability, and emergency response; and
- Greater ability to help the nation's passenger transportation network recover from service disruptions.

Coordinated, systemwide improvements to those portions of the rail network used by NS and CSX will benefit the freight railroads in terms of increased capacity and the potential for increased business. These private industry benefits also provide substantial public benefits, and therefore warrant consideration of public financial participation in the projects. The types of public benefits include:

- Increased freight capacity that helps relieve truck pressure on congested highways;
- Enhanced rail system safety, reliability, and emergency response;
- Upgraded service for double-stack intermodal container traffic and better access to international seaports;
- Improved capability to support military mobilization;
- Economic benefits to region's producers and consumers in the form of lower costs and more transportation choices; and
- Greater ability to help the nation's freight transportation network recover from service disruptions.

4.0 Current and Future Freight Flows in the MAROps Region

For the Initial Benefit Assessment, current and future freight flows were estimated for the Mid-Atlantic region using TRANSEARCH data provided by Reebie Associates. TRANSEARCH is a national database of freight tonnage flows between county of shipment origin and county of shipment destination. The database provides information on freight flows by commodity type and mode of transportation. It is constructed using a variety of public and proprietary data sources and estimation methods.

The freight flows of primary interest for the Initial Benefits Assessment were north-south freight flows because the MAROps program is geared to enhancing north-south rail corridor capacity. The data used in the Initial Benefit Assessment included the following:

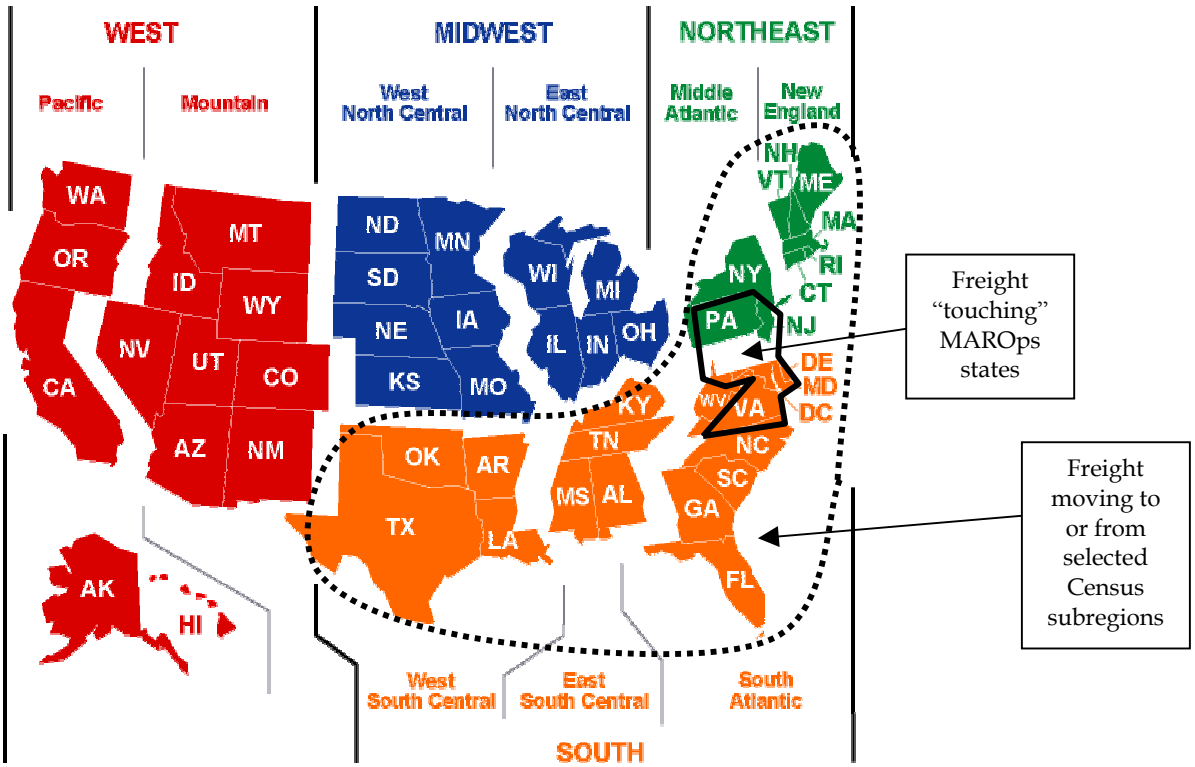
- Freight flows that "touch" (e.g., move into, out of, within, or through) the MAROps states and have an origin or destination in one of the following Census subregions: New England, Mid Atlantic, South Atlantic, East South Central, or West South Central. The Census subregions selected for freight-flow analysis are shown in Figure 4. These

flows capture broadly the freight moving to and from the geographic regions that utilize (or could potentially utilize) the I-95 and I-81 corridors to move freight into, out of, within, or through the MAROps states, while excluding most east-west corridor traffic.

- Tonnage flows, loaded units, and miles of travel for truck and rail. The freight flow data were separated by mode and general commodity class: truck dry van (e.g., containerizable freight); truck "other" (e.g., non-containerizable freight); rail intermodal (e.g., double-stack container, container-on-flatcar, trailer-on-flatcar, piggyback); rail autorack (e.g., dedicated auto-handling cars); rail unit train (major moves of single commodities such as coal and grain); and rail loose car (mix of commodities and rail-car types, but typically boxcars and tank cars).[8]

- Data for 2001 (benchmark year) and 2025 (forecast year).

Figure 4. U.S. Census Subregions Selected for MAROps Freight-Flow Analysis



[8] For the purposes of this study, it was not considered necessary to make finer-grained distinctions among commodity types, although these distinctions are important in marketing transportation services.

The 2001 benchmark freight flows extracted from the TRANSEARCH database for analysis are summarized in Tables 1a and 1b. These data show the following:

- Eighty-five percent of the tonnage is associated with trucking: 34 percent is carried in dry van (e.g., containerizable commodity) trucks; 51 percent in other types of trucks. Trucking is the dominant freight mode in the region.

- Fifteen percent of the tonnage is carried by rail: 11 percent goes by unit train; four percent by loose car; and less than one percent each by intermodal and autorack rail service.

- Rail accounts for a somewhat higher share of ton-miles (23 percent) than tonnage (15 percent) because the average freight-rail move is longer than the average truck move. If rail ton-miles were converted to truck ton-miles, rail-moved commodities would account for 19 percent of VMT versus 81 percent for truck-moved commodities.[9]

Table 1a. Freight Flows in the MAROps Region for 2001 Benchmark

	Volume (millions)			
	Tons	**Ton-Miles**	**Loaded Units**	**Actual Truck VMT**
Truck – Dry Van	574.0	64,120	55.2	15,779
Truck – Other	845.8	157,330	53.4	9,941
Subtotal Truck	*1,419.9*	*321,450*	*108.6*	*25,720*
				Equivalent Truck VMT
Rail – Intermodal	5.3	3,715	0.2	239
Rail – Autorack	1.2	826	0.0	73
Rail – Unit	177.0	58,063	2.0	3,746
Rail – Loose Car	65.1	34,743	1.1	2,057
Subtotal Rail	*248.5*	*97,348*	*3.3*	*6,115*
Total	**1,668.4**	**418,798**	**111.9**	**31,835**

Source: Reebie Associates TRANSEARCH data.

[9] The same tonnage carried on rail and truck will produce different rail ton-miles and truck ton-miles because the vehicles carry different loads (i.e., railcars typically carry 80 tons of commodity while trucks carry 17 tons or less) and the route lengths are somewhat different (i.e., rail lines between typical city pairs are often more circuitous and therefore longer than the corresponding highway route used by trucks).

Table 1b. Freight Flows in the MAROps Region for 2001 Benchmark

	Share by Mode			
	Tons	**Ton-Miles**	**Loaded Units**	**Actual Truck VMT**
Truck – Dry Van	34.4%	39.2%	49.3%	49.6%
Truck – Other	50.7	37.6	47.7	31.2
Subtotal Truck	*85.1%*	*76.8%*	*97.1%*	*80.8%*
Rail – Intermodal	0.3%	0.9%	0.2%	0.8%
Rail – Autorack	0.1	0.2	0.0	0.2
Rail – Unit	10.6	13.9	1.8	11.8
Rail – Loose Car	3.9	8.3	1.0	6.5
Subtotal Rail	*14.9%*	*23.2%*	*2.9%*	*19.2%*
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Reebie Associates TRANSEARCH data.

Table 2 summarizes the geographic distribution of the freight. Analysis of the geographic information shows that:

- Eighty-nine percent of MAROps truck and rail tonnage begins and ends along the eastern seaboard (e.g., within the New England, Mid Atlantic, and South Atlantic Census regions). This is traffic that is dependent on the I-95 and I-81 corridors through the MAROps states. Eleven percent of the tonnage is moving between the East South Central or West South Central regions and the MAROps states. This is freight tonnage that could utilize the I-95 and I-81 corridors or could move to and from the MAROps region using east-west routes.

- Seventy percent of rail tonnage is moving entirely along the eastern seaboard and would benefit from MAROps improvements. The other 30 percent of rail tonnage is Appalachian coal moving generally east-west (as is most of the unit train traffic). These east-west moves are not specifically targeted by the MAROps improvements, but some of this traffic utilizes portions of the north-south network and would benefit from the MAROps improvements.

- Ninety-three percent of truck tonnage captured in this dataset is moving entirely along the eastern seaboard and would benefit from MAROps improvements that allow this traffic to utilize rail. The other seven percent of traffic with an origin or destination in the East or West South Central regions also could benefit if such traffic were routed via the I-95 or I-81 rail corridors instead of their current truck routes.

Table 2. Origins and Destinations of Freight Flow in the MAROps Region for 2001 Benchmark

	Distribution of MAROps Tonnage		
	Mode Share	**Origin and Destination Within: NE, Mid-Atlantic, So. Atlantic Regions**	**Origin or Destination Within: E&W So. Central Regions**
Truck – Dry Van	34.4%	89%	11%
Truck – Other	50.7	95	5
Subtotal Truck	*85.1%*	*93%*	*7%*
Rail – Intermodal	0.3%	73%	27%
Rail – Autorack	0.1	41	59
Rail – Unit	10.6	69	31
Rail – Loose Car	3.9	74	26
Subtotal Rail	*14.9%*	*70%*	*30%*
Total	**100.0%**	**89%**	**11%**

Source: Reebie Associates TRANSEARCH data.

The 2025 base-case forecasts are shown in Table 3. They were developed by applying economic growth rates by industry and geographic region developed by Global Insight to the 2001 TRANSEARCH freight-flow patterns. The forecast of freight demand is unconstrained by freight transportation supply. Future freight demand is determined by underlying economic growth (which is driven largely by population growth, capital investment, labor productivity, and industry competitive position) and is not adjusted for transportation capacity constraints, pricing, or other factors. The forecasts assume that mode shares will remain constant within commodity-lanes. For example, if 90 percent of the coal moving between region X and region Y today were moving by rail and 10 percent were moving by truck, then the same mode split would be applied to the future coal tonnage in that commodity-lane. This approach is consistent with the approach used in the FHWA Freight Analysis Framework project and FRBL Report.[10]

[10]This approach is used to simplify the analysis, which would otherwise become unmanageably complex, requiring detailed industry analyses and extensive modal-diversion modeling. The underlying assumption is that the supply of transportation will more or less meet the demand for freight transportation. However, if the transportation supply fails in a significant way, then the economic growth patterns and forecasted freight volumes could be substantially different because businesses would grow more slowly or relocate production and jobs to other regions.

Table 3. Freight Flows in the MAROps Region for 2025 Base Case

	Volumes (in millions)			
	2001 Tons	**2025 Tons**	**% Change**	**CAGR**
Truck – Dry Van	574.0	1,151.4	101%	2.9%
Truck – Other	845.8	1,215.6	44	1.5
Subtotal Truck	*1,419.9*	*2,366.9*	*67%*	*2.2%*
Rail – Intermodal	5.3	10.8	105%	3.0%
Rail – Autorack	1.2	2.9	146	3.8
Rail – Unit	177.0	229.0	29	1.1
Rail – Loose Car	65.1	78.3	20	0.8
Subtotal Rail	*248.5*	*321.0*	*29%*	*1.1%*
Total	**1,668.4**	**2,688.0**	**61%**	**2.0%**

Source: Reebie Associates TRANSEARCH data.

An examination of the forecast shows the following:

- Overall, truck and rail freight tonnage in the MAROps region is expected to grow from 1.6 to 2.6 billion tons between 2001 and 2025, adding about one billion tons of freight to the system. This is a 61 percent increase and is consistent with other national forecasts previously produced by TRANSEARCH and the FHWA Freight Analysis Framework project.

- The overall mode share for trucking increases relative to rail in 2025 because truck-oriented commodities are projected to grow faster than rail-oriented commodities.[11]

- Trucking is expected to grow by 67 percent, with the highest growth in dry van commodities (101 percent). Conversely, rail is expected to grow at just 29 percent, reflecting lackluster growth in the rail industry's two largest tonnage markets—unit train commodities and loose car commodities. However, rail is expected to do well in the lower-tonnage, higher-value markets of intermodal (105 percent) and autorack (146 percent) services. If there were sufficient rail capacity, rail could keep pace with the growth in trucking in these markets.

[11] The structure of the U.S. economy changes over time. These changes are resulting in increased production and transportation of lighter, higher-value goods that are usually carried by truck and decreased production and transportation of heavy, lower-value goods that are usually transported by rail. Because the forecast holds mode share constant for a given commodity-lane, the forecast may understate the growth in truck traffic and the decline in rail traffic.

5.0 Service and Market Impacts of MAROps Program Improvements

How will freight transportation in the MAROps region be different if the MAROps program is implemented? A complete answer to this question requires detailed evaluation of the individual rail improvement projects and comprehensive modeling of the MAROps rail network. That analysis would take into account the physical capacity of the rail corridors, rail operating practices, business decisions, and shipper behavior. Such an analysis is beyond the scope of the present assessment. However, a methodology for generating an order-of-magnitude benefit assessment was developed for this study.

The key findings of the AASHTO FRBL Report provided a framework for the Initial Benefits Assessment. The findings were as follows:

- Current levels of rail system investment are insufficient for rail to retain its current market share against trucking at a systemwide level, with the likely result that railroads will continue to surrender their least profitable markets to trucking in order to focus investment on their most profitable markets.

- With a higher level of investment, the railroads could keep pace with trucking. The railroads would maintain the same share of the freight market that they hold today as the economy grows.

- With an even higher level of investment aimed at specific commodity and corridors, the railroads could increase their market share with respect to trucking, at least in rail's target markets.

Building on this framework, two scenarios were developed for the MAROps Initial Benefits Assessment:

1. *Without MAROps* 2025 scenario assumes that rail maintains its current overall volume, but does not grow its business. Rail grows its volume in certain commodity lanes, but "de-markets" in others, resulting in little or no growth in overall rail tonnage. Total rail tonnage in the *Without MAROps* 2025 scenario is significantly below the unconstrained 2025 base-case forecast. Trucking continues to grow and absorbs traffic that "wanted" to stay on rail but cannot.

2. *With MAROps* 2025 scenario assumes that rail maintains its current overall market share (as a percentage of total freight tonnage). But the scenario also assumes that rail increases its share of intermodal traffic relative to trucking. It assumes that up to 10 percent by tonnage of dry van commodities and automobiles moving 400 miles or more by truck shifts to rail intermodal.

A variety of hybrid scenarios also were explored, including futures in which the railroads grow their unit train traffic but nothing else, and futures in which the railroads grow their loose car traffic but nothing else. These represent plausible futures falling between the *Without MAROps* and *With MAROps* scenarios and could be estimated by interpolation.

The scenarios were discussed with NS and CSX. Both railroads concurred that the *Without MAROps* and *With MAROps* scenarios were reasonable for a first approximation of benefits, but both cautioned that substantially more detailed, project-specific analyses should be conducted as the program progresses to provide truly defensible results.

Tables 4a, 4b, 4c, and 4d compare the 2025 *Without MAROps* and *With MAROps* scenarios to the 2025 base case (the unconstrained demand forecast) and the 2001 benchmark. The tables show the tonnage, ton-miles, loaded units, and actual or equivalent VMT for the benchmark, the base case, and the two scenarios. The *Without MAROps* and *With MAROps* scenarios are identical in terms of the total amount of tonnage they move (2.7 billion tons), but the *With MAROps* scenario shows a decrease of 88.4 million tons (-3.6 percent) in truck tonnage and a corresponding increase of 88.4 million tons (35.6 percent) in rail tonnage in comparison to the *Without MAROps* scenario. The *With MAROps* scenario shows a slight increase in total ton-miles (0.13 percent) and modest decrease (-2.33 percent) in total loaded units (trucks and railcars), reflecting the increased tonnage carried by rail.

Table 4a. Freight Flows in the MAROps Region for the 2025 *Without MAROps* and *With MAROps* Scenarios

	Tons (millions)			
	2001	2025		
		Base Case	*Without MAROps*	*With MAROps*
Truck – Dry Van	574.0	1,151.4	1,156.9	1,135.6
Truck – Other	845.8	1,215.6	1,282.6	1,215.5
Subtotal Truck	*1,419.9*	*2,366.9*	*2,439.5*	*2,351.1*
Rail – Intermodal	5.3	10.8	5.3	26.6
Rail – Autorack	1.2	2.9	1.2	3.0
Rail – Unit	177.0	229.0	177.0	229.0
Rail – Loose Car	65.1	78.3	65.1	78.3
Subtotal Rail	*248.5*	*321.0*	*248.5*	*336.9*
Total	**1,668.4**	**2,688.0**	**2,688.0**	**2,688.0**

Source: Reebie Associates TRANSEARCH data and Cambridge Systematics estimates.

Table 4b. Freight Flows in the MAROps Region for the 2025 *Without MAROps* and *With MAROps* Scenarios

	Ton-Miles (millions)			
	2001	2025		
		Base Case	*Without MAROps*	*With MAROps*
Truck – Dry Van	64,120	314,622	318,029	301,338
Truck – Other	157,330	252,546	285,793	252,478
Subtotal Truck	*321,450*	*567,168*	*603,822*	*553,815*
Rail – Intermodal	3,715	7,996	3,715	24,568
Rail – Autorack	826	2,087	826	2,150
Rail – Unit	58,063	76,827	58,063	76,827
Rail – Loose Car	34,743	44,740	34,743	44,740
Subtotal Rail	*97,348*	*131,650*	*97,348*	*148,285*
Total	**418,798**	**698,818**	**701,171**	**702,100**

Source: Reebie Associates TRANSEARCH data and Cambridge Systematics estimates.

Table 4c. Freight Flows in the MAROps Region for the 2025 *Without MAROps* and *With MAROps* Scenarios

	Loaded Units (millions)			
	2001	2025		
		Base Case	*Without MAROps*	*With MAROps*
Truck – Dry Van	55.2	110.0	110.4	108.7
Truck – Other	53.4	75.1	79.5	75.1
Subtotal Truck	*108.6*	*185.1*	*189.8*	*183.9*
Rail – Intermodal	0.2	0.3	0.2	0.8
Rail – Autorack	0.0	0.1	0.0	0.1
Rail – Unit	2.0	2.5	2.0	2.5
Rail – Loose Car	1.1	1.3	1.1	1.3
Subtotal Rail	*3.3*	*4.3*	*3.3*	*4.8*
Total	**111.9**	**189.4**	**193.1**	**188.6**

Source: Reebie Associates TRANSEARCH data and Cambridge Systematics estimates.

Table 4d. Freight Flows in the MAROps Region for the 2025 *Without MAROps* and *With MAROps* Scenarios

	Actual and Equivalent Truck VMT (millions)			
	2001	2025		
		Base Case	*Without MAROps*	*With MAROps*
Truck – Dry Van	15,779	30,060	30,336	28,855
Truck – Other	9,941	15,606	17,705	15,601
Subtotal Truck	*25,720*	*45,665*	*48,041*	*44,456*
Rail – Intermodal	239	511	239	1,805
Rail – Autorack	73	185	73	190
Rail – Unit	3,746	4,957	3,746	4,957
Rail – Loose Car	2,057	2,657	2,057	2,657
Subtotal Rail	*6,115*	*8,309*	*6,115*	*9,608*
Total	**31,835**	**53,974**	**54,156**	**54,065**

Source: Reebie Associates TRANSEARCH data and Cambridge Systematics estimates.

The critical difference between the *Without MAROps* and *With MAROps* scenarios for the Initial Benefits Assessment is the amount of truck VMT generated. In the *Without MAROps* scenario, 2025 truck VMT is 48.0 billion; in the *With MAROps* scenario, 2025 truck VMT is reduced to 44.5 billion. Table 5 summarizes the differences between the scenarios.

Table 5 also shows that the largest VMT benefits are provided by unit train and intermodal services. The "Contribution to Truck VMT Reduction by Type of Rail Service," shown in the rightmost column of Table 5, shows the relative contribution of each type of rail service to reducing truck VMT. The largest VMT benefits are provided by unit train and intermodal services, in equal share. Rail unit train service carries twice as much tonnage as rail intermodal, but intermodal haul lengths tend on average to be twice as long as unit train hauls and therefore intermodal moves generate more VMT reduction benefits. Unit train traffic in the MAROps region is largely associated with east-west movements of Appalachian coal, which were not the primary focus of the MAROps improvements; however, a substantial share of this traffic utilizes at least a portion of the north-south network and will accrue some benefit from the MAROps improvements.

Table 5. Change in Truck VMT and Rail Tonnage in the MAROps Region Between the 2025 *Without MAROps* and *With MAROps* Scenarios

	***With MAROps* Minus *Without MAROps* (millions)**			
	Tons	**Ton-Miles**	**Loaded Units**	**Truck VMT**
Truck – Dry Van	-21.3	-16,691	-1.7	-1,481
Truck – Other	-67.1	-33,315	-4.4	-2,104
Subtotal Truck	*-88.4*	*-50,007*	*-5.9*	*-3,585*
				Contribution to Truck VMT Reduction by Type of Rail Service
Rail – Intermodal	21.3	20,853	0.6	41%
Rail – Autorack	1.8	1,324	0.1	4
Rail – Unit	52.0	18,764	0.5	40
Rail – Loose Car	13.2	9,997	0.2	15
Subtotal Rail	*88.4*	*50,937*	*1.5*	*100%*
Total	**0.0**	**929**	**-4.5**	**-3,585**

Source: Reebie TRANSEARCH data and Cambridge Systematics.

It was not possible in this analysis to allocate the reduction in truck VMT among the five MAROps states. However, it was possible to allocate truck VMT between the MAROps states as a group and the rest of the national transportation network. The highway mileage between origin Census region and destination Census region was calculated for each of the 23 origin-destination pairs in the TRANSEARCH data set. The mileage was divided between the MAROps region and the rest of nation and then weighted by the amount of truck traffic diverted to rail under the *With MAROps* scenario.

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

6.0 Business Benefits of MAROps Improvements to Freight Shippers

Freight shippers benefit if they can shift freight from truck to rail at comparable service levels because rail shipments are less costly than truck shipments. Nationally, trucking costs average two to four times more than rail costs on a per-mile basis. The cumulative savings to freight shippers over the period from 2005 (when the first MAROps projects are completed) through 2025 (when the last MAROps projects are completed) are estimated at $2.9 billion.

Table 6 shows the truck ton-mileage reduction associated with the MAROps improvements and the calculated savings. To calculate the cumulative savings between 2005 and 2025, the dollar per ton-mile savings in 2025 were determined ($4,001 million minus $2,250 million equals $1,751 million). This figure was divided by two to represent the savings in an average study period year ($875.5 million), and then multiplied by 20 years to obtain the total non-adjusted savings ($17,502 million).

Table 6. Shipper Cost Savings for the 2025 *Without MAROps* and *With MAROps* Scenarios

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

Source: Cambridge Systematics analysis using Reebie Associates TRANSEARCH data, AASHTO *Freight-Rail Bottom-Line Report* findings, and U.S. DOT Rail Waybill Sample summary information.

The total non-adjusted savings of $17,502 million were reduced by 50 percent as an approximate planning-level estimate of the effect of the following factors:

- The *Without MAROps* scenario assumes that some unit-train tonnage—typically heavier and bulkier commodities, such as coal, which generally moves east-west—are shifted from rail to truck because of the lack of rail capacity. The *With MAROps* scenario assumes that this tonnage is "recaptured." However, from a practical perspective it is not clear that coal traffic could shift readily from rail to truck and back to rail, so the benefits associated with these shifts were reduced.

- Shifting from rail to truck imposes a cost penalty on shippers, but for some shippers there may be offsetting benefits associated with increased speed, reliability, flexibility, etc. The MAROps benefit estimate should be reduced to reflect this.

- It may also be the case that shifting from rail to truck imposes not only a transportation cost penalty, but also a "business re-engineering" penalty, which would actually increase the cost differences between the scenarios. However, to provide a reasonable conservative estimate, no adjustments were made to capture this effect.

The resulting "adjusted" estimate of shipper savings from the 2025 *With MAROps* scenario totals $8.75 billion. Of this total, 33 percent or $2.9 billion was assigned to shippers within the MAROps region and 67 percent to shippers in other regions and states.[12]

The immediate beneficiary of these savings is the private-sector shipper. Freight shippers will pay less for transportation, freeing up money for other business purposes. However, these savings also will have significant secondary benefits to the public. The nature of the benefits will depend on what businesses decide to do with the savings—pass them on to consumers, expand business production, employ more workers, or increase capital investment. The economic impact of these changes is discussed in Section 8.0.

7.0 Highway User and System Benefits of MAROps Improvements Calculated from HERS Model

HERS is a computer simulation model that estimates the benefits and costs of investment in the Federal-aid highway system, currently the 958,000 miles of roadways that carry most of the nation's truck-freight traffic. Given an increase in VMT, HERS will calculate the level of new investment needed to keep user costs from increasing and maintain highway system performance at current levels. HERS evaluates pavement rehabilitation, roadway widening, and reconstruction needs, and then determines the most cost-effective investments to accommodate the additional auto and truck traffic. Given a decrease in VMT, HERS will calculate the benefits that accrue to users and the reduction in highway system maintenance costs. User costs are typically measured in terms of travel time, operating costs, and crash costs for automobile and truck drivers. System costs are typically measured in terms of maintenance costs and environmental costs (engine emissions). For the Initial Benefits Assessment, HERS was used to assess the costs and benefits of

[12]The approximate distribution of shipments by region of origin and the allocation of VMT between the MAROps region and the rest of the United States were used as very rough proxies to allocate shipper benefits. A more detailed analysis would apportion shipper benefits primarily by the geographic origin of the shipper.

reducing VMT by removing trucks from the highway system as a result of the MAROps improvements.[13]

As shown in the data in Table 7, the *With MAROps* scenario reduces total truck VMT by 3.6 billion VMT in comparison to the *Without MAROps* scenario. Of this 3.6 billion VMT, 33 percent or 1.2 billion VMT is within the MAROps region. This number was expanded by 33 percent to account for the additional truck VMT associated with empty truck moves, yielding a total truck VMT reduction in the MAROps region of 1.57 billion VMT.

Table 7. HERS Truck VMT for 2025 *Without MAROps* and *With MAROps* Scenarios

	HERS VMT (millions), 2025		
Vehicle Type	***Without MAROps***	***With MAROps***	**Difference**
Combination and Single-Unit Truck	41,431	39,845	(1,586)
All Other (autos and four-tired trucks)	395,203	395,245	42
Total	**436,634**	**435,090**	**1,544**

The scope of work for the study offered the possibility of testing the impact of improved passenger rail service on automobile VMT in the MAROps region. However, the available data would not support the analysis. Future intercity passenger volumes on Amtrak and their impact on automobile VMT across the MAROps region could not be estimated reliably for the *With MAROps* and *Without MAROps* scenarios within the scope of this study. The MAROps improvements should have a measurable impact on automobile VMT and should be addressed in future, more detailed benefits assessments.

The highway user costs and benefits calculated by the HERS model for the *With MAROps* and *Without MAROps* scenarios are shown in Table 8. The figures show that reducing truck VMT by implementing the MAROps improvements reduces travel time costs (e.g., reduces congestion delay, incident delay, etc.) and operating costs (e.g., reduces fuel consumption and wear-and-tear on the vehicle); however, the *With MAROps* scenario also produced a modest increase in crash costs because the reduction in truck VMT increases travel speeds.

[13]Some or all of the benefit of the MAROps improvements might instead be realized in the form of reduced or delayed highway investments, but because trucks are typically a small percentage of total vehicles on most highways and the reductions in truck VMT are spread out over a very large region, it was judged that the MAROps improvements would have less effect on highway investment decisions, such as widening and repaving, and more impact on direct user benefits like travel time and operating costs.

Table 8. Highway User Costs and Benefits for 2025 *Without MAROps* and *With MAROps* Scenarios

Measure	HERS 2025 Results ($ per 1,000 VMT) *Without MAROps* 2025	*With MAROps* 2025	Difference
Travel Time			
• Four-Tire Vehicles	470	468	-2.00
• Single-Unit Truck	470	468	-2.00
• Combination Truck	470	468	-2.00
Operating Cost			
• Four-Tire Vehicles	220.13	217.60	-2.53
• Single-Unit Truck	722.45	718.39	-4.06
• Combination Truck	722.45	718.39	-4.06
Crash			
• Four-Tire Vehicles	141.09	142.13	1.04
• Single-Unit Truck	141.09	142.13	1.04
• Combination Truck	141.09	142.13	1.04
Total Change			
• Four-Tire Vehicles	831.22	827.73	-3.49
• Single-Unit Truck	1,333.54	1,328.52	-5.02
• Combination Truck	1,333.54	1,328.52	-5.02

These reduced user costs would accrue to drivers of cars and trucks remaining on the road under the *With MAROps* scenario, as shown in Tables 9 and 10 below. To be conservative and consistent with the shipper benefit estimates, direct user benefits were reduced by 50 percent.[14] Automobile drivers remaining on the highway would benefit significantly from the MAROps improvements. The total savings to auto users over the period 2005-2025 is estimated at $5.5 billion dollars (in current dollars). Truck users remaining on the highway also would benefit from the MAROps improvements. The total savings to truck users over the period 2005-2025 is estimated at $0.8 billion dollars (in current dollars).

[14]Several considerations argue for taking a conservative approach to claiming full benefits for automobile and truck drivers continuing to use the highways. First is the recognition that the benefits are widely spread across the region and highway network and, while the cumulative benefits are significant and measurable at a system level, the benefits realized by some individual drivers will be modest. Second, a large portion of truck travel occurs during the mid-day off-peak hours or at night, and reducing truck VMT at these times will produce modest benefits.

Table 9. Auto User Costs and Benefits for 2025 *Without MAROps* and *With MAROps* Scenarios

Measure	Difference ($ per 1,000 VMT), Median Year	VMT (1,000) Receiving Benefit, Median Year	Auto User Costs (current $), Median Year	Cumulative User Cost Difference (current $), 2005-2025
Travel Time	-1.00	314,615,500	-314,615,500	-6,292,310,000
Operating Cost	-1.27	314,615,500	-397,988,608	-7,959,772,150
Crash	+0.52	314,615,500	163,600,060	3,272,001,200
Total	**-1.75**	**314,615,500**	**-549,004,048**	**-10,980,080,960**
Adjusted Total (50%)				**-5,490,040,480**

Table 10. Truck User Costs and Benefits for 2025 *Without MAROps* and *With MAROps* Scenarios

Measure	Difference ($ per 1,000 VMT), Median Year	VMT (1,000) Receiving Benefit, Median Year	Truck User Costs (current $), Median Year	Cumulative User Cost Difference (current $), 2005-2025
Travel Time	-1.00	30,997,500	-30,997,500	-619,950,000
Operating Cost	-2.03	30,997,500	-62,924,925	-1,258,498,500
Crash	+0.52	30,997,500	16,118,700	322,374,000
Total	**-2.51**	**30,997,500**	**-77,803,725**	**-1,556,074,500**
Adjusted Total (50%)				**-778,037,250**

MAROps improvements would reduce slightly annual highway maintenance costs and per unit emissions of vehicles remaining on the highway.[15] The cumulative savings of the 20-year period are estimated at $138 million and are shown in Table 11.

HERS did not show any changes in the need for highway system investment (e.g., roadway widening, etc.) because investment was held equal in both scenarios.

[15]The *With MAROps* scenario would reduce the amount of truck VMT on the highway, with corresponding reductions in truck engine emissions; however, these reductions must be balanced against the increased emissions associated with increased rail traffic and locomotive engine emission. Rail emissions were not calculated as part of this analysis.

Table 11. Highway System Costs and Benefits for 2025 *Without MAROps* and *With MAROps* Scenarios

Measure	HERS Runs, 2025 Results ($ per 1,000 VMT) *Without MAROps* 2025	*With MAROps* 2025	Difference	Cumulative System Cost Difference ($ current) 2005-2025
Annual Maintenance ($ per mile; 66,840 miles)	2,534	2,442	92	-61,492,800
Pollution ($ per 1,000 VMT) associated with trucks remaining on the highway *With MAROps*	6.24	6.20	0.04	-138,245,000

8.0 Economic Benefits of MAROps Improvements Calculated from REMI Model

Changes in transportation costs translate into increases in productivity and reductions in the cost of doing business—dollar savings that become available for other business purposes such as increasing profitability and market share, reducing consumer prices, investing in equipment, and adding employees. These benefits can be measured using a dynamic I/O economic model. The model converts changes in the cost of doing business into changes in industry and firm competitive position and business expansion effects, and then expresses them as changes in GRP, a measure of the value of the output of the MAROps region economy.

For this assessment, an economic simulation model of the economies of the five MAROps states was leased from REMI. The key inputs to the model were the shipper benefits (from Table 6), 12 percent of auto user benefits (from Table 10), and truck user benefits (from Table 11). It is estimated that 12 percent of auto VMT in the MAROps states is work related, and this factor was applied to the auto user benefits that were input to REMI. Only the benefits allocated to the five-state MAROps region were used in the economic calculations.

The cumulative economic benefits of the MAROps improvements are estimated to increase the GRP of the MAROps region by $3.7 billion (in 2003 dollars). The benefits are summarized in Table 12.

Table 12. Economic Impact of 2025 *With MAROps* Scenario

Measure	Input: Work-Related Benefit ($ millions, current), Cumulative Through 2025	Output: Change in GRP ($ millions, 2003), Cumulative Through 2025	Net Benefit: Output Minus Input ($ millions, 2003), Cumulative Through 2025
Shipper Cost Benefits	$2,888	$6,086	$3,198
Truck User Benefits	778	1,041	263
Auto User Benefits, Work-Related	659	880	221
Total	**$4,325**	**$8,007**	**$3,682**

9.0 Summary of Benefits

The benefits from the MAROps program improvements are estimated at $12.8 billion. These benefits are cumulative benefits for the period from 2005 (when the initial MAROps improvements are finished) through 2025 (when the final MAROps improvements are completed). The benefits accrue to the five-state MAROps region only. Additional benefits will accrue to regions and states outside the Mid-Atlantic region, but were not estimated as part of this Initial Benefits Assessment.

Two groups benefit from the MAROps improvements that shift freight from truck to rail and reduce truck VMT on the highways. Shippers—especially those shipping long distances, who will pay less to move freight by rail than they did by truck—benefit by an estimated $6.1 billion. Highway users benefit by an estimated $6.7 billion. Of the $6.7 billion of highway user benefits, automobile drivers making non-work-related trips get $4.8 billion; auto drivers making work-related trips get $0.9 billion; and truckers continuing to use the highways get about $1.0 billion.

Of the total $12.8 billion benefits, $9.1 billion are direct benefits to automobile drivers, shippers, and truckers. The remaining $3.7 billion are indirect economic benefits, the result of lower transportation costs for businesses. The benefits are summarized in Table 13.

Table 13. Summary of Estimated Benefits to the MAROps Region from MAROps Improvements, 2005-2025

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

The estimated $12.8 billion benefit of the MAROps program is significantly larger than the estimated $6.2 billion cost of the program, suggesting a positive benefit/cost ratio. However, the full net present value of the benefits and the costs must be estimated before an accurate benefit/cost ratio can be calculated. Nevertheless, the Initial Benefits Assessment supports a preliminary conclusion that the MAROps program could return positive benefits and that more detailed development is warranted.