

Transportation Needs of Target Industries

draft report

prepared for

Tennessee Department of Transportation

prepared by

Cambridge Systematics, Inc.

report

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1.0 Introduction

The Tennessee Department of Economic and Community Development (TN ECD) developed a Jobs4TN plan with the goal of improving high-quality jobs in Tennessee. An internal review process was used to identify six key industry clusters in which Tennessee has a competitive advantage. These industry clusters are:

1. Automotive;
2. Chemical products and plastics;
3. Transportation, logistics and distribution services;
4. Business services;
5. Healthcare; and
6. Advanced manufacturing and energy technologies.

The goal of the TN ECD is to proactively recruit companies to the State within these target industries and to retain and expand existing businesses within these target industries.

This report summarizes work done to determine the transportation needs of these key industries in Tennessee. The analysis identifies the location of these industries in the State, describes the supply chain of each industry in general terms, and describes current and future transportation needs of these industries based on projected growth patterns. The report is organized into the following sections:

- **Section 1.0 Introduction** - This section provides an overview for the project and describes the structure for this report.
- **Section 2.0 Description of Target Industries** - This section describes the economic importance of target industries through production and employment, recent and future growth trajectories, locations within Tennessee and supply chains of each target industry.
- **Section 3.0 Existing and Future Transportation Needs** - This section determines the transportation needs of key industries today and over the long term. It includes a description of the operational performance of key elements of the freight transportation system and how it relates to the supply chains of the target industries. It also provides high-level concepts of freight improvement projects to consider.

2.0 Description of Target Industries

This section describes the target industries based on output, employment, recent and projected growth trajectories, locations of businesses, and supply chains. A description of the data sources used and the economic definitions used for each industry is provided in Appendix A.

2.1 ECONOMIC OUTPUT AND EMPLOYMENT FOR TARGET INDUSTRIES

The total economic output of the target industries in Tennessee was \$89 billion (Table 2.1). The largest targeted industries are Business Services and Healthcare. Combined these industries represent \$63 billion of the total \$89 billion (over 70 percent) of the targeted industries. The transportation, logistics and distribution services is the next largest industry with \$4.3 billion worth of sales in 2009. This is followed by advanced manufacturing, chemicals and plastics, and the automotive industry in terms of size. Note that the energy sector was dispersed across several different industry classifications and is therefore not included in the advanced manufacturing category.

Relative to the entire U.S., Tennessee has a smaller business services industry. However, the other targeted industries are a larger percentage of the Tennessee industry than they are in the rest of the U.S. Of particular note are healthcare which is nearly 10 percent of the economy in Tennessee and only 7.5 percent in the rest of the U.S. This is likely in large part due to the healthcare and hospital-related businesses based in Nashville along with the growing pharmaceutical industry that is concentrated in the Memphis region. Additionally, the transportation, logistics and distribution services industry is significantly larger in Tennessee at 4.6 percent relative to the rest of the U.S. where the percentage is only 2.8 percent. The expansive transportation and logistics activity in the Memphis region is the primary driver of this outperformance for Tennessee.

The current employment from the target industries is substantial. Table 2.2 shows that over 1.2 million people in Tennessee are employed in one of these six industries. Nearly 500,000 employees are employed in the Business Services industry. Healthcare is the second largest industry with just under half a million. In descending order of number of employees, the next largest industries are transportation, logistics and distribution services; the automotive industry, the chemical and plastics industry, and the advanced manufacturing industries.

One of the reasons why these industries were selected as target industries for Tennessee is because the employment in these sectors is much higher for the State than for the entire U.S. For example, the percentage of people in Tennessee employed in the transportation, logistics, distribution services industry is twice as high as the percentage of people employed in the industry for the entire country. Similarly, the Tennessee employment percentage is double that of the U.S. for the Advanced Manufacturing and Chemical/Plastics industries. Overall, the targeted industries in Tennessee represent 21 percent of the current employment compared to 14 percent in the rest of the U.S.

Table 2.1 Output for Target Industries in U.S. and Tennessee
\$Millions, 2009

Target Industry	U.S.		Tennessee	
	Output	Percent Total	Output	Percent Total
Advanced Manufacturing	164,400	1.2%	5,841	2.4%
Automotive	168,900	1.2%	3,531	1.4%
Business Services	2,879,400	20.4%	39,082	16.0%
Chemical and Plastics	273,200	1.9%	5,108	2.1%
Healthcare	1,057,900	7.5%	24,215	9.9%
Transportation, Logistics and Distribution Services	389,500	2.8%	11,309	4.6%
Total Target Industries	4,933,300	35.0%	89,086	36.4%
Other	9,185,700	65.0%	154,763	63.6%
Total	14,119,000	100.0%	243,849	100.0%

Table 2.2 Employment for Target Industries
2009

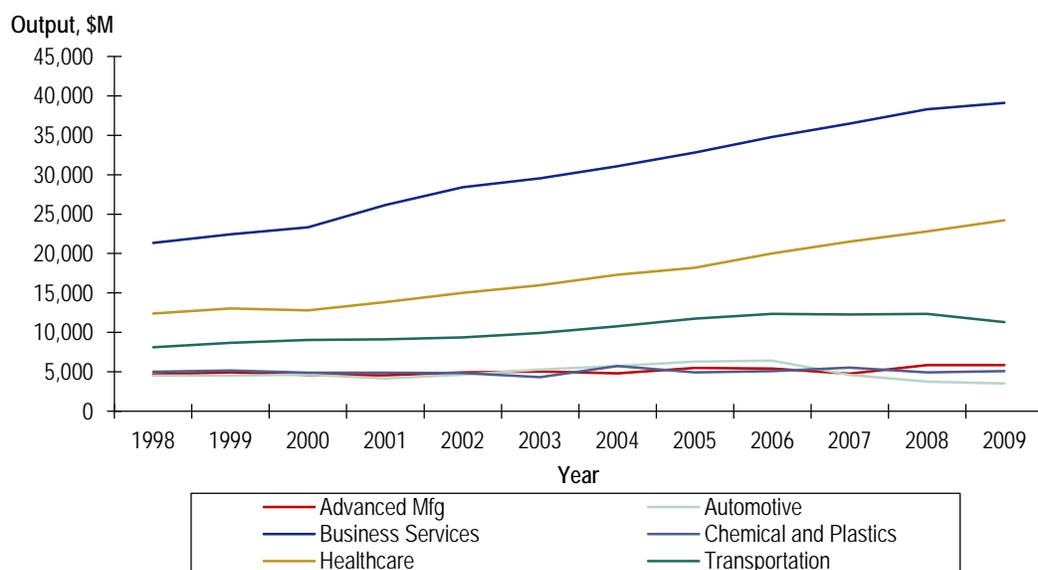
Industry	U.S.		Tennessee	
	Monthly Employees	Percent Total	Monthly Employees	Percent Total
Advanced Manufacturing	1,079,184	0.3%	44,960	0.8%
Automotive	4,369,750	1.1%	106,718	1.9%
Business Services	27,235,133	6.8%	489,182	8.8%
Chemical and Plastics	1,575,934	0.4%	48,854	0.9%
Healthcare	18,380,478	4.6%	378,880	6.8%
Transportation, Logistics, Distribution Services	4,935,603	1.2%	135,819	2.5%
Total Targeted Industries	57,576,082	14.4%	1,204,413	21.7%
Other Industries	286,947,558	71.2%	3,128,272	56.6%
Total	402,099,722	100.0%	5,537,098	100.0%

2.2 RECENT GROWTH OF TARGET INDUSTRIES

The target industries have experienced a range of growth rates over the past 15 years. Figure 2.1 shows the target industry economic output trends from 1998 to 2009. The Business Services industry has virtually doubled in this time period in terms of economic output going from \$20 billion of annual output to nearly \$40 billion. The Health Care industry also has roughly doubled in this time period going from \$12.5 billion to \$25 billion.

The Transportation, Logistics, and Distribution Services industry has increased significantly over this time period, but it did experience a decrease in output in the recessionary period post-2007. The Chemicals and Plastics industry along with the Advanced Manufacturing industry have roughly been flat over this same time period. The automotive industry increased through 2006, but decreased significantly during the recent recession.

Figure 2.1 Output Trends for Target Industries
1998 to 2009



Source: Bureau of Economic Analysis.

2.3 PROJECTED GROWTH OF TARGET INDUSTRIES

The future growth of the target industries was estimated using the Tennessee Department of Labor statewide employment projections for 2018. As shown in Table 2.3, half of these industries are forecast to decrease in employment, while half are expected to grow in terms of employment. The industries that are expected to grow are Business Services, Healthcare and Transportation, Logistics, and Distribution Services. These industries are expected to grow at rates of 1.0,

1.9, and 0.5 percent annually, respectively. The Advanced Manufacturing, Automotive, and Chemicals/Plastics industries are projected to shrink by -1.4 percent, -1.0 percent, and -0.5 percent annually through 2018. In total, these target industries are expected to grow by 0.6 percent annually between 2008 and 2018. It should be noted that these projects do not take into account additional efforts by the State to recruit, retain, and expand companies through the Governor’s targeted economic development program.

A forecast of tonnage growth was generated for four of the six target industries using TDOT’s TRANSEARCH database. The TRANSEARCH database is a freight flow database that has information on origins, destinations and modes by commodity for a base year of 2007 and a forecast year of 2035. Estimates for Business Services and Healthcare are not available as they are not heavily goods producing industries. As shown in Table 2.4, all of the target industries are forecast to grow between 2007 and 2035 in terms of the amount of tonnage. In total, the target industries are forecast to grow twice as fast as other types of commodities in Tennessee between 2007 and 2035 – 90 percent compared to 45 percent. This indicates that the target industries do have a great deal of expansion opportunities.

The fastest growth industry of the target industries is the Advanced Manufacturing industry. It is forecast to grow by 246 percent between 2007 and 2035 resulting in an average compound growth rate of 4.5 percent. This is followed by the Transportation, Logistics, Distribution Services, Plastics and Chemicals, and Automotive industries with forecasted growth of 132 percent, 69 percent and 55 percent.

The growth in tonnage output for these industries stands in contrast with the reduction in number of employees for three of the industries. These opposite rates of growth are possible if these industries become significantly more productive over the long term or if the subsectors within these industries that grow the fastest are the ones with the highest output per employee. It should be noted that industries that grow their output while shrinking their employment base can still contribute significantly to the tax base for Tennessee.

Table 2.3 Growth Projections for Employment
2008 to 2018

Industries	2008	2018	Compound Annual Growth Rate	Change Year Change
Advanced	88,490	76,470	-1.4%	-12,020
Automotive	72,340	65,730	-1.0%	-6,610
Business	516,620	570,660	1.0%	54,040
Chemical	55,590	53,000	-0.5%	-2,590
Healthcare	357,460	430,810	1.9%	73,350
Transportation, Logistics and Distribution Services	139,500	147,030	0.5%	7,530
All Industries Total	3,057,700	3,230,660	0.6%	172,960

Source: Tennessee Department of Labor.

Table 2.4 Current and Projected Tonnage Estimates by Industry

Industry	2007 Tons	2035 Tons	Total Growth 2007 to 2035	Annual Growth Rate
Advanced Manufacturing	3,609,493	12,493,735	246%	4.5%
Automotive	10,627,741	17,931,815	69%	1.9%
Chemical and Plastics	28,004,175	43,503,466	55%	1.6%
Transportation, Logistics, Distribution Services	14,547,210	33,811,854	132%	3.1%
Total of Select Target Industries	56,788,619	107,740,870	90%	2.4%
Other Commodities	357,196,800	517,035,512	45%	1.4%
All Commodities Total	413,985,419	624,776,382	51%	1.5%

Source: TDOT TRANSEARCH database.

2.4 LOCATIONS OF TARGET INDUSTRIES

Target industries are clustered in select geographies across Tennessee. Figure 2.2 provides a map of Tennessee with locations of the target industries based on employment data at the county level from the QCEW database. Counties with more than 40,000 employees in the targeted industries also feature a pie chart showing the distribution of this employment. The map in Figure 2.3 shows the location of tonnage production for the target industry in the State. Counties with over one million annual tons of freight moving also feature a pie chart to demonstrate the distribution of targeted commodities within those counties.

As shown in Figure 2.2, the employment of these target industries are clustered around the State’s major metropolitan regions of Nashville, Memphis, Knoxville, and Chattanooga. There also are smaller clusters of targeted industry employment in the Tri-Cities region, the Cleveland region, the Clarksville region, and the Jackson region. Within the Nashville region, the largest targeted industry is the Business Services industry. It represents roughly half of the targeted industry employment in Davidson and Rutherford Counties and over half of the targeted industry employment in Williamson County. In Davidson County there also is a large fraction of Healthcare industry employment. The Nissan auto plant in Smyrna along with its associated suppliers makes the automotive industry to be relatively large in Rutherford County.

In the Memphis region, the Business Services industry also is just less than half of the employment in the region. However, the Healthcare industry and the Transportation, Logistics, and Distribution Services industries each represent about 25 percent of the employment in the region. The presence of many pharmaceutical companies in the Memphis region makes the Healthcare industry in the Memphis region a significant employer. The role of Memphis as a logistics hub drives the region to be a top employer for transportation-related companies.

This strong focus on transportation is one of the largest differences between Memphis and Nashville employment within the target industries.

The Chattanooga region also has a relatively large percentage of its targeted industry employment within transportation-related industries. The Knoxville region has a large percentage of employment in the Healthcare industry.

Figure 2.3 shows that the tonnages of targeted commodities within the State are heaviest in the Nashville, Memphis, and Tri-Cities regions. Chattanooga and Knoxville also have high levels of freight tonnage within the targeted commodities. The Chattanooga, Knoxville, and Tri-Cities regions have high percentages of Chemicals and Plastics. The Memphis region has a high percentage of both transportation-related commodities (such as secondary flows moving from warehousing and distribution centers) along with Chemicals and Plastics. Counties in the Nashville region also have high levels of automotive-related tonnage output. In particular, the counties of Rutherford and Maury have over two-thirds of their total tonnage output in the targeted industries in the Automotive industry. Davidson County has a mix of all four of the freight-related commodities produced in their county.

Pies are generated for counties that have freight tonnages greater than one million tons to show the share of freight tonnages by industry. There are great variations among counties in terms of freight distribution. Specifically, Memphis is dominated by freight activity from the transport and chemical sector; Nashville has large shares of chemical, transport, and auto industry activities; Chattanooga, Cleveland, Knoxville, and the Tri-Cities area are all dominated by the chemical industry. In addition, Maury County and Rutherford County south of Nashville have high levels of auto industry activity, due to the presence of the General Motors plant in Spring Hill, Maury County, and the Nissan plant in Smyrna, Rutherford County.

The heavy concentration of these industries around the metropolitan regions indicates that moving goods within metropolitan regions along with moving goods around and through metropolitan regions will be a useful way to allow transportation to benefit the economic development efforts for these targeted industries.

Figure 2.2 County-Level Employment for Target Industries

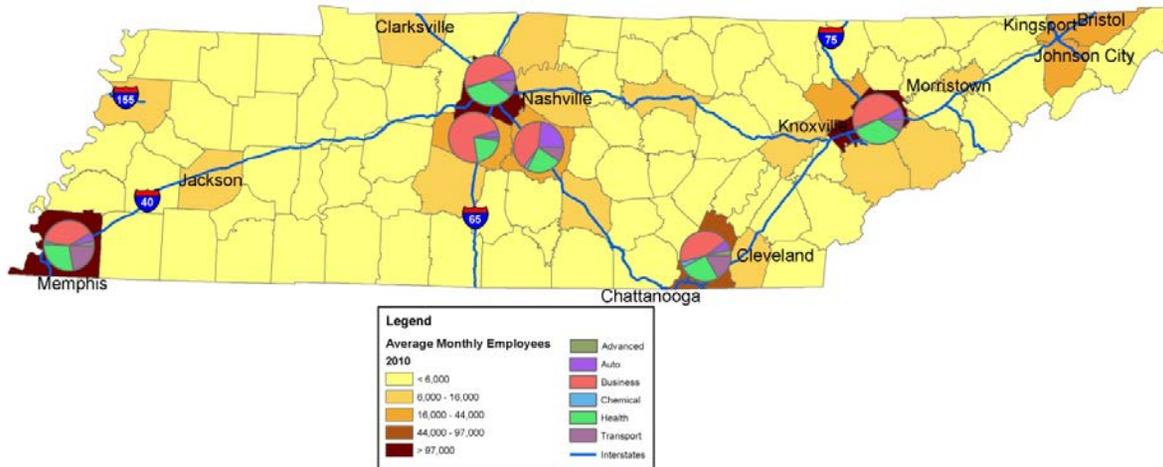
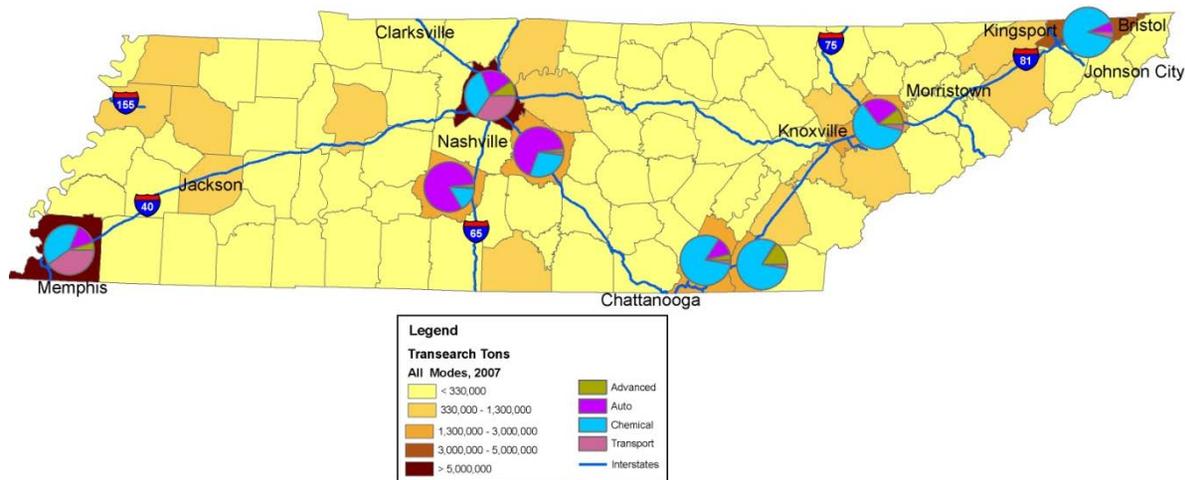


Figure 2.3 County-Level Freight Volumes for Target Industries



2.5 SUPPLY CHAINS OF TARGET INDUSTRIES

This section describes the supply chains of the target industries. Understanding the supply chains is a first step towards specifying the type and location of transportation improvements that will be most beneficial to the target industries.

Automotive Industry

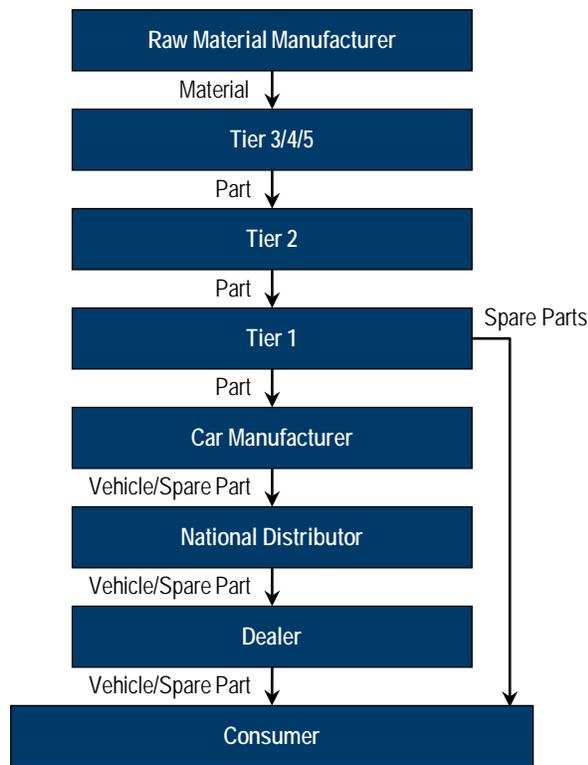
To manufacture cars, raw materials are needed which include rubber, glass, steel, plastic, and aluminum. Increasingly, less steel is used to manufacture cars so that they are lighter and more fuel efficient. Raw material suppliers are largely dependent on the auto industry, as vast quantities of these materials are needed. The raw materials are then made into parts, by parts manufacturers. These include tires, windshields, air bags, car bodies, transmission, engines, and so on. The U.S. auto parts industry is highly fragmented as it includes original equipment manufacturers, replacement parts manufacturers, replacement parts distributors, and rubber fabricating.

Once all the parts are gathered, the car is assembled at an auto manufacturing plant. A typical auto assembly plant is divided into three major sections. In the first section, exterior body panels and interior frame are assembled and welded together, mostly by robots. In the second section, painting is done. In the third process, final assembly of the vehicle happens where parts such as seats, dashboards, and power train are installed.

Typically, there are several suppliers that are colocated with automotive plants to streamline the processing of key component parts. However, the vast majority of parts are shipped in from outside locations. Most of these come by truck. However, there also are several rail inputs into automotive plants as well.

After the cars are manufactured, they are sold to dealerships all over the world to be sold. Figure 2.4 provides a generalized schematic of the automotive supply chain.

Figure 2.4 Generalized Supply Chain for Automotive Industry



Source: www.businesstheory.com.

Advanced Manufacturing Supply Chain

The Advanced Manufacturing includes the production of motors, generators, batteries, refrigeration equipment, and heating equipment. One of the constant threads of these products is the need for precision manufacturing and continuous innovation. For these industries, transportation costs tend to be of less concern as opposed to transportation reliability which is the primary concern for receiving supplies. Therefore, the air cargo and trucking mode tend to be the most commonly used modes. Additionally, parts suppliers tend to be more disperse and spread throughout the country and the world. The reliable delivery of supplies is critical towards insuring that facilities are operating at maximum capacity which is why air cargo and truck are the dominant modes for each. Rail shipments are used for larger shipments of regularly needed supplies. Finished products are typically shipped by truck for domestic portions of shipments and then by ship for international shipments. The portions of the supply chain most relevant for Tennessee are the highway corridors. Figure 2.5 shows a generalized supply chain for developing the power train of a motor vehicle.

Figure 2.5 Generalized Supply Chain for Advanced Manufacturing Industry



Source: GoldSim Technology Group.

Figure 2.6 1995 North American Airbag Supply Chain

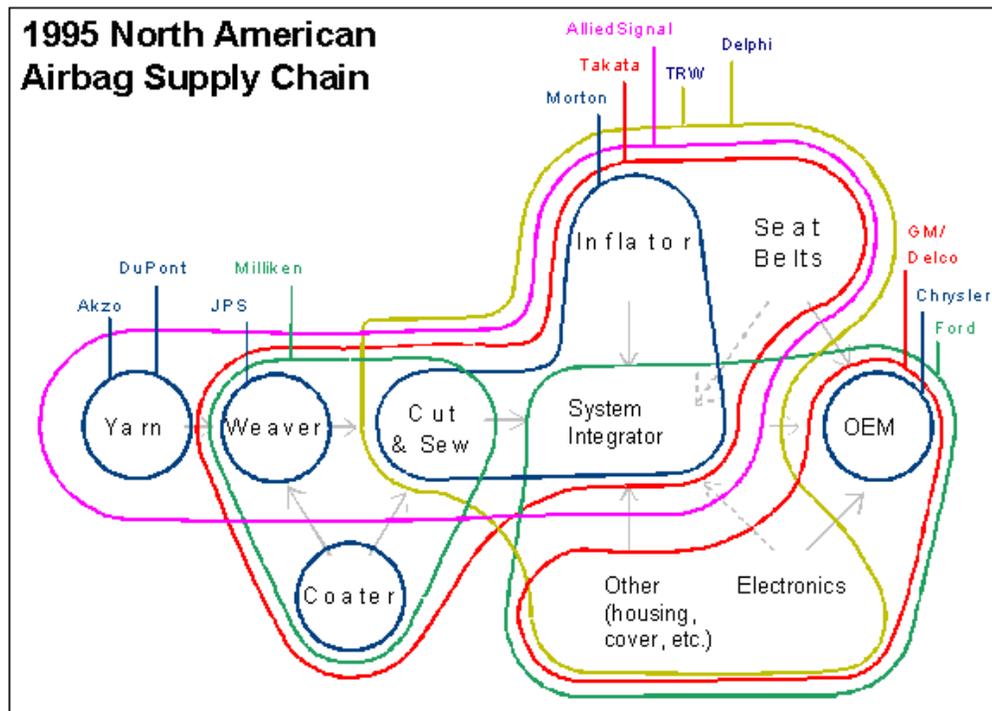


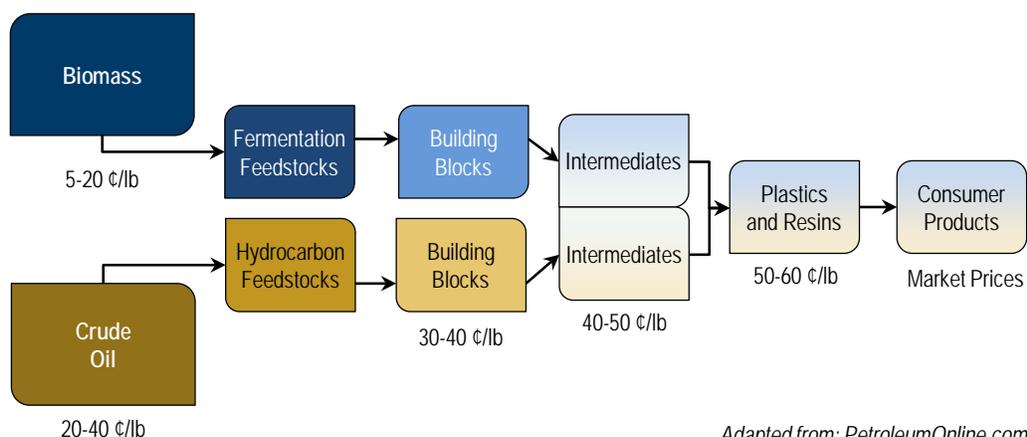
Figure 3

Source: IBIS Associates.

Chemical Products and Plastics

The vast majority of chemical and plastics products are derived from petroleum products. This typically requires a sophisticated network of pipelines to access chemicals and plastics facilities. Other types of specialized refined petroleum products may need to be shipped by rail or truck to plastics and chemical manufacturing locations. Chemical products tend to reach their end customers via rail or pipeline, while plastics typically are transported by trucks. Figure 2.7 shows a generalized supply chain for a plastics manufacturer.

Figure 2.7 Generalized Supply Chain for Chemicals and Plastics Industry



Source: Center for Biorenewable Chemicals.

Transportation, Logistics, and Distribution Services

The Transportation, Logistics, and Distribution Services industry is comprised of companies that cover all modes, networks, and industries. They do not have their own supply chain, but they do help to fulfill the supply chains of other industries. All facets of transportation infrastructure are important to this industry. However, the interstate system and the Class I railroads tend to carry the highest volume of freight, while the last-mile connectors to freight facilities tend to be critical for completing shipments.

This industry also will benefit tremendously from the development and expansion of intermodal railyards in the State such as the expansion of the BNSF yard in Memphis, the new intermodal Railyard in Collierville, and the new intermodal Railyard in eastern Tennessee. Additionally, other task work completed by TDOT has indicated that the Lamar Avenue Corridor is one of the most important freight improvement projects in the State. Additional needs in the State include an intermodal railyard in the Chattanooga region and better east-west rail service through the Nashville region. An interstate level bypass around Chattanooga along I-75 also has been found to have tremendous benefit by studies recently conducted by the Chattanooga and Cleveland MPOs along with studies completed by TDOT and GDOT.

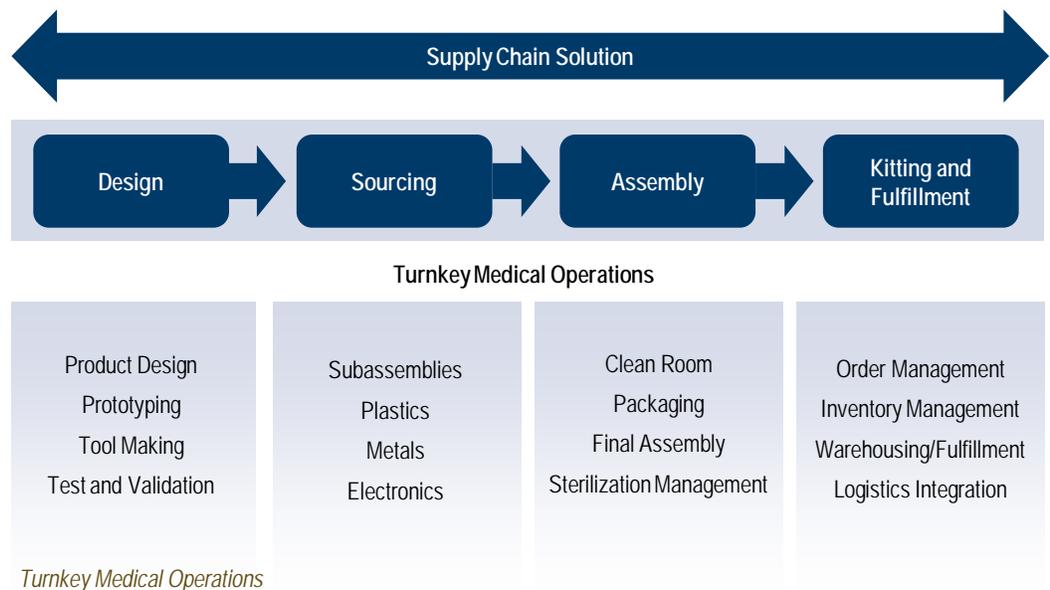
Business Services

Companies in the Business Services industry produce very few goods. The vast majority of their shipments are facilitated by parcel delivery. Therefore, the portions of the transportation infrastructure most important to this industry are the ones used for urban distribution.

Healthcare

Similar to Business Services, the Healthcare industry tends not to produce a large quantity of goods. A large component of this industry is related to Healthcare which do not require shipments of products or receipt of supplies above and beyond those that would be needed to care for patients. However, the pharmaceutical sector tends to rely on fast, reliable shipment such as that achieved through the Memphis region. Similarly, medical device companies tend to also need high-speed, highly reliable goods movement. They tend to source high-value items such as subassemblies, finished plastics, metals and electronics, while delivering finished devices using a combination of truck and air cargo. Figure 2.8 shows a generalized supply chain for the medical devices industry.

Figure 2.8 Generalized Supply Chain for Medical Devices



Source: Turnkey Medical Operations.

The TDOT TRANSEARCH database allows for the identification of freight flows for the targeted industries that move large volumes of freight. Tables 2.5 through 2.7 shows the distribution of goods by outbound, inbound, intracounty, and within state traffic. Table 2.5 shows the distribution for 2007. This table shows that all of the commodities related to the target industries have a large volume of traffic that is being shipped out of the State. This out-of-state

outbound traffic is over 50 percent for each of the commodities, except for transportation. The goods related to the transportation industry are drayage and secondary flows that are primarily leaving warehouses and arriving to retail locations for final sale. This table reinforces the need for Tennessee to have a freight infrastructure system that is well integrated with the larger national and global freight network.

Table 2.6 shows the forecasted freight flows. The high level of outbound out-of-state flows is forecast to be a feature of these freight flows as well. Therefore, these interstate networks will also be important to attract new business to Tennessee and to help current companies to expand their operations. Table 2.7 shows the growth rate by trip type and industry. It shows that the inbound out-of-state flows are growing the most quickly and that local (intracounty) traffic is also forecast grow at a fast rate. This indicates that infrastructure that facilitates the distribution of goods within metropolitan regions also will be important.

Table 2.5 Current Freight Flows by Direction for Target Industries
2007 Tons

Industries	Outbound (Out of State)	Inbound (Out of State)	Intracounty	Within State Traffic	Total
Advanced	1,640,112	1,825,744	19,160	124,477	3,609,493
Automotive	5,345,582	2,685,417	173,863	2,422,879	10,627,741
Chemical	14,919,636	10,941,591	456,763	1,686,184	28,004,175
Transportation	4,345,819	2,778,273	6,343,045	1,080,073	14,547,210

Table 2.6 Forecast Freight Flows by Direction for Target Industries
2035 Tons

Industries	Outbound (Out of State)	Inbound (Out of State)	Intracounty	Within State Traffic	Total
Advanced	4,813,997	7,301,785	62,235	315,718	12,493,735
Automotive	7,961,893	5,399,824	181,899	4,388,199	17,931,815
Chemical	23,914,247	16,253,310	418,508	2,917,400	43,503,466
Transportation	7,897,677	8,489,477	14,432,606	2,992,094	33,811,854

Table 2.7 Estimated Annual Growth Rates for Target Industries

Industries	Outbound (Out of State)	Inbound (Out of State)	Intracounty	Within State Traffic	Total
Advanced	3.9%	5.1%	4.3%	3.4%	4.5%
Automotive	1.4%	2.5%	0.2%	2.1%	1.9%
Chemical	1.7%	1.4%	-0.3%	2.0%	1.6%
Transportation	2.2%	4.1%	3.0%	3.7%	3.1%

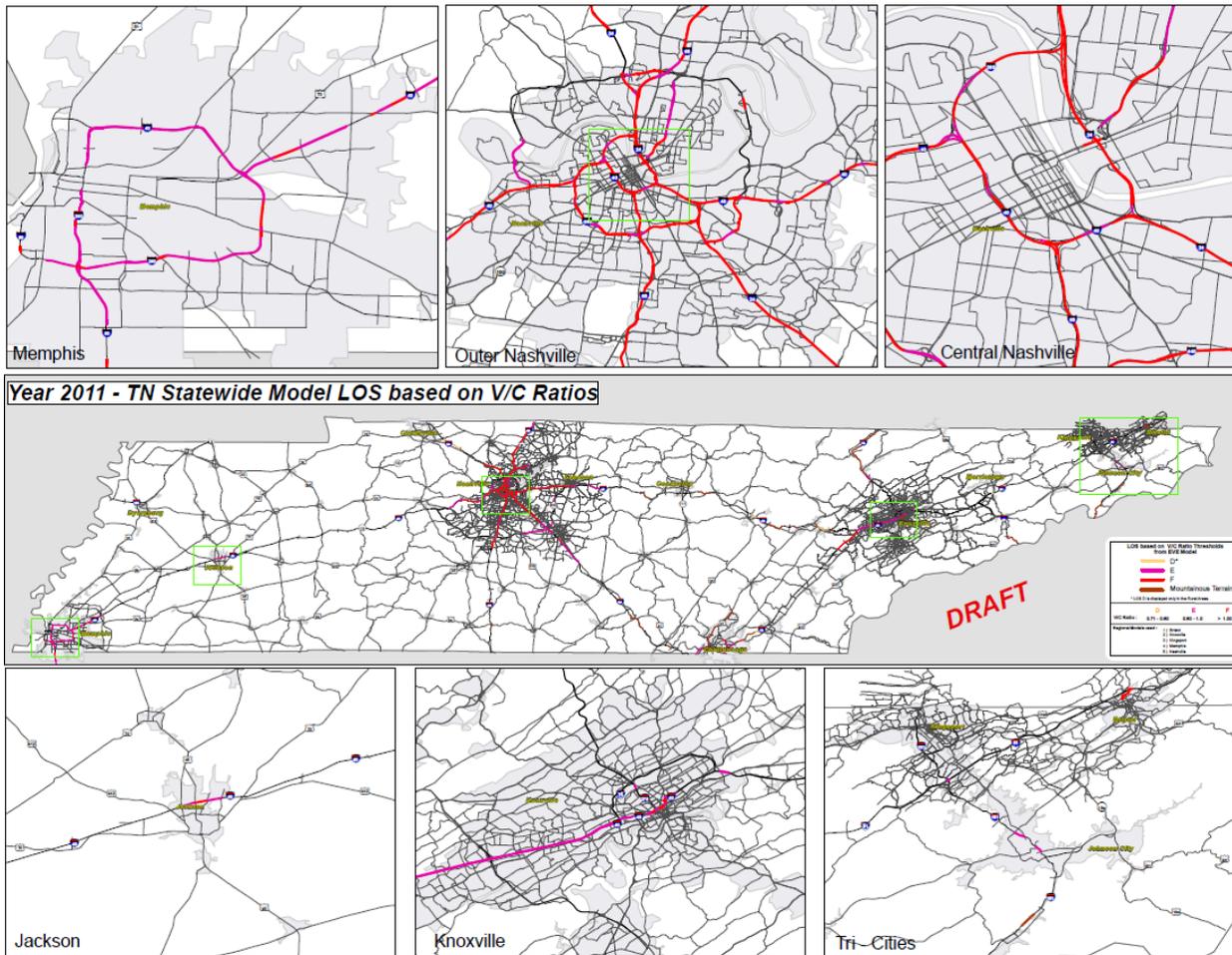
3.0 Current and Future Transportation Needs

This section describes the transportation improvements to the Tennessee freight infrastructure that is likely to have the most significant impact on improving the economic development potential of the target industries. It uses information provided in previous reports on the operational performance of the various freight modes in conjunction with the information provided in the previous section on the freight flows of the target industry to make program-level recommendations on improvements for the State.

3.1 PROGRAMMATIC HIGHWAY IMPROVEMENTS

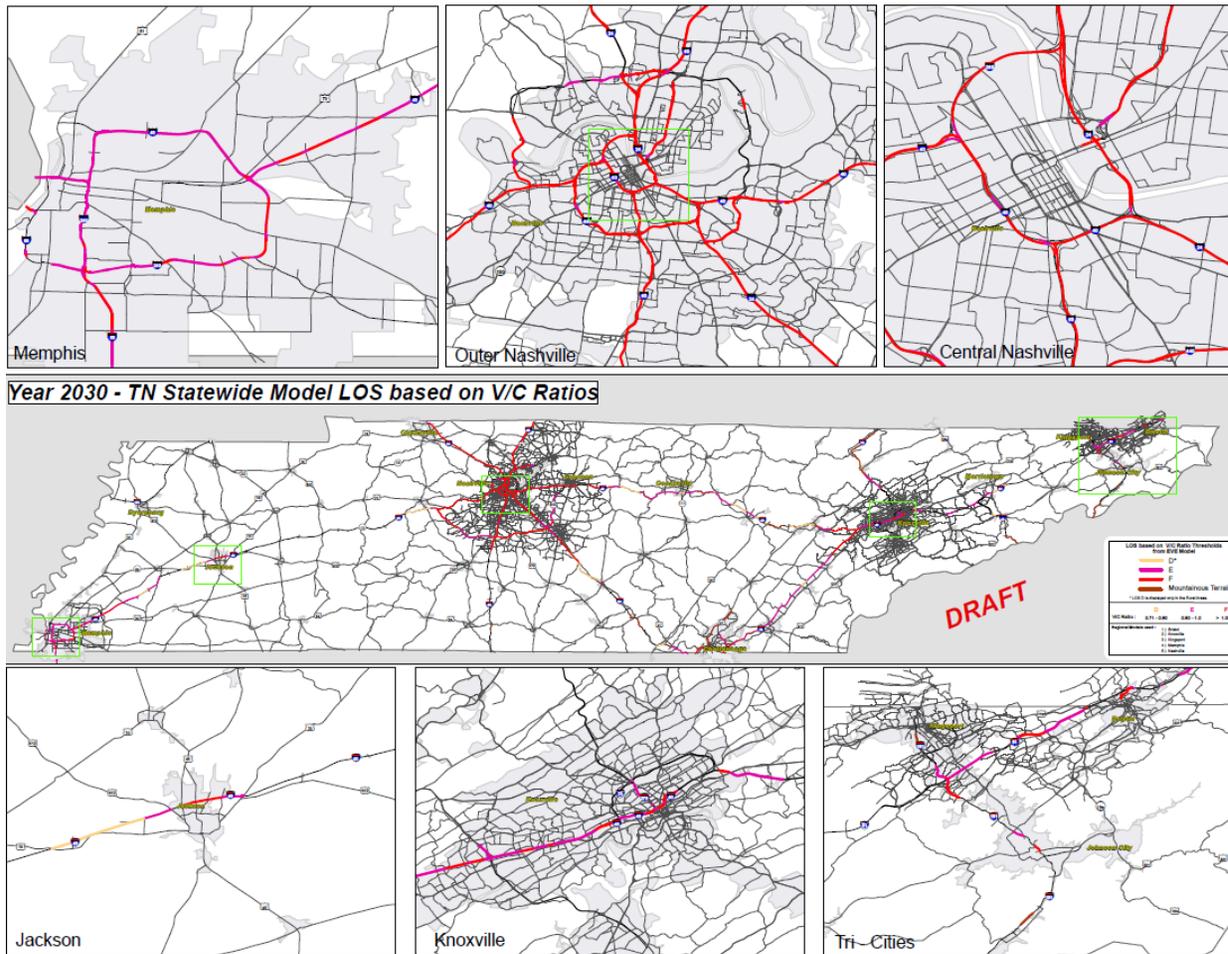
Figures 3.1 and 3.2 show the level of service for the highway network in 2011 and 2030 respectively based on the TDOT travel demand model output. The 2011 figure shows that the vast majority of interstate network in the major metropolitan regions of Memphis, Nashville, Chattanooga and Knoxville. These metropolitan regions also are the locations where the target industries have their highest concentrations. Therefore, these should be considered priority items for being improved to assist in the economic development issues for the State. The 2030 V/C ratios provided in Figure 3.2 show that the levels of service will continue to decrease within the metropolitan regions and that intercity travel also will become impacted if improvements are not made to the interstate system within Tennessee. Because Memphis and Tennessee are the most critical regions in terms of economic development for the State, the I-40 corridor should be prioritized for improvements on the roadway system. Additionally, the Freight Needs and Project Identification Task report identified several last-mile connectors to major freight facilities that warrant improvement to improve the free flow of goods at these critical locations.

Figure 3.1 2011 V/C Ratios Tennessee Highway Network



Source: TDOT I-40/I-81 Corridor Feasibility Study.

Figure 3.2 2030 V/C Ratios Tennessee Highway Network



Source: TDOT I-40/I-81 Corridor Feasibility Study.

3.2 PROGRAMMATIC RAIL IMPROVEMENTS

Levels of service also are definable for the rail network. Figure 3.3 describe the level of service as they relate to a standard grade structure. Figures 3.4 and 3.5 show the current and projected levels of service for the national rail network for the Class I railroads. CSX and NS are the most significant Class I railroads for Tennessee. However, it should be noted that the Memphis metropolitan region features all of the Class I railroads in the U.S. Figure 3.5 shows that there currently is not a high level of congestion along the rail network within Tennessee. The heaviest rail lines in terms of congestion are the east-west line CSX line that connects Memphis to Chattanooga. Technically, this line runs primarily through Alabama, but it does service these two key metropolitan regions. An additional rail hot spot that impacts Tennessee are the rail lines between Chattanooga and Atlanta. Both CSX and NS have heavily trafficked rail lines between these two cities, and this is often referred to as the most heavily trafficked rail corridor in the southeast. While the bulk of the congested line is located in Georgia, it impacts rail flows to Nashville and Memphis from some of the larger population centers in the south such as Atlanta and Florida.

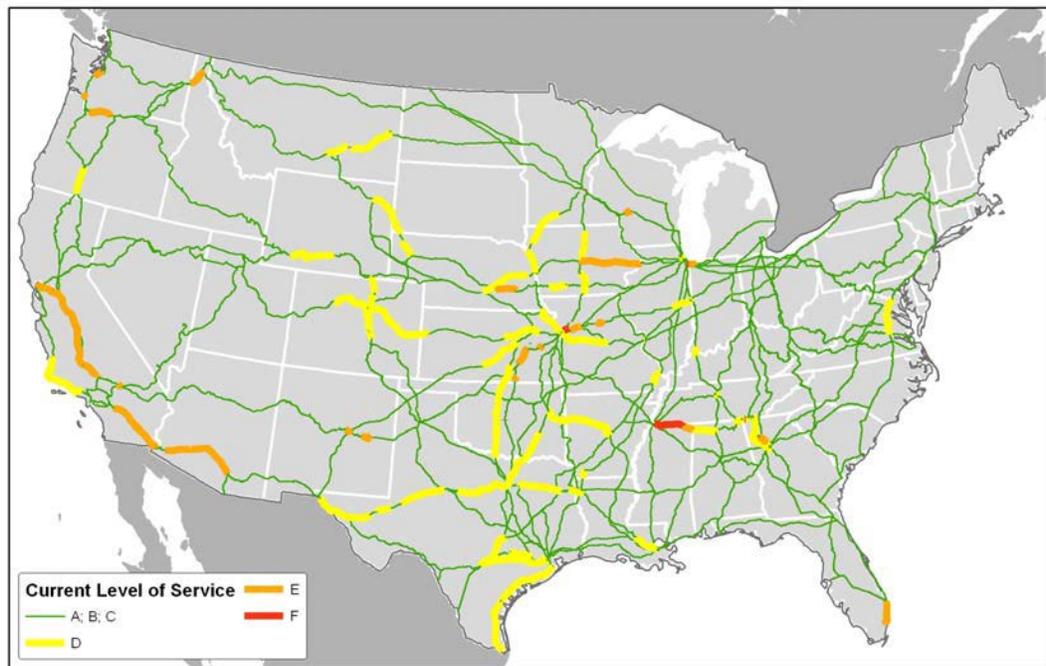
Rail traffic on the Class I network is forecast to grow significantly between now and 2030. Figure 3.5 shows rail levels of service in 2030. It shows that much more of the national network will be congested if there are no improvements made to the system. The CSX line from Atlanta to Nashville is forecast to operate at level of service "F" as is the rail line between Chattanooga to Memphis and the rail line between Chattanooga and Knoxville. The rail line between Nashville and Memphis is forecast to deteriorate from LOS A to LOS B/C. As mentioned in the previous section, there is the need for quality rail service for the Automotive industry in Nashville and Chattanooga along with the Chemicals and Plastic industry in Chattanooga, Knoxville and the Tri-Cities region. Therefore, the CSX rail line between Chattanooga and Nashville (along with the line between Atlanta and Chattanooga) should be prioritized for improvements. Similarly, the rail lines serving the eastern half of the State will be critical for attracting and expanding Chemicals and Plastics industry in Knoxville and the Tri-Cities region.

Figure 3.3 Volume-to-Capacity Ratios and Level of Service (LOS) Grades

LOS Grade	Description	Volume/Capacity Ratio
A B C	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents
		0.2 to 0.4
		0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents
E	At Capacity	Very heavy train flow with very limited capacity to accommodate maintenance and recover from incidents
F	Above Capacity	Unstable flows; service breakdown conditions

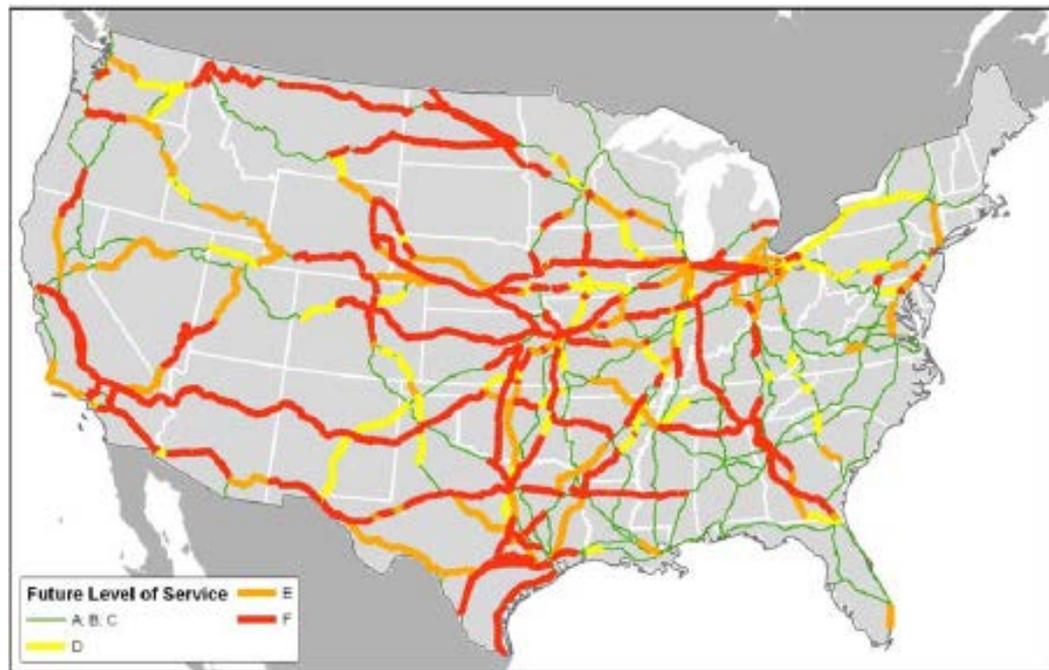
Source: AAR National Rail Infrastructure and Capacity Study.

Figure 3.4 Current Train Volumes Compared to Capacity



Source: AAR National Rail Infrastructure and Capacity Study.

Figure 3.5 Future Corridor Volumes Compared to Current Corridor Capacity



Source: AAR National Rail Infrastructure and Capacity Study.

3.3 PROGRAMMATIC WATERWAY IMPROVEMENTS

Tennessee’s waterway infrastructure also is part of a larger national waterway system that connects the Port of New Orleans to locations as far away as Kansas City, Kansas; Chicago, Illinois; and Pittsburgh, Pennsylvania. Within Tennessee, the waterway system connects to each of the State’s four major metropolitan regions – Memphis, Nashville, Chattanooga, and Knoxville (Figure 3.6). Specifically, the Memphis region is connected to the heavily trafficked Mississippi River. Chattanooga and Knoxville are located in close proximity to the Tennessee River. Nashville is located along the Cumberland River. The Cumberland River and the Tennessee River both connect to the Mississippi River along the Kentucky-Missouri state border. This connectivity to the major metropolitan area combined with the waterway mode’s overall cost-effectiveness creates a tremendous potential for economic development by optimally utilizing this mode.

The waterways opportunity is particularly relevant for the Chemicals and Plastics industry which relies heavily on various types of refined petroleum products as inputs. Barges moved on the waterway can be a cost-effective means of transporting feedstocks to this industry particularly to the Chattanooga and Knoxville regions which have a good amount of their economic development opportunity in the Chemicals and Plastics industry. Similarly, the waterways

can be used to ship Chemicals industry products to customers further inland in the U.S. Crude materials, petroleum and related products currently are over 30 percent of the commodities moved along each of Tennessee's three waterways. 12 percent of the shipments on the Mississippi River are chemical products indicating that there also is potential for shipments to move similar products on the other state waterways.

Primary manufactured products represent seven percent, seven percent, and six percent of the goods on the Mississippi, Cumberland, and Tennessee Rivers respectively. This indicates that there also is a secondary opportunity to move advanced manufactured products along the waterways. However, the types of goods and service characteristics typically required for Advanced Manufacturing are generally not compatible with the slower waterway mode.

The nation's waterways infrastructure has suffered from underinvestment for several years. Significant improvements are needed to the waterway locks and dams throughout the U.S., including all three of Tennessee's waterways to more cost-effectively utilize this mode. The TDOT Tennessee Waterway Assessment Study Phase II documented several improvements needed at the State's ports, locks, and dams. The improvements along the Mississippi River and the Tennessee River should be prioritized to match the targeted industries of the Tennessee Department of Economic and Community Development.

Figure 3.6 U.S. Inland Waterway System



Table 3.1 Forecast Freight Flows by Direction for Target Industries

Commodity	Mississippi River	Tennessee River	Cumberland River
Coal	13%	38%	51%
Crude Materials	18%	33%	36%
Oil and Oil Products	25%	N/A	2%
Food and Farm Products	24%	10%	2%
Chemicals	12%	N/A	N/A
Primary Manufactured Goods	7%	6%	7%
Other	1%	13%	2%
Total	100%	100%	100%

3.4 CONCLUSIONS ON TRANSPORTATION NEEDS OF TARGETED INDUSTRIES

This report has described the importance, supply chain and transportation needs of six of the State’s targeted industries. It was found that two of the industries (Business Services and Healthcare industries) do not create a tremendous amount of tonnage. However, these industries are heavily reliant on parcel delivery and to a lesser extent air cargo. The operational performance of both of these modes is relatively strong in Tennessee, so there are no new major transportation improvement projects needed to assist in attracting or retaining these industries. It should be mentioned that to the extent truck circulation around metropolitan regions is improved will keep costs down for the shipment of goods for these two industries.

The Advanced Manufacturing and Automotive industries are relatively much smaller than the Business Services and Healthcare indicates. They also are forecast to continue to shrink in employment as they have over the past 10 years even though their output from a tonnage perspective is likely to increase. To attract these industries to Tennessee, the key will be to ensure that the State’s intercity interstate network remains relatively congestion free as they are today. In particular, I-40 is critical, because it connects the State’s largest two metropolitan regions which would be likely places to locate these industries. However, continued growth of the overall State’s economy will cause congestion to occur on the interstate network if they are not continually improved. Additionally, continued investment in the rail network will be important for these industries as many of their supplies are brought to them by rail and for the automotive industry, several of their deliveries to dealerships are carried by rail as well.

The Chemicals and Plastics industry is a big generator of traffic in Chattanooga and eastern Tennessee from a tonnage perspective. This industry also will benefit from improvements to the State’s rail network as many of their inputs and

products are carried by this mode. Pipelines also are heavily used in the Chemicals and petro-related industries. However, the biggest improvements will be felt from improvements to the waterway system. This includes ports, locks, and dams both within Tennessee and further upstream and downstream along the Mississippi River.

The Transportation, Logistics, and Distribution Services industry already is a significant industry for Tennessee with more than double the percentage of employees in this industry relative to the rest of the U.S. This industry will benefit from the continued investment in the State's freight infrastructure. Recent developments along these lines include new intermodal railyards in eastern Tennessee and Rossville along with the BNSF intermodal railyard expansion in Memphis. Additionally, improvements to key freight corridors such as Lamar Avenue in Memphis, an interstate-level bypass around Chattanooga, and last-mile connectors around the State will help Tennessee remain competitive for this industry.

This report has demonstrated that there is a direct link between these targeted industries and Tennessee's freight transportation network. Therefore, continued investment in this network will greatly assist the state in meeting its economic development goals.

A. Sources of Data for Economic Analysis

Table A.1 shows the NAICS codes used for each industry for the output data. The NAICS codes only go down to three and four digits and therefore some subindustries cannot be identified and assigned to each target industry. Table A.2 shows the NAICS codes breakdown for the QCEW data and includes more detailed industry information, since it contains values at the 6-digit NAICS codes level. The employment data therefore more accurately reflects values for each target industry. However, the output data should offer sufficient detail for understanding general trends.

The employment data used for this report is the Quarterly Compensation and Employment Wages (QCEW) Data from the Bureau of Labor Statistics. It provides industry employment data at the county level. Output data used comes from the Bureau of Economic Analysis and the data is available and the state level.

Table A.1 NAICS Codes Used for Estimating Economic Output

NAICS Codes	Description	Target Industry Group
333	Machinery	Advanced Mfg and Energy Tech
335	Electrical equipment, appliances, and components	Advanced Mfg and Energy Tech
336	Motor vehicles, bodies and trailers, and parts	Automotive
336	Other transportation equipment	Automotive
325	Chemical products	Chemical Products and Plastics
326	Plastics and rubber products	Chemical Products and Plastics
48, 49 (except 491)	Transportation and warehousing	Transportation, Logistics and Distribution Services
51	Information	Business Services
52	Finance and insurance	Business Services
54	Professional, scientific, and technical services	Business Services
62	Health care and social assistance	Healthcare

Source: Bureau of Economic Analysis.

Table A.2 NAICS Codes Used for Estimating Employment

NAICS Codes	Description	Target Industry Group
2211	NAICS 2211 Power generation and supply	Advanced Mfg and Energy Tech
3334	NAICS 3334 HVACs and commercial refrigeration equipment	Advanced Mfg and Energy Tech
3336	NAICS 3336 Turbine and power transmission equipment mfg.	Advanced Mfg and Energy Tech
333996	NAICS 333996 Fluid power pump and motor manufacturing	Advanced Mfg and Energy Tech
335	NAICS 335 Electrical equipment and appliance mfg.	Advanced Mfg and Energy Tech
327211	NAICS 327211 Flat glass manufacturing	Automotive
3321	NAICS 3321 Forging and stamping	Automotive
336	NAICS 336 Transportation equipment manufacturing	Automotive
4231	NAICS 4231 Motor vehicle and parts merchant wholesalers	Automotive
441	NAICS 441 Motor vehicle and parts dealers	Automotive
5321	NAICS 5321 Automotive equipment rental and leasing	Automotive
8111	NAICS 8111 Automotive repair and maintenance	Automotive
1023	Financial activities	Business Services
1022	Information	Business Services
1024	Professional and business services	Business Services
325	NAICS 325 Chemical manufacturing	Chemical Products and Plastics
326	NAICS 326 Plastics and rubber products manufacturing	Chemical Products and Plastics
32712	NAICS 32712 Clay building material and refractories mfg.	Chemical Products and Plastics
332992	NAICS 332992 Small arms ammunition manufacturing	Chemical Products and Plastics
4246	NAICS 4246 Chemical merchant wholesalers	Chemical Products and Plastics
33322	NAICS07 33322 Plastics and rubber industry machinery	Chemical Products and Plastics
3391	NAICS 3391 Medical equipment and supplies manufacturing	Healthcare
62	NAICS 62 Health care and social assistance	Healthcare
48-49	NAICS 48-49 Transportation and warehousing	Transportation, Logistics and Distribution Services