

Final Report



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Final Report



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1.0 Introduction

1.1 Corridor Location and Overview

The purpose of the I-24 Multimodal Corridor Study is to examine potential multimodal transportation improvements that would address existing and emerging transportation system issues associated with this strategic corridor through central Tennessee connecting the Clarksville, Nashville and Chattanooga urban areas. The corridor extends from the Kentucky border to where it meets I-75 in Hamilton County, a distance of approximately 185 miles (refer to Figure 1.1).

The analysis of corridor needs has gone through a structured process of characterizing existing and projected corridor conditions, describing the purpose and need for corridor improvements, defining a set of performance measures against which to evaluate improvement options, and evaluating potential corridor improvements against these performance measures to develop a set of recommended and prioritized projects and strategies.

1.2 Purpose of This Document in the Study Process

The Final Report serves as a document that summarizes the entire evaluation and recommendation process that was conducted for the I-24 Multimodal Corridor Study. This document begins with Section 1 which gives an introduction to the I-24 corridor study process and discusses the major considerations and assumptions that were used to develop a final set of planning-level recommended projects and strategies. Next, Section 2 discusses and evaluates the currently planned projects in the I-24 corridor in order to provide the context for the proposal of additional projects and strategies in the corridor. This discussion is followed by Section 3 where a wide variety of new proposed projects and strategies are presented and evaluated. Section 4 then focuses on the critical investigation into the potential for freight diversion in the I-24 corridor. Section 5 follows with an emphasis on drilling down further using an in-depth screening analysis of the planned and proposed projects that were introduced in Sections 2 and 3, resulting in a list of recommended projects. The Final Report concludes with Section 6 where the planning-level recommended projects and strategies for the I-24 Multimodal Corridor Study are prioritized.

It should be noted that this study makes recommendations for projects and strategies that are at the planning level. This means that further study and design will be required before the recommended projects and strategies developed in this report should be implemented or constructed.

1.3 Project and Strategy Development Process

The purpose of the I-24 Multimodal Corridor Study is to recommend a list of cost-effective projects and strategies that will make I-24 safer and more efficient. Both technical analysis and input from the public and stakeholders were used to accomplish this goal. The paragraphs below will describe the sure foundation set for this study and will present the well-balanced approach that was used to develop a plan that will make I-24 safer and less congested.

1.3.1 Safety and Congestion Considerations

The early phases of the I-24 Multimodal Corridor Study established the need for I-24 to be safer and more efficient by evaluating crash data on I-24 as well as examining the high traffic volumes, including trucks, on I-24 throughout the corridor. TDOT is currently focused on making I-24 a safer interstate and already has several small studies underway that are examining improvements to increase safety.

This study has developed a variety of additional improvements that will help increase safety throughout the I-24 Corridor and developed a list of projects that will help address congestion in the morning and afternoon commute periods. This study also recommends specific multimodal strategies that will provide more options to those traveling on I-24 using modes of transportation that don't involve adding more lanes or require expensive construction.

While safety, congestion, and the potential diversion of freight movement from I-24 are the predominate issues that are being addressed in this study, all of the planning factors that are used in the development of metropolitan and statewide long range transportation plans have influenced the development and evaluation of the recommended projects and strategies of this study. These eight planning factors are:

1. Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency;
2. Increase the safety of the transportation system for motorized and nonmotorized users;
3. Increase the security of the transportation system for motorized and nonmotorized users;
4. Increase the accessibility and mobility of people and for freight;
5. Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns;
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;
7. Promote efficient system management and operation; and
8. Emphasize the preservation of the existing transportation system.

1.3.2 Public Input

The I-24 Multimodal Corridor Study was very successful in engaging the public and stakeholders. A substantial amount of feedback and suggestions on the perceived problems of I-24 and potential solutions were collected during the study. An array of methods that were used to engage the public and stakeholders is summarized below.

- Project website hosted by TDOT at www.tdot.state.tn.us/i24. This website included a project library, information about upcoming meetings, project videos, and other items that helped the public gather information about the study.
- Two (2) project videos produced by TDOT, at strategic times in the life of the study. These videos were performed by Deanna Lambert and provided an outstanding introduction and update of the I-24 Multimodal Corridor Study to those who attended the public meetings or viewed the videos on the project website.
- Online Comment Form. Using the internet survey service called SurveyMonkey, the project team designed and distributed a survey that citizens could fill out on the internet at any time and on any computer. The same survey could also be filled out by hand and mailed in using US mail. The survey was open to the public between January 24, 2013 and June 20, 2013 and received a total of 503 individual responses.
- Two (2) series of public involvement meetings were held during the study: one series was held in April 2013 and the other in October 2013. In each series of public meetings, a separate meeting was hosted in each metropolitan area: Clarksville, Nashville and Chattanooga. The project team made a presentation at each meeting and provided information about the status and progress of the study. The combined attendance by the general public for all six public meetings was approximately 120 citizens, with an average attendance of approximately 20 citizens per meeting. Citizens in attendance provided many comments and suggestions at these public meetings.
- The project team also made presentations at four (4) regularly scheduled MPO/TPO meetings during February and March 2013. A presentation was given at each meeting and comments were received from the various MPO/TPO committee members in attendance.
- Four (4) Advisory Committee Meetings were held throughout the study, including an introductory meeting at the beginning of the study.
- The project team also met with local TDOT and MPO staff to discuss potential projects and strategies for the I-24 corridor.

Input from citizens and stakeholders via the various public engagement opportunities mentioned above confirmed that the two main issues in the I-24 corridor were safety and congestion. A substantial number of multimodal potential improvements were proposed by citizens and stakeholders that were intended to make I-24 safer and less congested, as well as provide more traveling options involving other modes besides the automobile. These suggestions were used in conjunction with recommendations from the technical assessment of the corridor to develop a list of proposed projects and strategies for the I-24 corridor.

1.3.3 Technical Analysis Tools

The study team used two technical tools to evaluate the potential benefit of projects in the I-24 corridor. A macro-scopic computer program called TransCAD was used to model daily travel patterns for the entire I-24 corridor. A seamless travel demand model consisting of each metropolitan area's model, along with the Statewide model for the rural areas, was developed for the purposes of the I-24 Multimodal Corridor Study. Also, a meso-scopic computer program called TransModeler was used to develop a model of the entire I-24 corridor in order to study the impact of selected proposed improvements at a finer, more detailed level. These technical analysis tools helped to provide an unbiased and objective means of evaluating proposed projects, free of opinions and perceptions.

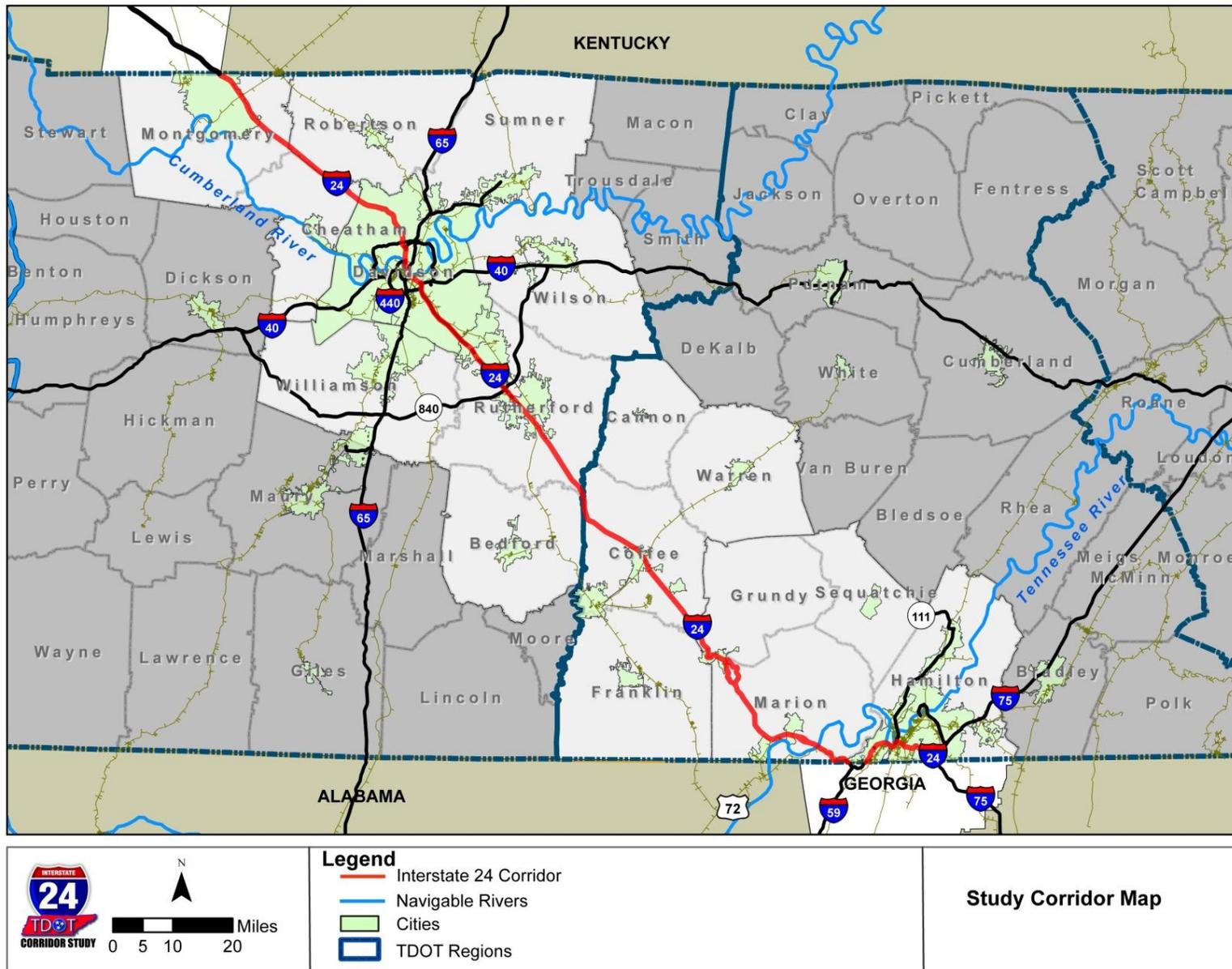
The macro-scopic and meso-scopic computer models were primarily used to determine performance measures such as vehicle-miles-of-travel (VMT), vehicle-hours-of-travel (VHT), vehicle-hours-of-delay (VHD) and daily time savings with selected proposed projects. The output from the models were also used to help develop benefit-cost ratios for selected projects in order to determine the cost-feasibility of proposed projects. Greater detail on the performance measures and the development of the benefit-cost ratios is provided in later sections of this document.

1.3.4 Evaluation Process

A comprehensive and structured evaluation process was used to develop the final list of recommended planning-level projects and strategies for the I-24 Multimodal Corridor Study. The evaluation process began with the evaluation of the existing plus-committed network, which represents the current network of highways as well as projects that have committed funding for right-of-way (ROW) or construction in the near term. Remaining deficiencies in the highway network were identified using the transportation computer models developed for this study. Next, the study team identified and evaluated the currently planned projects in the MPO Long Range Transportation Plans (LRTPs). Remaining deficiencies in the highway network were again identified using the transportation computer models. Next, projects were proposed in order to mitigate the remaining deficiencies and then evaluated using the transportation computer models to see how effective they were in addressing the deficiencies.

During the project and strategy development phase of the study, all types of projects and strategies were proposed. Not all projects could be evaluated using the transportation computer models. However, other metrics such as cost and the potential environmental and economic impacts were used to assess the viability of the proposed projects. Next, based on the operational performance, cost, potential environmental impacts and potential economic impact, the recommend projects were selected. Finally, the projects were prioritized based primarily on the type of project, the status of the project in the MPO planning process (if applicable), and how well the project performed in the benefit-cost ratio analysis.

Figure 1.1: Study Corridor Map



2.0 Existing Plus Committed and Currently Planned Transportation Projects Evaluation

The I-24 Corridor travel demand model was used in the process of developing a transportation plan that will be responsive to future travel demands and other plan objectives. Three different packages of major road improvements planned in the I-24 Corridor were evaluated by the model to assess the relative effectiveness each would have on traffic conditions in the future. They are listed below.

- E+C Model Scenario (Future baseline condition);
- LRTP Capacity Projects On I-24;
- LRTP Capacity Projects Off I-24; and,
- LRTP Interchange Projects On I-24.

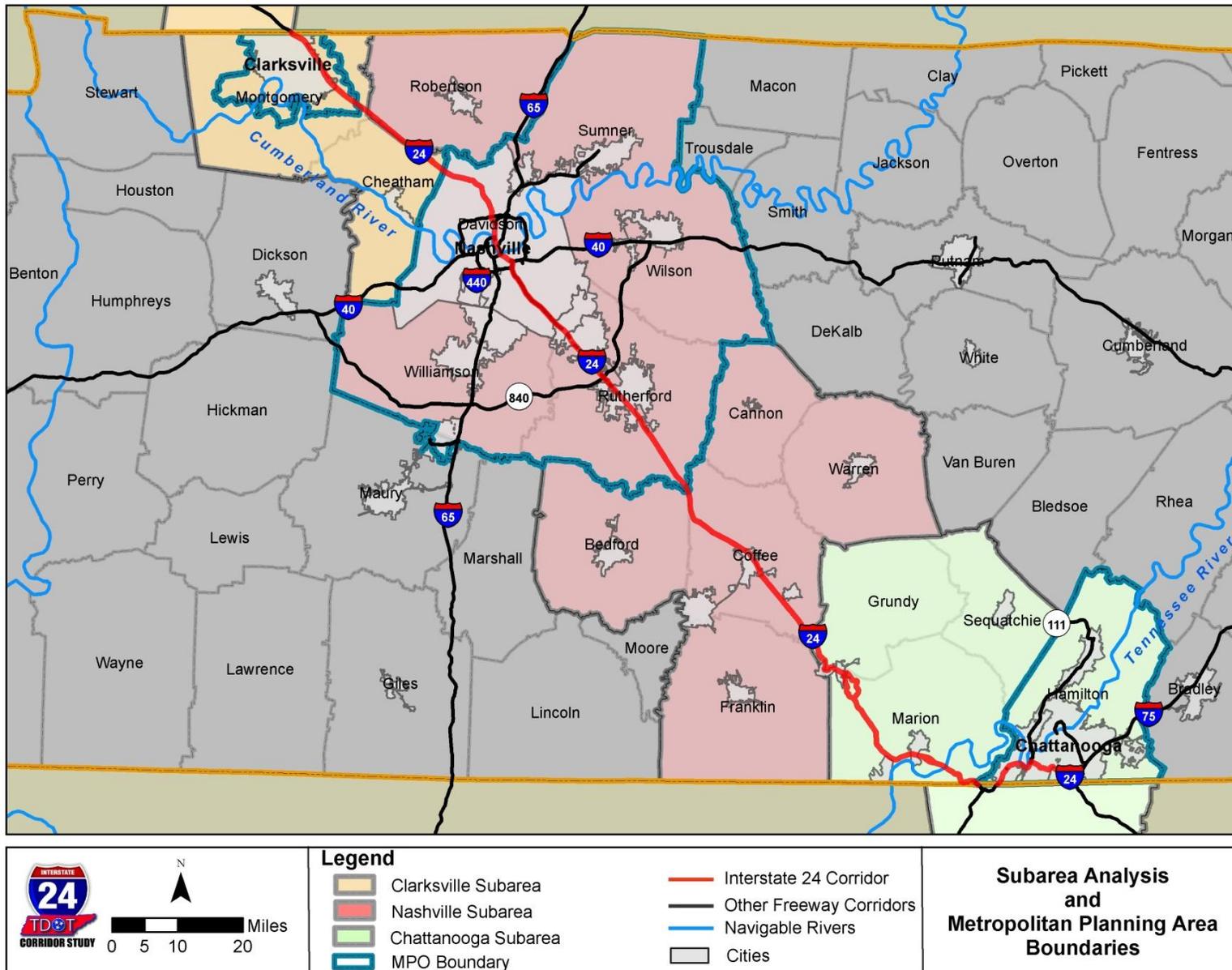
In all three model scenarios, forecasted future year 2040 travel demand for autos and trucks were assigned to three different future year highway networks which correspond to the different 'test' road improvement packages listed above, in addition to the E+C, or baseline, model scenario. The model networks represent optional levels of (assumed) capacity, contiguity and accessibility that would exist if a specified package of planned transportation improvements were to be added to the I-24 Corridor's highway network.

Modeled performance measures for each road improvement package were summarized in relation to the future year E+C model scenario which was built to represent the future No-Build condition. 'LRTP' projects are financially constrained, planned improvements that were listed in the MPO's Long Range Transportation Plans (LRTPs). In the I-24 Corridor, there are MPO's for the Nashville, Clarksville and Chattanooga metropolitan regions.

Modeled performance statistics denoting the relative effectiveness that different model scenarios have on operating conditions are summarized into the corridor's three geographic subareas. The boundary of each model subarea is highlighted in Figure 2.1 along with MPO boundaries. Traffic conditions on I-24 have far-reaching impacts on other highway facilities. As such, the subarea analysis boundaries used to capture operating conditions are generally wide enough to include one county on the west and east sides of I-24. Around Nashville, however, the analysis area bulges because the quality of traffic flow on I-24 influences operating conditions on highway facilities in all counties of the Nashville MPO region.

The impact of planned projects on traffic conditions in the corridor is first observed at the three subarea levels. This analysis offers a system-level evaluation of time saving benefits that can be realized through highway projects. Performance of the E+C scenario is used as a benchmark to evaluate other different packages of planned or proposed improvements.

Figure 2.1: I-24 Corridor Model Subareas



The 185-mile I-24 Corridor analysis area is split into subareas: Clarksville, Nashville and Chattanooga. Nashville, by far, is the largest of the three. Nashville's subarea extends southward to the Cumberland Mountains. It includes Coffee, Franklin and Warren counties whose commuting patterns show a larger connection to Nashville than to Chattanooga. MPO boundaries lie inside model subareas. The Clarksville subarea includes Montgomery and Cheatham counties. In contrast, the Clarksville MPO boundary encompasses the City of Clarksville plus urbanized portions of Montgomery County. Five (5) counties are in the Nashville subarea but are not included in the Nashville MPO planning area. Three (3) counties are outside the Chattanooga MPO region but are included in the Chattanooga subarea.

2.1 Existing Plus Committed Projects

The base year 2010 model highway network was updated to include a particular package of planned road improvement projects that are referred to as the 'Committed' projects. After adding these particular planned improvements to the base year 2010 highway network, a baseline future year highway network known as the 'Existing Plus Committed' or 'E+C' network was created. As such, the E+C system includes existing roads and geometric attributes plus new road links, revised road link attributes and new connectivity that reflect planned improvements that TDOT and local governments appear to be committed at this time. It is a profile of future year conditions intended to represent the connectivity and capacity of the I-24 Corridor's road network assuming that no other improvements would be constructed beyond those that are already 'committed'.

A 'committed' project was defined as a planned improvement that is either under construction or has construction funding programmed by TDOT or local governments as noted in the metropolitan planning organizations' (MPOs) Transportation Improvement Programs (TIPs). The list of committed projects for the E+C highway network came from the Clarksville, Nashville and Chattanooga metropolitan TIPs.

As the I-24 Corridor travel demand model was designed and built to be responsive to significant changes in highway capacity connectivity or accessibility, only planned improvements that have these characteristics were selected for addition to the base year 2010 model network. Other kinds of transportation improvements, like signal timing, intersection turn lanes, access management and freeway ramp treatments are not directly represented in the I-24 Corridor travel demand model. A list of committed projects that were added to the E+C network in counties located along the I-24 corridor are presented in Table 2.1. All of these projects are planned for roads whose orientation with respect to I-24 is generally perpendicular. Major road improvements planned for sections of I-24 or on facilities parallel to I-24 were identified as candidate projects for inclusion in the I-24 Corridor Plan's list of recommended projects.

Table 2.1: 'Committed' Projects

Clarksville Subarea		
County	Road Name	Project Description
Montgomery	SR-112	Road Widening
Montgomery	SR-149/13	Road Widening from proposed SR-374 to River Rd
Montgomery	SR-374	Road Widening from SR-149 to Dotsonville Rd
Montgomery	SR-374	New 2-lane from Dotsonville Rd to SR76
Montgomery	Oakland Rd	Realign Oakland Rd by US Hwy 79
Montgomery	Dunbar Cave Rd/Rossvie	Road Widening from I-24 and 3 lanes from Cardinal Ln
Montgomery	SR-374/North Pkwy	Road Widening from Dunbar Cave to Stokes Rd
Christian Co., KY	KY-911	Road Widening
Christian Co., KY	Cole Rd/Gate 7	Road Widening
Nashville Subarea		
County	Road Name	Project Description
Davidson	I-40/I-24	Auxiliary Lane from Fesslers Ln to Green St
Davidson	I-40	SR155/Briley Pkwy/Robertson interchange
Davidson	I-40	Interchange at McCrory Ln
Davidson	SR-255/Harding Pl Extension	New Road
Davidson	Gateway Blvd	Road Widening
Davidson	I-440	Road Widening
Davidson	I-65/I-24	Road Widening
Davidson	McCrory Ln	Road Widening
Rutherford	Cherry Lane Extension	New Road and SR-840 interchange
Rutherford	Stones River Battlefield	New Road
Rutherford	SR-99/Bradyville Pike	Road Widening
Rutherford	Fortress Blvd	Road Widening
Rutherford	SR-266/Jefferson Pike	Road Widening
Rutherford	SR-99/New Salem Highway	Road Widening
Rutherford	SR-268/Thompson Ln	Road Widening
Rutherford	Waldron Rd /Parthenon Pkwy	Road Widening
Robertson	SR-65/US-431	Road Widening
Chattanooga Subarea		
County	Road Name	County
Hamilton	I-75	Road Widening SR-2/US-11/Bonny Oaks Dr to SR-2/US-11/Lee Hwy
Hamilton/Catoosa, GA	Ringgold Rd	Road Widening from CR-40 to Frawley Rd
Hamilton	Shallowford Rd	Road Widening from Gunbarrel Rd to Jenkins Rd
Hamilton	Ashland Terrace	Road Widening from Norcross Rd to Knollwood Dr
Hamilton	US-27	Road Widening from Manufacturer's Rd to SR-8/US-127/Signal Mountain Blvd
Hamilton	Enterprise Pkwy	New alignment and widen from Hickory Valley Rd to so. of Hwy 58
Hamilton	Central Ave Extension	New Road from 3rd St to Riverside Dr
Hamilton	SR-317/Apison Pike	Road Widening from Old Lee Hwy to SR-321
Hamilton	Shallowford Road	Road Widening from Airport Rd to Jersey Pike
Hamilton	3rd/4th Streets	Redesign and widen from Mabel St to Hampton St and Lindsey St to Riverfront Pkwy

Table 2.1: 'Committed' Projects (Continued)

Chattanooga Subarea (Continued)		
County	Road Name	Project Description
Hamilton	US 27/Olgiati Bridge	Road Widening from Riverfront Pkwy to Manufacturers Rd
Catoosa Co, GA	SR-151/Alabama Hwy	Road Widening from Holcomb Rd to US-41/Nashville St
Hamilton	SR-320/East Brainerd Rd	Road Widening from East of Graysville Rd to Bel-Air Rd
Hamilton	SIA Rd	New Road to access VW facility in Enterprise South Industrial Park
Hamilton	US 27/I-24	Road Widening from I-24 to so of TN River

Approximately three dozen other committed projects that are planned for roads outside of the immediate I-24 Corridor were coded into the E+C model network but are not shown in the table. These were projects programmed for roadways located in Bedford, Sumner, Wilson and Williamson counties.

Future year 2040-level travel demand was applied to the E+C transportation system and the performance evaluation was obtained. This performance measure served as a benchmark upon which other types of improvement projects to improve the I-24 corridor were evaluated.

2.1.1 Subarea Operating Conditions

The subarea profile of traffic conditions for the future baseline condition consists of modeled vehicle-miles-of-travel (VMT), vehicle-hours-of-travel (VHT), Average Daily Speed and vehicle-hours-of-delay (VHD). These are benchmark measurements to which the other planned corridor improvement options will be compared.

Daily VMT assigned to all roads in the model network is estimated to total 121.1 million vehicle miles and is reported in Table 2.2 broken down by analysis subarea. Roadways in the Nashville subarea account for 88.7 million vehicle miles or 73% of the total for the entire corridor. Roads in the Chattanooga and Clarksville subareas have a significantly lower share of the corridor's VMT than Nashville. Chattanooga's road network accounts for a 20% share of corridor-wide VMT while the Clarksville subarea's share of the corridor's total is 7%.

The distribution of VMT by functional class group is notably different in the Nashville and Chattanooga subareas in comparison

Table 2.2: 2040 Daily VMT by Subarea (E+C Scenario)

Subarea Region	Functional Class Group	Daily VMT (1,000's)	Share of Subarea	Subarea Share of Analysis Area
Clarksville	Interstate	1,467	17%	N/A
	Arterial	4,980	57%	N/A
	Collector	2,215	26%	N/A
	Total	8,662	100%	7%
Nashville	Interstate	21,838	25%	N/A
	Arterial	42,108	47%	N/A
	Collector	24,755	28%	N/A
	Total	88,701	100%	73%
Chattanooga	Interstate	6,629	28%	N/A
	Arterial	13,158	56%	N/A
	Collector	3,906	16%	N/A
	Total	23,693	100%	20%
Analysis Area		121,056	N/A	100%

Source: Atkins, I-24 Corridor Travel Demand Model (2040 'E+C' Scenario)
N/A denotes 'not applicable'

with Clarksville. Nashville is located at the confluence of I-24, I-40 and I-65 and also includes such facilities as I-440, SR-840, SR-386, Briley Parkway and Ellington Parkway. The Chattanooga subarea includes sections of I-24, I-75 and I-59 plus other limited access facilities like US-27 and SR-153. In Chattanooga and Nashville the share of VMT in the Interstate group accounts for 28% and 25%, respectively, of total subarea VMT. The share of interstate VMT is 17% in the Clarksville subarea.

Table 2.3: 2040 Daily VHT by Subarea (E+C Scenario)

The amount of daily time vehicles were forecasted to spend on an average weekday totals just over 4 million hours over all roads in the I-24 model network. VHT assigned to all roads in the model network is reported in Table 2.3 broken down by analysis subarea. Roadways in the Nashville subarea account for 3.2 million vehicle hours or 80% of the total for the entire I-24 corridor. Roads in the Chattanooga and Clarksville subareas have much smaller shares of the corridor’s VHT than Nashville. Chattanooga’s road network accounts for a 14% share of corridor-wide VHT while the Clarksville subarea’s share of the corridor’s total is 6%.

Subarea Region	Functional Class Group	Daily VHT (1,000's)	Share of Subarea	Subarea Share of Analysis Area
Clarksville	Interstate	27	10%	N/A
	Arterial	169	66%	N/A
	Collector	62	24%	N/A
	Total	258	100%	6%
Nashville	Interstate	697	22%	N/A
	Arterial	1,634	51%	N/A
	Collector	871	27%	N/A
	Total	3,202	100%	80%
Chattanooga	Interstate	121	22%	N/A
	Arterial	329	59%	N/A
	Collector	103	19%	N/A
	Total	553	100%	14%
Analysis Area		4,013	N/A	100%

Source: Atkins, I-24 Corridor Travel Demand Model (2040 'E+C' Scenario)
N/A denotes 'not applicable'

Nashville’s share of total VHT by subarea shows that motorists generally experience more delay there than on Chattanooga and Clarksville subarea road systems. This is evidenced through a comparison of subarea VHT’s and VMT’s. Nashville’s 80% share of daily VHT is significantly greater than its 73% allocation of daily VMT. In contrast, Chattanooga’s modeled share of VHT is 14% which is significantly less than its 20% subarea allocation of VMT. Chattanooga’s modeled VHT and VHT statistics imply that motorists will experience a much lower increase in future delay than motorists in Nashville.

The largest relative differences between forecasted shares of VHT and VMT by functional class group occurred in the Clarksville subarea. On the Interstate group, for example, the share of subarea VHT was 10% which was substantially below VMT at 17%. That difference implies that the increase in delay on I-24 will be substantially less than delay projected for the arterial and collector groups.

Modeled average daily travel speeds for vehicles assigned to all roadways in the I-24 Corridor model network average 30.2 mph. Average speeds for all vehicles assigned to roads in the model network are reported in Table 2.4 broken down by functional class group and subarea. Forecasted travel speeds in the Nashville subarea bring down the corridor-wide average. Vehicles assigned to roads in the Nashville subarea average 27.7 mph. In the Chattanooga and

Clarksville subareas, average travel speeds are higher than those in the Nashville subarea. Average daily vehicle speeds on roadways in the Chattanooga and Clarksville subareas were 42.8 and 33.6 mph, respectively.

Forecasted VHD attributable to all roads in the I-24 Corridor network totals a little less than 1.5 million hours per day. VHD projected for all roads in the model's network is reported in Table 2.5 grouped by analysis subarea. Motorists using roads in the Nashville subarea are expected to experience a large majority of the delay. Nashville accounts for more than 1.3 million hours which is 90% of total delay in the I-24 Corridor region. Clarksville and Chattanooga, combined, account for 10% of the corridor's total vehicle delay.

Table 2.4: Average Speed (E+C Scenario)

Subarea Region	Functional Class Group	Daily Avg. Speed (mph)
Clarksville	Interstate	54.3
	Arterial	29.5
	Collector	35.7
	Total	33.6
Nashville	Interstate	31.3
	Arterial	25.8
	Collector	28.4
	Total	27.7
Chattanooga	Interstate	54.8
	Arterial	40.0
	Collector	37.9
	Total	42.8
Analysis Area		30.2

Source: Atkins, I-24 Corridor Travel Demand Model (2040 'E+C' Scenario)
N/A denotes 'not applicable'

Table 2.5: 2040 Daily VHD by Subarea (E+C Scenario)

Subarea Region	Functional Class Group	Daily VHD (1,000's)	Share of Subarea	Subarea Share of Analysis Area
Clarksville	Interstate	6	8%	N/A
	Arterial	57	77%	N/A
	Collector	11	15%	N/A
	Total	74	100%	5%
Nashville	Interstate	355	27%	N/A
	Arterial	709	53%	N/A
	Collector	270	20%	N/A
	Total	1,334	100%	90%
Chattanooga	Interstate	21	30%	N/A
	Arterial	40	57%	N/A
	Collector	9	13%	N/A
	Total	70	100%	5%
Analysis Area		1,478	N/A	100%

Source: Atkins, I-24 Corridor Travel Demand Model (2040 'E+C' Scenario)
N/A denotes 'not applicable'

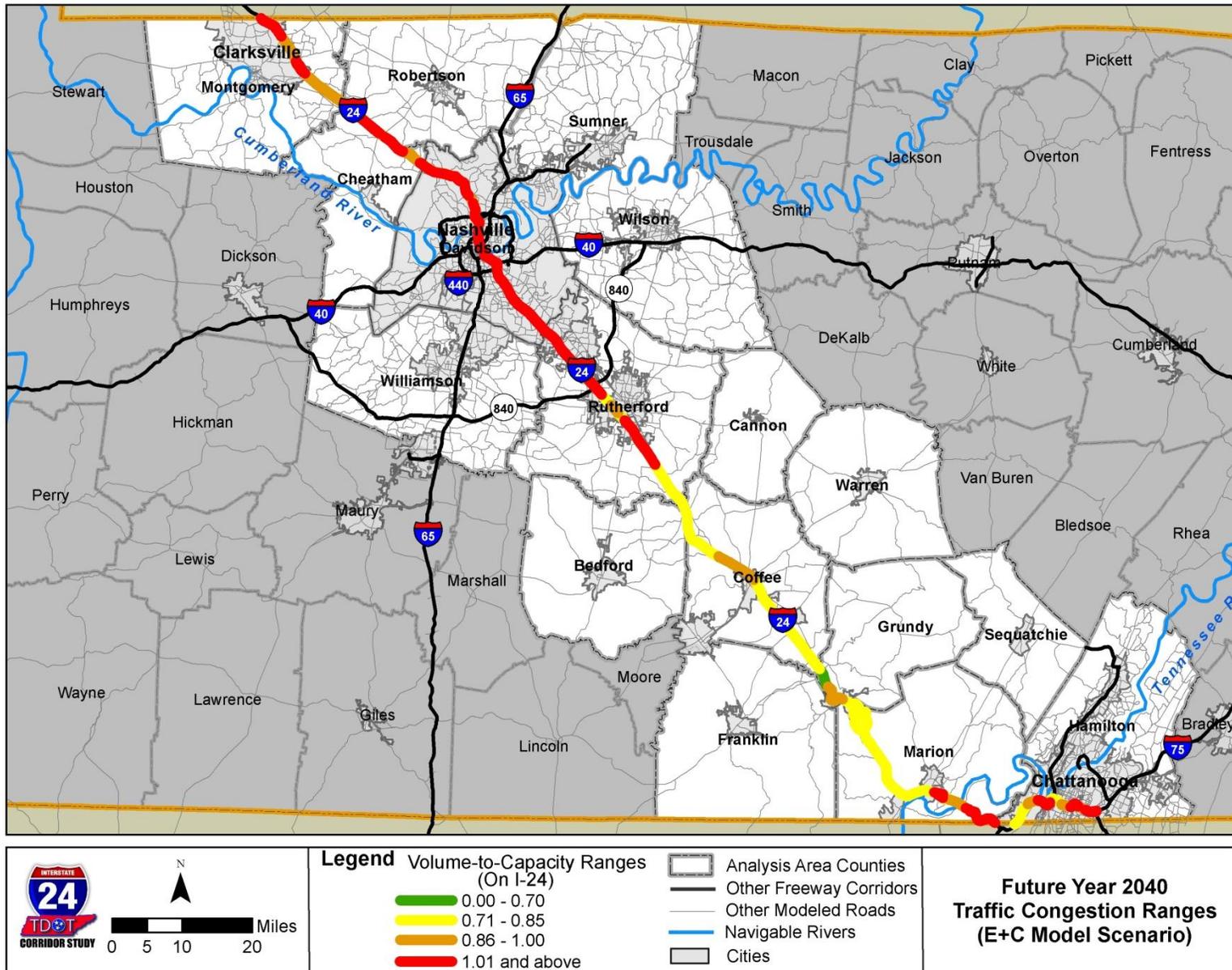
2.1.2 I-24 Level-of-Service

A section-level summary of forecasted traffic conditions on I-24, itself, for the future year 2040 'E+C' model scenario is presented in Figure 2.2 using colored bands to represent four different categories of congestion. Inside the Nashville, Chattanooga and Clarksville metropolitan areas forecasted travel demand is expected to near or exceed available capacity which is denoted by orange and red colored bands. Outside the corridor's metropolitan areas, there are sections of I-24 in the Cumberland Mountains where the level congestion is significantly influenced by both future travel demand and mountainous terrain.

Outside of operational types of strategies to add relatively small amounts of capacity to I-24, like auxiliary lanes, ramp treatments and electronic surveillance systems, there are no significant capacity expansion projects on I-24, itself, in the 'E+C' scenario's road network. The levels-of-congestion depicted in the figure represent the impact that anticipated increases in auto and truck traffic will have on I-24's operating conditions.

The future year 2040 congestion map does not convey the full extent of modeled congestion. Inside of the most congested volume-to-capacity range of 1.01 and above, there are varying levels of severity. A computed volume-to-capacity ratio of 1.01 marginally exceeds the capacity of a section of I-24. However, a modeled volume-to-capacity ratio of 1.30 greatly exceeds the capacity of a section. Outside of the Nashville region, the levels of congestion in the 1.01 and above category are marginally above 1.00 in most cases. For most sections of I-24 inside the Nashville metropolitan area, however, modeled 2040 volume-to-capacity ratios greatly exceed 1.01.

Figure 2.2: 2040 Level of Service with Existing Plus Committed Projects



2.2 Currently Planned LRTP Projects

Traffic assignments of 2040-level travel demand assigned to three other ‘assumed’ future year highway networks were performed to aid in the process of identifying and prioritizing projects that improve traffic conditions in the I-24 Corridor. These three ‘test’ model scenarios are listed and described, as follows:

- LRTP Capacity Projects On I-24: Capacity enhancement projects on I-24, described as ‘Add-Lanes’, that were programmed and funded in the Nashville 2035 LRTP and are designated as 2040 LRTP projects by the Clarksville MPO and the Chattanooga TPO;
- LRTP Capacity Projects Off I-24: Capacity enhancement projects on roadways oriented parallel to I-24, described as ‘Add-Lanes’, that were programmed and funded in the Nashville 2035 LRTP and are designated as 2040 LRTP projects by the Clarksville MPO and the Chattanooga TPO; and,
- LRTP Interchange Projects On I-24: New interchange or interchange modification projects, that are programmed and funded in the Nashville 2035 LRTP and are designated as 2040 LRTP projects by the Clarksville MPO and the Chattanooga TPO, whose traffic impacts can be quantified using the I-24 Corridor Travel Demand Model.

Performance statistics produced by the traffic assignments were compared with the results produced by the ‘E+C’ condition model scenario to determine the relative effectiveness of grouped and individual projects.

2.2.1 LRTP Capacity Projects On I-24

Six (6) capacity enhancement projects that were programmed in LRTP’s were grouped together for analysis using the I-24 Corridor model’s traffic assignment tool. Sections of I-24 where these capacity improvements are programmed are displayed in Figure 2.3. There are two planned, LRTP capacity enhancement projects in each subarea. Project descriptions and map reference ID numbers are embedded in the figure, as well. It is notable that there are no planned, LRTP capacity enhancement projects programmed on I-24 in southeast Davidson County and north Rutherford County, where some of the corridor’s most concentrated congestion is anticipated to occur in the future.

System-wide performance of the ‘LRTP Capacity Projects On I-24’ model scenario was evaluated against the ‘E+C’ or future year baseline model scenario over the entire I-24 Corridor’s analysis area. Modeled results for the ‘LRTP Capacity Projects On I-24’ scenario are presented in Table 2.6 by functional class group and subarea. Moreover, system-wide daily time savings benefiting motorists on all modeled roads in the I-24 Corridor are shown.

Modeled daily VMT of 121.2 million vehicle miles of travel in the 'LRTP Capacity Projects On I-24' package of improvements was 100,000 more vehicle miles than the grand total of 121.1 million generated by the 'E+C' condition over the entire analysis area. The addition of travel lanes on I-24, as defined by this package of improvements, produced a slight overall increase of VMT in the corridor. In the Clarksville region, VMT increased by 1.6% in the 'LRTP Capacity Projects On I-24' model scenario which was far more than in Chattanooga or Nashville.

Table 2.6: 2040 Subarea Performance for LRTP Capacity Projects On I-24

Subarea	Facility	Model Scenario Performance			Daily Time Savings ¹
		Daily VMT (000's)	Daily VHT (000's)	Daily VHD (000's)	
Clarksville	Interstate	1,700	28	4	2,500
	Arterial	4,949	166	54	2,781
	Collector	2,148	60	10	818
	Total	8,797	254	68	6,099
Nashville	Interstate	21,947	699	355	(733)
	Arterial	42,034	1,628	705	3,567
	Collector	24,726	870	269	185
	Total	88,707	3,198	1,330	3,019
Chattanooga	Interstate	6,921	124	19	1,345
	Arterial	12,965	323	38	1,892
	Collector	3,855	102	9	223
	Total	23,742	548	66	3,459
Grand Total		121,245	4,000	1,464	12,577

Source: I-24 Corridor Travel Demand Model, Atkins

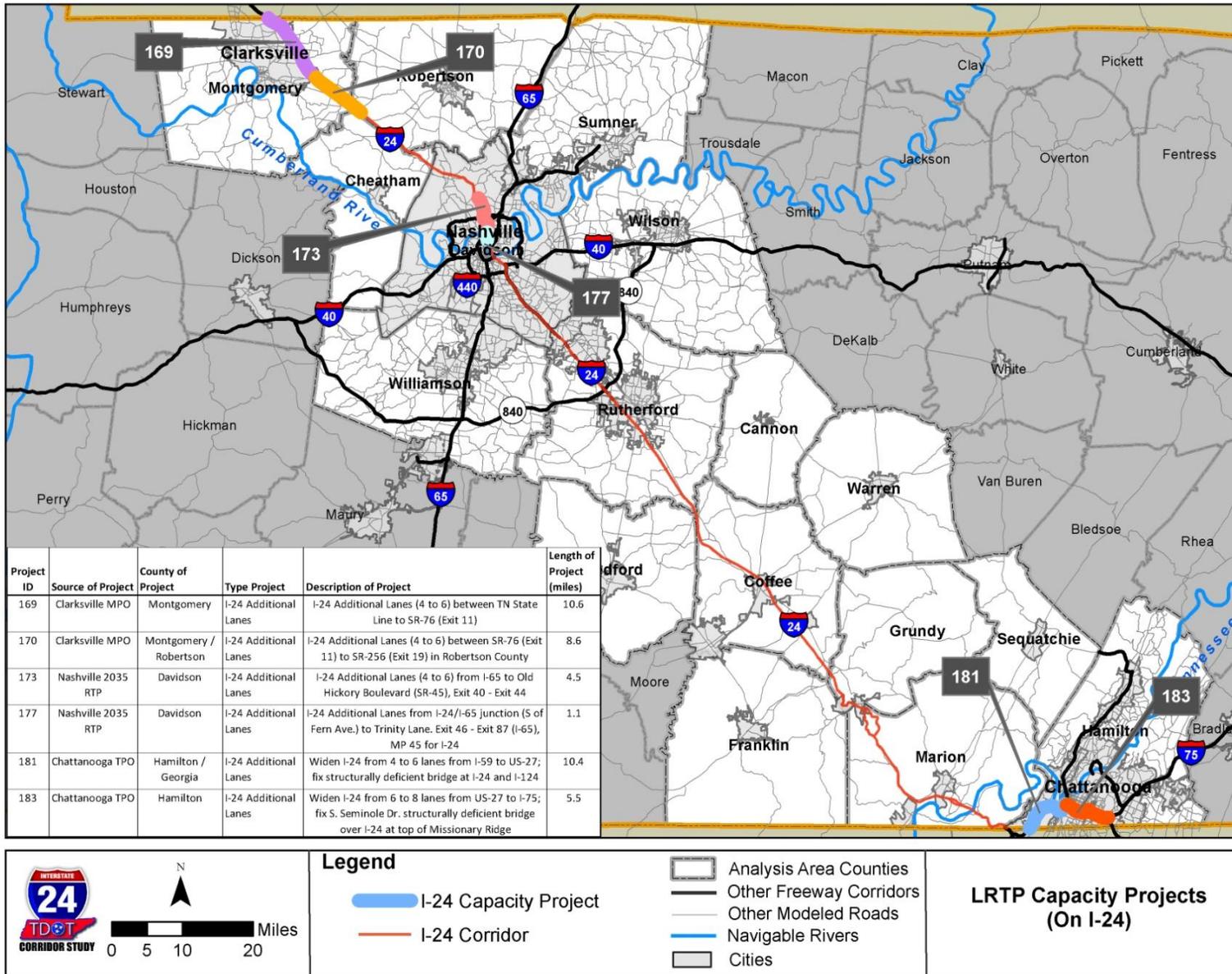
(1) In relation to the baseline E+C Model Scenario

Corridor-wide daily VHT dropped by 13,000 hours in comparison with the 'E+C' model scenario. Modeled daily VHT from the 'LRTP Capacity Projects On I-24' scenario was 4 million vehicle hours in comparison with slightly more than 4 million vehicle hours in the 'E+C'. At the subarea level of analysis, the largest relative decline in daily VHT was 1.6% in Clarksville. A notable consequence of the 'LRTP Capacity Projects On I-24' package of projects was a slight daily VHT increase of 2,000 hours on Interstate facilities in the Nashville subarea.

Net delay due to congestion was reduced by almost 13,000 daily vehicle hours or 1% corridor-wide by the 'LRTP Capacity Projects On I-24' group of projects. Delay reductions were most prominent in the Clarksville subarea where congestion delay dropped more than 6,000 hours per day for a 6% time savings.

Model results were used to assess the relative impact, in monetary terms, that each candidate project in the 'LRTP Capacity Projects On I-24' package would have in relation to 'E+C' or baseline conditions. Annual dollar savings, in current dollars, attributable to each I-24 capacity enhancement project are presented in Table 2.7. These dollar figures are based on future year 2040 modeled VMT, VHT and delay statistics that were accumulated from those sections of I-24 that were most influenced by each individual project. Monetary benefits from individual projects will be important parameters in developing the list of factors to screen and prioritize plan recommendations.

Figure 2.3: LRTP Capacity Projects On I-24



**Table 2.7: 2040 Project Performance for LRTP Capacity
Projects On I-24**

Project ID	Subarea	From Exit	To Exit	Daily Time Savings ¹ (hours)	Annual Dollar Savings ¹ (\$'000's)
169	Clarksville	KY Border	11	2,975	\$ 25,585.6
170	Clarksville	11	19	545	\$ 4,689.0
173	Nashville	40	44	597	\$ 4,817.1
177	Nashville	45	46	1,064	\$ 8,581.3
181	Chattanooga	169	178	1,641	\$ 13,666.5
183	Chattanooga	178	185	1,649	\$ 13,729.5

Source: I-24 Corridor Travel Demand Model, Atkins

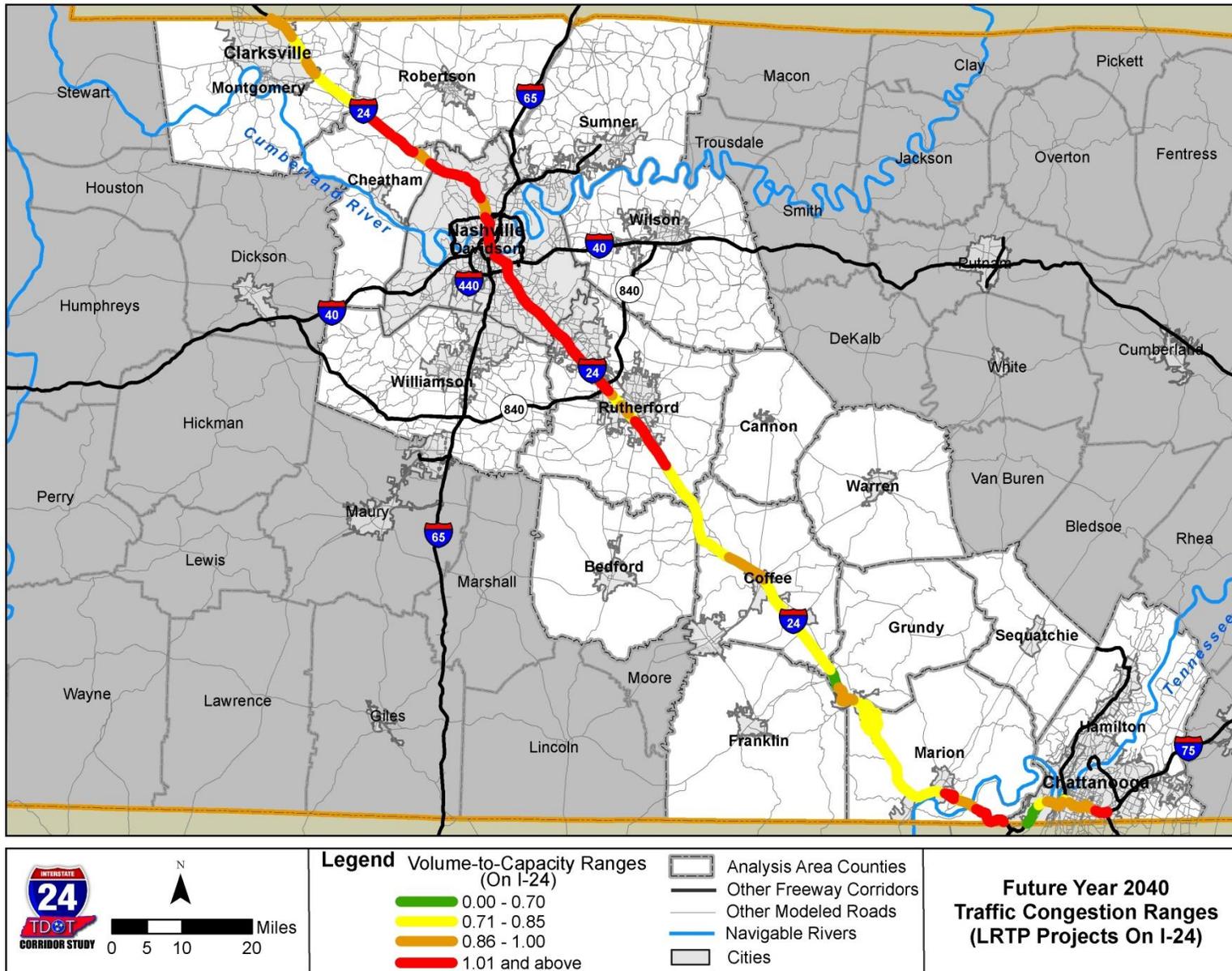
(1) In relation to the baseline E+C Model Scenario

Annual dollar savings attributable to the I-24 widening project from the Kentucky border to Exit 11/SR-76 in Montgomery County, project 169, were the highest of all six planned LRTP capacity improvements. The estimated monetary benefits from this project amounted to \$25.6 million. The smallest monetary benefits, \$4.7 million, were computed for project 170 which is located on sections of I-24 immediately south of project 169.

A section-level summary of forecasted traffic conditions on I-24, itself, for the future year 2040 'LRTP Capacity Projects On I-24' package of projects is presented in Figure 2.4 using colored bands to represent four categories of congestion. There are several intermittently spaced patches of dark red bands, indicating that volume-to-capacity ratios exceed 1.0 on those sections of I-24, outside of the metropolitan Nashville area. Nevertheless, the largest concentration of I-24 sections with volume-to-capacity ratios exceeding 1.0 are located inside the Nashville metropolitan area.

In the Clarksville and Chattanooga subareas there are some notable changes in volume-to-capacity ratio band colors, in comparison with the 'E+C' map. Levels-of-congestion on sections of I-24 around Clarksville change from the 1.01 and above to the 0.86 to 1.0 range. This improvement in operating performance is attributable to the two capacity enhancement projects planned for the Clarksville subarea, project 169 and project 170. Similar differences in the modeled level of congestion on I-24 occurs on sections of I-24 in the Chattanooga subarea, too. Dark red colored bands assigned to sections of I-24 situated southwest and east of downtown Chattanooga in the 'E+C' condition change to orange colored bands in the model scenarios containing the 'LRTP Capacity Projects On I-24' set of projects. Improvements to operating conditions on sections of I-24 in Chattanooga result from added capacity in project 181 and project 183. There is a short section of I-24 in north Davidson County where the volume-to-capacity ratio color changes from 1.01 and above to the 0.86 to 1.0 range. This occurs between SR-45/Old Hickory Blvd and SR-155/Briley Parkway on the north side of Nashville.

Figure 2.4: Modeled 2040 Volume-to-Capacity Ratios (L RTP Capacity On I-24)



2.2.2 L RTP Capacity Projects Off I-24

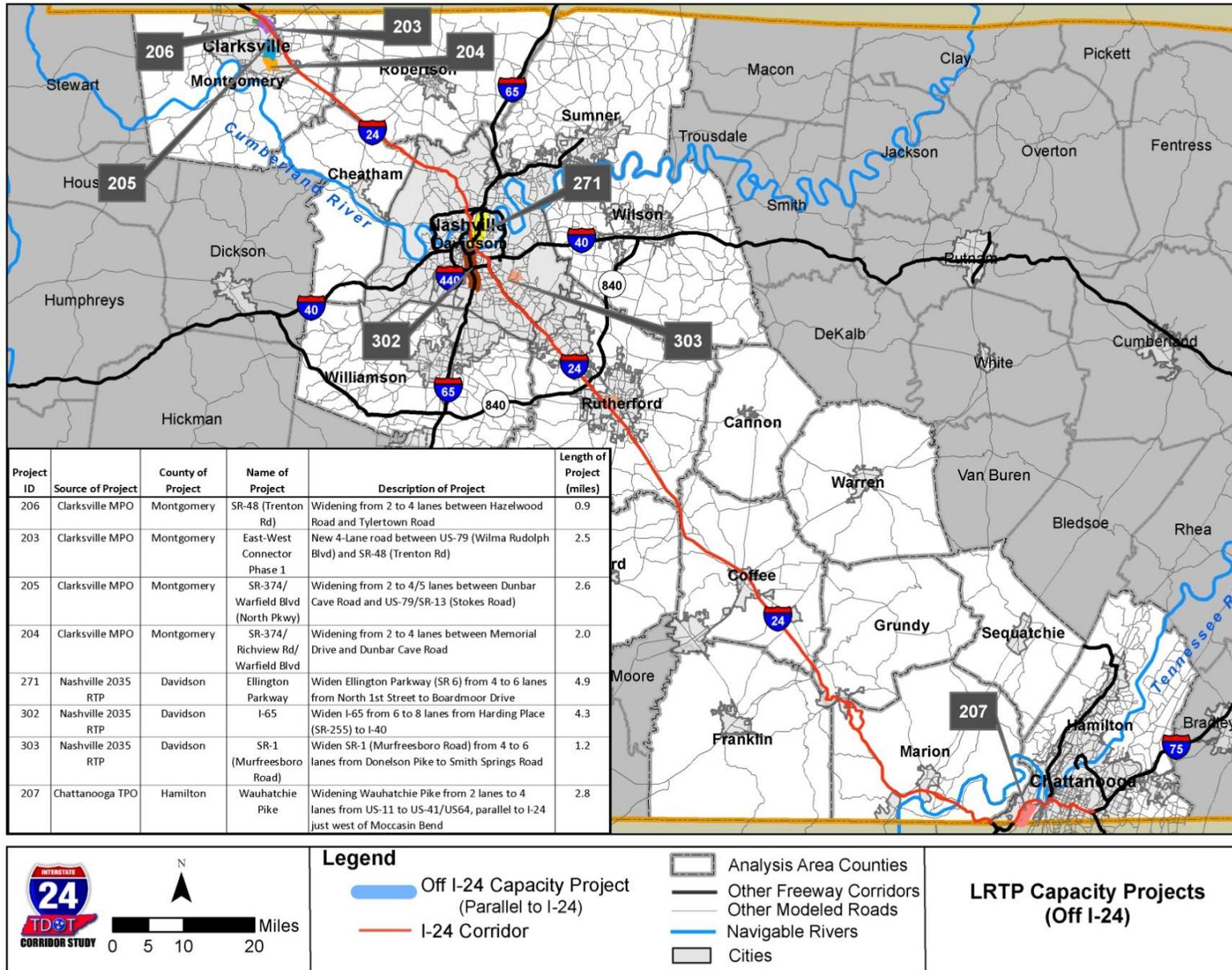
Eight (8) capacity enhancement projects that were programmed in L RTP's for roadways oriented parallel to I-24 were grouped together for travel model analysis. The locations where these types of capacity improvements are programmed are displayed in Figure 2.5. There are planned, L RTP capacity enhancement projects in each subarea; four in Clarksville; three in Nashville; and, one in Chattanooga. Brief project descriptions and map reference ID numbers are embedded in the figure, as well.

Several notable road widening projects are planned for facilities in the Nashville subarea. There are two planned, L RTP capacity enhancement projects programmed on roads parallel to I-24 in south Davidson County, where some of the corridor's most concentrated congestion is anticipated to occur in the future. One of these is a 4.3 mile widening of I-65 from Harding Place to I-40. The other is a much shorter 1.2 mile widening of US-41/Murfreesboro Pike from Donelson Pike to Smith Springs Road. A third L RTP project is a planned 4.9 mile capacity enhancement on Ellington Pkwy in north Davidson County, parallel to the portion of I-24 that is shared with I-65.

System-wide performance of the 'L RTP Capacity Projects Off I-24' model scenario was evaluated against the 'E+C' or future year baseline model scenario over the entire I-24 Corridor's analysis area. Modeled results for the 'L RTP Capacity Projects Off I-24' scenario are presented in Table 2.8 by functional class group and subarea. Also included is system-wide daily time savings benefiting motorists on all roads in the I-24 Corridor model's network.

Modeled daily VMT of 121.1 million vehicle miles of travel in the 'L RTP Capacity Projects Off I-24' package of improvements amounted to a marginal increase of 35,000 more vehicle miles than the grand total generated by the 'E+C' condition over the entire analysis area. The addition of travel lanes on facilities parallel to I-24, as defined by this package of improvements, produced a slight overall increase of VMT over the entire corridor analysis area. In the Clarksville region, however, the four capacity enhancement projects decreased subarea VMT by 44,000 vehicle miles or 0.5% which was opposite the direction of VMT changes in Chattanooga and Nashville.

Figure 2.5: LRTP Capacity Projects Off I-24



Corridor-wide daily VHT dropped by 9,000 hours in comparison with the 'E+C' model scenario. Lower daily VHT from the 'LRTP Capacity Projects Off I-24' package of projects amounts to an extremely small percentage change, well below 1%. Daily VHT in the Clarksville and Nashville subareas exhibited small drops in comparison with the 'E+C' baseline while there was no net VHT change in Chattanooga. The largest relative decline in daily VHT was 1.6% in Clarksville. Nashville's drop was very small in comparison with total subarea VHT, representing much less than a 1% change. The impact that 'LRTP Capacity Projects Off I-24' projects had on daily VHT attributable to the interstate system was neutral in the Clarksville and Nashville subareas. Chattanooga's Interstate's, however, showed a slight drop of 1,000 vehicle hours.

Table 2.8: 2040 Subarea Performance for LRTP Capacity Projects Off I-24

Subarea	Facility	Model Scenario Performance			Daily Time Savings ¹
		Daily VMT (000's)	Daily VHT (000's)	Daily VHD (000's)	
Clarksville	Interstate	1,459	27	6	692
	Arterial	4,972	165	53	3,946
	Collector	2,186	62	11	347
	Total	8,618	254	69	4,984
Nashville	Interstate	21,897	697	354	1,066
	Arterial	42,152	1,630	705	3,784
	Collector	24,724	870	270	(174)
	Total	88,774	3,197	1,328	4,676
Chattanooga	Interstate	6,625	120	21	27
	Arterial	13,164	329	40	42
	Collector	3,910	103	9	(38)
	Total	23,699	553	70	32
Grand Total		121,091	4,004	1,467	9,692

Source: I-24 Corridor Travel Demand Model, Atkins

(1) In relation to the baseline E+C Model Scenario

Net delay due to congestion was reduced by almost 10,000 daily vehicle hours or 1% corridor-wide by the 'LRTP Capacity Projects Off I-24' group of projects. Delay reductions were most prominent in the Clarksville subarea where congestion delay dropped by almost 5,000 hours per day which is 7% of total delay in the Clarksville subarea. Delay was reduced by almost 5,000 hours per day in Nashville as well, but the reduction accounted for less than half a percent of the subarea's total delay.

Model results were used to assess the relative impact, in monetary terms, that each candidate project in the 'LRTP Capacity Projects Off I-24' package would have in relation to 'E+C' or baseline conditions. Annual dollar savings attributable to each I-24 capacity enhancement project are presented in Table 2.9. These dollar figures are based on future year 2040 modeled VMT, VHT and delay statistics that were accumulated from those sections of I-24 that were most influenced by each individual project. Monetary benefits from individual projects will be important parameters in developing the list of factors to screen and prioritize plan recommendations.

Annual dollar savings to motorists traveling on I-24 but that are attributable to the I-65 widening project from Harding Place to I-40 in Davidson County, project 302, were the highest of all eight LRTP capacity improvements in the 'LRTP Capacity Projects Off I-24' model scenario.

The estimated monetary benefits from this project amounted to \$3.5 million. Annual dollar savings attributable to the SR-374/Warfield Blvd widening project from Memorial Drive to

Dunbar Drive in Montgomery County, project 204, were nearly as great as the I-65 widening project. Monetary savings from the SR-374/Warfield Blvd project was \$3.4 million annually. The smallest monetary benefits, \$0.3 million, were computed for project 207 which is located on Wautachie Pike in Hamilton County.

A section-level summary of forecasted traffic conditions on I-24, itself, for the future year 2040 'LRTP Capacity Projects Off I-24' package of projects is presented in Figure 2.6 using colored bands to represent four categories of congestion. There are intermittently spaced patches of dark red bands, indicating that volume-to-capacity ratios exceed 1.0 on those sections of I-24, outside of the metropolitan Nashville area. The largest concentration with volume-to-capacity ratios exceeding 1.0 are located inside the Nashville metropolitan area. The 'LRTP Capacity Projects Off I-24' collection of projects does not materially impact volume-to-capacity ratios anywhere in the I-24 Corridor. Band color patterns along the entire 185 mile corridor from Kentucky to I-75 are the same as those shown for the 'E+C' model scenario.

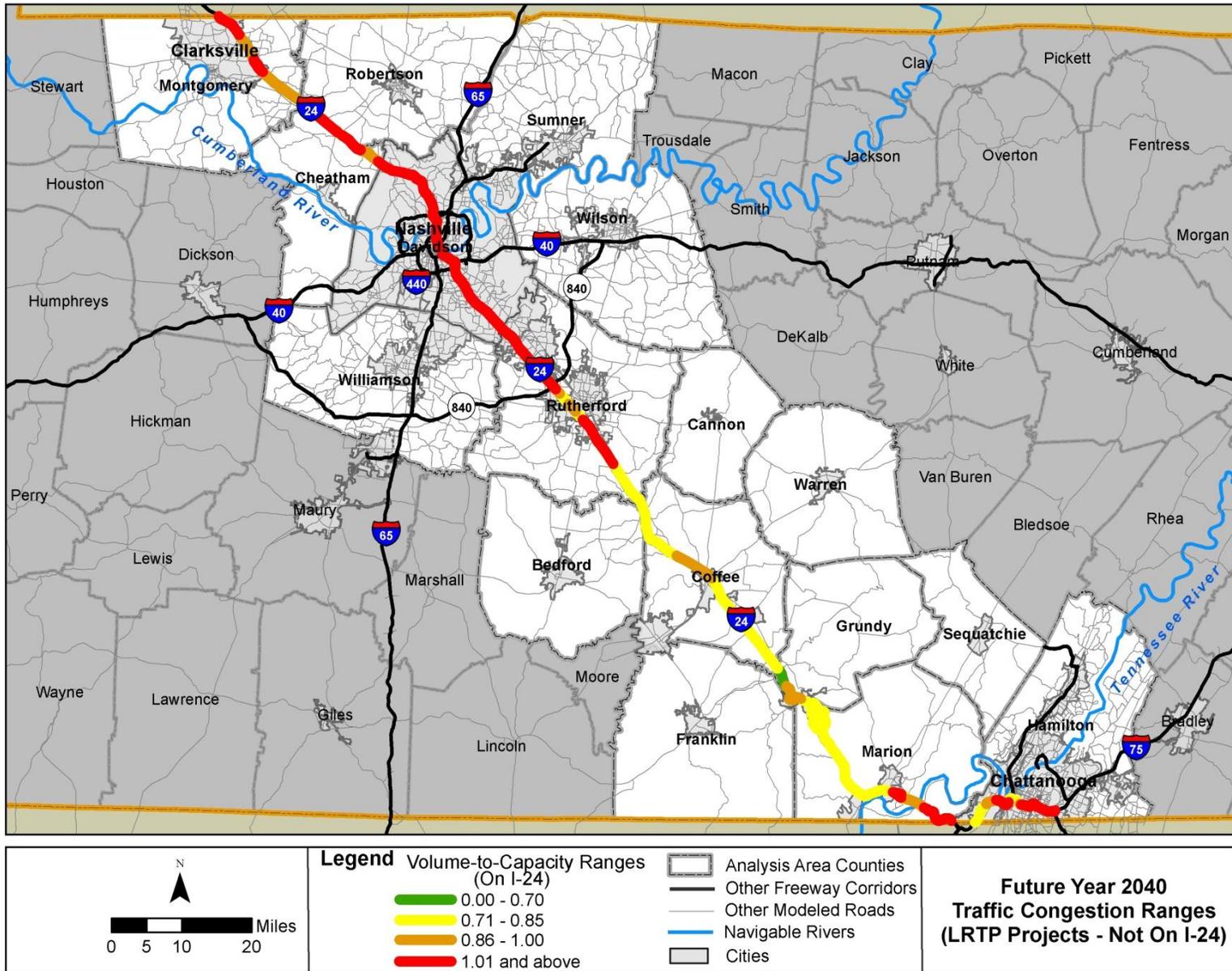
Table 2.9: 2040 Project Performance for LRTP Capacity Projects Off I-24

Project ID	Subarea	From Exit	To Exit	Daily Time Savings ¹ (hours)	Annual Dollar Savings ¹ (\$000's)
203	Clarksville	1	4	115	\$ 1,040.5
204	Clarksville	8	11	375	\$ 3,399.7
205	Clarksville	4	8	98	\$ 888.7
206	Clarksville	1	1	105	\$ 949.7
271	Nashville	44	47	217	\$ 1,756.4
302	Nashville	50	52	436	\$ 3,529.0
303	Nashville	54	54	228	\$ 1,851.2
207	Chattanooga	171	175	27	\$ 298.0

Source: I-24 Corridor Travel Demand Model, Atkins

(1) In relation to the baseline E+C Model Scenario

Figure 2.6: Modeled 2040 Volume-to-Capacity Ratios (LRTP Capacity Projects Off I-24)



2.2.3 LRTP Interchange Projects

Eight (8) interchange projects were programmed in LRTP's for roadways that either currently provide access or will provide access to and from I-24 were grouped to assess their impact on traffic conditions. The locations of these LRTP interchange improvements are displayed in Figure 2.7. There are planned, LRTP interchange projects in two subareas: six in Nashville and two in Chattanooga. No new interchanges or interchange modifications were programmed on I-24 in the Clarksville subarea. Brief project descriptions and map reference project ID numbers are embedded in the figure, as well.

Seven of the major interchange projects are interchange modifications. Only one of them is a completely new interchange. A new interchange is proposed in north Rutherford County at Rocky Fork Road.

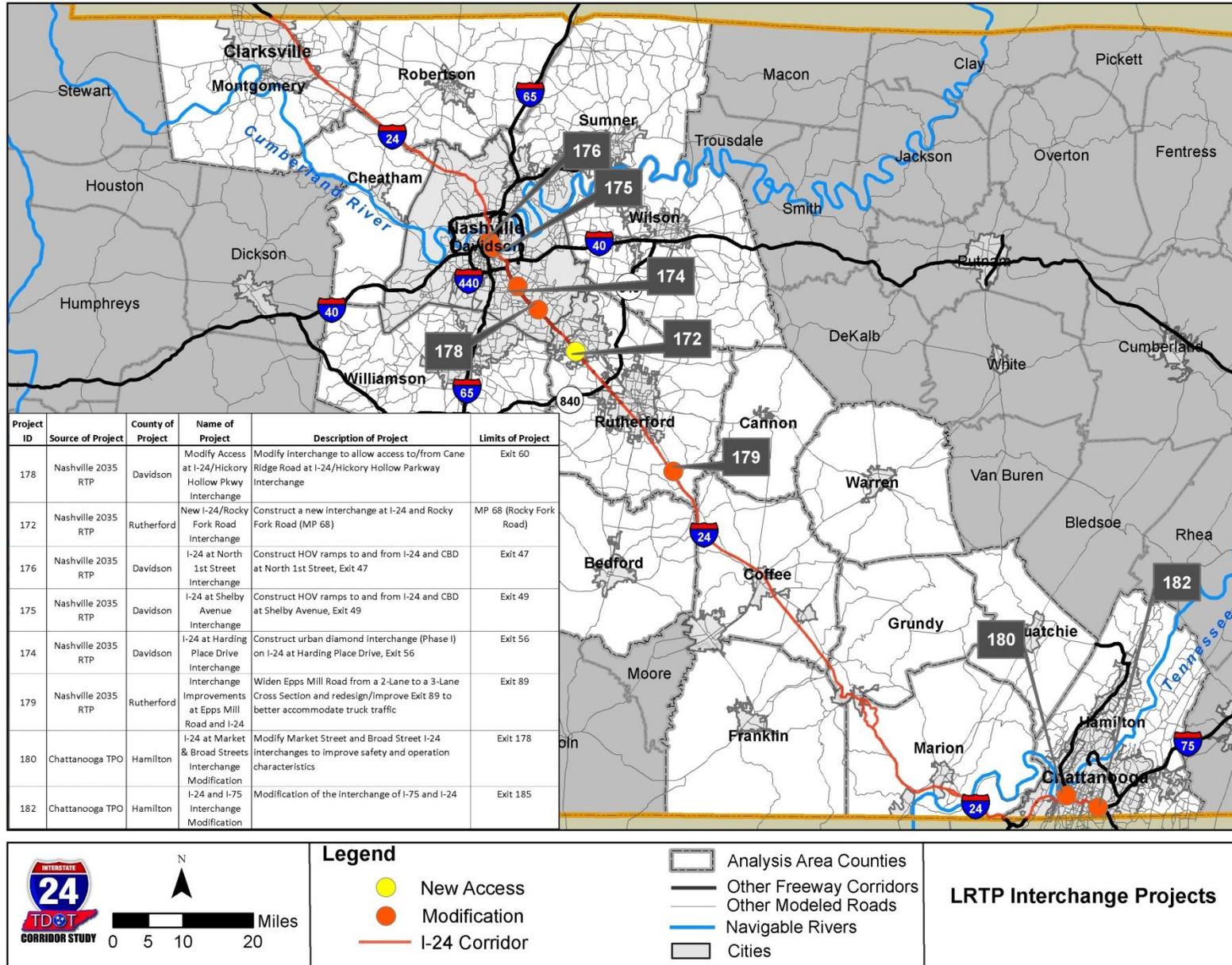
Only two of the interchange improvements were evaluated using the I-24 Corridor Travel Demand Model to assess their impact on I-24 and other roadways in the corridor analysis area. These are:

- Project 172 - the new interchange at Rocky Fork Road in north Rutherford County; and,
- Project 178 - an interchange modification at Hickory Hollow Parkway that will provide a connection to Cane Ridge Road on the west side of I-24.

Two of the interchange projects, in Chattanooga, were considered to have mostly operational and safety benefits that would not be estimated well using a macro-scopic travel demand model like the I-24 Corridor Travel Demand Model. Instead, the interchange modifications at Market Street and Broad Street in downtown Chattanooga and at I-75 in East Ridge were evaluated for traffic impacts using a small area, meso-scopic, modeling tool. Performance measures for these two interchange projects are presented in this section as well.

Four of the interchange projects, in the Nashville subarea, were considered to have mostly operational and safety benefits that would not be estimated well using a macro-scopic travel demand model like the I-24 Corridor Travel Demand Model. Two of these projects (176 and 175) involve adding HOV ramps to the downtown Nashville area. While the new HOV access to downtown will have a beneficial operational impact, the models developed for the purposes of the I-24 Corridor are not able to model HOV trips. The other two of the non-modeled interchange projects (174 and 179) in the Nashville subarea are interchange modifications that would provide operational and safety benefits but have improvements too subtle for the macro-scopic or meso-scopic models to evaluate.

Figure 2.7: L RTP Operational Projects



System-level subarea performance measures are not reported in this section for new interchange and interchange modification projects. Only two of them were modeled with the macro-scopic I-24 Corridor Travel Model. In order to consider the merits of all interchange projects on a balanced scale, only net annual benefits in comparison with the 'E+C' were estimated and reported for new interchanges. This was done using a meso-scopic scale traffic model, in contrast to the macro-scopic I-24 Corridor model used to evaluate candidate capacity enhancement projects. Annual monetary benefits estimated for the new interchange projects and select interchange modification projects are presented in Table 2.10. Monetary benefits from individual interchange projects will be important factors used by the study team to screen and prioritize plan recommendations.

Based almost exclusively on time savings, the largest annual dollar savings, \$41.4 million, of the 'LRTP Interchange' projects comes from the interchange modification at Hickory Hollow Parkway which is project 178. Estimated annual dollar savings from the new interchange at Rocky Ford Road, project 172, is \$18.5 million.

Table 2.10: 2040 Project Performance for LRTP Operational Projects

Project ID	Subarea	From Exit	To Exit	Daily Time Savings ¹ (hours)	Annual Dollar Savings ¹ (\$000's)
172	Nashville	66	70	2,470	\$ 18,546.2
178	Nashville	59	60	5,227	\$ 41,421.6
180	Chattanooga	178	178	-3,080	\$ (1,141.0)
182	Chattanooga	185	185	26,938	\$ 9,706.6

Source: I-24 Corridor Travel Demand Model, I-24 Meso-scopic Scale Traffic Model, Atkins
 (1) In relation to the baseline E+C Model Scenario

Project 182, which is the interchange modification of the existing interchange with I-75 in Chattanooga, was projected to generate annual dollar savings of \$9.7 million. Traffic model results for the other LRTP interchange modification in Chattanooga were not beneficial. A net reduction in annual dollar savings was projected for the modification and collector-distributor lanes project at Broad Street and Market Street. After reviewing the model results for this project in greater detail, the project team noticed that the proposed improvements significantly helped I-24 in the vicinity of the interchange at Broad Street and Market Street but allowed additional traffic through this area that caused a "bottle-neck" further downstream which caused traffic to back-up in the Broad Street and Market Street area, which was reflected in the model results.

A colored volume-to-capacity band map denoting different levels of congestion on sections of I-24 was not prepared for the 'LRTP Interchanges' model scenario to treat the evaluation of all interchange projects consistently.

3.0 Proposed Capacity and Operational Projects and Strategies Evaluation

In the last section, planned LRTP projects were assessed to determine their impact on traffic conditions in the I-24 Corridor. This section is similar, but it consists of transportation improvement packages that were identified from a variety of different sources. Some of these improvements came from metropolitan planning organizations or local governments, but were not programmed into a LRTP or local transportation plan for lack of available funding. Others were fashioned from field studies, gap analysis or crash analyses performed by the study team. Some projects and strategies were proposed by TDOT staff or previous TDOT studies and others were obtained from the I-24 Corridor Study's web-based comment form and public meetings.

Most of the operational projects identified in this section have operational and safety benefits that were not quantified using the macro-scopic travel demand model or meso-scopic scale traffic model. Since nearly all of the operational projects are designed to improve motor vehicle safety, high crash rate locations will be an important consideration in filtering and prioritizing candidate transportation improvements. An assessment of TDOT's database of crashes on mainline sections of I-24, itself, yielded valuable findings that identified sections of I-24 where the observed crash rate exceeded the statewide average crash rate. These sections are highlighted in Figure 3.1. The colored markings denote sections of I-24 where the estimated crash rate on I-24 exceeded two times the statewide average crash rate for all similar types of Interstate.

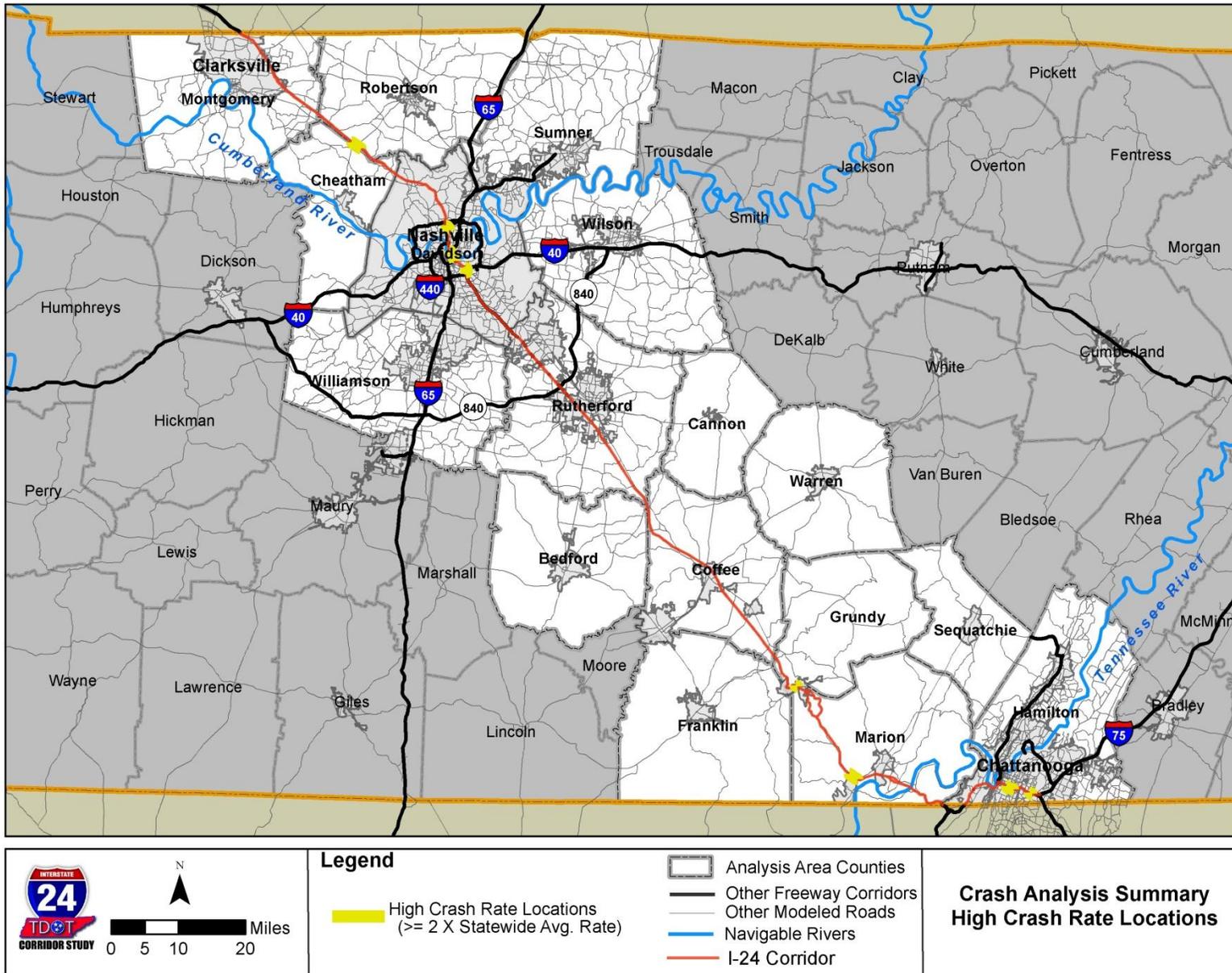
3.1 Proposed Capacity Projects Evaluation

Two different groups of capacity enhancement projects are evaluated in this section. These are non-LRTP projects that were grouped into the following two improvement packages and evaluated by the macro-scopic I-24 Corridor travel demand model.

- Proposed Capacity Projects On I-24
- Proposed Capacity Projects Off I-24

For both capacity enhancement scenarios, modeled network link capacities were additive to the LRTP capacity enhancements.

Figure 3.1: I-24 Corridor Crash Analysis Summary



3.1.1 Proposed Capacity Projects On I-24 Evaluation

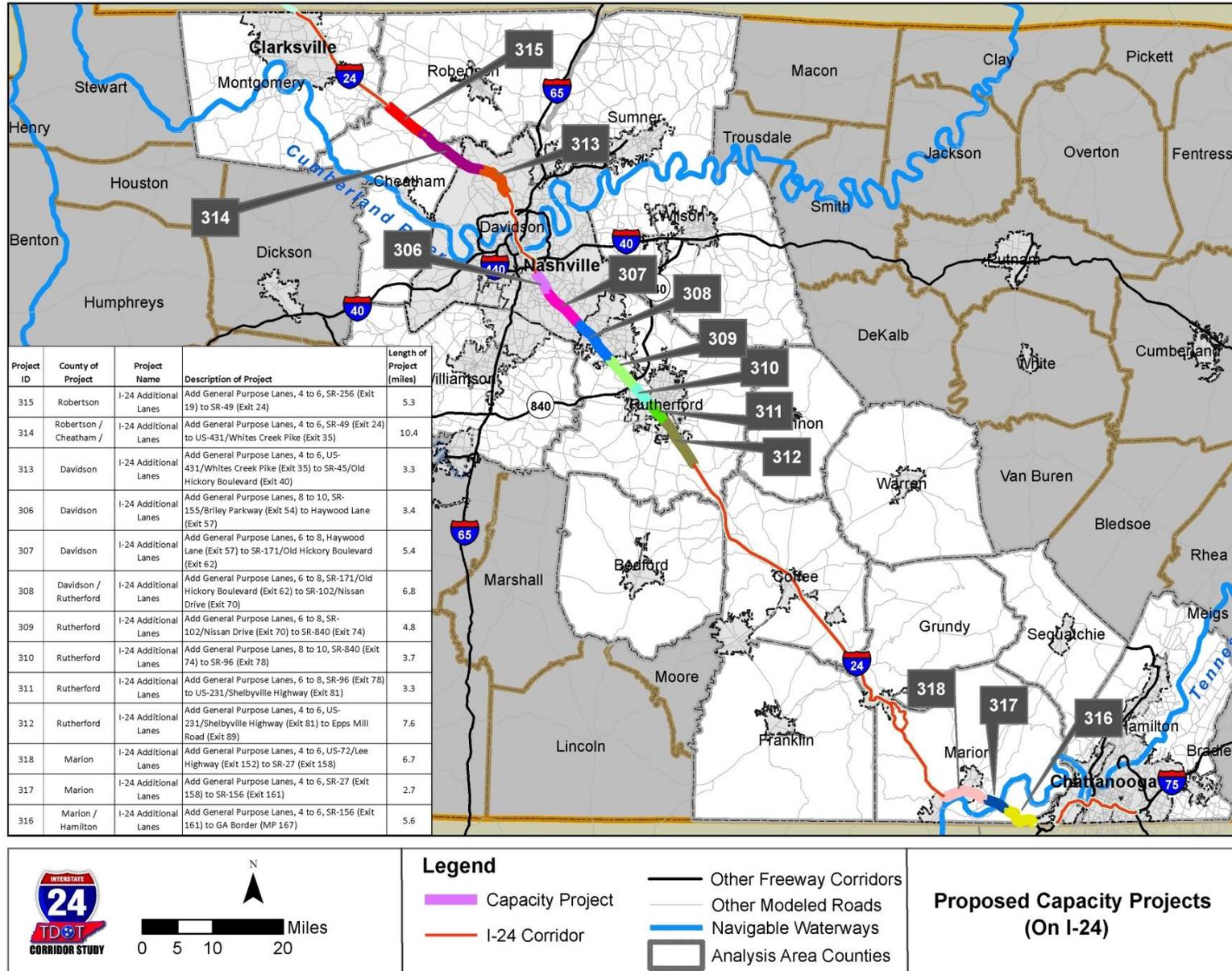
Based on a review of traffic assignment results from the 'LRTP Capacity Projects On I-24' model scenario described in the previous section, another 69 centerline miles of I-24 were identified as capacity deficient. These sections were contiguous to those that have already been proposed for widening in current LRTP's. It did not, however, include sections of I-24, I-24/I-40 or I-24/I-65 located in downtown Nashville although traffic forecasted on this portion of I-24 is expected to exceed the roadway's design capacity in the future. There are too many significant problems associated with widening I-24 in downtown Nashville to make widening recommendations. Some of the problems are: topography; rock formations; Interstate-to-Interstate connections and bottlenecks; right-of-way and land acquisition; and, coordinating improvement strategies for I-24 with other regional mobility strategies for the region that are being studied by the Nashville MPO.

After considering logical termini and project scale, thirteen (13) capacity enhancement projects, in addition to those already planned in LRTP's, were proposed for further consideration in the process of formulating a cost effective plan for the I-24 Corridor. Sections of I-24 where these capacity improvement projects are proposed are displayed in Figure 3.2. Project descriptions and map reference ID numbers are embedded in the figure, as well. Two proposed projects are located in the Clarksville subarea. One of them extends to the south into Davidson County and the Nashville subarea. Eight proposed capacity enhancement projects are specified in the Nashville subarea. One is located in north Davidson County while the other six are in south Davidson County and Rutherford County. The last three capacity enhancements were proposed for Marion County and a small piece of Hamilton County in the Chattanooga subarea. Modeled future year 2040 traffic conditions forecast for these sections were influenced by a combination of high truck volumes and hilly terrain.

System-wide performance of the 'Proposed Capacity Projects On I-24' model scenario was evaluated against the 'E+C' or future year baseline model scenario over the entire I-24 Corridor's analysis area. Modeled results for the 'Proposed Capacity Projects On I-24' scenario are presented in Table 3.1 by functional class group and subarea. Moreover, system-wide daily time savings benefiting motorists on all modeled roads in the I-24 Corridor are shown.

Modeled daily VMT of 121.3 million vehicle miles of travel in the 'Proposed Capacity Projects On I-24' package of improvements was 200,000 more vehicle miles than the grand total of 121.1 million generated by the 'E+C' condition over the entire analysis area. For perspective, the 200,000 gain in VMT represents a 0.2% change in relation to total VMT for the entire I-24 Corridor. Daily VMT in the Nashville subarea exhibited a different pattern than the other two subareas. Nashville's VMT dropped by 100,000 vehicle miles or 0.1% in the 'Proposed Capacity Projects On I-24' model scenario.

Figure 3.2: Proposed Capacity Projects On I-24



Corridor-wide daily VHT dropped by 118,000 hours in comparison with the 'E+C' model scenario. Modeled daily VHT from the 'Proposed Capacity Projects On I-24' scenario was 3.9 million vehicle hours in comparison with slightly more than 4 million vehicle hours in the 'E+C'. At the subarea level of analysis, the largest relative decline in daily VHT was 3.5% in Nashville. Nashville's projected daily VHT was 3.1 million hours for the 'Proposed Capacity Projects On I-24' in comparison with 3.2 million hours for the 'E+C'.

Net delay due to congestion was reduced by 109,000 daily vehicle hours or 8% corridor-wide by the 'Proposed Capacity Projects On I-24' improvement package. Delay reductions were most prominent in the Nashville and Chattanooga Subareas where congestion delay dropped by almost 8% in comparison with the 'E+C'.

Model results were used to assess the relative impact, in monetary terms, that each candidate project in the 'Proposed Capacity Projects On I-24' package would have in relation to 'E+C' or baseline conditions. Annual dollar savings, in current dollars, attributable to each I-24 capacity enhancement project are presented in Table 3.2. These dollar figures are based on future year 2040 modeled VMT, VHT and delay statistics that were accumulated from those sections of I-24 that were most influenced by each individual project. Monetary benefits from individual projects will be

Table 3.1: Subarea Performance Measures for Proposed Capacity Projects On I-24

Subarea	Facility	Model Scenario Performance			Daily Time Savings ¹
		Daily VMT (000's)	Daily VHT (000's)	Daily VHD (000's)	
Clarksville	Interstate	1,828	31	5	1,242
	Arterial	4,893	162	52	5,086
	Collector	2,049	58	10	920
	Total	8,770	251	67	7,247
Nashville	Interstate	22,251	644	299	55,231
	Arterial	41,864	1,604	684	25,027
	Collector	24,465	847	253	17,052
	Total	88,580	3,094	1,236	97,310
Chattanooga	Interstate	7,136	125	18	2,826
	Arterial	12,956	323	38	1,634
	Collector	3,834	101	9	25
	Total	23,926	549	65	4,485
Grand Total		121,275	3,895	1,368	109,042

Source: I-24 Corridor Travel Demand Model, Atkins
(1) In relation to the baseline E+C Model Scenario

Table 3.2: Project Performance Measures for Proposed Capacity Projects On I-24

Project ID	Subarea	From Exit	To Exit	Daily Time Savings ¹ (hours)	Annual Dollar Savings ¹ (\$000's)
306	Nashville	54	57	4,994	\$ 16,661.1
307	Nashville	57	62	9,523	\$ 31,764.4
308	Nashville	62	70	11,147	\$ 37,180.3
309	Nashville	70	74	1,995	\$ 6,674.9
310	Nashville	74	78	301	\$ 1,020.4
311	Nashville	78	81	90	\$ 312.3
312	Nashville	81	89	1,345	\$ 4,502.1
313	Nashville	35	40	687	\$ 2,306.2
314	Clarksville	24	35	495	\$ 1,338.2
315	Clarksville	19	24	436	\$ 1,181.6
316	Chattanooga	161	166	766	\$ 5,012.4
317	Chattanooga	158	161	175	\$ 1,148.5
318	Chattanooga	152	158	376	\$ 2,464.7

Source: I-24 Corridor Travel Demand Model, Atkins
(1) In relation to the baseline E+C Model Scenario

important parameters in developing the list of factors to screen and prioritize plan recommendations.

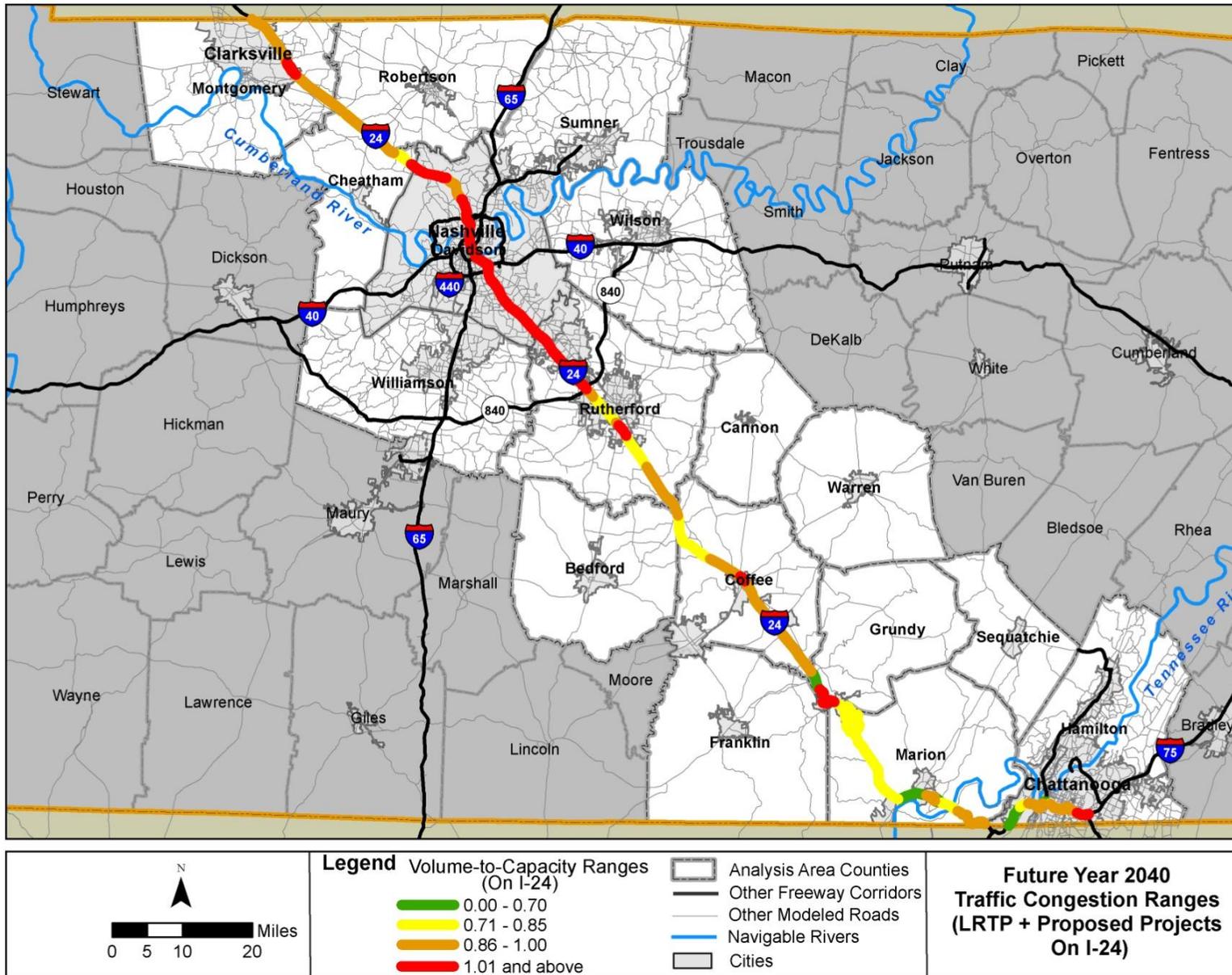
Annual dollar savings attributable to the six-lane to eight-lane general purpose lane capacity enhancement project from SR-171/Old Hickory Blvd to SR-102/Nissan Drive in Rutherford County, project 308, were the highest of all thirteen proposed capacity improvements. The estimated monetary benefits from this project amounted to \$37.2 million. The capacity improvements with the second and third highest benefits were project 307 and project 306 which are positioned immediately north of project 308, in south Davidson County. The smallest monetary benefits, \$0.3 million, were computed for project 311 which is located in Rutherford County between SR-96 and US-231/Shelbyville Highway.

A section-level summary of forecasted traffic conditions on I-24, itself, for the future year 2040 'Proposed Capacity Projects On I-24' package of projects is presented in Figure 3.3 using colored bands to represent four categories of congestion. Outside of metropolitan Nashville, there are several intermittently spaced patches of dark red bands, indicating that volume-to-capacity ratios still exceed 1.0 despite the additional 69 miles of road widenings. Nevertheless, the largest concentration of I-24 sections with volume-to-capacity ratios exceeding 1.0 are located inside the Nashville metropolitan area.

In the Clarksville and Chattanooga subareas there are notable changes in volume-to-capacity ratio band colors, in comparison with the 'E+C' map. Levels-of-congestion on sections of I-24 around Clarksville and further south into Robertson County and Cheatham County are in the 0.86 to 1.0 range, except between SR-236 and SR-76 which remains in the 1.01 and above range. Better operating conditions in the Clarksville subarea are attributable to the two LRTP capacity enhancement projects and the two proposed capacity projects. Similar differences in the modeled level of congestion occur in the Chattanooga subarea, too. Dark red colored bands assigned to sections of I-24 situated southwest and east of downtown Chattanooga in the 'E+C' condition change to orange and other colored bands in the model scenario containing the 'Proposed Capacity Projects On I-24' package. Better operating conditions on sections of I-24 in comparison with the 'E+C' extend westward in the 'Proposed Capacity Projects On I-24' scenario. These changes occur between the Georgia border and US-72 in South Pittsburgh.

In the middle of the corridor, between Epps Mill Road in Rutherford County and US-72 in Marion County, volume-to-capacity ratio band color ranges indicate that additional traffic will be attracted to I-24 in relation to the 'E+C' as a result of 'Proposed Capacity Projects On I-24' set of projects. This is shown by a red colored band on I-24 immediately north of Monteagle on the border between Grundy and Marion counties. Other sections of I-24 in the center of the corridor change from yellow colored volume-to-capacity bands in the 'E+C' to an orange color band in the 'Proposed Capacity Projects On I-24' model scenario.

Figure 3.3: Modeled 2040 Volume-to-Capacity Ratios (LRTP and Proposed Capacity Projects On I-24)



3.1.2 Proposed Capacity Projects Off I-24 Evaluation

Seventeen (17) capacity enhancement projects are proposed for roadways parallel to I-24, in addition to those already planned in LRTP's. These road widening projects came from several sources including metropolitan planning organizations, local governments and the public. They were screened by the study team so they would not conflict with LRTP projects and meet minimal cost effectiveness standards. Model results from this package of improvements will be used to refine the pool of proposed I-24 Corridor improvement projects in subsequent phases of plan development. Locations where these capacity improvement projects are proposed are displayed in Figure 3.4. Project descriptions and map reference ID numbers are embedded in the figure, as well. Twelve of the projects, 71%, are located in the south Davidson County and Rutherford County sector of metropolitan Nashville where future growth is expected to be robust. Two other proposed capacity enhancement projects off of I-24 are specified north of Nashville in Davidson County. There is one project in Clarksville subarea, a 20 mile widening of US-41A through Montgomery, Robertson and Cheatham counties. The last two proposed capacity enhancements are in Chattanooga.

System-wide performance of the 'Proposed Capacity Projects Off I-24' model scenario was evaluated against the 'E+C' or future year baseline model scenario over the entire I-24 Corridor's analysis area. Modeled results for the 'Proposed Capacity Projects Off I-24' scenario are presented in Table 3.3 by functional class group and subarea. Moreover, system-wide daily time savings benefiting motorists on all modeled roads in the I-24 Corridor are shown.

Modeled daily VMT of 121.2 million vehicle miles of travel in the 'Proposed Capacity Projects Off I-24' package of improvements netted 159,000 more vehicle miles than the grand total of generated by the 'E+C' condition over the entire analysis area. For perspective, the 159,000 gain in VMT represents a little over a 0.1% change in relation to total VMT for the entire I-24 Corridor. Daily VMT on all modeled roads in the analysis area exhibited increases across all three subareas.

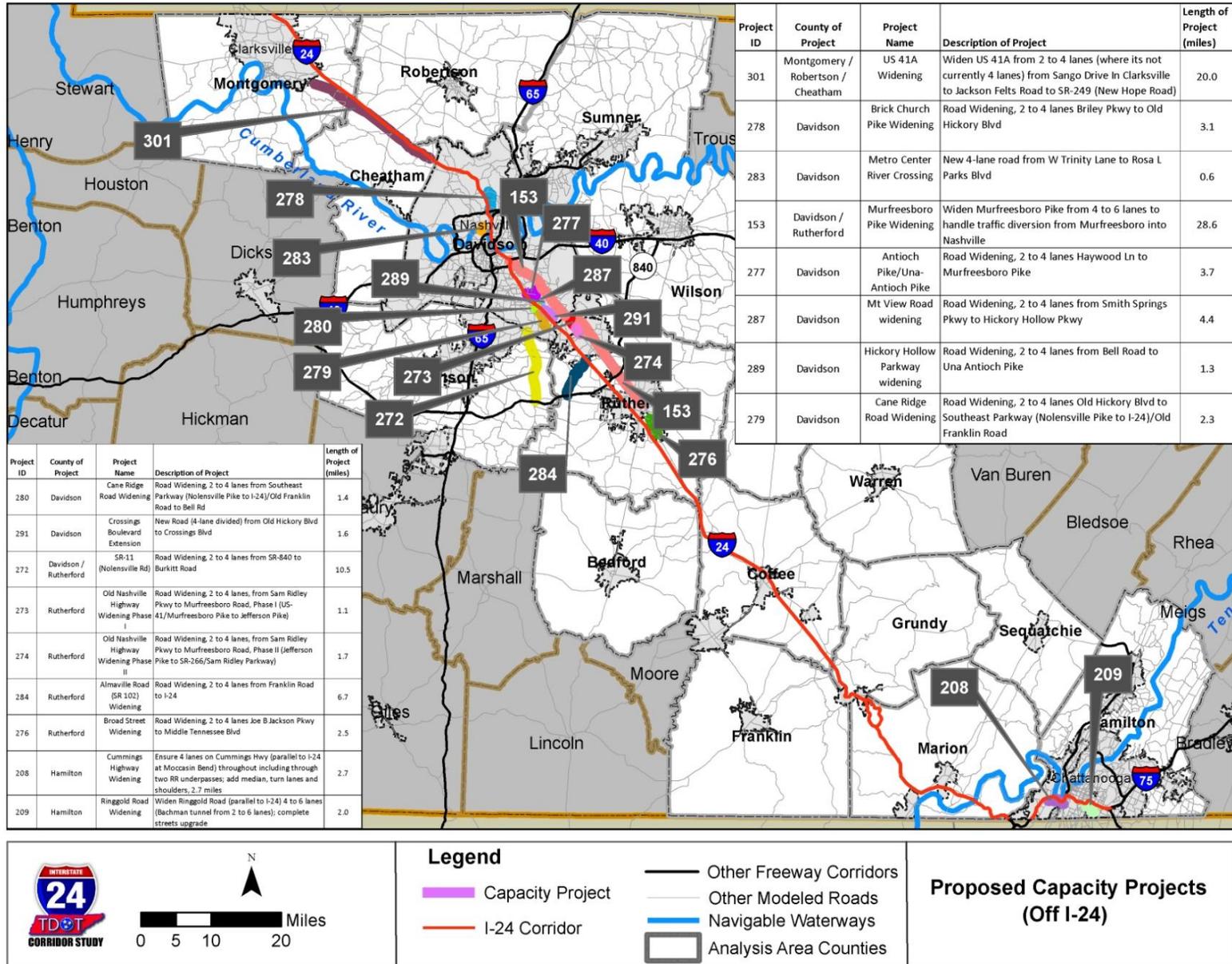
Table 3.3: Subarea Performance Measures for Proposed Capacity Projects Off I-24

Subarea	Facility	Model Scenario Performance			Daily Time Savings ¹
		Daily VMT (000's)	Daily VHT (000's)	Daily VHD (000's)	
Clarksville	Interstate	1,460	27	6	417
	Arterial	5,077	167	52	4,928
	Collector	2,136	60	11	370
	Total	8,674	254	68	5,715
Nashville	Interstate	21,549	652	315	39,965
	Arterial	42,814	1,598	656	52,546
	Collector	24,416	828	235	34,837
	Total	88,779	3,078	1,206	127,348
Chattanooga	Interstate	6,649	121	21	9
	Arterial	13,207	330	39	432
	Collector	3,907	103	9	(12)
	Total	23,763	554	69	429
Grand Total		121,215	3,886	1,343	133,492

Source: I-24 Corridor Travel Demand Model, Atkins

(1) In relation to the baseline E+C Model Scenario

Figure 3.4: Proposed Capacity Projects Off I-24



Corridor-wide daily VHT dropped by 127,000 hours in comparison with the 'E+C' model scenario. Modeled daily VHT from the 'Proposed Capacity Projects Off I-24' scenario was 3.9 million vehicle hours in comparison with slightly more than 4 million vehicle hours in the 'E+C'. At the subarea level of analysis, the largest relative decline in daily VHT was 3.8% in Nashville. Projected daily VHT in the Nashville subarea was 3.1 million hours for the 'Proposed Capacity Projects Off I-24' in comparison with 3.2 million hours in the 'E+C'.

Net delay due to congestion was reduced by 134,000 daily vehicle hours or 9% of corridor-wide by the 'Proposed Capacity Projects Off I-24' improvement package. Delay reductions were most prominent in the Nashville and Clarksville subareas where congestion delay dropped by almost 10% and 8%, respectively, in comparison with the 'E+C'.

Model results were used to assess the relative impact, in monetary terms, that each candidate project in the 'Proposed Capacity Projects Off I-24' package would have in relation to 'E+C' or baseline conditions. Annual dollar savings attributable to each I-24 capacity enhancement project are presented in Table 3.4. These dollar figures are based on future year 2040 modeled VMT, VHT and delay statistics that were accumulated from those sections of I-24 that were most influenced by each individual project. Monetary benefits from individual projects will be important parameters in developing the list of factors to screen and prioritize plan recommendations.

Annual dollar savings attributable to the 28.6 mile, 4-lane to 6-lane widening project on US-41/Murfreesboro Pike from Murfreesboro to SR-155/Briley Pkwy in Nashville, project 153, were the highest of all seventeen proposed capacity improvements. The estimated monetary benefits from this project amounted to \$92.4 million. The capacity improvements with the second and third highest benefits were project 272 and project 273 which are located on roads west of I-24 in south Davidson County and north Rutherford County.

Table 3.4: Project Performance Measures for Proposed Capacity Projects Off I-24

Project ID	Subarea	From Exit	To Exit	Daily Time Savings ¹ (hours)	Annual Dollar Savings ¹ (\$000's)
301	Clarksville	11	31	64	\$ 527.9
153	Nashville	52	81	11,359	\$ 92,417.9
272	Nashville	62	74	2,526	\$ 20,551.1
273	Nashville	64	66	2,263	\$ 18,411.1
274	Nashville	64	66	127	\$ 1,031.5
276	Nashville	81	84	209	\$ 1,704.2
277	Nashville	54	54	466	\$ 3,794.6
278	Nashville	40	43	131	\$ 1,063.2
279	Nashville	59	62	7	\$ 56.8
280	Nashville	59	62	352	\$ 2,865.0
283	Nashville	45	46	206	\$ 1,677.2
284	Nashville	70	74	621	\$ 5,049.8
287	Nashville	57	60	357	\$ 2,908.3
289	Nashville	57	59	138	\$ 1,123.5
291	Nashville	60	62	658	\$ 5,357.2
208	Chattanooga	175	178	98	\$ 594.5
209	Chattanooga	181	184	228	\$ 1,387.2
513	Chattanooga	152	158	376	\$ 2.5

Source: I-24 Corridor Travel Demand Model, Atkins

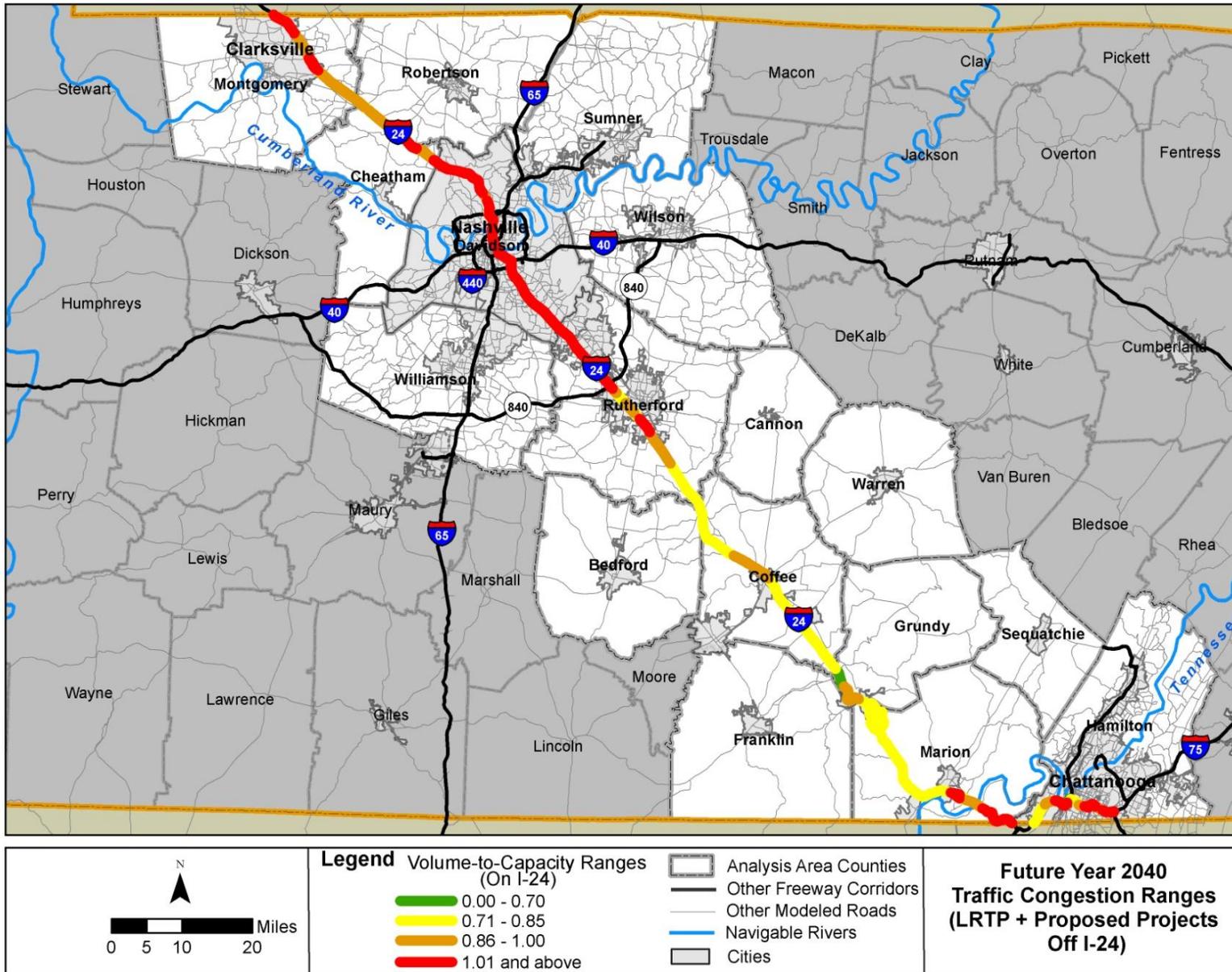
(1) In relation to the baseline E+C Model Scenario

Many of the proposed improvements to parallel roads were located in a sector of south Davidson County and north Rutherford County where a lot of future development is planned.

A section-level summary of forecasted traffic conditions on I-24, itself, for the future year 2040 'Proposed Capacity Projects Off I-24' package of projects is presented in Figure 3.5 using colored bands to represent four categories of congestion. Outside of metropolitan Nashville, there are intermittently spaced patches of dark red bands, indicating that volume-to-capacity ratios still exceed 1.0 in spite of the seventeen capacity projects off I-24. With a couple exceptions, the volume-to-capacity band colors follow a similar pattern to those produced in the 'E+C' scenario.

One difference shows up near Clarksville, on sections of I-24 south of SR-256 in Robertson County. The volume-to-capacity color band changes from red in the 'E+C' to orange in the 'Proposed Capacity Projects Off I-24' package of improvements. This change would be attributable to the 20 mile widening of US-41A, project 301. The second difference in comparison with the 'E+C' occurs south of Murfreesboro in Rutherford County. Again, a red colored band in the 'E+C', from Joe B Jackson to Epps Mill, changes to orange as a result of adding the proposed capacity improvements off I-24 to the model network.

Figure 3.5: Modeled 2040 Volume-to-Capacity Ratios (LRTP and Proposed Capacity Projects Off I-24)



3.2 Proposed Operational Projects and Strategies Evaluation

3.2.1 Proposed New Interstate Access

Five (5) new interchanges were proposed on I-24, in addition to the one already planned in the Nashville MPO's LRTP. Two are proposed in the Clarksville subarea and three in the greater Nashville subarea. These were proposed for further consideration in the process of formulating a plan for the I-24 Corridor. New interchanges are generally considered to be beneficial for economic development in the corridor. In terms of their impact on traffic operations, they tend to benefit local circulation patterns but can hinder through movements on the Interstate System since new interchanges oftentimes attract development and additional vehicle trips that otherwise would not use the Interstate. New interchange locations proposed for I-24 are displayed in Figure 3.6. Annual monetary benefits estimated for each individual new interchange project are presented in Table 3.5. Monetary benefits from individual interchange projects will be important factors used by the study team to screen and prioritize plan recommendations.

Table 3.5: Project Performance Measures for Proposed New Interstate Access

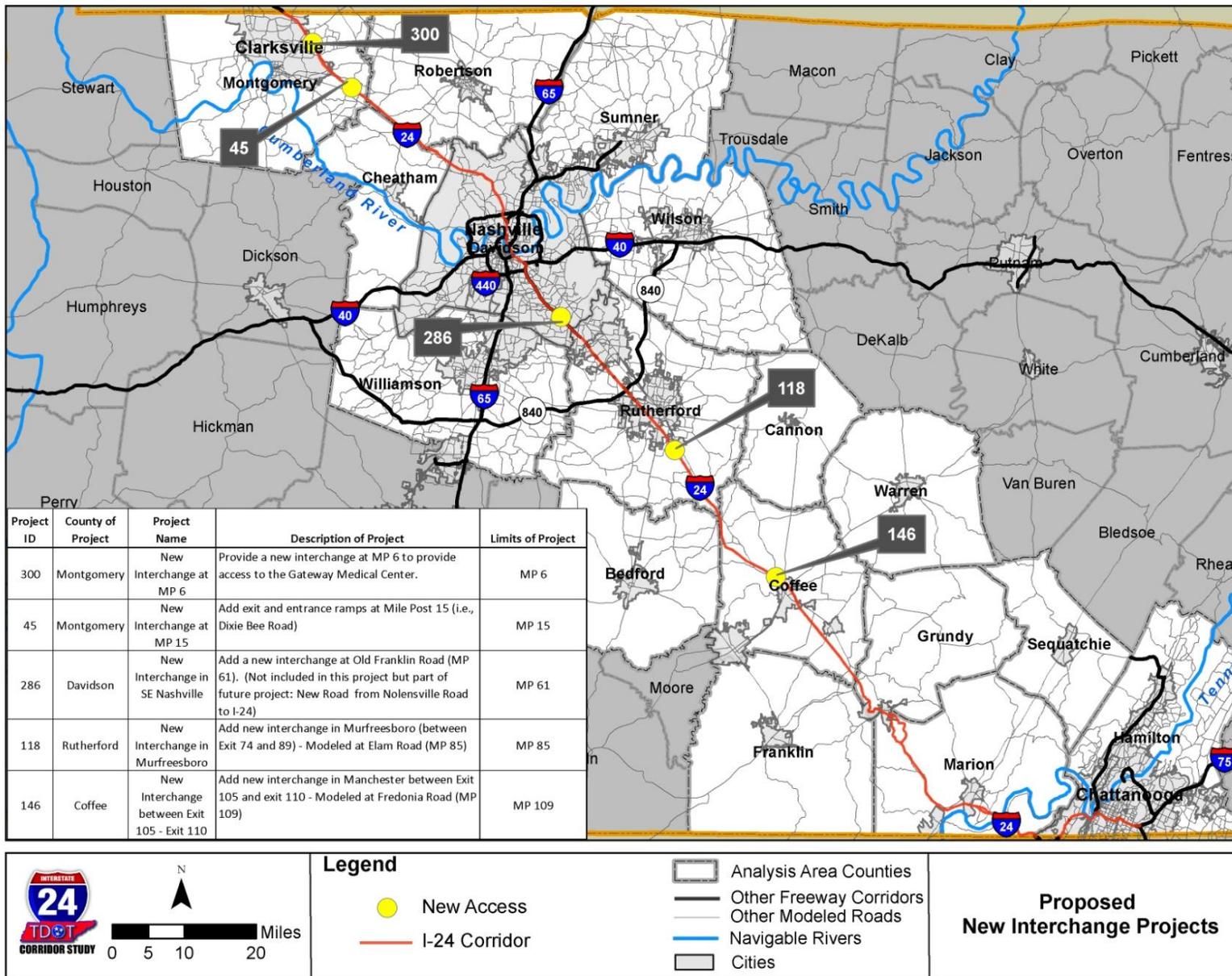
Project ID	Subarea	From Exit	To Exit	Daily Time Savings ¹ (hours)	Annual Dollar Savings ¹ (\$000's)
118	Nashville	74	89	370	\$ 2,775.0
146	Nashville	105	110	122	\$ 871.0
286	Nashville	60	62	2,362	\$ 18,126.0
45	Clarksville	11	19	(570)	\$ (5,510.0)
300	Clarksville	4	8	(620)	\$ (5,708.0)

Source: I-24 Corridor Travel Demand Model, Atkins

(1) In relation to the baseline E+C Model Scenario

Annual dollar savings attributable to the proposed new interchange at Old Franklin Road in south Davidson County, project 286, was clearly the highest of all five projects. The estimated monetary benefits from this project amounted to \$18.1 million. The next highest monetary benefit, \$2.8 million, is associated with the new interchange located between Joe B Jackson Parkway and Epps Mill Road in south Rutherford County. Neither of the proposed new interchanges in Montgomery County performed well. Estimated annual benefits for these two interchanges were less than the 'E+C' scenario.

Figure 3.6: Proposed New Interchange Projects



3.2.2 Proposed Interchange Modifications

Eight (8) interchange modification projects were proposed on I-24, in addition to the two already planned in LRTP's of metropolitan planning organizations in the corridor. Six are proposed in the Nashville subarea and two in the Chattanooga subarea. These interchange modifications are major capital investments that would be designed to address operational and safety issues. They are different from other proposed projects grouped into the operational improvements category, such as 'Ramp Improvement' or 'Bridge Improvement' projects. The locations where interchange modifications are proposed are displayed in Figure 3.7. Project ID numbers and project descriptions are shown in a table that is embedded into the figure. Two of the proposed modifications, project 211 and project 258, were essentially reconstruction and re-design projects with marginal operational benefits. These two modifications were not analyzed using the meso-scopic traffic model.

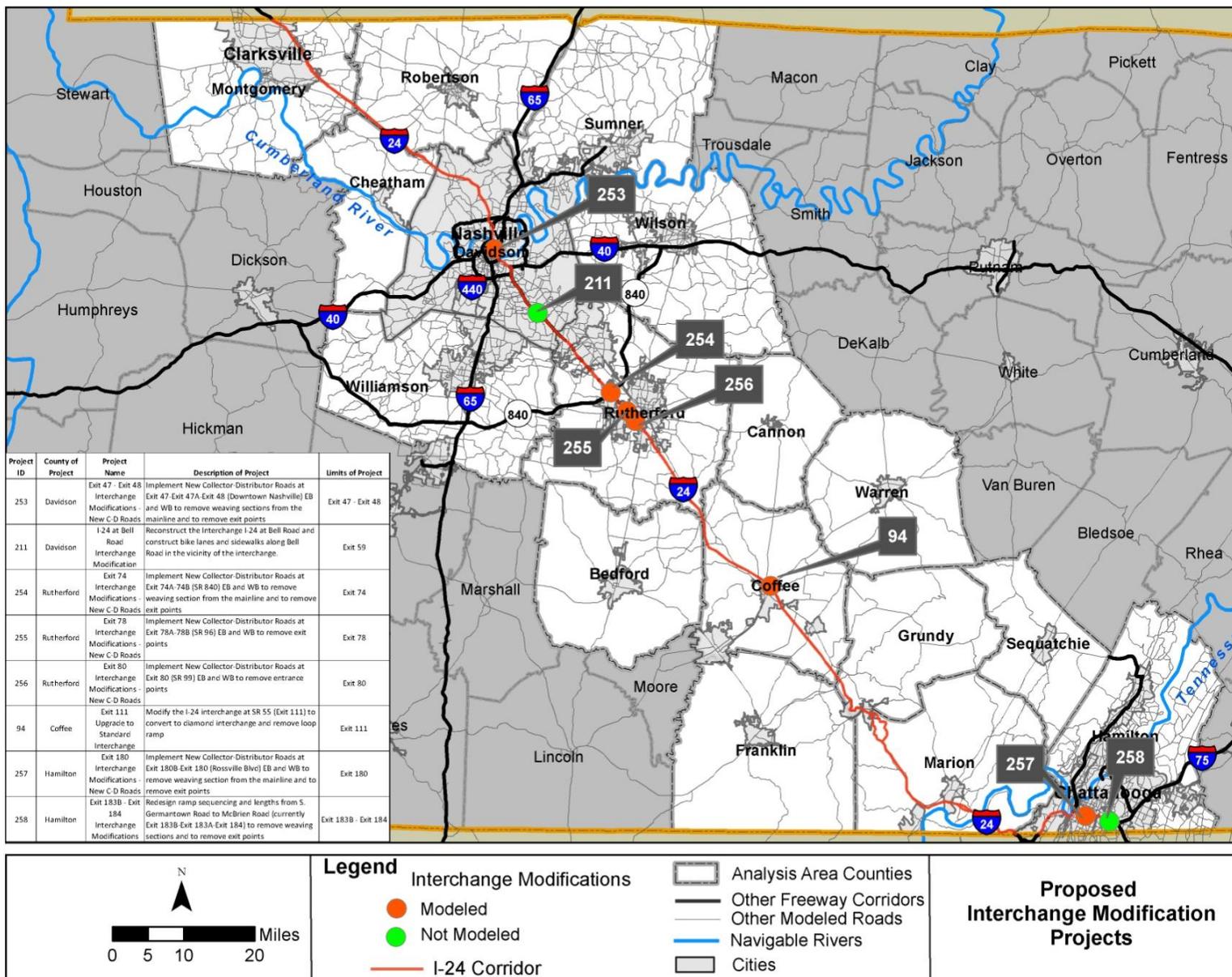
Traffic impacts anticipated from six of the proposed interchange modifications were evaluated using the meso-scopic model since the meso-scopic model is more sensitive than the macro-scopic model to impacts of operational improvements. Only delay reduction and net annual benefits in comparison with the 'E+C' were estimated. Annual monetary benefits estimated for each individual interchange modification are presented in Table 3.6. Monetary benefits from individual interchange modification projects will be important factors used by the study team to screen and prioritize plan recommendations.

Table 3.6: Project Performance Measures for Proposed Interchange Modifications

Project ID	Source	Subarea	Exit	Daily	Annual
				Time Savings ¹	Dollar Savings ¹ (\$000's)
94	Proposed	Nashville	111	324	\$ 160.8
253	Proposed	Nashville	47/48	(56,480)	\$ (20,982.7)
254	Proposed	Nashville	74	930	\$ 654.2
255	Proposed	Nashville	78	1,044	\$ 741.7
256	Proposed	Nashville	80	648	\$ 538.9
257	Proposed	Chattanooga	180	16,367	\$ 5,919.1

Source: I-24 Corridor Mesoscopic Model, Atkins
 (1) In relation to the baseline E+C Model Scenario

Figure 3.7: Proposed Interchange Modification Projects



Annual dollar savings attributable to the proposed modification with collector-distributor lanes at Rossville Blvd in Chattanooga, project 257, were clearly the highest of all six projects. The estimated monetary benefits from this project amounted to \$5.9 million. The next highest monetary benefit, \$0.7 million, is associated with project 255 which the interchange modification located at the SR-96/Old Fort interchange in Murfreesboro. After reviewing the model results for project 253 where daily time savings was negative in greater detail, the project team noticed that the proposed improvements significantly helped I-24 in the vicinity of Exits 47 and 48 in downtown Nashville but allowed additional traffic through this area that caused a “bottle-neck” further downstream which caused traffic to back-up in the Exit 47 and 48 area, which was reflected in the model results.

3.2.3 Proposed Ramp Improvements

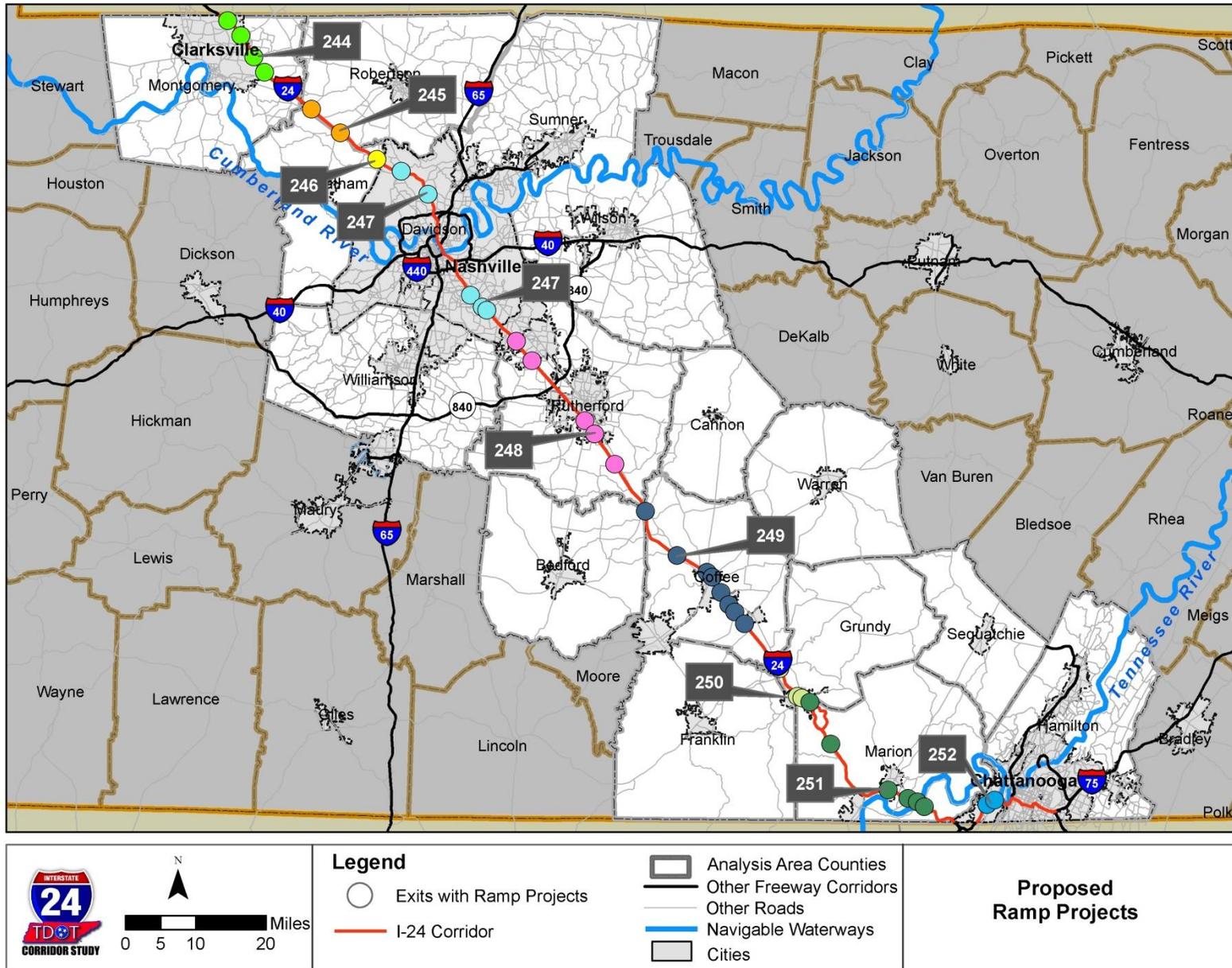
Technical analysis was completed to determine I-24 interchange ramps that were too short based on the ramp design speed, the existing ramp length, and the ramp vertical grade. Proposals to lengthen or redesign short ramps were based on Tables 10-3 and 10-5 of AASHTO – A Policy on Geometric Design of Highways Streets 2011. Generally speaking, existing short ramps that are recommended for lengthening were constructed based on old design standards. Lengthening short ramps will improve safety and operations on I-24 by allowing automobiles and trucks to attain the desired speed when merging with the I-24 mainline lanes from entrance ramps and also have sufficient distance to stop safely at the ramp termini on exit ramps. Comments from the public were also very helpful in confirming the location of short ramps.

Ramps that are proposed to be lengthened or redesigned were grouped by county for the purposes of this study. It is envisioned that a program to lengthen short ramps would be pursued on a county basis. The exit numbers and number of ramps that are proposed for lengthening are provided in Table 3.7 and also shown on Figure 3.8. A detailed summary of the specific ramps at each exit or rest stop that are proposed to be lengthened or redesigned is shown in Appendix E.

Table 3.7: Proposed Ramp Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project
244	Montgomery	Montgomery County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 1 (2 ramps), Exit 4 (2), Exit 8 (2), Exit 11 (2)	Exit 1 - Exit 11
245	Robertson	Robertson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 19 (2 ramps), Exit 24 (2)	Exit 19 - Exit 24
246	Cheatham	Cheatham County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 31 (2 ramps)	Exit 31
247	Davidson	Davidson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 35 (2 ramps), Exit 40 (2), Exit 57 (1), Exit 59 (4), Exit 60 (1)	Exit 35 - Exit 60
248	Rutherford	Rutherford County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 66 (1 ramp), Exit 70 (4), Exit 81 (2), Exit 84 (2), Exit 89 (4)	Exit 66 - Exit 89
249	Coffee	Coffee County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 97 (3 ramps), Exit 105 (3), Exit 110 (4), Exit 111 (4), Exit 114 (4), MP 116-Weigh Station (4), Exit 117 (4), MP 119-Truck Rest Area (4)	Exit 97 - MP 119
250	Grundy	Grundy County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 127 (4 ramps), MP 133-Rest Area (3), Exit 134 (3)	Exit 127 - Exit 134
251	Marion	Marion County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 135 (4 ramps), Exit 143 (4), Exit 155 (2), Exit 158 (4), MP 159-Welcome Center (4), Exit 161 (3)	Exit 135 - Exit 161
252	Hamilton	Hamilton County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 174 (4 ramps), Exit 175 (1)	Exit 174 - Exit 175

Figure 3.8: Proposed Ramp Improvements



3.2.4 Proposed ITS Improvements

3.2.4.1 Intelligent Transportation Systems

The I-24 Corridor currently has urban ITS deployments in the cities of Chattanooga, Murfreesboro, and Nashville. Along with the current deployments, TDOT is constructing the I-24 expansion of the Nashville Smartway system towards SR-840 and Murfreesboro. Also, TDOT has let for construction the rural ITS deployment along the Monteagle Mountain section of the corridor.

Based on the feedback obtained from the public, the Project Advisory Committee and review of the corridor by the project team, a list of proposed ITS projects and strategies were identified. The following sections will provide more detail on these proposed projects and strategies. The expansion of the existing urban deployments and the construction of rural deployments will provide both congestion and safety benefits to the I-24 corridor.

3.2.4.2 Corridor Recommendations

The ITS recommendations for the I-24 Corridor are divided into three categories:

- (1) Entire Corridor – projects or strategies that extend throughout the study corridor
- (2) Urban Areas – project or strategies that are located within the urbanized areas of Clarksville, Nashville, Murfreesboro or Chattanooga
- (3) Rural Areas – projects or strategies that are located in the rural areas of the study corridor such as Monteagle Mountain

The proposed ITS improvements are listed in Table 3.8 and are also shown in Figure 3.9.

3.2.4.3 Entire Corridor

As a way to gain travelers attention and provide traveler information for the roadway network, additional “Dial *511” signs should be installed throughout the study corridor. These signs should be installed at regular intervals (every 5-8 miles) throughout the rural areas.

Another corridor strategy identified during the initial stages of the study is the installation of additional dynamic message signs (DMS) throughout the study corridor to provide traveler information. Instead of making this an “entire corridor” strategy, specific DMS locations are identified in the following sections.

3.2.4.4 Urban Areas

The urban ITS deployments in the Chattanooga and Nashville regions already include roadway traffic sensors, closed-circuit television (CCTV) cameras, DMS, weather monitoring devices, highway advisory radio (HAR), and service patrols. The ITS strategies identified during this study and considered for these urban areas include variable speed limit (VSL) , road weather

information system (RWIS) and ramp metering. Each of these types of deployments will require additional software at the regional traffic management center (TMC).

VSL systems are a type of ITS that uses traffic detection data (speed, volume and occupancy), weather information and road surface condition technology to determine appropriate speeds at which drivers should be traveling. Most motorists tend to drive as fast as conditions allow until congestion arises, which can result in abrupt slowdown or stops, which creates a breakdown in the flow of traffic. VSL systems lower the posted speeds as the density increases in an attempt to prevent or delay the breakdown in traffic flow. Along with reducing the negative effects of congestion, the safety benefits associated with VSL systems include reducing the abrupt slowdowns in speed which can cause primary incidents and also by reducing the speeds in advance of these primary incidents and slow-downs the system helps decrease the frequency and severity of secondary crashes.

Ramp metering systems are a type of ITS that use mainline traffic conditions to “meter” traffic from the surface street onto the interstate system. The use of ramp metering along interstate corridors enable motorists to merge more easily into the mainline traffic flow, allows the mainline to flow at a more consistent rate of travel (i.e. reduce the amount of stop-and-go conditions due to friction from entering vehicles), mainline motorists experience fewer backups and incidents are reduced due to each of congestion benefits.

For these strategies, there are several urban segments within the I-24 corridor that may benefit (congestion and safety) from these strategies; however a ramp metering study and a VSL study should be conducted to identify the limits of the segments, identify the overall benefits, and to prioritize those segments for deployment. Potential segments (actual deployment segments and limits to be determined by further study) include:

- **Ramp Metering** - Davidson/Rutherford Counties - Westbound between Exit 66 (Sam Ridley Parkway) and Exit 56 (Harding Place);
- **Ramp Metering** - Rutherford County - Westbound between Exit 81 (S. Church Street) and Exit 76 (Medical Center Parkway)
- **Ramp Metering** – Hamilton County – Eastbound between Exit 174 (Lee Highway) and Exit 175 (Browns Ferry Road)
- **VSL with RWIS** – Hamilton County – Westbound/Eastbound between Exit 185 (I-75) and Exit 174 (Lee Highway)
- **Ramp Metering** – Hamilton County – Westbound between Exit 184 (S. Moore Road) and Exit 183 (S. Germantown Road)

NOTE: Some of these segments are on the boundary of the existing TDOT Smartway systems; therefore they were identified as part of the urban area recommendations. Also, the actual limits of these segments should be determined through a detailed ramp metering or VSL study.

Within the urbanized areas, the I-24 corridor carries significantly high traffic volumes. During typical peak periods, the traffic volumes on many of the urban segments of I-24 begin to approach a volume-to-capacity ratio equal to 1.0. Also, if an incident occurs that restricts traffic flow by closing a lane or entirely closes the roadway, many of the travelers begin to seek alternate routes.

Within the Nashville urbanized area, this is particularly true on the segment of I-24 between Exit 52 in Davidson County and Exit 78 in Rutherford County. When this occurs, traffic diverts from I-24 onto State Route 1 (US Highway 41/70S, Murfreesboro Pike). This arterial is not designed to handle the high volume of diverted traffic, so gridlock typically occurs. Therefore, the State Route 1 (US Highway 41/70S, Murfreesboro Pike) corridor should be implemented with ITS technologies and an incident management plan developed to mitigate the diverted traffic from I-24. These technologies may include CCTV, traffic signal coordination/diversion timing plans, communications, detection devices and arterial DMS. The communication protocols with adjoining agencies and TDOT should be identified as part of an incident management plan.

With respect to this portion of I-24 located in southeast Nashville, a grant application for an Integrated Corridor Management (ICM) program was submitted by TDOT to FHWA in January 2014. If granted, the proposed ICM program would focus on I-24 beginning at Rutherford County at the Elam Road overpass and ending in Davidson County at I-440, totaling about 28 miles. TDOT is requesting federal funds through the ICM Deployment Planning Program to enhance the development and management of the I-24 Corridor and to build upon the existing deployed infrastructure. With the potential ICM program, the various partner agencies will manage the I-24 Corridor as a system rather than the current approach of managing individual assets. With the potential ICM program, stakeholders will also work together to improve travel time reliability and predictability, help manage congestion, and empower travelers through better information and more choices.

TDOT also has formed a Transportation Systems Management and Operations (TSMO) committee. This committee helps plan and implement innovative systems, potentially such as the projects recommended in this section, that will improve travel times and reduce congestion throughout the state.

3.2.4.5 Rural Areas

Through the project identification stage, several potential rural ITS projects were identified. These included such projects installation of DMS and installation of VSL. Based on the review of the existing conditions data (crash data, geometrics, traffic volumes, etc.) several locations were identified for potential rural ITS deployments.

For the segment of I-24 between Clarksville (Exit 11) and Joelton (Exit 35), due to the lack of diversion routes parallel to I-24 and the high crash locations near Exit 24 and between Exit 35 and 40, consideration was given for a potential deployment of ITS devices. Based on the

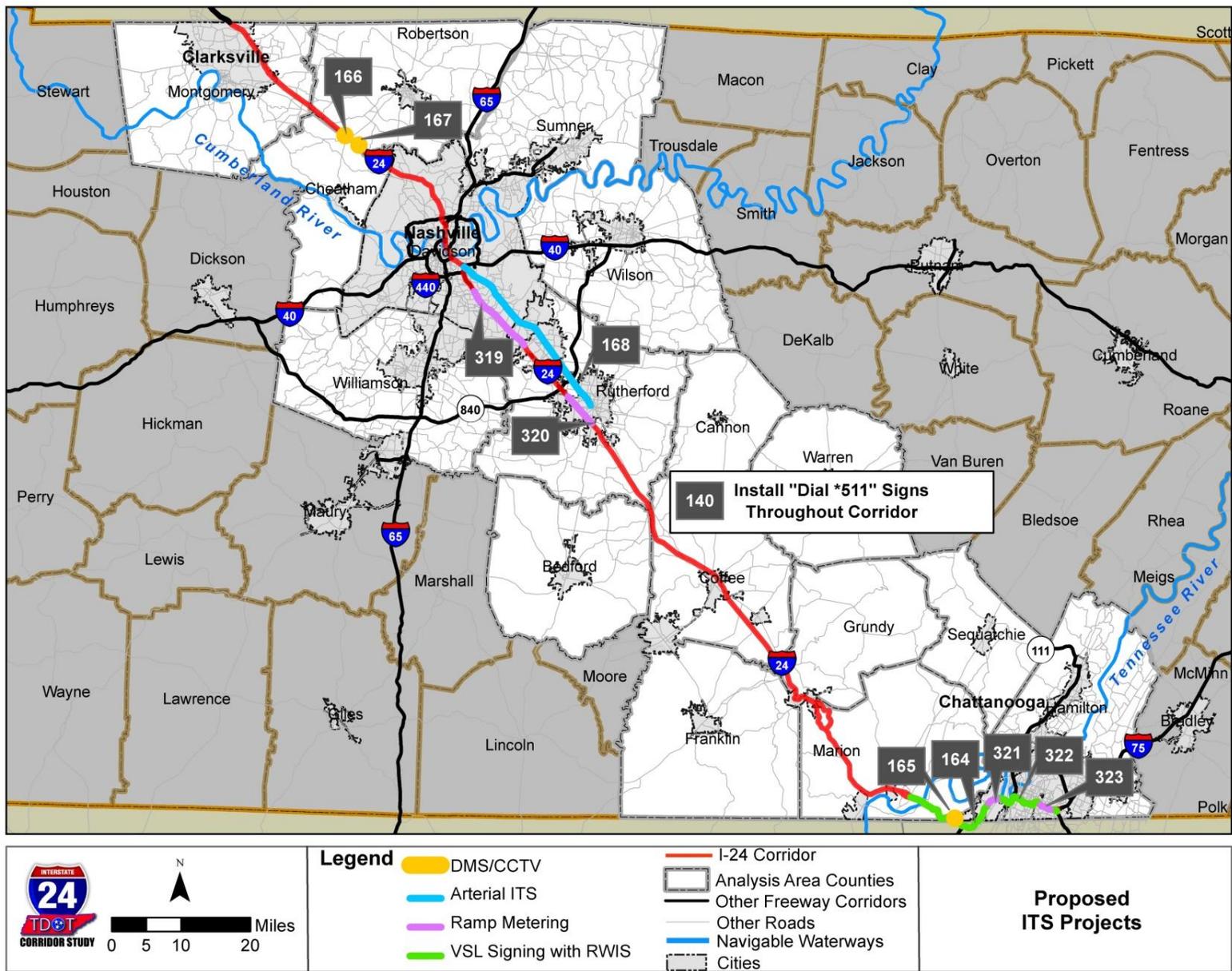
roadway network and the collected data, a DMS and a CCTV (with communications to the Region 3 TMC) should be deployed for the eastbound direction of I-24 approximately one mile in advance of Exit 24 (State Route 49). Also, a DMS and a CCTV (with communications to the Region 3 TMC) should be deployed for the westbound direction of I-24 approximately one mile in advance of Exit 24 (State Route 49).

The rural segment between the Nickajack Lake Bridge and the Georgia state line was brought up several times during the initial stages of the study. This segment has areas where the vertical and horizontal curvatures are difficult to maneuver especially during adverse weather conditions. Based on the information obtained during the data collection phase, this segment was identified for potential ITS deployment. The ITS deployment should include the installation of a westbound DMS and a CCTV (with communications to the Region 2 TMC) just on west/north of the Tennessee/Georgia state line (approximately mile marker 166) and VSL (both directions) between Exit 158 and Exit 174.

Table 3.8: Proposed ITS Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project
140	All Counties	Install "Dial *511" Signs	Install "Dial *511" signs throughout corridor	Entire I-24 Corridor
166	Robertson	MP 23 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 23 (EB) (approximately)	MP 23
167	Robertson	MP 25 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 25 (WB) (approximately)	MP 25
168	Davidson / Rutherford	SR 1 Arterial ITS	Install arterial ITS instrumentation and communications on SR 1 between I-440 interchange and SR 96 (Murfreesboro)	Exit 52 - Exit 78
319	Davidson / Rutherford	Exit 66 - Exit 56 Ramp Metering	Install ramp metering components and system software from Exit 66 to Exit 56 (8 ramps)	Exit 66 - Exit 56
320	Rutherford	Exit 81 - Exit 76 Ramp Metering	Install ramp metering components and system software from Exit 81 to Exit 76	Exit 81 - Exit 76
164	Marion / Hamilton	Exit 158 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 158 to Exit 174	Exit 158 - Exit 174
165	Marion	MP 166 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 166 (WB) (approximately)	MP 166
321	Hamilton	Exit 174 - Exit 175 Ramp Metering	Install ramp metering components and system software from Exit 174 to Exit 175	Exit 174 - Exit 175
322	Hamilton	Exit 185 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 185 to Exit 174	Exit 185 - Exit 174
323	Hamilton	Exit 184 - Exit 183 Ramp Metering	Install ramp metering components and system software from Exit 184 to Exit 183	Exit 184 - Exit 183

Figure 3.9: Proposed ITS Improvements



3.2.5 Proposed Transit & Park-and-Ride Lot Facilities Strategies

3.2.5.1 Current Corridor Transit Operations

There are existing transit operations within each of the three corridor analysis areas. The transit operations that influence the level of mobility on I-24 are primarily those that operate directly on I-24 or on adjacent roads and rights-of-way. Express buses currently run from Clarksville to Nashville, Springfield to Nashville, Murfreesboro to Nashville, and from suburban Chattanooga into downtown Chattanooga; all on I-24 or along parallel facilities. These existing Express Bus Routes are shown in Figure 3.10.

Transit operations provide mobility for those without cars or without ready access to cars, or who are unable to drive and alternatives to those with cars particularly when they provide offsets to the costs of driving a car in terms of either direct costs (i.e. gas, parking, insurance) or time (reduced travel time or increased productive or leisure time in transit) or some combination of the two. In addition they may provide societal benefits in terms of reduced pollutant emissions, less energy use, increased access to employment and basic services, and potentially the ability to minimize or obviate the need for a car. Express bus services typically work in tandem with park-and-ride (P&R) lots that allow commuters to park their vehicle while using the transit service. Existing P&R Lots are also shown in Figure 3.10.

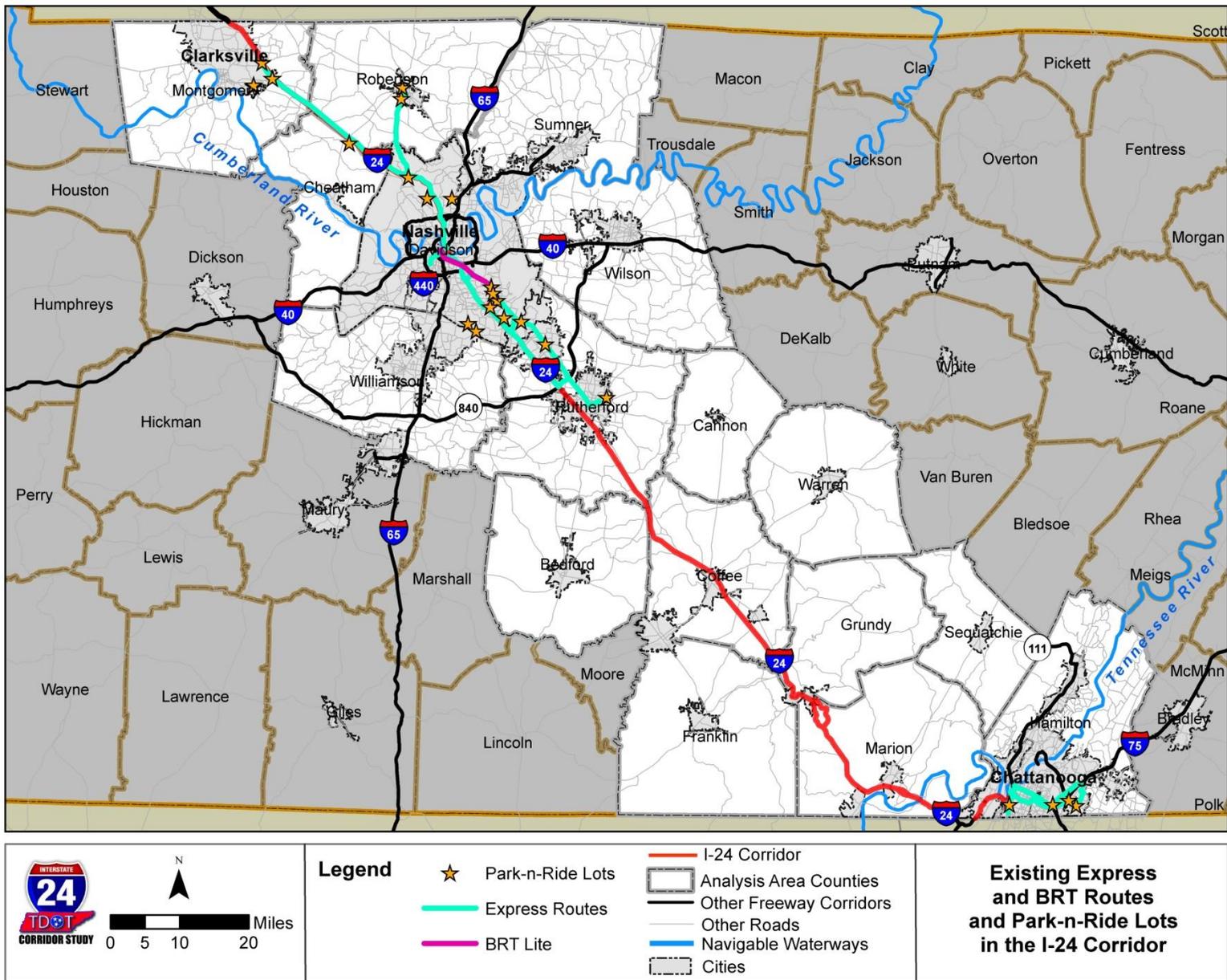
Nashville

The Middle Tennessee RTA operates three routes from Murfreesboro to Nashville: route 84X Murfreesboro Express on I-24 using the HOV system, route 96X Nashville/Murfreesboro Relax and Ride on US-41/ Murfreesboro Pike, and route 86X, the Smyrna/LaVergne Express which uses a combination of US-41 and the I-24 HOV system. The Middle Tennessee RTA operates one route from Clarksville to Nashville, the route 94X Clarksville Express on I-24. The Middle Tennessee RTA also operates the Springfield/Joelton Express, route 89X, from Springfield to Nashville which operates on US-431 and I-24.

Express bus fare on the Middle Tennessee RTA routes is \$4/trip or users can purchase a 20 trip pass for \$75. Connecting transit service to destinations in the Nashville metropolitan area is provided by the Nashville MTA.

Route 84X stops at P&R lots at the James Union Building located at the Middle Tennessee State University (MTSU) and the North Boulevard Church of Christ in Murfreesboro. Route 84X makes three a.m. weekday inbound runs to Nashville and three p.m. outbound runs to Murfreesboro. Inbound travel times between MTSU and the Nashville Greyhound Bus Station, the terminal stop after Music City Central, are from 80 to 100 minutes duration depending on time of departure.

Figure 3.10: Existing Transit and Park-and-Ride Lot Facilities



Route 86X stops at P&R lots at the Smyrna Kmart and the LaVergne Kroger. Route 86X makes three a.m. weekday inbound runs to Nashville and three p.m. outbound runs to Smyrna/LaVergne. Inbound travel times between the Smyrna Kmart P&R lot and the Nashville Greyhound Bus Station, the terminal stop after Music City Central, are approximately 75 minutes in duration.

Route 96X stops at P&R lots at the James Union Building (MTSU), the Smyrna Kmart and the LaVergne Kroger. Route 96X operates as closed door express from Bell Road to downtown Nashville only stopping to drop off passengers. Route 96X makes ten inbound runs to Nashville and nine outbound runs to Murfreesboro each weekday. Inbound travel times between MTSU and the Nashville Greyhound Bus Station, the terminal stop after Music City Central, are approximately 100 minutes.

A new Nashville MTA service, the 55 Murfreesboro Pike Bus Rapid Transit (BRT) lite, running from downtown Nashville to the Antioch area near the Global Mall at the Crossings (Bell Road/SR254 and I-24) started in 2013. Route 55 has 15 minute headways during peak periods and takes approximately 50 minutes to go from the Hickory Hollow P&R lot (near the mall) to Music City Central in downtown Nashville. The fare is \$1.70 per trip with multi-trip tickets and passes sold at a discount.

The Nashville MTA also operates BRT lite in the northeast corridor between Rivergate and Music City Central in downtown Nashville which crosses over I-24, and has plans for a new BRT service called the AMP which will connect east and west Nashville, also crossing over I-24.

Data provided by the Middle Tennessee Rural Planning Organization show daily human resource and rural transit trips from Cheatham County to both Nashville and Clarksville that potentially eliminate some vehicle trips from I-24.

Clarksville

The route 94X Clarksville Express operates on I-24 between Clarksville and Nashville. There is a longer range concept plan to develop commuter rail in an abandoned rail corridor, which currently is partially developed into a bicycle/mixed use trail, that parallels I-24¹ to the west. The Clarksville Transit System (CTS) provides connecting bus service from downtown Clarksville to the (I-24) Exit 8 P&R lot.

The 94X route stops at the Exit 8 Rossvie Road and Exit 24 Pleasant View P&R lots. In total, these P&R lots provide 230 spaces on paved, lighted lots. There are three buses outbound to Nashville on weekday mornings and one bus inbound from Nashville. In the evening there are three inbound buses from Nashville to Clarksville and one outbound bus from Clarksville to Nashville. The a.m. outbound Nashville buses take 51 minutes from the Exit 8 P&R lot to their

¹ Clarksville Area MPO 2035 Metropolitan Transportation Plan, March 2010, Nashville MPO 2035 Regional Transportation Plan, December 2010, and Initial Feasibility Study Commuter Rail Nashville, TN to Clarksville, TN, November 2008, CSR Engineering

destination at Music City Central. The a.m. inbound bus to Clarksville from Nashville takes 57 minutes from Music City Central to the I-24 Exit 8 Rossvie Road P&R lot.

It should be noted that the I-24 Exit 8 Rossvie Road P&R lot may need to be relocated in order to expand the size of the lot to accommodate more parking spaces in the future.

In addition to express bus services, there are fourteen current van pools and numerous carpools and informal ridesharing between Clarksville and Nashville each weekday.

Chattanooga

The Chattanooga Area Regional Transit Authority (ARTA) provides express bus service to downtown in the I-24 corridor on Route 4 Eastgate/Hamilton, and crossing I-24 into downtown Chattanooga on Route 15 St. Elmo Avenue.

Route 4 stops at the Brainerd Bi-Lo and Concord Baptist P&R lots. Route 4 runs regularly scheduled local service throughout the day but makes two a.m. inbound express trips and two p.m. outbound express trips. The inbound a.m. express trip takes approximately 50 minutes to go from the Hamilton Place Mall to 4th Street and Market Street.

Route 15 stops at the Lookout Mountain Incline Railway P&R lot. Route 15 runs as scheduled local service from 5:30 a.m. until 6:30 p.m. on weekdays with reduced service on Saturdays. Inbound service to downtown takes approximately 20 minutes to go from 56th Street and St. Elmo Avenue to 6th Street and Broad Street in downtown Chattanooga.

3.2.5.2 Public Comments on Transit

A number of comments received from the public favored new or enhanced transit service as a means of improving mobility within the I-24 corridor. Specifically mentioned transit improvements included: commuter rail between Clarksville and Nashville, passenger rail between Nashville and Chattanooga, BRT and/or express bus service on I-24 with stops at Exits 59 and 60, shuttle service from Smyrna and LaVergne to the downtown Nashville government center and Westside business complexes, express bus service from Lookout Valley and downtown Chattanooga using I-24, and express bus between Murfreesboro and downtown Nashville using the shoulders on I-24.

The public also favored new or improved P&R lots as an adjunct to improved transit service and HOV or managed lanes. Specific P&R improvements were mentioned by the public for Clarksville and Murfreesboro, with a new P&R lot desired for Cool Springs. In Nashville, a suggestion was made to provide free taxi vouchers for use within the downtown for those using P&R and transit.

3.2.5.3 MPO Planned Projects

Clarksville

The 2035 Clarksville Area Metropolitan (CAMPO) LRTP notes the high utilization of existing P&R lots and existing census data that show more than 5,000 commuters between the two regions. Although the plan does not include specific P&R projects, it mentions their encouragement as a way to increase mobility and as a way to reduce greenhouse gas emissions. In discussing public comments on the LRTP, CAMPO notes the need to improve access by transit to P&R lots, the desire for commuter rail service to Nashville, and the need to increase the use of bus and other alternative transport modes. The LRTP supports continued evaluation of commuter rail service between Clarksville and Nashville.

Nashville

The long range vision for regional transit is incorporated in the 2035 Nashville Area MPO RTP. It identifies seven regional corridors serving the Nashville region. It calls for future rapid transit – either light rail or BRT -- in the northeast, southeast and south regional corridors, with transition from short-term express bus service and mid-term BRT with reevaluation of fixed guideway transit service within the next 5 to 10 years. The southeast regional corridor is from Nashville to Murfreesboro and includes I-24 and Murfreesboro Pike. The plan specifically mentions development of a 100 space P&R lot at Medical Center Parkway and I-24. The 2035 RTP also supports development of commuter rail between Nashville and Clarksville. The Nashville Area MPO is currently conducting the Southeast Area Transportation and Land Use Study which will produce multimodal transportation recommendations in addition to a preferred vision of growth and development, land use recommendations, and a growth management toolbox.

Chattanooga

The Chattanooga Transportation Planning Organization (TPO) 2035 LRTP has development of transit as a goal for making the region's transportation system more sustainable, and in conjunction with policies that favor the complete streets concept. There are a number of rail proposals including development of passenger rail to Atlanta, and the potential for a light rail system using old freight rail rights of way between Chattanooga and Cleveland, Tennessee. However there are no specific transit improvements, only further study and anticipated expansion. There are a number of potential complete streets projects that include transit elements but these may be roads that include existing transit service. The LRTP discusses the importance of P&R facilities but makes no location specific recommendations.

3.2.5.4 Analysis of Existing Transit and Park-n-Ride Service

Existing transit services in the I-24 corridor help to provide mobility options and reduce peak congestion on I-24 in the more urban sections. Supplementing existing transit services may be critical to maintaining mobility and easing congestion particularly in those areas where it is cost prohibitive or unfeasible to widen I-24. There may be opportunities to improve transit operations within the I-24 corridor by improving enforcement, access to and operations on the

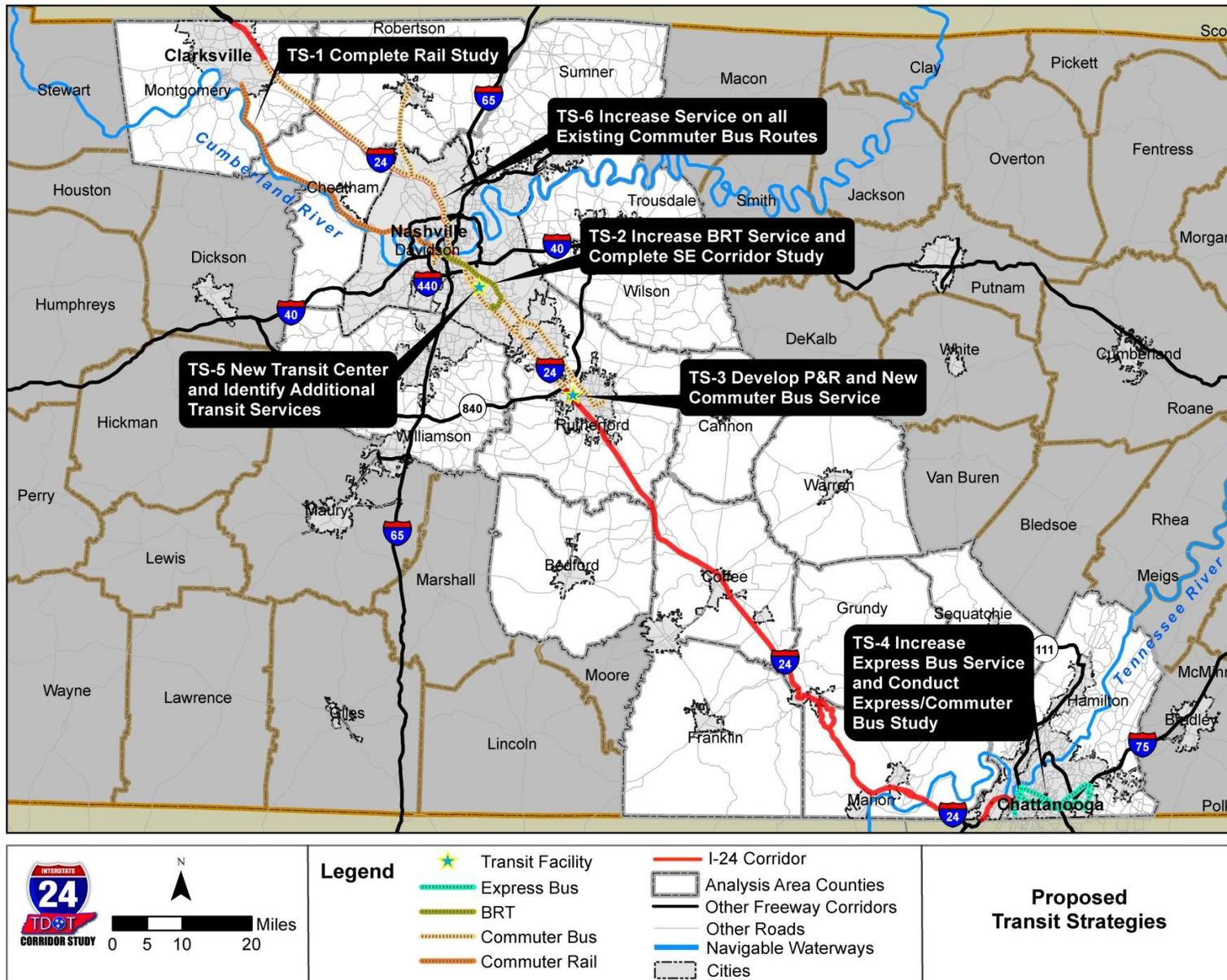
I-24 HOV system, and through implementation of complementary Intelligent Transportation Systems (ITS) improvements.

3.2.5.5 *Transit Strategies*

A number of transit and Park-and-Ride (P&R) Lot strategies were identified from existing plans or assessment of corridor conditions that may benefit operations of the I-24 Corridor in addition to providing mobility and access benefits. It should be noted that this study did not forecast transit ridership or perform detailed transit alternatives analyses. However, the I-24 Study does site in its proposed strategies past or current studies in the I-24 Corridor that are performing transit ridership forecasts using transit models and performing transit alternatives analyses. The proposed strategies for the I-24 Corridor are listed below and those that are able to be mapped are also shown graphically on Figure 3.11. 'TS' represents 'Transit Strategy' in the list below and on Figure 3.11.

- TS-1 Complete New Starts Assessment of Commuter Rail from Clarksville to Nashville.
- TS-2 Increase BRT Service on MTA Route #55 and complete the Southeast Area Transportation and Land Use Study to determine long range transit preferred alternative and FTA New Starts potential.
- TS-3 Develop a P&R Lot with associated express bus service at I-24 Exit 76, Medical Center Parkway/Fortress Boulevard.
- TS-4 Increase service on existing CARTA express bus routes and conduct an Express/Commuter Bus Study to identify additional routes.
- TS-5 Evaluate transit center near the terminus of existing HOV system at Harding Place in Nashville and options to provide increased transit service between Harding Place and downtown Nashville.
- TS-6 Increase Express Transit Services between Clarksville and Nashville, and Murfreesboro and Nashville during peak periods.
- TS-7 Evaluate ramp volumes for potential new P&R lots to serve Express Transit Routes. (Included in this evaluation should be a determination if the Exit 8 P&R lot needs to be relocated in order to accommodate the need for future growth.)
- TS-8 Evaluate options to provide exclusive access/egress for transit to the HOV system.
- TS-9 Consider transit operations on I-24 shoulders during peak hours in selected locations.
- TS-10 Support and promote paratransit and rural transit systems in the Nashville area.
- TS-11 Support and promote additional vanpool services in the Nashville area.

Figure 3.11: Proposed Transit Strategies



3.2.6 Proposed Managed Lanes Strategies

3.2.6.1 Managed Lanes

Managed lanes are highway lanes in which the use can be restricted to certain types of vehicles and/or vehicles paying a toll. High Occupancy Vehicle (HOV) lanes are a type of managed lane as are High Occupancy Toll (HOT) lanes. The idea is that the capacity of some lanes can be managed via restrictions on eligibility or pricing to improve overall road capacity by providing incentive to carpools or transit, or other fuel efficient vehicles, and/or to provide premium service to those who are willing to pay for comparatively higher speeds during congested periods than in the general purpose travel lanes. Lanes can be managed through vehicle eligibility, access control, and pricing.

Managed lanes are frequently access restricted in order to provide controls over access and egress to specific vehicles. Managed lane systems are sometimes barrier separated or have separate access and egress points than the general purpose travel lanes, at times including their own interchange ramps. Managed lanes can be used to provide right of way for premium transit service such as bus rapid transit (BRT), or to restrict trucks to provide a higher level of service for cars. The system of lane management can change during the course of the day such that restrictions or pricing may only apply during peak periods when there is heavy congestion. In some instances managed lanes are reversed diurnally to provide additional capacity in the peak direction of flow. HOV and other managed lane systems sometimes allow use by motorcycles or alternative fuel vehicles to promote fuel efficiency and reduced emissions.

3.2.6.2 Current Corridor Lane Management

The I-24 HOV system is approximately 50 miles in length, for the combined mileage of the northbound and southbound lanes, and is shown in Figure 3.11. The I-24 HOV system runs from US-231 in Rutherford County to Harding Place in Davidson County, approximately 8 miles south of downtown Nashville. The HOV lanes are signed and striped but not barrier separated from the general travel lanes on I-24. The current I-24 HOV lanes do not have separate access or egress from the general travel lanes. The Nashville area HOV system including the I-24 HOV and park-n-ride lots within the I-24 corridor is shown in Figure 3.12. There are no HOV lanes in either the Clarksville or Chattanooga metropolitan areas.

3.2.6.3 Public Comments on Managed Lanes

A majority of public comments (23) received regarding the I-24 HOV lanes were in favor of eliminating the HOV requirement between downtown Nashville and Murfreesboro. There were suggestions to add reversible HOV lanes through Nashville, to add contra flow lanes, and to extend the hours of the I-24 HOV lanes. There was one public comment in favor of designating HOV lanes in the Chattanooga area.

3.2.6.4 MPO Planned Projects

Nashville

The Nashville Area MPO has projects to add HOV ramps to I-24 at Shelby Avenue (Exit 49) and at North 1st Street (Exit 47). Currently there is no HOV facility on I-24 in this location but the HOV ramps may serve as a queue bypass to provide a time incentive to carpools and transit accessing downtown Nashville.

3.2.6.5 Analysis of Existing HOV System

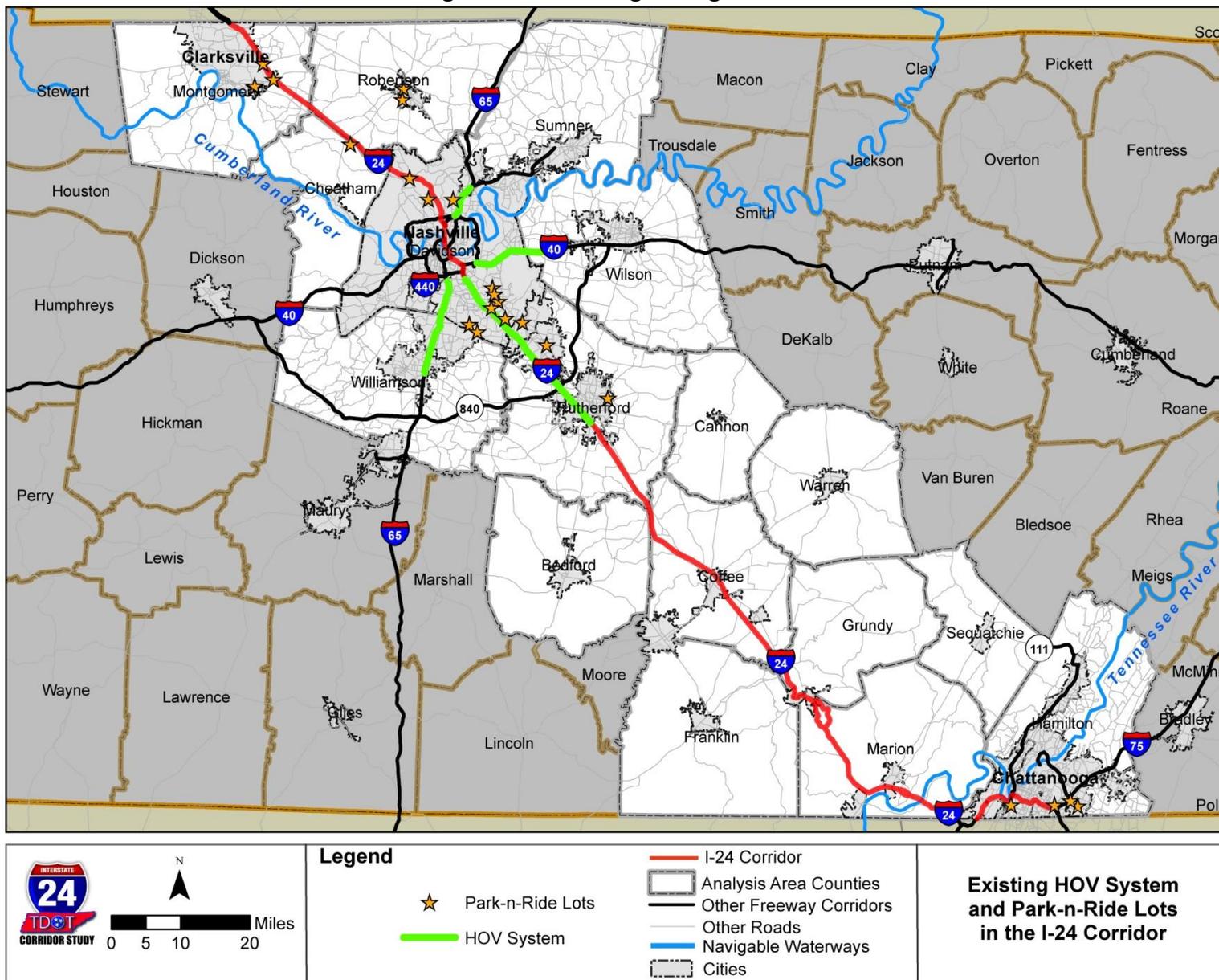
The current HOV system on I-24 is not well enforced. Managed Lanes in Tennessee² includes an exhibit (Figure 3-1) that shows that checks on the HOV lanes during July and August 2012 found more SOVs during peak periods than HOVs in both Nashville and Memphis. There is a need for more vigorous enforcement of HOV occupancy restrictions in order for the lanes to function effectively. Currently, the I-24 HOV system stops approximately 8 miles south of downtown Nashville at Harding Place where the northbound HOV lane becomes a general purpose travel lane. This configuration, coupled with a lack of enforcement and lack of direct access to and from the HOV lanes, eliminates much of the travel benefit for HOVs heading to and from downtown Nashville.

3.2.6.6 Corridor Recommendations

- Increase enforcement of HOV lane restrictions and associated fines for violators.
- Evaluate options for transition to daily rather than peak hour HOV operation.
- Evaluate options for providing direct HOV lane access and egress at selected locations.
- Evaluate queue bypass for HOVs and transit at potential future ramp metering locations.
- Encourage legislation that allows for implementation of managed lanes at the State level including additional allowable access restrictions, express lanes, and variable pricing.
- Investigate tag systems that allow some measure of automated enforcement.

² Managed Lanes in Tennessee, TDOT, December 2012

Figure 3.12: Existing Managed Lanes



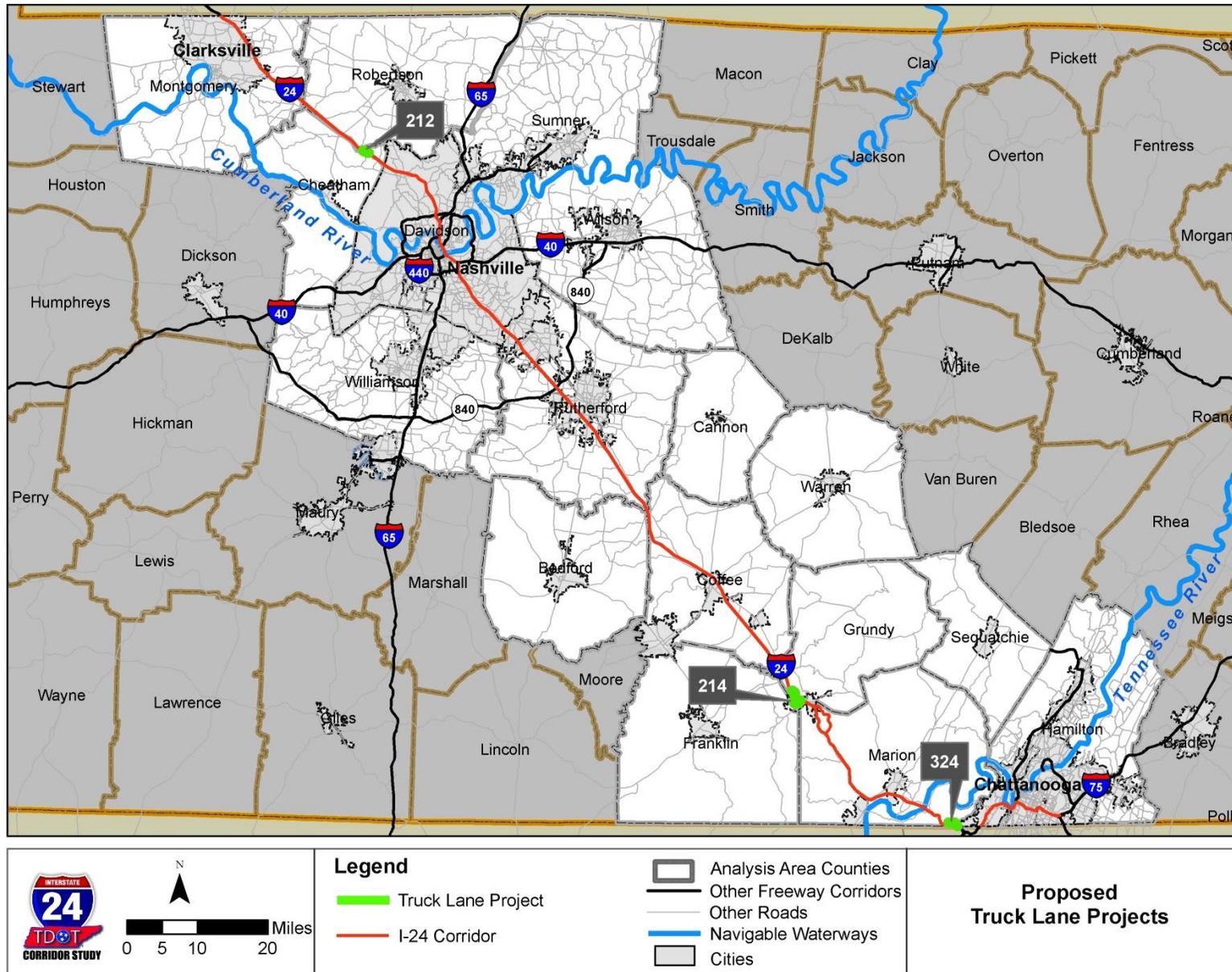
3.2.7 Proposed Truck Lanes

The TRIMS database was used to obtain vertical grade data on I-24 and the study team determined if each section of I-24 met the current design allowable based on terrain type. Grades were also evaluated to determine if they were of sufficient magnitude and length to indicate the need for a truck climbing lanes. Existing truck climbing lanes were also evaluated in the field to determine if extending the existing lanes would be beneficial. The vertical grade data obtained from the TRIMS database was also confirmed in the field as part of the existing conditions geometric evaluation. Based on this technical analysis, field reviews and public comments, there are three truck lane projects that are proposed. One proposed project is an extension of an existing truck climbing lane in Cheatham County and the other proposed projects are new truck climbing lanes in Grundy and Marion Counties. These projects are described in Table 3.9 and shown in Figure 3.13.

Table 3.9: Proposed Truck Lanes

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project
212	Cheatham	Cheatham County - Extend Existing EB Truck Lane	Extend existing EB Truck Lane on I-24 in Cheatham County, Log Mile (2) 0.05 to 0.569 (MP 28)	0.5	MP 28 (Cheatham County Log Mile (2) 0.05 - 0.569)
214	Grundy	Grundy County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Grundy County, Log Mile 3.40 to 6.55 (MP 130 to MP 133)	3.2	MP 130 - MP 133 (Grundy County Log Mile 3.40 - 6.55)
324	Marion	Marion County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Marion County, Log Mile 30.50 to 32.10 (MP 165 to MP 167)	1.6	MP 165 - MP 167 (Marion County Log Mile 30.50 - 32.10)

Figure 3.13: Proposed Truck Lanes



3.2.8 Proposed Bridge Improvements

Data on bridge conditions was gathered using TDOT's Inventory of Structurally Deficient State maintained Bridges and Bridge Inventory and Appraisal Reports. Bridges listed on the Structurally Deficient list of any bridge with a sufficiency rating of less than 50, which would qualify them for replacement, were identified as deficient. In addition, bridges with a Sufficiency Rating of greater than 50 and less than 75, making them candidates for either replacement or major rehabilitation if widened, were identified to assist in the future identification of projects. Some bridges have railings which may not be NCHRP-350 compliant. These structures were also identified and list as deficient.

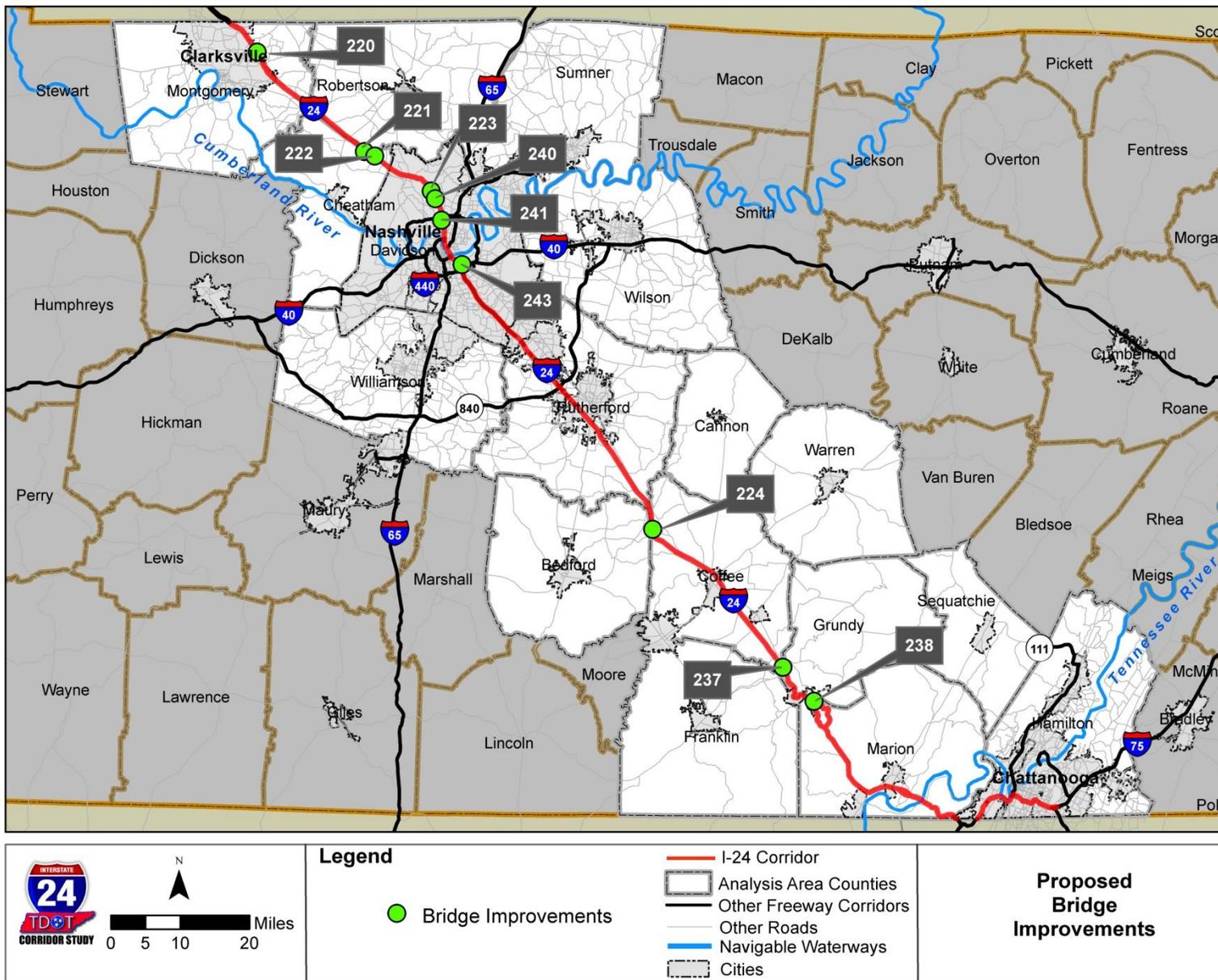
Bridge Inventory and Appraisal Reports and field inspections were also used to identify any structures with deficient horizontal or vertical clearances that were less than 16.0 feet for I-24 mainline sections and ramps, 21.5 feet for railroads, and 14.5 feet for all other non-interstate roadways.

Based on the technical analysis completed for this study and coordination with TDOT staff, ten bridge improvement projects were proposed. These projects consist of bridge railing replacements, bridge rehabilitations, and bridge modifications and are described in Table 3.10 and shown on Figure 3.14.

Table 3.10: Proposed Bridge Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project
220	Montgomery	Montgomery County Bridge Railing Replacements	Replace pipe bridge railings for 6 bridges in Montgomery County between MP 3 and MP 15 which do not conform to current Report 350 crash test standards	MP 3 - MP 15
221	Robertson	Robertson County Bridge Railing Replacements	Replace pipe bridge railings for 2 bridges in Robertson County between MP 27 and MP 28 which do not conform to current Report 350 crash test standards	MP 27 - MP 28
222	Cheatham	Cheatham County Bridge Railing Replacement	Replace pipe bridge railings for 1 bridge in Cheatham County at MP 29 which does not conform to current Report 350 crash test standards	MP 29
223	Davidson	Davidson County Bridge Railing Replacements	Replace pipe bridge railings for 8 bridges in Davidson County between MP 34 and MP 45 which do not conform to current Report 350 crash test standards	MP 34 - MP 45
240	Davidson	MP 40 Bridge Rehabilitation	Davidson County Log Mile 8.51 (MP 40), I-24 RL (EB) at Old Hickory Boulevard, BIN# 19I00240071. Sufficiency Rating is 70.0. Rehabilitate existing bridge.	MP 40 (Davidson County Log Mile 8.51)
241	Davidson	MP 44 Bridge Rehabilitation	Davidson County Log Mile 11.86 (MP 44), I-24 RL (EB) at Ewing Drive, BIN# 19I00240081. Sufficiency Rating is 62.6. Rehabilitate existing bridge.	MP 44 (Davidson County Log Mile 11.86)
243	Davidson	MP 52 Bridge Rehabilitation	Davidson County Log Mile for I-40 is 21.58 (MP 52 for I-24), I-40 Structure 5B at I-24, BIN# 19I00240067. Sufficiency Rating is 67.0. Rehabilitate existing bridge.	MP 52 for I-24 (Davidson County Log Mile for I-40 is 21.58)
224	Coffee	Coffee County Bridge Railing Replacements	Replace pipe bridge railings for 4 bridges in Coffee County between MP 97 and MP 100 which do not conform to current Report 350 crash test standards	MP 97 - MP 100
237	Grundy	MP 127 Bridge Modification	Grundy County Log Mile 0.55 (MP 127), US 64/SR 50 at I-24, BIN# 31I00240001. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	MP 127 (Grundy County Log Mile 0.55)
238	Marion	MP 135 Bridge Modification	Marion County Log Mile 0.77 (MP 135), Trussell Road at I-24, BIN# 58I00240063. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	MP 135 (Marion County Log Mile 0.77)

Figure 3.14: Proposed Bridge Improvements



3.2.9 Proposed Rock Fall/Slide Mitigation Improvements

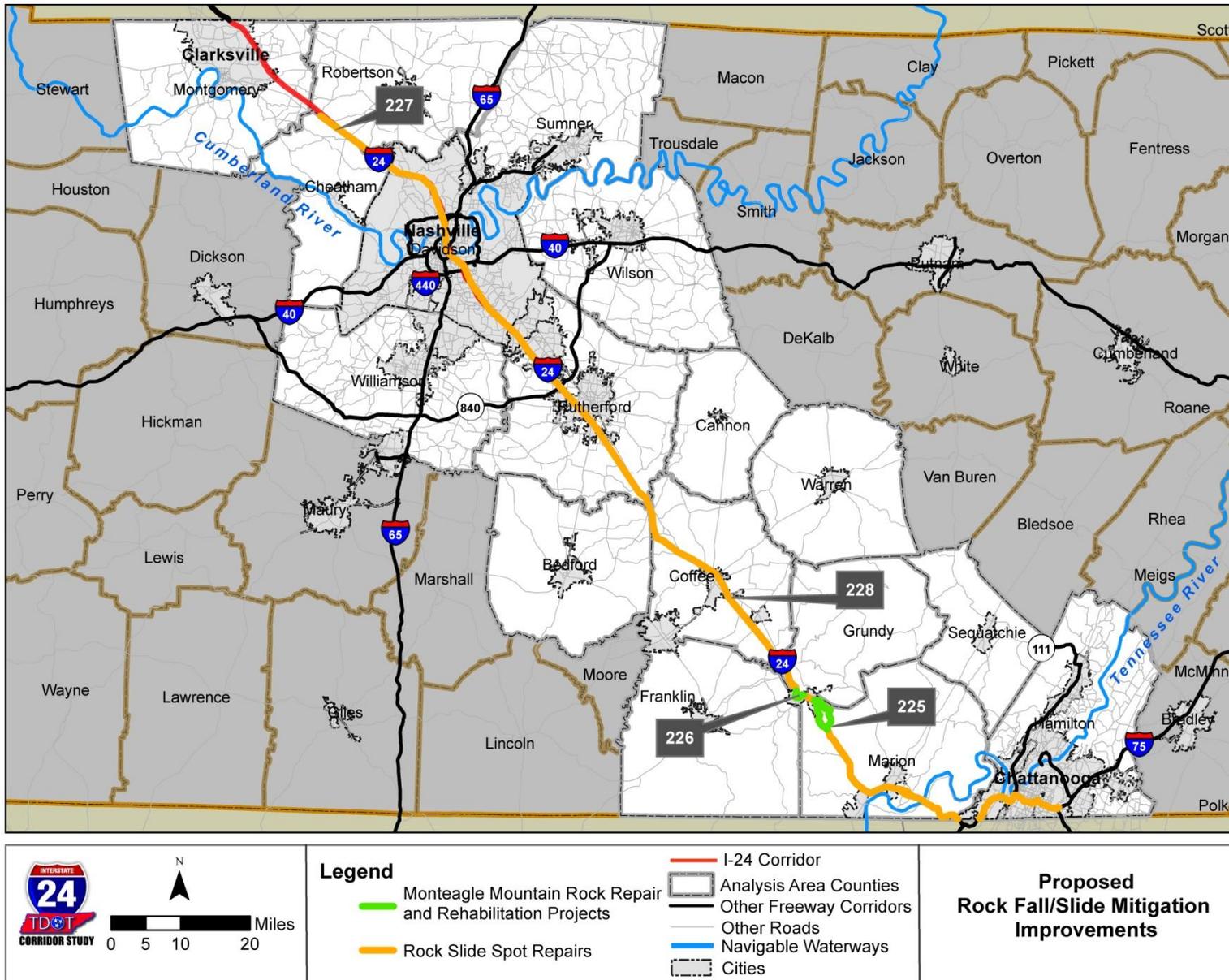
Rock cuts that were of sufficient height and in close enough proximity to I-24 to pose a threat to traffic if a slide occurred were evaluated in the field. Potential slide locations were identified by areas that either 1) showed signs of recent failures that could threaten traffic, 2) showed noticeable erosion of the soil surrounding the rock cut, 3) included a cut that contained layers of “weathering shale” that showed signs of noticeable deterioration, or 4) previously repaired areas where the repair showed signs of deterioration. The project team also coordinated with TDOT Region 2 staff to determine appropriate rock fall/slide mitigation improvements.

Based on the technical analysis and coordination with TDOT staff, four rock fall/slide mitigation projects were proposed. These projects consist of detailed geotechnical reviews and mitigation of rock fall/slide areas in almost every county in the corridor. Two of the proposed projects focus on the areas west and east of Monteagle. These proposed projects are described in Table 3.11 and shown in Figure 3.15. An additional strategy that should also be considered is the potential use of video surveillance along I-24 of potential rock fall/slide locations in order to alert TDOT and travelers in the case of a rock fall/slide that poses a threat to traffic.

Table 3.11: Proposed Rock Fall/Slide Mitigation Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project
227	Robertson / Cheatham / Davidson / Rutherford / Bedford	West I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 15 locations between MP 27 and MP 97	MP 27 - MP 97
228	Coffee / Grundy / Marion / Hamilton	East I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 12 locations between MP 97 and MP 185	MP 97 - MP 185
226	Grundy	West Monteagle Mountain Geotechnical Projects	West of Monteagle MP 131 to MP 133 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	MP 131 - MP 133
225	Marion	East Monteagle Mountain Geotechnical Projects	East of Monteagle MP 135 to MP 140 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	MP 135 - MP 140

Figure 3.15: Proposed Rock Fall/Slide Mitigation Improvements



3.2.10 Proposed Miscellaneous Improvements

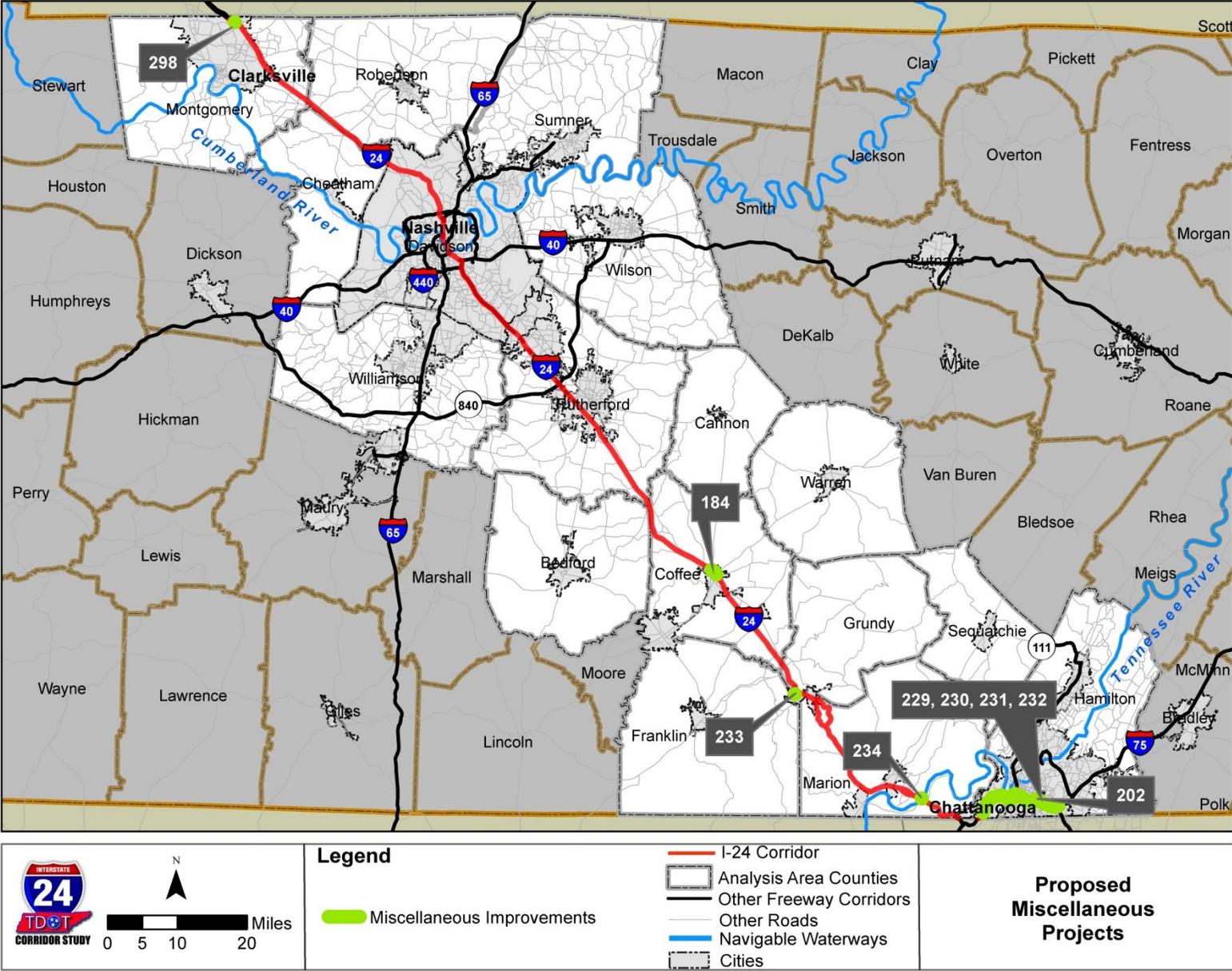
Based on coordination with TDOT Region 2 staff, field studies by the project team, comments from the public, and review of crash data, additional projects were proposed that will help improve safety along I-24. These projects include ramp termini improvements, drainage correction, barriers/glare screens, lighting improvements, pavement improvements and signing and marking improvements. Proposed miscellaneous projects are located in Montgomery, Coffee, Grundy, Marion and Hamilton Counties and are described in Table 3.12 and shown on Figure 3.16.

It should also be noted that several projects were proposed by citizens that involved the implementation of new signals at I-24 ramp termini, or the improvement of signal systems on cross streets at interchanges with I-24, especially in the Clarksville area. Also, there were proposed improvements such as additional lighting at interchanges, especially in Hamilton County. These are very important projects but will require more detailed study and analysis which is best handled by focused studies (i.e., signal warrant analysis, lighting study) that are intended to investigate these types of specific projects using more detailed data and analysis tools which are outside the scope of this study.

Table 3.12: Proposed Miscellaneous Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project
298	Montgomery	Exit 1 Ramp Termini Improvement	Modify right-turn at termini on Exit 1 southbound exit ramp.	Exit 1
184	Coffee	Exit 111 Drainage Correction	Correction for I-24 westbound sheet flow during rain. Rain draining across three westbound lanes toward median.	Exit 111 - Exit 110
233	Grundy	MP 132 Barrier Improvement	MP 132, Replace cable barrier in narrow bifurcated median section with concrete barrier	MP 132
234	Marion	MP 160 Barrier Improvement	MP 160, Extend barrier on the west side of the Tennessee River bridge	MP 160
232	Hamilton	MP 173 - MP 185 Barrier Improvement	MP 173 to MP 185, Add roadway barriers to replace curb and gutter	MP 173 - MP 185
231	Hamilton	MP 173 - MP 185 Lighting Improvements	MP 173 to MP 185, Eliminate lighting in clear zone and upgrade continuous lighting	MP 173 - MP 185
229	Hamilton	MP 173 - MP 185 Pavement Improvements	MP 173 to MP 185, Upgrade pavement surface for improved drainage and friction factors	MP 173 - MP 185
230	Hamilton	MP 173 - MP 185 Signing and Marking Improvements	MP 173 to MP 185, Upgrade signing and marking	MP 173 - MP 185
202	Hamilton	I-24 Missionary Ridge Glare Screen Improvement	Add glare screens on I-24 on either side of Missionary Ridge	Exit 181 - Exit 183

Figure 3.16: Proposed Miscellaneous Improvements



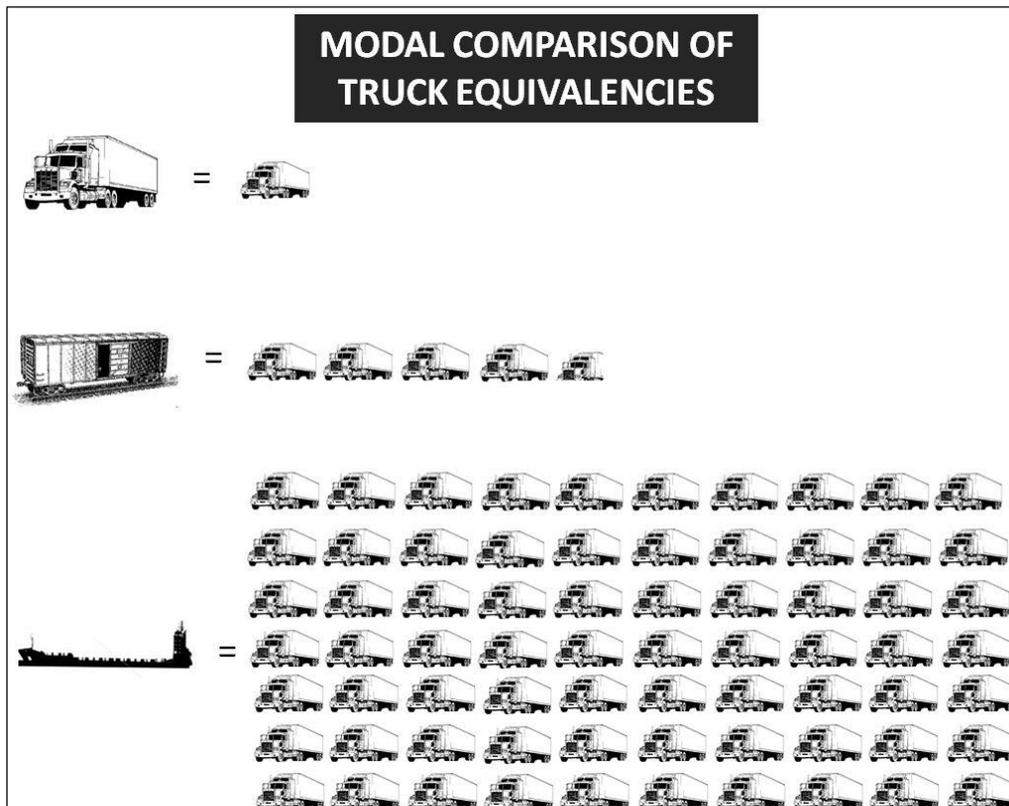
4.0 Freight Diversion

The safe and efficient movement of goods in the I-24 Corridor through Tennessee has a broad impact on the quality of life for people and businesses in the I-24 Corridor, as well as toward achieving a first class national freight system. While helping to make business processes more efficient and consumer goods more affordable, freight movements also present challenges with regards to peak period congestion and assimilating with local traffic in communities. The focus of this section is aimed at the first challenge, which is to reduce the impact of large trucks on operating conditions experienced on sections of I-24 during peak travel times. In particular, it explains the results of an assessment to gage the impact that future diversions of cargo shipped by truck might have on I-24, assuming that a significant share of freight that is currently shipped by truck could be diverted to the rail network or waterway system.

4.1 Introduction

The basic theory behind using freight diversion to free-up capacity on the roadway system is simple. Traffic movements through congested bottlenecks during peak travel hours will operate with less congestion and fewer delays. Both commuters and freight shippers stand to benefit from the more efficient use of infrastructure. Capacity relationships between freight modes are illustrated in Figure 4.1 for truck, rail and barge.

Figure 4.1: Freight Mode Truck Equivalencies



Source: Texas Transportation Institute, Center for Ports and Waterways

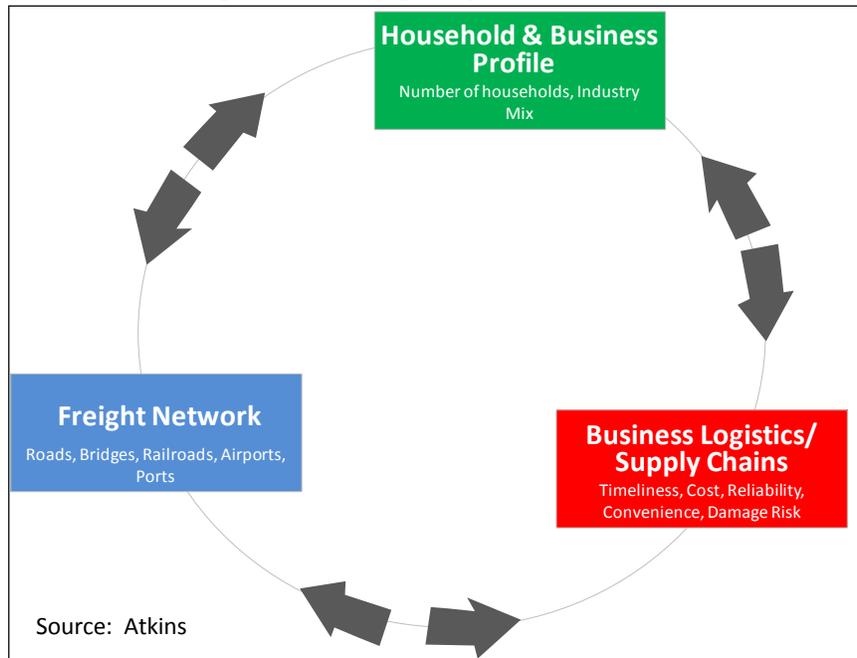
By diverting enough cargo from trucks to fill one railcar, 4.5 large trucks could be removed from the roadway system. The capacity of a fully loaded barge is equivalent to the capacity of 70 large trucks. The freight diversion strategy is more appealing in theory, however, than it is in actual practice. Even the procedure to identify how specific freight diversions will affect highway operating conditions is imprecise. To maximize the effectiveness of freight diversion on reducing congestion, a diversion strategy would target shipments made by truck that tend to occur during peak travel times at congested chokepoints in the road network. This is difficult in practice because truck drivers already try to avoid congested bottlenecks during peak periods to reduce delivery costs. As such, there is not necessarily a large sector of typical daily truck movements traveling through bottlenecks at peak commute times to target for diversion. Moreover, truck equivalencies are not identical for all commodity types across all modes so the relationships in Figure 4.1 will vary.

4.1.1 Freight Diversion Overview

It is important to recognize that decisions to ship commodities by truck, rail, barge or combinations of modes are determined by business logistics processes which in turn consider prevailing marketplace conditions and industry-specific supply chains. An individual supply chain consists of a family of retailers, distributors, transport carriers, storage facilities, and suppliers who take part in the sale, delivery and production of a particular product. The State of Tennessee and Tennessee Department of Transportation (TDOT) partner with private sector freight carriers to supply infrastructure and promote safety over public and private portions of the transportation system, but government does not control the marketplace, capital investments or logistics decisions of private businesses. To this end, future marketplace conditions may or may not lead to investment decisions pertaining to infrastructure and equipment that lead to diversions of freight from truck to rail or waterways in the I-24 Corridor. A visual image representing an overview of freight system supply and demand is presented in Figure 4.2.

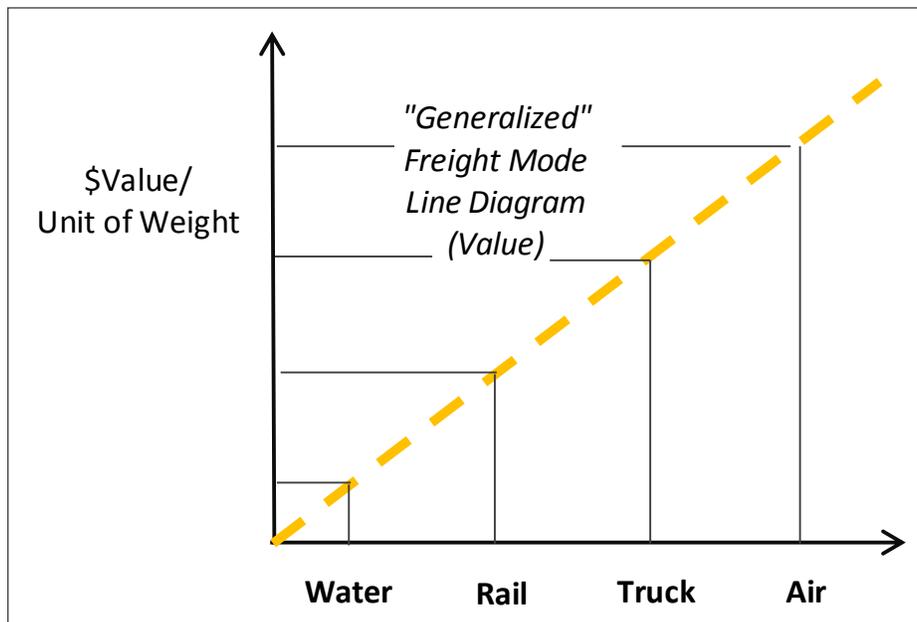
The factors influencing how commodities are shipped through the freight transport network are many. With few exceptions, freight movements will be shipped by a mode or combination of modes using a sequence of transport links that minimize transportation cost but also maximizing the efficiency of the overall supply chain process associated with a particular product or industry. The location of businesses, population centers, mix of industry types in a region, as well as having accessibility to individual freight transport modes all factor into determining how different commodities will be shipped most effectively.

Figure 4.2: Freight System Overview



Despite the dynamic nature of the marketplace, there are general rules of thumb governing the predominant mode that is used to transport specific commodities and delivery characteristics. For one, the value-to-unit weight ratio of a particular commodity shipment is a partial predictor. A linear probability diagram showing the relationship between value and mode as the value of a shipment increases is presented in Figure 4.3. For shipments having relatively low 'Value/Weight' ratios, water (barge) and rail are highly correlated. The correlation

Figure 4.3: Value-to-Weight Ratio Diagram

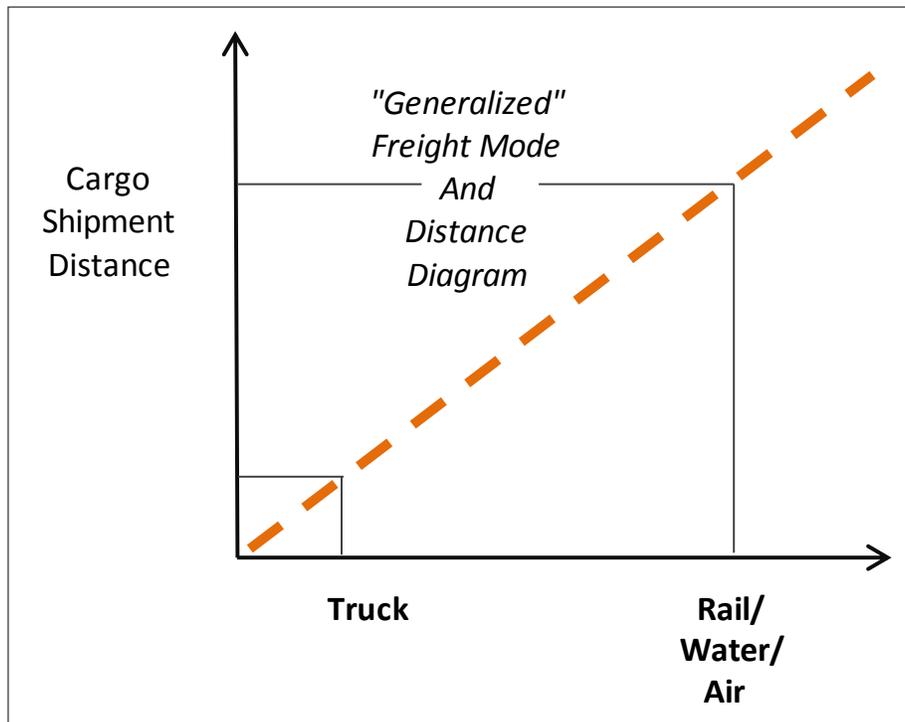


Source: Atkins

between 'Value/Weight' ratios and barge or rail shipments is better when there is direct or good access to those modes. Due to site location properties, some business establishments are not able to take advantage of the efficiencies that barge or rail provide to other businesses in the same industry.

Shipping distance is another property that can be used to predict freight mode. Longer distances favor air, rail and barge while shorter freight movements will tend to use trucks. Distance and freight mode relationships are illustrated in Figure 4.4.

Figure 4.4: Shipment Distance Diagram



Source: Atkins

4.1.2 Commodity Flow Database

A "Transearch" commodity flow database was purchased by TDOT to analyze movements of individual commodities between their origins and destinations. Transearch databases are custom-made by IHS Global Insights, Inc. for state DOT's and other organizations who want to consider freight patterns by individual commodities and by freight mode in developing transportation plans. The database includes a base year (2007) set of commodity flows, as well as a forecasted, future year 2035 set of commodity flows. TDOT's investment in Transearch data supports statewide, corridor-level and metropolitan area planning efforts.

The original database from IHS Global Insights is built from samples obtained from a number of different data sources and subsequently expanded to represent a full population of intercity freight movements. The primary source of commodity flow data used to build TDOT's Transearch database was the US Census Bureau's 2007 Commodity Flow Survey. Other sources of data used to build a customized Transearch database include the following:

- Annual Survey of Manufacturers by state and industry;
- Surface Transportation Board (STB) Carload Rail Waybill Sample of market-to-market rail activity by industry;
- Army Corps of Engineers waterborne commerce data describing market-to-market water activity by industry;
- Federal Aviation Administration (FAA) enplanement statistics and airport-to-airport cargo volumes;
- Rail, water, and air freight flow data deducted from the Bureau of Census Annual Survey of Manufacturers (ASM)-based production data; and
- IHS-Global Insight's own Motor Carrier Data Exchange Program, which provides information on actual market-to-market trucking industry movement activity.

The base and future years of the original Transearch data set did not coincide with the base and horizon years of the I-24 Corridor Study. In an effort to integrate Transearch tabulations with other census, traffic and travel pattern data being used in the I-24 Corridor Study, the base and future, forecast years for the Transearch were shifted to 2010 and 2040. This was accomplished using a 2-step approach.

Base year 2010 tabulations were created directly from the original 2007 Transearch dataset. This approach was considered reasonable because the period of time between 2007 and 2010 coincided with a national and regional economic recession. The level of change in gross domestic product (GDP) nationally and for Tennessee was relatively small during that time frame. Moreover, it was not reflective of any long-term pattern.

Future year 2040 tabulations for the I-24 Corridor Study were created from the original 2007 and 2035 Transearch data sets. This was accomplished by computing average annual percent changes for specific commodity groups corresponding to the 2007 to 2035 time period. The individual average annual percent changes from the 2007 to 2035 time frame were expanded to represent an extrapolation factor for the future time span from 2035 to 2040 and applied to the original future year 2035 commodity flows.

4.1.3 Mode Shares

Existing and projected future year mode shares from the Transearch database are presented in this section for the plan's base and horizon years, 2010 and 2040. The mode splits are based on 'tonnage' and are shown for travel in the I-24 Corridor analysis area as well as for the entire state of Tennessee. The following freight modes are represented: truck, rail, water (barge), and air.

The focus of freight diversion analysis is on shipments passing within, into, out of, and through the I-24 Corridor. These mode shares are presented in Table 4.1 along with those for freight movements traveling within, into, out of, and passing through the entire State of Tennessee. The I-24 Corridor analysis area used to tabulate Transearch commodity flows is the same subarea of Tennessee that was used to tabulate system-level performance data produced by the I-24 Corridor Travel Model, presented in Section 2. A separate map to summarize commodity flow geography is shown later in this section.

Table 4.1: Mode Shares (2010 and 2040)

Analysis Year	Mode	I-24 Corridor		Statewide	
		Tonnage (in 1,000's)	Share	Tonnage (in 1,000's)	Share
2010	Truck	78,967	43%	573,289	54%
	Rail ¹	88,051	48%	292,086	28%
	Water	16,511	9%	187,961	18%
	Air	9	0%	2,054	0%
	Total	183,529	100%	1,055,390	100%
2040	Truck	154,599	50%	1,189,600	64%
	Rail ¹	128,661	42%	398,327	21%
	Water	24,106	8%	275,940	15%
	Air	26	0%	5,249	0%
	Total	307,392	100%	1,869,116	100%

Source: IHS Global Insights, Cambridge Systematics, Inc., Atkins

(1) Rail includes both traditional railcars plus intermodal containers

In the base year 2010, the mode transporting the largest share of freight based on tonnage in the I-24 Corridor, was rail. A total of 88 million tons of freight was shipped by rail which accounted for 48% of all cargo shipped in or through the I-24 Corridor. Shares of truck, waterway (barge) and air freight amounted to 43%, 9% and 0% of the 183.5 million tons of freight shipped in the corridor during 2010. Selection of the study geography could play a role in the mode distribution calculations. The origin-destination movement from 'Kentucky to Georgia' was defined as being a component of through-travel in the I-24 Corridor. That particular origin-destination pair would include tonnages associated with coal trains moving between Kentucky and Georgia, lower South Carolina and Florida. It is also possible that truck shipment tonnages were lower than what would be considered customary during 2010 as a result of suffering national and local economies at that time.

The forecast of 2040 commodity flows suggests that trucks will transport the highest share of cargo in the I-24 Corridor in the future. In 2040, the total weight of commodities shipped through the corridor is forecast to reach 307.4 million tons and be distributed among trucks, rail, water and rail, as follows: 50%, 42%, 8% and 0%. Cargo shipments by air do not register on a percentage scale but that particular mode is expected to achieve the highest rate of growth

out of these four modes between 2010 and 2040 with nearly a 200% difference. Despite that kind of growth, shipments by air are not expected to create a significant diversion of goods from the truck mode.

4.2 Commodity Flows

Existing and future demands of freight in the I-24 Corridor are represented by commodity flow movements between origin-destination pairs that are in the Transearch database. In order to understand the I-24 Corridor commodity flows presented later in this section, it is necessary to understand how the origin and destination attributes in the original Transearch database were transformed into new attributes for the I-24 Corridor freight diversion analysis. In addition to study geography, it is important to understand how specific commodities were grouped together for the diversion analysis.

4.2.1 Geography

The original Transearch database geography for commodity flows was transformed into a set of subareas appropriate for an assessment of freight diversion in the I-24 Corridor analysis area. The full extent of Tennessee's freight flows, including those in the I-24 Corridor, is global. Cargo movements with explicit origins and destinations in North America are included in the Transearch database while South American, European and Asian imports and exports are indirectly identified by origins or destinations in New Orleans, LA, Charleston, SC, Houston, TX, Laredo, TX and other US ports of entry.

Transearch's original geographic tagging of commodity flows incorporated a graduated approach that was dependent on an area's distance from Tennessee. The following tagging rules were generally applied to origins and destinations in the original Transearch database:

Inside Tennessee – origins and destinations were identified at the county level-of-geography.

States Bordering Tennessee – origins and destinations of the first three rows of counties nearest the Tennessee border were coded at the county-level of geography. Groups of counties located beyond those three levels closest to Tennessee were assigned a single code representing the 'Rest of the State'. This type of coding applied to Kentucky, Virginia, North Carolina, Georgia, Alabama, Mississippi, Arkansas and Missouri.

Non-Border States – origins and destinations were assigned a geographic code for the state. Portions of some southeastern states also had separate codes for metropolitan regions anchored by a major port. Examples of these were Charleston, SC, Savannah, GA, and Jacksonville, FL. US Census Bureau of Economic Analysis (BEA) zone codes were assigned to these metropolitan regions.

Canada and Mexico – origins and destinations were assigned geographic codes by administrative and province codes for Mexico and Canada, respectively.

4.2.1.1 North American Perspective

Assigning geographic codes to commodity flow origins and destinations for the I-24 Corridor diversion analysis entailed an aggregation of the original geography that was assigned to the Transearch database. A color-coded map highlighting the diversion analysis geography is presented in Figure 4.5, showing the mainland United States, part of Mexico and part of Canada. There are twelve (12) geographic codes of which five are in Tennessee. The other seven areas correspond to regions of the United States, Mexico and Canada. All of the boundaries were drawn to identify major trade movement flows in the I-24 Corridor analysis area.

The focus of this investigation was determining if it is reasonable for TDOT and its planning partners to consider freight diversions from truck to other transport modes as a viable strategy to reduce congestion and delay in the I-24 Corridor during peak travel periods. Those commodity flow movements that were assessed to determine their future mode split and traffic operations in the I-24 Corridor are those that occur between the following geographic subareas shown in Figure 4.5:

- O-D movements inside the '*I-24 Corridor Analysis Area*';
- O-D movements between the '*I-24 Corridor Analysis Area*' and the '*Southeast Atlantic*' area;
- O-D movements between the '*I-24 Corridor Analysis Area*' and the '*Central Midwest, Northwest and Canada*' area; and,
- O-D movements between the '*Southeast Atlantic*' area and the '*Central Midwest, Northwest and Canada*' area.

This investigation focused on the specific O-D pairs listed above, as they most directly influence commodity flows in the I-24 Corridor. O-D movements between the '*Southwest, Mexico*' area and '*Middle Atlantic*' area, for example, were not considered even though there are possibly some cargo shipments transported by truck within this trade route that use a portion of I-24 in Tennessee in its routing.

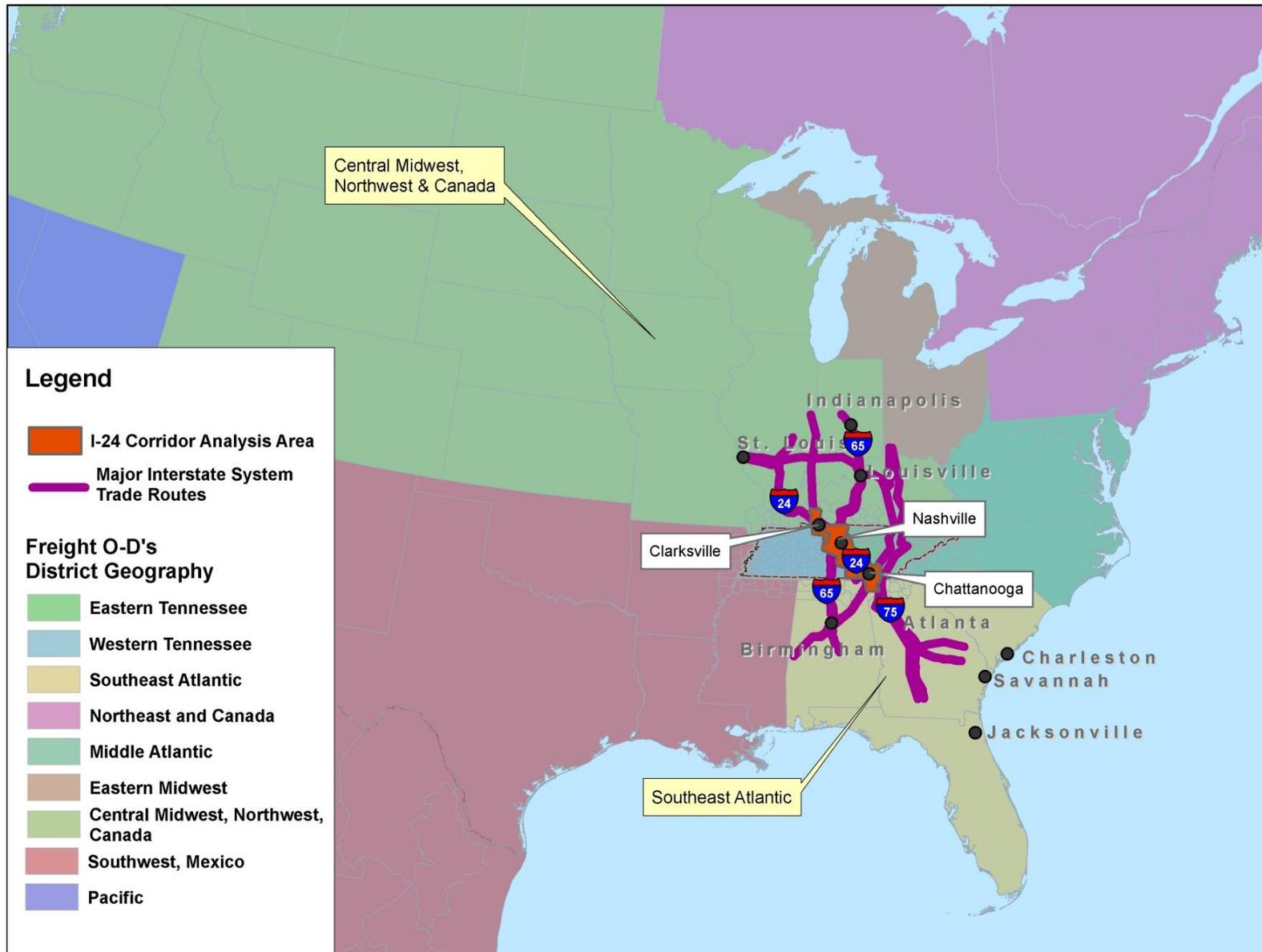
4.2.1.2 I-24 Corridor Perspective

A consistent set of O-D orientations for freight shipments was used to frame Transearch commodity flow tabulations and to assess the likelihood for future freight diversion in the I-24 Corridor. These four (4) orientations are defined below.

Internal – freight shipments having both their origin and destination inside the '*I-24 Corridor Analysis Area*'. Examples include county-to-county movements, such as: Montgomery County to Davidson County; Rutherford County to Hamilton County.

External to Internal (IEIN) – freight shipments having either their origin or destination in the '*Southeast Atlantic*' area or '*Central Midwest, Northwest and Canada*' area plus the other trip

Figure 4.5: I-24 Corridor Freight Diversion Geography



end inside the 'I-24 Corridor Analysis Area'. This type of shipment might also be referred to as an 'Inbound Internal-External' oriented trip. Examples include county-to-county movements, such as: St. Louis, MO to Davidson County; Atlanta, GA to Hamilton County; Birmingham, AL to Montgomery County.

Internal to External (IEOUT) – freight shipments having either their origin or destination inside the 'I-24 Corridor Analysis Area' plus the other trip end in either the 'Southeast Atlantic' area or 'Central Midwest, Northwest and Canada' area. This type of shipment is also referred to as an 'Outbound Internal-External' oriented trip. Examples include county-to-county movements, such as: Davidson County to St. Louis, MO; Hamilton County to Atlanta, GA; Montgomery County to Birmingham, AL.

External to External (THRU) – freight shipments having both their origin and destination outside the 'I-24 Corridor Analysis Area' and located inside either the 'Southeast Atlantic' area or 'Central Midwest, Northwest and Canada' area. This type of shipment is also referred to as a 'THRU' orientation. This class of trips does not distinguish between southbound or northbound shipments. Examples include movements, such as: Chicago, IL to Jacksonville, FL; St. Louis, MO to Atlanta, GA; Savannah, GA; to Louisville, KY.

4.2.2 Commodity Classification

Several different commodity classifications are used by freight service providers. Each has its advantages and is preferred by different entities. The Transearch database uses a classification system developed and updated by the Association of American Railroads (AAR) called the Standard Transportation Commodity Codes (STCC).

An advantage of using the STCC code system is its hierarchical organization. For example, commodity flows in the original Transearch database are maintained in the 4-digit STCC code level-of-detail. There are more than 400 different commodity categories in the 4-digit level-of-detail. In this analysis of freight diversion, the number of commodity categories tabulated and summarized was reduced from more than 400 to 11 through a collapsing process enabled by the hierarchical organization of STCC codes. The eleven (11) simplified classification groupings used in this application of Transearch data are listed below. A detailed summarization showing the correspondence between 4-digit classifications and the 11 groupings is presented in Table 4.2.

- Construction & Mining (CONMIN)
- Food & Kindred Products (FOODKIND)
- Chemicals (CHEMS)
- Timber & Lumber (TIMBRLMBR)
- Agriculture & Marine (AGMARINE)
- Machinery (MACHINE)
- Paper Products (PAPRPRODS)
- Primary Metals (PRIMETLS)
- Waste Materials (WASTEMATS)
- Mixed Miscellaneous Shipments (MIXEDWRHSE)
- Household Goods (HHOTHER)

Table 4.2: 4-digit STCC to Freight Diversion Classification Summary

Group Code	Commodity Group	STCC2	Commodity (STCC2)
1	Construction & Mining (CONMIN)	10	Metallic ores: Iron Ores; Copper Ores; Gold Ore; Misc Metal Ore. Etc.
		11	Coal: Anthracite; Bituminous Coal Or Lignite;
		13	Crude Petrol; Or Natural Gas: Natural Gasoline; Chem Or Fertilizer Minerals
		14	Nonmetallic ores: minerals; Clay Ceramic Or Refrac Minerals; excluding fuels
		19	Ordnance or accessories: Guns,howitzers,mortars, Etc.; Military Fire Control Equip; Tracked Combat Vehic Or Parts
		29	Petroleum or coal products: Asphalt Coatings Or Felt; Paving Or Roofing Materials
		30	Rubber or miscellaneous plastics products: Rub Or Plas Hose Or Belting; Reclaimed Rubber
		32	Clay, concrete, glass, or stone products: Flat Glass; Portland Cement; Clay Brick Or Tile; Gypsum Products
2	Food and kindred products (FOODKIND)	20	Food and kindred products: Meat Or Poultry, Fresh Or Chilled; Animal By-prod,inedible: Canned Fruits,vegetables, Etc.
		21	Tobacco products, excluding insecticides
3	Chemicals (CHEMS)	28	Chemicals or allied products: Plastic Mater Or Synth Fibres: Misc Agricultural Chemicals: Paints, Lacquers, Etc.
		49	Harzardous poison, corrosive, other regulated materials: Flammable Liquids; Oxidizing Materials; Radioactive Materials
4	Timber & Lumber (TIMBLBR)	8	Forest products: Barks Or Gums,crude; Misc Forest Products
		24	Lumber or wood products, excluding furniture: Primary Forest Materials: Plywood Or Veneer; Structural Wood Prod, Nec
5	Agriculture & Marine (AGMARINE)	1	Farm products: Field Crops; Cotton,raw; Grain; Horticultural Specialties; Misc Fresh Fruits Or Tree Nuts; Livestock
		9	Marine products: Fresh Fish Or Marine Products; Fish Hatcheries
		22	Textile mill products: Cord Or Fabrics,industrial; Wool Broad-woven Fabrics; Knit Fabrics: Wool Or Mohair; Yarn
6	Machinery (MACHINE)	35	Machinery, excluding electrical: Engines Or Turbines; Farm Machinery Or Equipment; Constr Machinery Or Equipment; Machine Tools, Metal Cutting
		36	Electrical machinery, equipment, or supplies: Electrical Transformers; Industrial Electrical Equipment; Welding Apparatus; Household Appliances
		37	Transportation equipment: Motor Vehic Or Equipment; Aircraft Or Parts; Ships Or Boats; Motorcycles, Bicycles Or Parts; Railroad Cars
		38	Instruments, photographic goods, optical goods, watches, or clocks: Engrg, Lab Or Scientific Equipment; Measuring Or Controlling Equipment
7	Paper products (PAPPRODS)	26	Pulp, paper, or allied products; Pulp Or Pulp Mill Products; Fiber, Paper Or Pulpboard; Containers Or Boxes,paper
		27	Printed matter: Newspapers; Books; Greeting Cards, Seals, Etc.Manifold Business Forms
8	Primary metal (PRIMETLS)	33	Primary metal products: Steel Mill Products; Iron Or Steel Forgings; Nonferrous Metal Basic Shapes; Steel Wire, Nails Or Spikes
		40	Waste or scrap materials not identified by producing industry
9	Waste materials (WASTEMATS)	48	Waste hazardous, explosives, corrosive, other regulated materials
		41	Miscellaneous freight shipments
10	Mixed miscellaneous shipments, Warehouse, rail intermodal drayage, secondary traffic & Container back empty (Rail Only) (MIXEDWRHSE)	42	Containers, carriers or devices, shipping, returned empty
		43	Mail or express and other contract traffic
		44	Freight forwarder traffic
		45	Shipper association traffic:
		46	Fak and mixed shipments: Misc Mixed Shipments; Mixed Shipments, Multi-stcc
		47	Small packaged freight shipments
		50	Warehouse & rail intermodal drayage, secondary traffic
		23	Apparel or other finished textile products or producing industry knit apparel: Clothing; Misc Apparel Or Accessories; Textile Housefurnishings
11	Household goods & Other manufactures (HHOTHER)	25	Furniture or fixtures: Household Or Office Furniture; Benches,chairs, Stools; Sofas, Couches, Etc.; Beds,dressers,chest, Etc.
		31	Leather or leather products: Leather Luggage Or Handbags; Leather Gloves Or Mittens; Boot Or Shoe Cut Stock
		34	Fabricated metal products: Metal Cans; Cutlery, Hand Tools Or Hardware: Plumbing Or Heating Fixtures; Bolts, Nuts, Screws, Etc.
		39	Miscellaneous products of manufacturing

4.2.3 Freight Movement by Commodity Group

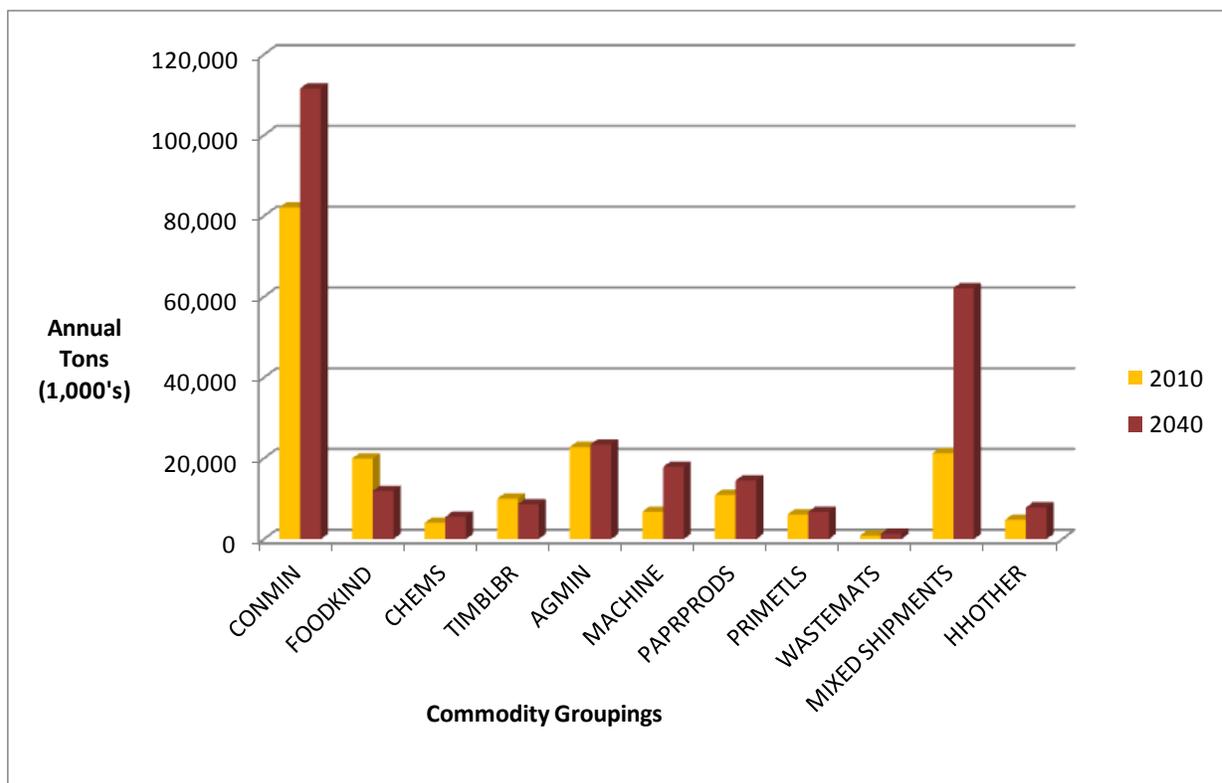
This freight diversion analysis focuses on potential freight diversions from truck to rail that could occur in the future. The analysis structure is defined by commodity flows in annual tons stratified by (a) commodity group code; (b) O-D orientation; and, (c) mode (truck or rail).

Barge service accounts for a significant share of freight in the I-24 Corridor. Despite the significant mode share, no analyses were performed to determine the potential for commodities shipped by truck to divert onto barges in the future. There is essentially no competition between barge and truck carriers for bulk commodities a long distance.

Base year 2010 and future year 2040 commodity flow summaries for the I-24 Corridor Analysis area, in 1,000's of tons, are presented in Figure 4.6 for each commodity group. These summaries are for total shipments within a commodity grouping including all freight passing through the I-24 Corridor but in just a north-south directional orientation.

'CONMIN' or *Construction and Mining* was the lead commodity group transported in base year 2010 as well as in future year 2040. The weight of 'CONMIN' shipments is projected to grow by 36% from 82 million tons in 2010 to 112 million tons in 2040. At the other extreme, the commodity group with the smallest amount of cargo in the base year is 'WASTEMATS'. Only 0.8

Figure 4.6: Tonnages by Commodity Group (2010-2040)



million tons of 'WASTEMATs' were transported in 2010. By 2040, however, shipments of materials in this commodity group are forecast to grow 60% to 1.4 million tons. The fastest growing commodity group is 'MIXED SHIPMENTS' whose tonnage is expected to grow by 192%. Many movements in the 'MIXED SHIPMENTS' category are subject to mode competition as Intermodal (rail-truck), Truck and Railcar modes compete to transport those kinds of goods.

Freight shipment tonnages in the I-24 Corridor are projected to grow for all commodity groups between 2010 and 2040, except in the 'FOODKIND' and 'TIMBLBR' commodity group categories. It is notable that 'FOODKIND' tonnage is forecast to drop by approximately 40%, from 20 million to 11.9 million tons in 2010 and 2040, respectively.

4.2.4 *Freight Movements by Mode*

The I-24 Corridor freight diversion analysis is based on a cross-examination of commodity flows by commodity group categories and transport mode. In practice, however, logistical decisions to determine the best method of shipping is made for specific commodities. A list of detailed commodity descriptions for the highest ten specific commodity types shipped in the I-24 Corridor, and their corresponding commodity groups, is presented in Table 4.3 for truck, railcars and intermodal. The level of abstraction between detailed, 4-digit STCC's and commodity group codes are illustrated in the table, using the highest volume (in terms of tonnage) commodities.

Of the three lists of commodity descriptions, the most notable entries are those that are listed under more than one mode. These are commodities that are candidates for diversion from truck to rail or intermodal. Only three (3) 4-digit commodity descriptions are listed twice. They are listed below.

1. 'Primary Iron or Steel Products' – associated with the 'PRIMETLS' commodity group and listed under Truck and Railcar.
2. 'Motor Vehicle Parts or Accessories' – associated with the 'MACHINE' commodity group and listed under Truck and Intermodal.
3. 'Misc Agricultural Chemicals' – associated with the 'CHEMS' commodity group and listed under Truck and Intermodal.

The only grouped commodity category that does not show up in Table 2-2 as one of the top 10 commodities shipped is 'WASTEMATs'.

Table 4.3: Example of 4-digit STCC's Tonnage to Mode Relationships

Truck			
Rank	Description	Group	Tonnage
1	Warehouse & Distribution Center	MIXEDWRHSE	75,601,060
2	Broken Stone Or Riprap	CONMIN	71,570,371
3	Misc Plastic Products	CONMIN	21,442,543
4	Misc. Field Crops	AGMARINE	17,363,073
5	Potassium Or Sodium Compound	CHEMS	11,873,094
6	Misc Agricultural Chemicals	CHEMS	11,485,016
7	Primary Iron Or Steel Products	PRIMETLS	11,236,654
8	Gravel Or Sand	CONMIN	11,051,036
9	Primary Forest Materials	TIMBLBR	9,827,399
10	Motor Vehicle Parts Or Accessories	MACHINE	8,302,287
Railcar			
Rank	Description	Group	Tonnage
1	Bituminous Coal	CONMIN	120,142,448
2	Grain	AGMARINE	22,912,572
3	Plastic Mater Or Synth Fibres	CHEMS	10,066,964
4	Primary Iron Or Steel Products	PRIMETLS	7,595,184
5	Motor Vehicles	MACHINE	7,240,920
6	Misc Coal Or Petroleum Products	CONMIN	6,790,124
7	Nonmetal Minerals, Processed	CONMIN	6,113,935
8	Oil Kernels, Nuts Or Seeds	AGMARINE	5,839,068
9	Fiber, Paper Or Pulpboard	PAPRPRODS	5,787,400
10	Misc Industrial Organic Chemicals	CHEMS	5,578,128
Intermodal			
Rank	Description	Group	Tonnage
1	Fak Shipments	MIXEDWRHSE	14,165,152
2	Semi-trailers Returned Empty	MIXEDWRHSE	1,431,880
3	Misc Fabricated Textile Products	HHOTHER	291,280
4	Wine,brandy Or Brandy Spirit	FOODKIND	258,440
5	Misc Food Preparations, Nec	FOODKIND	254,440
6	Motor Vehicle Parts Or Accessories	MACHINE	253,920
7	Paper	PAPRPRODS	240,800
8	Tires Or Inner Tubes	CONMIN	161,920
9	Misc Wood Products	TIMBLBR	129,560
10	Misc Agricultural Chemicals	CHEMS	127,520

4.2.5 Freight Shipments by O-D Orientation

Base year 2010 and future year 2040 commodity flow distributions for truck, rail and intermodal are reported below and subdivided by O-D Orientation. These flows represent commodities whose O-D orientations fall into these categories: within; coming into; going out of; and, passing through the I-24 Corridor. Those categories correspond to the following orientation labels: Internal; I-E Inbound; I-E Outbound; and, Thru-Bound.

Commodities shipped within the I-24 Corridor (Internal) are the shortest distance movements and are least likely to be diverted to rail or intermodal. A relatively small portion of the longer distance shipments coming into and being transported out of the I-24 Corridor area (I-E Inbound and I-E Outbound) are candidates for diversion from truck to rail or intermodal. Commodities shipped through the corridor (Thru-Bound) have the highest likelihood of being candidates for diversion from truck to rail or intermodal.

There are other logistics parameters to consider in determining the likelihood that certain commodity movements will be candidates for truck to rail diversion. Most importantly, all shipments by railcar need to have origin and destination terminals accessible by the rail network. Intermodal rail-truck traffic is one of the fastest growing methods to ship non-bulk goods. As railroad carriers invest in more intermodal equipment and facilities within and near Tennessee, the intermodal (rail-truck) mode will become more attractive from a cost and service standpoint to shippers. Intermodal freight services are most attractive to commodities in the category labeled 'MIXEDWRHSE'. 'MIXEDWRHSE' is also the leading commodity group for freight shipments transported by truck.

The base year 2010 distribution of I-24 Corridor goods being shipped by trucks and by O-D orientation is presented in Table 4.4. Thru-Bound freight movements by truck exceed 62 million tons. The O-D orientation with the next largest total cargo movement by truck is Internal which logged nearly 23 million tons. The two commodity groups in the Thru-Bound orientation category with the highest tonnages were 'FOODKIND' and 'MIXED SHIPMENTS' with 11.5 million tons each. Both of these commodity groups are also transported by rail or intermodal.

Table 4.4: Base Year 2010 Tonnages by Commodity Group and O-D Orientation (Trucks)

GROUP CODE	COMMODITY GROUP	INTERNAL		I-E INBOUND		I-E OUTBOUND		THRU-BOUND	
		Tonnage (1,000's)	Share						
1	CONMIN	15,998.0	70%	4,225.6	49%	3,012.5	37%	7,106.4	11%
2	FOODKIND	823.1	4%	602.1	7%	848.7	10%	11,548.0	19%
3	CHEMS	304.2	1%	57.3	1%	95.2	1%	960.3	2%
4	TIMBLBR	98.3	0%	344.1	4%	314.5	4%	7,336.2	12%
5	AGMIN	1,456.2	6%	711.7	8%	323.1	4%	7,524.4	12%
6	MACHINE	537.5	2%	259.9	3%	407.8	5%	3,910.6	6%
7	PAPRPRODS	257.1	1%	209.5	2%	350.8	4%	5,918.4	10%
8	PRIMETLS	133.2	1%	358.4	4%	152.0	2%	3,370.0	5%
9	WASTEMATs	0.0	0%	0.1	0%	0.0	0%	8.3	0%
10	MIXED SHIPMENTS	2,554.1	11%	1,520.4	18%	1,848.1	23%	11,469.6	18%
11	HHOTHER	554.1	2%	258.2	3%	791.7	10%	3,009.7	5%
		22,715.8	100%	8,547.3	100%	8,144.4	100%	62,161.9	100%

Base year 2010 distributions of goods being shipped by means of rail or intermodal are presented in Table 4.5 by O-D Orientation. The most important statistics are the railcar and intermodal tonnage totals for the Thru-Bound O-D Orientation. Cargo tonnage in railcars

totaled 79.2 million while intermodal freight shipments amounted to almost 4 million tons. The next highest rail mode and O-D Orientation was railcar shipments in the I-E Inbound orientation which accounted for 3.1 million tons.

Table 4.5: Base Year 2010 Tonnages by Commodity Group and O-D Orientation (Rail and Intermodal)

GROUP CODE	COMMODITY GROUP	INTERNAL			I-E INBOUND			I-E OUTBOUND			THRU-BOUND		
		Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share	Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share	Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share	Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share
1	CONMIN	10.7	0.00	15%	180.6	23.40	6%	121.0	17.96	12%	51,380.8	61.52	62%
2	FOODKIND	11.7	0.00	16%	752.4	0.80	20%	50.0	1.76	5%	5,030.8	294.08	6%
3	CHEMS	12.0	0.00	16%	116.2	0.64	3%	35.3	2.56	3%	2,348.7	98.64	3%
4	TIMBLBR	0.0	0.00	0%	61.0	4.32	2%	6.4	0.80	1%	1,809.2	32.28	2%
5	AGMIN	0.0	0.00	0%	1,598.9	0.00	43%	168.3	0.00	15%	10,972.0	39.48	13%
6	MACHINE	0.0	0.00	0%	17.5	2.24	1%	64.7	2.60	6%	1,499.1	85.24	2%
7	PAPRPRODS	0.0	0.00	0%	141.8	0.88	4%	3.1	1.76	0%	3,655.3	393.96	5%
8	PRIMETLS	0.0	0.00	0%	188.1	0.00	5%	11.6	0.00	1%	1,857.0	1.44	2%
9	WASTEMATS	38.4	0.00	53%	11.8	11.36	1%	125.5	11.56	12%	583.2	51.96	1%
10	MIXED SHIPMENTS	0.0	0.00	0%	17.8	546.68	15%	0.0	515.60	45%	55.6	2,753.88	3%
11	HHOTHER	0.0	0.00	0%	0.0	4.76	0%	0.0	2.84	0%	3.4	146.48	0%
		72.8	0.0	100%	3,086.1	595.1	100%	585.9	557.4	100%	79,195.1	3,959.0	100%

Under the Thru-Bound O-D Orientation, the highest tonnage commodity groups are 'CONMIN' and 'AGMIN' with 51.4 million and 11 million tons, respectively. For intermodal freight, 'MIXED SHIPMENTS' is the highest tonnage commodity group at 2.8 million tons. The 'MIXED SHIPMENTS' commodity group is a market niche where there could be significant competition between modes. In this case, the competition is primarily between shipping exclusively by truck or by a combination of rail and truck (intermodal).

IHS Global made commodity flow forecasts to a future year 2035 which were extrapolated by the study team to a future year 2040. The projected future year 2040 distribution of goods in the I-24 Corridor being shipped by trucks and by O-D orientation is presented in Table 4.6. Thru-Bound freight movements by truck almost reach 91 million tons. The O-D orientation with the next largest total cargo movement by truck is Internal which logged nearly 20 million tons. The two commodity groups in the Thru-Bound orientation category with the highest tonnages were 'MIXED SHIPMENTS' and 'MACHINE' with 35 million and 12.9 million tons each, respectively. Both of these commodity groups are also transported by rail or intermodal.

Table 4.6: Future Year 2040 Tonnages by Commodity Group and O-D Orientation (Trucks)

GROUP CODE	COMMODITY GROUP	INTERNAL		I-E INBOUND		I-E OUTBOUND		THRU-BOUND	
		Tonnage (1,000's)	Share						
1	CONMIN	14,816.9	75%	4,829.7	37%	4,617.9	25%	9,546.3	10%
2	FOODKIND	268.9	1%	690.8	5%	2,274.6	13%	1,057.3	1%
3	CHEMS	13.3	0%	165.7	1%	163.1	1%	1,450.4	2%
4	TIMBLBR	108.3	1%	228.8	2%	881.6	5%	5,359.4	6%
5	AGMIN	864.3	4%	563.7	4%	466.7	3%	7,640.5	8%
6	MACHINE	326.6	2%	683.4	5%	1,085.0	6%	12,884.9	14%
7	PAPRPRODS	144.6	1%	332.0	3%	961.5	5%	8,972.5	10%
8	PRIMETLS	16.2	0%	329.8	3%	262.4	1%	3,462.8	4%
9	WASTEMATS	0.0	0%	0.0	0%	0.0	0%	28.4	0%
10	MIXED SHIPMENTS	3,246.3	16%	4,940.9	37%	6,042.9	33%	34,727.9	38%
11	HHOTHER	71.6	0%	427.0	3%	1,387.9	8%	5,793.0	6%
		19,877.0	100%	13,191.8	100%	18,143.7	100%	90,923.4	100%

Future year 2040 tonnages are distributed by rail or intermodal and are presented in Table 4.7 by O-D Orientation. The most important statistics are the railcar and intermodal tonnage totals for the Thru-Bound O-D Orientation. Cargo tonnage in railcars totaled 111.8 million while intermodal freight shipments amounted to almost 9 million tons. The next highest rail mode and O-D Orientation in 2040 was railcar shipments in the I-E Inbound orientation which accounted for 2.8 million tons.

Table 4.7: Future Year 2040 Tonnages by Commodity Group and O-D Orientation (Rail and Intermodal)

GROUP CODE	COMMODITY GROUP	INTERNAL			I-E INBOUND			I-E OUTBOUND			THRU-BOUND		
		Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share	Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share	Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share	Railcar Tonnage (1,000's)	IMX Tonnage (1,000's)	Share
1	CONMIN	11.8	0.00	11%	84.3	29.40	3%	122.7	34.94	4%	77,446.6	87.21	64%
2	FOODKIND	9.5	0.00	9%	890.9	0.38	20%	36.3	3.27	1%	6,480.2	225.39	6%
3	CHEMS	24.9	0.00	24%	183.1	1.94	4%	87.4	3.78	2%	3,207.6	228.74	3%
4	TIMBLBR	0.0	0.00	0%	86.4	4.88	2%	27.4	2.12	1%	1,912.0	34.41	2%
5	AGMIN	0.0	0.00	0%	1,155.5	0.00	26%	151.7	0.00	4%	12,531.5	37.16	10%
6	MACHINE	0.0	0.00	0%	24.4	2.35	1%	52.6	4.51	1%	2,799.1	9.50	2%
7	PAPRPRODS	0.0	0.00	0%	207.8	0.98	5%	2.9	1.80	0%	3,867.8	16.24	3%
8	PRIMETLS	0.0	0.00	0%	130.2	0.00	3%	10.5	0.00	0%	2,528.2	1.56	2%
9	WASTEMATS	58.3	0.00	56%	21.1	33.90	1%	231.6	15.31	6%	917.7	43.53	1%
10	MIXED SHIPMENTS	0.0	0.00	0%	30.7	1,623.25	37%	0.0	3,218.60	80%	149.2	8,161.18	7%
11	HHOTHER	0.0	0.00	0%	0.0	4.69	0%	0.0	2.20	0%	1.5	136.90	0%
		104.4	0.0	100%	2,814.5	1,701.77	100%	723.2	3,286.53	100%	111,841.5	8,981.81	100%

Under the Thru-Bound O-D Orientation, the highest tonnage commodity groups are 'CONMIN' and 'AGMIN' with 77.4 million and 12.5 million tons, respectively. For intermodal freight,

‘MIXED SHIPMENTS’ is the highest tonnage commodity group at 8.2 million tons. The ‘MIXED SHIPMENTS’ commodity group is a market niche where there could be significant competition between modes. In this case, the competition is primarily between shipping exclusively by truck or by a combination of rail and truck (intermodal).

Total tonnage shipped by truck and rail are projected to increase by 40 and 47 percent, respectively, according to IHS Global Insights’ Transearch database. While the rate of increase for rail plus container freight is projected to be slightly higher than for trucks, total freight tonnage shipped by truck in 2040 is higher than it is for rail plus container. Projected tonnages shipped by truck and rail in 2040 are 142.1 million and 129.5 million, respectively. Rates of change between 2010 and 2040 commodity shipments for trucks and rail plus containers are presented in Table 4.8.

There are some significant shifts forecasted to occur between 2010 and 2040 in certain commodities. The category ‘MIXED SHIPMENTS’ shows prolific growth in tonnages for both truck and rail. Truck shipments increase 181%, from 17.4 million to 49 million tons. For rail and containers, freight tonnage increase 239%, from 3.9 million to 13.2 million tons. Another commodity category showing a lot of growth in the I-24 Corridor is ‘MACHINE’. Truck tonnages are projected to increase from 5.1 million to 15 million and rail from 1.7 million to 2.9 million, equivalent to 193% and 73% growth, respectively. The sharpest decline in tonnage occurs with Trucks in the ‘FOODKIND’ commodity group. ‘FOODKIND’ shipments by truck were projected to drop from 13.8 million to 4.3 million tons. There was not a similar 2010 to 2040 change for ‘FOODKIND’ commodities shipped by rail.

Table 4.8: 2010 to 2040 Change in Tonnage by Truck and Rail Plus Container

GROUP CODE	COMMODITY GROUP	Trucks			Rail + Containers		
		2010 Tonnage (1,000's)	2040 Tonnage (1,000's)	2010/2040 Change	2010 Tonnage (1,000's)	2040 Tonnage (1,000's)	2010/2040 Change
1	CONMIN	30,343	33,811	11%	51,796	77,817	50%
2	FOODKIND	13,822	4,292	-69%	6,142	7,646	24%
3	CHEMS	1,417	1,792	26%	2,614	3,737	43%
4	TIMBLBR	8,093	6,578	-19%	1,914	2,067	8%
5	AGMIN	10,015	9,535	-5%	12,779	13,876	9%
6	MACHINE	5,116	14,980	193%	1,671	2,892	73%
7	PAPRPRODS	6,736	10,411	55%	4,197	4,097	-2%
8	PRIMETLS	4,014	4,071	1%	2,058	2,671	30%
9	WASTEMATS	8	28	239%	834	1,321	58%
10	MIXED SHIPMENTS	17,392	48,958	181%	3,890	13,183	239%
11	HHOTHER	4,614	7,680	66%	157	145	-8%
Total		101,569	142,136	40%	88,051	129,454	47%

4.3 Demographics

Local and national economic conditions stimulate demand for the movement of goods and raw materials reflected in IHS Global Inc.'s commodity flow database. However, demand for a significant portion of large truck traffic, especially within metropolitan areas, is created by total population. Population growth and stable household purchasing power will lead to increased consumption which, in turn, leads to more demand for production and goods plus the local distribution of goods within a region. Total employment is a necessary condition to sustain population growth and support consumption. 2010 to 2040 forecasts of the basic socio-economic indicators, population and total employment, are presented in this section.

Relative increases in corridor-wide population and total employment changes between 2010 and 2040 are not identical but consistent with commodity flow tonnage forecasts reported in the preceding section. Changes in demographics like population and total employment inside the I-24 Corridor are good indicators of how freight movement demands will change in the future. Nevertheless, they are only partial indicators. Commodity flow shipments by O-D orientation, presented earlier, showed that cargo movements transported 'THRU' the I-24 Corridor were clearly the predominant type of O-D freight movement when measured in tonnage.

In considering freight diversion, it is important to distinguish between the component of freight movements that is driven by population and consumption from those that are largely generated by increased industrial production. Local goods distribution is mostly done by trucks and that is not expected to change in the future. The freight sector that is a candidate for truck-to-rail diversion are those movements shipped over long distances which includes a lot of the commodity flow shipments that were categorized into the 'THRU' O-D orientation and some of the 'I-E Inbound' and 'I-E Outbound' O-D orientations.

4.3.1 Population

Total population in the I-24 Corridor analysis area is forecast to grow 41% between 2010 and 2040 with a base year population of 2.3 million persons and a future year estimate of 3.3 million. Base level and future year population projections in the I-24 Corridor are presented in Table 4.9 by analysis subarea. At the subarea summary level, both Nashville and Clarksville are anticipating relatively large population increases, in the 40% to 50% range. Currently, population is concentrated in the Nashville subarea which is evidenced by the 1.6 million persons out of 2.3 million residing there. Future year 2040 population projections indicate that 2.4 million persons out of a corridor-wide total of 3.3 million are expected to reside in the Nashville subarea.

Table 4.9: 2010 to 2040 Population

I-24 Corridor Analysis Subareas	Population		
	2010	2040	2010/2040 Change
Clarksville	221,579	315,136	42%
Nashville	1,605,934	2,398,869	49%
Chattanooga	498,680	562,931	13%
Corridor-wide Totals	2,326,193	3,276,936	41%

Sources: Atkins, US Census Bureau, Metropolitan Planning Organizations, University of Tennessee and I-24 Travel Demand Model

4.3.2 Total Employment

Total employment in the I-24 Corridor analysis area is forecast to grow at a higher rate than population. From 2010 to 2040 total employment is forecast to grow by 63%, from 1.4 million employees in the base year to 2.2 million in the future year. Base and future year total employment projections are presented in Table 4.10 by I-24 Corridor analysis subarea. At the subarea summary level, both Nashville and Clarksville are anticipating relatively large increases, in the 65% to 75% range. Modest total employment gains are anticipated in the Chattanooga subarea as well. Chattanooga is projected to grow from 273 thousand employees in 2010 to 333 thousand in 2040 for a 22% relative change. Currently, total employment is concentrated in the Nashville subarea which is evidenced by the 1.0 million employees out of 1.4 million corridor-wide employees working there. Future year 2040 population projections indicate that 1.8 million employees out of a corridor-wide total of 2.2 million are expected to work in the Nashville subarea.

Table 4.10: 2010 to 2040 Employment

I-24 Corridor Analysis Subareas	Total Employment		
	2010	2040	2010/2040 Change
Clarksville	81,610	137,853	69%
Nashville	1,010,912	1,755,526	74%
Chattanooga	273,475	332,523	22%
Corridor-wide Totals	1,365,997	2,225,902	63%

Sources: Atkins, US Census Bureau, Metropolitan Planning Organizations, University of Tennessee and I-24 Travel Demand Model

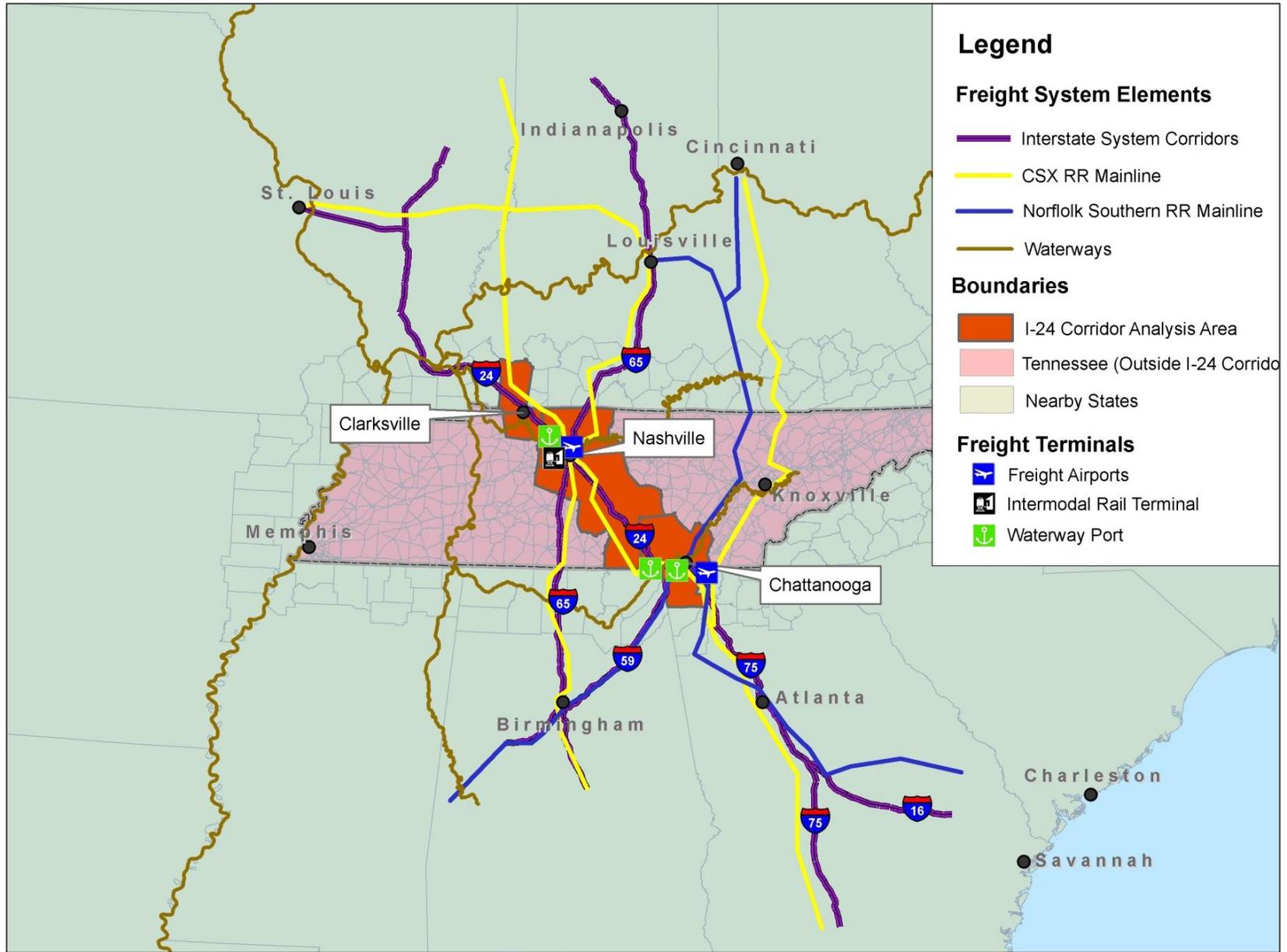
4.4 Freight System

To get a sense for how much diversion from truck to rail may be possible in the future, the core of the existing freight system in 2010 will be identified along with some key roadway and rail improvements that are anticipated in the future. A comparison of planned highway corridor improvements with rail system improvements will provide some insight to assessing how much freight could reasonably be expected to divert from truck to rail.

4.4.1 Existing Freight Assets

The current core, freight network and assets influencing transport mode choice in the I-24 Corridor are presented in Figure 4.7. I-24, itself, stretches across Tennessee in the center of the I-24 Corridor. It has major Interstate-to-Interstate interchange access with I-65 and I-40 in Nashville, I-75 in Chattanooga and I-59 nearly 10 miles west of Chattanooga. There are other freeway-to-freeway interchanges between I-24 and several Tennessee state highways. In addition to access with other roads, I-24 in Nashville lies adjacent to CSX's Radnor Yard which operates an intermodal rail-truck container service that serves the Greater Nashville region. Nashville International Airport and Chattanooga's Lovell Field provide freight services by air. I-24 is not the primary access route for these air freight terminals, but is not more than 10 miles from either of them. Industrial parks with warehousing and truck terminals located along I-24 near both airports serve as transshipment terminals for cargo shipped by truck and air. Freight-dominant industrial parks with storage and truck terminals are located along the entire length of I-24, from Chattanooga to Clarksville. They are concentrated, however, in the Nashville area especially between downtown Nashville and Murfreesboro.

Figure 4.7: Existing Freight Assets



Two large Class I rail carriers provide freight services through the I-24 Corridor. However, inside the I-24 Corridor, CSX is the only Class I rail carrier. CSX partners with a number of smaller, shortline or feeder railroads in the corridor. They are listed with their service areas in Table 4.11 below.

Table 4.11: Shortline Railroads in I-24 Corridor

Name	Service Area
RJ Gorman	Clarksville
Nashville & Western	Ashland City, Nashville
Nashville & Eastern	Cookeville, Lebanon, Nashville
Caney Fork & Western	Sparta, Manchester, Tullahoma
Chattanooga Belt	Chattanooga
Chattanooga & Chickamauga	Lafayette, GA, Chattanooga

CSX has three major north-south rail lines that can be used to transport goods through the I-24 Corridor while Norfolk Southern, the other Class I rail carrier, owns one rail line to transport goods through the corridor. One of the CSX routes and Norfolk Southern’s route are located in the I-75 Corridor as opposed to the I-24 Corridor but, these two routes are capable of moving north-south freight shipments that could also be shipped by truck in the I-24 Corridor.

The Cumberland River and Tennessee River, in combination with the Tennessee-Tombigbee and Mississippi River waterways also provide barge service for transporting commodities in the I-24 Corridor. In this freight diversion analysis, it is assumed that commodities currently shipped by truck will not divert to barges in the future.

4.4.2 Planned Improvements

There are highway, rail and waterway improvements planned in the corridor. They are not all equally developed, in terms of consensus building, design and funding. In fact, there is uncertainty associated with the actual implementation of many of the planned freight system improvements. In light of funding constraints and other implementation issues, it is unclear if any single mode would be favored such that a shift would occur within the existing freight mode split for the I-24 Corridor. An illustrative list containing some of the freight improvements being planned for the I-24 Corridor are listed in Table 4.12.

These are planned improvement projects and programs that have been advocated by a number of different sponsors. Nearly all of them have funding and political obstacles to a degree that will affect the scale of the project, schedule and ability of sponsors to implement other projects.

Table 4.12: Planned Freight System Improvements

Mode	Project/Program Description
Highway	US41/Murfreesboro Road (widen to 7-lanes)
	I-65 from I-40 to SR-255/Harding Place (widen to 8-lanes)
	I-24/I-65 on shared alignment north and south of W. Trinity Lane (add lanes)
	I-24 from KY state line to SR-76 in Clarksville area (widen to 6-lanes)
	I-24/I-75 Interchange reconstruction and improvements in Chattanooga
	I-24 from US27 to I-75 in Chattanooga (add lanes)
	I-24 from US27 to I-59 in Chattanooga area (add lanes)
	Statewide – expand facilities for truck parking
Rail	CSX – Relocate and expand intermodal container facility in Nashville
	Norfolk Southern –Crescent Corridor improvements project (Norfolk, Va. To New Orleans)
	TN Shortline Rehabilitation (improve track infrastructure to accommodate standard Class I size railcars)
Waterway	Kentucky Lock Addition (Tennessee River near Paducah, KY)
	Chickamauga Lock and Dam (Tennessee River, north of Chattanooga)
	Ten-Tom Intermodal (container) Corridor, AL and MS

There are other factors, beyond freight system project/program improvements that could influence mode split in the I-24 Corridor. Some of these include trade agreements between the U.S. and foreign countries, improvements to port facilities outside of the I-24 Corridor, the Panama Canal expansion, fuel prices, wages, manufacturing processes, changes in technology and shifts in commodity flow movements.

Multi-state and public-private partnerships that arise in response to economic conditions that shape the most efficient methods of shipping can be valuable institutional assets to effect change. Tennessee and its major freight carriers have a history in these kinds of institutions and public-private partnerships. Institutionally, Tennessee DOT has worked in cooperation with the FHWA and neighboring DOT’s to construct the I-69 International Trade Corridor. The Tennessee Valley Authority (TVA), Appalachian Regional Commission (ARC) and several Tennessee-Tombigbee Waterway organizations are involved in multi-state transportation investments. Both Class I rail carriers, CSX and Norfolk Southern, are in the midst of implementing large-scale multi-state, public-private, rail corridor improvements to enhance their intermodal container freight services. CSX is implementing the National Gateway project

and Norfolk Southern the Crescent Corridor. Both major investments, however, are targeting freight markets whose origin and destination pairs are located outside of the I-24 Corridor.

4.5 Diversion Analysis

After assessing the current and future status of several factors influencing the mode split of freight shipped into, out of and through the I-24 Corridor, there is not enough evidence to believe that current shares of freight shipped by truck, rail and barge will significantly change in the future. IHS Global Insights, Inc., an industry leader in global trade and commodity flows, forecasted that the share of freight shipped by truck in the I-24 Corridor would increase from 43% to 50% in the 2010 to 2040 time frame. IHS Global Insights' forecast is partially influenced by the corridor study team's choice of geography to define commodity shipments within and through the I-24 Corridor for this study.

This section provides a concise summary of several different factors that contribute to the determination of how freight will be shipped inside and through the I-24 Corridor in the future. That summary is used to provide a framework to define three travel demand model scenarios that will be used to show how different levels of freight diversion would influence traffic operations in the I-24 Corridor.

4.5.1 Future Freight Demand and Projected Mode Splits

From 2010 to 2040, IHS Global Insights, Inc. projected freight shipments inside and through the I-24 Corridor to jump 73%, from 1.1 billion to 1.9 billion annual tons. This particular forecast is approximately 7 years old now, but many of the same forecasting indicators used in that projection are still applicable today. One of the primary objectives of this analysis is to determine how the additional 800 million tons of cargo will be transported in the future. Is it reasonable to assume that essentially the same mode split that was calculated in 2010 will continue 30 years into the future? Or, do we foresee a shift from truck to rail heading into the future? IHS Global Insights, Inc. projected a 7% shift of freight away from rail to truck as tabulated by the I-24 Corridor study team. In assessing the likelihood of diversions in the future, this analysis focuses on truck and rail. It assumes that the mode share of cargo shipped by barge will be the same in the future as it is now.

4.5.2 Diversion by Commodity Group Types

Total commodity flow was grouped into eleven (11) commodity groups as defined in Section 4.2. In terms of total annual tonnage shipped inside and through the I-24 Corridor, the three commodity groups with the largest forecasted increases between 2010 and 2040 were: (1) Mixed Shipments (41 million); (2) Construction and Mining (29 million); and, (3) Machine (11 million). Each of the 11 commodity groups used in TDOT's freight model contains dozens of specific commodity types. Each of those individual commodity groupings is associated with its own industry-specific or population center supply chains. For each of the three high-growth commodity groups listed above, the largest individual commodity types shipped by truck, rail or intermodal transport are reported in Table 4.13 for base year 2010. For example, the largest

Table 4.13: Detailed 4-Digit STCC Categories By Freight Mode

Commodity Group	Detailed Commodity Type By Freight Mode		
	Truck	Rail	Intermodal
Mixed Shipments	Warehouse & Distribution Center (75 million tons)	None	Fak Shipments (14.2 million tons)
Construction & Mining	Broken Stone or Riprap (71.5 million tons)	Bituminous Coal (120 million tons)	Tires or Inner Tubes (0.2 million tons)
Machine	Motor Vehicle Parts Or Accessories (8 million tons)	Motor Vehicles (7.2 million tons)	Motor Vehicle Parts Or Accessories (0.3 million tons)

Source: IHS Global Insights, Inc., Cambridge Systematics, Inc. and Atkins

individual commodity type in the Mixed Shipment group transported by truck is called “Warehouse & Distribution Center”. Under the rail mode, there is not a specific commodity type in the top 10 list for the Mixed Shipment commodity group. There could be a relatively high volume commodity type for railcars in the Mixed Shipments group, but its annual tonnage would fall beneath 5.6 million tons. “Bituminous Coal” is in the Construction & Mining group and currently accounts for 120 million annual tons of freight shipped by rail in the I-24 Corridor, as defined by the study team. The only specific commodity type to show up under two modes is “Motor Vehicle Parts or Accessories”. Trucks transport 8 million tons annually while Intermodal shipments of “Motor Vehicle Parts or Accessories” total just 0.3 million tons.

The largest forecasted increases from 2010 to 2040 in terms of tonnage by commodity group are: ‘Mixed Shipments’; ‘Construction and Mining’; and, ‘Machine’. The category ‘Mixed Shipments’ includes specific commodity types shipped by truck and intermodal. There could be a significant amount of railcar shipments, as well, although ‘Mixed Shipments’ were not evident in rail’s top 10 list of specific commodity types. Tabulations of the Transearch database comparing 2010 and 2040 commodity flows by commodity group and mode indicate that ‘Mixed Shipments’ transported by intermodal will gain market share in relation to truck. Using intermodal, as opposed to truck, means that there should be some freight diversion from truck to rail between large metropolitan areas but not necessarily inside metropolitan areas. The net diversion between trucks and rail in the future will actually be based on the cumulative sum of truck-rail mode splits for hundreds of specific 4-digit STCC commodity types.

4.5.3 Shipping Distance

Shipping distance is a determinant of transport mode, much like individual commodity types. Commodities shipped ‘THRU’ the I-24 Corridor, in a north-south or south-north direction of flow, are more likely to be transported by rail than the ‘INTERNAL’, ‘IEIN’, and ‘IEOUT’ O-D commodity flow orientations. Base year 2010 freight mode splits and annual tonnages are

reported in Table 4.14 for the four kinds of commodity flow O-D movements described in Section 4.2. Commodities shipped ‘THRU’ the corridor total 145.5 million annual tons in comparison with just 22.8 million ‘INTERNAL’ annual tons which is the second largest O-D orientation.

Table 4.14: 2010 Mode Split by O-D Orientation of Shipment

O-D Orientation	Truck		Rail		Intermodal		Total Tonnage (millions)
	Tonnage (millions)	Mode Share	Tonnage (millions)	Mode Share	Tonnage (millions)	Mode Share	
INTERNAL	22.7	100%	0.1	0%	0.0	0%	22.8
IEIN	8.5	70%	3.1	25%	0.6	5%	12.2
IEOUT	8.1	87%	0.6	6%	0.6	6%	9.3
THRU	62.2	43%	79.2	54%	4.0	3%	145.4

Source: IHS Global Insights, Inc., Cambridge Systematics, Inc. and Atkins

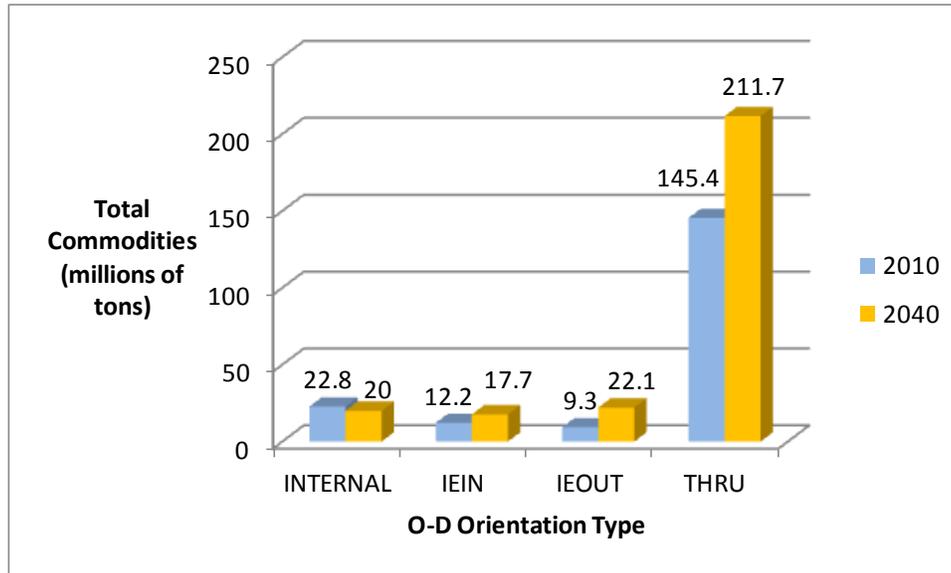
‘THRU’ freight movements by means of rail accounts for 54% of the tonnage while trucks haul 43% and intermodal gets a 3% market share. The current rail share consists primarily of north-south Bituminous Coal shipments transported from eastern Kentucky to destinations south of Tennessee.

Freight shipments inside the I-24 Corridor, like commodity movements between Chattanooga and Nashville or Clarksville and Nashville, experience the lowest rail mode share. Virtually 100% of ‘INTERNAL’ O-D movements are made by truck. For inbound freight shipments, ‘IEIN’, the mode share for trucks is 70% and for outbound freight, ‘IEOUT’, trucks haul 87% of total tonnage.

Out of the four different O-D movement orientations, long distance ‘THRU’ freight movements are forecast to increase most from 2010 to 2040 in terms of tonnage. A comparison of 2010 and 2040 commodity flows by O-D movement orientation is shown in Figure 4.8 for truck, rail and intermodal shipments. ‘THRU’ movement freight shipped by truck, rail and intermodal is projected to increase by 66.3 million tons between 2010 and 2040, from a base of 145.4 in 2010 to 211.7 million tons in 2040. The highest market shares for rail are currently associated with the ‘THRU’ O-D commodity flow orientation. The fast growing share of freight by intermodal transport is highest in the ‘IEIN’ and ‘IEOUT’ O-D orientations.

The large market share and relative growth of ‘THRU’ movements in the I-24 Corridor highlights the point that meaningful freight diversion strategies that are designed to relieve truck traffic off the Interstate System require federal, multi-state and public-private partnerships.

Figure 4.8: 2010-2040 Commodity Flow Tonnages by O-D Orientation



Source: IHS Global Insights, Inc., Cambridge Systematics, Inc. and Atkins

4.5.4 Demographics

Population and total employment estimates for the Chattanooga, Nashville and Clarksville subareas inside the I-24 Corridor generally support projected commodity flow increases made by IHS Global Insights. Base year 2010 and future year 2040 demographic projections were made by the metropolitan planning organizations (MPO's) to support their long range transportation planning processes. Demographic projections for pockets of the I-24 Corridor located outside of metropolitan areas were compiled using University of Tennessee estimates and subsequently refined by TDOT and Atkins to support statewide travel demand modeling activities.

Population change projections provide an indication of how total consumption will change in the future, as well as how much additional freight transport will be needed to deliver goods into the region. In the I-24 Corridor, population is projected to grow by nearly a million people from 2010 to 2040. Inside the Nashville subarea alone, an estimated 800,000 additional persons are expected. Both Chattanooga and Clarksville were forecast to grow by almost 100,000 persons during that time frame.

Total employment is a gauge that generally predicts both consumption and the production of goods. Large sectors of total employment, like manufacturing especially, along with other employment categories like mining, agriculture, food processing, chemical and transportation/distribution are predictors of how much freight will be exported outside of the region. Total employment from 2010 to 2040 throughout the I-24 Corridor is forecast to rise by 800,000 which is generally supportive of the commodity flow forecasts. Most of the additional employment is anticipated in the Nashville area, over 700,000. Total employment in

Chattanooga and Clarksville is projected to increase in the 50,000 to 60,000 range between 2010 and 2040.

Population and total employment numbers forecasted for the I-24 Corridor are consistent with IHS Global Insights' commodity flow projections, except for the 'INTERNAL' O-D orientation market segment. The methodology and data sources that IHS Global Insights uses to prepare its Transearch commodity flow data bases does not allow for an accurate estimate of freight movements inside metropolitan areas. Its methodology omits a significant portion of the local distribution of goods inside of metropolitan areas. This does not affect existing mode shares for rail and intermodal, but it does underestimate tonnages shipped by trucks between origins and destinations located inside the I-24 Corridor.

4.5.5 Freight Assets

While the volume of freight being shipped within and through the I-24 Corridor is clearly expected to significantly increase, the coverage and capacity of freight assets to keep pace is less clear. Making investments to improve and expand the reach of the freight system is a shared responsibility between public and private institutions. Based on the study team's understanding of public revenue sources that can be allocated to highway improvements or expansions and in light of publicized private sector projects to improve rail and port facilities in the I-24 Corridor, known future changes in the supply of freight assets does not appear to favor any particular freight mode over another.

A review of current and future freight system conditions and assets are summarized below by mode.

Highway and Trucks

Based on TDOT's current plans, we anticipate that state and local governments will have resources to maintain its roads and bridges in satisfactory state of repair. In addition, we anticipate there will be funding to incorporate demand management and intelligent transportation strategies as well as to make a limited number of localized operational and safety types of improvements. Examples of these kinds of improvements are: operational and safety improvements on I-24/I-40 near Fesslers Lane in Nashville; modifying the I-24/I-75 interchange in Chattanooga; expanding carpool lots; and providing more parking spaces at rest areas for trucks.

In terms of the diversion analysis, it is assumed there will not be funding from TDOT and local governments to widen long stretches of I-24, widen parallel highways or build new roads. Moreover, we assume that the current level of truck regulations pertaining to truck routes, height, weight and size restrictions remain unchanged moving into the future.

The net result of these assumptions on freight shipments by truck in the I-24 Corridor is that congestion will spread and gradually worsen which will tend to increase the unit cost motor carriers will need to charge. This will not affect all truck movements, however, since many cargo shipments will have no feasible alternative to motor carriers.

Warehousing and Distribution Centers

As levels of population and economic activity increase inside the I-24 Corridor there will be demand for more warehousing and distribution centers. For purposes of this analysis, it is assumed that the private sector, with cooperation from the state and local governments, will generally provide this kind of freight infrastructure and in proximity to the Interstate System or limited access facilities like SR-840.

The net result of this assumption on freight shipments by truck in the I-24 Corridor is that there will be added capacity for storage and subsequent distribution. Moreover, there should eventually be some benefits to intermodal rail-truck shipments. It is assumed that CSX will build a larger intermodal rail-truck terminal outside of downtown Nashville prior to our plan horizon year of 2040 that will trigger development of a large-scale warehousing and distribution center. This kind of investment and development should add a lot of capacity for more commodity flow movements by intermodal rail-truck services in the Nashville region.

Rail and Intermodal

Outside of relocating and expanding the existing CSX intermodal terminal in Nashville, the study team assumes there will be no major rail capacity or other facility investments directly in the I-24 Corridor. It is assumed that the State of Tennessee will continue to provide financial support for short line railroads that interface with Class I rail carriers in the corridor and that basic maintenance, repair of tracks, signals and switching yards.

While Norfolk Southern does not own tracks physically inside the I-24 Corridor, it does deliver north-south rail service through the I-24 Corridor on tracks located to the east, near the I-75 corridor. CSX owns and operates a line that runs through the entire length of the I-24 Corridor from Chattanooga to Clarksville and provides a more direct route for freight shipments from Atlanta to Midwestern cities like St. Louis, Chicago and Louisville. Nevertheless, Norfolk Southern's service from Atlanta to those same Midwestern cities along the I-75 corridor competes with CSX for many of the same commodities that can be shipped by rail or intermodal 'THRU' the I-24 Corridor. Norfolk Southern is investing in new intermodal facilities near to the I-24 Corridor, in Birmingham, Knoxville and Memphis as part of their Crescent Corridor project.

The net effect of known improvements to rail infrastructure on Class I and short line carriers operating in the I-24 Corridor is minimal. In relation to freight shipments by truck, it appears that there is excess capacity in the rail network for north-south 'THRU' O-D movements and that rail carriers' unit costs will be stable through the 2010 to 2040 time frame. Added intermodal service capacity in Nashville should provide an advantage for intermodal rail-truck services in the 'IEIN' and 'IEOUT' O-D orientation markets in relation to truck-only service.

Waterway

The Cumberland River and Tennessee River, in combination with the Tennessee-Tombigbee and Mississippi River waterways provide freight services by barge for transporting commodities in and through the I-24 Corridor. There are some ongoing and planned waterway improvement

projects as noted in Section 4. For the purposes of this freight diversion analysis, the study team is assuming that commodities currently shipped by truck will not divert to barges in the future and that freight currently shipped by barge will not divert to motor carriers.

Trade Developments

Globalization of industries and trade is contributing to commodity flow levels. The United States engages in treaties, like the North American Free Trade Agreement (NAFTA), which encourages trade with foreign countries. As a consequence of globalization, a growing share of imports and exports pass through highway, rail and deepwater ports of entry. The net result of trade agreements and globalization in the I-24 Corridor and elsewhere in Tennessee appears to be high growth in commodity shipments that are transported 'THRU' travel corridors.

Expansion of the Panama Canal, expected to be completed in 2015, is a consequence of the globalization of trade. This project will have an impact on how imports and exports move through supply chains in the eastern United States. Its impact on the I-24 Corridor, however, is not clear to the study team at this time. For purposes of the diversion analysis, the Panama Canal expansion had a neutral effect on the mode shares of freight shipped into and through the I-24 Corridor.

While trade patterns change in response to increasing globalization, manufacturing and production processes are changing to produce more efficient businesses. These kinds of changes in business practices tend to place more emphasis on customer service, timely distribution and reliability of freight providers as opposed to their unit shipping costs.

The net effect of trade patterns assumed herein does not favor any particular mode. A higher proportion of freight being shipped long distances appears to favor rail and intermodal transport over motor carriers. The counterpoint is that evolving manufacturing and business processes appear to favor truck-only transport over rail and intermodal shipping services.

4.5.6 Potential Impacts on I-24 Operating Conditions

It is not clear how existing mode shares of freight shipped into, out of and through the I-24 Corridor will be affected by current trends and planned freight system changes. Nearly all freight movements having an origin and destination inside the I-24 Corridor are shipped by truck and are expected to be transported by truck in the future. For longer distance freight movements, there may be small changes to the existing truck-rail-intermodal mode split in the future. It just isn't clear whether the share of freight shipped by trucks will increase or if shares of rail or intermodal service will increase.

A high increase in average weekday large truck volumes were forecast by the I-24 Corridor travel demand model into the future. Percentage truck growth from 2010 to 2040 varies from 40% to 83% on sections of I-24. Modeled 2010 and 2040 average daily truck volumes for selected sections of I-24 are reported in Table 4.15. According to the travel demand model, the highest load sections for large trucks on I-24 are the shared sections with I-40 and I-65 in Nashville. On the shared section with I-40, around Fesslers Lane, the future year 2040 forecast

is 23,000 trucks per day. The average weekday truck volume on the shared section with I-65, around Trinity Lane, is projected to reach 28,000 in 2040.

Table 4.15: 2010-2040 Modeled Daily Truck Volumes on I-24

I-24 Section	County	Modeled Daily Truck Volumes		2010/2040 Change
		2010	2040	
Between I-59 and Chattanooga	Hamilton	10,000	16,000	60%
Between Manchester and Murfreesboro	Coffee	6,000	11,000	83%
I-24/I-40 in Nashville	Davidson	13,000	23,000	77%
Between Nashville and Clarksville	Cheatham	10,000	14,000	40%

Source: I-24 Corridor Travel Demand Model and Atkins

Future year 2040 truck volumes are from the 2040 E+C (enhanced) model scenario

The largest modeled 2010 to 2040 percentage increase occurs in Coffee County, on sections of I-24 between Manchester and Murfreesboro, where daily truck volumes increase by 83%. The absence of heavy peak period traffic congestion on I-24 between Murfreesboro and Manchester in the future is a factor in the strong truck growth from 2010 to 2040.

Modeled base year and future large truck volumes presented in the table above should be used as routing and growth indicators recognizing that many other factors, in addition to those incorporated in the travel demand model, determine the actual routing of trucks onto a highway network. The I-24 Corridor travel model assigns trucks to the highway network using an algorithm that applies a 'shortest path' route between an origin and destination. In actual practice, truckers and logistics specialists do not always route freight using a 'shortest path' technique.

Based on the high truck volumes forecast on sections of I-24 in the future, TDOT will be interested in determining what kind of operational improvements could be expected from freight diversion from truck to rail in the future. Recognizing the portrait of future conditions that influence mode split and in the absence of more public-private intervention, it is just as likely that some freight shipped by rail could switch to truck. With this background, three different future year freight diversion scenarios were tested to determine what impact each would have on operating conditions experienced on I-24.

4.5.7 Model Scenarios

Three reasonably likely freight diversion scenarios were defined and tested to determine how much impact different levels of diversion would have on traffic conditions in the I-24 Corridor. Each diversion scenario was created using the 2040 E+C highway network and the future year 2040 trip tables. The 2040 E+C model scenario was used to benchmark baseline traffic conditions on I-24. Each of the three test scenarios is explained below.

1. +5% Freight Diversion - This travel model scenario was created to reflect a 5% diversion of trucks off of I-24 and onto rail.
2. +10% Freight Diversion - This travel model scenario reflects a 10% diversion of trucks off of I-24 and onto rail.
3. -5% Freight Diversion - This travel model scenario was created to reflect a 5% increase in I-24 truck trips as a result of freight diversions from rail.

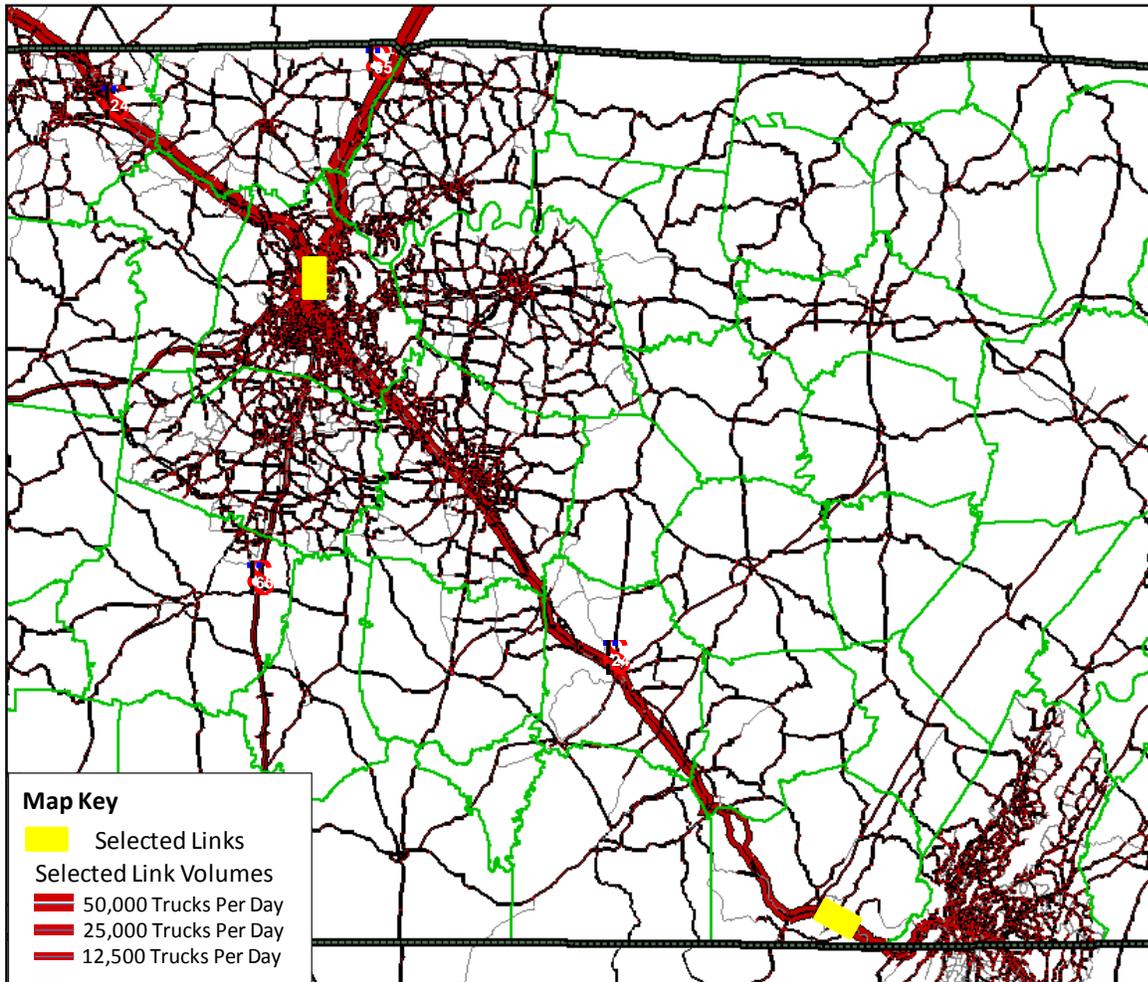
The first scenario, +5%, is a reasonable consequence of how the freight mode split could change assuming the portrayal of future conditions outlined herein. The second model scenario, +10%, is representative of the level of future diversion that could result if a more aggressive program of incentives designed to shift freight from truck to rail were to be implemented in the future. In the study teams' opinion, the third scenario of -5%, is also a reasonable outcome assuming that future conditions for freight diversion remain unchanged with respect to the current level of planned investments by mode in the I-24 Corridor.

The model freight diversion scenarios were created by means of modifying the future year 2040 truck trip table. No other I-24 Corridor model parameters were modified. Modifications to the 2040 truck trip table came from a multi-link selected link trip table filled with truck trips that were picked off the highway network at two locations on I-24. The two selected link locations and a bandwidth flow map of total select-link truck trips assigned to highway network links is presented in Figure 4.9. In the modeled freight diversion scenarios, only 5% or 10% of total truck trips in the selected link trip table are used to modify the baseline 2040 truck trip table.

The two selected links were located on the following two sections of I-24:

- Between W. Trinity Lane and the northernmost I-24/I-65 split in north Nashville; and,
- At Nickajack Lake south of Jasper and South Pittsburgh.

Figure 4.9: Traffic Assignment of Selected Links Truck Trip Table



4.5.8 Model Findings

Diversions of freight from trucks using I-24 to rail on the order of 5% will have minimal impact on I-24's operating conditions according to the I-24 Corridor travel demand model. Model results describing the relative impacts that each freight diversion scenario will have on I-24 are reported in Table 4.16. Performance statistics reflect traffic conditions for autos and trucks combined over the entire length of I-24 on an average weekday based on forecasted future year 2040 travel demand and essentially the same capacity on I-24 that existed in the base year 2010. Bar charts highlighting differences in performance between diversion scenarios are presented in Figure 4.10 and Figure 4.11 for 'Average Daily Travel Speed' and 'Total Daily Delay', respectively.

Table 4.16: Modeled Performance Measures for Freight Diversion Scenarios

Modeled Performance Statistics	E+C Scenario (Baseline)	Diversion Scenario 1 (+5%)	Diversion Scenario 2 (+10%)	Diversion Scenario 3 (-5%)
Total Daily VMT (in 1,000's)	12,431	12,455	12,478	12,418
Total Daily VHT (in 1,000's)	334	332	332	335
Avg. Daily Travel Speed (in mph)	37	37	38	37
Total Daily Delay (in 1,000's)	145	144	143	147

Source: I-24 Corridor Travel Demand Model, Atkins

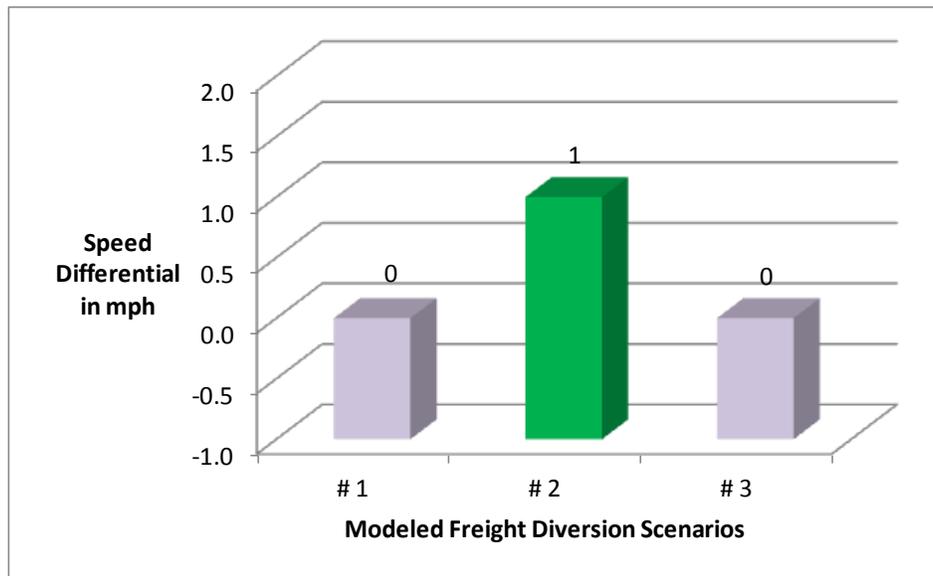
Notes: VMT – Vehicle Miles of Travel for all vehicles using I-24 (in units of ‘vehicle miles’)

VHT – Vehicle Hours of Travel for all vehicles using I-24 (in units of ‘vehicle hours’), where the time component of VHT is calculated using a weighted average of free-flow speed and average peak period speed.

Total daily delay is in units of hours and applies to all vehicles using I-24

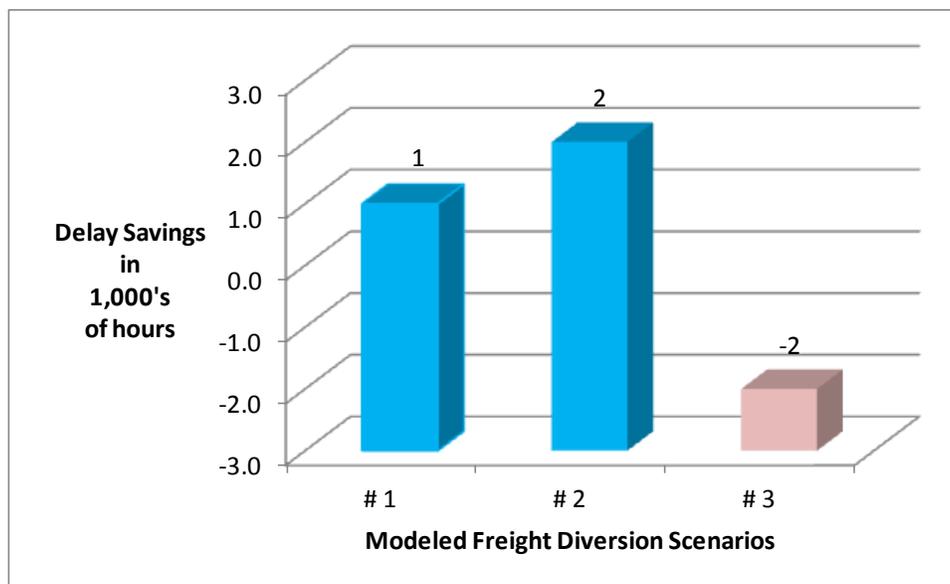
‘Diversion Scenario 1’, a 5% reduction of large trucks on I-24, does not change the average daily travel speed on I-24. The average daily travel speed is 37 mph in Scenario 1 and is also 37 mph in the baseline condition. Although average daily travel speeds remain virtually the same, Scenario 1 does reduce daily delay on I-24 by approximately 1,000 hours in comparison with the baseline condition. While slightly lower total delay time is an improvement in operating conditions, it does not translate into a significant time savings for individual motorists. Total daily VMT on I-24 increases under ‘Diversion Scenario 1’ which may seem counter-intuitive since there are fewer truck trips than in the baseline condition. This outcome implies that 2040 travel demand is so much greater than available capacity in the I-24 corridor that trucks diverted from I-24 will be quickly replaced with auto and truck trips that were not using I-24 prior to the assumed truck-rail diversion.

Figure 4.10: Corridor-Wide Change in Daily Travel Speed by Diversion Scenario



'Scenario 2', the 10% reduction, does actually reduce average travel speed by 1 mph and daily delay by 2,000 hours. Better performance from freight diversion is stifled because autos and trucks not using I-24 prior to the diversion will replace the diverted trucks. There are 47,000 more vehicle miles of travel in 'Scenario 2' than the baseline condition, even though 10% of trucks on I-24 were removed from the 2040 truck trip table.

Figure 4.11: Corridor-Wide Travel Time Savings by Diversion Scenario



Model results for diversion 'Scenario 3', a 5% increase in large trucks on I-24, reveals how I-24 will perform if the mode share of trucks increases. There is no impact on overall average daily travel speed over the length of I-24 inside Tennessee. However, total daily delay was projected to increase by 2,000 hours. The increase of trucks on daily vehicle miles of travel was again counter-intuitive. Daily VMT dropped by 13,000 vehicle miles in relation to the baseline.

5.0 Project Screening

The LRTP and proposed projects presented in Sections 2 and 3 were evaluated using a screening process to help determine their feasibility. In this section, projects were screened for cost, potential environmental impact, potential economic impact and estimated benefit-cost ratio. Based on these screening elements, projects were then recommended for prioritization in Section 6 or recommended for elimination from further consideration. The subsections below describe the screening process completed for the three major categories of projects: 'Capacity Projects On I-24,' 'Capacity Projects Off I-24,' and 'Operational' improvements (i.e., all other improvements).

5.1 Capacity Projects On I-24

The first category of projects that were screened involve capacity improvements, or additional lanes, on I-24. These projects are grouped, for presentation purposes, by MPO 'Long Range Transportation Plan' (LRTP) projects and 'Proposed' projects.

5.1.1 Estimated Costs

Planning-level costs were estimated for all LRTP and proposed projects using TDOT's 2013-2014 Cost Data Sheet unit costs (see Appendix A). Cost estimates are provided for right-of-way (ROW), construction, preliminary engineering (PE), and contingency costs and are sensitive to area type (i.e., urban, residential, rural, etc.), terrain (i.e., flat, rolling, mountainous, etc.) and type of construction (i.e., new versus modifying existing). Cost estimates also take new or modified bridges into consideration. It should be noted that the actual costs may be higher or lower than the planning-level costs presented in this study based on more detailed analysis of these projects.

Table 5.1 presents the estimated costs in 2013 dollars for the 'LRTP Capacity Projects On I-24' and Table 5.2 presents the estimated costs in 2013 dollars for the 'Proposed Capacity Projects On I-24'. The total estimated costs for the 'LRTP Capacity Projects On I-24' range from \$13.7 million to \$223.8 million, while the total costs for the 'Proposed Capacity Projects On I-24' range from \$32.6 million to \$142.2 million.

Table 5.1: Estimated 2013 Costs for LRTP Capacity Projects On I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
169	Montgomery	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between TN State Line to SR-76 (Exit 11), 10.6 miles	10.6	\$144,888,964	\$ 22,872,150	\$ 97,613,451	\$ 9,761,345	\$ 14,642,018
170	Montgomery / Robertson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between SR-76 (Exit 11) to SR-256 (Exit 19) in Robertson County, 8.6 miles	8.6	\$ 76,600,316	\$ 10,603,800	\$ 52,797,213	\$ 5,279,721	\$ 7,919,582
173	Davidson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) from I-65 to Old Hickory Boulevard (SR-45), Exit 40 - Exit 44, 4.5 miles	4.5	\$ 69,832,216	\$ 18,032,625	\$ 41,439,673	\$ 4,143,967	\$ 6,215,951
177	Davidson	I-24 Additional Lanes	I-24 Additional Lanes from I-24/I-65 junction (S of Fern Ave.) to Trinity Lane. Replace underpass to acc. 6 lanes in each direction. Exit 46 - Exit 87 (I-65), MP 45 for I-24, 1.1 miles	1.1	\$ 13,668,769	\$ 2,157,750	\$ 9,208,815	\$ 920,882	\$ 1,381,322
181	Hamilton / Georgia	I-24 Additional Lanes	Widen I-24 from 4 to 6 lanes from I-59 to US-27; fix structurally deficient bridge at I-24 and I-124, 10.4 miles	10.4	\$223,778,808	\$ 22,440,600	\$161,070,566	\$ 16,107,057	\$ 24,160,585
183	Hamilton	I-24 Additional Lanes	Widen I-24 from 6 to 8 lanes from US-27 to I-75; fix S. Seminole Dr. structurally deficient bridge over I-24 at top of Missionary Ridge, 5.5 miles	5.5	\$171,683,138	\$ 22,039,875	\$119,714,610	\$ 11,971,461	\$ 17,957,192

Table 5.2: Estimated 2013 Costs for Proposed Capacity Projects On I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
315	Robertson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-256 (Exit 19) to SR-49 (Exit 24), 5.3 miles	5.3	\$ 72,444,483	\$ 11,436,075	\$ 48,806,726	\$ 4,880,673	\$ 7,321,009
314	Robertson / Cheatham / Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-49 (Exit 24) to US-431/Whites Creek Pike (Exit 35), 10.4 miles	10.4	\$142,155,210	\$ 22,440,600	\$ 95,771,688	\$ 9,577,169	\$ 14,365,753
313	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-431/Whites Creek Pike (Exit 35) to SR-45/Old Hickory Boulevard (Exit 40), 3.3 miles	3.3	\$ 96,906,528	\$ 7,120,570	\$ 71,828,766	\$ 7,182,877	\$ 10,774,315
306	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-155/Briley Parkway (Exit 54) to Haywood Lane (Exit 57), 3.4 miles	3.4	\$ 46,473,819	\$ 7,336,350	\$ 31,309,975	\$ 3,130,998	\$ 4,696,496
307	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, Haywood Lane (Exit 57) to SR-171/Old Hickory Boulevard (Exit 62), 5.4 miles	5.4	\$ 73,811,353	\$ 11,651,850	\$ 49,727,601	\$ 4,972,761	\$ 7,459,141
308	Davidson / Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-171/Old Hickory Boulevard (Exit 62) to SR-102/Nissan Drive (Exit 70), 6.8 miles	6.8	\$ 92,947,637	\$ 14,672,700	\$ 62,619,950	\$ 6,261,995	\$ 9,392,992
309	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-102/Nissan Drive (Exit 70) to SR-840 (Exit 74), 4.8 miles	4.8	\$ 65,610,198	\$ 10,357,200	\$ 44,202,318	\$ 4,420,332	\$ 6,630,348
310	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-840 (Exit 74) to SR-96 (Exit 78), 3.7 miles	3.7	\$ 50,574,450	\$ 7,983,675	\$ 34,072,620	\$ 3,407,262	\$ 5,110,893
311	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-96 (Exit 78) to US-231/Shelbyville Highway (Exit 81), 3.3 miles	3.3	\$ 45,106,941	\$ 7,120,575	\$ 30,389,093	\$ 3,038,909	\$ 4,558,364
312	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-231/Shelbyville Highway (Exit 81) to Epps Mill Road (Exit 89), 7.6 miles	7.6	\$103,882,653	\$ 16,398,900	\$ 69,987,003	\$ 6,998,700	\$ 10,498,050
318	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-72/Lee Highway (Exit 152) to SR-27 (Exit 158), 6.7 miles	6.7	\$ 59,676,990	\$ 8,261,100	\$ 41,132,712	\$ 4,113,271	\$ 6,169,907
317	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-27 (Exit 158) to SR-156 (Exit 161), 2.7 miles	2.7	\$ 32,569,528	\$ 3,329,100	\$ 23,392,343	\$ 2,339,234	\$ 3,508,851
316	Marion / Hamilton	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-156 (Exit 161) to GA Border (MP 167), 5.6 miles	5.6	\$ 57,004,275	\$ 6,904,800	\$ 40,079,580	\$ 4,007,958	\$ 6,011,937

5.1.2 Environmental Screening

The purpose of this environmental screening analysis is to identify and quantify potential environmental impacts resulting from the proposed projects along I-24. The screening used data acquired from existing, readily available mapping and database sources. The screening boundaries included a 1,000-foot buffer (500 feet on either side) around the centerline of existing I-24 at each proposed project that would potentially need additional right-of-way (ROW).

The potential environmental resources that were screened for the purposes of this study were cultural resources (National Register of Historic Places (NRHP) listed sites and cemeteries), hazardous material sites reporting to the Environmental Protection Agency (EPA) (RCRA, CERCLIS, etc.), ecological resources (waters of the U.S, floodplains, and threatened and endangered species), and parks/recreation areas. Social resources identified in the Screening include potential Environmental Justice (EJ) populations (low-income and/or minority), churches and schools. The full results of the screening are presented in Appendix B, which provides the number of each environmental/social resource that fell within the 1,000-foot buffer (500 feet on either side of the existing centerline) of each applicable project.

It should be noted that the location of previously identified archeological sites is protected information and is only provided to Cultural Resource professionals conducting archaeological investigations. Therefore, information on previously identified archaeological sites was not included in this screening. It should also be noted that the identification of resources within the I-24 corridor was based on readily available mapping and may not correctly represent actual field conditions.

A ranking system was devised to determine the potential impacts for each project. Due to the overall low number of historic structures, parks, cemeteries, churches, schools, and floodplain crossings, potential impacts were ranked on all of these categories combined, and then separately by both the stream and wetlands within the project buffers. A ranking system was then applied to determine which projects may potentially have the most environmental impact.

The rankings for the historic structures, parks, cemeteries, churches, schools, and floodplain crossings were given a 'low' ranking if there were 0-10 potential impacts meaning these projects would have the least amount of impact, a 'moderate' ranking if they had 11-25 potential impacts and a 'high' ranking if they had above 25 potential impacts. As seen in Table 5.3 for the 'LRTP Capacity Projects On I-24', only project 183 had a high ranking, while the other projects all had a low ranking. As seen in Table 5.4 for the 'Proposed Capacity Projects On I-24', all the projects had a low ranking.

The ranking system for wetlands was based on the total number of acres of wetlands within each project buffer. A rank of 'low' was given to those projects that had between 0-58 acres of wetlands, a 'moderate' was assigned to projects that had between 59-115 acres and a 'high' was assigned to projects with more than 115 acres of wetlands within their project buffers. As

seen in Tables 5.3 and 5.4, only project 317 had a high ranking. Projects 181 and 318 had a moderate ranking and the remaining projects all had a low ranking.

The ranking system for streams was based on the total feet of stream within each project buffer. A rank of 'low' was given to those projects that had between 0-10,665 feet of stream, a 'moderate' was assigned to projects that had between 10,665 and 21,330 feet of stream and a 'high' was assigned to projects with more than 21,330 feet of stream within their project buffers. As seen in Tables 5.3 and 5.4, only project 316 had a high ranking while all the other projects had a moderate or low ranking.

Once each resource or group of resources was ranked, a number was assigned corresponding to the ranking. A one (1) was given to all 'lows,' a two (2) was assigned to 'moderate' ranks and a three (3) was assigned to all 'highs.' Each project's rankings were tallied based on these numerical values and assigned a final ranking based on the total. A final tally of 1-3 resulted in the project ranking as a 'low', meaning there is a lower chance of environmental impact for the project. A final tally of 4-6 resulted in the project ranking as a 'moderate,' meaning there is a moderate chance of adverse environmental impact, and projects scoring 7-9 received a 'high' ranking, meaning they had the most potential for environmental impact.

As seen in Tables 5.3 and 5.4, none of the 'LRTP' or 'Proposed Capacity Projects On I-24' received a high ranking but all projects received either moderate or low rankings. Therefore, it may be assumed that, based on the screening process, none of the 'LRTP' or 'Proposed Capacity Projects On I-24' likely has the potential to adversely impact the environment. However, projects 183, 316 and 317 should be monitored closely since each of these projects was given a 'high' ranking in one of the environmental screening categories. Please see Appendix B for a fuller presentation and explanation of the environmental screening analysis completed for the I-24 Corridor.

Table 5.3: Environmental Screening for LRTP Capacity Projects On I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Potential Environmental Impacts Rankings						
					Total Sites (including Floodplains)	Site Impact Ranking	Wetlands (In Acres)	Wetlands Impact Ranking	Streams (In Feet)	Streams Impact Ranking	Total Impact Ranking
169	Montgomery	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between TN State Line to SR-76 (Exit 11), 10.6 miles	10.6	9	Low	21	Low	13,256	Moderate	Moderate
170	Montgomery / Robertson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between SR-76 (Exit 11) to SR-256 (Exit 19) in Robertson County, 8.6 miles	8.6	2	Low	3	Low	9,077	Low	Low
173	Davidson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) from I-65 to Old Hickory Boulevard (SR-45), Exit 40 - Exit 44, 4.5 miles	4.5	6	Low	1	Low	16,119	Moderate	Moderate
177	Davidson	I-24 Additional Lanes	I-24 Additional Lanes from I-24/I-65 junction (S of Fern Ave.) to Trinity Lane. Replace underpass to acc. 6 lanes in each direction. Exit 46 - Exit 87 (I-65), MP 45 for I-24, 1.1 miles	1.1	1	Low	0	Low	3,146	Low	Low
181	Hamilton / Georgia	I-24 Additional Lanes	Widen I-24 from 4 to 6 lanes from I-59 to US-27; fix structurally deficient bridge at I-24 and I-124, 10.4 miles	10.4	10	Low	110	Moderate	21,018	Moderate	Moderate
183	Hamilton	I-24 Additional Lanes	Widen I-24 from 6 to 8 lanes from US-27 to I-75; fix S. Seminole Dr. structurally deficient bridge over I-24 at top of Missionary Ridge, 5.5 miles	5.5	28	High	5	Low	17,680	Moderate	Moderate

Table 5.4: Environmental Screening for Proposed Capacity Projects On I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Potential Environmental Impacts Rankings						
					Total Sites (including Floodplains)	Site Impact Ranking	Wetlands (In Acres)	Wetlands Impact Ranking	Streams (In Feet)	Streams Impact Ranking	Total Impact Ranking
315	Robertson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-256 (Exit 19) to SR-49 (Exit 24), 5.3 miles	5.3	0	Low	3	Low	1,227	Low	Low
314	Robertson / Cheatham / Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-49 (Exit 24) to US-431/Whites Creek Pike (Exit 35), 10.4 miles	10.4	1	Low	5	Low	18,586	Moderate	Moderate
313	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-431/Whites Creek Pike (Exit 35) to SR-45/Old Hickory Boulevard (Exit 40), 3.3 miles	3.3	2	Low	3	Low	20,812	Moderate	Moderate
306	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-155/Briley Parkway (Exit 54) to Haywood Lane (Exit 57), 3.4 miles	3.4	8	Low	6	Low	6,206	Low	Low
307	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, Haywood Lane (Exit 57) to SR-171/Old Hickory Boulevard (Exit 62), 5.4 miles	5.4	7	Low	1	Low	19,087	Moderate	Moderate
308	Davidson / Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-171/Old Hickory Boulevard (Exit 62) to SR-102/Nissan Drive (Exit 70), 6.8 miles	6.8	6	Low	3	Low	11,983	Moderate	Moderate
309	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-102/Nissan Drive (Exit 70) to SR-840 (Exit 74), 4.8 miles	4.8	3	Low	25	Low	3,810	Low	Low
310	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-840 (Exit 74) to SR-96 (Exit 78), 3.7 miles	3.7	2	Low	4	Low	2,133	Low	Low
311	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-96 (Exit 78) to US-231/Shelbyville Highway (Exit 81), 3.3 miles	3.3	2	Low	9	Low	1,591	Low	Low
312	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-231/Shelbyville Highway (Exit 81) to Epps Mill Road (Exit 89), 7.6 miles	7.6	8	Low	20	Low	11,238	Moderate	Moderate
318	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-72/Lee Highway (Exit 152) to SR-27 (Exit 158), 6.7 miles	6.7	2	Low	89	Moderate	17,374	Moderate	Moderate
317	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-27 (Exit 158) to SR-156 (Exit 161), 2.7 miles	2.7	3	Low	173	High	5,701	Low	Moderate
316	Marion / Hamilton	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-156 (Exit 161) to GA Border (MP 167), 5.6 miles	5.6	4	Low	19	Low	31,807	High	Moderate

5.1.3 Economic Impact Screening

The economic impact screening completed for this study is different from the other screening elements in that it evaluates packages/scenarios of projects, rather than individual projects. See Appendix C for a full presentation and explanation of the economic impact analysis completed for the I-24 Multimodal Corridor Study.

This subsection summarizes the results of the economic analysis of the job creation and economic stimulus that would be created by the several highway improvement scenarios under consideration in the I-24 Multimodal Corridor Study. It should be noted that this analysis assumes that all the LRTP and proposed projects included in Section 5 will be implemented by 2040. This will not likely happen. However, the relative values presented in this analysis are very informative and can be scaled to reflect the actual, or expected, expenditure of construction dollars on I-24 projects as well as the time benefits from these projects.

This analysis includes the effect of the expenditure of highway construction funds and the resulting, ongoing highway benefits for each modeled project package. The economic analysis is at a sketch planning level that gives approximate order-of-magnitude estimates of economic impacts. Two types of economic impacts are estimated:

- Economic output, earnings, and jobs from construction spending, which would occur during the construction periods for the scenarios (Table 5.5), and
- Economic output, earnings, and jobs from ongoing travel benefits in the corridor created by the analyzed scenarios, which would occur annually from project completion to the 2040 horizon year (Table 5.6).

This analysis uses RIMS II multipliers applied to estimated construction costs for the construction spending effects. An elasticity model was developed to predict effects on metropolitan area gross domestic product (GDP) for the ongoing highway benefits resulting from improved travel conditions on I-24. The methodology and assumptions are described in greater detail in Appendix C.

As shown in Table 5.5, construction spending is estimated to increase corridor economic output by approximately twice the total construction costs net of right-of-way costs or \$5.5 to \$6.4 billion for the two capacity increasing scenarios modeled: '2040 LRTP' + 'Proposed Capacity On I-24' and '2040 LRTP' + 'Proposed Capacity Off I-24'. Other less expensive scenarios would have correspondingly less economic output due to the lower construction spending, ranging from \$47 million for Proposed ITS Projects to \$2.0 billion for LRTP + Proposed Operation and Miscellaneous Projects (not modeled). The modeled 2040 LRTP + Proposed Operation and Miscellaneous Projects would have approximately \$920 million in economic output and the 2040 LRTP + Proposed New Access/Interchanges would have \$230 million in economic output. This economic output would be generated over the construction period of a scenario. Table 5.5 indicates the distribution of the economic output by analysis area based on the assumption that construction labor and supplies are local to each analysis area. In reality, output increases would tend to follow the locations of the construction labor and supply purchases in the corridor, which might not always be the same analysis areas where the projects are being constructed.

Table 5.5 also shows the estimated construction impact on earnings and jobs in the I-24 corridor. Earnings would range from \$1.9 to \$2.2 billion for the two capacity increasing scenarios and from \$16 to \$680 million for the other scenarios shown in Table 5.5. Direct, indirect, and induced jobs resulting from the construction spending are similarly estimated to

range from approximately 43,000 to 50,000 jobs (full-time annual equivalents or FTE) for the two capacity increasing scenarios and from approximately 363 to 15,000 jobs for the other scenarios shown in Table 5.5. Distribution of these jobs by time and analysis areas would be similar to that described above for economic output.

Table 5.5: Economic Impacts from Construction Costs for All Projects
Construction Impacts - Regional Economic Output, Total Earnings, and Jobs by Scenario and Analysis Region

Units are millions of 2013 dollars except for jobs, which are total full time equivalent jobs in one year

Scenario	Analysis Region (1)	Estimated Project Costs		Regional Economic Impact (2)		
		Total Cost	Cost w/o ROW	Economic Output	Total Earnings	Jobs
2040 E+C (modeled)	1	n/a	n/a	n/a	n/a	n/a
	2	n/a	n/a	n/a	n/a	n/a
	3	n/a	n/a	n/a	n/a	n/a
	Total	n/a	n/a	n/a	n/a	n/a
2040 LRTP + Proposed (modeled) Capacity On I-24	1	\$221	\$188	\$741	\$257	5,700
	2	\$873	\$737	\$2,903	\$1,008	22,337
	3	\$545	\$482	\$1,899	\$659	14,606
	Total	\$1,640	\$1,406	\$5,543	\$1,924	42,643
2040 LRTP +Proposed (modeled) Capacity Off I-24	1	\$459	\$398	\$1,570	\$545	12,082
	2	\$1,279	\$1,108	\$4,368	\$1,516	33,601
	3	\$152	\$130	\$512	\$178	3,941
	Total	\$1,890	\$1,637	\$6,450	\$2,239	49,623
2040 LRTP +Proposed (modeled) New Access/Interchanges	1	\$0	\$0	\$0	\$0	0
	2	\$60	\$58	\$227	\$79	1,743
	3	\$0	\$0	\$0	\$0	0
	Total	\$60	\$58	\$227	\$79	1,743
2040 LRTP+Proposed (modeled) Operational & Misc. Projects	1	\$0	\$0	\$0	\$0	0
	2	\$63	\$62	\$243	\$84	1,870
	3	\$177	\$172	\$679	\$236	5,225
	Total	\$239	\$234	\$922	\$320	7,095
LRTP+Proposed (not modeled) Operational & Misc. Projects	1	\$20	\$20	\$76	\$26	585
	2	\$254	\$248	\$979	\$340	7,533
	3	\$241	\$229	\$903	\$313	6,949
	Total	\$515	\$497	\$1,960	\$680	15,080
Proposed ITS Projects (not modeled)	1	\$0	\$0	\$0	\$0	1
	2	\$9	\$9	\$37	\$13	286
	3	\$3	\$3	\$10	\$3	76
	Total	\$12	\$12	\$47	\$16	363

Notes:

(1) Region:

- (1) Clarksville
- (2) Nashville
- (3) Chattanooga

(2) Source: Regional Input-Output Modeling System (RIMS II), Regional Product Division, Bureau of Economic Analysis, Atkins, 2013.

Table 5.6 presents economic output, earnings, and jobs for scenarios similar to Table 5.5, but in this case the effects are efficiency impacts estimated from the annual 2040 vehicle-hours-of-travel (VHT) savings for the scenarios. Because the corridor time savings have less impact on

the regional economy than the direct construction spending, which purchases actual goods and services, the annual economic benefits from time savings are less than those from the total construction spending. Typically the annual corridor benefits average 4% to 5% of the total construction spending benefits for the capacity increasing scenarios and higher for the interchange and operational and miscellaneous project scenarios. Because the annual corridor benefits occur every year after the projects are built, these benefits can equal or exceed the construction benefits over time.

Table 5.6 shows that improved travel efficiency in the I-24 corridor is estimated to increase corridor economic output by approximately \$296 to \$318 million in 2040 for the two capacity increasing scenarios modeled: '2040 LRTP' + 'Proposed I-24 Capacity On I-24' and '2040 LRTP' + 'Proposed Capacity Off I-24'. The modeled 2040 LRTP + Proposed Operation and Miscellaneous Projects would have approximately \$71 million in 2040 economic output and the 2040 LRTP + Proposed New Access/Interchanges would have approximately \$116 million in 2040 economic output. Two scenarios were not modeled and consequently have no estimates of VHT savings: the Proposed ITS Projects and the LRTP + Proposed Operation and Miscellaneous Projects (not modeled). The year 2040 is an index year that is higher than the earlier years of the analysis period beginning in 2013, indicating that efficiency benefits in the earlier years would be lower than in 2040. As did Table 5.5 for construction spending impacts, Table 5.6 indicates the distribution of the economic output from improved efficiency by analysis area based on the assumption that economic impacts of efficiency savings are local to each analysis area. Although the travel time savings were calculated for each analysis area, the impacts may spread further, depending on trip lengths in the corridor.

Table 5.6 also shows the estimated annual efficiency impact on earnings and jobs in the I-24 Corridor. Earnings in 2040 would range from about \$75 to \$81 million for the two capacity increasing scenarios and from \$18 to \$29 million for the other two modeled scenarios shown in Table 5.6. Direct, indirect, and induced jobs in 2040 resulting from the economic efficiency impacts of VHT savings are similarly estimated to range from approximately 1,800 to 1,900 jobs (full-time annual equivalents) for the two capacity increasing scenarios and from approximately 400 to 700 jobs for the other two modeled scenarios. Distribution of these jobs by analysis areas would be similar to that described above for economic output.

Table 5.6: Economic Impacts from Highway Efficiency for All Projects

Annual Highway Efficiency Impacts - Regional Economic Output, Total Earnings, and Jobs by Scenario and Analysis Region

Economic Impact units are millions of 2013 dollars except for jobs, which are total full time equivalent jobs in one year

Scenario	Analysis Region (1)	Weighted Daily VHT (2) (thousands)	Annualized VHT (2) (thousands)	% Change wrt E+C	Regional Economic Impact (3)		
					Economic Output	Total Earnings	Jobs
2040 E+C (modeled)	1	259	94,535	n/a	n/a	n/a	n/a
	2	3,201	1,168,365	n/a	n/a	n/a	n/a
	3	553	201,845	n/a	n/a	n/a	n/a
	Total	4,013	1,464,745	n/a	n/a	n/a	n/a
2040 LRTP + Proposed (modeled) Capacity On I-24	1	251	91,615	3.1%	\$28.9	\$7.4	174
	2	3,094	1,129,310	3.3%	\$254	\$65	1,531
	3	549	200,385	0.7%	\$12.7	\$3.2	77
	Total	3,894	1,421,310	3.0%	\$296	\$75	1,782
2040 LRTP +Proposed (modeled) Capacity Off I-24	1	254	92,710	1.9%	\$17.7	\$4.5	107
	2	3,078	1,123,470	3.8%	\$293	\$75	1,763
	3	554	202,210	0.4%	\$7.3	\$1.9	44
	Total	3,886	1,418,390	3.2%	\$318	\$81	1,914
2040 LRTP +Proposed (modeled) New Access/Interchanges	1	259	94,535	0.0%	\$0	\$0	0
	2	3,152	1,150,480	1.5%	\$115	\$29	696
	3	553	201,845	0.0%	\$0	\$0	0
	Total	3,964	1,446,860	1.2%	\$115	\$29	696
2040 LRTP+Proposed (modeled) Operational & Misc. Projects	1	259	94,535	0.0%	\$0	\$0	0
	2	3,185	1,162,525	0.5%	\$38	\$9.8	232
	3	543	198,195	1.8%	\$33	\$8.3	197
	Total	3,987	1,455,255	0.6%	\$71	\$18	429
LRTP+Proposed (not modeled) Operational & Misc. Projects	1	n/a	n/a	n/a	n/a	n/a	n/a
	2	n/a	n/a	n/a	n/a	n/a	n/a
	3	n/a	n/a	n/a	n/a	n/a	n/a
	Total	n/a	n/a	n/a	n/a	n/a	n/a
Proposed ITS Projects (not modeled)	1	n/a	n/a	n/a	n/a	n/a	n/a
	2	n/a	n/a	n/a	n/a	n/a	n/a
	3	n/a	n/a	n/a	n/a	n/a	n/a
	Total	n/a	n/a	n/a	n/a	n/a	n/a

Notes:

(1) Region

(1) Clarksville

(2) Nashville

(3) Chattanooga

(2) 2040 Avg. Weekday VHT (Weighted by Free-flow & Congested Time), I-24 Corridor Travel Demand Model, Atkins

(3) Annualized is a factor of '365' for all subareas and entire corridor, per prior TDOT Interstate Corridor Studies

(3) Economic multipliers are based on the following:

Regional Input-Output Modeling System (RIMS II), Regional Product Division, Bureau of Economic Analysis, 2013.

Metropolitan Gross Domestic Product Data for Clarksville, Nashville, and Chattanooga, Bureau of Economic Analysis, 2013.

User and Non-User Benefit Analysis for Highways, AASHTO, September 2010.

Atkins, 2013.

5.1.4 Benefit-Cost Screening

The last screening element that was completed for the 'LRTP' and 'Proposed Capacity Projects On I-24' was a benefit-cost ratio analysis. Benefit-cost ratios were developed for all the 'LRTP' and 'Proposed Capacity Projects On I-24'. The benefit side of the ratio is developed using travel time output for cars and trucks from the travel models and using assumptions for the

value of time, operating costs, crashes and air pollution. The cost side of the ratio is the total cost of the project, already provided in Section 5.1.1. All benefit and cost values are in current dollars (i.e., 2013). Please see Appendix D for an in-depth presentation and explanation of the benefit-cost parameters and assumptions used in this study.

Total annual cost savings (i.e., benefits) compared to the 'E+C' network under 2040 conditions is provided for each project. It is important to note that only the benefit to I-24 is included in this benefit-cost analysis. Next, the estimated cumulative benefits are provided for each project for three time horizons: 2013 to 2020, 2013 to 2030, and 2013 to 2040. (Benefits for each year between 2013 and 2040 are interpolated.) This assumes that each project is theoretically constructed in 2013. This is not the case; however, the results of this benefit-cost methodology provides a valuable indication of the feasibility of the project within each of the three time horizons (i.e., short-term, mid-term, and long-term). Finally, benefit-cost ratios are provided for each time horizon.

See Table 5.7 for the benefit-cost ratios for the 'LRTP Capacity Projects On I-24' and see Table 5.8 for the benefit-cost ratios for the 'Proposed Capacity Projects On I-24'. As seen in Table 5.7, each LRTP capacity project has a benefit-cost ratio for the long-term horizon that is very near or above 1.0, indicating that the benefits just on I-24 are equal to or greater than the costs for that time period. As seen in Table 5.8, many of the proposed capacity projects on I-24 have a benefit-cost ratio less than 1.0 for the long-term horizon, indicating that the benefits for I-24 are less than the costs for that time period. However, there are several projects that have a benefit-cost ratio well over 1.0. It should be noted that all the capacity projects on I-24 were proposed because the 2040 travel model indicated that traffic was exceeding the capacity of I-24. The low benefit-cost ratio for some of the proposed projects does not indicate that the projects are not needed. Rather, they indicate that the projects are less cost-feasible.

Table 5.7: Benefit-Cost Ratios for LRTP Capacity Projects On I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	2040 Total Annual Cost Savings	Estimated Cumulative Benefits			Benefit/Cost Ratios		
						(2013 - 2020)	(2013 - 2030)	(2013 - 2040)	(2013 - 2020)	(2013 - 2030)	(2013 - 2040)
169	Montgomery	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between TN State Line to SR-76 (Exit 11), 10.6 miles	10.6	\$ 25,585,560	\$ 26,533,174	\$144,984,842	\$358,197,844	0.2	1.0	2.5
170	Montgomery / Robertson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between SR-76 (Exit 11) to SR-256 (Exit 19) in Robertson County, 8.6 miles	8.6	\$ 4,688,981	\$ 4,862,647	\$ 26,570,892	\$ 65,645,732	0.1	0.3	0.9
173	Davidson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) from I-65 to Old Hickory Boulevard (SR-45), Exit 40 - Exit 44, 4.5 miles	4.5	\$ 4,817,147	\$ 4,995,560	\$ 27,297,167	\$ 67,440,059	0.1	0.4	1.0
177	Davidson	I-24 Additional Lanes	I-24 Additional Lanes from I-24/I-65 junction (S of Fern Ave.) to Trinity Lane. Replace underpass to acc. 6 lanes in each direction. Exit 46 - Exit 87 (I-65), MP 45 for I-24, 1.1 miles	1.1	\$ 8,581,332	\$ 8,899,160	\$ 48,627,550	\$120,138,654	0.7	3.6	8.8
181	Hamilton / Georgia	I-24 Additional Lanes	Widen I-24 from 4 to 6 lanes from I-59 to US-27; fix structurally deficient bridge at I-24 and I-124, 10.4 miles	10.4	\$ 13,666,523	\$ 14,172,690	\$ 77,443,630	\$191,331,320	0.1	0.3	0.9
183	Hamilton	I-24 Additional Lanes	Widen I-24 from 6 to 8 lanes from US-27 to I-75; fix S. Seminole Dr. structurally deficient bridge over I-24 at top of Missionary Ridge, 5.5 miles	5.5	\$ 13,729,485	\$ 14,237,985	\$ 77,800,417	\$192,212,794	0.1	0.5	1.1

Table 5.8: Benefit-Cost Ratios for Proposed Capacity Projects On I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	2040 Total Annual Cost Savings	Estimated Cumulative Benefits			Benefit/Cost Ratios		
						(2013 - 2020)	(2013 - 2030)	(2013 - 2040)	(2013 - 2020)	(2013 - 2030)	(2013 - 2040)
315	Robertson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-256 (Exit 19) to SR-49 (Exit 24), 5.3 miles	5.3	\$ 1,181,588	\$ 1,225,350	\$ 6,695,665	\$ 16,542,231	0.0	0.1	0.2
314	Robertson / Cheatham / Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-49 (Exit 24) to US-431/Whites Creek Pike (Exit 35), 10.4 miles	10.4	\$ 1,338,205	\$ 1,387,769	\$ 7,583,164	\$ 18,734,875	0.0	0.1	0.1
313	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-431/Whites Creek Pike (Exit 35) to SR-45/Old Hickory Boulevard (Exit 40), 3.3 miles	3.3	\$ 2,306,177	\$ 2,391,590	\$ 13,068,334	\$ 32,286,472	0.0	0.1	0.3
306	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-155/Briley Parkway (Exit 54) to Haywood Lane (Exit 57), 3.4 miles	3.4	\$ 16,661,137	\$ 17,278,216	\$ 94,413,110	\$233,255,919	0.4	2.0	5.0
307	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, Haywood Lane (Exit 57) to SR-171/Old Hickory Boulevard (Exit 62), 5.4 miles	5.4	\$ 31,764,443	\$ 32,940,904	\$179,998,513	\$444,702,208	0.4	2.4	6.0
308	Davidson / Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-171/Old Hickory Boulevard (Exit 62) to SR-102/Nissan Drive (Exit 70), 6.8 miles	6.8	\$ 37,180,344	\$ 38,557,393	\$210,688,613	\$520,524,809	0.4	2.3	5.6
309	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-102/Nissan Drive (Exit 70) to SR-840 (Exit 74), 4.8 miles	4.8	\$ 6,674,923	\$ 6,922,142	\$ 37,824,561	\$ 93,448,916	0.1	0.6	1.4
310	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-840 (Exit 74) to SR-96 (Exit 78), 3.7 miles	3.7	\$ 1,020,436	\$ 1,058,230	\$ 5,782,472	\$ 14,286,107	0.0	0.1	0.3
311	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-96 (Exit 78) to US-231/Shelbyville Highway (Exit 81), 3.3 miles	3.3	\$ 312,276	\$ 323,842	\$ 1,769,567	\$ 4,371,871	0.0	0.0	0.1
312	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-231/Shelbyville Highway (Exit 81) to Epps Mill Road (Exit 89), 7.6 miles	7.6	\$ 4,502,072	\$ 4,668,816	\$ 25,511,742	\$ 63,029,010	0.0	0.2	0.6
318	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-72/Lee Highway (Exit 152) to SR-27 (Exit 158), 6.7 miles	6.7	\$ 2,464,748	\$ 2,556,035	\$ 13,966,907	\$ 34,506,475	0.0	0.2	0.6
317	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-27 (Exit 158) to SR-156 (Exit 161), 2.7 miles	2.7	\$ 1,148,538	\$ 1,191,076	\$ 6,508,381	\$ 16,079,531	0.0	0.2	0.5
316	Marion / Hamilton	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-156 (Exit 161) to GA Border (MP 167), 5.6 miles	5.6	\$ 5,012,351	\$ 5,197,994	\$ 28,403,323	\$ 70,172,916	0.1	0.5	1.2

5.1.5 Conclusions

Based on the screening analysis completed for the 'Capacity Project On I-24', the project team has developed recommendations to either add the LRTP and proposed projects to the I-24 plan or to eliminate them from further consideration. To summarize, the following elements were included in the screening evaluation:

- Is the project included in a current MPO LRTP?
- Will the project reduce delay on I-24?
- Will the project improve safety on I-24?
- Is the project located in a high crash rate area on I-24 (i.e., a segment of I-24 that has a crash rate 2.0 or more times the average Statewide crash rate for interstates)?
- Will the project potentially have low to moderate impacts on the environment?
- Does the project have a favorable benefit-cost ratio (i.e., a benefit-cost ratio greater than 0.7, recognizing the fact that the benefit-cost ratio only takes into consideration benefits to a limited section of I-24, and not to any other roads)?
- Does the project have a relatively low total cost in 2013 dollars (i.e., less than \$5 million)?
- Will the project have a potential significant economic impact on the study area (i.e., a total project cost greater than \$40 million would potentially translate into a benefit of approximately 1,000 jobs created, in full-time annual equivalents)?
- Will the project support local economic development, primarily by providing new or substantially improved access to I-24?

Based on this screening analysis, the following projects are recommended:

- LRTP projects: 169, 170, 173, 177, 181, and 183.
- Proposed (i.e., Non-LRTP) projects: 315, 314, 313, 306, 307, 308, 309, 310, 311, 312, 318, 317, and 316.

Section 6 will present the prioritization of the projects that have been recommended as a result of the screening analysis. A summary of the evaluation, recommendation, and prioritization analysis for each 'Capacity Project On I-24' is found in Appendix F.

5.2 Capacity Projects Off I-24

The second category of projects that were screened involves capacity improvements, or additional lanes, off I-24. These are projects on roads that are parallel to I-24 and may provide relief to I-24 in terms of diversion of traffic. These projects are grouped, for presentation purposes, by MPO 'LRTP' projects and 'Proposed' projects.

5.2.1 Estimated Costs

Planning-level costs were estimated for all the LRTP and proposed projects using TDOT's 2013-2014 Cost Data Sheet unit costs (see Appendix A). The only exceptions are for the proposed projects 208 and 209, which are projects located in Chattanooga with unique attributes (i.e., railroad bridges and tunnels). The costs for these projects were provided by the Chattanooga TPO. Cost estimates are provided for right-of-way (ROW), construction, preliminary

engineering (PE), and contingency costs and are sensitive to area type (i.e., urban, residential, rural, etc.), terrain (i.e., flat, rolling, mountainous, etc.) and type of construction (i.e., new versus modifying existing). Cost estimates also take new or modified bridges into consideration. It should be noted that the actual costs may be higher or lower than the planning-level costs presented in this study based on more detailed analysis of these projects.

Table 5.9 presents the estimated costs in 2013 dollars for the ‘LRTP Capacity Projects Off I-24’ and Table 5.10 presents the estimated costs in 2013 dollars for the ‘Proposed Capacity Projects Off I-24’. The total estimated costs for the ‘LRTP Capacity Projects Off I-24’ range from \$15.0 million to \$175.4 million, while the total costs for the ‘Proposed Capacity Projects Off I-24’ range from \$13.4 million to \$360.0 million.

Table 5.9: Estimated 2013 Costs for LRTP Capacity Projects Off I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
206	Montgomery	SR-48 (Trenton Rd)	Widening from 2 to 4 lanes between Hazelwood Road and Tylertown Road, 0.9 miles	0.9	\$ 15,045,135	\$ 1,963,553	\$ 10,465,265	\$ 1,046,527	\$ 1,569,790
203	Montgomery	East-West Connector Phase 1	New 4-Lane road between US-79 (Wilma Rudolph Blvd) and SR-48 (Trenton Rd), 2.5 miles	2.5	\$ 38,621,875	\$ 5,394,375	\$ 26,582,000	\$ 2,658,200	\$ 3,987,300
205	Montgomery	SR-374/ Warfield Blvd (North Pkwy)	Widening from 2 to 4/5 lanes between Dunbar Cave Road and US-79/SR-13 (Stokes Road), 2.6 miles	2.6	\$ 43,002,167	\$ 5,610,150	\$ 29,913,614	\$ 2,991,361	\$ 4,487,042
204	Montgomery	SR-374/ Richview Rd/ Warfield Blvd	Widening from 2 to 4 lanes between Memorial Drive and Dunbar Cave Road, 2.0 miles	2.0	\$ 33,156,475	\$ 4,315,500	\$ 23,072,780	\$ 2,307,278	\$ 3,460,917
271	Davidson	Ellington Parkway Widening	Widen Ellington Parkway (SR 6) from 4 to 6 lanes from North 1st Street to Boardmoor Drive, 4.85 miles	4.9	\$ 61,218,216	\$ 10,465,088	\$ 40,602,503	\$ 4,060,250	\$ 6,090,375
302	Davidson	I-65 Widening	Widen I-65 from 6 to 8 lanes from Harding Place (SR-255) to I-40, 4.3 miles	4.3	\$175,441,719	\$ 17,231,175	\$126,568,435	\$ 12,656,844	\$ 18,985,265
303	Davidson	SR-1 (Murfreesboro Road) Widening	Widen SR-1 (Murfreesboro Road) from 4 to 6 lanes from Donelson Pike to Smith Springs Road, 1.2 miles	1.2	\$ 20,547,158	\$ 2,589,300	\$ 14,387,886	\$ 1,438,789	\$ 2,131,183
207	Hamilton	Wauhatchie Pike (parallel to I-24)	Widening Wauhatchie Pike from 2 lanes to 4 lanes from US-11 to US-41/US64, parallel to I-24 just west of Moccasin Bend, 2.8 miles	2.8	\$ 36,309,100	\$ 6,041,700	\$ 24,213,920	\$ 2,421,392	\$ 3,632,088

Table 5.10: Estimated 2013 Costs for Proposed Capacity Projects Off I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
301	Montgomery / Robertson / Cheatham	US 41A Widening	Widen US 41A from 2 to 4 lanes (where its not currently 4 lanes) from Sango Drive In Clarksville to Jackson Felts Road to SR-249 (New Hope Road), 20.0 miles	20.0	\$329,089,750	\$ 43,155,000	\$228,747,800	\$ 22,874,780	\$ 34,312,170
278	Davidson	Brick Church Pike Widening	Road Widening, 2 to 4 lanes Briley Pkwy to Old Hickory Blvd, 3.1 miles	3.1	\$ 39,924,700	\$ 6,689,025	\$ 26,599,340	\$ 2,659,934	\$ 3,976,401
283	Davidson	Metro Center River Crossing	New 4-lane road from W Trinity Lane to Rosa L Parks Blvd, 0.6 miles	0.6	\$ 79,057,830	\$ 1,295,650	\$ 62,209,744	\$ 6,220,974	\$ 9,331,462
153	Davidson / Rutherford	Murfreesboro Pike Widening	Widen Murfreesboro Pike from 4 to 6 lanes to handle traffic diversion from Murfreesboro into Nashville, 28.6 miles	28.6	\$359,996,052	\$ 61,711,650	\$238,627,522	\$ 23,862,752	\$ 35,794,128
277	Davidson	Antioch Pike/Una-Antioch Pike Widening	Road Widening, 2 to 4 lanes Haywood Lane to Murfreesboro Pike, 3.7 miles	3.7	\$ 47,533,900	\$ 7,983,675	\$ 31,640,180	\$ 3,164,018	\$ 4,746,027
287	Davidson	Mt. View Road widening	Road Widening, 2 to 4 lanes from Smith Springs Pkwy to Hickory Hollow Pkwy, 4.4 miles	4.4	\$ 56,922,810	\$ 9,494,100	\$ 37,986,160	\$ 3,798,616	\$ 5,643,934
289	Davidson	Hickory Hollow Parkway widening	Road Widening, 2 to 4 lanes from Bell Road to Una Antioch Pike, 1.3 miles	1.3	\$ 16,813,600	\$ 2,805,075	\$ 11,206,820	\$ 1,120,682	\$ 1,681,023
279	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes Old Hickory Blvd to Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road, 2.3 miles	2.3	\$ 29,773,100	\$ 4,962,825	\$ 19,848,220	\$ 1,984,822	\$ 2,977,233
280	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes from Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road to Bell Rd, 1.4 miles	1.4	\$ 18,098,300	\$ 3,020,850	\$ 12,061,960	\$ 1,206,196	\$ 1,809,294
291	Davidson	Crossings Boulevard Extension	New Road (4-lane divided) from Old Hickory Blvd to Crossings Blvd, 1.6 miles	1.6	\$ 24,614,500	\$ 3,452,400	\$ 16,929,680	\$ 1,692,968	\$ 2,539,452
272	Davidson / Rutherford	SR-11 (Nolensville Rd)	Road Widening, 2 to 4 lanes from SR-840 to Burkitt Road, 10.5 miles	10.5	\$163,264,744	\$ 12,946,500	\$120,254,595	\$ 12,025,460	\$ 18,038,189
273	Rutherford	Old Nashville Highway Widening Phase I	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase I (US-41/Murfreesboro Pike to Jefferson Pike), 1.1 miles	1.1	\$ 13,400,275	\$ 2,373,525	\$ 8,821,400	\$ 882,140	\$ 1,323,210
274	Rutherford	Old Nashville Highway Widening Phase II	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase II (Jefferson Pike to SR-266/Sam Ridley Parkway), 1.7 miles	1.7	\$ 20,300,425	\$ 3,668,175	\$ 13,305,800	\$ 1,330,580	\$ 1,995,870
284	Rutherford	Almaville Road (SR 102) Widening	Road Widening, 2 to 4 lanes from Franklin Road to I-24, 6.7 miles	6.7	\$110,506,066	\$ 14,456,925	\$ 76,839,313	\$ 7,683,931	\$ 11,525,897
276	Rutherford	Broad Street Widening	Road Widening, 2 to 4 lanes Joe B Jackson Pkwy to Middle Tennessee Blvd, 2.5 miles	2.5	\$ 41,361,219	\$ 5,394,375	\$ 28,773,475	\$ 2,877,348	\$ 4,316,021
208	Hamilton	Cummings Highway Widening	Ensure 4 lanes on Cummings Hwy (parallel to I-24 at Moccasin Bend) throughout including through two RR underpasses; add median, turn lanes and shoulders, 2.7 miles	2.7	\$ 63,612,144	\$ 8,774,089	\$ 43,870,444	\$ 4,387,044	\$ 6,580,567
209	Hamilton	Ringgold Road Widening	Widen Ringgold Road (parallel to I-24) 4 to 6 lanes (Bachman tunnel from 2 to 6 lanes); complete streets upgrade, 2 miles	2.0	\$ 52,038,328	\$ 7,177,700	\$ 35,888,502	\$ 3,588,850	\$ 5,383,275

5.2.2 Environmental Screening

Environmental screening was not completed for the 'Capacity Projects Off I-24' since that was beyond the scope of this project, which is to look at the impact of potential improvements on I-24 itself. Environmental screening should be completed for these individual projects as they advance in the planning process.

5.2.3 Economic Impact Screening

The economic impact screening completed for this study is different from the other screening elements in that it evaluates packages/scenarios of projects, rather than individual projects. See Section 5.1.3 for a comparison of the economic impacts of the 'Capacity Projects Off I-24' versus the economic impact of the capacity projects on I-24 and the operational projects. Also, see Appendix C for a full presentation and explanation of the economic impact analysis completed for the I-24 Multimodal Corridor Study.

5.2.4 Benefit-Cost Screening

The last screening element that was completed for the 'LRTP' and 'Proposed Capacity Projects Off I-24' was a benefit-cost ratio analysis. Benefit-cost ratios were developed for all the 'LRTP' and 'Proposed Capacity Projects Off I-24'. The benefit side of the ratio is developed using travel time output for cars and trucks from the travel models and using assumptions for the value of time, operating costs, crashes and air pollution. The cost side of the ratio is the total cost of the project, already provided in Section 5.2.1. All benefit and cost values are in current dollars (i.e., 2013). Please see Appendix D for an in-depth presentation and explanation of the benefit-cost parameters and assumptions used in this study.

Total annual cost savings (i.e., benefits) compared to the 'E+C' network under 2040 conditions is provided for each project. It is important to note that only the benefits to I-24 are included in this benefit-cost analysis. These projects 'Off I-24' will obviously provide benefits to the road the project is on as well as to other roads. However, in order to keep the benefit-cost analysis consistent between project types, only the impact on I-24 was considered.

Next, the estimated cumulative benefits are provided for each project for three time horizons: 2013 to 2020, 2013 to 2030, and 2013 to 2040. (Benefits for each year between 2013 and 2040 are interpolated.) This assumes that each project is theoretically constructed in 2013. This is not the case, however the results of this benefit-cost methodology provides a valuable indication of the feasibility of the project within each of the three time horizons (i.e., short-term, mid-term, and long-term). Finally, benefit-cost ratios are provided for each time horizon.

See Table 5.11 for the benefit-cost ratios for the 'LRTP Capacity Projects Off I-24' and see Table 5.12 for the benefit-cost ratios for the 'Proposed Capacity Projects Off I-24'. As seen in Table 5.11, there are only two 'LRTP Capacity Projects Off I-24' (projects 204 and 303) that have a benefit-cost ratio for the long-term horizon that is above 1.0, indicating that the benefits (to I-24) are greater than the costs for that time period. As seen in Table 5.12, there are six 'Proposed Capacity Projects Off I-24' (projects 153, 277, 280, 291, 272 and 273) that have a

benefit-cost ratio greater than 1.0 for the long-term horizon. It should be noted that just because a project 'Off I-24' does not have a high benefit-cost ratio does not mean it is not a feasible project. Rather, it just infers that it is not a project that brings a significant benefit to I-24.

Table 5.11: Benefit-Cost Ratios for LRTP Capacity Projects Off I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	2040 Total Annual Cost Savings	Estimated Cumulative Benefits			Benefit/Cost Ratios		
						(2013 - 2020)	(2013 - 2030)	(2013 - 2040)	(2013 - 2020)	(2013 - 2030)	(2013 - 2040)
206	Montgomery	SR-48 (Trenton Rd)	Widening from 2 to 4 lanes between Hazelwood Road and Tylertown Road, 0.9 miles	0.9	\$ 949,721	\$ 984,896	\$ 5,381,753	\$ 13,296,095	0.1	0.4	0.9
203	Montgomery	East-West Connector Phase 1	New 4-Lane road between US-79 (Wilma Rudolph Blvd) and SR-48 (Trenton Rd), 2.5 miles	2.5	\$ 1,040,513	\$ 1,079,051	\$ 5,896,243	\$ 14,567,188	0.0	0.2	0.4
205	Montgomery	SR-374/ Warfield Blvd (North Pkwy)	Widening from 2 to 4/5 lanes between Dunbar Cave Road and US-79/SR-13 (Stokes Road), 2.6 miles	2.6	\$ 888,653	\$ 921,566	\$ 5,035,701	\$ 12,441,143	0.0	0.1	0.3
204	Montgomery	SR-374/ Richview Rd/ Warfield Blvd	Widening from 2 to 4 lanes between Memorial Drive and Dunbar Cave Road, 2.0 miles	2.0	\$ 3,399,677	\$ 3,525,591	\$ 19,264,839	\$ 47,595,485	0.1	0.6	1.4
271	Davidson	Ellington Parkway Widening	Widen Ellington Parkway (SR 6) from 4 to 6 lanes from North 1st Street to Boardmoor Drive, 4.85 miles	4.9	\$ 1,756,423	\$ 1,821,476	\$ 9,953,065	\$ 24,589,925	0.0	0.2	0.4
302	Davidson	I-65 Widening	Widen I-65 from 6 to 8 lanes from Harding Place (SR-255) to I-40, 4.3 miles	4.3	\$ 3,528,978	\$ 3,659,681	\$ 19,997,543	\$ 49,405,695	0.0	0.1	0.3
303	Davidson	SR-1 (Murfreesboro Road) Widening	Widen SR-1 (Murfreesboro Road) from 4 to 6 lanes from Donelson Pike to Smith Springs Road, 1.2 miles	1.2	\$ 1,851,167	\$ 1,919,728	\$ 10,489,945	\$ 25,916,335	0.1	0.5	1.3
207	Hamilton	Wauhatchie Pike (parallel to I-24)	Widening Wauhatchie Pike from 2 lanes to 4 lanes from US-11 to US-41/US64, parallel to I-24 just west of Moccasin Bend, 2.8 miles	2.8	\$ 297,976	\$ 309,012	\$ 1,688,530	\$ 4,171,662	0.0	0.0	0.1

Table 5.12: Benefit-Cost Ratios for Proposed Capacity Projects Off I-24

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	2040 Total Annual Cost Savings	Estimated Cumulative Benefits			Benefit/Cost Ratios		
						(2013 - 2020)	(2013 - 2030)	(2013 - 2040)	(2013 - 2020)	(2013 - 2030)	(2013 - 2040)
301	Montgomery / Robertson / Cheatham	US 41A Widening	Widen US 41A from 2 to 4 lanes (where its not currently 4 lanes) from Sango Drive In Clarksville to Jackson Felts Road to SR-249 (New Hope Road), 20.0 miles	20.0	\$ 527,885	\$ 547,437	\$ 2,991,350	\$ 7,390,394	0.0	0.0	0.0
278	Davidson	Brick Church Pike Widening	Road Widening, 2 to 4 lanes Briley Pkwy to Old Hickory Blvd, 3.1 miles	3.1	\$ 1,063,205	\$ 1,102,583	\$ 6,024,830	\$ 14,884,875	0.0	0.2	0.4
283	Davidson	Metro Center River Crossing	New 4-lane road from W Trinity Lane to Rosa L Parks Blvd, 0.6 miles	0.6	\$ 1,677,159	\$ 1,739,276	\$ 9,503,903	\$ 23,480,232	0.0	0.1	0.3
153	Davidson / Rutherford	Murfreesboro Pike Widening	Widen Murfreesboro Pike from 4 to 6 lanes to handle traffic diversion from Murfreesboro into Nashville, 28.6 miles	28.6	\$ 92,417,882	\$ 95,840,766	\$523,701,329	\$ 1,293,850,343	0.3	1.5	3.6
277	Davidson	Antioch Pike/Una-Antioch Pike Widening	Road Widening, 2 to 4 lanes Haywood Lane to Murfreesboro Pike, 3.7 miles	3.7	\$ 3,794,602	\$ 3,935,143	\$ 21,502,745	\$ 53,124,430	0.1	0.5	1.1
287	Davidson	Mt. View Road widening	Road Widening, 2 to 4 lanes from Smith Springs Pkwy to Hickory Hollow Pkwy, 4.4 miles	4.4	\$ 2,908,334	\$ 3,016,050	\$ 16,480,559	\$ 40,716,676	0.1	0.3	0.7
289	Davidson	Hickory Hollow Parkway widening	Road Widening, 2 to 4 lanes from Bell Road to Una Antioch Pike, 1.3 miles	1.3	\$ 1,123,460	\$ 1,165,070	\$ 6,366,275	\$ 15,728,443	0.1	0.4	0.9
279	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes Old Hickory Blvd to Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road, 2.3 miles	2.3	\$ 56,752	\$ 58,853	\$ 321,592	\$ 794,522	0.0	0.0	0.0
280	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes from Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road to Bell Rd, 1.4 miles	1.4	\$ 2,864,952	\$ 2,971,062	\$ 16,234,729	\$ 40,109,332	0.2	0.9	2.2
291	Davidson	Crossings Boulevard Extension	New Road (4-lane divided) from Old Hickory Blvd to Crossings Blvd, 1.6 miles	1.6	\$ 5,357,156	\$ 5,555,569	\$ 30,357,217	\$ 75,000,182	0.2	1.2	3.0
272	Davidson / Rutherford	SR-11 (Nolensville Rd)	Road Widening, 2 to 4 lanes from SR-840 to Burkitt Road, 10.5 miles	10.5	\$ 20,551,061	\$ 21,312,211	\$116,456,013	\$ 287,714,855	0.1	0.7	1.8
273	Rutherford	Old Nashville Highway Widening Phase I	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase I (US-41/Murfreesboro Pike to Jefferson Pike), 1.1 miles	1.1	\$ 18,411,093	\$ 19,092,986	\$104,329,529	\$ 257,755,307	1.4	7.8	19.2
274	Rutherford	Old Nashville Highway Widening Phase II	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase II (Jefferson Pike to SR-266/Sam Ridley Parkway), 1.7 miles	1.7	\$ 1,031,531	\$ 1,069,736	\$ 5,845,345	\$ 14,441,441	0.1	0.3	0.7
284	Rutherford	Almaville Road (SR 102) Widening	Road Widening, 2 to 4 lanes from Franklin Road to I-24, 6.7 miles	6.7	\$ 5,049,760	\$ 5,236,788	\$ 28,615,305	\$ 70,696,637	0.0	0.3	0.6
276	Rutherford	Broad Street Widening	Road Widening, 2 to 4 lanes Joe B Jackson Pkwy to Middle Tennessee Blvd, 2.5 miles	2.5	\$ 1,704,172	\$ 1,767,289	\$ 9,656,973	\$ 23,858,403	0.0	0.2	0.6
208	Hamilton	Cummings Highway Widening	Ensure 4 lanes on Cummings Hwy (parallel to I-24 at Moccasin Bend) throughout including through two RR underpasses; add median, turn lanes and shoulders, 2.7 miles	2.7	\$ 594,506	\$ 616,525	\$ 3,368,866	\$ 8,323,081	0.0	0.1	0.1
209	Hamilton	Ringgold Road Widening	Widen Ringgold Road (parallel to I-24) 4 to 6 lanes (Bachman tunnel from 2 to 6 lanes); complete streets upgrade, 2 miles	2.0	\$ 1,387,180	\$ 1,438,557	\$ 7,860,687	\$ 19,420,522	0.0	0.2	0.4

5.2.5 Conclusions

Based on the screening analysis completed for the 'Capacity Project Off I-24', the project team has developed recommendations to either add the LRTP and proposed projects to the I-24 plan or to eliminate them from further consideration. To summarize, the following elements were included in the screening evaluation:

- Is the project included in a current MPO LRTP?
- Will the project reduce delay on I-24?
- Will the project improve safety on I-24?
- Is the project located in a high crash rate area on I-24 (i.e., a segment of I-24 that has a crash rate 2.0 or more times the average Statewide crash rate for interstates)?
- Will the project potentially have low to moderate impacts on the environment?
- Does the project have a favorable benefit-cost ratio (i.e., a benefit-cost ratio greater than 0.7, recognizing the fact that the benefit-cost ratio only takes into consideration benefits to a limited section of I-24, and not to any other roads)?
- Does the project have a relatively low total cost in 2013 dollars (i.e., less than \$5 million)?
- Will the project have a potential significant economic impact on the study area (i.e., a total project cost greater than \$40 million would potentially translate into a benefit of approximately 1,000 jobs created, in full-time annual equivalents)?
- Will the project support local economic development, primarily by providing new or substantially improved access to I-24?

The recommendation process for the 'Capacity Projects Off I-24' is different than the other projects that are located on I-24 in that these recommendations highlight the projects adjacent to I-24 that have a beneficial impact on I-24. If this study does not recommend a particular project that is located adjacent to I-24, it does not necessarily mean that the project is not viable. In fact, the project may provide significant benefits to the road it improves or to other roads near it, but just not to I-24. However, these recommendations will provide meaningful information as to what projects are beneficial to I-24.

Special consideration was given for projects 207 and 208 located in Hamilton County. Both of these projects are located parallel to I-24 near Moccasin Bend along the foot of Lookout Mountain in Chattanooga and are the only alternate emergency detour routes for I-24. However, the roads that projects 207 and 208 will improve currently have three narrow/low railroad overpasses that significantly inhibit the flow of traffic and emergency vehicle access. The recommended projects 207 and 208 will improve these bridges to allow the needed access.

Based on this screening analysis, the following projects are recommended:

- LRTP projects: 206, 203, 205, 204, 271, 271, 302, 303, and 207.
- Proposed (i.e., Non-LRTP) projects: 153, 277, 287, 289, 279, 280, 291, 272, 273, 274, and 208.

Section 6 will present the prioritization of the projects that have been recommended as a result of the screening analysis. A summary of the evaluation, recommendation, and prioritization analysis for each 'Capacity Project Off I-24' is found in Appendix F.

5.3 Operational Projects

The third category of projects that were screened involve operational improvements on I-24 which include new or modified access on I-24, ramp improvements, Intelligent Transportation System (ITS) improvements, truck lanes, bridge improvements, rock fall/slide mitigation improvements and miscellaneous improvements. These projects are grouped, for presentation purposes, by MPO 'Long Range Transportation Plan' (LRTP) projects and 'Proposed' projects.

5.3.1 Estimated Costs

Planning-level costs were estimated for all the LRTP and proposed projects using TDOT's 2013-2014 Cost Data Sheet unit costs (see Appendix A). The only exceptions are for the proposed ITS projects and the rock fall/slide mitigation improvements as well as for two of the modified access interchange projects. The costs for the ITS projects and the rock fall/slide mitigation improvements were estimated using costs from similar projects in Tennessee or in other states. The costs for interchange projects 180 and 182 were taken from recent detailed TDOT studies of these improvements. Cost estimates are provided for right-of-way (ROW), construction, preliminary engineering (PE), and contingency costs and are sensitive to area type (i.e., urban, residential, rural, etc.), terrain (i.e., flat, rolling, mountainous, etc.) and type of construction (i.e., new versus modifying existing). Cost estimates also take new or modified bridges into consideration. It should be noted that the actual costs may be higher or lower than the planning-level costs presented in this study based on more detailed analysis of these projects.

Table 5.13 presents the estimated costs in 2013 dollars for the LRTP new and modified access projects and Table 5.14 presents the estimated costs in 2013 dollars for the proposed new and modified access projects. Table 5.15 presents the estimated costs in 2013 dollars for the proposed ramp improvement projects and Table 5.16 presents the estimated costs in 2013 dollars for the proposed ITS improvement projects. Table 5.17 presents the estimated costs in 2013 dollars for the proposed truck lane projects and Table 5.18 presents the estimated costs in 2013 dollars for the proposed bridge improvement projects. Table 5.19 presents the estimated costs in 2013 dollars for the proposed rock fall/slide mitigation projects and Table 5.20 presents the estimated costs in 2013 dollars for the proposed safety improvement projects.

Cost estimates for the operational projects range widely depending on the type of improvement. Generally speaking, the ITS, bridge, and miscellaneous projects are the lowest in cost while the new and modified access projects are the highest in cost.

Table 5.13: Estimated 2013 Costs for LRTP New and Modified Access Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
178	Davidson	Modify Access at I-24/Hickory Hollow Pkwy Interchange	Modify interchange to allow access to/from Cane Ridge Road at I-24/Hickory Hollow Parkway Interchange	\$ 13,500,000	\$ 1,000,000	\$ 10,000,000	\$ 1,000,000	\$ 1,500,000
172	Rutherford	New I-24/Rocky Fork Road Interchange	Construct a new interchange at I-24 and Rocky Fork Road (MP 68)	\$ 46,000,000	\$ 1,000,000	\$ 36,000,000	\$ 3,600,000	\$ 5,400,000
180	Hamilton	I-24 at Market & Broad Streets Interchange Modification	Modify Market Street and Broad Street I-24 interchanges to improve safety and operation characteristics	\$ 48,125,000	\$ 2,000,000	\$ 36,900,000	\$ 3,690,000	\$ 5,535,000
182	Hamilton	I-24 and I-75 Interchange Modification	Modification of the interchange of I-75 and I-24	\$113,250,000	\$ 2,000,000	\$ 89,000,000	\$ 8,900,000	\$ 13,350,000
176	Davidson	I-24 at North 1st Street Interchange	Construct HOV ramps to and from I-24 and CBD at North 1st Street, Exit 47	\$ 23,000,000	\$ 500,000	\$ 18,000,000	\$ 1,800,000	\$ 2,700,000
175	Davidson	I-24 at Shelby Avenue Interchange	Construct HOV ramps to and from I-24 and CBD at Shelby Avenue, Exit 49	\$ 23,000,000	\$ 500,000	\$ 18,000,000	\$ 1,800,000	\$ 2,700,000
174	Davidson	I-24 at Harding Place Drive Interchange	Construct urban diamond interchange (Phase I) on I-24 at Harding Place Drive, Exit 56	\$ 10,250,000	\$ 250,000	\$ 8,000,000	\$ 800,000	\$ 1,200,000
179	Rutherford	Interchange Improvements at Epps Mill Road and I-24	Widen Epps Mill Road from a 2-Lane to a 3-Lane Cross Section and redesign/improve Exit 89 to better accommodate truck traffic	\$ 13,500,000	\$ 1,000,000	\$ 10,000,000	\$ 1,000,000	\$ 1,500,000

Table 5.14: Estimated 2013 Costs for Proposed New and Modified Access Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
286	Davidson	New Interchange in SE Nashville	Add a new interchange at Old Franklin Road (MP 61). (Not included in this project but part of future project: New Road from Nolensville Road to I-24)	\$ 46,000,000	\$ 1,000,000	\$ 36,000,000	\$ 3,600,000	\$ 5,400,000
118	Rutherford	New Interchange in Murfreesboro	Add new interchange in Murfreesboro (between Exit 74 and 89) - Modeled at Elam Road (MP 85)	\$ 27,250,000	\$ 1,000,000	\$ 21,000,000	\$ 2,100,000	\$ 3,150,000
146	Coffee	New Interchange between Exit 105 - Exit 110	Add new interchange in Manchester between Exit 105 and exit 110 - Modeled at Fredonia Road (MP 109)	\$ 27,250,000	\$ 1,000,000	\$ 21,000,000	\$ 2,100,000	\$ 3,150,000
253	Davidson	Exit 47 - Exit 48 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 47-Exit 47A-Exit 48 (Downtown Nashville) EB and WB to remove weaving sections from the mainline and to remove exit points	\$ 15,200,000	\$ 250,000	\$ 11,960,000	\$ 1,196,000	\$ 1,794,000
254	Rutherford	Exit 74 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 74A-74B (SR 840) EB and WB to remove weaving section from the mainline and to remove exit points	\$ 15,200,000	\$ 250,000	\$ 11,960,000	\$ 1,196,000	\$ 1,794,000
255	Rutherford	Exit 78 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 78A-78B (SR 96) EB and WB to remove exit points	\$ 15,200,000	\$ 250,000	\$ 11,960,000	\$ 1,196,000	\$ 1,794,000
256	Rutherford	Exit 80 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 80 (SR 99) EB and WB to remove entrance points	\$ 15,200,000	\$ 250,000	\$ 11,960,000	\$ 1,196,000	\$ 1,794,000
94	Coffee	Exit 111 Upgrade to Standard Interchange	Modify the I-24 interchange at SR 55 (Exit 111) to convert to diamond interchange and remove loop ramp	\$ 2,025,000	\$ 150,000	\$ 1,500,000	\$ 150,000	\$ 225,000
257	Hamilton	Exit 180 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 180B-Exit 180 (Rossville Blvd) EB and WB to remove weaving section from the mainline and to remove exit points	\$ 15,200,000	\$ 250,000	\$ 11,960,000	\$ 1,196,000	\$ 1,794,000
211	Davidson	I-24 at Bell Road Interchange Modification	Reconstruct the Interchange I-24 at Bell Road and construct bike lanes and sidewalks along Bell Road in the vicinity of the interchange	\$ 33,750,000	\$ -	\$ 27,000,000	\$ 2,700,000	\$ 4,050,000
258	Hamilton	Exit 183B - Exit 184 Interchange Modifications	Redesign ramp sequencing and lengths from S. Germantown Road to McBrien Road (currently Exit 183B-Exit 183A-Exit 184) to remove weaving sections and to remove exit points	\$ 47,482,750	\$ 8,014,000	\$ 31,575,000	\$ 3,157,500	\$ 4,736,250

Table 5.15: Estimated 2013 Costs for Proposed Ramp Improvement Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
244	Montgomery	Montgomery County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 1 (2 ramps), Exit 4 (2), Exit 8 (2), Exit 11 (2)	\$ 13,612,850	\$ 400,000	\$ 10,570,280	\$ 1,057,028	\$ 1,585,542
245	Robertson	Robertson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 19 (2 ramps), Exit 24 (2)	\$ 6,806,425	\$ 200,000	\$ 5,285,140	\$ 528,514	\$ 792,771
246	Cheatham	Cheatham County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 31 (2 ramps)	\$ 3,403,213	\$ 100,000	\$ 2,642,570	\$ 264,257	\$ 396,386
247	Davidson	Davidson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 35 (2 ramps), Exit 40 (2), Exit 57 (1), Exit 59 (4), Exit 60 (1)	\$ 25,274,833	\$ 500,000	\$ 19,819,930	\$ 1,981,993	\$ 2,972,910
248	Rutherford	Rutherford County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 66 (1 ramp), Exit 70 (4), Exit 81 (2), Exit 84 (2), Exit 89 (4)	\$ 22,120,881	\$ 650,000	\$ 17,176,705	\$ 1,717,670	\$ 2,576,506
249	Coffee	Coffee County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 97 (3 ramps), Exit 105 (3), Exit 110 (4), Exit 111 (4), Exit 114 (4), MP 116-Weigh Station (4), Exit 117 (4), MP 119-Truck Rest Area (4)	\$ 51,048,188	\$ 1,500,000	\$ 39,638,550	\$ 3,963,855	\$ 5,945,783
250	Grundy	Grundy County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 127 (4 ramps), MP 133-Rest Area (3), Exit 134 (3)	\$ 17,016,063	\$ 500,000	\$ 13,212,850	\$ 1,321,285	\$ 1,981,928
251	Marion	Marion County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 135 (4 ramps), Exit 143 (4), Exit 155 (2), Exit 158 (4), MP 159-Welcome Center (4), Exit 161 (3)	\$ 35,733,732	\$ 1,050,000	\$ 27,746,985	\$ 2,774,699	\$ 4,162,048
252	Hamilton	Hamilton County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 174 (4 ramps), Exit 175 (1)	\$ 12,637,063	\$ 250,000	\$ 9,909,650	\$ 990,965	\$ 1,486,448

Table 5.16: Estimated 2013 Costs for Proposed ITS Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost (1)	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
140	All Counties	Install "Dial *511" Signs	Install "Dial *511" signs throughout corridor	\$ 93,750	\$ -	\$ 75,000	\$ 7,500	\$ 11,250
166	Robertson	MP 23 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 23 (EB) (approximately)	\$ 625,000	\$ -	\$ 500,000	\$ 50,000	\$ 75,000
167	Robertson	MP 25 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 25 (WB) (approximately)	\$ 625,000	\$ -	\$ 500,000	\$ 50,000	\$ 75,000
168	Davidson / Rutherford	SR 1 Arterial ITS	Install arterial ITS instrumentation and communications on SR 1 between I-440 interchange and SR 96 (Murfreesboro)	\$ 6,562,500	\$ -	\$ 5,250,000	\$ 525,000	\$ 787,500
319	Davidson / Rutherford	Exit 66 - Exit 56 Ramp Metering	Install ramp metering components and system software from Exit 66 to Exit 56 (8 ramps)	\$ 1,000,000	\$ -	\$ 800,000	\$ 80,000	\$ 120,000
320	Rutherford	Exit 81 - Exit 76 Ramp Metering	Install ramp metering components and system software from Exit 81 to Exit 76	\$ 593,750	\$ -	\$ 475,000	\$ 47,500	\$ 71,250
164	Marion / Hamilton	Exit 158 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 158 to Exit 174	\$ 343,750	\$ -	\$ 275,000	\$ 27,500	\$ 41,250
165	Marion	MP 166 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 166 (WB) (approximately)	\$ 625,000	\$ -	\$ 500,000	\$ 50,000	\$ 75,000
321	Hamilton	Exit 174 - Exit 175 Ramp Metering	Install ramp metering components and system software from Exit 174 to Exit 175	\$ 468,750	\$ -	\$ 375,000	\$ 37,500	\$ 56,250
322	Hamilton	Exit 185 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 185 to Exit 174	\$ 562,500	\$ -	\$ 450,000	\$ 45,000	\$ 67,500
323	Hamilton	Exit 184 - Exit 183 Ramp Metering	Install ramp metering components and system software from Exit 184 to Exit 183	\$ 468,750	\$ -	\$ 375,000	\$ 37,500	\$ 56,250

Note:

(1) Cost for ramp metering projects includes system software. The cost does not include reconstruction or modification of the ramp or adjacent surface street.

Table 5.17: Estimated 2013 Costs for Proposed Truck Lane Projects

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
212	Cheatham	Cheatham County - Extend Existing EB Truck Lane	Extend existing EB Truck Lane on I-24 in Cheatham County, Log Mile (2) 0.05 to 0.569 (MP 28)	0.5	\$ 5,037,500	\$ 325,000	\$ 3,770,000	\$ 377,000	\$ 565,500
214	Grundy	Grundy County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Grundy County, Log Mile 3.40 to 6.55 (MP 130 to MP 133)	3.2	\$ 30,542,500	\$ 1,955,000	\$ 22,870,000	\$ 2,287,000	\$ 3,430,500
324	Marion	Marion County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Marion County, Log Mile 30.50 to 32.10 (MP 165 to MP 167)	1.6	\$ 21,716,200	\$ 986,400	\$ 16,583,840	\$ 1,658,384	\$ 2,487,576

Table 5.18: Estimated 2013 Costs for Proposed Bridge Improvement Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
220	Montgomery	Montgomery County Bridge Railing Replacements	Replace pipe bridge railings for 6 bridges in Montgomery County between MP 3 and MP 15 which do not conform to current Report 350 crash test standards	\$ 670,200	\$ -	\$ 536,160	\$ 53,616	\$ 80,424
221	Robertson	Robertson County Bridge Railing Replacements	Replace pipe bridge railings for 2 bridges in Robertson County between MP 27 and MP 28 which do not conform to current Report 350 crash test standards	\$ 147,200	\$ -	\$ 117,760	\$ 11,776	\$ 17,664
222	Cheatham	Cheatham County Bridge Railing Replacement	Replace pipe bridge railings for 1 bridge in Cheatham County at MP 29 which does not conform to current Report 350 crash test standards	\$ 63,900	\$ -	\$ 51,120	\$ 5,112	\$ 7,668
223	Davidson	Davidson County Bridge Railing Replacements	Replace pipe bridge railings for 8 bridges in Davidson County between MP 34 and MP 45 which do not conform to current Report 350 crash test standards	\$ 774,600	\$ -	\$ 619,680	\$ 61,968	\$ 92,952
240	Davidson	MP 40 Bridge Rehabilitation	Davidson County Log Mile 8.51 (MP 40), I-24 RL (EB) at Old Hickory Boulevard, BIN# 19100240071. Sufficiency Rating is 70.0. Rehabilitate existing bridge.	\$ 1,250,000	\$ -	\$ 1,000,000	\$ 100,000	\$ 150,000
241	Davidson	MP 44 Bridge Rehabilitation	Davidson County Log Mile 11.86 (MP 44), I-24 RL (EB) at Ewing Drive, BIN# 19100240081. Sufficiency Rating is 62.6. Rehabilitate existing bridge.	\$ 1,250,000	\$ -	\$ 1,000,000	\$ 100,000	\$ 150,000
243	Davidson	MP 52 Bridge Rehabilitation	Davidson County Log Mile for I-40 is 21.58 (MP 52 for I-24), I-40 Structure 5B at I-24, BIN# 19100240067. Sufficiency Rating is 67.0. Rehabilitate existing bridge.	\$ 1,250,000	\$ -	\$ 1,000,000	\$ 100,000	\$ 150,000
224	Coffee	Coffee County Bridge Railing Replacements	Replace pipe bridge railings for 4 bridges in Coffee County between MP 97 and MP 100 which do not conform to current Report 350 crash test standards	\$ 315,600	\$ -	\$ 252,480	\$ 25,248	\$ 37,872
237	Grundy	MP 127 Bridge Modification	Grundy County Log Mile 0.55 (MP 127), US 64/SR 50 at I-24, BIN# 31100240001. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	\$ 54,688	\$ -	\$ 43,750	\$ 4,375	\$ 6,563
238	Marion	MP 135 Bridge Modification	Marion County Log Mile 0.77 (MP 135), Trussell Road at I-24, BIN# 58100240063. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	\$ 54,688	\$ -	\$ 43,750	\$ 4,375	\$ 6,563

Table 5.19: Estimated 2013 Costs for Proposed Rock Fall/Slide Mitigation Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
227	Robertson / Cheatham / Davidson / Rutherford / Bedford	West I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 15 locations between MP 27 and MP 97	\$ 18,000,000	\$ -	\$ 14,400,000	\$ 1,440,000	\$ 2,160,000
228	Coffee / Grundy / Marion / Hamilton	East I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 12 locations between MP 97 and MP 185	\$ 16,125,000	\$ -	\$ 12,900,000	\$ 1,290,000	\$ 1,935,000
226	Grundy	West Monteagle Mountain Geotechnical Projects	West of Monteagle MP 131 to MP 133 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	\$ 3,000,000	\$ -	\$ 2,400,000	\$ 240,000	\$ 360,000
225	Marion	East Monteagle Mountain Geotechnical Projects	East of Monteagle MP 135 to MP 140 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	\$ 5,250,000	\$ -	\$ 4,200,000	\$ 420,000	\$ 630,000

Table 5.20: Estimated 2013 Costs for Proposed Miscellaneous Improvement Projects

Project ID	County of Project	Name of Project	Description of Project	Estimated Total Cost	Estimated ROW Cost	Estimated Construction Cost	Estimated PE Cost	Estimated Contingency Cost
298	Montgomery	Exit 1 Ramp Termini Improvement	Modify right-turn at termini on Exit 1 southbound exit ramp.	\$ 2,577,413	\$ 100,000	\$ 1,981,930	\$ 198,193	\$ 297,290
184	Coffee	Exit 111 Drainage Correction	Correction for I-24 westbound sheet flow during rain. Rain draining across three westbound lanes toward median.	\$ 17,102,085	\$ -	\$ 13,681,668	\$ 1,368,167	\$ 2,052,250
233	Grundy	MP 132 Barrier Improvement	MP 132, Replace cable barrier in narrow bifurcated median section with concrete barrier	\$ 312,500	\$ -	\$ 250,000	\$ 25,000	\$ 37,500
234	Marion	MP 160 Barrier Improvement	MP 160, Extend barrier on the west side of the Tennessee River bridge	\$ 500,000	\$ -	\$ 400,000	\$ 40,000	\$ 60,000
232	Hamilton	MP 173 - MP 185 Barrier Improvement	MP 173 to MP 185, Add roadway barriers to replace curb and gutter	\$ 1,612,500	\$ -	\$ 1,290,000	\$ 129,000	\$ 193,500
231	Hamilton	MP 173 - MP 185 Lighting Improvements	MP 173 to MP 185, Eliminate lighting in clear zone and upgrade continuous lighting	\$ 37,500,000	\$ -	\$ 30,000,000	\$ 3,000,000	\$ 4,500,000
229	Hamilton	MP 173 - MP 185 Pavement Improvements	MP 173 to MP 185, Upgrade pavement surface for improved drainage and friction factors	\$ 22,500,000	\$ -	\$ 18,000,000	\$ 1,800,000	\$ 2,700,000
230	Hamilton	MP 173 - MP 185 Signing and Marking Improvements	MP 173 to MP 185, Upgrade signing and marking	\$ 9,375,000	\$ -	\$ 7,500,000	\$ 750,000	\$ 1,125,000
202	Hamilton	I-24 Missionary Ridge Glare Screen Improvement	Add glare screens on I-24 on either side of Missionary Ridge	\$ 562,500	\$ -	\$ 450,000	\$ 45,000	\$ 67,500

5.3.2 Environmental Screening

The purpose of this environmental screening analysis is to identify and quantify potential environmental impacts resulting from the proposed projects along I-24. For the operational projects, only those projects which may need new ROW were considered for the environmental screening. This limited the screening to the new and modified interchange access as well as truck lanes. It was assumed that all the other types of operational improvements being considered in this study could be implemented within existing ROW.

The screening used data acquired from existing, readily available mapping and database sources. The screening boundaries included a 1,000-foot buffer (500 feet on either side) around the centerline of existing I-24 at each proposed project that would potentially need additional right-of-way (ROW). At proposed new or modified interchange projects, the buffer was set at 500 feet on either side of the interchange centerpoint for the cross street and 1,000 feet on I-24.

The potential environmental resources that were screened for the purposes of this study were cultural resources (National Register of Historic Places (NRHP) listed sites and cemeteries), hazardous material sites reporting to the Environmental Protection Agency (EPA) (RCRA, CERCLIS, etc.), ecological resources (waters of the U.S, floodplains, and threatened and endangered species), and parks/recreation areas. Social resources identified in the Screening include potential Environmental Justice (EJ) populations (low-income and/or minority), churches and schools. The full results of the screening are presented in Appendix B, which provides the number of each environmental/social resource that fell within the 1,000-foot buffer (500 feet on either side of the existing centerline) of each study corridor.

It should be noted that the location of previously identified archeological sites is protected information and is only provided to Cultural Resource professionals conducting archaeological investigations. Therefore, information on previously identified archeological sites was not included in this screening. It should also be noted that the identification of resources within the I-24 corridor was based on readily available mapping and may not correctly represent actual field conditions.

A ranking system was devised to determine the potential impacts for each project. Due to the overall low number of historic structures, parks, cemeteries, churches, schools, and floodplain crossings, potential impacts were ranked on all of these categories combined, and then separately by both the stream and wetlands within the project buffers. A ranking system was then applied to determine which projects may potentially have the most environmental impact.

The rankings for the historic structures, parks, cemeteries, churches, schools, and floodplain crossings were given a 'low' ranking if there were 0-10 potential impacts meaning these projects would have the least amount of impact, a 'moderate' ranking if they had 11-25 potential impacts and a 'high' ranking if they had above 25 potential impacts. As seen in Table 5.21 for the LRTP new and modified access projects, only project 175 had a high ranking, while all the other projects had a moderate or low ranking. As seen in Table 5.22 for the proposed new and modified access projects, all the projects had a moderate or low ranking. As seen in Table 5.23 for the proposed truck lane projects, all three projects had a low ranking.

The ranking system for wetlands was based on the total number of acres of wetlands within each project buffer. A rank on 'low' was given to those projects that had between 0-58 acres of wetlands, a 'moderate' was assigned to projects that had between 59-115 acres and a 'high' was assigned to projects with more than 115 acres of wetlands within their project buffers. As seen in Tables 5.21, 5.22 and 5.23, all projects had a low ranking.

The ranking system for streams was based on the total feet of stream within each project buffer. A rank on 'low' was given to those projects that had between 0-10,665 feet of stream, a 'moderate' was assigned to projects that had between 10,665 and 21,330 feet of stream and a 'high' was assigned to projects with more than 21,330 feet of stream within their project buffers. As seen in Tables 5.21, 5.22 and 5.23, most projects had a low ranking while a few projects had a moderate ranking.

Once each resource or group of resources was ranked, a number was assigned corresponding to the ranking. A one (1) was given to all 'lows,' a two (2) was assigned to 'moderate' ranks and a three (3) was assigned to all 'highs.' Each project's rankings were tallied based on these numerical values and assigned a final ranking based on the total. A final tally of 1-3 resulted in the project ranking as a 'low', meaning there is a lower chance of environmental impact for the project. A final tally of 4-6 resulted in the project ranking as a 'moderate,' meaning there is a moderate chance of adverse environmental impact, and projects scoring 7-9 received a 'high' ranking, meaning they had the most potential for environmental impact. As seen in Tables 5.21, 5.22 and 5.23, none of the LRTP or proposed new/modified access projects or the proposed truck lane projects received a high ranking but all projects received either moderate or low rankings. Therefore, it may be assumed that, based on the screening process, none of the LRTP or proposed new/modified access projects or proposed truck lanes likely has the potential to adversely impact the environment. However, project 175 should be monitored closely since this project was given a 'high' ranking in one of the environmental screening categories. Please see Appendix B for a fuller presentation and explanation of the environmental screening analysis completed for the I-24 Corridor.

Table 5.21: Environmental Screening for LRTP New and Modified Access Projects

Project ID	County of Project	Name of Project	Description of Project	Potential Environmental Impacts Rankings						
				Total Sites (including Floodplains)	Site Impact Ranking	Wetlands (In Acres)	Wetlands Impact Ranking	Streams (In Feet)	Streams Impact Ranking	Total Impact Ranking
178	Davidson	Modify Access at I-24/Hickory Hollow Pkwy Interchange	Modify interchange to allow access to/from Cane Ridge Road at I-24/Hickory Hollow Parkway Interchange	9	Low	1	Low	12,324	Moderate	Moderate
172	Rutherford	New I-24/Rocky Fork Road Interchange	Construct a new interchange at I-24 and Rocky Fork Road (MP 68)	1	Low	3	Low	0	Low	Low
180	Hamilton	I-24 at Market & Broad Streets Interchange Modification	Modify Market Street and Broad Street I-24 interchanges to improve safety and operation characteristics	17	Moderate	0	Low	127	Low	Moderate
182	Hamilton	I-24 and I-75 Interchange Modification	Modification of the interchange of I-75 and I-24	9	Low	1	Low	11,140	Moderate	Moderate
176	Davidson	I-24 at North 1st Street Interchange	Construct HOV ramps to and from I-24 and CBD at North 1st Street, Exit 47	18	Moderate	19	Low	0	Low	Moderate
175	Davidson	I-24 at Shelby Avenue Interchange	Construct HOV ramps to and from I-24 and CBD at Shelby Avenue, Exit 49	37	High	1	Low	0	Low	Moderate
174	Davidson	I-24 at Harding Place Drive Interchange	Construct urban diamond interchange (Phase I) on I-24 at Harding Place Drive, Exit 56	5	Low	1	Low	5,320	Low	Low
179	Rutherford	Interchange Improvements at Epps Mill Road and I-24	Widen Epps Mill Road from a 2-Lane to a 3-Lane Cross Section and redesign/improve Exit 89 to better accommodate truck traffic	3	Low	0	Low	0	Low	Low

Table 5.22: Environmental Screening for Proposed New and Modified Access Projects

Project ID	County of Project	Name of Project	Description of Project	Potential Environmental Impacts Rankings						
				Total Sites (including Floodplains)	Site Impact Ranking	Wetlands (In Acres)	Wetlands Impact Ranking	Streams (In Feet)	Streams Impact Ranking	Total Impact Ranking
286	Davidson	New Interchange in SE Nashville	Add a new interchange at Old Franklin Road (MP 61). (Not included in this project but part of future project: New Road from Nolensville Road to I-24)	0	Low	0	Low	2,310	Low	Low
118	Rutherford	New Interchange in Murfreesboro	Add new interchange in Murfreesboro (between Exit 74 and 89) - Modeled at Elam Road (MP 85)	2	Low	1	Low	0	Low	Low
146	Coffee	New Interchange between Exit 105 - Exit 110	Add new interchange in Manchester between Exit 105 and exit 110 - Modeled at Fredonia Road (MP 109)	0	Low	1	Low	5,141	Low	Low
253	Davidson	Exit 47 - Exit 48 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 47-Exit 47A-Exit 48 (Downtown Nashville) EB and WB to remove weaving sections from the mainline and to remove exit points	12	Moderate	1	Low	0	Low	Moderate
254	Rutherford	Exit 74 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 74A-74B (SR 840) EB and WB to remove weaving section from the mainline and to remove exit points	0	Low	7	Low	0	Low	Low
255	Rutherford	Exit 78 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 78A-78B (SR 96) EB and WB to remove exit points	2	Low	3	Low	2,183	Low	Low
256	Rutherford	Exit 80 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 80 (SR 99) EB and WB to remove entrance points	1	Low	0	Low	0	Low	Low
94	Coffee	Exit 111 Upgrade to Standard Interchange	Modify the I-24 interchange at SR 55 (Exit 111) to convert to diamond interchange and remove loop ramp	1	Low	1	Low	1,176	Low	Low
257	Hamilton	Exit 180 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 180B-Exit 180 (Rossville Blvd) EB and WB to remove weaving section from the mainline and to remove exit points	21	Moderate	1	Low	7,298	Low	Moderate
211	Davidson	I-24 at Bell Road Interchange Modification	Reconstruct the Interchange I-24 at Bell Road and construct bike lanes and sidewalks along Bell Road in the vicinity of the interchange	8	Low	2	Low	9,109	Low	Low
258	Hamilton	Exit 183B - Exit 184 Interchange Modifications	Redesign ramp sequencing and lengths from S. Germantown Road to McBrien Road (currently Exit 183B-Exit 183A-Exit 184) to remove weaving sections and to remove exit points	14	Moderate	0	Low	14,021	Moderate	Moderate

Table 5.23: Environmental Screening for Proposed Truck Lane Projects

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Potential Environmental Impacts Rankings						
					Total Sites (including Floodplains)	Site Impact Ranking	Wetlands (In Acres)	Wetlands Impact Ranking	Streams (In Feet)	Streams Impact Ranking	Total Impact Ranking
212	Cheatham	Cheatham County - Extend Existing EB Truck Lane	Extend existing EB Truck Lane on I-24 in Cheatham County, Log Mile (2) 0.05 to 0.569 (MP 28)	0.5	0	Low	0	Low	0	Low	Low
214	Grundy	Grundy County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Grundy County, Log Mile 3.40 to 6.55 (MP 130 to MP 133)	3.2	0	Low	0	Low	5,803	Low	Low
324	Marion	Marion County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Marion County, Log Mile 30.50 to 32.10 (MP 165 to MP 167)	1.6	2	Low	0	Low	9,575	Low	Low

5.3.3 Economic Impact Screening

The economic impact screening completed for this study is different from the other screening elements in that it evaluates packages/scenarios of projects, rather than individual projects. See Section 5.1.3 for a comparison of the economic impact of the operational projects versus the economic impact of the capacity projects on I-24 and the capacity projects off I-24. Also, see Appendix C for a full presentation and explanation of the economic impact analysis completed for the I-24 Multimodal Corridor Study.

5.3.4 Benefit-Cost Screening

The last screening element that was completed for the LRTP and proposed operational projects was a benefit-cost ratio analysis. Benefit-cost ratios were only developed for select LRTP and proposed new/modified access projects that had improvements that could produce a significant enough benefit that could be detected by the travel models. New access to I-24 general purpose lanes and major reconfigurations/new collector-distributor roads were modeled with either the macro-scopic travel demand model (i.e., TransCAD) or the meso-scopic (i.e., TransModeler) model.

The benefit side of the ratio is developed using travel time output for cars and trucks from the travel models and using assumptions for the value of time and operating cost. The cost side of the ratio is the total cost of the project, already provided in Section 5.2.1. All benefit and cost values are in current dollars (i.e., 2013). Please see Appendix D for an in-depth presentation and explanation of the benefit-cost parameters and assumptions used in this study.

Total annual cost savings (i.e., benefits) compared to the 'E+C' network under 2040 conditions is provided for each applicable project. It is important to note that for the LRTP and proposed modified access at I-24 interchanges, only the benefits to I-24 are included in this benefit-cost analysis. However, for the LRTP and proposed new access to I-24, included the benefit to the metropolitan study area in order to measure the full impact of a new interchange.

Next, the estimated cumulative benefits are provided for each project for three time horizons: 2013 to 2020, 2013 to 2030, and 2013 to 2040. (Benefits for each year between 2013 and 2040 are interpolated.) This assumes that each project is theoretically constructed in 2013. This is not the case, however the results of this benefit-cost methodology provides a valuable indication of the feasibility of the project within each of the three time horizons (i.e., short-term, mid-term, and long-term). Finally, benefit-cost ratios are provided for each time horizon.

See Table 5.24 for the benefit-cost ratios for the LRTP new and modified access projects and see Table 5.25 for the benefit-cost ratios for the proposed new and modified access projects. As seen in Table 5.24, the two LRTP new/modified access projects (projects 178 and 172) in Davidson County and Rutherford County have benefit-cost ratios well over 1.0, indicating that benefits will greatly exceed the costs. Table 5.24 also shows the LRTP modified access project at the Market Street and Broad Street interchange (project 180) with a negative benefit-cost

ratio. The reason for the negative benefit-cost ratio is due to the ‘bottle-neck’ at this interchange being fixed and causing more traffic to travel downstream and get caught in another ‘bottle-neck,’ which causes the model to estimate more delay because there are more vehicles in the system. So, a closer look at the travel model (i.e., TransModeler) reveals that the modified access project is a feasible project, but shows that improvements need to be implemented downstream of the interchange. Table 5.24 also shows that the LRTP I-75/I-24 interchange modification project (project 182) results in a benefit-cost ratio of greater than 1.0 for the time period between 2013 and 2040.

Table 5.25 also shows two proposed new/modified access projects (projects 286 and 118) in Davidson County and Rutherford County that have benefit-cost ratios over 1.0, indicating that benefits will exceed the costs. And, similar to the phenomenon that occurs at the LRTP modified access project at the Market Street and Broad Street interchange, the proposed modified access project in downtown Nashville (project 253) results in a negative benefit-cost ratio. This is another indication that when one ‘bottle-neck’ is fixed, that another ‘bottle-neck’ downstream will be created, causing traffic to back-up into the improvement interchange. Table 5.25 does show that two proposed modified access projects (projects 94 and 257) have a benefit-cost ratio greater than 1.0 for the time period between 2013 and 2040.

Table 5.24: Benefit-Cost Ratios for LRTP New and Modified Access Projects

Project ID	County of Project	Name of Project	Description of Project	2040 Total Annual Cost Savings	Estimated Cumulative Benefits			Benefit/Cost Ratios		
					(2013 - 2020)	(2013 - 2030)	(2013 - 2040)	(2013 - 2020)	(2013 - 2030)	(2013 - 2040)
178	Davidson	Modify Access at I-24/Hickory Hollow Pkwy Interchange	Modify interchange to allow access to/from Cane Ridge Road at I-24/Hickory Hollow Parkway Interchange	\$ 41,195,609	\$ 42,721,372	\$233,441,782	\$576,738,520	3.2	17.3	42.7
172	Rutherford	New I-24/Rocky Fork Road Interchange	Construct a new interchange at I-24 and Rocky Fork Road (MP 68)	\$ 18,512,447	\$ 19,198,093	\$104,903,865	\$259,174,254	0.4	2.3	5.6
180	Hamilton	I-24 at Market & Broad Streets Interchange Modification	Modify Market Street and Broad Street I-24 interchanges to improve safety and operation characteristics	\$ (1,141,047)	\$ (1,183,308)	\$ (6,465,935)	\$ (15,974,663)	0.0	-0.1	-0.3
182	Hamilton	I-24 and I-75 Interchange Modification	Modification of the interchange of I-75 and I-24	\$ 9,706,604	\$ 10,066,108	\$ 55,004,092	\$135,892,463	0.1	0.5	1.2
176	Davidson	I-24 at North 1st Street Interchange	Construct HOV ramps to and from I-24 and CBD at North 1st Street, Exit 47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
175	Davidson	I-24 at Shelby Avenue Interchange	Construct HOV ramps to and from I-24 and CBD at Shelby Avenue, Exit 49	N/A	N/A	N/A	N/A	N/A	N/A	N/A
174	Davidson	I-24 at Harding Place Drive Interchange	Construct urban diamond interchange (Phase I) on I-24 at Harding Place Drive, Exit 56	N/A	N/A	N/A	N/A	N/A	N/A	N/A
179	Rutherford	Interchange Improvements at Epps Mill Road and I-24	Widen Epps Mill Road from a 2-Lane to a 3-Lane Cross Section and redesign/improve Exit 89 to better accommodate truck traffic	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 5.25: Benefit-Cost Ratios for Proposed New and Modified Access Projects

Project ID	County of Project	Name of Project	Description of Project	2040 Total Annual Cost Savings	Estimated Cumulative Benefits			Benefit/Cost Ratios		
					(2013 - 2020)	(2013 - 2030)	(2013 - 2040)	(2013 - 2020)	(2013 - 2030)	(2013 - 2040)
286	Davidson	New Interchange in SE Nashville	Add a new interchange at Old Franklin Road (MP 61). (Not included in this project but part of future project: New Road from Nolensville Road to I-24)	\$ 18,126,265	\$ 18,797,608	\$ 102,715,502	\$ 253,767,710	0.4	2.2	5.5
118	Rutherford	New Interchange in Murfreesboro	Add new interchange in Murfreesboro (between Exit 74 and 89) - Modeled at Elam Road (MP 85)	\$ 2,774,845	\$ 2,877,617	\$ 15,724,120	\$ 38,847,826	0.1	0.6	1.4
146	Coffee	New Interchange between Exit 105 - Exit 110	Add new interchange in Manchester between Exit 105 and exit 110 - Modeled at Fredonia Road (MP 109)	\$ 871,342	\$ 903,614	\$ 4,937,607	\$ 12,198,794	0.0	0.2	0.4
253	Davidson	Exit 47 - Exit 48 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 47-Exit 47A-Exit 48 (Downtown Nashville) EB and WB to remove weaving sections from the mainline and to remove exit points	\$ (20,982,701)	\$ (21,759,838)	\$ (118,901,972)	\$ (293,757,813)	-1.4	-7.8	-19.3
254	Rutherford	Exit 74 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 74A-74B (SR 840) EB and WB to remove weaving section from the mainline and to remove exit points	\$ 654,218	\$ 678,448	\$ 3,707,234	\$ 9,159,049	0.0	0.2	0.6
255	Rutherford	Exit 78 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 78A-78B (SR 96) EB and WB to remove exit points	\$ 741,743	\$ 769,215	\$ 4,203,212	\$ 10,384,405	0.1	0.3	0.7
256	Rutherford	Exit 80 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 80 (SR 99) EB and WB to remove entrance points	\$ 538,877	\$ 558,835	\$ 3,053,637	\$ 7,544,279	0.0	0.2	0.5
94	Coffee	Exit 111 Upgrade to Standard Interchange	Modify the I-24 interchange at SR 55 (Exit 111) to convert to diamond interchange and remove loop ramp	\$ 160,802	\$ 166,758	\$ 911,213	\$ 2,251,233	0.1	0.4	1.1
257	Hamilton	Exit 180 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 180B-Exit 180 (Rossville Blvd) EB and WB to remove weaving section from the mainline and to remove exit points	\$ 5,919,068	\$ 6,138,292	\$ 33,541,383	\$ 82,866,947	0.4	2.2	5.5
211	Davidson	I-24 at Bell Road Interchange Modification	Reconstruct the Interchange I-24 at Bell Road and construct bike lanes and sidewalks along Bell Road in the vicinity of the interchange	N/A	N/A	N/A	N/A	N/A	N/A	N/A
258	Hamilton	Exit 183B - Exit 184 Interchange Modifications	Redesign ramp sequencing and lengths from S. Germantown Road to McBrien Road (currently Exit 183B-Exit 183A-Exit 184) to remove weaving sections and to remove exit points	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5.3.5 Conclusions

Based on the screening analysis completed for the operational projects, the project team has developed recommendations to either add the LRTP and proposed projects to the I-24 plan or to eliminate them from further consideration. To summarize, the following elements were included in the screening evaluation:

- Is the project included in a current MPO LRTP?
- Will the project reduce delay on I-24?
- Will the project improve safety on I-24?
- Is the project located in a high crash rate area on I-24 (i.e., a segment of I-24 that has a crash rate 2.0 or more times the average Statewide crash rate for interstates)?
- Will the project potentially have low to moderate impacts on the environment?

- Does the project have a favorable benefit-cost ratio (i.e., a benefit-cost ratio greater than 0.7, recognizing the fact that the benefit-cost ratio only takes into consideration benefits to a limited section of I-24, and not to any other roads)?
- Does the project have a relatively low total cost in 2013 dollars (i.e., less than \$5 million)?
- Will the project have a potential significant economic impact on the study area (i.e., a total project cost greater than \$40 million would potentially translate into a benefit of approximately 1,000 jobs created, in full-time annual equivalents)?
- Will the project support local economic development, primarily by providing new or substantially improved access to I-24?

Based on this screening analysis, the following projects are recommended:

- LRTP new/modified access projects: 178, 172, 180, 182, 176, 175, 174, and 179.
- Proposed (i.e., Non-LRTP) new/modified access projects: 286, 118, 253, 254, 255, 256, 94, 257, and 258.
- Because all of the other operational improvements are based primarily on design or safety considerations, they are all recommended for the I-24 Corridor.

It is important to mention that the proposed project to reconstruct the Bell Road interchange (project 211) was not recommended. However, several improvements in and near the Bell Road interchange have been recommended. It is recommended that all the Bell Road ramps be lengthened/redesigned to improve operations and safety at the Bell Road interchange (included in project 247). Also, a project to modify the I-24/Hickory Hollow Parkway interchange to allow access to/from Cane Ridge Road is recommended (project 178) that will potentially divert traffic away from the Bell Road interchange to and from I-24 on the south side. Furthermore, it is recommended that if Bell Road is improved in the future in the vicinity of I-24 that improvements should be implemented to accommodate bicyclists and pedestrians.

It is also important to note that several of the proposed interchange projects are already in TDOT's Interstate Access Request Project List in various stages of planning. These include projects 94, 172, 179, 180 and 182. These projects are also included in the I-24 Study in order to document that the I-24 Study confirmed that these interchange projects are viable.

Section 6 will present the prioritization of the projects that have been recommended as a result of the screening analysis. A summary of the evaluation, recommendation, and prioritization analysis for each Operational Project is found in Appendix F.

6.0 Recommendations and Prioritization of Projects and Strategies

The purpose of the I-24 Multimodal Corridor Study is to examine potential multimodal transportation improvements that would address existing and emerging transportation system issues associated with this strategic corridor through central Tennessee connecting the Clarksville, Nashville and Chattanooga urban areas. The corridor extends from the Kentucky border to where it meets I-75 in Hamilton County, a distance of approximately 185 miles.

The analysis of corridor needs has gone through a structured process of characterizing existing and projected corridor conditions, describing the purpose and need for corridor improvements, defining a set of performance measures against which to evaluate improvement options, and evaluating potential corridor improvements against these performance measures to develop a set of recommended and prioritized projects and strategies.

The Final Report now concludes with Section 6 where the planning-level recommended projects and strategies for the I-24 Multimodal Corridor Study are prioritized. It should be noted that this study makes recommendations for projects and strategies that are at the planning level. This means that further study and design will be required before the recommended projects and strategies developed in this report should be implemented or constructed.

While this study recommends a number of capacity improvements on I-24, the project team realizes that TDOT cannot afford to keep adding lanes to its interstates as the only solution to reduce congestion in the urban areas. That is why freight, transit and managed lane strategies will be critical to help manage and maintain the current utility of the interstate facilities in the State. Also, lower-cost solutions are needed to maximize the operations of the current interstate facilities.

Strategies should also be pursued that will help divert freight from trucks to rail where and when possible. While auto travel demand in the urban areas will likely 'fill the gap' left by any diversion of truck traffic, there will still be some benefit in slightly increased speed and less delay when trucks are diverted from I-24.

Improving safety on I-24 is also a critical goal of this study. Several types of projects ranging from interchange modifications to ITS improvements are recommended in this study that will improve safety in areas along I-24 that have exhibited higher than average crash rates.

As part of the prioritization process, projects that are generally located in the same place were coordinated as much as possible so that construction on the various projects could be completed at the same time. Also, in some areas along I-24, lower cost projects are recommended to be implemented earlier than some of the more expensive improvements, realizing that funding may not be as readily available for the larger, more expensive projects. The recommended projects were also prioritized based on the type of project, the status of the project in the MPO planning process (if applicable), and how well the project performed in the benefit-cost ratio analysis.

Table 6.1 provides a summary of the cost, in year of expenditure (YOE), of each type of project by study subarea/region and by the horizon year. Three horizon years were used to prioritize the recommended projects: 2020 (short-term), 2030 (mid-term) and 2040 (long-term).

As seen in Table 6.1, the capacity projects 'On I-24' and 'Off I-24' have the highest costs while the operational projects such as ITS projects, bridge improvements, truck lanes, rock fall/mitigation projects, and miscellaneous improvements account for a much smaller portion of the total costs. The Nashville subarea has 53% to 67% of the total costs for the various horizon years, followed by the Chattanooga subarea which has between 17% and 46%, and Clarksville, which has between 0% and 21%.

The prioritized projects in Section 6 are organized into three distinct types of projects: 'Capacity Projects On I-24,' 'Capacity Projects Off I-24,' and 'Operational' projects. The following subsections will present the individual projects for these three general types of projects and will provide the recommended 'build year' and associated year of expenditure (YOE) cost. Section 6 also includes a subsection that presents the recommended multimodal strategies for freight, transit and managed lanes in the I-24 Corridor.

It should also be noted that while the I-24 Multimodal Corridor Study provides recommendations based on input from stakeholders and on technical analysis, it is not a commitment on the part of TDOT to implement any of the projects or strategies. The Study is a set of recommendations that are not fiscally constrained. There is no need for the MPOs to amend their Long Range Transportation Plans or Transportation Improvement Programs until such time as TDOT is ready to begin implementing a project(s).

Table 6.1: Summary of Year of Expenditure Costs by Subarea and by Horizon Year

Category of Recommended Projects	Subarea 1 - Clarksville			Subarea 2 - Nashville			Subarea 3 - Chattanooga			Total		
	2020 YOE Cost (millions)	2030 YOE Cost (millions)	2040 YOE Cost (millions)	2020 YOE Cost (millions)	2030 YOE Cost (millions)	2040 YOE Cost (millions)	2020 YOE Cost (millions)	2030 YOE Cost (millions)	2040 YOE Cost (millions)	2020 YOE Cost (millions)	2030 YOE Cost (millions)	2040 YOE Cost (millions)
Capacity Projects On I-24	\$ -	\$ 264.3	\$ 199.0	\$ 290.6	\$ 247.1	\$ 1,328.0	\$ -	\$ 313.2	\$ 969.3	\$ 290.6	\$ 824.6	\$ 2,496.3
Capacity Projects Off I-24	\$ -	\$ 236.9	\$ -	\$ -	\$ 1,170.9	\$ 1,045.7	\$ -	\$ 116.1	\$ -	\$ -	\$ 1,523.8	\$ 1,045.7
New and Modified Interstate Access	\$ -	\$ -	\$ -	\$ 111.4	\$ 192.5	\$ 189.3	\$ 287.0	\$ -	\$ -	\$ 398.4	\$ 192.5	\$ 189.3
Ramp Improvements	\$ -	\$ 24.8	\$ 8.8	\$ 106.5	\$ -	\$ 57.5	\$ 21.8	\$ -	\$ 125.7	\$ 128.3	\$ 24.8	\$ 192.0
ITS Projects	\$ 0.04	\$ -	\$ -	\$ 12.1	\$ -	\$ -	\$ 3.2	\$ -	\$ -	\$ 15.3	\$ -	\$ -
Truck Lanes	\$ -	\$ -	\$ -	\$ 6.5	\$ -	\$ -	\$ 66.9	\$ -	\$ -	\$ 73.4	\$ -	\$ -
Bridge Improvements	\$ 0.9	\$ -	\$ -	\$ 6.4	\$ -	\$ -	\$ 0.1	\$ -	\$ -	\$ 7.5	\$ -	\$ -
Rock Fall/Slide Mitigation Improvements	\$ -	\$ -	\$ -	\$ 23.1	\$ -	\$ -	\$ 31.2	\$ -	\$ -	\$ 54.3	\$ -	\$ -
Miscellaneous Projects	\$ 3.3	\$ -	\$ -	\$ 21.9	\$ -	\$ -	\$ 92.7	\$ -	\$ -	\$ 117.9	\$ -	\$ -
Total	\$ 4.3	\$ 526.0	\$ 207.9	\$ 578.4	\$ 1,610.5	\$ 2,620.4	\$ 503.0	\$ 429.3	\$ 1,095.0	\$ 1,085.7	\$ 2,565.8	\$ 3,923.3
Percentage of Horizon Year	0%	21%	5%	53%	63%	67%	46%	17%	28%	100%	100%	100%

Note:

YOE = Year of Expenditure

6.1.1 Capacity Projects On I-24

The LRTP and Non-LRTP capacity projects ‘On I-24’ that are recommended for the I-24 Corridor were given a recommended ‘build year’ based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT’s guidelines. The recommended LRTP and Non-LRTP ‘Capacity Projects On I-24’ are presented in Tables 6.2 and 6.3, respectively, and are also shown on Figures 6.1 and 6.2, respectively. (A description and evaluation of the ‘Capacity Projects On I-24’ is explained in detail in Sections 3 and 5.)

Table 6.2: Recommended Capacity Projects On I-24 (LRTP)

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
169	Montgomery	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between TN State Line to SR-76 (Exit 11), 10.6 miles	10.6	MP 0 - Exit 11	1	2030	\$ 264,332,856
170	Montgomery / Robertson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between SR-76 (Exit 11) to SR-256 (Exit 19) in Robertson County, 8.6 miles	8.6	Exit 11 - Exit 19	1	2040	\$ 199,041,647
173	Davidson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) from I-65 to Old Hickory Boulevard (SR-45), Exit 40 - Exit 44, 4.5 miles	4.5	Exit 40 - Exit 44	2	2030	\$ 127,400,656
177	Davidson	I-24 Additional Lanes	I-24 Additional Lanes from I-24/I-65 junction (S of Fern Ave.) to Trinity Lane. Replace underpass to acc. 6 lanes in each direction. Exit 46 - Exit 87 (I-65), MP 45 for I-24, 1.1 miles	1.1	MP 45 - Exit 46	2	2020	\$ 17,508,450
181	Hamilton / Georgia	I-24 Additional Lanes	Widen I-24 from 4 to 6 lanes from I-59 to US-27; fix structurally deficient bridge at I-24 and I-124, 10.4 miles	10.4	Exit 169 - Exit 178	3	2040	\$ 581,476,747
183	Hamilton	I-24 Additional Lanes	Widen I-24 from 6 to 8 lanes from US-27 to I-75; fix S. Seminole Dr. structurally deficient bridge over I-24 at top of Missionary Ridge, 5.5 miles	5.5	Exit 178 - Exit 185	3	2030	\$ 313,215,672

Table 6.3: Recommended Capacity Projects On I-24 (Non-LRTP)

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
315	Robertson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-256 (Exit 19) to SR-49 (Exit 24), 5.3 miles	5.3	Exit 19 - Exit 24	2	2040	\$ 188,242,947
314	Robertson / Cheatham / Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-49 (Exit 24) to US-431/Whites Creek Pike (Exit 35), 10.4 miles	10.4	Exit 24 - Exit 35	2	2040	\$ 369,382,382
313	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-431/Whites Creek Pike (Exit 35) to SR-45/Old Hickory Boulevard (Exit 40), 3.3 miles	3.3	Exit 35 - Exit 40	2	2040	\$ 251,806,206
306	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-155/Briley Parkway (Exit 54) to Haywood Lane (Exit 57), 3.4 miles	3.4	Exit 54 - Exit 57	2	2020	\$ 59,528,734
307	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, Haywood Lane (Exit 57) to SR-171/Old Hickory Boulevard (Exit 62), 5.4 miles	5.4	Exit 57 - Exit 62	2	2020	\$ 94,545,629
308	Davidson / Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-171/Old Hickory Boulevard (Exit 62) to SR-102/Nissan Drive (Exit 70), 6.8 miles	6.8	Exit 62 - Exit 70	2	2020	\$ 119,057,468
309	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-102/Nissan Drive (Exit 70) to SR-840 (Exit 74), 4.8 miles	4.8	Exit 70 - Exit 74	2	2030	\$ 119,698,082
310	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-840 (Exit 74) to SR-96 (Exit 78), 3.7 miles	3.7	Exit 74 - Exit 78	2	2040	\$ 131,414,887
311	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-96 (Exit 78) to US-231/Shelbyville Highway (Exit 81), 3.3 miles	3.3	Exit 78 - Exit 81	2	2040	\$ 117,207,869
312	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-231/Shelbyville Highway (Exit 81) to Epps Mill Road (Exit 89), 7.6 miles	7.6	Exit 81 - Exit 89	2	2040	\$ 269,933,278
318	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-72/Lee Highway (Exit 152) to SR-27 (Exit 158), 6.7 miles	6.7	Exit 152 - Exit 158	3	2040	\$ 155,067,329
317	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-27 (Exit 158) to SR-156 (Exit 161), 2.7 miles	2.7	Exit 158 - Exit 161	3	2040	\$ 84,630,101
316	Marion / Hamilton	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-156 (Exit 161) to GA Border (MP 167), 5.6 miles	5.6	Exit 161 - MP 167	3	2040	\$ 148,122,428

Figure 6.1: Recommended Capacity Projects On I-24 (LRTP)

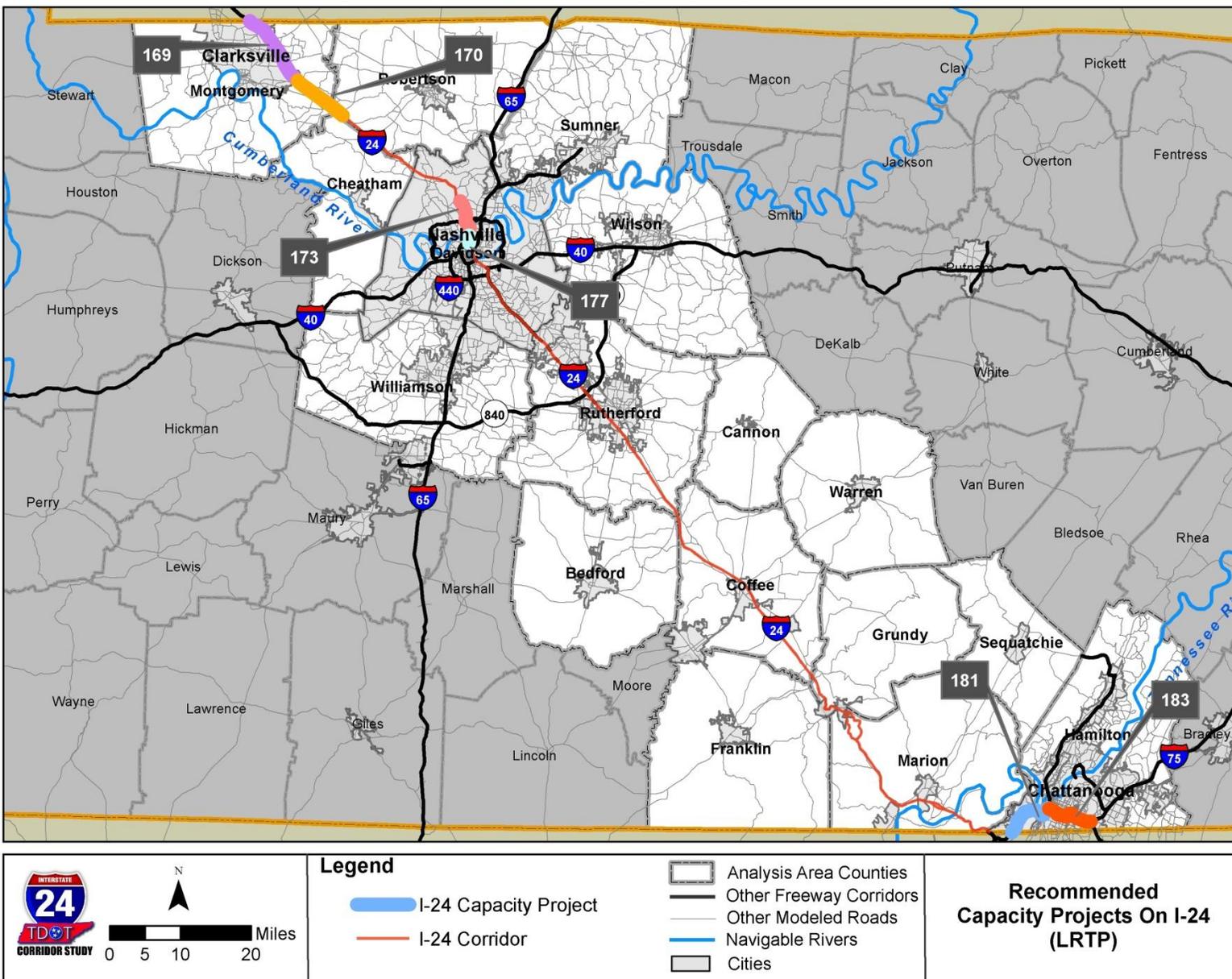
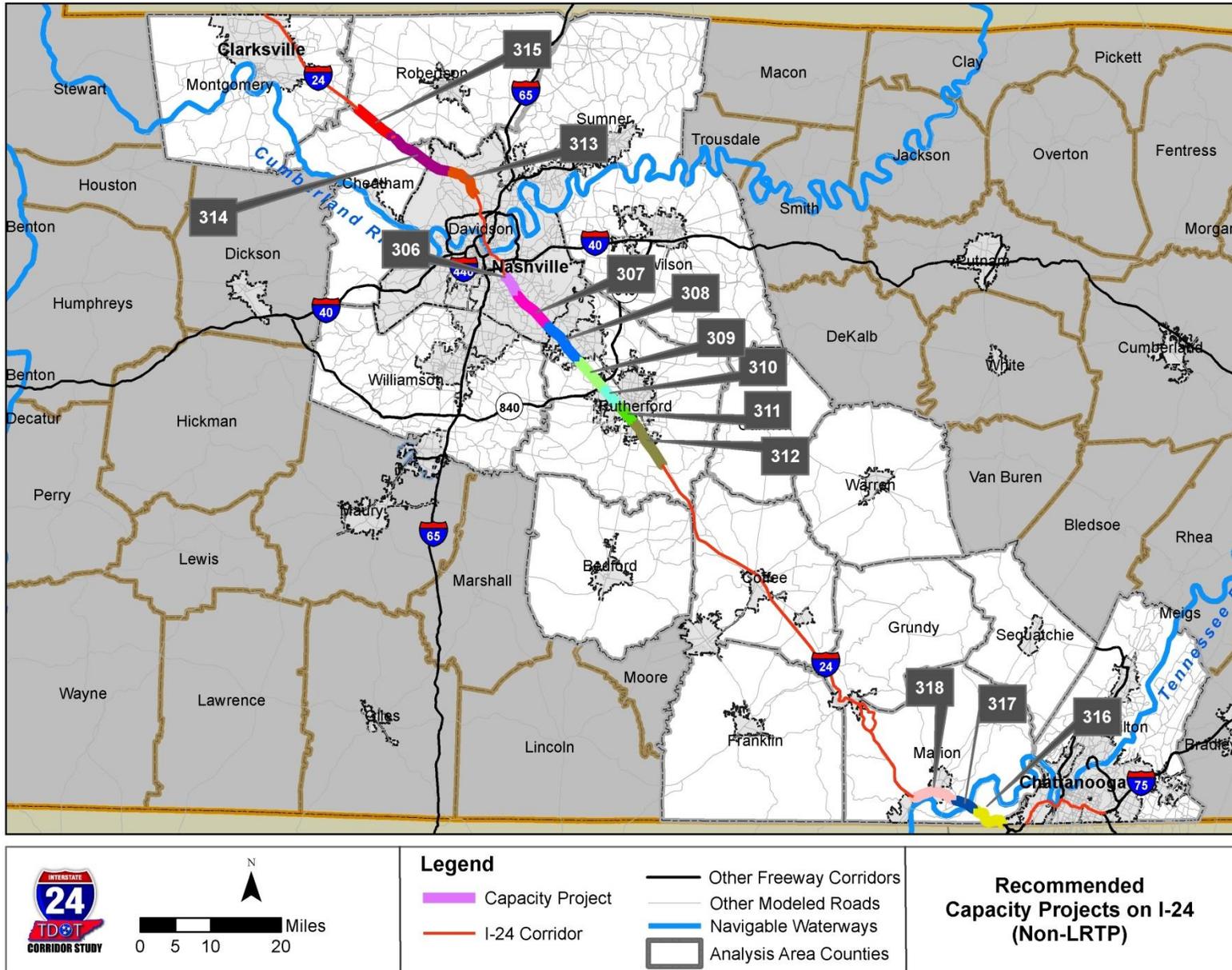


Figure 6.2: Recommended Capacity Projects On I-24 (Non-LRTP)



6.1.2 Capacity Projects Off I-24

The LRTP and Non-LRTP capacity projects ‘Off I-24’ (i.e., roadways generally parallel to I-24) that are recommended for the I-24 Corridor were given a recommended ‘build year’ based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT’s guidelines. The recommended LRTP and Non-LRTP ‘Capacity Projects Off I-24’ are presented in Tables 6.4 and 6.5, respectively, and are also shown on Figures 6.3 and 6.4, respectively. (A description and evaluation of the ‘Capacity Projects Off I-24’ is explained in detail in Sections 3 and 5.) It is also recommended that the ‘Off I-24’ projects that involve non-interstate improvements should accommodate bicyclists and pedestrians when implemented.

Table 6.4: Recommended Capacity Projects Off I-24 (LRTP)

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
206	Montgomery	SR-48 (Trenton Rd)	Widening from 2 to 4 lanes between Hazelwood Road and Tylertown Road, 0.9 miles	0.9	1	2030	\$ 27,448,077
203	Montgomery	East-West Connector Phase 1	New 4-Lane road between US-79 (Wilma Rudolph Blvd) and SR-48 (Trenton Rd), 2.5 miles	2.5	1	2030	\$ 70,461,064
205	Montgomery	SR-374/ Warfield Blvd (North Pkwy)	Widening from 2 to 4/5 lanes between Dunbar Cave Road and US-79/SR-13 (Stokes Road), 2.6 miles	2.6	1	2030	\$ 78,452,391
204	Montgomery	SR-374/ Richview Rd/ Warfield Blvd	Widening from 2 to 4 lanes between Memorial Drive and Dunbar Cave Road, 2.0 miles	2.0	1	2030	\$ 60,490,085
271	Davidson	Ellington Parkway Widening	Widen Ellington Parkway (SR 6) from 4 to 6 lanes from North 1st Street to Boardmoor Drive, 4.85 miles	4.9	2	2030	\$ 111,685,428
302	Davidson	I-65 Widening	Widen I-65 from 6 to 8 lanes from Harding Place (SR-255) to I-40, 4.3 miles	4.3	2	2030	\$ 320,072,761
303	Davidson	SR-1 (Murfreesboro Road) Widening	Widen SR-1 (Murfreesboro Road) from 4 to 6 lanes from Donelson Pike to Smith Springs Road, 1.2 miles	1.2	2	2030	\$ 37,485,871
207	Hamilton	Wauhatchie Pike (parallel to I-24)	Widening Wauhatchie Pike from 2 lanes to 4 lanes from US-11 to US-41/US64, parallel to I-24 just west of Moccasin Bend, 2.8 miles	2.8	2	2040	\$ 94,347,171

Table 6.5: Recommended Capacity Projects Off I-24 (Non-LRTP)

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
153	Davidson / Rutherford	Murfreesboro Pike Widening	Widen Murfreesboro Pike from 4 to 6 lanes to handle traffic diversion from Murfreesboro into Nashville, 28.6 miles	28.6	2	2030	\$ 656,770,413
277	Davidson	Antioch Pike/Una-Antioch Pike Widening	Road Widening, 2 to 4 lanes Haywood Lane to Murfreesboro Pike, 3.7 miles	3.7	2	2040	\$ 123,514,187
287	Davidson	Mt. View Road widening	Road Widening, 2 to 4 lanes from Smith Springs Pkwy to Hickory Hollow Pkwy, 4.4 miles	4.4	2	2040	\$ 147,910,746
289	Davidson	Hickory Hollow Parkway widening	Road Widening, 2 to 4 lanes from Bell Road to Una Antioch Pike, 1.3 miles	1.3	2	2040	\$ 43,689,202
279	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes Old Hickory Blvd to Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road, 2.3 miles	2.3	2	2040	\$ 77,363,739
280	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes from Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road to Bell Rd, 1.4 miles	1.4	2	2040	\$ 47,027,423
291	Davidson	Crossings Boulevard Extension	New Road (4-lane divided) from Old Hickory Blvd to Crossings Blvd, 1.6 miles	1.6	2	2030	\$ 44,906,257
272	Davidson / Rutherford	SR-11 (Nolensville Rd)	Road Widening, 2 to 4 lanes from SR-840 to Burkitt Road, 10.5 miles	10.5	2	2040	\$ 424,234,328
273	Rutherford	Old Nashville Highway Widening Phase I	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase I (US-41/Murfreesboro Pike to Jefferson Pike), 1.1 miles	1.1	2	2040	\$ 34,819,867
274	Rutherford	Old Nashville Highway Widening Phase II	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase II (Jefferson Pike to SR-266/Sam Ridley Parkway), 1.7 miles	1.7	2	2040	\$ 52,749,522
208	Hamilton	Cummings Highway Widening	Ensure 4 lanes on Cummings Hwy (parallel to I-24 at Moccasin Bend) throughout including through two RR underpasses; add median, turn lanes and shoulders, 2.7 miles	2.7	3	2030	\$ 116,052,867

Figure 6.3: Recommended Capacity Projects Off I-24 (LRTP)

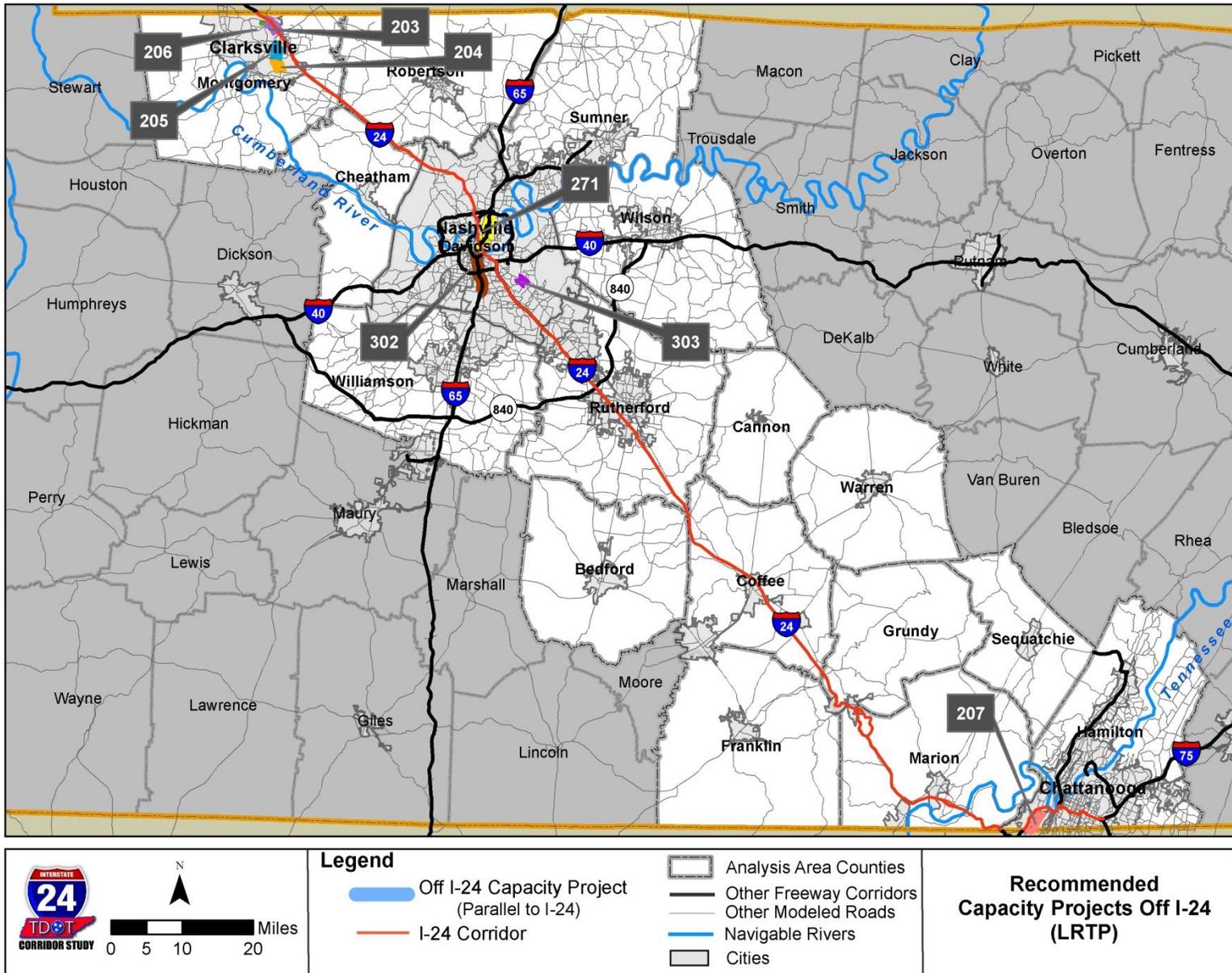
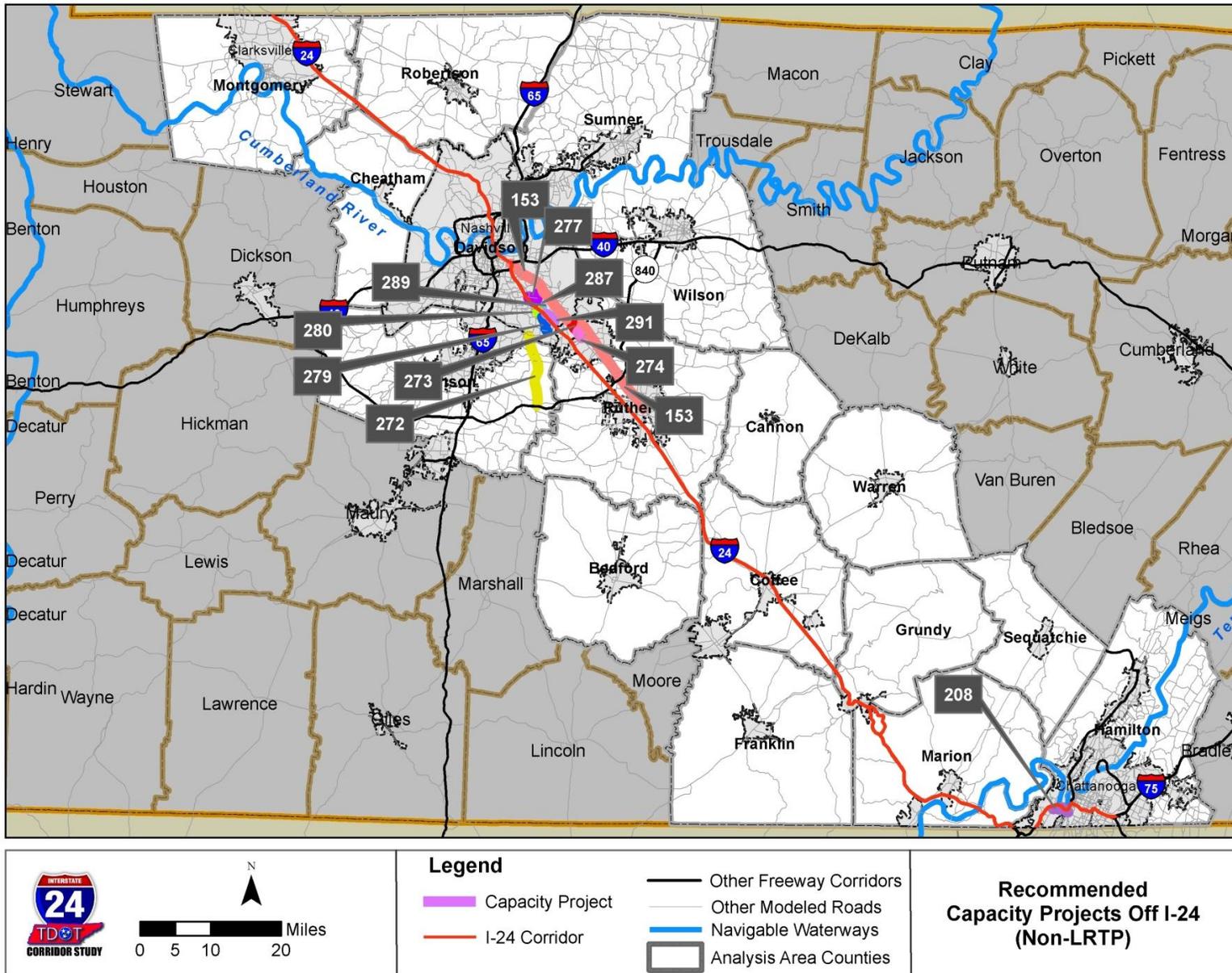


Figure 6.4: Recommended Capacity Projects Off I-24 (Non-LRTP)



6.1.3 Operational Projects

Several types of operational projects are recommended for the I-24 Corridor and are shown separately on the tables and figures. A description and evaluation of the different types of operational projects is presented in detail in Sections 3 and 5.

The LRTP and Non-LRTP interchange projects (including new access and modified access) that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The recommended LRTP and Non-LRTP interchange projects are presented in Tables 6.6 and 6.7, respectively, and are also shown on Figures 6.5 and 6.6, respectively.

Table 6.6: Recommended Interchange Projects (LRTP)

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
178	Davidson	Modify Access at I-24/Hickory Hollow Pkwy Interchange	Modify interchange to allow access to/from Cane Ridge Road at I-24/Hickory Hollow Parkway Interchange	Exit 60	2	2020	\$ 17,292,272
172	Rutherford	New I-24/Rocky Fork Road Interchange	Construct a new interchange at I-24 and Rocky Fork Road (MP 68)	MP 68 (Rocky Fork Road)	2	2030	\$ 83,921,584
180	Hamilton	I-24 at Market & Broad Streets Interchange Modification	Modify Market Street and Broad Street I-24 interchanges to improve safety and operation characteristics	Exit 178	3	2020	\$ 61,643,747
182	Hamilton	I-24 and I-75 Interchange Modification	Modification of the interchange of I-75 and I-24	Exit 185	3	2020	\$ 145,062,948
176	Davidson	I-24 at North 1st Street Interchange	Construct HOV ramps to and from I-24 and CBD at North 1st Street, Exit 47	Exit 47	2	2020	\$ 29,460,908
175	Davidson	I-24 at Shelby Avenue Interchange	Construct HOV ramps to and from I-24 and CBD at Shelby Avenue, Exit 49	Exit 49	2	2020	\$ 29,460,908
174	Davidson	I-24 at Harding Place Drive Interchange	Construct urban diamond interchange (Phase I) on I-24 at Harding Place Drive, Exit 56	Exit 56	2	2020	\$ 13,129,318
179	Rutherford	Interchange Improvements at Epps Mill Road and I-24	Widen Epps Mill Road from a 2-Lane to a 3-Lane Cross Section and redesign/improve Exit 89 to better accommodate truck traffic	Exit 89	2	2030	\$ 24,629,161

Table 6.7: Recommended Interchange Projects (Non-LRTP)

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
286	Davidson	New Interchange in SE Nashville	Add a new interchange at Old Franklin Road (MP 61). (Not included in this project but part of future project: New Road from Nolensville Road to I-24)	MP 61	2	2030	\$ 83,921,584
118	Rutherford	New Interchange in Murfreesboro	Add new interchange in Murfreesboro (between Exit 74 and 89) - Modeled at Elam Road (MP 85)	MP 85	2	2040	\$ 70,807,605
253	Davidson	Exit 47 - Exit 48 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 47-Exit 47A-Exit 48 (Downtown Nashville) EB and WB to remove weaving sections from the mainline and to remove exit points	Exit 47 - Exit 48	2	2020	\$ 19,469,817
254	Rutherford	Exit 74 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 74A-74B (SR 840) EB and WB to remove weaving section from the mainline and to remove exit points	Exit 74	2	2040	\$ 39,496,352
255	Rutherford	Exit 78 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 78A-78B (SR 96) EB and WB to remove exit points	Exit 78	2	2040	\$ 39,496,352
256	Rutherford	Exit 80 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 80 (SR 99) EB and WB to remove entrance points	Exit 80	2	2040	\$ 39,496,352
94	Coffee	Exit 111 Upgrade to Standard Interchange	Modify the I-24 interchange at SR 55 (Exit 111) to convert to diamond interchange and remove loop ramp	Exit 111	2	2020	\$ 2,593,841
257	Hamilton	Exit 180 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 180B-Exit 180 (Rossville Blvd) EB and WB to remove weaving section from the mainline and to remove exit points	Exit 180	3	2020	\$ 19,469,817
258	Hamilton	Exit 183B - Exit 184 Interchange Modifications	Redesign ramp sequencing and lengths from S. Germantown Road to McBrien Road (currently Exit 183B-Exit 183A-Exit 184) to remove weaving sections and to remove exit points	Exit 183B - Exit 184	3	2020	\$ 60,821,083

Figure 6.5: Recommended Interchange Projects (LRTP)

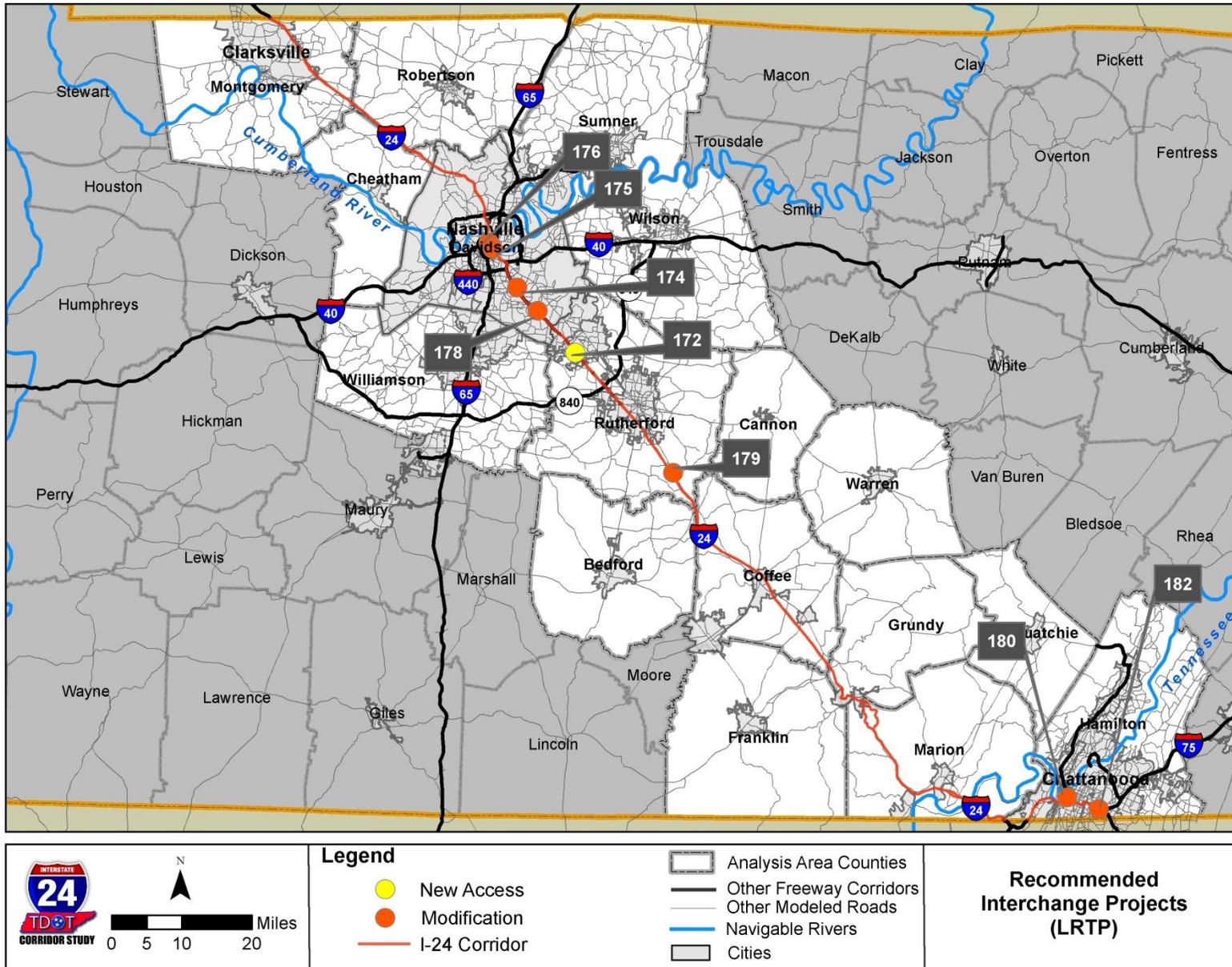
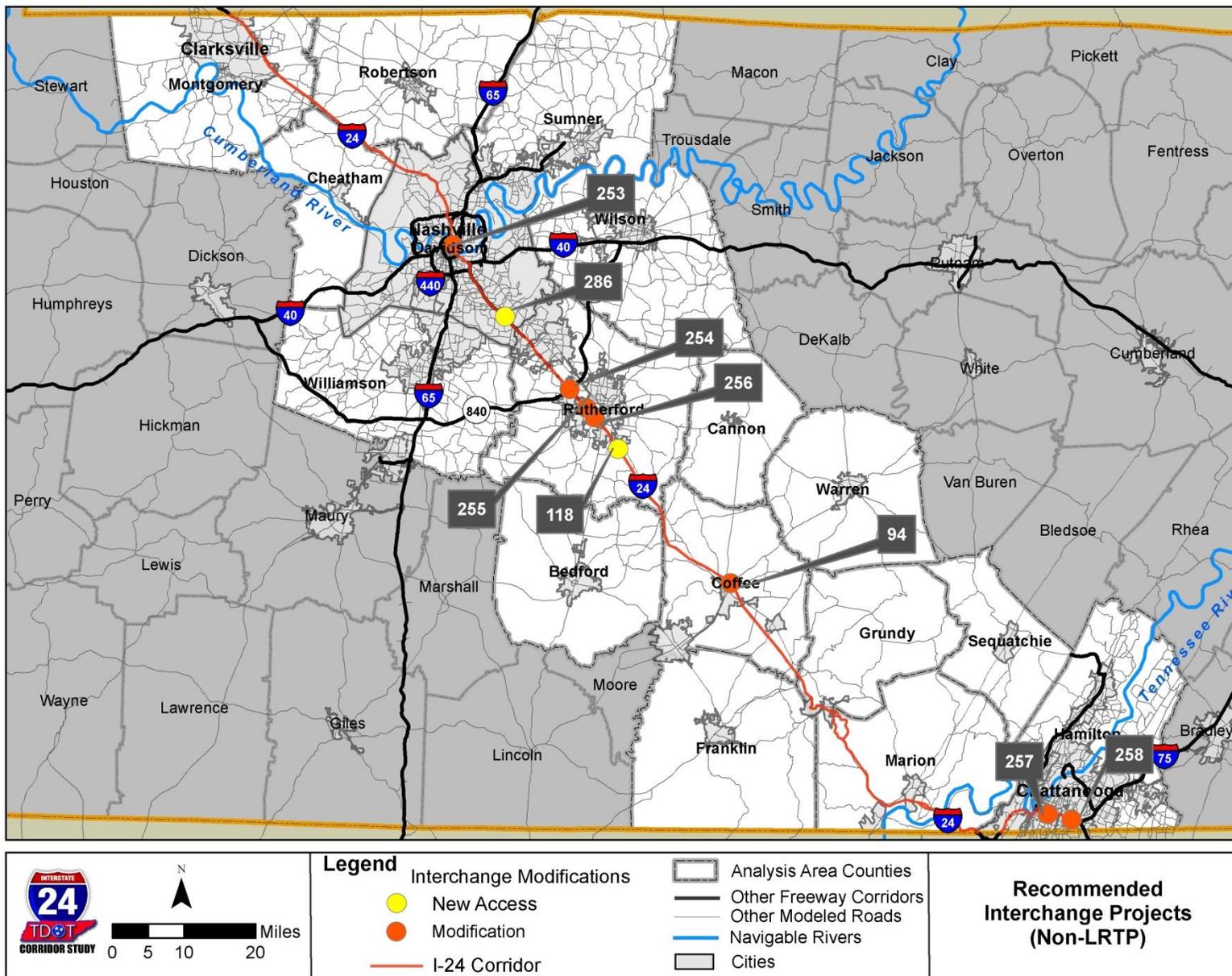


Figure 6.6: Recommended Interchange Projects (Non-LRTP)

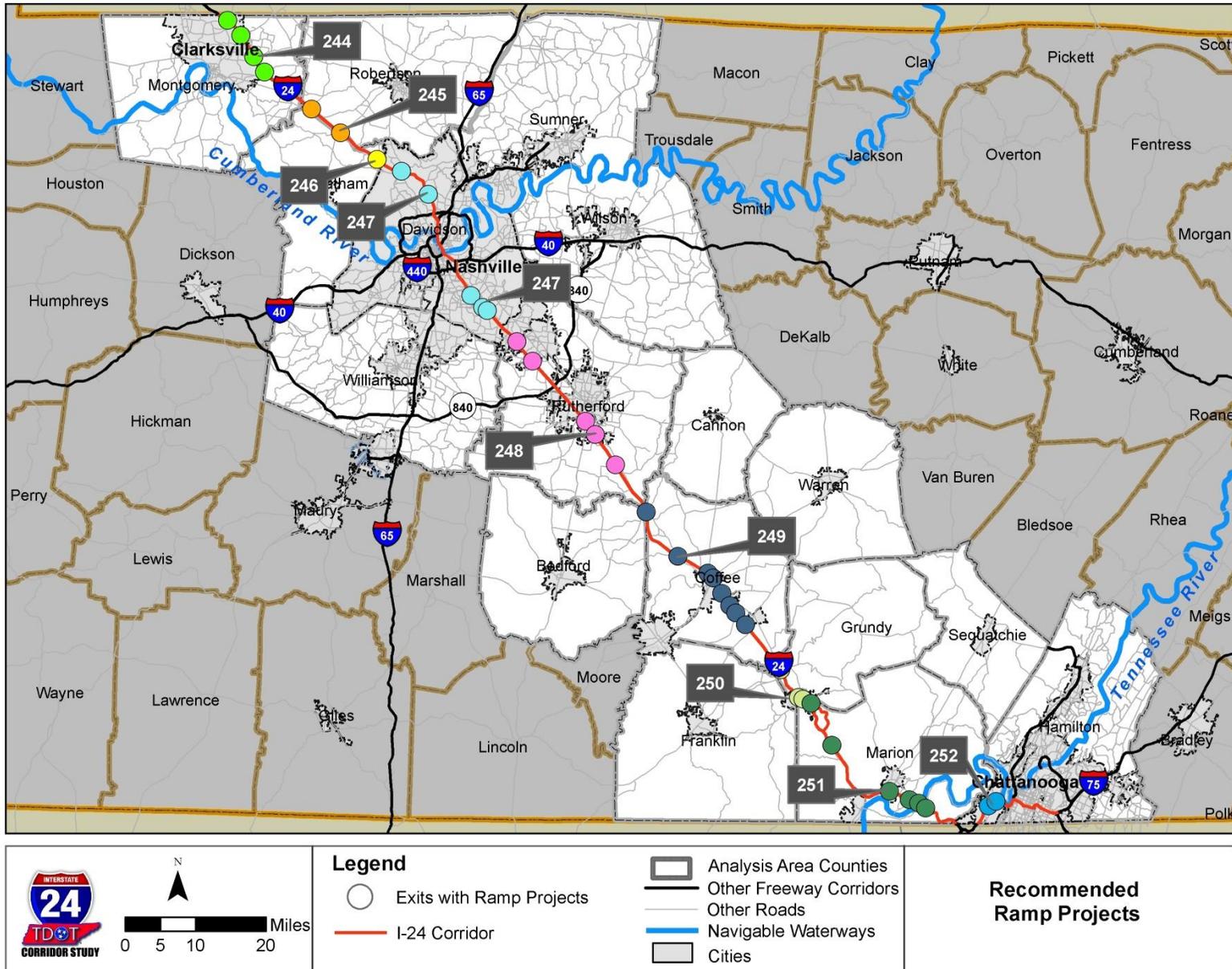


The 'Ramp Improvement' projects that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The ramp improvement projects are presented in Table 6.8 and are also shown on Figure 6.7.

Table 6.8: Recommended Ramp Projects

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3 - Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
244	Montgomery	Montgomery County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 1 (2 ramps), Exit 4 (2), Exit 8 (2), Exit 11 (2)	Exit 1 - Exit 11	1	2030	\$ 24,835,042
245	Robertson	Robertson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 19 (2 ramps), Exit 24 (2)	Exit 19 - Exit 24	2	2020	\$ 8,718,411
246	Cheatham	Cheatham County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 31 (2 ramps)	Exit 31	1	2040	\$ 8,843,059
247	Davidson	Davidson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 35 (2 ramps), Exit 40 (2), Exit 57 (1), Exit 59 (4), Exit 60 (1)	Exit 35 - Exit 60	2	2020	\$ 32,374,762
248	Rutherford	Rutherford County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 66 (1 ramp), Exit 70 (4), Exit 81 (2), Exit 84 (2), Exit 89 (4)	Exit 66 - Exit 89	2	2040	\$ 57,479,875
249	Coffee	Coffee County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 97 (3 ramps), Exit 105 (3), Exit 110 (4), Exit 111 (4), Exit 114 (4), MP 116-Weigh Station (4), Exit 117 (4), MP 119-Truck Rest Area (4)	Exit 97 - MP 119	2	2020	\$ 65,388,085
250	Grundy	Grundy County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 127 (4 ramps), MP 133-Rest Area (3), Exit 134 (3)	Exit 127 - Exit 134	3	2020	\$ 21,796,029
251	Marion	Marion County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 135 (4 ramps), Exit 143 (4), Exit 155 (2), Exit 158 (4), MP 159-Welcome Center (4), Exit 161 (3)	Exit 135 - Exit 161	3	2040	\$ 92,852,109
252	Hamilton	Hamilton County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 174 (4 ramps), Exit 175 (1)	Exit 174 - Exit 175	3	2040	\$ 32,836,703

Figure 6.7: Recommended Ramp Projects



The 'ITS' projects that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The ITS projects are presented in Table 6.9 and are also shown on Figure 6.8.

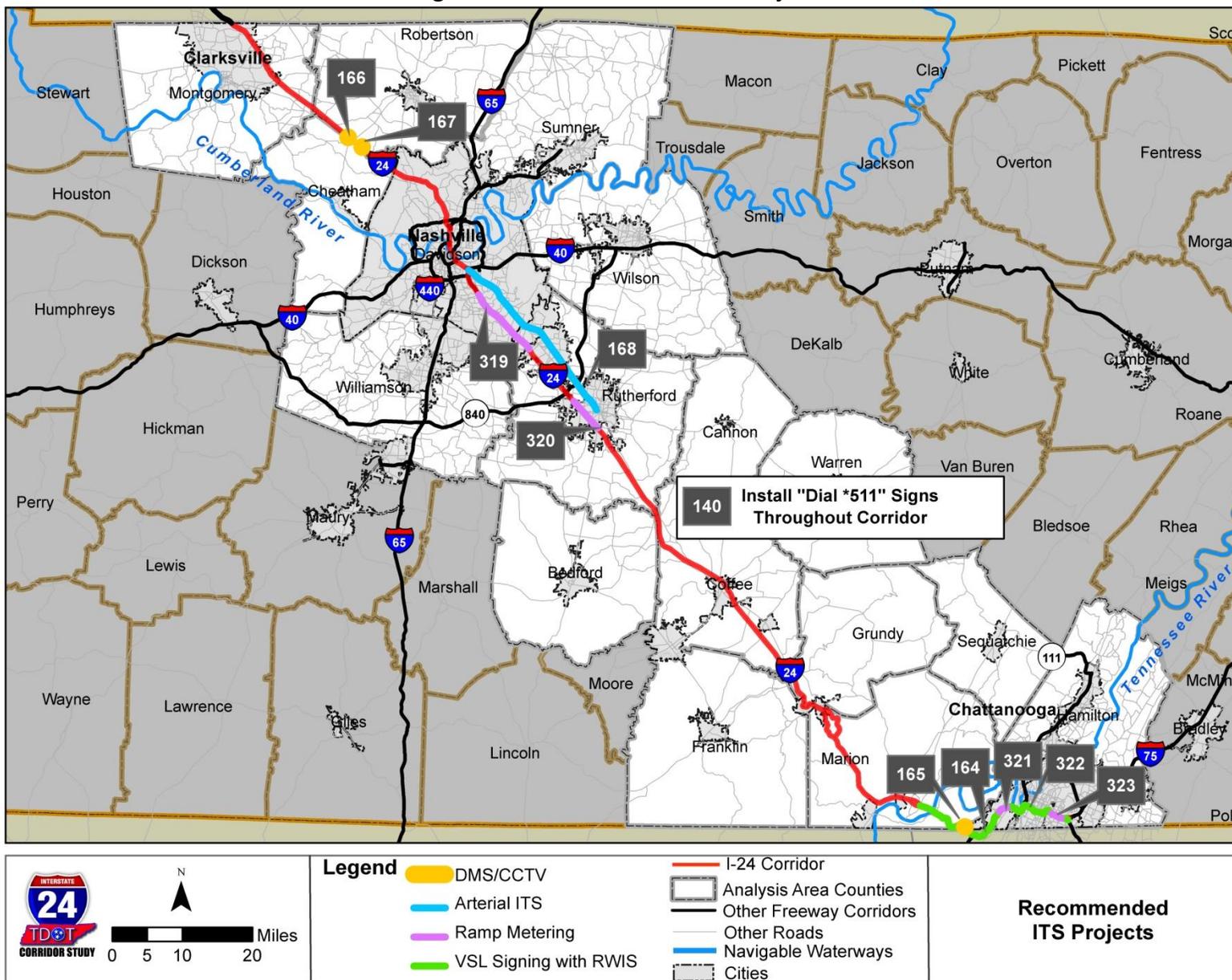
Table 6.9: Recommended ITS Projects

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3 - Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost (1)
140	All Counties	Install "Dial *511" Signs	Install "Dial *511" signs throughout corridor	Entire I-24 Corridor	1	2020	\$ 120,085
166	Robertson	MP 23 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 23 (EB) (approximately)	MP 23	2	2020	\$ 800,568
167	Robertson	MP 25 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 25 (WB) (approximately)	MP 25	2	2020	\$ 800,568
168	Davidson / Rutherford	SR 1 Arterial ITS	Install arterial ITS instrumentation and communications on SR 1 between I-440 interchange and SR 96 (Murfreesboro)	Exit 52 - Exit 78	2	2020	\$ 8,405,966
319	Davidson / Rutherford	Exit 66 - Exit 56 Ramp Metering	Install ramp metering components and system software from Exit 66 to Exit 56 (8 ramps)	Exit 66 - Exit 56	2	2020	\$ 1,280,909
320	Rutherford	Exit 81 - Exit 76 Ramp Metering	Install ramp metering components and system software from Exit 81 to Exit 76	Exit 81 - Exit 76	2	2020	\$ 760,540
164	Marion / Hamilton	Exit 158 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 158 to Exit 174	Exit 158 - Exit 174	3	2020	\$ 440,312
165	Marion	MP 166 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 166 (WB) (approximately)	MP 166	3	2020	\$ 800,568
321	Hamilton	Exit 174 - Exit 175 Ramp Metering	Install ramp metering components and system software from Exit 174 to Exit 175	Exit 174 - Exit 175	3	2020	\$ 600,426
322	Hamilton	Exit 185 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 185 to Exit 174	Exit 185 - Exit 174	3	2020	\$ 720,511
323	Hamilton	Exit 184 - Exit 183 Ramp Metering	Install ramp metering components and system software from Exit 184 to Exit 183	Exit 184 - Exit 183	3	2020	\$ 600,426

Note:

(1) Cost for ramp metering projects includes system software. The cost does not include reconstruction or modification of the ramp or adjacent surface street.

Figure 6.8: Recommended ITS Projects

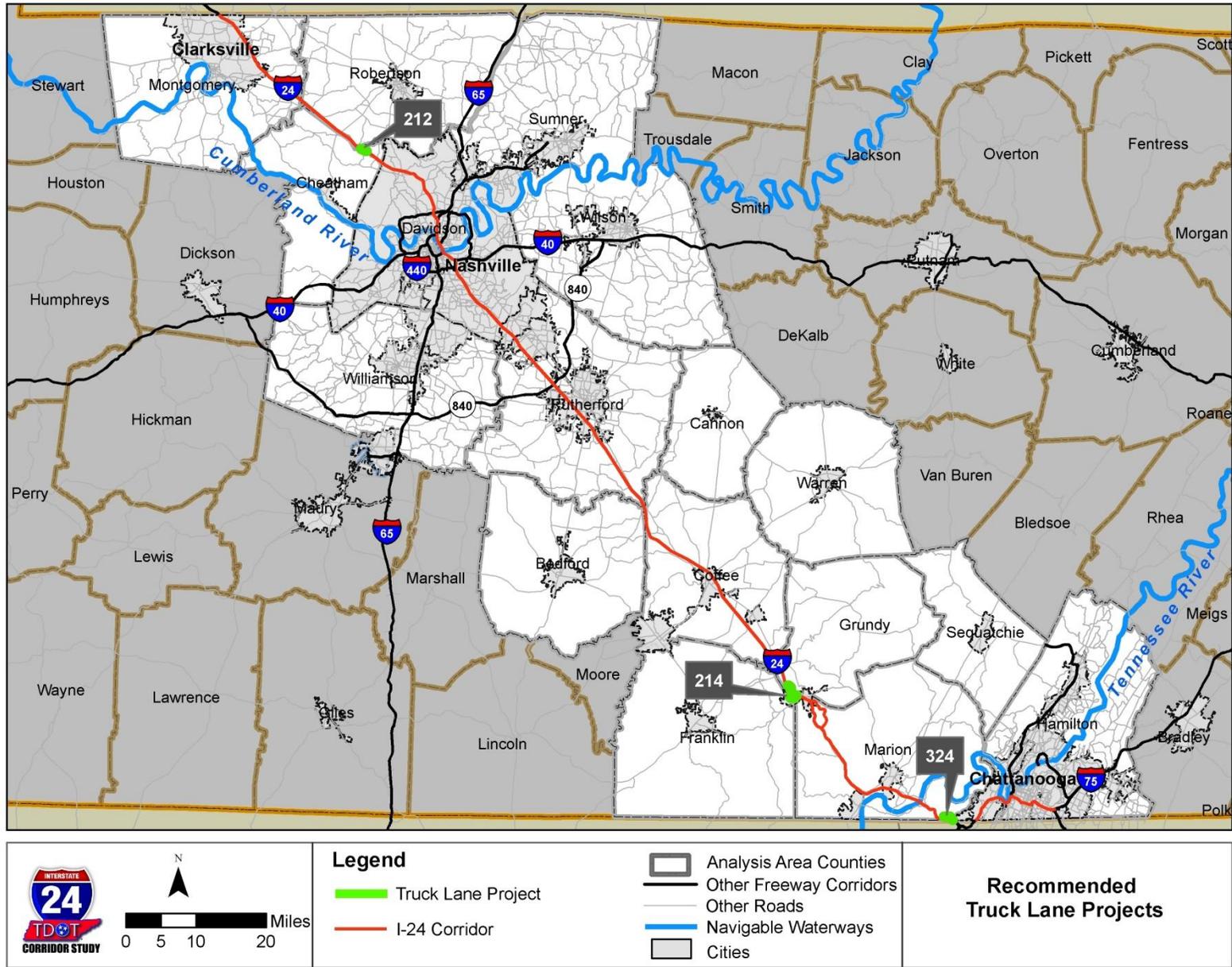


The 'Truck Lane' projects that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The truck lane projects are presented in Table 6.10 and are also shown on Figure 6.9.

Table 6.10: Recommended Truck Lane Projects

Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
212	Cheatham	Cheatham County - Extend Existing EB Truck Lane	Extend existing EB Truck Lane on I-24 in Cheatham County, Log Mile (2) 0.05 to 0.569 (MP 28)	0.5	MP 28 (Cheatham County Log Mile (2) 0.05 - 0.569)	2	2020	\$ 6,452,579
214	Grundy	Grundy County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Grundy County, Log Mile 3.40 to 6.55 (MP 130 to MP 133)	3.2	MP 130 - MP 133 (Grundy County Log Mile 3.40 - 6.55)	3	2020	\$ 39,122,164
324	Marion	Marion County - New EB Truck Lane	Add new EB Truck Lane on I-24 in Marion County, Log Mile 30.50 to 32.10 (MP 165 to MP 167)	1.6	MP 165 - MP 167 (Marion County Log Mile 30.50 - 32.10)	3	2020	\$ 27,816,477

Figure 6.9: Recommended Truck Lane Projects

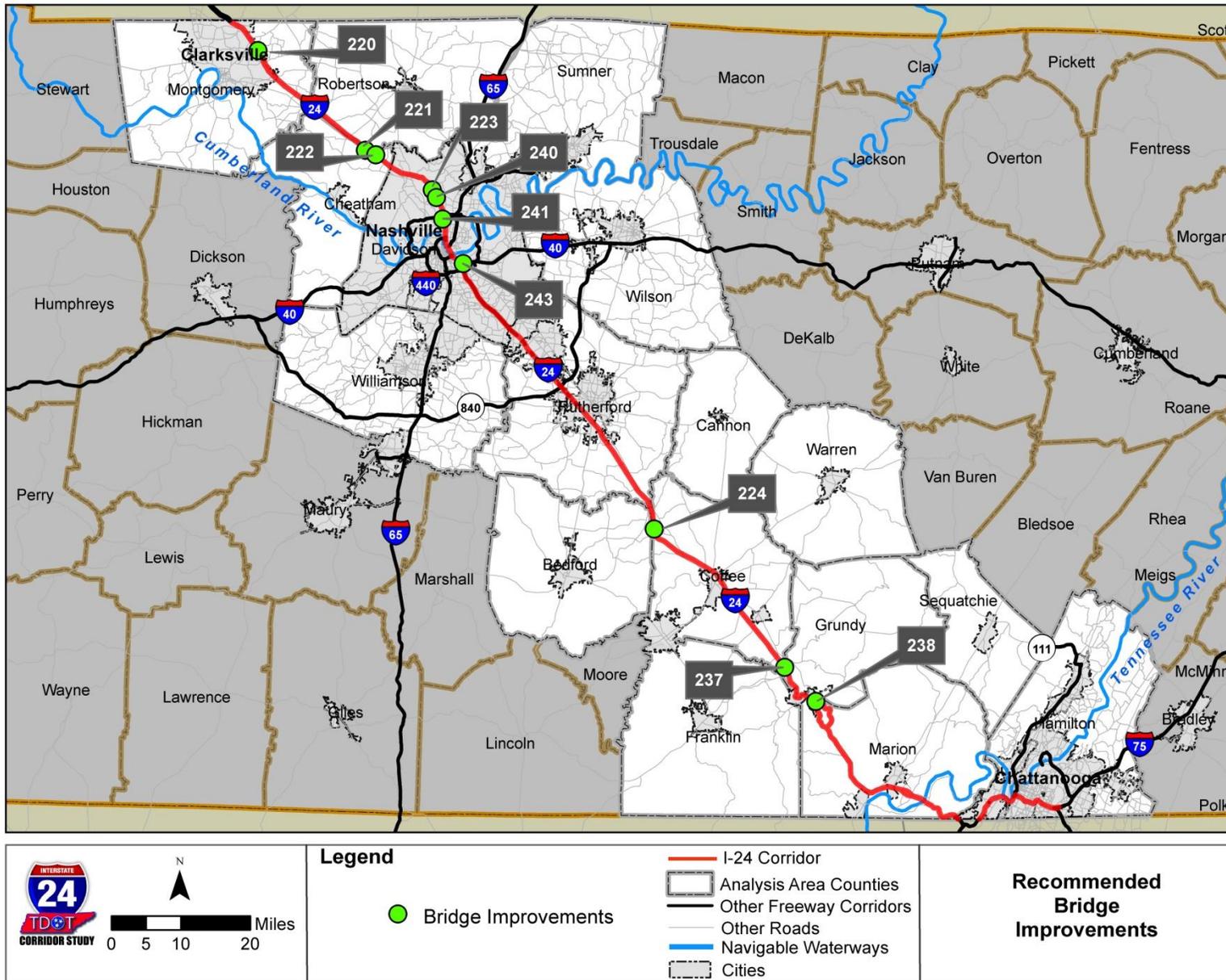


The 'Bridge Improvement' projects that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The bridge improvement projects are presented in Table 6.11 and are also shown on Figure 6.10.

Table 6.11: Recommended Bridge Improvement Projects

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
220	Montgomery	Montgomery County Bridge Railing Replacements	Replace pipe bridge railings for 6 bridges in Montgomery County between MP 3 and MP 15 which do not conform to current Report 350 crash test standards	MP 3 - MP 15	1	2020	\$ 858,465
221	Robertson	Robertson County Bridge Railing Replacements	Replace pipe bridge railings for 2 bridges in Robertson County between MP 27 and MP 28 which do not conform to current Report 350 crash test standards	MP 27 - MP 28	2	2020	\$ 188,550
222	Cheatham	Cheatham County Bridge Railing Replacement	Replace pipe bridge railings for 1 bridge in Cheatham County at MP 29 which does not conform to current Report 350 crash test standards	MP 29	1	2020	\$ 81,850
223	Davidson	Davidson County Bridge Railing Replacements	Replace pipe bridge railings for 8 bridges in Davidson County between MP 34 and MP 45 which do not conform to current Report 350 crash test standards	MP 34 - MP 45	2	2020	\$ 992,192
240	Davidson	MP 40 Bridge Rehabilitation	Davidson County Log Mile 8.51 (MP 40), I-24 RL (EB) at Old Hickory Boulevard, BIN# 19I00240071. Sufficiency Rating is 70.0. Rehabilitate existing bridge.	MP 40 (Davidson County Log Mile 8.51)	2	2020	\$ 1,601,136
241	Davidson	MP 44 Bridge Rehabilitation	Davidson County Log Mile 11.86 (MP 44), I-24 RL (EB) at Ewing Drive, BIN# 19I00240081. Sufficiency Rating is 62.6. Rehabilitate existing bridge.	MP 44 (Davidson County Log Mile 11.86)	2	2020	\$ 1,601,136
243	Davidson	MP 52 Bridge Rehabilitation	Davidson County Log Mile for I-40 is 21.58 (MP 52 for I-24), I-40 Structure 5B at I-24, BIN# 19I00240067. Sufficiency Rating is 67.0. Rehabilitate existing bridge.	MP 52 for I-24 (Davidson County Log Mile for I-40 is 21.58)	2	2020	\$ 1,601,136
224	Coffee	Coffee County Bridge Railing Replacements	Replace pipe bridge railings for 4 bridges in Coffee County between MP 97 and MP 100 which do not conform to current Report 350 crash test standards	MP 97 - MP 100	2	2020	\$ 404,255
237	Grundy	MP 127 Bridge Modification	Grundy County Log Mile 0.55 (MP 127), US 64/SR 50 at I-24, BIN# 31I00240001. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	MP 127 (Grundy County Log Mile 0.55)	3	2020	\$ 70,050
238	Marion	MP 135 Bridge Modification	Marion County Log Mile 0.77 (MP 135), Trussell Road at I-24, BIN# 58I00240063. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	MP 135 (Marion County Log Mile 0.77)	3	2020	\$ 70,050

Figure 6.10: Recommended Bridge Improvement Projects

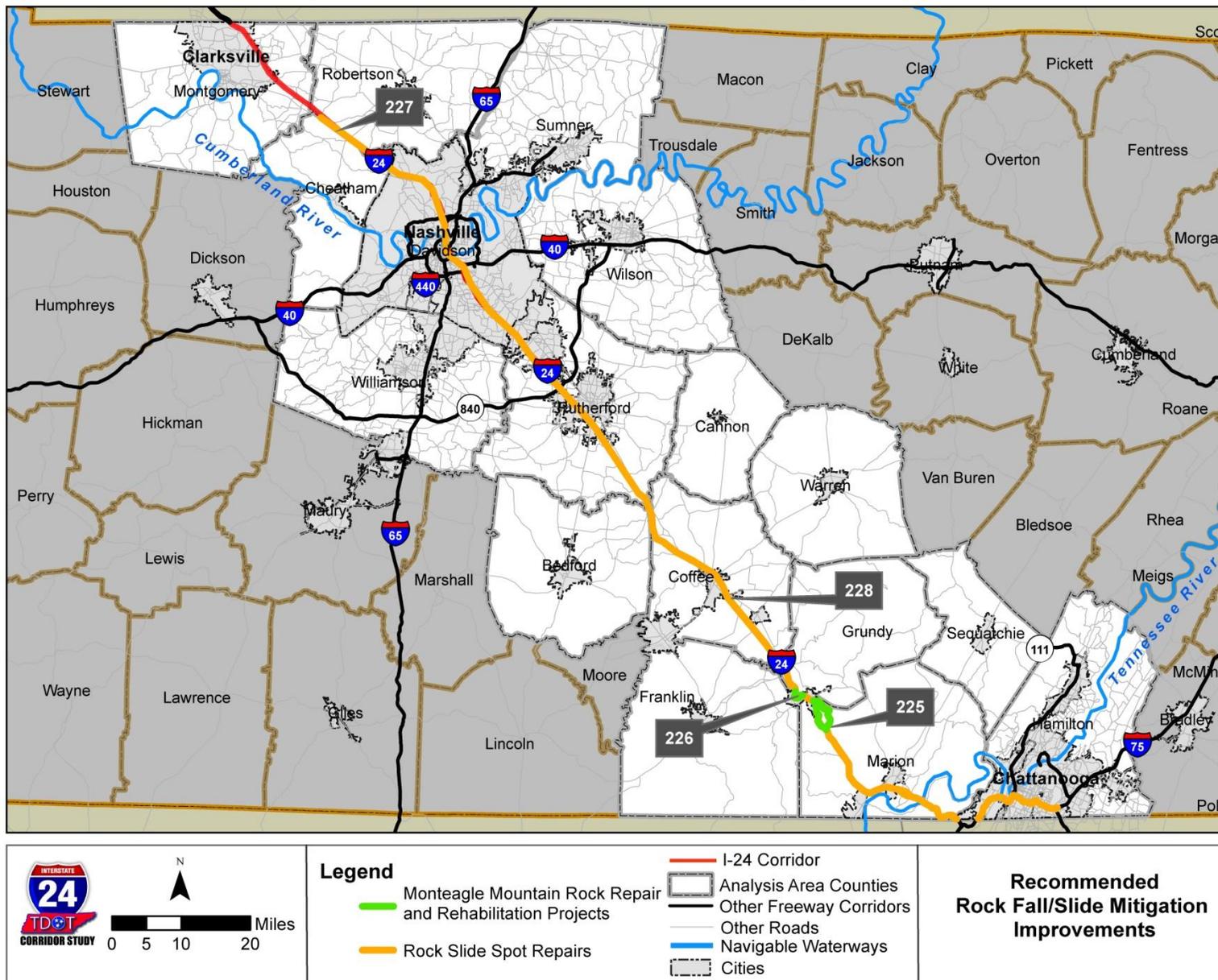


The 'Rock Fall/Slide Mitigation' projects that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The rock fall/slide mitigation projects are presented in Table 6.12 and are also shown on Figure 6.11.

Table 6.12: Recommended Rock Fall/Slide Mitigation Projects

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
227	Robertson / Cheatham / Davidson / Rutherford / Bedford	West I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 15 locations between MP 27 and MP 97	MP 27 - MP 97	2	2020	\$ 23,056,363
228	Coffee / Grundy / Marion / Hamilton	East I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 12 locations between MP 97 and MP 185	MP 97 - MP 185	3	2020	\$ 20,654,658
226	Grundy	West Monteagle Mountain Geotechnical Projects	West of Monteagle MP 131 to MP 133 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	MP 131 - MP 133	3	2020	\$ 3,842,727
225	Marion	East Monteagle Mountain Geotechnical Projects	East of Monteagle MP 135 to MP 140 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	MP 135 - MP 140	3	2020	\$ 6,724,772

Figure 6.11: Recommended Rock Fall/Slide Mitigation Projects



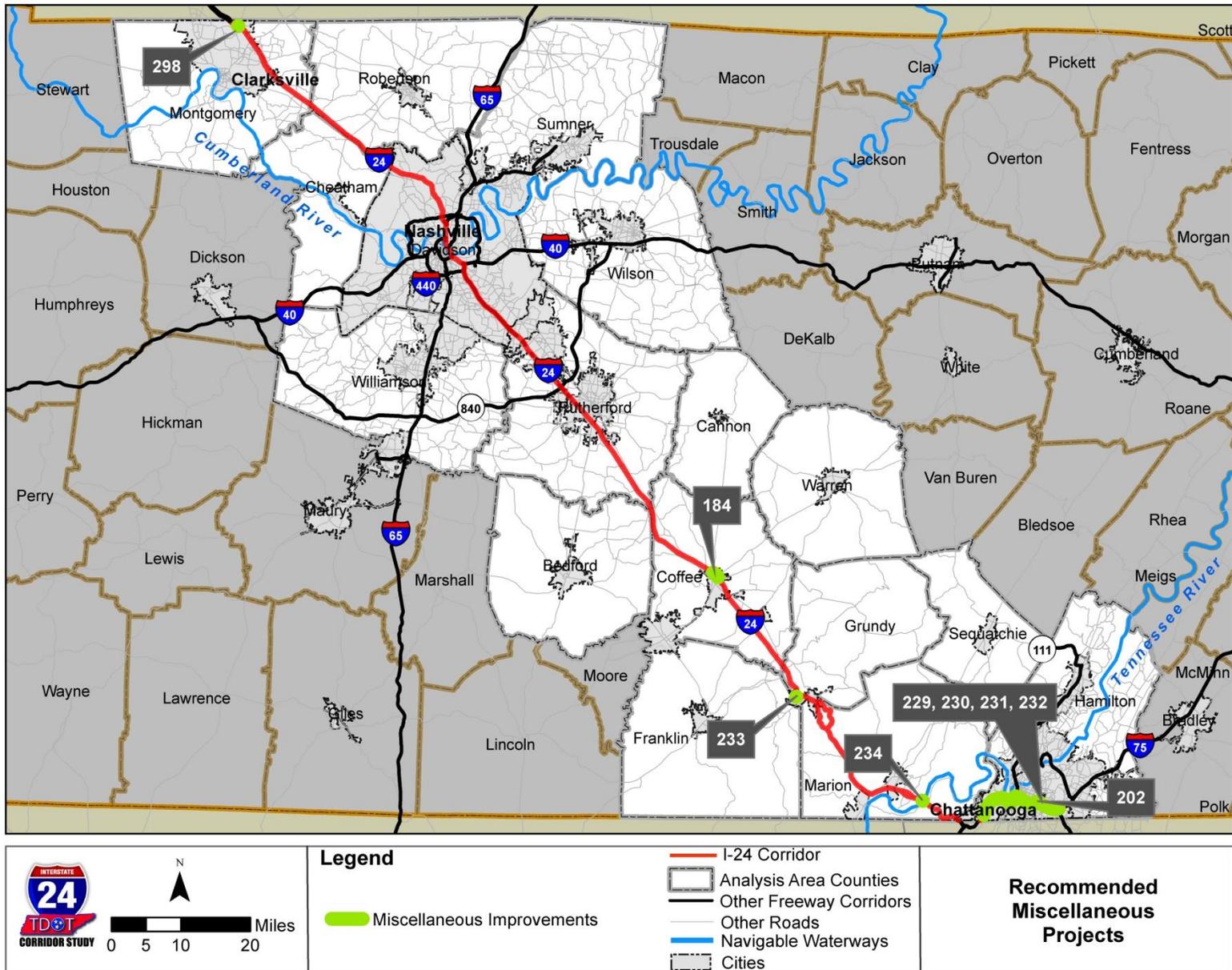
The 'Miscellaneous Improvement' projects that are recommended for the I-24 Corridor were given a recommended 'build year' based on the screening analysis summarized in Section 5 and then an associated year of expenditure total cost using an annual inflation rate of 3.6%, per TDOT's guidelines. The safety improvement projects are presented in Table 6.13 and are also shown on Figure 6.12.

Table 6.13: Recommended Miscellaneous Projects

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Recommended Build Year (2020, 2030 or 2040)	Year of Expenditure (YOE) Total Cost
298	Montgomery	Exit 1 Ramp Termini Improvement	Modify right-turn at termini on Exit 1 southbound exit ramp.	Exit 1	1	2020	\$ 3,301,432
184	Coffee	Exit 111 Drainage Correction	Correction for I-24 westbound sheet flow during rain. Rain draining across three westbound lanes toward median.	Exit 111 - Exit 110	2	2020	\$ 21,906,215
233	Grundy	MP 132 Barrier Improvement	MP 132, Replace cable barrier in narrow bifurcated median section with concrete barrier	MP 132	3	2020	\$ 400,284
234	Marion	MP 160 Barrier Improvement	MP 160, Extend barrier on the west side of the Tennessee River bridge	MP 160	3	2020	\$ 640,455
232	Hamilton	MP 173 - MP 185 Barrier Improvement	MP 173 to MP 185, Add roadway barriers to replace curb and gutter	MP 173 - MP 185	3	2020	\$ 2,065,466
231	Hamilton	MP 173 - MP 185 Lighting Improvements	MP 173 to MP 185, Eliminate lighting in clear zone and upgrade continuous lighting	MP 173 - MP 185	3	2020	\$ 48,034,089
229	Hamilton	MP 173 - MP 185 Pavement Improvements	MP 173 to MP 185, Upgrade pavement surface for improved drainage and friction factors	MP 173 - MP 185	3	2020	\$ 28,820,453
230	Hamilton	MP 173 - MP 185 Signing and Marking Improvements	MP 173 to MP 185, Upgrade signing and marking	MP 173 - MP 185	3	2020	\$ 12,008,522
202	Hamilton	I-24 Missionary Ridge Glare Screen Improvement	Add glare screens on I-24 on either side of Missionary Ridge	Exit 181 - Exit 183	3	2020	\$ 720,511

With respect to project 184 in Coffee County, some lower cost strategies such as utilizing an Open Graded Friction Course (OGFC) or milling transverse drainage grooves in the pavement may provide some improvement in the drainage. However, these would be interim measures and should not be substituted for improving the geometry by reconstructing the roadway.

Figure 6.12: Recommended Miscellaneous Projects



6.1.4 Multimodal Strategies

6.1.4.1 Freight Strategies

Tennessee's freight system, including manufacturers and retailers, comprises a significant share of the state's economy. Within the state, more than 800,000 jobs or 36% of the total non-government employment base was highly inter-related to producing, receiving, storing or transporting goods according to the 2011 US Census Bureau's County Business Pattern statistics. For this reason, the State of Tennessee and TDOT are constantly looking for ways to improve performance of its freight system to the extent its resources allow. On the other hand, growing volumes of cargo place a strain on the road system as trucks and autos share the same road facilities. Local governments face difficult land use decisions that are needed to balance residential interests against the goal of supporting economic development.

TDOT's resources are channeled to accomplish a broad spectrum of objectives. Two of their guiding principles reported in its 25-Year Vision, *Plan Go*, are re-stated below.

"Build new and stronger partnerships, public and private, to develop and finance transportation projects that maximize public investments and support community and regional growth strategies"

and

"Promote competitive freight options by improving existing transportation facilities in strategic corridors"

TDOT provides or supports a wide array of programs that support freight industry interests and balance the impacts that affect quality of life in communities as espoused in their guiding principles. A list of improvement strategies that will improve freight mobility in the I-24 Corridor are presented in Table 6.14 and brief descriptions of them are included below. Freight strategies that can be mapped are shown in Figure 6.13. 'FS' represents 'Freight Strategies.'

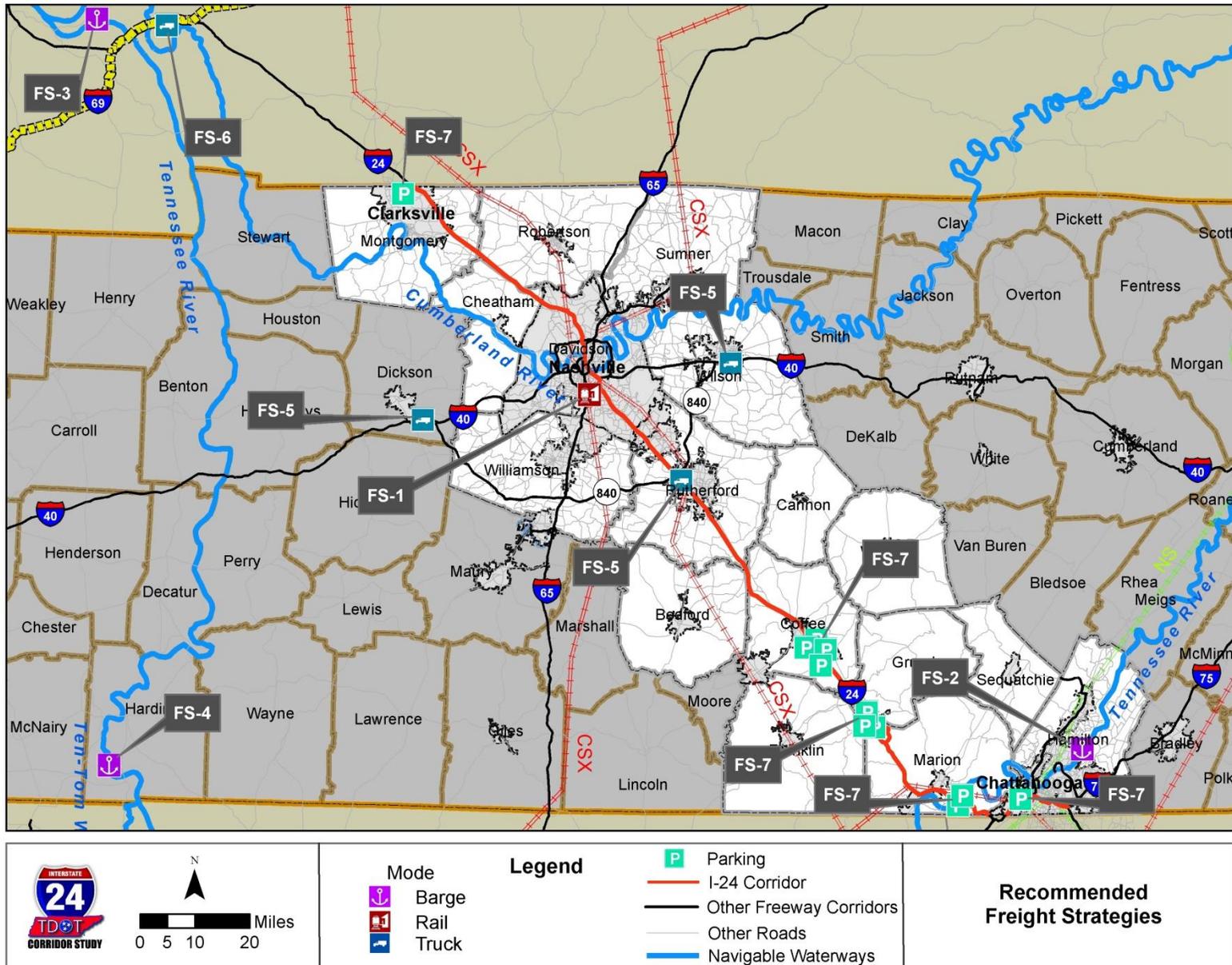
Road improvements are not explicitly referenced in the freight strategies table, as they are already listed and mapped in other parts of this section. In light of the heavy reliance on trucks to ship freight within, into and out of the I-24 Corridor, nearly all repairs and capital investments that TDOT allocates for roads, bridges and rail-highway crossings will improve the efficient and safe movement of goods as well as provide more mobility for residents. I-24, itself, is one of the state's primary freight assets.

Notwithstanding, TDOT's authorized responsibilities for preserving and building the state's primary road system, TDOT's influence and resources for other forms of transportation are smaller. TDOT, for example, does not dictate how private Class I rail carriers, air cargo businesses or barge companies make capital investments. They do, however, have a program to sustain and improve shortline rail carriers who provide vital service to businesses in communities not directly serviced by a Class I railroads.

Table 6.14: Recommended Freight Strategies

Strategy ID	Primary Mode	County of Strategy	Name of Strategy	Description of Strategy	Status of Strategy
FS-1	Rail/Truck	Davidson	Intermodal Rail Facility Relocation/Expansion	Relocate existing Radnor Yard in south Nashville. Long range Nashville MPO freight strategy to better distribute freight on regional freight network.	Unfunded MPO Project
FS-2	Barge	Hamilton	Chicamauga Lock and Dam	Reconstruct to address structural needs and increase capacity	Ongoing TVA/USACE Project
FS-3	Barge	Near Paducah, KY	Kentucky Lock Addition	Increase lock capacity	Ongoing TVA/USACE Project
FS-4	Barge	West Central Tennessee	Ten-Tom Intermodal Container Project	Bi-state barge/waterway project to attract intermodal container freight to Tennessee River/Ten-Tom Waterway	Ongoing USACE/Ten-Tom Waterway Authority Project
FS-5	Truck	Rutherford/Davidson	SR-840 - signage & communication	Design a cost-effective signage and notification program to maximize utilization of SR-840 by trucks	I-24 Corridor Study Recommendation
FS-6	Truck	West Tennessee	New multi-state Interstate, I-69	Continue supporting completion of new Interstate Corridor connecting Michigan to Texas/Mexico border. Possible freight diversion strategy.	Ongoing TDOT Program
FS-7	Truck	Statewide	Truck Parking	Monitor supply of truck parking facilities around perimeters of the large metropolitan areas. (Welcome centers, rest areas and large truck stops.)	I-24 Corridor Study Recommendation
FS-8	Truck	Statewide	ITS and Incident Management	Metropolitan area Incident management and surveillance system programs that reduce duration of queuing and delay from non-recurring incidents	Ongoing TDOT Program & I-24 Corridor Study Recommendation
FS-9	Rail	Statewide	Provided Support for Shortline Railroads	Monitor and continue funding, as needed, to support operations of Shortline railroads and capital improvements to interline rail freight with Class I rail carriers	Ongoing TDOT Program
FS-10	All	Statewide	Tennessee Freight Advisory Committee	Provide a framework for public and private freight stakeholders to share concerns and find opportunities that will maximize the value of public investments in freight system	Ongoing TDOT Program
FS-11	All	Statewide	Multi-State Planning & Cooperation	Include interests of border-state DOT's in formulating freight projects and strategies	Ongoing TDOT Program
FS-12	All	Statewide	Environmental and Community Impacts of Freight	Provide assistance to local governments in efforts to mitigate intrusive impacts from freight and warehousing industry	Ongoing TDOT Program

Figure 6.13: Recommended Freight Strategies



Intermodal rail-truck facilities, at-grade highway-rail crossings, logistics parks and barge services can benefit from selected repair, gateway access, and operational and safety investments TDOT makes to the road system. ITS architecture, variable message signs and incident management programs enhance the driving experience for all users. Despite TDOT's lighter role in non-highway freight modes, they are and will continue to be significant partners with private sector freight providers. TDOT and State government have a role in influencing and implementing federal regulatory agencies that affect private sector freight carriers.

Unstable funding streams have slowed progress on waterway-barge strategies. Even if these projects were completed, there is uncertainty about the volume of freight movements currently shipped by truck that might divert to barge. Barges mostly haul bulk commodity like sand, gravel, grains and fuels. The impact that the ongoing waterway projects listed in Table 6.14 are likely to have on the I-24 Corridor is a slight diversion from rail transport to barge but virtually none from truck to barge.

There is broad interest in relocating CSX's existing, intermodal rail-truck facility at Radnor Yard to a different location in the Nashville region where more space is available to increase its capacity. Both CSX and the Nashville MPO are proponents but it is not a funded project even though intermodal rail is a fast-growing sector of CSX's freight business. CSX Corporation is currently committed to investing in its National Gateway project, designed to grow its intermodal and other rail services between the northeast and upper midwest. It has not transpired yet, but a similar CSX project could someday be planned between the Gulf of Mexico ports and the upper midwest through Nashville. This kind of multi-state, public-private rail investment could possibly produce the kind of mode shift from truck to rail that would improve traffic conditions in the I-24 Corridor.

As a land-locked state that shares its border with eight other states, Tennessee's Interstate system is besieged by long-haul truckers who pass-through with their loads. Due to competition in the truck industry, customer delivery specifications and a lack of adequate parking at rest areas and private truck stops, many truckers park their rigs alongside the Interstate system or ramps leading to and from the Interstate. Motor carrier regulations designed to reduce driver fatigue and improve road safety also contribute to the problem according to a 15-year old study done for TDOT.³ The investigation determined there was a 133-space shortage at rest areas and welcome centers in the I-24 Corridor.

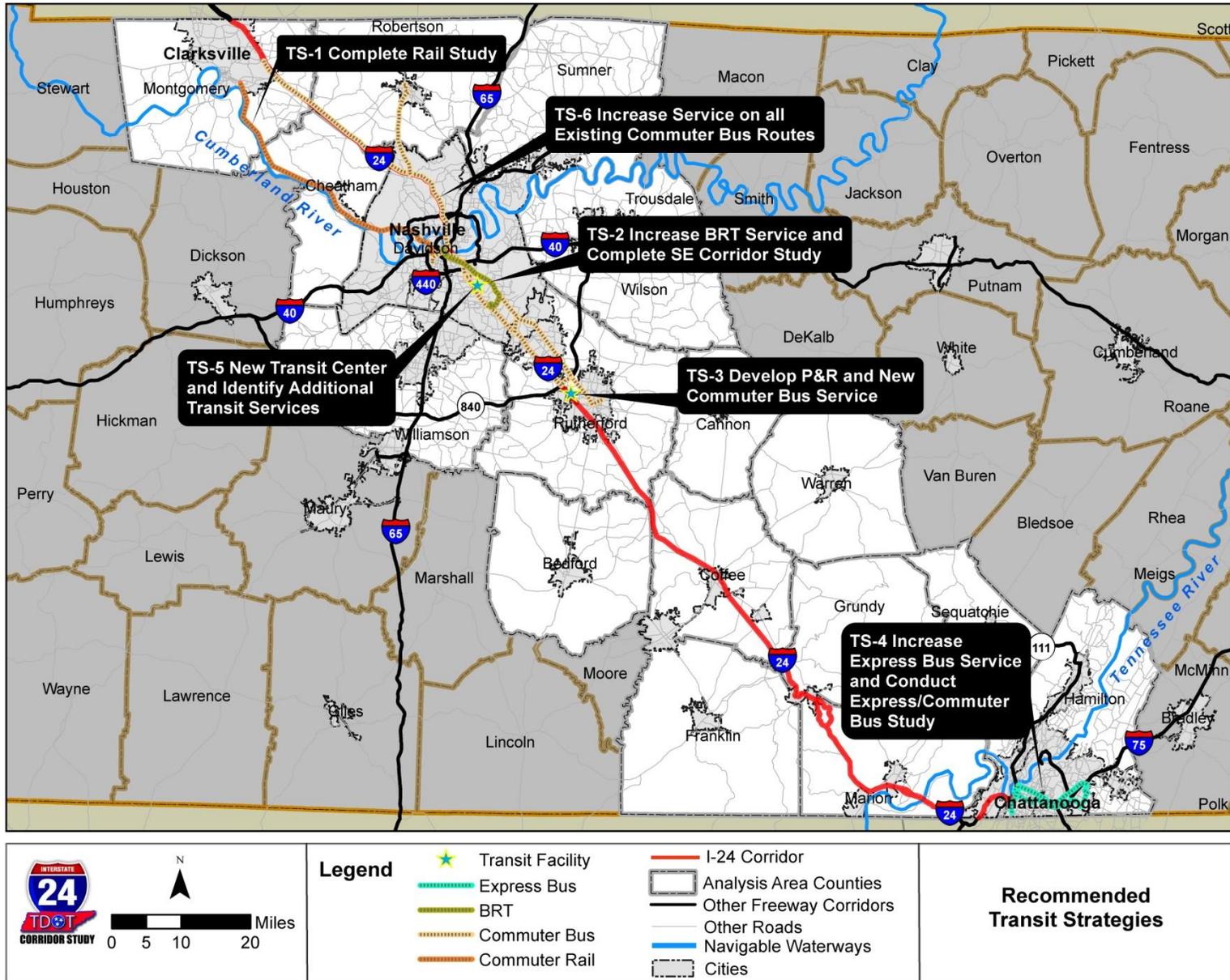
³ *Truck Parking and Safety in Rest Areas in Tennessee*, White Paper memorandum prepared for Tennessee DOT in 1999 by University of Tennessee Environmental Engineering Department

6.1.4.2 Transit Strategies

A number of transit and Park-and-Ride (P&R) Lot strategies were identified from existing plans or assessment of corridor conditions that may benefit operations of the I-24 Corridor in addition to providing mobility and access benefits. These recommended strategies are listed below and those that are able to be mapped are also shown graphically on Figure 6.14. 'TS' represents 'Transit Strategy' in the list below and on Figure 6.14.

- TS-1 Complete New Starts Assessment of Commuter Rail from Clarksville to Nashville.
- TS-2 Increase BRT Service on MTA Route #55 and complete the Southeast Area Transportation and Land Use Study to determine long range transit preferred alternative and FTA New Starts potential.
- TS-3 Develop a P&R Lot with associated express bus service at I-24 Exit 76, Medical Center Parkway/Fortress Boulevard.
- TS-4 Increase service on existing CARTA express bus routes and conduct an Express/Commuter Bus Study to identify additional routes.
- TS-5 Evaluate transit center near the terminus of existing HOV system at Harding Place in Nashville and options to provide increased transit service between Harding Place and downtown Nashville.
- TS-6 Increase Express Transit Services between Clarksville and Nashville, and Murfreesboro and Nashville during peak periods.
- TS-7 Evaluate ramp volumes for potential new P&R lots to serve Express Transit Routes. (Included in this evaluation should be a determination if the Exit 8 P&R lot needs to be relocated in order to accommodate the need for future growth.)
- TS-8 Evaluate options to provide exclusive access/egress for transit to the HOV system.
- TS-9 Consider transit operations on I-24 shoulders during peak hours in selected locations.
- TS-10 Support and promote paratransit and rural transit systems in the Nashville area.
- TS-11 Support and promote additional vanpool services in the Nashville area.

Figure 6.14: Recommended Transit Strategies



6.1.4.3 *Managed Lane Strategies*

The I-24 HOV system is approximately 50 miles in length, for the combined mileage of the northbound and southbound lanes. The I-24 HOV system runs from US-231 in Rutherford County to Harding Place in Davidson County, approximately 8 miles south of downtown Nashville. The HOV lanes are signed and striped but not barrier separated from the general travel lanes on I-24. The current I-24 HOV lanes do not have separate access or egress from the general travel lanes. There are no HOV lanes in either the Clarksville or Chattanooga metropolitan areas.

A number of managed lane strategies were identified from existing plans or assessment of corridor conditions that may benefit operations of the I-24 corridor in addition to providing mobility and access benefits. These recommended strategies are listed below.

- Increase enforcement of HOV lane restrictions and associated fines for violators.
- Evaluate options for transition to daily rather than peak hour HOV operation.
- Evaluate options for providing direct HOV lane access and egress at selected locations.
- Evaluate queue bypass for HOVs and transit at potential future ramp metering locations.
- Encourage legislation that allows for implementation of managed lanes at the State level including additional allowable access restrictions, express lanes, and variable pricing.
- Investigate tag systems that allow some measure of automated enforcement.

Appendix A Cost Estimating Data

2013-2014 COST DATA SHEET

ROW Cost Per Mile x ROW Factor + Construction Cost Per Mile x Terrain Factor x Construction Factor
 + PE Cost (10% of Construction Cost)+ Contingencies Cost (15% of Construction Cost) x Distance

Base Per Mile ROW Cost (based on reconstructing two to four lanes in a rural area). \$1,233,000

Right Of Way (ROW) Factor

<u>Area</u>	<u>Factor</u>
CBD	3.25
CBD Urbanized	12.50
Heavy Commercial (High Rise, Large Building)	3.25
Strip Commercial	3.25
Fringe (Mixed, Residential/Commercial)	1.75
Industries (Factories, Warehouse)	1.75
Light Residential (1/4- Acres)	1.75
Medium Residential (Acres+)	1.75
Heavy Residential (Apartments)	1.75
Public Use (Parks, School)	1.75
Rural	1.00

State Route Base Per Mile Construction Cost \$7,973,000

Local Road Base Per Mile Construction Cost \$5,980,000

Terrain Factor

<u>Area</u>	<u>Factor</u>
Flat	1.00
Rolling	1.10
Mountainous	2.60
Heavy Mountainous	5.00

Construction Factor

<u>Recommendation</u>	<u>Factor</u>	<u>Recommendation</u>	<u>Factor</u>
New 2 Lane	1.00	New 4 Lane	1.60
Reconstruct 2 Lane	0.90	Reconstruct 4 Lane	1.50
Reconstruct 3 Lane	1.10	Reconstruct 4 to 6 Lane	0.90
Reconstruct 2 to 4 Lane	1.30	Reconstruct 4 to 7 Lane	1.00
Reconstruct 2 to 5 Lane	1.50	New 4 Lane Interstate	1.80
Reconstruct 2 to 6 Lane	1.80	Add 2 Interstate Lanes	0.70
Reconstruct 2 to 7 Lane	1.80	Add 4 Interstate Lanes	1.00

Interstate Urbanized Area Factor = Construction Cost x 1.5

Interstate Widening Within Median Factor = Construction Cost x 0.2

Preliminary Engineering Cost 10% of construction cost
 Contingencies 15% of construction cost

Other Types of Construction

Resurface only (Interstate) = \$180,000 per lane mile
Resurface only (State Route) = \$63,200 per lane mile

Welcome Center = \$4,800,000

Rest Area = \$2,200,000

Sidewalks = \$185,000 per mile (per side).

Signalized Intersection - \$118,000 This includes mobilization and maintenance of traffic and should be used on projects that are only proposing a signal.

Signalized Intersection - \$86,000 - \$91,000 This is for signalization only, where other roadway/ intersection improvements are also proposed.

Rural Roundabout = \$750,000 - \$1 Million
Urban Roundabout = \$1 million - \$1.5 million

Major River Crossing = \$37 million to \$58 million
(e.g., Cumberland River \$37million)

New Rural Interchange = \$8 to \$36 million; (\$21 million average)
New Urban Interchange = \$18 to \$86 million; (\$36 million average)

Modified Rural Interchange = \$2 to \$26 million; (\$14 million average)
Modified Urban Interchange = \$2 to \$65 million; (\$27 million average)

General Notes:

Data is derived from Tennessee Department of Transportation state-wide cost estimates used for planning purposes;
Cost specifications for individual projects may vary significantly from state-wide averages.

10% of the construction cost is estimated for PE (environmental and design). As a general rule, 60% of the PE cost is environmental and 40% of the PE cost is design.

Use 3.6% inflation rate per year to estimate cost for year of expenditure

STATE ROUTES	Cost		Terrain	Construction			
	Per Mile	Area Factor	Factor	Factor	Area Factor	Length	Cost
ROW	\$1,233,000	1.75				4.77	\$10,296,783
CON	\$7,973,000		1.10	1.50		2.35	\$30,888,997
PE					0.10		\$3,088,900
CONTINGENCY					0.15		\$4,633,349
Total Cost							48,908,029

INTERSTATE							
ROW	\$1,233,000	1.00				1.00	\$1,233,000
CON	\$7,973,000		1.00	1.00		1.00	\$7,973,000
PE					0.10		\$797,300
CONTINGENCY					0.15		\$1,195,950
							11,199,250

LOCAL ROAD	Cost		Terrain	Construction			
	Per Mile	Area Factor	Factor	Factor	Area Factor	Length	Cost
ROW	\$1,233,000	1.00				1	\$1,233,000
CON	\$5,980,000		1.00	1.00		1	\$5,980,000
PE					0.10		\$598,000
CONTINGENCY					0.15		\$897,000
Total Cost							8,708,000

Appendix B Environmental Screening Analysis Summary

Interstate 24 Multimodal Corridor Study

Environmental Screening Analysis Summary

Introduction

The purpose of this environmental screening analysis is to identify and quantify potential environmental impacts resulting from the proposed projects along Interstate 24 (I-24). This Environmental Screening (Screening) of the project corridor was conducted in December 2013. The Screening used data acquired from existing, readily available mapping and database sources. The Screening boundaries included a 1,000-foot buffer (500 feet on either side) around the centerline of existing I-24 at each proposed project that would potentially need additional right-of-way (ROW). At proposed new or modified interchange projects, the buffer was set at 500 feet on either side of the interchange centerpoint for the cross street and 1,000 feet on I-24.

The potential environmental resources that were screened for the purposes of this study were cultural resources (National Register of Historic Places (NRHP) listed sites and cemeteries), hazardous material sites reporting to the Environmental Protection Agency (EPA) (RCRA, CERCLIS, etc.), ecological resources (waters of the U.S, floodplains, and threatened and endangered species), and parks/recreation areas. Social resources identified in the Screening include potential Environmental Justice (EJ) populations (low-income and/or minority), churches and schools. The results of the Screening are presented in Table 1, which provides the number of each environmental/social resource that fell within the 1,000-foot buffer (500 feet on either side of the existing centerline) of each applicable project.

Data Limitations

It should be noted that the location of previously identified archeological sites is protected information and is only provided to Cultural Resource professionals conducting archaeological investigations. Therefore, information on previously identified archaeological sites was not included in this screening.

It should also be noted that the identification of resources within the I-24 corridor was based on readily available mapping and may not correctly represent actual field conditions.

Potential Environmental Impacts

Due to the preliminary stage of this screening, right-of-way or construction limits were not set. Instead, the potential impacts quantified in this analysis are based on the 1,000-foot buffer (500 feet on either side) around the centerline of existing I-24 at each proposed project or at new or modified interchange projects, 500 feet on either side of the interchange centerpoint for the cross street and 1,000 feet on I-24. Selected proposed projects on I-24 with their potential impacts are shown on Table 1.

Table 1: Results of Environmental Screening Analysis

Project ID	Historic Sites	Parks/Rec Areas	Cemetery	Churches	Schools	Community Resources	HAZMAT Sites	Wetlands (In Acres)	Streams (In Feet)	Floodplains
I-24 Roadway Capacity Projects - LRTP										
169	0	0	2	2	0	1	3	21	13,256	Y
170	0	1	1	0	0	0	0	3	9,077	N
173	0	1	0	0	0	0	4	1	16,119	Y
177	0	0	0	0	0	0	1	0	3,146	N
181	2	1	0	1	0	0	5	110	21,018	Y
183	1	1	0	11	0	0	14	5	17,680	Y
I-24 Roadway Capacity Projects - Proposed										
306	0	0	0	0	0	0	7	6	6,206	Y
307	0	1	0	0	1	0	4	1	19,087	Y
308	0	0	1	0	0	0	4	3	11,983	Y
309	0	0	0	0	0	0	2	25	3,810	Y
310	0	0	0	0	0	0	1	4	2,133	Y
311	0	0	0	0	0	0	1	9	1,591	Y
312	0	0	2	0	0	0	5	20	11,238	Y
313	0	0	0	1	0	0	0	3	20,812	Y
314	0	0	1	0	0	0	0	5	18,586	N
315	0	0	0	0	0	0	0	3	1,227	N
316	0	0	2	2	0	0	0	19	31,807	N
317	0	1	0	1	0	0	0	173	5,701	Y
318	0	0	0	0	0	0	1	89	17,374	Y
I-24 Interchange Projects (New or Modified Access) - LRTP & Proposed										
94	0	0	0	0	1	0	0	1	1,176	N
118	0	0	1	1	0	0	0	1	0	N
146	0	0	0	0	0	0	0	1	5,141	N
172	0	0	0	1	0	0	0	3	0	N
174	0	0	0	0	0	0	4	1	5,320	Y
175	2	1	0	1	0	0	33	1	0	N
176	0	1	0	1	0	0	16	19	0	N
178	0	0	0	0	0	0	8	1	12,324	Y
179	0	0	1	1	0	0	1	0	0	N
180	1	1	0	3	1	0	11	0	127	N
182	0	2	0	4	1	1	0	1	11,140	Y
211	0	0	0	0	0	0	8	2	9,109	N
253	0	0	0	0	0	0	12	1	0	N
254	0	0	0	0	0	0	0	7	0	N
255	0	0	0	1	0	0	1	3	2,183	N
256	0	0	0	0	0	0	1	0	0	N
257	1	2	0	4	0	0	14	1	7,298	N
258	0	0	0	10	2	0	1	0	14,021	Y
286	0	0	0	0	0	0	0	0	2,310	N
I-24 Truck Lanes - Proposed										
212	0	0	0	0	0	0	0	0	0	N
214	0	0	0	0	0	0	0	0	5,803	N
324	0	0	0	2	0	0	0	0	9,575	N

Cultural Resources

Section 106 of the National Historic Preservation Act requires consideration be given to historic and archaeological resources that are listed in or may be eligible for listing in NRHP. A search of NRHP listed historic sites was undertaken to identify if any are located within the study corridors.

The Chickamauga and Chattanooga National Military Park is a NRHP historic district. Portions of the study buffers for Projects 181, 183, 180 and 257 fall within the park boundary. St. Ann's Episcopal Church in Davidson County is listed on the NRHP and falls with the 1,000 foot buffer of Project 175. There are also two historic districts within the I-24 project buffers. A portion of the Edgefield Historic District, which is an NRHP listed resource, falls within the Project 175 buffer and Lookout Mountain Caverns and Cavern Castle in Hamilton County is an NRHP historic district that falls within Project 181. It should be noted that St. Ann's Episcopal Church discussed above is also on the border of Project 253; however, it is not conclusive from GIS boundaries if the resource falls within that project's 1,000 foot buffer area and therefore, is only included in the summary Table 1 for Project 175.

It should be noted that potentially eligible archaeological sites may exist within the ROW limits of I-24 and potentially eligible historic structures may exist adjacent to and within the viewshed of these roadways. Therefore, a historic structures survey and a Phase I archaeological survey would be required for the proposed projects in order to determine if any eligible historic or archaeological resources exist within the projects' area of potential effect (APE).

Parklands, Recreation Areas, Wildlife Refuges

The Chickamauga and Chattanooga National Military Park is listed as a National Military Park and operates under the National Park Service. Portions of the study buffers for Projects 181, 183, 180 and 257 fall within the park boundary.

In addition, Brown Acres Golf Course (a public golf course owned by the City of Chattanooga) and Camp Jordon Park are located within the buffer of Project 182. Montague Park is located in Project 257, Running Water Public Use Area is in Project 317, Anitoch Park is within the buffer of Project 307, Buffalo Park is within the buffers of Projects 175 and 176, Rucker Avenue Park is within the buffer of Project 173, and Eastland Green Golf Course (a public golf course in Clarksville, Tennessee) is within the buffer of Project 170.

There are no identified National Wildlife Refuge areas in any of the project study areas.

Section 4(f) Resources

Section 4(f) of the U.S. Department of Transportation Act refers to the temporary and/or permanent or constructive use of land from a significant publicly owned park, recreation area, or wildlife or waterfowl refuge, or any significant historic site. The most common form of use is when land is permanently incorporated into a transportation facility. This occurs when land from a Section 4(f) property is either purchased outright as transportation ROW or when the applicant for Federal-aid funds has acquired a property interest that allows permanent access

onto the property such as a permanent easement for maintenance or other transportation-related purpose.

The second form of use is commonly referred to as temporary occupancy and results when Section 4(f) property, in whole or in part, is required for project construction-related activities. The property is not permanently incorporated into a transportation facility but the activity is considered to be adverse in terms of the preservation purpose of Section 4(f).

The third and final type of use is called constructive use. A constructive use involves no actual physical use of the Section 4(f) property via permanent incorporation of land or a temporary occupancy of land into a transportation facility. A constructive use occurs when the proximity impacts of a proposed project adjacent to, or nearby, a Section 4(f) property result in substantial impairment to the property's activities, features, or attributes that qualify the property for protection under Section 4(f).

In making any finding of use involving Section 4(f) properties, it is necessary to have up to date ROW information and clearly defined property boundaries for the Section 4(f) properties. For publicly owned parks, recreation areas, and refuges, the boundary of the Section 4(f) resource is generally determined by the property ownership boundary. For historic properties, the boundary of the Section 4(f) resource is generally the NR boundary. Since preliminary engineering level of detail (not final design) is customary during environmental analyses, it may be necessary to conduct more detailed preliminary design in some portions of the study area to finalize determinations of use.

Cemeteries

There are numerous previously identified/mapped cemeteries within the I-24 study buffer areas. Harris Cemetery is within the buffer of Project 308, Pearson Cemetery is within the buffer of Projects 312 and 179, Mt Pleasant Cemetery is within the buffer of Project 118, Howland Cemetery is with the buffer of Project 312, Childs Cemetery is within the buffer of Project 169, and Lee Cemetery is with the buffer of Project 316. In addition to those listed, there are unnamed cemeteries identified with the project buffers of 169, 170, 314 and 316.

Schools and Churches

The I-24 study corridor was reviewed using available mapping to determine if any schools or churches exist within the buffers of the project corridors. Project 313 contains Life House Fellowship Church, Project 316 contains Whiteside Church of God and Whiteside Baptist Church, Project 181 contains a Church of God, Project 183 contains First Church of Nazarene, The Net Church, Unitarian Universalist Church, Harris Chapel AME Zion Church, Chattanooga Spanish Seventh Church, Calvary Christian Church, Missionary Church, North Terrace Church of Christ, Charity Baptist Church, New Greater Veulah Missionary Baptist Church, and New Emmanuel Missionary Baptist Church, Project 169 contains Faith Outreach Church and Gateway Christian Church, Project 118 contains New Bethel AME Church, Project 175 contains St Ann's Episcopal Church, Project 176 contains Mt. Moriah Community Church, Project 172 contains Mountain View Church, Project 179 contains Liberty Church, Project 180 contains St Philips

Lutheran Church, Philadelphia Missionary Baptist Church, and New Emmanuel Missionary Baptist Church, Project 182 contains First Church of Nazarene, The Net Church, Calvary Christian Church and Missionary Church, Project 255 contains Calvary Chapel of Murfreesboro, Project 257 contains Charity Baptist Church, New Greater Veulah Missionary Baptist Church, Rock Metro Community Church and St Matthews Primitive Baptist Church, and Project 258 contains First Church of Nazarene, The Net Church, Unitarian Universalist Church, Calvary Christian Church, Missionary Church, North Terrace Church of Christ, Eastridge Church of Christ, Our Lady of Perpetual Help Catholic Church, Brainerd Baptist Church, and Oakwood Baptist Church. Project 324 contains Westside Church of God and Westside Baptist Church.

Project 307 contains the Lighthouse Christian School and may contain a portion of Anitoch Middle School (only Lighthouse Christian School is included in the Table 1 tally), Project 258 contains the Our Lady of Perpetual Help School and Calvary Christian Church Elementary School, Project 180 contains Howard Middle School, Project 182 contains Calvary Christian Church Elementary School and Project 94 contains Coffee Middle School.

A map review of community resources that were within the project buffers was conducted. It was noted that the East Ridge Fire and Police Station #2 is located with the buffer of Project 182 and the Gateway Medical Center is within the buffer for Project 169.

Hazardous Materials

A search of the Environmental Protection Agency's (EPA's) EnviroMapper was undertaken to identify facilities that are associated with hazardous material and waste sites that are located in project buffers. EPA's Oil Database, showing facilities that store large quantities of oil; RCRAInfo database, showing facilities that generate, transport, and treat, store, or dispose of hazardous waste; Toxics Release Inventory System (TRIS), showing information about facilities where toxic chemicals are being used, manufactured, treated, transported, or released into the environment, and Underground Storage Tank (UST) database, showing underground storage tanks where more than 10% of a facility's volume is underground, were all consulted. When one facility appeared in more than one database, it was only counted once and, if it was in the RCRAInfo database, it was included within that count.

Projects 181, 175 and 257 each have an OIL listed facility within the project buffer. Projects 181, 183, 173, 177, 169, 174, 175, 176, 178, 179, 180, 211, 253, 255, 256, 257, 258, 306, 307, 308, 309, 310, 311 and 312 all have at least one RCRA site within the project buffer. Project 175 has the most with 33 reported RCRA sites. Projects 181, 173, 169, 176, 180, 253, and 318 each have one TRIS facility that is not included as a RCRAInfo site within the project buffer and Project 169 has an EPA reported UST within its project buffer.

The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) inventory is a list compiled by EPA of sites that have been investigated or are being investigated for release or threatened release of contaminated substances. CERCLA sites may ultimately be placed on the National Priorities List (NPL). The NPL, commonly known as the

Superfund List, is a listing of uncontrolled or abandoned hazardous waste sites. A review of the CERCLIS database revealed no CERCLA sites located in the project study area.

Waters of the U.S.- Wetlands

A wetland is defined by the United States Army Corps of Engineers (USACE) as: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. National Wetland Inventory (NWI) maps were examined in order to determine the number of mapped wetlands that fall within the I-24 study corridor. Based on NWI mapping, all projects except for 177, 179, 180, 212, 214, 256, 258, 286, and 324 have wetlands within the study buffer. With 173.4 acres of wetlands, Project 317 has the most wetlands within its buffer.

It should be noted that the measurement for wetlands was based on the previously described project buffers. These measurements are total wetlands within the project buffer, actual impacts should be lower.

Waters of the U.S. - Streams

The National Hydrography Dataset (NHD) from the U.S. Geological Survey was examined to determine if the study corridors cross any mapped jurisdictional streams. Based on this mapping, all projects except 118, 172, 175, 176, 179, 253, 254, 256 and 212 have identified jurisdictional streams within their study buffers. With 31,807 feet of streams, project 316 has the most streams within its buffer.

It should be noted that the measurement for streams was based on the previously described project buffers. The estimates include the entire buffer area, and do not account for streams that already pass under the existing roadway. These measurements are total streams within the project buffer; actual impacts should be lower.

Floodplains

A floodplain is an area located adjacent to a stream, lake, or depression area that may be covered by water by a 100 year storm event. Floodplain information was obtained from Flood Insurance Rate Maps (FIRM) prepared by the Federal Emergency Management Agency (FEMA) for the study corridor. Projects 181, 183, 173, 169, 174, 178, 182, 258, 306, 307, 308, 309, 310, 311, 312, 313, 317, and 318 included a regulatory floodplain within their study buffer.

Any project in a floodway must be reviewed to determine if the project will increase flood heights; however, design is not detailed enough to know if the project would increase flood heights. An engineering analysis must be conducted before a No-rise certification can be issued by FEMA under the National Flood Insurance Program (NFIP). The No-rise Certification must be supported by technical data and signed by a registered professional engineer. The supporting technical data should be based on the standard step-backwater computer model used to develop the 100-year floodway shown on the FIRM or Flood Boundary and Floodway Map (FBFM).

Threatened and Endangered Species

The US Fish and Wildlife’s Information, Planning and Conservation System (IPaC) website was consulted to compile a list of federally threatened and endangered species for the project counties (Table 2). Critical habitat, as designated by the USFWS, is not known to occur in any of the project buffer areas.

Table 2: Federally Protected Species Listed for Project Counties

Species Name	County	Federal Status
Clams		
clubshell (<i>Pleurobema clava</i>)	Cannon, Rutherford, Williamson, Wilson	Endangered
Cracking pearlymussel (<i>Hemistena lata</i>)	Bedford, Coffee, Grundy, Marion	Endangered
Cumberland bean (<i>Villosa trabalis</i>)	Cannon, Hamilton, Rutherford, Wilson	Endangered
Cumberlandian combshell (<i>Epioblasma brevidens</i>)	Cheatham, Davidson, Robertson, Sumner, Williamson	Endangered
Cumberland elktoe (<i>Alasmidonta atropurpurea</i>)	Coffee, Grundy, Marion	Endangered
Cumberland pigtoe (<i>Pleurobema gibberum</i>)	Coffee, Grundy, Marion, Rutherford	Endangered
Cumberlandian combshell (<i>Epioblasma brevidens</i>)	Coffee, Grundy, Marion, Rutherford	Endangered
Dromedary pearlymussel (<i>Dromus dromas</i>)	Coffee, Davidson, Grundy, Hamilton, Marion, Robertson, Rutherford	Endangered
fanshell (<i>Cyprogenia stegaria</i>)	Hamilton, Marion, Rutherford,	Endangered
Finerayed pigtoe (<i>Fusconaia cuneolus</i>)	Coffee, Grundy, Marion	Endangered
Fluted kidneyshell (<i>Ptychobranhus subtentum</i>)	Coffee, Grundy, Marion	Endangered
Littlewing pearlymussel (<i>Pegias fabula</i>)	Coffee, Grundy, Marion, Rutherford	Endangered
Orangefoot pimpleback (<i>Plethobasus cooperianus</i>)	Coffee, Davidson, Hamilton, Marion, Robertson, Rutherford	Endangered
Oyster mussel (<i>Epioblasma capsaeformis</i>)	Cheatham, Coffee, Davidson, Grundy, Marion, Robertson, Rutherford	Endangered
Pale lilliput (<i>Toxolasma cylindrellus</i>)	Coffee, Grundy, Marion, Rutherford	Endangered
Pink mucket (<i>Lampsilis abrupta</i>)	Davidson, Franklin, Grundy, Hamilton, Marion, Robertson	Endangered
purple cat's paw (<i>Epioblasma obliquata obliquata</i>)	Davidson, Robertson	Endangered

Species Name	County	Federal Status
Rayed Bean (<i>Villosa fabalis</i>)	Coffee, Grundy, Marion, Rutherford	Endangered
ring pink (<i>Obovaria retusa</i>)	Robertson	Endangered
Rough pigtoe (<i>Pleurobema plenum</i>)	Davidson, Hamilton, Marion, Robertson	Endangered
Shiny pigtoe (<i>Fusconaia cor</i>)	Coffee, Grundy, Marion	Endangered
Slabside pearlymussel (<i>Lexingtonia dolabelloides</i>)	Coffee, Grundy, Hamilton, Marion, Rutherford	Endangered
Spectaclecase (mussel) (<i>Cumberlandia monodonta</i>)	Grundy, Marion, Rutherford	Endangered
Tan riffleshell (<i>Epioblasma florentina walkeri</i> (=e. <i>walkeri</i>))	Coffee, Davidson, Franklin, Hamilton, Rutherford	Endangered
Turgid blossom (<i>Epioblasma turgidula</i>)	Coffee, Rutherford,	Endangered
White wartyback (<i>Plethobasus cicatricosus</i>)	Davidson, Robertson, Rutherford	Endangered
Crustaceans		
Nashville crayfish (<i>Orconectes shoupi</i>)	Cheatham, Davidson, Robertson, Rutherford	Endangered
Ferns and Allies		
American Hart'S-Tongue fern (<i>Asplenium scolopendrium</i> var. <i>americanum</i>)	Marion	Threatened
Fishes		
Bluemask Darter (<i>Etheostoma</i> sp.)	Coffee, Grundy, Marion, Rutherford	Endangered
Boulder darter (<i>Etheostoma wapiti</i>)	Coffee, Grundy, Marion	Endangered
Laurel dace (<i>Chrosomus saylori</i>)	Hamilton, Marion	Endangered
Snail darter (<i>Percina tanasi</i>)	Grundy, Hamilton, Marion	Threatened
Flowering Plants		
Braun's rock-cress (<i>Arabis perstellata</i>)	Davidson, Rutherford	Endangered
Guthrie's ground-plum (<i>Astragalus bibullatus</i>)	Davidson, Rutherford	Endangered
Large-Flowered skullcap (<i>Scutellaria montana</i>)	Hamilton, Marion	Threatened
Leafy prairie-clover (<i>Dalea foliosa</i>)	Rutherford	Endangered
Morefield's leather flower (<i>Clematis morefieldii</i>)	Grundy	Endangered
Price's potato-bean (<i>Apios priceana</i>)	Davidson, Franklin, Marion, Montgomery	Threatened
Small Whorled pogonia (<i>Isotria medeoloides</i>)	Hamilton	Threatened
Virginia spiraea (<i>Spiraea virginiana</i>)	Hamilton	Threatened
Mammals		
Gray bat (<i>Myotis grisescens</i>)	Coffee, Grundy, Marion, Montgomery, Robertson, Rutherford	Endangered
Indiana bat (<i>Myotis sodalis</i>)	Cheatham, Coffee, Davidson, Grundy, Hamilton, Marion, Montgomery, Robertson, Rutherford	Endangered

Species Name	County	Federal Status
Snails		
Anthony's riversnail (<i>Atheurnia anthonyi</i>)	Grundy, Marion	Endangered
Royal marstonia (<i>Pyrgulopsis ogmorhapse</i>)	Marion	Endangered

Impacts to protected species and/or their habitat must be assessed via a field survey. If habitat for a particular species is identified during the field survey, then a presence/absence survey for that species during the appropriate survey season would also be conducted.

Environmental Justice Populations

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations) was issued in 1994. The document focuses federal attention on the environmental and human health conditions in minority communities and low-income communities with the goal of achieving environmental justice (EJ). Data from the U.S. Bureau of the Census (2008-2012 American Community Survey 5-Year Estimates) was used to determine potential environmental justice communities. Data was collected at the county level for the I-24 project improvement corridor.

Census data at the tract level would be able to more definitively determine potential impacts to EJ communities. Once study areas are narrowed, data should be reviewed to determine if impacts would occur in the specific project areas.

Based on the Census data provided in Table 3, Davidson County (projects 173, 177, 174, 175, 176, 178, 211, 253, 286, 306, 307, 313 and a portion of 314), Hamilton County (projects 181, 183, 180, 182, 257, and 258), and Montgomery County (projects 169 and 170) all have a higher concentration of black individuals than the State.

Table 3: Population and Race Data for the Study Area (County Level)

Geographic Region	Total Population	White	Black	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other	Two or More Races
State of Tennessee (percent of total pop)	6,353,226	4,982,977 (78%)	1,060,494 (17%)	15,991 (0.3%)	92,800 (1.5%)	2,765 (3%)	88,272 (1%)	109,927 (2%)
Cheatham County (percent of total pop)	39,103	37,509 (95.9%)	597 (1.5%)	96 (0.2%)	213 (0.5%)	0 (0.0%)	246 (0.6%)	442 (1.1%)
Coffee County (percent of total pop)	52,853	48,433 (91.6%)	1,400 (2.6%)	94 (0.2%)	533 (1.0%)	51 (0.1%)	832 (1.6%)	1,510 (2.9%)
Davidson County (percent of total pop)	629,113	396,049 (63.0%)	174,582 (27.8%)	1,393 (0.2%)	19,586 (3.1%)	270 (0.0%)	24,074 (3.8%)	13,159 (2.1%)
Grundy County (percent of total pop)	13,751	11,422 (83.1%)	95 (0.7%)	86 (0.6%)	51 (0.5%)	0 (0.0%)	41 (0.3%)	2,056 (15.0%)
Hamilton County (percent of total pop)	337,023	251,934 (74.8%)	68,448 (20.3%)	681 (0.2%)	6,267 (1.9%)	62 (0.0%)	4,717 (1.4%)	4,914 (1.5%)
Marion County (percent of total pop)	28,184	26,474 (93.9%)	396 (1.4%)	21 (0.1%)	99 (0.4%)	0 (0.0%)	85 (0.3%)	1,109 (3.9%)
Montgomery County (percent of total pop)	173,138	125,335 (72.4%)	33,312 (19.2%)	1,096 (0.6%)	3,652 (2.1%)	727 (0.4%)	2,534 (1.5%)	6,482 (3.7%)
Robertson County (percent of total pop)	66,143	58,726 (88.8%)	5,017 (7.6%)	274 (0.4%)	158 (0.2%)	66 (0.1%)	1,010 (1.5%)	892 (1.3%)
Rutherford County (percent of total pop)	263,815	212,818 (80.7%)	33,361 (12.6%)	785 (0.3%)	8,122 (3.1%)	65 (0.0%)	3,292 (1.2%)	5,372 (2.0%)

In addition to race, in order to determine Hispanic/Latino populations, Census “Ethnicity” data was also consulted. This data is shown on Table 4. Based on Census data, Davidson County (projects 173, 177, 174, 175, 176, 178, 211, 253, 286, 306, 307, 313 and a portion of 314), Montgomery County (project 169), Robertson County (projects 212, 510 and portions of projects 170 and 314), and Rutherford County (project 118, 172, 179, 254, 255, 256, 308, 309, 310, 311, and 312), all have a higher concentration of Hispanic/Latino individuals than the State.

Table 4: Ethnicity Data for the Study Areas (County Level)

Geographic Region	Total Population	Hispanic
State of Tennessee (percent of total pop)	6,353,226	288,582 (4.5%)
Cheatham County (percent of total pop)	39,103	930 (2.4%)
Coffee County (percent of total pop)	52,853	2,012 (3.8%)
Davidson County (percent of total pop)	629,113	60,357 (9.6%)
Grundy County (percent of total pop)	13,751	122 (0.9%)
Hamilton County (percent of total pop)	337,023	14,854 (4.4%)
Marion County (percent of total pop)	28,184	361 (1.3%)
Montgomery County (percent of total pop)	173,138	14,019 (8.1%)
Robertson County (percent of total pop)	66,143	3,866 (5.8%)
Rutherford County (percent of total pop)	263,815	17,587 (6.7%)

In addition to race and ethnicity, EJ also looks at whether a project might have a disproportionate impact on low-income populations. The 2008-2012 American Community Survey conducted as part of the U.S. Census was reviewed to determine the number of individuals living below the poverty level for the State of Tennessee and the project study area counties (see Table 5). Coffee County (projects 146 and 94), Davidson County (projects 173, 177, 174, 175, 176, 178, 211, 253, 286, 306, 307, 313 and a portion of 314), Grundy County (project 214), and Marion County (projects 316, 317, 318, and 324) have a higher concentration of individuals living below poverty level than the State.

Table 5: Percent of Population in Poverty (County Level)

Geographic Region	Percent of Population Living in Poverty
State of Tennessee	17.3%
Cheatham County	11.7%
Coffee County	20.6%
Davidson County	18.5%
Grundy County	29.0%
Hamilton County	16.2%
Marion County	19.2%
Montgomery County	16.2%
Robertson County	13.0%
Rutherford County	13.0%

The Census data above provides an indication of where potential impact to minority and low-income populations are most likely. However, due to the review of county level data, once preferred projects are identified, the project areas should be reviewed on a census tract level and field review level to better determine if EJ communities are present. Furthermore, it would depend on the magnitude of the proposed project and the amount of right-of-way needed to determine if there would be impacts to identified communities.

Summary of Potential Environmental Issues

A ranking system was devised to determine the potential impacts for each project. Due to the overall low number of historic structures, parks, cemeteries, churches, schools, and floodplain crossings, potential impacts were ranked on all of these categories combined, and then separately by both the stream and wetlands within the project buffers. A ranking system was then applied to determine which projects may potentially have the most environmental impact.

The rankings for the historic structures, parks, cemeteries, churches, schools, and floodplain crossings were given a 'low' rank if there were 0-10 potential impacts meaning these projects would have the least amount of impact, a 'moderate' ranking if they had 11-25 potential impacts and a 'high' rank if they had above 25 potential impacts. As seen in Table 6, only projects 175 and 183 had a high rank, while projects 176, 180, 253, 257 and 258 had moderate rankings. The remaining projects had a low ranking.

The ranking system for wetlands was based on the total number of acres of wetlands within each project buffer. A rank on 'low' was given to those projects that had between 0-58 acres of wetlands, a 'moderate' was assigned to projects that had between 59-115 acres and a 'high' was assigned to projects with more than 115 acres of wetlands within their project buffers. Only project 317 had a high ranking. Projects 318 and 181 had a moderate ranking and the remaining projects all had a low ranking.

The ranking system for streams was based on the total feet of stream within each project buffer. A rank on 'low' was given to those projects that had between 0-10,665 feet of stream, a 'moderate' was assigned to projects that had between 10,665 and 21,330 feet of stream and a 'high' was assigned to projects with more than 21,330 feet of stream within their project buffers. Project 316 had a high ranking while projects 181, 183, 173, 169, 307, 308, 312, 313, 314, 318, 178, 182 and 258 had a moderate ranking. The remaining projects all had a low ranking.

Once each resource or group of resources was ranked, a number was assigned corresponding to the ranking. A one (1) was given to all 'lows,' a two (2) was assigned to 'moderate' ranks and a three (3) was assigned to all 'highs.' Each project's rankings were tallied based on these numerical values and assigned a final ranking based on the total. A final tally of 1-3 resulted in the project ranking as a 'low', meaning there is a lower chance of environmental impact for the project. A final tally of 4-6 resulted in the project ranking as a 'moderate,' meaning there is a moderate chance of adverse environmental impact, and projects scoring 7-9 received a 'high' ranking, meaning they had the most potential for environmental impact. None of the proposed projects received high rankings. Projects 307, 308, 312, 313, 314, 316, 317, 318, 181, 183, 173, 169, 175, 176, 178, 180, 182, 253, 257 and 258 all received moderate rankings. The remaining projects received low rankings and it may be assumed based on the screening process that these projects would have the least overall potential to adversely impact the environment.

Table 6: Potential Environmental Impacts Rankings

Project ID	Total Historic, Park, Cemetery, Church, School Hazmat and Floodplain Sites within Project Buffer	Site Impact Ranking	Wetlands (In Acres)	Wetlands Impact Ranking	Streams (In Feet)	Streams Impact Ranking	Total Impact Ranking
I-24 Roadway Capacity Projects - LRTP							
169	9	Low	21	Low	13,256	Moderate	Moderate
170	2	Low	3	Low	9,077	Low	Low
173	6	Low	1	Low	16,119	Moderate	Moderate
177	1	Low	0	Low	3,146	Low	Low
181	10	Low	110	Moderate	21,018	Moderate	Moderate
183	28	High	5	Low	17,680	Moderate	Moderate
I-24 Roadway Capacity Projects - Proposed							
306	8	Low	6	Low	6,206	Low	Low
307	7	Low	1	Low	19,087	Moderate	Moderate
308	6	Low	3	Low	11,983	Moderate	Moderate
309	3	Low	25	Low	3,810	Low	Low
310	2	Low	4	Low	2,133	Low	Low
311	2	Low	9	Low	1,591	Low	Low
312	8	Low	20	Low	11,238	Moderate	Moderate
313	2	Low	3	Low	20,812	Moderate	Moderate
314	1	Low	5	Low	18,586	Moderate	Moderate
315	0	Low	3	Low	1,227	Low	Low
316	4	Low	19	Low	31,807	High	Moderate
317	3	Low	173	High	5,701	Low	Moderate
318	2	Low	89	Moderate	17,374	Moderate	Moderate
I-24 Interchange Projects (New or Modified Access) - LRTP & Proposed							
94	1	Low	1	Low	1,176	Low	Low
118	2	Low	1	Low	0	Low	Low
146	0	Low	1	Low	5,141	Low	Low
172	1	Low	3	Low	0	Low	Low
174	5	Low	1	Low	5,320	Low	Low
175	37	High	1	Low	0	Low	Moderate
176	18	Moderate	19	Low	0	Low	Moderate
178	9	Low	1	Low	12,324	Moderate	Moderate
179	3	Low	0	Low	0	Low	Low
180	17	Moderate	0	Low	127	Low	Moderate
182	9	Low	1	Low	11,140	Moderate	Moderate
211	8	Low	2	Low	9,109	Low	Low
253	12	Moderate	1	Low	0	Low	Moderate
254	0	Low	7	Low	0	Low	Low
255	2	Low	3	Low	2,183	Low	Low
256	1	Low	0	Low	0	Low	Low
257	21	Moderate	1	Low	7,298	Low	Moderate
258	14	Moderate	0	Low	14,021	Moderate	Moderate
286	0	Low	0	Low	2,310	Low	Low
I-24 Truck Lanes - Proposed							
212	0	Low	0	Low	0	Low	Low
214	0	Low	0	Low	5,803	Low	Low
324	2	Low	0	Low	9,575	Low	Low

Appendix C Economic Impact Analysis Summary

Technical Memo

To:	Project File		
From:	Gui Shearin, Ph.D.	Date	30 Dec 2013
Ref:	TDOT I-24 Corridor Study	cc:	
Subject:	Economic Impacts of Proposed Projects		

Summary of Results

This memo summarizes the methodology and results of an economic analysis of the job creation and economic stimulus that would be created by the several highway improvement scenarios under consideration by the TDOT I-24 Corridor Study. It includes the effect of the expenditure of highway construction funds and the resulting, ongoing highway benefits for each modeled project package. The economic analysis is at a sketch planning level that gives approximate order-of-magnitude estimates of economic impacts. Two types of economic impacts are estimated:

- Economic output, earnings, and jobs from construction spending, which would occur during the construction periods for the scenarios (Table 1), and
- Economic output, earnings, and jobs from ongoing travel benefits in the corridor created by the analyzed scenarios, which would occur annually from project completion to the 2040 horizon year (Table 2).

This study uses RIMS II multipliers applied to estimated construction costs for the construction spending effects. An elasticity model was developed to predict effects on metropolitan area gross domestic product (GDP) for the ongoing highway benefits resulting from improved travel conditions on I-24. The methodology and assumptions are described following this summary of results.

As shown in Table 1, construction spending is estimated to increase corridor economic output by approximately twice the total construction costs net of right-of-way costs or \$5.5 to \$6.4 billion for the two capacity increasing scenarios modeled: 2040 LRTP + Proposed Capacity On I-24 and 2040 LRTP + Proposed Capacity Off I-24. Other less expensive scenarios would have correspondingly less economic output due to the lower construction spending, ranging from \$47 million for Proposed ITS Projects to \$2.0 billion for LRTP + Proposed Operation and Miscellaneous Projects (not modeled). The modeled 2040 LRTP + Proposed Operation and Miscellaneous Projects would have approximately \$920 million in economic output and the 2040 LRTP + Proposed New Access/Interchanges would have \$230 million in economic output. This economic output would be generated over the construction period of a scenario. Table 1 indicates the distribution of the economic output by analysis area based on the assumption that construction labor and supplies are local to each analysis area. In reality, output increases would tend to follow the locations of the construction labor and supply purchases in the corridor, which might not always be the same analysis areas where the projects are being constructed.

Table 1 also shows the estimated construction impact on earnings and jobs in the I-24 corridor. Earnings would range from \$1.9 to \$2.2 billion for the two capacity increasing scenarios and from \$16 to \$680 million for the other scenarios shown in Table 1. Direct, indirect, and induced jobs resulting from the construction spending are similarly estimated to range from approximately 43,000 to 50,000 jobs (full-time annual equivalents or FTE) for the two capacity increasing scenarios and from approximately 363 to 15,000 jobs for the other scenarios shown in Table 1. Distribution of these jobs by time and analysis areas would be similar to that described above for economic output.

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Table 1: Construction Impacts - Regional Economic Output, Total Earnings, and Jobs by Scenario and Analysis Region

Units are millions of 2013 dollars except for jobs, which are total full time equivalent jobs in one year

Scenario	Analysis Region (1)	Estimated Project Costs		Regional Economic Impact (2)		
		Total Cost	Cost w/o ROW	Economic Output	Total Earnings	Jobs
2040 E+C (modeled)	1	n/a	n/a	n/a	n/a	n/a
	2	n/a	n/a	n/a	n/a	n/a
	3	n/a	n/a	n/a	n/a	n/a
		n/a	n/a	n/a	n/a	n/a
2040 LRTP + Proposed (modeled) Capacity On I-24	1	\$221	\$188	\$741	\$257	5,700
	2	\$873	\$737	\$2,903	\$1,008	22,337
	3	\$545	\$482	\$1,899	\$659	14,606
	Total	\$1,640	\$1,406	\$5,543	\$1,924	42,643
2040 LRTP +Proposed (modeled) Capacity Off I-24	1	\$459	\$398	\$1,570	\$545	12,082
	2	\$1,279	\$1,108	\$4,368	\$1,516	33,601
	3	\$152	\$130	\$512	\$178	3,941
	Total	\$1,890	\$1,637	\$6,450	\$2,239	49,623
2040 LRTP +Proposed (modeled) New Access/Interchanges	1	\$0	\$0	\$0	\$0	0
	2	\$60	\$58	\$227	\$79	1,743
	3	\$0	\$0	\$0	\$0	0
	Total	\$60	\$58	\$227	\$79	1,743
2040 LRTP+Proposed (modeled) Operational & Misc. Projects	1	\$0	\$0	\$0	\$0	0
	2	\$63	\$62	\$243	\$84	1,870
	3	\$177	\$172	\$679	\$236	5,225
	Total	\$239	\$234	\$922	\$320	7,095
LRTP+Proposed (not modeled) Operational & Misc. Projects	1	\$20	\$20	\$76	\$26	585
	2	\$254	\$248	\$979	\$340	7,533
	3	\$241	\$229	\$903	\$313	6,949
	Total	\$515	\$497	\$1,960	\$680	15,080
Proposed ITS Projects (not modeled)	1	\$0	\$0	\$0	\$0	1
	2	\$9	\$9	\$37	\$13	286
	3	\$3	\$3	\$10	\$3	76
	Total	\$12	\$12	\$47	\$16	363

Notes:

(1) Region:

- (1) Clarksville
- (2) Nashville
- (3) Chattanooga

(2) Source: Regional Input-Output Modeling System (RIMS II), Regional Product Division, Bureau of Economic Analysis, Atkins, 2013.

Table 2 presents economic output, earnings, and jobs for scenarios similar to Table 1, but in this case the effects are efficiency impacts estimated from the annual 2040 VHT savings for the scenarios. Because the corridor time savings have less impact on the regional economy than the direct construction spending, which purchases actual goods and services, the annual economic benefits from time savings are less than those from the total construction spending. Typically the annual corridor benefits average 4% to 5% of the total construction spending benefits for the capacity increasing scenarios and higher for the interchange and operational and miscellaneous project scenarios. Because the annual corridor benefits occur every year after the projects are built, these benefits can equal or exceed the construction benefits over time.

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Table 2: Annual Highway Efficiency Impacts - Regional Economic Output, Total Earnings, and Jobs by Scenario and Analysis Region

Economic Impact units are millions of 2013 dollars except for jobs, which are total full time equivalent jobs in one year

Scenario	Analysis Region (1)	Weighted Daily VHT (2) (thousands)	Annualized VHT (2) (thousands)	% Change wrt E+C	Regional Economic Impact (3)		
					Economic Output	Total Earnings	Jobs
2040 E+C (modeled)	1	259	94,535	n/a	n/a	n/a	n/a
	2	3,201	1,168,365	n/a	n/a	n/a	n/a
	3	553	201,845	n/a	n/a	n/a	n/a
	Total	4,013	1,464,745	n/a	n/a	n/a	n/a
2040 LRTP + Proposed (modeled) Capacity On I-24	1	251	91,615	3.1%	\$28.9	\$7.4	174
	2	3,094	1,129,310	3.3%	\$254	\$65	1,531
	3	549	200,385	0.7%	\$12.7	\$3.2	77
	Total	3,894	1,421,310	3.0%	\$296	\$75	1,782
2040 LRTP + Proposed (modeled) Capacity Off I-24	1	254	92,710	1.9%	\$17.7	\$4.5	107
	2	3,078	1,123,470	3.8%	\$293	\$75	1,763
	3	554	202,210	0.4%	\$7.3	\$1.9	44
	Total	3,886	1,418,390	3.2%	\$318	\$81	1,914
2040 LRTP + Proposed (modeled) New Access/Interchanges	1	259	94,535	0.0%	\$0	\$0	0
	2	3,152	1,150,480	1.5%	\$115	\$29	696
	3	553	201,845	0.0%	\$0	\$0	0
	Total	3,964	1,446,860	1.2%	\$115	\$29	696
2040 LRTP+Proposed (modeled) Operational & Misc. Projects	1	259	94,535	0.0%	\$0	\$0	0
	2	3,185	1,162,525	0.5%	\$38	\$9.8	232
	3	543	198,195	1.8%	\$33	\$8.3	197
	Total	3,987	1,455,255	0.6%	\$71	\$18	429
LRTP+Proposed (not modeled) Operational & Misc. Projects	1	n/a	n/a	n/a	n/a	n/a	n/a
	2	n/a	n/a	n/a	n/a	n/a	n/a
	3	n/a	n/a	n/a	n/a	n/a	n/a
	Total	n/a	n/a	n/a	n/a	n/a	n/a
Proposed ITS Projects (not modeled)	1	n/a	n/a	n/a	n/a	n/a	n/a
	2	n/a	n/a	n/a	n/a	n/a	n/a
	3	n/a	n/a	n/a	n/a	n/a	n/a
	Total	n/a	n/a	n/a	n/a	n/a	n/a

Notes:

(1) Region

- (1) Clarksville
- (2) Nashville
- (3) Chattanooga

(2) 2040 Avg. Weekday VHT (Weighted by Free-flow & Congested Time), I-24 Corridor Travel Demand Model, Atkins

(3) Annualized is a factor of '365' for all subareas and entire corridor, per prior TDOT Interstate Corridor Studies

(3) Economic multipliers are based on the following:

Regional Input-Output Modeling System (RIMS II), Regional Product Division, Bureau of Economic Analysis, 2013.

Metropolitan Gross Domestic Product Data for Clarksville, Nashville, and Chattanooga, Bureau of Economic Analysis, 2013.

User and Non-User Benefit Analysis for Highways, AASHTO, September 2010.

Atkins, 2013.

Table 2 shows that improved travel efficiency in the I-24 corridor is estimated to increase corridor economic output by approximately \$296 to \$318 million in 2040 for the two capacity increasing scenarios modeled: 2040 LRTP + Proposed Capacity On I-24 and 2040 LRTP + Proposed Capacity Off I-24. The modeled 2040 LRTP + Proposed Operation and Miscellaneous Projects would have approximately \$71 million in 2040 economic output and the 2040 LRTP + Proposed New Access/Interchanges would have approximately \$116 million in 2040 economic output. Two scenarios were not modeled and consequently have no estimates of VHT savings: the Proposed ITS Projects and the LRTP + Proposed Operation and Miscellaneous Projects (not modeled). The year 2040 is an index year that is higher than the earlier years of the analysis period beginning in 2013, indicating that efficiency benefits in the earlier years would be lower than in 2040. As did Table 1 for construction spending impacts, Table 2 indicates the distribution of the economic output from

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improved efficiency by analysis area based on the assumption that economic impacts of efficiency savings are local to each analysis area. Although the travel time savings were calculated for each analysis area, the impacts may spread further, depending on trip lengths in the corridor.

Table 2 also shows the estimated annual efficiency impact on earnings and jobs in the I-24 corridor. Earnings in 2040 would range from about \$75 to \$81 million for the two capacity increasing scenarios and from \$18 to \$29 million for the other two modeled scenarios shown in Table 2. Direct, indirect, and induced jobs in 2040 resulting from the economic efficiency impacts of VHT savings are similarly estimated to range from approximately 1,800 to 1,900 jobs (full-time annual equivalents) for the two capacity increasing scenarios and from approximately 400 to 700 jobs for the other two modeled scenarios. Distribution of these jobs by analysis areas would be similar to that described above for economic output.

Methodology and Assumptions

Construction Spending Impacts

The job creation and economic stimulus estimates from construction spending are based on the application of multipliers from the Regional Input-Output Modeling System (RIMS II) for the combined analysis areas. This area includes the following Tennessee counties along the I-24 corridor: Bedford, Cannon, Cheatham, Coffee, Davidson, Franklin, Grundy, Hamilton, Marion, Montgomery, Robertson, Rutherford, Sequatchie, Sumner, Warren, Williamson, and Wilson. The economic output includes the multiplier effect of direct construction and engineering dollars being re-spent in service or other sectors of the economy to give direct, indirect, and induced impacts. The multipliers were purchased from the Regional Product Division, Bureau of Economic Analysis, US Department of Commerce, and address the base year of 2010, the latest available. Multipliers for the construction industry were applied to the estimated construction costs less right-of-way, plus the contingency. Multipliers for professional, scientific, and technical services were applied to the estimated PE costs. The job multipliers were adjusted for inflation between 2010 and 2013 based on the unadjusted Consumer Price Index for all urban consumers, resulting in job multipliers of 16.9 jobs per million 2013 construction dollars. Jobs are expressed as annual full-time construction jobs. The 2013 job multiplier for engineering jobs was 16.0.

Because right-of-way purchases for undeveloped land can simply be a transfer payment that generates no new spending or jobs, right-of-way costs were excluded from the calculations. For well developed areas where right-of-way purchases could include a high percentage of improvements, this assumption understates the economic output that would be generated to replace the demolished structures and other property improvements elsewhere in the corridor.

Ongoing Travel Benefit Impacts

The annual job creation and economic stimulus estimates from reductions in I-24 corridor travel costs by the modeled scenarios are based on a combination of (1) elasticity estimates of how much highway improvement affects the regional economy, as defined by local metropolitan GDP, and (2) average earning and job multipliers for the corridor from the RIMS II data applied to the incremental economic output.

Output elasticities for investment in transportation infrastructure have been estimated and reported in the economic impact literature. This study uses the range for state and metropolitan investments from Nadiri and Mamuneas as reported in the current "Red Book".¹ Nadiri and Mamuneas found output elasticities in their

¹ AASHTO, *User and Non-User Benefit Analysis for Highways*, September 2010, p. 9-17.

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review of economic literature that ranged between 0.06 and 0.20 for state and metropolitan areas. Elasticity is a dimensionless ratio of the estimated change in output for a unit change in input. Typically elasticities can be applied to the investment budgets or some other measure of highway capital stock change such the percentage increase in corridor capacity. Thus a 10% increase in corridor capacity would suggest a range of increased economic output from 0.6% to 2% (10% x 0.06 to 0.20). To be conservative, this study selects a value close to the lower end of the suggested elasticity range (0.08), but applies it to the percentage of time savings (VHT) in the corridor as a more meaningful measure of what transportation projects actually improve. Because a given percentage change in link capacity leads to a lower percentage change in travel time savings, except at very high levels of congestion ($V/C > 1.5$)², this approach is thought to be both conservative and more relevant than applying the elasticity to a percentage capacity increase.

Table 2 lists the percentage change of 2040 analysis area VHT for the various investment scenarios as compared with the baseline of 2040 Existing + Committed improvements. The percentage improvements in travel time were multiplied by 0.08 and applied to estimates of the GDP for each analysis area shown in Table 3:

Table 3. Metro Area GDP		
Millions of current year dollars		
Year	2012	2013
Clarksville Metro Area	\$11,470	\$11,646
Nashville Metro Area	\$94,789	\$96,245
Chattanooga Metro Area	\$22,405	\$22,749
Total Metro Areas	\$128,664	\$130,641

Sources: Bureau of Economic Analysis, US Department of Commerce, <http://bea.gov/iTable/iTable.cfm?ReqID=70&step=1#reqid=70&step=1&isuri=1> (accessed on 12/23/13); CPI – All Urban Consumers, Unadjusted, <http://data.bls.gov/cgi-bin/srgate> (accessed on 12/29/13); Atkins, 2013.

The metro areas for Clarksville, Nashville, and Chattanooga do not exactly match the corresponding three analysis areas. To compensate for any high side errors, GDP was not escalated to 2040, which made 2040 GDP equal 2013 GDP in real terms, thus understating 2040 GDP by a factor of about two.

Table 2 shows the resulting regional economic output estimates for the above calculations (0.08 x percentage decrease in VHT x metro area GDP) along with estimated earnings and jobs. RIMS II earnings and jobs multipliers for all I-24 corridor industries were averaged and used to derive earnings and jobs from economic output based on their ratios to corridor economic output.

² Based on Bureau of Public Roads speed formula $S = S_0 / (1 + 0.15 (V/C)^4)$, where S_0 is free flow speed.

Appendix D Benefit-Cost Analysis Parameters Summary

Memo

To:	Project File	
From:	J. Pease	Email:
Phone:		Date: 08 August 2013
Ref:	TDOT I-24 Corridor Study	cc:
Subject:	Benefit-Cost Analysis Parameters	

This memo includes background information about parameters customarily used in developing Benefit-Cost (B-C) Ratios for traffic analyses, corridor studies and developing transportation plans.

There are a number of references that discuss different methods for assigning a value to 'benefits' and 'costs', but this investigation reported herein relies heavily on FHWA Economic Analysis Primer for Benefit-Cost Analyses.¹

Background Research

Travel time and delay. Travel associated with business trips or conducting commerce is usually valued at the average traveler's wage plus overhead - representing the cost to the traveler's employer. In contrast, personal travel time (either for commuting or leisure) is usually valued as a percentage of average personal wage and/or through estimates of what travelers would be willing to pay to reduce travel time. U.S. Department of Transportation (USDOT) recommends using a value for local personal travel time at 50 percent of average wage (see "Departmental Guidance for the Valuation of Travel Time in Economic Analysis," available on the internet, for additional guidance). FHWA notes that the value of travel time often accounts for the greatest share of a transportation project's benefits. No reference is made to distinguish between the value of time for autos and trucks. Moreover, there is not a reference in this source for determining values for Non-recurrent congestion and Recurrent congestion for autos and trucks.

Recurrent and Non-recurrent delay. There is some discussion that motorists are more sensitive to variability in travel time delays. According to research published under the web name, Transportation Economics, improved reliability of travel time creates additional value for many kinds of trips. This line of thought recognizes that uncertainty makes travellers and freight operators adjust their departure times to account for the possibility that their trips may take longer than usual. The less uncertain they are about the extra time they need to allocate for this contingency, the more precisely they can schedule their trip, which saves them time.²

Crashes. The use of reasonable crash values is critical to avoid under-investing in highway safety. Medical, property, legal, and crash-related costs are calculated and factored into the value. USDOT offers extensive guidance on this subject (see "Revision of Departmental Guidance on Treatment of the Value of Life and Injuries," and "The Economic Impact of Motor Vehicle Crashes," 2000 (DOT HS 809 446)).³

Vehicle operating costs (VOC). This is the benefit category where estimates of the value of air pollution would be discussed. However, USDOT does not provide official guidance on estimating VOC, but useful information on the valuation of VOC is provided in AASHTO's 1977 "Manual on User Benefit Analysis of Highway and Bus-

¹ <http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer05.cfm>

² <http://bca.transportationeconomics.org/benefits/travel-time>

³ <http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer05.cfm>

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Transit Improvements" and its successor document, and in the "Highway Economic Requirements System Volume IV: Technical Report" (FHWA-PL-00-028).⁴

There was an indication showing how much air pollution contributes to the net benefits of a project. Transportation Economics' B-C Ratio research cites a California DOT case study for a rail project.⁵ The net impact of emissions in that particular benefit-cost analysis was zero.

TDOT's Parameters Update

Based on the background information cited above and the list of fundamental data most commonly used in calculating or updating B-C Ratio parameters, see Exhibit 1, a recommended set of TDOT's B-C Analysis parameters are reported below.

Recurrent congestion:

TDOT's 2010 for autos = \$19.82. This Value of Time (VOT) appears to be slightly on the high-side but reasonable in light of FHWA's guidance. We recommend applying the 2010 to 2012 CPI adjustment to it, which would give TDOT a value of **\$20.81 per hour** for 2012.

TDOT's 2010 for trucks = \$36.05. There is no information from the reference cited to determine an appropriate base for the value of time assigned to truck delay savings. Based on typical travel demand modelling theory for assigning autos and trucks, separately, to a highway network by cost, the value of time for trucks is approximately twice as large as for autos. TDOT's 2010 values of time for autos and trucks is pretty consistent with that so we do not recommend any changes outside of a 2010 to 2012 CPI adjustment bump. This adjustment would give TDOT a value of **\$37.85 per hour** for 2012.

Non-Recurrent congestion:

There was no information cited in the literature review that cited the relative change in value of time between Recurrent and Non-Recurrent motor vehicle delay. However, there was a reference that supported TDOT's 2010 generalized relationship that Non-Recurrent delay is more sensitive to motorists than Recurrent delay. No information was revealed to dispute that Non-recurrent delay is valued at double the rate of Recurrent delay. Therefore, it is recommended that TDOT retain the same values for this kind of delay but apply the 2010 to 2012 CPI adjustment factor. As such, Non-Recurrent delay for autos would increase in value, from \$39.64 for autos in 2010 to **\$41.62 per hour in 2012**. For trucks, the recommendation is the same. Non-Recurrent delay for trucks would then go from \$72.10 in 2010 to **\$75.71 per hour in 2012**. It should be noted that Non-Recurrent delay was not used in the development of user benefits for the purposes of the I-24 Multimodal Corridor Study due to the high variability and unpredictability of these values.

Crashes:

We recommend that TDOT accept the monetary value of fatal crashes as reported in the reference in Exhibit 1. A procedure to check TDOT's 2010 value of a crash fatality would be to estimate the 2010 value from a CPI adjustment. Applying a 1994 to 2010 adjustment factor would produce an estimate of \$3.8 million per fatality. This is a half million less than the value used by TDOT in the 2010 corridor study but the units might be different. In the absence of other information, it is recommended that TDOT use a fatality value of \$3.8 million for 2010

⁴ <http://www.fhwa.dot.gov/infrastructure/asstmgmt/primer05.cfm>

⁵ <http://bca.transportationeconomics.org/models/cal-b-c>

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which would be equivalent to **\$4.0 million per fatality** in 2012. If this value, per fatality, were adjusted to represent the fatality rate per fatal crash (which sometimes involves multiple fatalities) then the recommended value per fatality in 2012 would be essentially the same as the CPI adjusted value used by TDOT in 2010.

TDOT's average rate per crash in 2010 (not including fatal crashes) appears reasonable based on the scale of monetary values for different kinds of reported injury crashes and the property damage only crash type, as reported in Exhibit 1. We recommend applying the 2010 to 2012 CPI adjustment to it which equates to a **2012 dollar value per crash (non-fatality) of \$8,925**.

Air Pollution:

The literature search did not reveal composite air pollutant values per VMT. It did, however, indicate that its contribution to the 'benefits' component of the B-C Ratio was small. As such, we recommend that TDOT does not make any changes, but simply adjusts its 2010 values per the CPI change. In this case, the **2012 values for autos and trucks will be \$0.012 per auto VMT and \$0.041 per truck VMT** for autos and trucks, respectively.

Memo

Exhibit-1

B-C Analysis Background

Travel Delay Benefits and the Value of Time (VOT)

Facts:

AVERAGE WAGE DATA

US Department of Labor, Bureau of Labor Statistics

May 2012 State Occupational Employment and Wage Estimates

Statewide:	Hourly Wage "Mean"
All Occupations	\$18.90
Transportation & Materials Moving	\$14.99
Heavy Truck Operators	\$18.22

Greater Nashville (2009):	Hourly "Mean" Wage		
	Civilian	Private Industry	State & Local Govt.
All Workers	\$19.71	\$19.24	\$22.47
Production, Transportation & Material Moving	\$15.81	\$15.81	-

INFLATION ADJUSTMENTS

US DOL, Bureau of Labor Statistics

CPI Inflation Calculator

1997-2012 = 1.430

2009-2012 = 1.07

2010-2012 = 1.053

Comprehensive Costs In Police-Reported Crashes

By K-B-B-C Scale Severity

(in 1994 dollars)

Severity	Value	Unit
Fatal Crashes	\$ 2.6 million	per fatality
Incapacitating	\$180,000	per injury
Evident	\$36,000	per injury
Possible	\$19,000	per injury
Property Damage	\$2,000	per crash

Source: *Motor Vehicle Accident Costs*, US Dept. of Transportation, FHWA, October 31, 1994

Appendix E Ramp Improvements Summary

I-24 Multimodal Corridor Study Ramp Improvements Summary

County	Exit or Mile Post	Short Ramps Recommended to be Lengthened/Redesigned			
		Eastbound Exit	Eastbound Entrance	Westbound Exit	Westbound Entrance
Montgomery	1		Yes		Yes
	4		Yes		Yes
	8		Yes		Yes
	11		Yes		Yes
Robertson	19		Yes		Yes
	24		Yes		Yes
Cheatham	31		Yes		Yes
Davidson	35		Yes		Yes
	40		Yes		Yes
	57		Yes		
	59	Yes	Yes	Yes	Yes
	60			Yes	
Rutherford	66			Yes	
	70	Yes	Yes	Yes	Yes
	81		Yes		Yes
	84		Yes		Yes
	89	Yes	Yes	Yes	Yes
Coffee	97	Yes	Yes	Yes	
	105	Yes	Yes		Yes
	110	Yes	Yes	Yes	Yes
	111	Yes	Yes	Yes	Yes
	114	Yes	Yes	Yes	Yes
	116	Yes	Yes	Yes	Yes
	117	Yes	Yes	Yes	Yes
	119	Yes	Yes	Yes	Yes
Grundy	127	Yes	Yes	Yes	Yes
	133	Yes	Yes		Yes
	134		Yes	Yes	Yes
Marion	135	Yes	Yes	Yes	Yes
	143	Yes	Yes	Yes	Yes
	155		Yes		Yes
	158	Yes	Yes	Yes	Yes
	159	Yes	Yes	Yes	Yes
	161		Yes	Yes	Yes
Hamilton	174	Yes	Yes	Yes	Yes
	175	Yes			

Appendix F Project Evaluation, Recommendation, and Prioritization Summary

L RTP Capacity Projects On I-24

Project Evaluation, Recommendation, and Prioritization Summary																	
Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
169	Montgomery	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between TN State Line to SR-76 (Exit 11), 10.6 miles	10.6	MP 0 - Exit 11	1	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2030
170	Montgomery / Robertson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) between SR-76 (Exit 11) to SR-256 (Exit 19) in Robertson County, 8.6 miles	8.6	Exit 11 - Exit 19	1	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2040
173	Davidson	I-24 Additional Lanes	I-24 Additional Lanes (4 to 6) from I-65 to Old Hickory Boulevard (SR-45), Exit 40 - Exit 44, 4.5 miles	4.5	Exit 40 - Exit 44	2	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	2030
177	Davidson	I-24 Additional Lanes	I-24 Additional Lanes from I-24/I-65 junction (S of Fern Ave.) to Trinity Lane. Replace underpass to acc. 6 lanes in each direction. Exit 46 - Exit 87 (I-65), MP 45 for I-24, 1.1 miles	1.1	MP 45 - Exit 46	2	Yes	Yes	Yes	No	Yes	Yes	No	No	No	Yes	2020
181	Hamilton / Georgia	I-24 Additional Lanes	Widen I-24 from 4 to 6 lanes from I-59 to US-27; fix structurally deficient bridge at I-24 and I-124, 10.4 miles	10.4	Exit 169 - Exit 178	3	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2040
183	Hamilton	I-24 Additional Lanes	Widen I-24 from 6 to 8 lanes from US-27 to I-75; fix S. Seminole Dr. structurally deficient bridge over I-24 at top of Missionary Ridge, 5.5 miles	5.5	Exit 178 - Exit 185	3	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	2030

Note:

(1) High Crash Area is defined as a segment of I-24 with a crash rate 2.0 or more times the average Statewide crash rate for interstates.

Proposed Capacity Projects On I-24

Project Evaluation, Recommendation, and Prioritization Summary																	
Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project	MPO Region (1 - Nash., 2 - Chatt., 3 - Chatt.)	Currently a L RTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
315	Robertson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-256 (Exit 19) to SR-49 (Exit 24), 5.3 miles	5.3	Exit 19 - Exit 24	2	No	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	2040
314	Robertson / Cheatham / Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-49 (Exit 24) to US-431/Whites Creek Pike (Exit 35), 10.4 miles	10.4	Exit 24 - Exit 35	2	No	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	2040
313	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-431/Whites Creek Pike (Exit 35) to SR-45/Old Hickory Boulevard (Exit 40), 3.3 miles	3.3	Exit 35 - Exit 40	2	No	Yes	Yes	No	Yes	No	No	Yes	No	Yes	2040
306	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-155/Briley Parkway (Exit 54) to Haywood Lane (Exit 57), 3.4 miles	3.4	Exit 54 - Exit 57	2	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2020
307	Davidson	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, Haywood Lane (Exit 57) to SR-171/Old Hickory Boulevard (Exit 62), 5.4 miles	5.4	Exit 57 - Exit 62	2	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2020
308	Davidson / Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-171/Old Hickory Boulevard (Exit 62) to SR-102/Nissan Drive (Exit 70), 6.8 miles	6.8	Exit 62 - Exit 70	2	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2020
309	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-102/Nissan Drive (Exit 70) to SR-840 (Exit 74), 4.8 miles	4.8	Exit 70 - Exit 74	2	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	2030
310	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 8 to 10, SR-840 (Exit 74) to SR-96 (Exit 78), 3.7 miles	3.7	Exit 74 - Exit 78	2	No	Yes	Yes	No	Yes	No	No	Yes	No	Yes	2040
311	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 6 to 8, SR-96 (Exit 78) to US-231/Shelbyville Highway (Exit 81), 3.3 miles	3.3	Exit 78 - Exit 81	2	No	Yes	Yes	No	Yes	No	No	Yes	No	Yes	2040
312	Rutherford	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-231/Shelbyville Highway (Exit 81) to Epps Mill Road (Exit 89), 7.6 miles	7.6	Exit 81 - Exit 89	2	No	Yes	Yes	No	Yes	No	No	Yes	No	Yes	2040
318	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, US-72/Lee Highway (Exit 152) to SR-27 (Exit 158), 6.7 miles	6.7	Exit 152 - Exit 158	3	No	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	2040
317	Marion	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-27 (Exit 158) to SR-156 (Exit 161), 2.7 miles	2.7	Exit 158 - Exit 161	3	No	Yes	Yes	No	No	No	No	No	No	Yes	2040
316	Marion / Hamilton	I-24 Additional Lanes	Add General Purpose Lanes, 4 to 6, SR-156 (Exit 161) to GA Border (MP 167), 5.6 miles	5.6	Exit 161 - MP 167	3	No	Yes	Yes	No	No	Yes	No	Yes	No	Yes	2040

Note:

(1) High Crash Area is defined as a segment of I-24 with a crash rate 2.0 or more times the average Statewide crash rate for interstates.

L RTP Capacity Projects Off I-24

Project Evaluation, Recommendation, and Prioritization Summary																
Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	MPO Region (1 - Clarks., 2 - Nash., 3 - Chatt.)	Currently a L RTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
206	Montgomery	SR-48 (Trenton Rd)	Widening from 2 to 4 lanes between Hazelwood Road and Tylertown Road, 0.9 miles	0.9	1	Yes	Yes	-	-	-	Yes	No	Yes	No	Yes	2030
203	Montgomery	East-West Connector Phase 1	New 4-Lane road between US-79 (Wilma Rudolph Blvd) and SR-48 (Trenton Rd), 2.5 miles	2.5	1	Yes	Yes	-	-	-	No	No	Yes	No	Yes	2030
205	Montgomery	SR-374/ Warfield Blvd (North Pkwy)	Widening from 2 to 4/5 lanes between Dunbar Cave Road and US-79/SR-13 (Stokes Road), 2.6 miles	2.6	1	Yes	Yes	-	-	-	No	No	Yes	No	Yes	2030
204	Montgomery	SR-374/ Richview Rd/ Warfield Blvd	Widening from 2 to 4 lanes between Memorial Drive and Dunbar Cave Road, 2.0 miles	2.0	1	Yes	Yes	-	-	-	Yes	No	Yes	No	Yes	2030
271	Davidson	Ellington Parkway Widening	Widen Ellington Parkway (SR 6) from 4 to 6 lanes from North 1st Street to Boardmoor Drive, 4.85 miles	4.9	2	Yes	Yes	-	-	-	No	No	Yes	No	Yes	2030
302	Davidson	I-65 Widening	Widen I-65 from 6 to 8 lanes from Harding Place (SR-255) to I-40, 4.3 miles	4.3	2	Yes	Yes	-	-	-	No	No	Yes	No	Yes	2030
303	Davidson	SR-1 (Murfreesboro Road) Widening	Widen SR-1 (Murfreesboro Road) from 4 to 6 lanes from Donelson Pike to Smith Springs Road, 1.2 miles	1.2	2	Yes	Yes	-	-	-	Yes	No	Yes	No	Yes	2030
207	Hamilton	Wauhatchie Pike (parallel to I-24)	Widening Wauhatchie Pike from 2 lanes to 4 lanes from US-11 to US-41/US64, parallel to I-24 just west of Moccasin Bend, 2.8 miles	2.8	2	Yes	Yes	-	-	-	No	No	Yes	No	Yes	2040

Note:

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Proposed Capacity Projects Off I-24

Project Evaluation, Recommendation, and Prioritization Summary																
Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
301	Montgomery / Robertson / Cheatham	US 41A Widening	Widen US 41A from 2 to 4 lanes (where its not currently 4 lanes) from Sango Drive In Clarksville to Jackson Felts Road to SR-249 (New Hope Road), 20.0 miles	20.0	1	No	Yes	-	-	-	No	No	Yes	No	No	N/A
278	Davidson	Brick Church Pike Widening	Road Widening, 2 to 4 lanes Briley Pkwy to Old Hickory Blvd, 3.1 miles	3.1	2	No	Yes	-	-	-	No	No	No	No	No	N/A
283	Davidson	Metro Center River Crossing	New 4-lane road from W Trinity Lane to Rosa L Parks Blvd, 0.6 miles	0.6	2	No	Yes	-	-	-	No	No	Yes	No	No	N/A
153	Davidson / Rutherford	Murfreesboro Pike Widening	Widen Murfreesboro Pike from 4 to 6 lanes to handle traffic diversion from Murfreesboro into Nashville, 28.6 miles	28.6	2	No	Yes	-	-	-	Yes	No	Yes	No	Yes	2030
277	Davidson	Antioch Pike/Una-Antioch Pike Widening	Road Widening, 2 to 4 lanes Haywood Lane to Murfreesboro Pike, 3.7 miles	3.7	2	No	Yes	-	-	-	Yes	No	Yes	No	Yes	2040
287	Davidson	Mt. View Road widening	Road Widening, 2 to 4 lanes from Smith Springs Pkwy to Hickory Hollow Pkwy, 4.4 miles	4.4	2	No	Yes	-	-	-	Yes	No	Yes	No	Yes	2040
289	Davidson	Hickory Hollow Parkway widening	Road Widening, 2 to 4 lanes from Bell Road to Una Antioch Pike, 1.3 miles	1.3	2	No	Yes	-	-	-	Yes	No	No	No	Yes	2040
279	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes Old Hickory Blvd to Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road, 2.3 miles	2.3	2	No	No	-	-	-	No	No	No	No	Yes	2040
280	Davidson	Cane Ridge Road Widening	Road Widening, 2 to 4 lanes from Southeast Parkway (Nolensville Pike to I-24)/Old Franklin Road to Bell Rd, 1.4 miles	1.4	2	No	Yes	-	-	-	Yes	No	No	No	Yes	2040
291	Davidson	Crossings Boulevard Extension	New Road (4-lane divided) from Old Hickory Blvd to Crossings Blvd, 1.6 miles	1.6	2	No	Yes	-	-	-	Yes	No	No	No	Yes	2030
272	Davidson / Rutherford	SR-11 (Nolensville Rd)	Road Widening, 2 to 4 lanes from SR-840 to Burkitt Road, 10.5 miles	10.5	2	No	Yes	-	-	-	Yes	No	Yes	No	Yes	2040
273	Rutherford	Old Nashville Highway Widening Phase I	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase I (US-41/Murfreesboro Pike to Jefferson Pike), 1.1 miles	1.1	2	No	Yes	-	-	-	Yes	No	No	No	Yes	2040
274	Rutherford	Old Nashville Highway Widening Phase II	Road Widening, 2 to 4 lanes, from Sam Ridley Pkwy to Murfreesboro Road, Phase II (Jefferson Pike to SR-266/Sam Ridley Parkway), 1.7 miles	1.7	2	No	Yes	-	-	-	Yes	No	No	No	Yes	2040
284	Rutherford	Almaville Road (SR 102) Widening	Road Widening, 2 to 4 lanes from Franklin Road to I-24, 6.7 miles	6.7	2	No	Yes	-	-	-	No	No	Yes	No	No	N/A
276	Rutherford	Broad Street Widening	Road Widening, 2 to 4 lanes Joe B Jackson Pkwy to Middle Tennessee Blvd, 2.5 miles	2.5	2	No	Yes	-	-	-	No	No	Yes	No	No	N/A
208	Hamilton	Cummings Highway Widening	Ensure 4 lanes on Cummings Hwy (parallel to I-24 at Moccasin Bend) throughout including through two RR underpasses; add median, turn lanes and shoulders, 2.7 miles	2.7	3	No	Yes	-	-	-	No	No	Yes	No	Yes	2030
209	Hamilton	Ringgold Road Widening	Widen Ringgold Road (parallel to I-24) 4 to 6 lanes (Bachman tunnel from 2 to 6 lanes); complete streets upgrade, 2 miles	2.0	3	No	Yes	-	-	-	No	No	Yes	No	No	N/A

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L RTP New and Modified Interstate Access

Project Evaluation, Recommendation, and Prioritization Summary																
Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
178	Davidson	Modify Access at I-24/Hickory Hollow Pkwy Interchange	Modify interchange to allow access to/from Cane Ridge Road at I-24/Hickory Hollow Parkway Interchange	Exit 60	2	Yes	No	No	No	Yes	Yes	No	No	Yes	Yes	2020
172	Rutherford	New I-24/Rocky Fork Road Interchange	Construct a new interchange at I-24 and Rocky Fork Road (MP 68)	MP 68 (Rocky Fork Road)	2	Yes	No	No	No	Yes	Yes	No	Yes	Yes	Yes	2030
180	Hamilton	I-24 at Market & Broad Streets Interchange Modification	Modify Market Street and Broad Street I-24 interchanges to improve safety and operation characteristics	Exit 178	3	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	2020
182	Hamilton	I-24 and I-75 Interchange Modification	Modification of the interchange of I-75 and I-24	Exit 185	3	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	2020
176	Davidson	I-24 at North 1st Street Interchange	Construct HOV ramps to and from I-24 and CBD at North 1st Street, Exit 47	Exit 47	2	Yes	Yes	Yes	Yes	Yes	-	No	No	Yes	Yes	2020
175	Davidson	I-24 at Shelby Avenue Interchange	Construct HOV ramps to and from I-24 and CBD at Shelby Avenue, Exit 49	Exit 49	2	Yes	Yes	Yes	Yes	No	-	No	No	Yes	Yes	2020
174	Davidson	I-24 at Harding Place Drive Interchange	Construct urban diamond interchange (Phase I) on I-24 at Harding Place Drive, Exit 56	Exit 56	2	Yes	Yes	Yes	No	Yes	-	No	No	No	Yes	2020
179	Rutherford	Interchange Improvements at Epps Mill Road and I-24	Widen Epps Mill Road from a 2-Lane to a 3-Lane Cross Section and redesign/improve Exit 89 to better accommodate truck traffic	Exit 89	2	Yes	Yes	Yes	No	Yes	-	No	No	No	Yes	2030

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Proposed New and Modified Interstate Access

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Project Evaluation, Recommendation, and Prioritization Summary										
						Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
286	Davidson	New Interchange in SE Nashville	Add a new interchange at Old Franklin Road (MP 61). (Not included in this project but part of future project: New Road from Nolensville Road to I-24)	MP 61	2	No	No	No	No	Yes	Yes	No	Yes	Yes	Yes	2030
118	Rutherford	New Interchange in Murfreesboro	Add new interchange in Murfreesboro (between Exit 74 and 89) - Modeled at Elam Road (MP 85)	MP 85	2	No	No	No	No	Yes	Yes	No	No	Yes	Yes	2040
146	Coffee	New Interchange between Exit 105 - Exit 110	Add new interchange in Manchester between Exit 105 and exit 110 - Modeled at Fredonia Road (MP 109)	MP 109	2	No	No	No	No	Yes	No	No	No	Yes	No	N/A
253	Davidson	Exit 47 - Exit 48 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 47-Exit 47A-Exit 48 (Downtown Nashville) EB and WB to remove weaving sections from the mainline and to remove exit points	Exit 47 - Exit 48	2	No	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	2020
254	Rutherford	Exit 74 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 74A-74B (SR 840) EB and WB to remove weaving section from the mainline and to remove exit points	Exit 74	2	No	Yes	Yes	No	Yes	No	No	No	No	Yes	2040
255	Rutherford	Exit 78 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 78A-78B (SR 96) EB and WB to remove exit points	Exit 78	2	No	Yes	Yes	No	Yes	Yes	No	No	No	Yes	2040
256	Rutherford	Exit 80 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 80 (SR 99) EB and WB to remove entrance points	Exit 80	2	No	Yes	Yes	No	Yes	No	No	No	No	Yes	2040
94	Coffee	Exit 111 Upgrade to Standard Interchange	Modify the I-24 interchange at SR 55 (Exit 111) to convert to diamond interchange and remove loop ramp	Exit 111	2	No	No	Yes	No	Yes	Yes	Yes	No	No	Yes	2020
257	Hamilton	Exit 180 Interchange Modifications - New C-D Roads	Implement New Collector-Distributor Roads at Exit 180B-Exit 180 (Rossville Blvd) EB and WB to remove weaving section from the mainline and to remove exit points	Exit 180	3	No	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	2020
211	Davidson	I-24 at Bell Road Interchange Modification	Reconstruct the Interchange I-24 at Bell Road and construct bike lanes and sidewalks along Bell Road in the vicinity of the interchange	Exit 59	2	No	Yes	Yes	No	Yes	-	No	No	Yes	No	N/A
258	Hamilton	Exit 183B - Exit 184 Interchange Modifications	Redesign ramp sequencing and lengths from S. Germantown Road to McBrien Road (currently Exit 183B-Exit 183A-Exit 184) to remove weaving sections and to remove exit points	Exit 183B - Exit 184	3	No	Yes	Yes	Yes	Yes	-	No	Yes	Yes	Yes	2020

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Proposed Ramp Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Project Evaluation, Recommendation, and Prioritization Summary											
						Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?	
244	Montgomery	Montgomery County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 1 (2 ramps), Exit 4 (2), Exit 8 (2), Exit 11 (2)	Exit 1 - Exit 11	1	No	Yes	Yes	No	No	-	No	No	No	No	Yes	2030
245	Robertson	Robertson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 19 (2 ramps), Exit 24 (2)	Exit 19 - Exit 24	2	No	Yes	Yes	Yes	No	-	No	No	No	No	Yes	2020
246	Cheatham	Cheatham County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 31 (2 ramps)	Exit 31	1	No	Yes	Yes	No	No	-	Yes	No	No	No	Yes	2040
247	Davidson	Davidson County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 35 (2 ramps), Exit 40 (2), Exit 57 (1), Exit 59 (4), Exit 60 (1)	Exit 35 - Exit 60	2	No	Yes	Yes	No	No	-	No	No	No	No	Yes	2020
248	Rutherford	Rutherford County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 66 (1 ramp), Exit 70 (4), Exit 81 (2), Exit 84 (2), Exit 89 (4)	Exit 66 - Exit 89	2	No	Yes	Yes	No	No	-	No	No	No	No	Yes	2040
249	Coffee	Coffee County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 97 (3 ramps), Exit 105 (3), Exit 110 (4), Exit 111 (4), Exit 114 (4), MP 116-Weigh Station (4), Exit 117 (4), MP 119-Truck Rest Area (4)	Exit 97 - MP 119	2	No	Yes	Yes	No	No	-	No	Yes	No	No	Yes	2020
250	Grundy	Grundy County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 127 (4 ramps), MP 133-Rest Area (3), Exit 134 (3)	Exit 127 - Exit 134	3	No	Yes	Yes	Yes	No	-	No	No	No	No	Yes	2020
251	Marion	Marion County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 135 (4 ramps), Exit 143 (4), Exit 155 (2), Exit 158 (4), MP 159-Welcome Center (4), Exit 161 (3)	Exit 135 - Exit 161	3	No	Yes	Yes	No	No	-	No	No	No	No	Yes	2040
252	Hamilton	Hamilton County Ramp Improvements	Lengthen/Redesign Short Ramps at Exit 174 (4 ramps), Exit 175 (1)	Exit 174 - Exit 175	3	No	Yes	Yes	No	No	-	No	No	No	No	Yes	2040

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Proposed ITS Projects

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Project Evaluation, Recommendation, and Prioritization Summary										
						Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
140	All Counties	Install "Dial *511" Signs	Install "Dial *511" signs throughout corridor	Entire I-24 Corridor	1	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
166	Robertson	MP 23 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 23 (EB) (approximately)	MP 23	2	No	Yes	Yes	No	Yes	-	Yes	No	No	Yes	2020
167	Robertson	MP 25 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 25 (WB) (approximately)	MP 25	2	No	Yes	Yes	No	Yes	-	Yes	No	No	Yes	2020
168	Davidson / Rutherford	SR 1 Arterial ITS	Install arterial ITS instrumentation and communications on SR 1 between I-440 interchange and SR 96 (Murfreesboro)	Exit 52 - Exit 78	2	No	Yes	Yes	-	Yes	-	No	No	No	Yes	2020
319	Davidson / Rutherford	Exit 66 - Exit 56 Ramp Metering	Install ramp metering components and system software from Exit 66 to Exit 56 (8 ramps)	Exit 66 - Exit 56	2	No	Yes	Yes	No	Yes	-	Yes	No	No	Yes	2020
320	Rutherford	Exit 81 - Exit 76 Ramp Metering	Install ramp metering components and system software from Exit 81 to Exit 76	Exit 81 - Exit 76	2	No	Yes	Yes	No	Yes	-	Yes	No	No	Yes	2020
164	Marion / Hamilton	Exit 158 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 158 to Exit 174	Exit 158 - Exit 174	3	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
165	Marion	MP 166 DMS/CCTV	Install dynamic message sign (DMS) with closed-circuit television (CCTV) and communications at MP 166 (WB) (approximately)	MP 166	3	No	Yes	Yes	No	Yes	-	Yes	No	No	Yes	2020
321	Hamilton	Exit 174 - Exit 175 Ramp Metering	Install ramp metering components and system software from Exit 174 to Exit 175	Exit 174 - Exit 175	3	No	Yes	Yes	No	Yes	-	Yes	No	No	Yes	2020
322	Hamilton	Exit 185 - Exit 174 VSL with RWIS	Install variable speed limit (VSL) signing with road weather information system (RWIS) and system software from Exit 185 to Exit 174	Exit 185 - Exit 174	3	No	No	Yes	Yes	Yes	-	Yes	No	No	Yes	2020
323	Hamilton	Exit 184 - Exit 183 Ramp Metering	Install ramp metering components and system software from Exit 184 to Exit 183	Exit 184 - Exit 183	3	No	Yes	Yes	Yes	Yes	-	Yes	No	No	Yes	2020

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Proposed Truck Lanes

Project Evaluation, Recommendation, and Prioritization Summary																	
Project ID	County of Project	Name of Project	Description of Project	Length of Project (miles)	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3 - Chatt.)	Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
212	Cheatham	Cheatham County - Extend Existing EB Truck Lane	Extend existing EB Truck Lane on I-24 in Cheatham County, Log Mile (2) 0.05 to 0.569 (MP 28)	0.5	MP 28 (Cheatham County Log Mile (2) 0.05 - 0.569)	2	No	Yes	Yes	No	Yes	-	No	No	No	Yes	2020
214	Grundy	Grundy County New EB Truck Lane	Add new EB Truck Lane on I-24 in Grundy County, Log Mile 3.40 to 6.55 (MP 130 to MP 133)	3.2	MP 130 - MP 133 (Grundy County Log Mile 3.40 - 6.55)	3	No	Yes	Yes	No	Yes	-	No	No	No	Yes	2020
324	Marion	Marion County New EB Truck Lane	Add new EB Truck Lane on I-24 in Marion County, Log Mile 30.50 to 32.10 (MP 165 to MP 167)	1.6	MP 165 - MP 167 (Marion County Log Mile 30.50 - 32.10)	3	No	Yes	Yes	No	Yes	-	No	No	No	Yes	2020

Note:

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Proposed Bridge Improvements

Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Project Evaluation, Recommendation, and Prioritization Summary										
						Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
220	Montgomery	Montgomery County Bridge Railing Replacements	Replace pipe bridge railings for 6 bridges in Montgomery County between MP 3 and MP 15 which do not conform to current Report 350 crash test standards	MP 3 - MP 15	1	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
221	Robertson	Robertson County Bridge Railing Replacements	Replace pipe bridge railings for 2 bridges in Robertson County between MP 27 and MP 28 which do not conform to current Report 350 crash test standards	MP 27 - MP 28	2	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
222	Cheatham	Cheatham County Bridge Railing Replacement	Replace pipe bridge railings for 1 bridge in Cheatham County at MP 29 which does not conform to current Report 350 crash test standards	MP 29	1	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
223	Davidson	Davidson County Bridge Railing Replacements	Replace pipe bridge railings for 8 bridges in Davidson County between MP 34 and MP 45 which do not conform to current Report 350 crash test standards	MP 34 - MP 45	2	No	No	Yes	Yes	Yes	-	Yes	No	No	Yes	2020
240	Davidson	MP 40 Bridge Rehabilitation	Davidson County Log Mile 8.51 (MP 40), I-24 RL (EB) at Old Hickory Boulevard, BIN# 19I00240071. Sufficiency Rating is 70.0. Rehabilitate existing bridge.	MP 40 (Davidson County Log Mile 8.51)	2	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
241	Davidson	MP 44 Bridge Rehabilitation	Davidson County Log Mile 11.86 (MP 44), I-24 RL (EB) at Ewing Drive, BIN# 19I00240081. Sufficiency Rating is 62.6. Rehabilitate existing bridge.	MP 44 (Davidson County Log Mile 11.86)	2	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
243	Davidson	MP 52 Bridge Rehabilitation	Davidson County Log Mile for I-40 is 21.58 (MP 52 for I-24), I-40 Structure 5B at I-24, BIN# 19I00240067. Sufficiency Rating is 67.0. Rehabilitate existing bridge.	MP 52 for I-24 (Davidson County Log Mile for I-40 is 21.58)	2	No	No	Yes	Yes	Yes	-	Yes	No	No	Yes	2020
224	Coffee	Coffee County Bridge Railing Replacements	Replace pipe bridge railings for 4 bridges in Coffee County between MP 97 and MP 100 which do not conform to current Report 350 crash test standards	MP 97 - MP 100	2	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
237	Grundy	MP 127 Bridge Modification	Grundy County Log Mile 0.55 (MP 127), US 64/SR 50 at I-24, BIN# 31I00240001. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	MP 127 (Grundy County Log Mile 0.55)	3	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
238	Marion	MP 135 Bridge Modification	Marion County Log Mile 0.77 (MP 135), Trussell Road at I-24, BIN# 58I00240063. Vertical clearance is 15.94'. Raise bridge or lower profile to restore minimum clearance.	MP 135 (Marion County Log Mile 0.77)	3	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020

Note:

(1) High Crash Area is defined as a segment of I-24 with a crash rate 2.0 or more times the average Statewide crash rate for interstates.

Proposed Rock Fall/Slide Mitigation Improvements

					Project Evaluation, Recommendation, and Prioritization Summary											
Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
227	Robertson / Cheatham / Davidson / Rutherford / Bedford	West I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 15 locations between MP 27 and MP 97	MP 27 - MP 97	2	No	No	Yes	No	Yes	-	No	No	No	Yes	2020
228	Coffee / Grundy / Marion / Hamilton	East I-24 Geotechnical Projects	Perform detailed geotechnical review of rock slide areas and develop repair program for up to 12 locations between MP 97 and MP 185	MP 97 - MP 185	3	No	No	Yes	No	Yes	-	No	No	No	Yes	2020
226	Grundy	West Monteagle Mountain Geotechnical Projects	West of Monteagle MP 131 to MP 133 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	MP 131 - MP 133	3	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
225	Marion	East Monteagle Mountain Geotechnical Projects	East of Monteagle MP 135 to MP 140 - Repair rock slides and rehabilitate existing/previous rock anchor and gunite repair to the weathering shale layers in the vertical rock cuts	MP 135 - MP 140	3	No	No	Yes	No	Yes	-	No	No	No	Yes	2020

Note:

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Proposed Miscellaneous Projects

Project Evaluation, Recommendation, and Prioritization Summary																
Project ID	County of Project	Name of Project	Description of Project	Limits of Project	MPO Region (1 - Clarks., 2 - Nash., 3- Chatt.)	Currently a LRTP Project?	Reduces Delay on I-24?	Improves Safety on I-24?	In a High-Crash Area? (1)	Low/Mod Environ. Impacts?	Favorable B-C Ratio (>0.7)?	Low Cost Project (<\$5M)?	Econ. Imp. (Cost >\$40M)?	Supports Local Econ. Develop.?	Include in I-24 Plan?	Build Year?
298	Montgomery	Exit 1 Ramp Termini Improvement	Modify right-turn at termini on Exit 1 southbound exit ramp.	Exit 1	1	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
184	Coffee	Exit 111 Drainage Correction	Correction for I-24 westbound sheet flow during rain. Rain draining across three westbound lanes toward median.	Exit 111 - Exit 110	2	No	No	Yes	No	Yes	-	No	No	No	Yes	2020
233	Grundy	MP 132 Barrier Improvement	MP 132, Replace cable barrier in narrow bifurcated median section with concrete barrier	MP 132	3	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
234	Marion	MP 160 Barrier Improvement	MP 160, Extend barrier on the west side of the Tennessee River bridge	MP 160	3	No	No	Yes	No	Yes	-	Yes	No	No	Yes	2020
232	Hamilton	MP 173 - MP 185 Barrier Improvement	MP 173 to MP 185, Add roadway barriers to replace curb and gutter	MP 173 - MP 185	3	No	No	Yes	Yes	Yes	-	Yes	No	No	Yes	2020
231	Hamilton	MP 173 - MP 185 Lighting Improvements	MP 173 to MP 185, Eliminate lighting in clear zone and upgrade continuous lighting	MP 173 - MP 185	3	No	No	Yes	Yes	Yes	-	No	No	No	Yes	2020
229	Hamilton	MP 173 - MP 185 Pavement Improvements	MP 173 to MP 185, Upgrade pavement surface for improved drainage and friction factors	MP 173 - MP 185	3	No	No	Yes	Yes	Yes	-	No	No	No	Yes	2020
230	Hamilton	MP 173 - MP 185 Signing and Marking Improvements	MP 173 to MP 185, Upgrade signing and marking	MP 173 - MP 185	3	No	No	Yes	Yes	Yes	-	No	No	No	Yes	2020
202	Hamilton	I-24 Missionary Ridge Glare Screen Improvement	Add glare screens on I-24 on either side of Missionary Ridge	Exit 181 - Exit 183	3	No	No	Yes	Yes	Yes	-	Yes	No	No	Yes	2020

Note:

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