Technical Memorandum

To: Wasatch Front Central Corridor Study Management Team

From: Wasatch Front Central Corridor Study (WFCCS) Technical Team

Date: May 2017

Subject: Economic Evaluation of Long-Term Investment Packages

Executive Summary

This technical memorandum summarizes the results of the economic evaluation of the three WFCCS scenarios. The economic evaluation included estimates of benefit-cost ratios, and changes in gross regional product, personal income, and employment, as well as fiscal sustainability. The results for the three WFCCS scenarios for these considerations are shown in the table below. The following pages provide more detailed information on the analysis.

Evaluation		Scenario 1	Scenario 2	Scenario 3
Benefit/Cost Ratio	Ranking	Best	Medium	Worst
	Reason	Lowest cost of all scenarios	Highest benefits, but with expensive infrastructure	Lower benefits due to increased VMT and travel time, with highest infrastructure costs
Gross Regional Product	Ranking	Worst	Best	Medium
	Reason	Fewest construction jobs, and smaller transportation efficiency impact due to fewer improvement projects	Large impact from construction jobs, as well as high positive impacts from improved transportation efficiencies	Highest impact from construction jobs, but lowest impact from improved transportation efficiencies
Personal Income	Ranking	Worst	Best	Medium
	Reason	Fewest jobs created and relatively small improvement in worker productivity	Fewer jobs created than in Scenario 3, but higher paying	Most jobs created, but lower paying

Evaluation		Scenario 1	Scenario 2	Scenario 3
Employment	Ranking	Worst	Medium	Best
	Reason	Fewest construction jobs	Fewer construction jobs than Scenario 3, but higher levels of transportation efficiencies increase GRP and personal income, thereby adding employment opportunities	High numbers of construction jobs in this build-centric scenario

Introduction

This technical memorandum reports the results of evaluating the long-term investment packages for the Wasatch Front Central Corridor Study (WFCCS). The memorandum includes results from three separate evaluations. The first evaluation is a **benefit-cost analysis (BCA)** of the long-term investment packages. This evaluation compares estimates of monetized benefits to investment costs to develop measures of economic return, such as a benefit-cost ratio. Monetized benefits were derived from changes in travel conditions predicted by the WFCCS transportation analysis, while investment costs were based on cost estimates for individual transportation project elements that make up each investment package. The second evaluation is an **economic impact analysis (EIA)** to understand the long-term implications of the investment packages on the regional economy. This evaluation summarizes impacts in terms of gross regional product (GRP), jobs, and personal income. The third evaluation is a **financial sustainability analysis** to compare the costs of the investment packages with available agency revenues. This evaluation provides a picture of the region's ability to fund the investment packages, while maintaining a state of good repair for infrastructure.

Following this introduction, this memorandum is organized into the following sections:

- Project Overview;
- Long-Term Investment Packages;
- Benefit-Cost Analysis (BCA);
- Economic Impact Analysis (EIA); and
- Fiscal Sustainability Analysis.

The last three sections describe the methodology, key assumptions, data, and results for the three separate evaluations. Details of the analyses and results are provided in appendices.

Project Overview

The WFCCS assessed solutions to accommodate future travel in the I-15 study corridor. The study area is approximately 45-miles long and four-miles wide along I-15 from southern Davis County to northern Utah County. The majority of the state's population as well as roadway traffic and transit ridership are located within the study area. Utah's population is projected to double by 2050, which will profoundly increase travel demand in the study area. Significant travel demand growth will be difficult to accommodate in the study corridor through conventional methods that rely on capacity expansion due to geographic and environmental constraints plus community interest in expanding travel choices and improving travel reliability. With these challenges in mind, the WFCCS focused on innovative solutions that meet the goals identified by the WFCCS Management Team: improve safety, increase person throughput, improve travel time reliability, increase accessibility to jobs, improve air quality, improve economic outcomes, reduce household transportation costs, and improve mode balance.

WFCCS is a collaborative effort involving the Utah Department of Transportation (UDOT), Utah Transit Authority (UTA), Wasatch Front Regional Council (WFRC), and Mountainland Association of Governments (MAG). All four agencies are part of the Management Team and are assisted by a study team. The four agencies, in collaboration with area stakeholders, are recommending solutions that incorporate multiple modes of transportation and are compatible with emerging technologies through 2050. Solutions include improved connectivity between modes and a variety of choices and strategies for getting around. These solutions will be integrated into the WFRC and MAG 2019-2050 Regional Transportation Plans (RTPs), which are part of Utah's Unified Transportation Plan.[1]

Long-Term Investment Packages

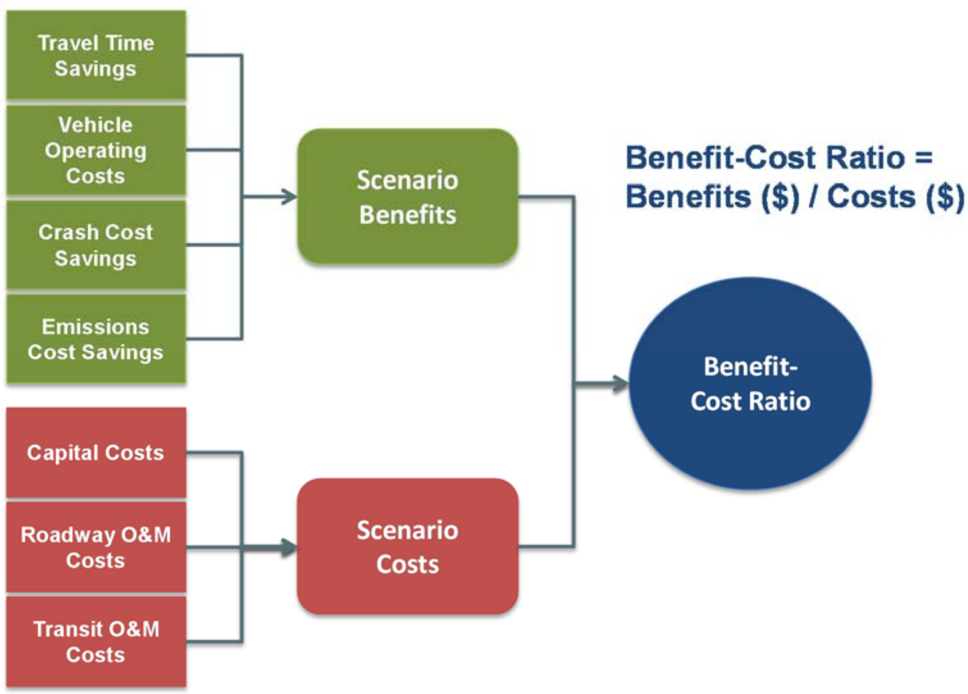
Three long-term investment packages (WFCCS scenarios) containing different sets of project improvements were assessed during the project planning phases. **Scenario 1** balances managing existing infrastructure more efficiently with building more infrastructure. **Scenario 2** tightly manages the existing transportation network to use available travel space and seats more efficiently. **Scenario 3** invests significant funding into building more infrastructure to meet projected travel demands. More information on the contents of the three WFCCS scenarios can be found in the *Initial Scenarios Development and Screening Technical Memorandum* (October 2016).

[1] Wasatch Front Central Corridor Study Project Website, www.wfccstudy.org

Benefit-Cost Analysis (BCA)

BCA is a systematic approach to comparing the benefits and costs of investments throughout their lifecycles. The benefit-cost evaluations for the WFCCS compare conditions in a "business as usual" scenario (Scenario 0) to the WFCCS scenarios. The BCA puts multiple measures of effectiveness into a single measure (benefit-cost ratio) to assess investment decisions. As presented in Exhibit 1, the benefit-cost ratio compares the benefits generated in each scenario to the capital and operating and maintenance (O&M) expenditures. The benefit-cost ratio is a key measure for comparing the cost effectiveness of the WFCCS scenarios. The BCA supports the WFCCS by informing investment decisions to improve economic outcomes and reduce direct household transportation costs in the study area.

Exhibit 1: Benefit-Cost Ratio Calculation



Scenario Costs

The BCA includes estimates for three types of costs over a 2025-2050 analysis period. The time period starts in 2025 because all projects were assumed to start in Phase 2 of the current RTP cycle, which is from 2025-2034. These costs are listed below and explained in further detail in the sections that follow:

- Capital Costs;
- Roadway Operations and Maintenance (O&M) Costs; and
- Transit O&M Costs.

Capital Costs

The capital costs associated with each WFCCS scenario include the upfront design, engineering, and construction costs. Each WFCCS scenario contains a different set of roadway, biking/pedestrian, and transit projects. These projects are assumed to be constructed in one of three phases in the analysis period:

- Phase 2 (2025 - 2034);
- Phase 3 (2035 - 2040); and
- The "Unfunded" or "Vision" phase in the 2015 RTP (2041 - 2050).

Phase 1 is included in Utah's Unified Transportation Plan and occurs before the first WFCCS investments. The approximate phasing of the projects was determined in discussions with the WFCCS study team. More detailed information on the capital cost assumptions is available in Appendix A and Appendix B (Scenario Costs Part 1 and Part 2).

Exhibit 2 summarizes the project elements contained in each WFCCS scenario. Project elements in red font and denoted by asterisks represent improvements for which capital costs were estimated and included in the BCA. The methodology used to estimate costs for these project elements is detailed in the *Capital Cost Assumptions Memorandum* in Appendix B. The capital costs of other project elements are considered minor and are not included in the BCA.

Exhibit 2: Project Elements by WFCCS Scenario

	Project Element	Scenario 1	Scenario 2	Scenario 3
Roadway	Barrier separated HOV, toll, and express bus lanes on I-15*	✓	✓	
	I-15 elevated*			✓
	Expanded C/D system along I-15*			✓
	HOV/HOT lane conversions on major arterials	✓		
	New HOV/BRT lanes with grade separated intersections*			✓
	"Freight-encouraged lanes" on I-15		✓	
	Increased access consolidation/management on select arterials		✓	
	Fully priced freeway lanes		✓	
	Reversible lanes on I-15 in Davis County*			✓
Biking /	"Grid 2.0" - refine the surface street grid network*	✓	✓	

	Project Element	Scenario 1	Scenario 2	Scenario 3
	Implement planned active transportation networks*	✓		✓
	"Cycle super highway" network*	✓		✓
	Mobility Hubs*			✓
	Mobility-as-a-service centers	✓		✓
	Buffered bike lanes/cycle tracks on selected arterials			✓
Transit	"Grid 3.0" - refine the surface street grid network*		✓	
	Doubletrack/electrify FrontRunner commuter rail*		✓	✓
	Add infill rail transit stations*			✓
	Reduce barriers to carpooling and transit use through choice architecture TDM strategy	✓		
	Vision Zero	✓		
	Prioritize transportation projects in WC2040 Vision nodes	✓		
	Transit pricing	✓	✓	
	Extend station platforms to accommodate longer consists		✓	
	Aggressive TDM strategy - individual elements to be determined		✓	
	Increased transit frequency during peak period*		✓	
	New arterial HOV and BRT lanes with grade-separated intersections			✓

**Capital or operating costs estimated and included in the BCA*

Roadway O&M Costs

Roadway O&M costs are associated with maintaining new roadways and bike paths, including pavement resurfacing and annual maintenance. The study team estimated roadway maintenance, lifecycle rehabilitation, and bike path maintenance costs associated with each WFCCS scenario. These estimates were developed using specific project information such as the length and width of roadway added. The length of the roadway improvement was applied to RTP lifecycle cost per mile factors obtained from UDOT to estimate total maintenance costs. Some projects, such as mobility hubs and infill stations, lacked readily available unit cost factors and were not included in the overall estimates. Maintenance costs were increased over the analysis period based on the phasing of capital cost expenditures. Additional information on the assumptions used to estimate Roadway O&M costs is available in Appendix A and Appendix B.

Transit O&M Costs

Transit O&M costs are the incremental costs (e.g., employee wages, materials and supplies, and other operating expenses) of operating and maintaining new transit services. More than one WFCCS scenario increases transit service frequency with the construction of bus rapid transit (BRT) lines and increased Frontrunner rail capacity. The study team used travel demand model projections to estimate vehicle revenue-miles by transit mode for each WFCCS scenario. The operating cost per revenue mile was derived from the 2014 Utah Transit Authority (UTA) Agency Profile available in the National Transit Database. The incremental revenue mileage in each WFCCS scenario was compared to Scenario 0. The difference in revenue-miles was monetized by transit mode using the corresponding operating cost per mile. Transit O&M costs were extrapolated over the analysis period according to the phasing of transit projects in each WFCCS scenario. Appendix A presents the assumptions used to estimate Transit O&M costs in more detail.

Travel Demand Model Outputs

The WFCCS study team ran five travel demand model scenarios:

- **2014 Base Year –** Base Year of Model;
- **2050 Scenario 0 –** "Business as Usual" No Build Horizon Year (all relevant Vision projects included);
- **2050 Scenario 1 –** Horizon Year for Scenario 1 (several Vision projects excluded);
- **2050 Scenario 2 –** Horizon Year for Scenario 2 (some Vision projects included); and
- **2050 Scenario 3 –** Horizon Year for Scenario 3 (some Vision projects included).

The base year represents current conditions according to 2014 data. The "business as usual" scenario (Scenario 0) is a representation of the study area in 2050, presuming selected Vision projects from the RTP are built (all Vision transit projects in the corridor, all Vision highway projects in the corridor, and major north-south highway capacity improvements such Bangerter Highway interchange upgrades and Mountain View Corridor widening). Three WFCCS scenarios (i.e., Scenario 1, Scenario 2, and Scenario 3) were analyzed using a representation of the region with project improvements implemented by 2050. The travel demand model outputs were the basic inputs to estimating the benefits generated by each WFCCS scenario with the exception of benefits associated with crash reduction strategies.

Travel Demand Model Data

The BCA used several outputs from the travel demand model to estimate project benefits for passenger and freight vehicles as well as various modes of transit. The output data needed for the BCA are summarized below.

Passenger and Freight Vehicles

To estimate passenger and freight vehicle benefits, the BCA used three key outputs including vehicles-miles traveled (VMT) by speed bin, vehicle-hours traveled (VHT) by speed bin, and the number of person-trips. These outputs were reported separately by vehicle type (i.e., auto or truck) and extrapolated over the entire analysis period.

Transit

Transit benefits were estimated for each of the following transit modes in the study area:

- Local Bus;
- BRT;
- Express Bus;
- Light Rail (TRAX); and
- Commuter Rail (FrontRunner).

Transit benefits were estimated by mode using vehicle revenue-miles, vehicle revenue-hours, passenger-hours traveled (PHT), and the number of person trips.

BCA Inputs

The travel demand model included the potential for induced travel when estimating the impacts of the WFCCS scenarios compared to the "business as usual" scenario, Scenario 0. For the BCA analysis, it was assumed that the changes in travel observed on the transportation network were a result of the transportation investments in each scenario; however, changes in travel can also be affected by underlying population or employment patterns, and these varied in each scenario. For the BCA, benefits were calculated only for trips made as part of business as usual. Induced trips were allowed to impact travel conditions (i.e., increased congestion and lower speeds compared to no induced demand), but the benefits of the induced trips were not included. To estimate scenario benefits, the travel demand model outputs were adjusted to represent an equivalent number of person trips for auto, truck, and transit users. This approach ensures that benefits are included for the same group of existing travelers. Overall scenario benefits would be higher if induced travel benefits were included, but the relative ranking of the scenarios would not change. The factors used to adjust the data are presented in Appendix C, Travel Demand Model Outputs.

In addition, a 2014 'Build year' was generated for each WFCCS scenario using the 2014 base year outputs and the percentage difference between Scenario 0 and the WFCCS scenarios in 2050. The travel demand model outputs for Scenario 0 and each WFCCS scenario were interpolated between the generated 2014 'Build year' and the 2050 horizon year for Scenario 0. Since the specific year of construction within the RTP phases was unknown, project benefits were assumed to ramp up over the analysis period proportionally with the capital costs in each scenario.

Essentially, additional benefits were delivered as additional money was spent on infrastructure projects. More information regarding these assumptions is available in Appendix C.

Scenario Benefits

The outputs of the travel demand model were used to derive the economic benefits of each WFCCS scenario. Benefits were estimated separately for passenger and freight vehicles and various transit modes. Four categories of benefits were considered for the BCA:

- Travel Time Savings;
- Vehicle Operating Cost Savings;
- Crash Cost Savings (Safety); and
- Emissions Cost Savings.

The data and methodology used to estimate benefits for each of these categories is summarized in the following sections.

Travel Time Savings

Travel time savings are the benefits from reduced travel times as a result of project improvements.

Passenger and Freight Vehicles

Travel time savings were monetized using the difference in VHT between Scenario 0 and the WFCCS scenarios, the average vehicle occupancy for passenger and freight vehicles, and the value of time derived from regional wage rates. The value of time was calculated using United States Department of Transportation (USDOT) guidance and US Census and Bureau of Labor Statistics (BLS) data on median household incomes and hourly wage rates for freight vehicle drivers. More information on these assumptions is included in Appendix D, Scenario Benefits. The key driver of vehicle travel time savings in each WFCCS scenario is VHT.

Transit

Travel time savings for transit users were monetized using the differences in PHT between Scenario 0 and the WFCCS scenarios by transit mode and the value of time of transit users. These assumptions are documented and explained in greater detail in Appendix D.

Vehicle Operating Costs

Vehicle Operating Costs are the benefits to roadway users from savings in fuel consumption and other reductions in out-of-pocket costs that result from project improvements.

Passenger and Freight Vehicles

Vehicle operating costs were estimated separately for fuel and non-fuel operating costs. Fuel costs are related to fuel consumption from vehicle use. Non-fuel costs include distance-based vehicle maintenance and depreciation. Fuel costs were estimated using fuel consumption rates by speed bin and vehicle type using averages from the California Air Resources Board (CARB)

EMFAC model. This model was used rather than Environmental Protection Agency (EPA) Motor Vehicle Emissions Simulator (MOVES) model because EMFAC is able to provide fuel consumption by vehicle speed. The same fuel consumption rates were used for all years of the analysis, because EMFAC 2011 did show substantial differences in fuel consumption rates over time. The new EMFAC 2014 shows increasing vehicle fuel efficiency, but this information was not available in time for the analysis. Had increased fuel efficiency been taken into account, the fuel-related benefits for all three WFCCS scenarios would be slightly lower in the later years of the analysis. However, this would not change the relative ranking of the scenarios.

Fuel consumption was monetized using the cost per gallon for gasoline and diesel in Utah. Non-fuel operating costs were estimated using a per mile value from the American Automobile Association (AAA) for autos and trucks. The fuel and non-fuel operating costs were calculated based on VMT by vehicle type in each WFCCS scenario. More information on these assumptions is available in Appendix D. The key drivers of vehicle operating costs in each WFCCS scenario are VMT and vehicle speed changes.

Transit

The treatment of transit operating costs is described in the previous section detailing the estimation of Transit O&M Costs. These are a cost to the transit agency rather than a user benefit.

Crash Cost Savings (Safety)

Crash cost savings are benefits from safety improvements. They were quantified using the number of crashes avoided as a result of the project improvements.

Passenger and Freight Vehicles

A high-level safety analysis that calculates anticipated crash reductions due to project improvements was conducted for the WFCCS scenarios. Crash reductions were estimated based on speed changes, additional lighting, and pedestrian and other improvements in the study area. The crash reductions were estimated using the crash rates by severity, crash reduction factors, and VMT in each WFCCS scenario compared to Scenario 0. The number of crashes avoided was monetized using values provided by USDOT. More information on these assumptions is available in Appendix D, and a more detailed discussion of the safety analysis is available in the *Evaluation of Investment Scenarios Technical Memorandum* (March 2017). The key drivers of crash cost savings in the BCA are VMT and the crash reduction factors used for each WFCCS scenario. Higher VMT results in more exposure to potential crashes, resulting in lower crash cost savings.

Transit

Transit crash cost savings are calculated by transit mode and are a function of vehicle revenue-miles, transit collision rates, and costs per collision. Vehicle revenue-miles were estimated from travel demand model outputs. Transit collision rates by mode were derived from USDOT Transportation Statistics Annual Report. The costs per transit collision are from Federal Transit

Administration (FTA) Transit Safety and Security Statistics. These assumptions are documented and presented in Appendix D.

Emissions Cost Savings

Emissions cost savings are the benefits of reduced vehicle emissions in the study area.

Passenger and Freight Vehicles

The emissions for passenger and freight vehicles were determined based on vehicle speeds and VMT from the travel demand model. Emissions rates were estimated using the Environmental Protection Agency (EPA) Motor Vehicle Emissions Simulator (MOVES) model based on characteristics for Salt Lake County, Utah. Vehicle emissions were monetized throughout the analysis period using values per US ton as specified by USDOT. The key drivers for emissions cost savings from the investment scenarios are VMT and speed changes altering vehicle emissions rates in each WFCCS scenario. Appendix D contains additional documentation on the calculation of emissions cost savings.

Transit

Transit emissions rates were estimated using vehicle revenue-miles by mode. Emissions rates for buses come from MOVES, while the emissions rates for rail transit vehicles come from CARB research. The emissions estimated are monetized using the values per US ton specified by USDOT.

Benefit-Cost Results

The BCA includes benefits from 2025 to 2050. Not all projects included in the scenarios will be fully operational when the benefits start in 2025. So, project benefits were staged in proportionally with project expenditures throughout the analysis period. Benefits were estimated for passenger and freight vehicles and transit. Bike and pedestrian benefits were not estimated in this analysis. In the BCA, all project benefits and costs are reported in 2016 dollars and with an annual discount rate of 4 percent.

Scenario Costs

Exhibit 3 summarizes the costs for each WFCCS scenario compared to the "business as usual" scenario, Scenario 0. Overall costs for each WFCCS scenario are presented in Exhibit 3. Scenario 3 has the highest total cost of all three scenarios at $3.3 billion, with a majority of the costs coming from capital expenditures. Scenario 2 has the second highest total cost at $3.0 billion, which is attributed to the transit O&M costs associated with increased transit service frequency. Scenario 1 has the lowest cost of all three scenarios at $0.9 billion. There are transit O&M cost savings in Scenario 1 (shown as a negative cost in Exhibit 3) because all WFCCS scenario costs are compared relative to Scenario 0. Some of the transit projects to be constructed in Scenario 0 are not included in Scenario 1.

Exhibit 3: WFCCS Discounted Project Costs ($ Millions)

Project Costs	Scenario 1	Scenario 2	Scenario 3
Capital Costs	$1,062.9	$1,614.4	$2,977.8
Roadway O&M Costs	$6.9	$5.8	$9.5
Transit O&M Costs	-$159.5	$1,349.2	$339.3
Total Costs	**$910.2**	**$2,969.5**	**$3,326.5**

Scenario Benefits

Exhibit 4 shows the benefits generated in each WFCCS scenario. Travel time savings are the largest of all benefit categories across all scenarios. Scenario 2 has the biggest travel time savings with $6.1 billion over the analysis period, primarily due to pricing and management of all I-15 lanes in the peak period and direction. There are also substantial vehicle operating cost savings in Scenario 2, due primarily to the decrease in VMT as a result of increased transit service. Scenario 1 employs many Vision Zero strategies to improve safety outcomes, resulting in the highest crash cost savings of the WFCCS scenarios. Emissions cost savings make up a relatively small portion of total benefits in all three scenarios. Scenario 3 has the lowest overall benefits, primarily due to lower reductions in VMT compared to the other WFCCS scenarios. A more detailed breakdown of annual benefits over the analysis period is available in Appendix E.

Exhibit 4: WFCCS Discounted Project Benefits ($ Millions)

Results Summary	Scenario 1	Scenario 2	Scenario 3
Travel Time Savings	$1,268.6	$6,054.9	$1,219.7
Vehicle Operating Costs	$921.4	$2,453.8	($75.0)
Crash Cost Savings	$940.7	$247.0	$10.6
Emissions	$63.5	$108.3	$1.3
Total Benefits	**$3,194.2**	**$8,864.1**	**$1,156.6**

BCA Results

The BCA results over the analysis period are presented in Exhibit 5. Scenario 1 has the highest benefit-cost ratio of 3.51. Scenario 2 generates the most economic benefits ($8.8 billion), but has a lower benefit-cost ratio than Scenario 1. Scenario 3 has the highest costs of the WFCCS scenarios and a negative net present value over the analysis period due to the lower level of project benefits.

Exhibit 5: WFCCS Discounted BCA Results

Project Costs	Scenario 1	Scenario 2	Scenario 3
Lifecycle Benefits ($ Millions)	$3,194.2	$8,864.1	$1,156.6
Lifecycle Costs ($ Millions)	$910.2	$2,969.5	$3,326.5

Project Costs	Scenario 1	Scenario 2	Scenario 3
Net Present Value ($ Millions)	$2,284.0	$5,894.6	($2,169.9)
B/C Ratio	**3.51**	**2.99**	**0.35**

Sensitivity Analysis – Vision Projects

Several Vision projects that are part of Scenario 0 are not included in Scenarios 1 or 2. As a result, these scenarios would have additional cost reductions due to the avoided capital expenditures for Vision projects. A separate sensitivity analysis was conducted to estimate the BCA impacts when factoring in the cost reduction due to Vision projects. In the sensitivity analysis, the cost of Vision projects are added as project benefits in the WFCCS scenarios. This represents a conservative estimate assuming that the benefits generated by reallocating the money that would have been spent on Vision projects is at least equal to the costs of the projects. The BCA results for the sensitivity analysis with the Vision projects excluded are summarized in Exhibit 6. The B/C ratio in Scenario 1 increases from 3.51 to 3.87 when accounting for the Vision projects. Additional information on the Vision projects associated with each WFCCS scenario is available in Appendix E.

Exhibit 6: WFCCS Discounted BCA Results – Vision Projects Sensitivity Analysis

Project Costs	Scenario 1	Scenario 2	Scenario 3
Lifecycle Benefits ($ Millions)	$3,524.5	$9,007.5	$1,156.6
Lifecycle Costs ($ Millions)	$910.2	$2,959.8	$3,326.5
Net Present Value ($ Millions)	$2,614.3	$6,047.7	($2,169.9)
B/C Ratio	**3.87**	**3.04**	**0.35**

Economic Impact Analysis (EIA)

The main objective of the economic impact analysis is to determine the changes in regional economic activity due to the level of investment associated with each WFCCS scenario. These impacts occur as a result of changes in demand for goods and services resulting from construction expenditures and efficiencies gained from transportation improvements.

The total economic impacts of the WFCCS investment scenarios are the sums of three different economic effects:

- Direct effect: changes in economic activity as a direct consequence of the investments (e.g., transportation-related construction expenditures or savings in production costs due to transportation-related efficiencies);

- Indirect effect: changes in economic activity related to spending by industries that supply the ones impacted by the direct effects; and
- Induced effect: changes in economic activity related to employee spending (by employees of firms affected by the direct and indirect effects).

The indirect and induced effects are sometimes referred to as multiplier effects since they can make the total economic impact substantially larger than the direct effect alone. In theory, a larger multiplier will generate a larger overall response (total economic impact) to the initial change (direct effect). In reality though, while indirect and induced impacts always occur, the net impact on the total level of economic activity in an area may or may not be increased by the multiplier effects. That outcome depends on the study area and its ability to provide additional workers and capital resources, or attract them from elsewhere. This means that the economic impact on the study area could be smaller than the impacts estimated in this analysis if some of the indirect effects occur outside the region.

Multipliers are often expressed in terms of employment. An employment multiplier measures the increase in jobs in the overall economy per new job created in a specific industry. For example, consider a general contractor that hires 10 new employees for constructing a transportation improvement proposed in the WFCCS. If the employment multiplier for the construction industry in the study area is 1.9, 9 additional jobs[2] would be created in the economy (as a result of the 10 positions created at the general contractor) for a total of 19 new jobs.

The economic multiplier is strongly influenced by the size of the study area – generally, the larger the study area, the higher the multiplier since more of the spending would remain in the study area. However, it is possible for the multiplier to be smaller in a larger study area. Also, a number of key sectors may be more concentrated at the regional level (thus requiring fewer imports) than at the state level. Multipliers in the Salt Lake region may be higher due to the region's relative isolation compared to other large metropolitan areas.

Methodology

The economic impact analysis for the WFCCS was conducted using a REMI PI+ model licensed to the Kem C. Gardner Policy Institute at the University of Utah. The model includes economic data on 23 aggregate industries for all 29 counties in Utah.

REMI PI+

REMI PI+ is a widely applied economic impact analysis model that evaluates the effects of public investments and policies at the regional level.[3] This is a dynamic tool that generates iterative

[2] (10*1.9)-10=9
[3] A full description of the model is available on REMI's website at http://www.remi.com/products/pi.

estimates year upon year, accounting for economic growth over time. It consists of five major blocks:

- Output and demand;
- Labor and capital demand;
- Population and labor supply;
- Compensation, prices, and costs; and
- Market shares.

EIA Methodology

The WFCCS economic impact analysis considers two types of impacts:

- **Short-term construction impacts** due to the expenditure of transportation funding on construction and lifecycle O&M costs.
- **Long-term transportation efficiency impacts** due to production cost savings (meaning that vehicles circulating for business purposes can move more easily), amenity benefits (resulting from reduced emissions), and consumption reallocation (related to fuel expenditures, so funds previously spent on fuel can be spent on other goods and services).

Exhibit 7 illustrates the process used to conduct the economic impact analysis. The first step was to retrieve undiscounted, annualized outputs from the BCA results:

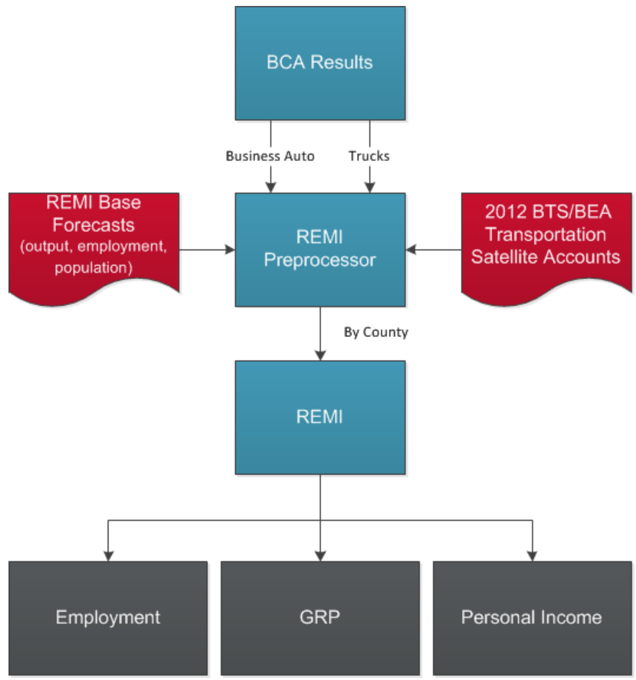
- Capital costs and O&M costs to estimate the construction impacts; and
- User benefits for passenger cars (business-related travel only) and trucks to estimate the transportation efficiency impacts.

These outputs were discounted in the BCA to take into account the time value of money from today's vantage point. The EIA considers what happens to the economy over time. It uses undiscounted outputs from the BCA because the economy operates in dollars that are not adjusted for the time value of money.

The user benefits could not be used directly in REMI and needed to be converted into:

- Production cost savings (i.e., travel time savings, vehicle operating cost savings, and accident cost savings to trucks and business auto trips);
- Consumption re-allocation (i.e., fuel and non-fuel vehicle operating cost savings for non-business auto trips); and
- Emissions amenity (i.e., emissions cost savings to trucks and automobiles).

Exhibit 7: EIA Process



The conversion was done using a spreadsheet-based, REMI preprocessor with information from the 2012 Transportation Satellite Accounts (TSA) [4] and REMI base forecasts for output, employment, and population. Exhibit 8 summarizes the REMI policy variables and user benefits in the preprocessor.

Exhibit 8: REMI Pre-Processor Variables

REMI Policy Variable	Detail	User Benefits
Production Cost	By industry	Business auto and truck
Personal Taxes	Total	Business auto and truck
Proprietor's Income	Farm	Business auto and truck
Non-Pecuniary (Amenity) Aspects*	Total	Emissions (all vehicles)
Consumer Spending	Gasoline and oil	Other auto fuel savings
Consumer Spending	Motor vehicle parts	Other auto fuel savings
Consumption Reallocation	All consumption sectors	Other auto fuel savings

* Non-monetary aspects.

[4] The TSA accounts for in-house transportation (i.e., transportation services supporting the activities of a business in a non-transportation industry) in the analysis. The TSA methodology is available at: https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/transportation_satellite_accounts/2002_2012/methodology/index.html.

The REMI preprocessor outputs were subsequently expressed by industry in 2015 dollars using REMI conversion factors. O&M costs for Transportation and Warehousing were converted to intermediate inputs for the Transportation and Warehousing sector using the national input-output (I-O) tables in REMI PI⁺. These tables show purchases by the Transportation and Warehousing sector from all industries as a share of total output for the Transportation and Warehousing sector. These shares were normalized to sum to 1 and multiplied by the O&M cost for each county.

The results were entered as final demand estimates in the REMI PI⁺ model to simulate the economic impacts of the three WFCCS scenarios in Davis, Salt Lake, and Utah counties. The total results for the region equal the sum of the county results. Economic impacts were assessed in terms of Gross Regional Product (i.e., total value added within the region including employee compensation, proprietor's income, and other property type income), personal income (i.e., total earnings from work, investments, and other sources), and employment (i.e., total number of full-time and part-time jobs).

EIA Results

The economic impact analysis was conducted in REMI PI⁺ for each scenario and for each county through 2050. The results reported represent the sum of direct, indirect, and induced effects. Also, unless otherwise specified, all dollar amounts were expressed in millions of 2016 dollars. Additional results are available in Appendix F, Economic Impact Analysis (EIA) Results.

Overall, the results show that the magnitude of impacts is similar under Scenarios 2 and 3, but Scenario 1 yields significantly lower impacts (less than half of Scenario 2 or Scenario 3) because it has considerably fewer projects for construction during the study period. Over the 2025-2050 period, the cumulative impact on GRP is estimated at $5.8 billion for Scenario 1, $14.7 billion for Scenario 2, and $11.8 billion for Scenario 3 (see Exhibit 9).[5] The employment impact is largest in Scenario 3, even though the impact on GRP is nearly 20 percent lower than Scenario 2. This is because nearly all the impacts in Scenario 3 are due to construction, which is very labor intensive. As a result, the output per employee is relatively low, because construction work requires more employees to produce the same unit of output as other industries. It should additionally be noted that, while construction jobs are counted as an economic benefit, members of the traveling public may not necessarily perceive construction as a benefit due to its temporary impact on their daily commutes.

[5] This represents an incremental increase in total GRP of approximately 0.1 percent for Scenario 1, 0.3 percent for Scenario 2, and 0.2 percent for Scenario 3.

Exhibit 9: Summary of Economic Impact Analysis Results, 2025-2050

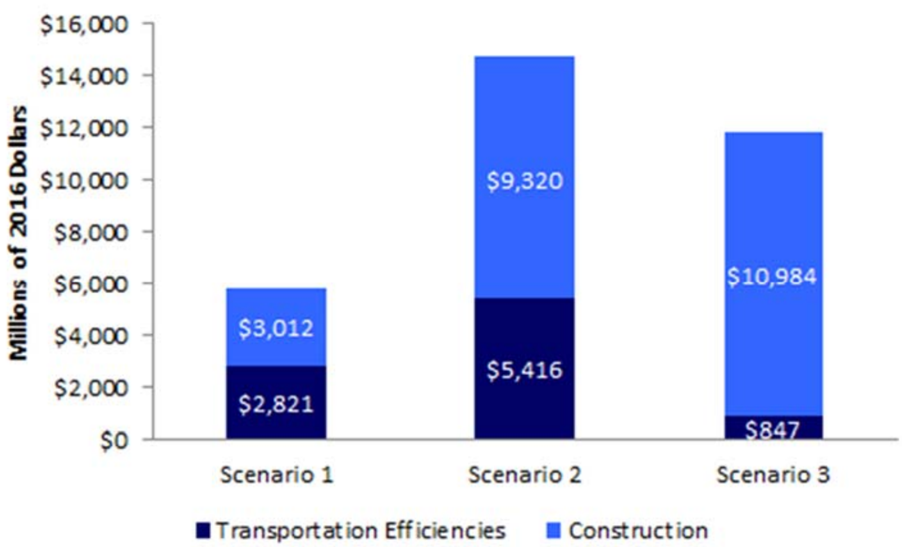
Impact Metric	Scenario 1	Scenario 2	Scenario 3
Gross Regional Product ($ Millions)	$5,833.3	$14,735.9	$11,831.8
Personal Income ($ Millions)	$4,652.9	$10,650.7	$10,244.6
Employment (Job-Years)	44,242	103,263	103,615

Note: A job-year is simply defined as one (part- or full-time) job for a year.

Exhibit 10 through Exhibit 12 provide a breakdown of economic impacts by type (i.e., construction versus transportation efficiencies) for selected metrics (i.e., GRP, personal income, and employment) under each scenario.

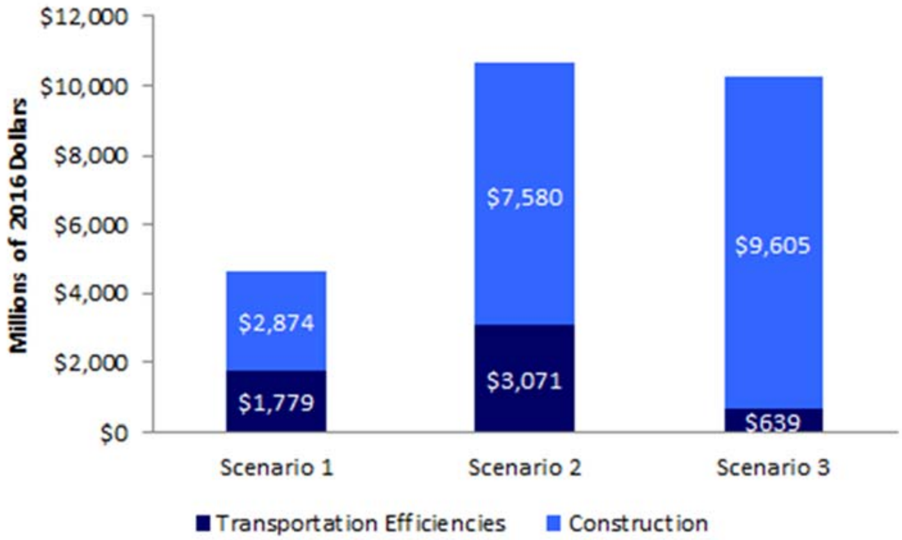
In terms of GRP, Scenario 2 has the highest impact with a cumulative $14.7 billion generated from 2025 to 2050. A majority of the impacts are from construction. They represent 52 percent of the total in Scenario 1, 63 percent of the total in Scenario 2, and 93 percent of the total in Scenario 3. These shares are similar for personal income and employment and mirror the BCA results. For instance, the benefits are very low compared to the costs in Scenario 3. As a result, the economic impacts from transportation efficiencies (GRP of $847 million) are low compared to the economic impacts from construction spending (GRP of nearly $11 billion).

Exhibit 10: Total GRP Impacts by Scenario ($ Millions)



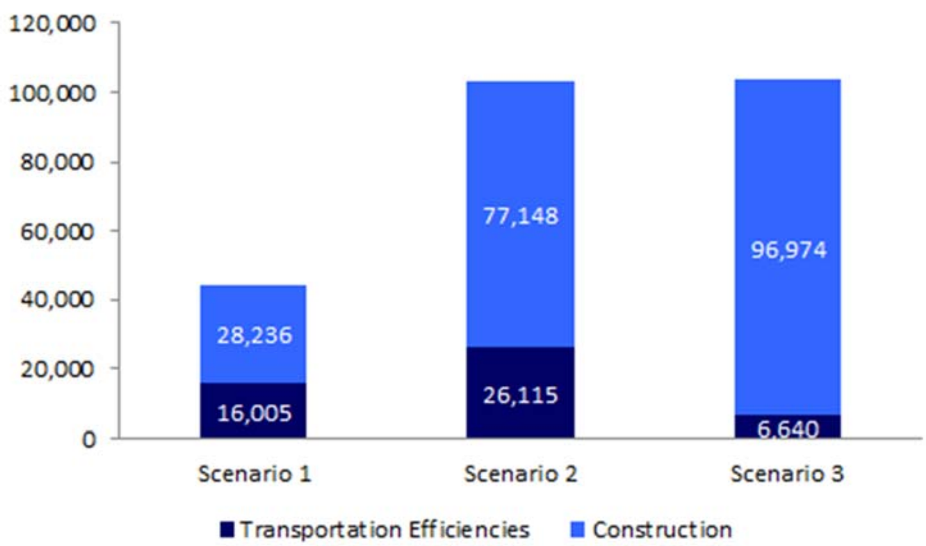
The personal income impact represents about 80 percent of the GRP impact on average across the scenarios. A comparison of Exhibit 11 with Exhibit 10 shows that the relative share of the construction impact for personal income is higher than it is for GRP under each scenario. This is because the personal income multiplier is proportionally higher than the GRP multiplier for construction.

Exhibit 11: Total Personal Income Impacts by Scenario ($ Millions)



In terms of total employment impact (see Exhibit 12), Scenario 2 and Scenario 3 yield similar results with slightly more than 103,000 job-years created from 2025 to 2050 (or an average of about 1,700 jobs annually over the time period).

Exhibit 12: Total Employment Impacts by Scenario (Job-Years)



The timing of the construction impacts is different from the transportation efficiency impacts. While the construction impacts occur primarily from 2035 to 2040 (Phase 3), the transportation efficiency impacts gradually increase from 2035 to 2050 as projects are implemented (and continue increasing thereafter). In addition, as shown in Exhibit 13, uneven construction spending can hurt the economy. In Scenario 1, construction spending has a slight negative impact on employment after 2042 as some employees in the construction sector leave the region to work elsewhere. Similar relocation effects can be seen for Scenario 2 (see Exhibit 14) and Scenario 3 (see Exhibit 15) as the slight dips in GRP that occur from 2041 to 2042.

Exhibit 13: GRP Impacts by Type, Scenario 1, 2025-2050 ($ Millions)

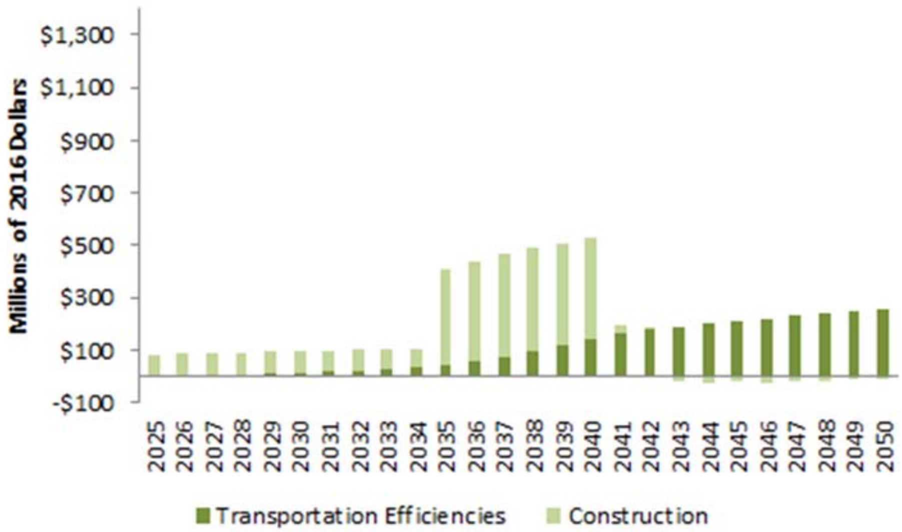


Exhibit 14: GRP Impacts by Type, Scenario 2, 2025-2050 ($ Millions)

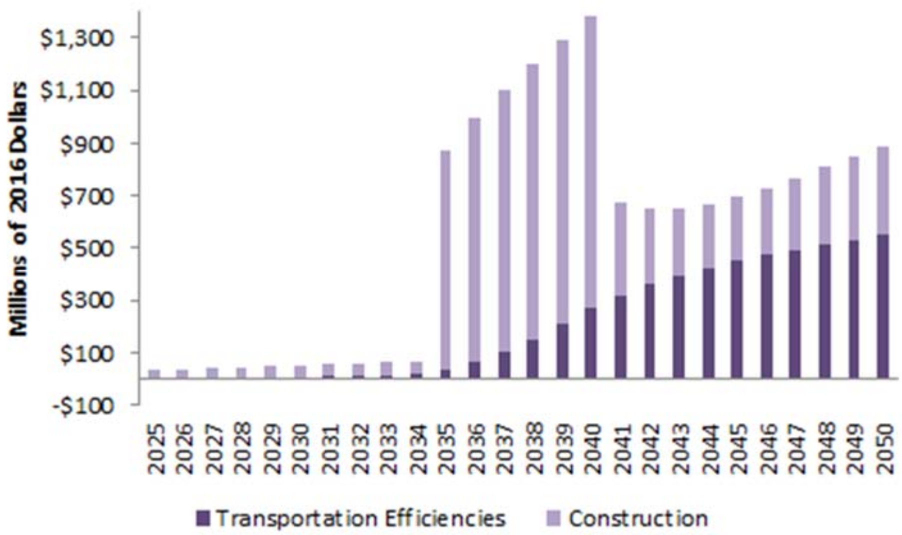
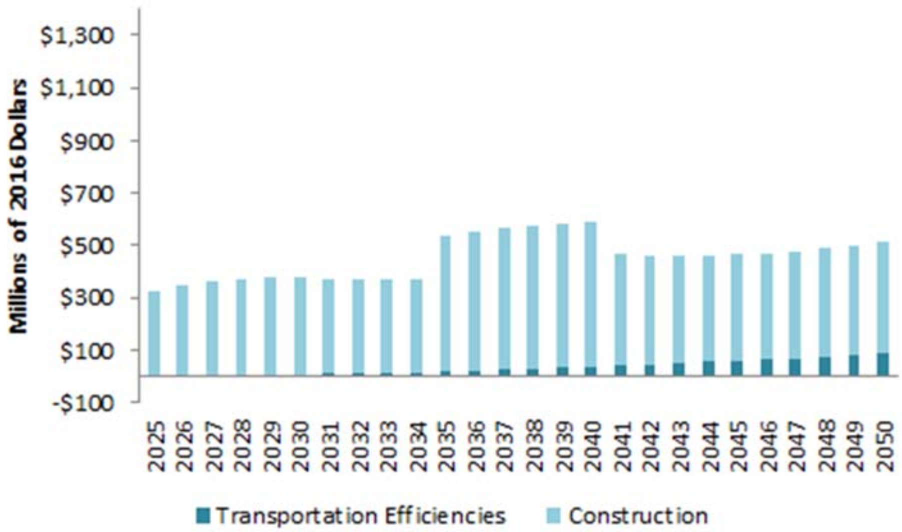
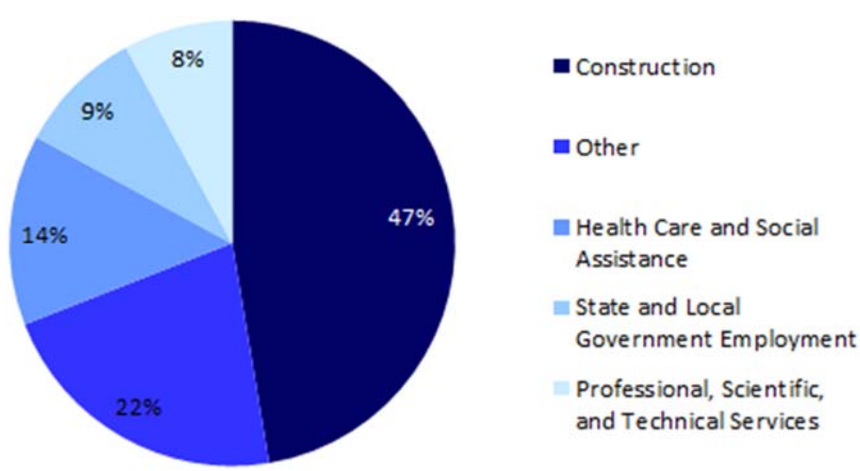


Exhibit 15: GRP Impacts by Type, Scenario 3, 2025-2050 ($ Millions)



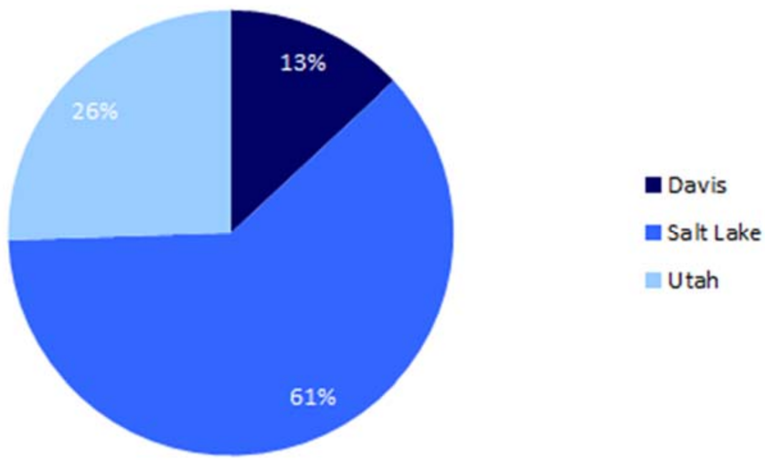
As shown in Exhibit 16, Construction is the industry most impacted by the WFCCS investments, followed by Health Care and Social Assistance, State and Local Governments, and Professional, Scientific, and Technical Services. These four industries represent 75 percent of all jobs created in the study area. This same distribution occurs for all three WFCCS scenarios and the differences across counties are very small.

Exhibit 16: Distribution of Employment Impact by Industry



Salt Lake County accounts for more than half of the economic impacts in the study area, but this merely reflects the relative size of the county's economy. As shown in Exhibit 17, 61 percent of the job impact occurs in Salt Lake County, while Davis and Utah counties represent 13 percent and 26 percent respectively. These estimates are very consistent across scenarios (regardless of the construction/transportation efficiencies breakdown) and across impact metrics (GRP, personal income, and employment).

Exhibit 17: Distribution of Employment Impact by County



Summary of Results

Overall, the findings of the EIA indicate that Scenarios 2 and 3 have the largest economic impacts, but Scenario 2 will have longer lasting impacts due to transportation efficiency gains. The economic impacts in Scenario 1 are half the size of other scenarios, but the transportation efficiency gains in Scenario 1 are larger than in Scenario 3. Transportation efficiency impacts are smaller than construction impacts during the analysis period, but they will continue to grow after 2050.

Project phasing also had an effect on economic impacts. Across scenarios, the largest impacts occur between 2034 and 2050, when the bulk of construction is anticipated to occur. Reductions in construction spending cause negative impacts as the regional economy restructures. This means that even construction spending is better for the economy than uneven spending.

Salt Lake County represents more than half of the economic impacts in the study area. The largest economic impacts are in construction, followed by health care, government, and professional services. The distribution is similar across the WFCCS scenarios and it reflects infrastructure construction and personal consumption.

Household Transportation Cost Savings

Household transportation cost savings are reported in Exhibit 18. These include reductions in transit fares, tolls, and vehicle operating costs (such as mileage-based wear and tear plus gasoline consumption). Positive numbers indicate a cost savings per household compared to Scenario 0, whereas negative numbers indicate an increase in transportation costs per household when compared to Scenario 0.

Exhibit 18: Household Transportation Cost Savings

Scenario	Cumulative (2025-2050)	Annual Average
Scenario 1	$5,045	$194
Scenario 2	$8,812	$339
Scenario 3	-$1,136	-$44

Fiscal Sustainability Analysis

The fiscal sustainability analysis compares the available agency revenues with the estimated lifecycle costs of the WFCCS scenarios. The results of the analysis are an estimation of the ability to fund all projects in the WFCCS scenarios while maintaining a state of good repair for infrastructure in the study area. The analysis was conducted primarily using the inputs available from the 2015 Unified Plan Model developed by Lewis Young Robertson & Burningham. More information on the Fiscal Sustainability Analysis Results is in Appendix G.

Several caveats arose while assessing the future fiscal sustainability. First, not all Vision project costs were estimated and, therefore, some were not included in the assessment. As described in the BCA section, the WFCCS scenarios assume that a certain set of Vision projects would be constructed. However, there were limited data available on the estimated cost and timing of these projects. Second, more information is needed on the deferred maintenance needs because the estimates for this analysis were derived using the growth assumptions from the Unified Plan. Increases in future maintenance needs could limit the revenue available for funding new projects. Third, revenue tolls generated by HOV/HOT lane improvements could provide funding for new project improvements and preservation needs, but the tolls may carry more uncertainty than traditional funding sources (although declining gas tax revenues are creating uncertainty for funding sources as well).

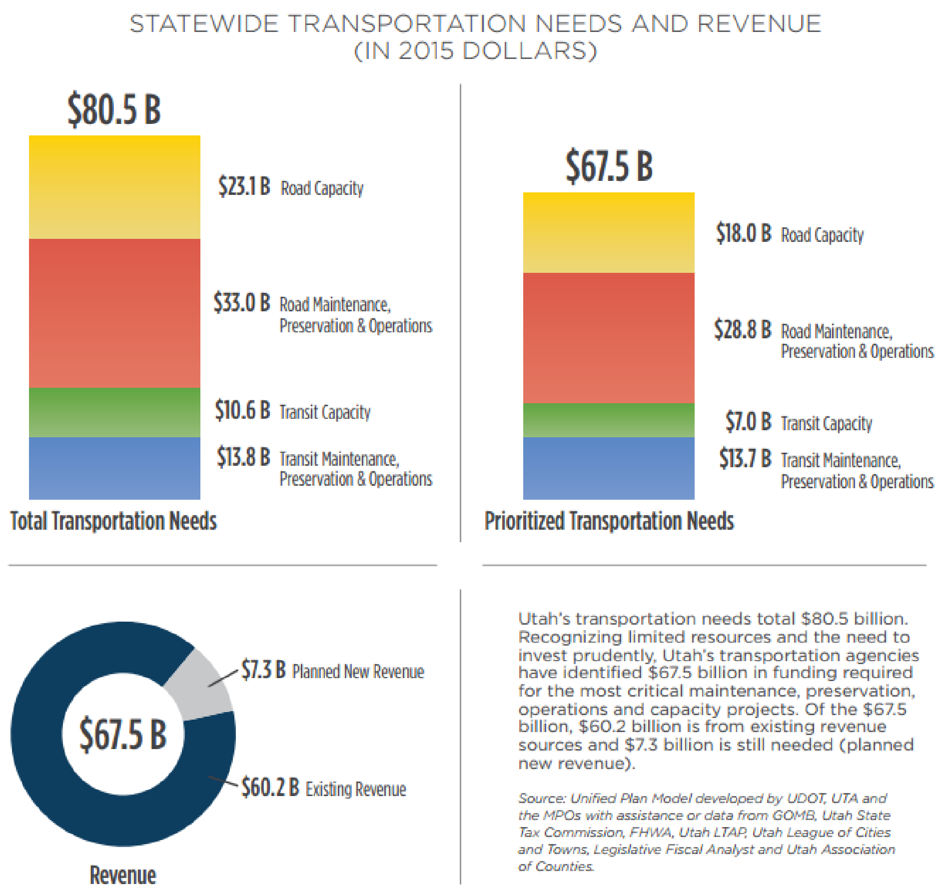
2015 Unified Plan Model

The Unified Plan model estimates existing revenues, new revenues, and financing sources and compares them with the total needs of the study area. Revenues and needs are estimated through

2040. According to the model, there is currently $13 billion in unfunded future needs statewide between 2015 and 2040 ($67.5 billion in funded needs out of a total estimate of $80.5 billion in 2015 dollars) as presented in Exhibit 19.

Based on the list of future projects identified in the Unified Plan, about 81 percent of future roadway and 74 percent of transit capacity are assumed to be funded for WFRC (on a total cost basis). For MAG, the comparable figures are 100 percent of future roadway and 56 percent of transit capacity.

Exhibit 19: Total Statewide Needs and Revenue – 2015 Unified Plan Model



Source: Utah's Unified Transportation Plan, 2015-2040

Unfunded Phase (2041-2050) Estimates

The fiscal sustainability analysis included developing a forecast for the previously unfunded phase (2041-2050) since the 2015 Unified Plan study period was limited to investments through 2040. When estimated using the same forecasting assumptions and techniques as in the Unified Plan, the anticipated preservation needs in the unfunded phase for existing infrastructure are approximately $6.91 billion for WFRC and MAG combined. This accounts for all projects funded in the plan. The estimated revenue from various existing sources amounts to $10.45 billion from revenue streams implemented by 2040. In addition, there are approximately $912 million in new tax revenues available between 2041 and 2050 as summarized in Exhibit 20. This analysis assumes the same escalation rates for roadway needs apply throughout the analysis period. Transit revenues in the unfunded phase were assumed to be the same as the average annual revenues in Phase 3.

The agency needs and revenues for the unfunded phase are summarized in Exhibit 20 and Exhibit 21. The comparison of revenues and preservation needs means that approximately $4.46 billion is available to fund Vision and WFCCS scenario projects.

Exhibit 20: WFRC and MAG Unfunded Phase New Tax Revenues (2016 dollars)

New Tax Revenues (2041-2050)	Year Added	Amount	WFRC	MAG
Fuel Tax			**$118,427,056**	**$51,177,580**
Motor Fuel Tax	2045	$0.05		
Special Fuel Tax	2045	$0.05		
WFRC Sales Tax			**$507,386,292**	**-**
Salt Lake County Sales Tax	2045	0.25%		
Davis County Sales Tax	2045	0.25%		
Weber County Sales Tax	2045	0.25%		
Box Elder County Sales Tax	2045	0.25%		
Tooele County Sales Tax	2045	0.25%		
MAG Sales Tax			**-**	**$189,218,661**
Utah County Sales Tax	2045	0.25%		
UDOT Vehicle Registration Tax	2048	$10.00	**$32,075,536**	**$13,998,300**
Total Net Present Value (2016 $)			**$657,888,885**	**$254,394,540**

Exhibit 21: WFRC and MAG Unfunded Phase Needs and Revenues (billions of 2016 dollars)

Unfunded Phase Total Revenues and Needs	Present Value
Revenues Based on Unified Plan	$10.45
+ New Tax Revenues	+ $0.91
- Preservation Needs	- $6.91
Capital Funding Available	**$4.46**

The total represents the present value of funding available to fund new capital projects (some of which were identified in the 2015 Unified Plan and would need to be prioritized) in addition to a potential need for $2.6 billion in highway investments outside the study area.

Toll Revenue Estimates and Scenario Funding Analysis

In addition to tax revenues, tolls generated by HOV/HOT lane improvements could be a source of revenue for new capital investments. The toll estimates summarized in Exhibit 22 were derived based on the travel demand output and the following planned toll rates to be implemented in 2035:

- Drivers in general purpose (GP) lanes would pay 24 cents per mile in the peak direction during the peak period.
- Drivers in the barrier-separated, limited-access HOT lanes would pay 48 cents per mile in the peak direction during the peak period, but carpools and transit would pay no fee.
- No tolls would be charged to vehicles traveling in the GP lanes during non-peak periods and in non-peak directions.
- Drivers in the barrier-separated, limited-access HOT lanes would pay 5 cents per mile during the non-peak periods.

Exhibit 23 summarizes the toll revenues generated compared to the anticipated capital and O&M costs for roadway and transit projects in each scenario. The difference would need to be covered by the capital funding available (described in Exhibit 21).

Exhibit 22: Present Value of Future Toll Revenues (millions of 2016 dollars)

Location/Time	Scenario 1	Scenario 2	Scenario 3
General Purpose (GP) Lanes			
AM	$169	$74	$192
PM	$210	$96	$248
Off-Peak	$0	$0	$0
HOT Lanes			
AM	$164	$379	$97
PM	$299	$1,920	$199
Off-Peak	$65	$362	$57
Total	**$907**	**$2,831**	**$793**

Exhibit 23: Toll Revenues and Total Costs by Scenario (millions of 2016 dollars)

Scenario 1				
(Million 2016 dollars)	**Phase 2 (2025-2034)**	**Phase 3 (2035-2040)**	**Unfunded Phase (2041-2050)**	**Total**
New Toll Revenues	$0	$145	$763	$907
Total Capital Costs	($542)	($1,577)	($194)	($2,314)
Total O&M Savings	$41	$93	$291	$425
Total	**($500)**	**($1,340)**	**$859**	**($981)**
Scenario 2				

(Million 2016 dollars)	Phase 2 (2025-2034)	Phase 3 (2035-2040)	Unfunded Phase (2041-2050)	Total
New Toll Revenues	$0	$708	$2,123	$2,831
Total Capital Costs	($220)	($3,337)	($141)	($3,699)
Total O&M Costs	($102)	($909)	($2,926)	($3,937)
Total	**($322)**	**($3,538)**	**($945)**	**($4,805)**
Scenario 3				
(Million 2016 dollars)	**Phase 2 (2025-2034)**	**Phase 3 (2035-2040)**	**Unfunded Phase (2041-2050)**	**Total**
New Toll Revenues	$0	$97	$696	$793
Total Capital Costs	($2,253)	($2,016)	($2,443)	($6,712)
Total O&M Costs	($126)	($244)	($554)	($924)
Total	**($2,379)**	**($2,163)**	**($2,301)**	**($6,844)**

Exhibit 24 compares the available funding compared to the anticipated net costs of the WFCCS scenarios. Note that, unlike the costs shown in Exhibit 3, these numbers are not discounted. The difference between the available funding and costs of the investment packages is the amount of funding available for Vision projects in the study area. The costs of these projects has not yet been determined, but there are some Vision projects included among the WFCCS scenarios, as described earlier in the BCA analysis. Based on these estimates, Scenario 1 shows a $3.48 billion surplus (before accounting for remaining Vision projects), while Scenarios 2 and 3 show deficits of $347 million and $2.39 billion respectively. The Vision projects assessed in the analysis are included in Appendix E.

Exhibit 24: Funding Available and WFCCS Scenario Costs (billions of 2016 dollars)

	Scenario 1	Scenario 2	Scenario 3
Funding Available	**$4.46**	**$4.46**	**$4.46**
New Toll Revenues	$0.91	$2.83	$0.79
Total Capital Costs	($2.31)	($3.70)	($6.71)
Total O&M (Costs)/Savings	$0.42	($3.94)	($0.92)
Funding Available for Vision Projects	**$3.48**	**($0.35)**	**($2.39)**

2017 UDOT Strategic Direction

The 2017 UDOT Strategic Direction plan describes strategies to extend pavement life through recommended timelines of preservation, rehabilitation, and reconstruction. Overall, pavement expenditures are expected to be relatively constant, which is consistent with the lifecycle costs estimated for the WFCCS scenarios. The pavement conditions based on current funding are summarized on UDOT's website, and take into account the gas tax increases approved in the 2016 legislative session. Pavement condition data presented in the 2017 Strategic Direction indicates that with the new gas tax revenues, roads on both the high volume system and the low volume system should meet performance targets by 2020. Projections beyond 2020 are not available.

Summary of Results

Overall, the financial sustainability analysis indicates that additional revenues are needed to fund the WFCCS scenarios. The Unified Plan model suggests that over $11 billion will be available during the previously unfunded phase (2041-2050). Once preservation needs are considered, only about $4.46 billion remains to fund the capital and O&M costs of the WFCCS scenarios. These funds may be supplemented by toll revenues ranging from about $1 billion to $3 billion, depending on the scenario. As a result, Scenario 1 shows a surplus ($3.48 billion), while Scenario 2 roughly breaks even ($347 million deficit) and Scenario 3 shows a deficit ($2.39 billion). Readers should note that the results shown here include only the WFCCS scenario projects and those unfunded Vision-phase projects that were within the study area or provided a parallel alternative to I-15. This means that there is not generally enough transportation funding to accommodate the WFCCS projects as well as the unfunded Vision projects. Decision-making agencies will either need to generate new sources of revenue beyond those already assumed, or eliminate planned projects from further consideration.

Appendices

WASATCH FRONT CENTRAL
CORRIDOR STUDY
2050

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WASATCH FRONT CENTRAL CORRIDOR STUDY 2050

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Appendix A: Scenario Costs Part 1

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Lifecycle Project Costs

- **Capital Costs**
  - – Upfront design, engineering and construction costs
- **Roadway O&M Costs**
  - – Includes pavement resurfacing, annual maintenance, etc.
- **Transit O&M Costs**
  - – Incremental costs to operate and maintain new transit services

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Projects Requiring Capital Costs

- Grid 2.0
- Grid 3.0
- Cycle Superhighway
- Active Transportation elements
- Barrier Separated HOV, toll, and express bus lanes on I-15
- Doubletrack FrontRunner
- Mobility Hubs
- C/D Expansion (I-15)
- Infill Stations
- HOV & BRT with Grade Separated Intersections (Redwood Rd. and State St.)
- I-15 Reversible Lanes (Davis County)
- I-15 Elevated

Projects with Capital Costs from Previous Studies

- I-15 Elevated
  - *I-15 Elevated Feasibility Study (2012)*
- C/D Expansion (I-15)
  - *Sandy City Frontage Road Study*
- Active Transportation Elements
  - *WFRC: Priority Bicycle Routes per RTP*
  - *Salt Lake County: EW Trails per trails plan*

Projects with Capital Costs Based on a Cost Per Mile Value and ROW

- Grid 3.0
- Cycle Superhighway (State Street)
- Doubletrack FrontRunner
- Barrier Separated HOV, toll, and express bus lanes on I-15
- I-15 Reversible Lanes (Davis County)

Cost per mile derived from previous studies, RTP project costs, and engineering judgment

Projects with Capital Costs Based Concept Cost Estimates

- Grid 2.0
- Cycle Superhighway (Jordan River Parkway Trail)
  - Concept costs developed based on major elements
    - Proposed bridges and tunnels
    - Retaining Walls
    - Pavement

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Project Phasing

- Projects in each scenario are constructed in three phases throughout the analysis
- Phase 1 (2015-2024) includes Regional Transportation Plan (RTP) projects

Phase 2	Phase 3	Phase 4
2025 - 2034	2035 - 2040	2041 - 2050

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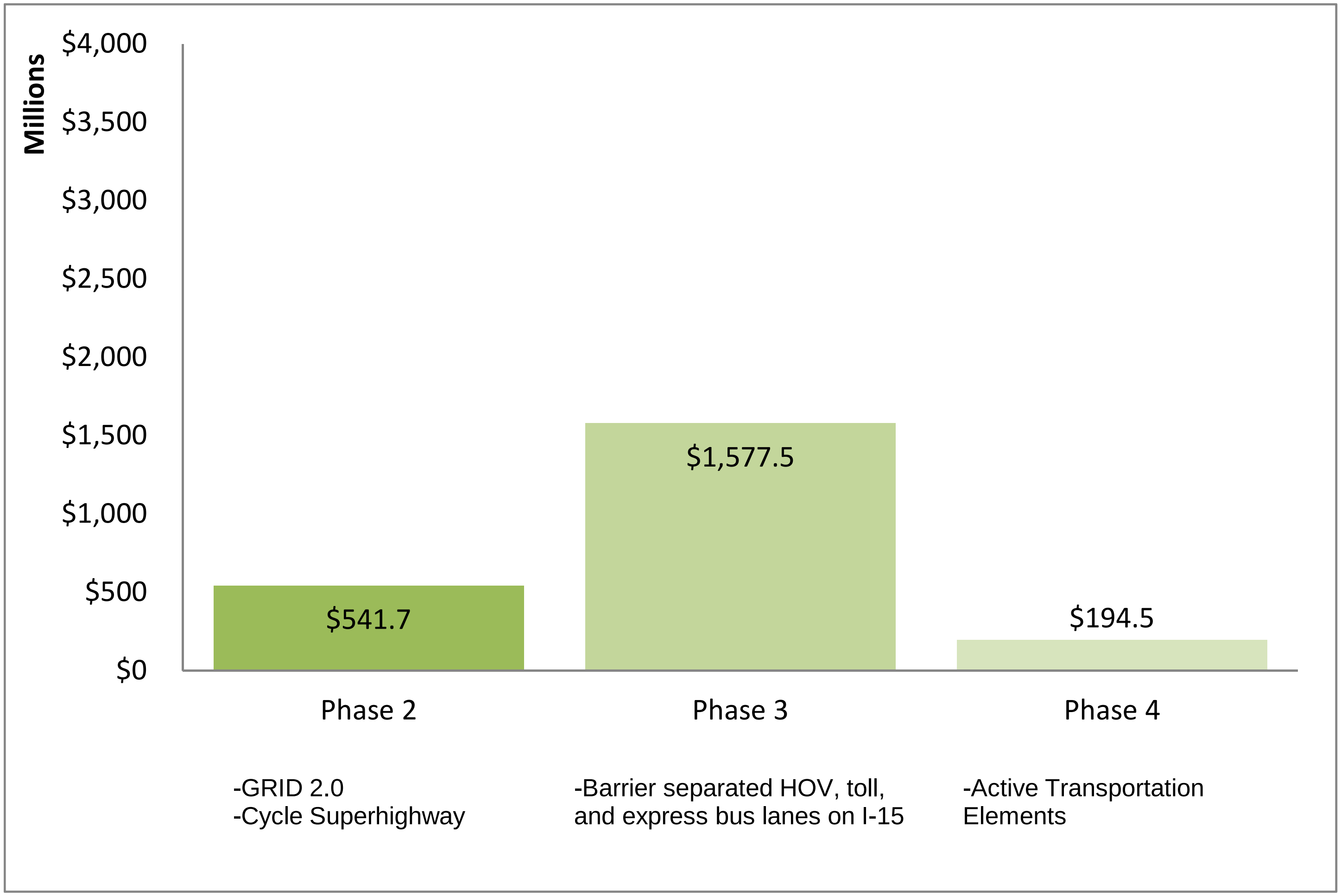
Scenario 1 Capital Costs (2016 $)

Phase	Scenario 1	Cost ($ millions)
Phase 2 2025-2034	• GRID 2.0	$220.0
	• Cycle Superhighway	$321.7
Phase 3 2035-2040	• Barrier separated HOV, toll, and express bus lanes on I-15	$1,577.5
Phase 4 2041-2050	• Active Transportation Elements	$194.5
Total Capital Costs		**$2,313.6**

Undiscounted Millions of 2016 $

Scenario 1 Capital Costs by Phase



Undiscounted Millions of 2016 $

Scenario 2 Capital Costs (2016 $)

Phase	Scenario 2 Elements	$ millions
Phase 2 2025-2034	• GRID 2.0	$220.0
Phase 3 2035-2040	• Doubletrack FrontRunner	$1,759.9
	• Barrier separated HOV, toll, and express bus lanes on I-15	$1,577.5
Phase 4 2041-2050	• GRID 3.0	$141.4
Total Capital Costs		**$3,698.7**

Undiscounted Millions of 2016 $

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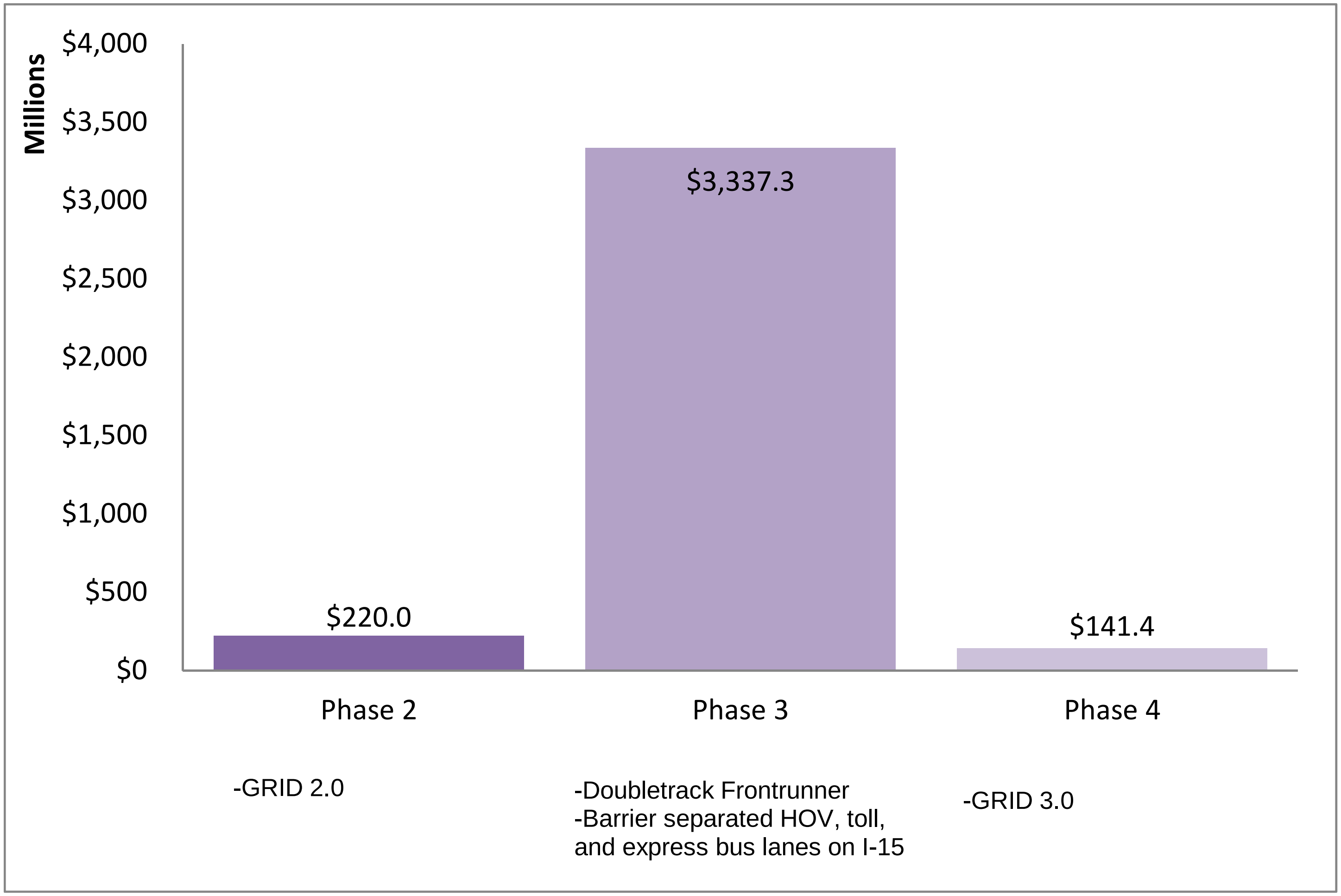
Scenario 2 Capital Costs by Phase



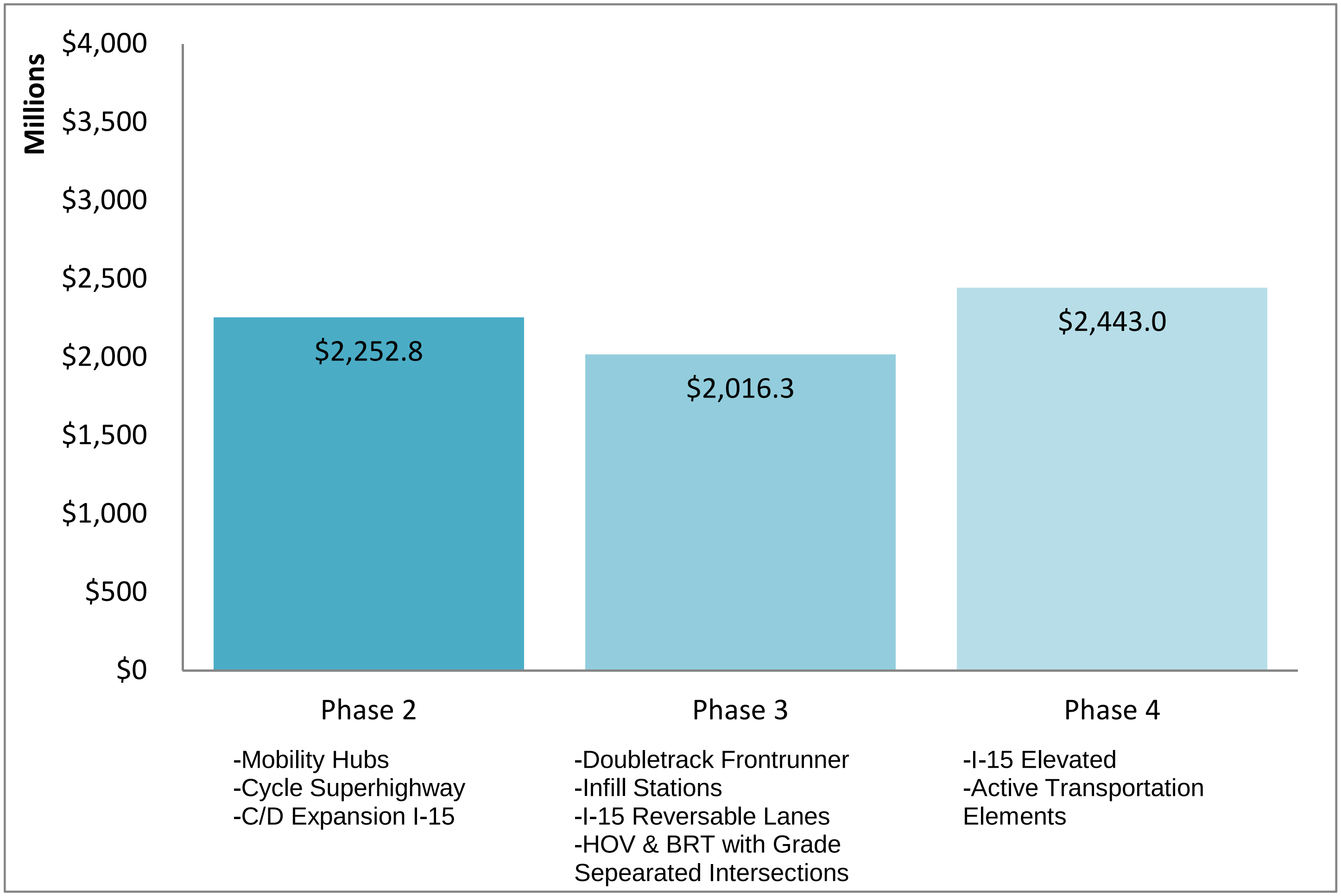
Undiscounted Millions of 2016 $

Scenario 3 Capital Costs (2016 $)

Phase	Scenario 3	$ millions
Phase 2 2025-2034	• Mobility Hubs	$1,511.2
	• Cycle Superhighway	$321.7
	• C/D Expansion I-15	$420.0
Phase 3 2035-2040	• Doubletrack FrontRunner	$1,759.9
	• Infill Stations	$20.1
	• I-15 Reversible Lanes (Davis County)	$236.3
Phase 4 2041-2050	• HOV & BRT with Grade Separated Intersections (Redwood Rd. and State St.)	$535.9
	• I-15 Elevated	$1,712.7
	• Active Transportation Elements	$194.5
	Total Capital Costs	**$6,712.1**

Undiscounted Millions of 2016 $

Scenario 3 Capital Costs by Phase



Undiscounted Millions of 2016 $

Roadway O&M Costs

- **Roadway Maintenance Costs**
  - Costs associated with routine maintenance of roadways according to UDOT Maintenance Planning
- **Lifecycle Rehabilitation Costs**
  - Costs associated with roadway rehabilitation schedule
- **Bike Path Maintenance Costs**
  - Costs associated with routine maintenance of bike paths

Roadway and Bike Path Maintenance Cost Assumptions

- Annual maintenance estimated using project characteristics and maintenance cost per lane-mile

O&M Cost	Value ($ / lane-mile)	Source
Annual Roadway Maintenance Cost	$4,386	UDOT Maintenance Planning - 2015
Annual Bike Path Maintenance Cost	$1,560	Iowa DOT, University of Delaware TRB presentation

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Lifecycle Rehabilitation Costs and Schedule

- Lifecycle rehabilitation costs estimated based on project lane-miles and year of pavement replacement
- Major rehabilitation costs occur beyond the analysis period

Time of Replacement	Asphalt Pavement ($ / lane-mile)	Concrete Pavement ($ / lane-mile)
10 years	$75,000	-
15 years	-	$30,000
20 years	$85,000	-
30 years	$175,000	$75,000

Source: UDOT Maintenance Planning

Scenario 1 Roadway O&M Costs (2016 $)

Phase	Scenario 1	$ millions
Phase 2 2025-2034	• GRID 2.0	$3.3
	• Cycle Superhighway	$2.7
Phase 3 2035-2040	• Barrier separated HOV, toll, and express bus lanes on I-15	$9.0
Phase 4 2041-2050	• Active Transportation Elements	$5.2
Total Costs Over Project Lifecycle		**$20.2**

Undiscounted Millions of 2016 $

Scenario 2 Roadway O&M Costs (2016 $)

Phase	Scenario 2	$ millions
Phase 2 2025-2034	• GRID 2.0	$3.3
Phase 3 2035-2040	• Doubletrack FrontRunner	**
	• Barrier separated HOV, toll, and express bus lanes on I-15	$9.0
Phase 4 2041-2050	• GRID 3.0	$5.9
Total Costs Over Project Lifecycle		**$18.1**

Undiscounted Millions of 2016 $
***Impact Captured in Transit O&M Costs*

Scenario 3 Roadway O&M Costs (2016 $)

Phase	Scenario 3	$ millions
Phase 2 2025-2034	• Mobility Hubs	n/a
	• Cycle Superhighway	$2.7
	• C/D Expansion I-15	$10.1
Phase 3 2035-2040	• Doubletrack FrontRunner	**
	• Infill Stations	n/a
	• I-15 Reversible Lanes (Davis County)	$0.8
Phase 4 2041-2050	• HOV & BRT with Grade Separated Intersections (Redwood Rd. and State St.)	$4.5
	• I-15 Elevated	$5.2
	• Active Transportation Elements	$5.2
Total Costs Over Project Lifecycle		**$28.5**

Undiscounted Millions of 2016 $
***Impact Captured in Transit O&M Costs*

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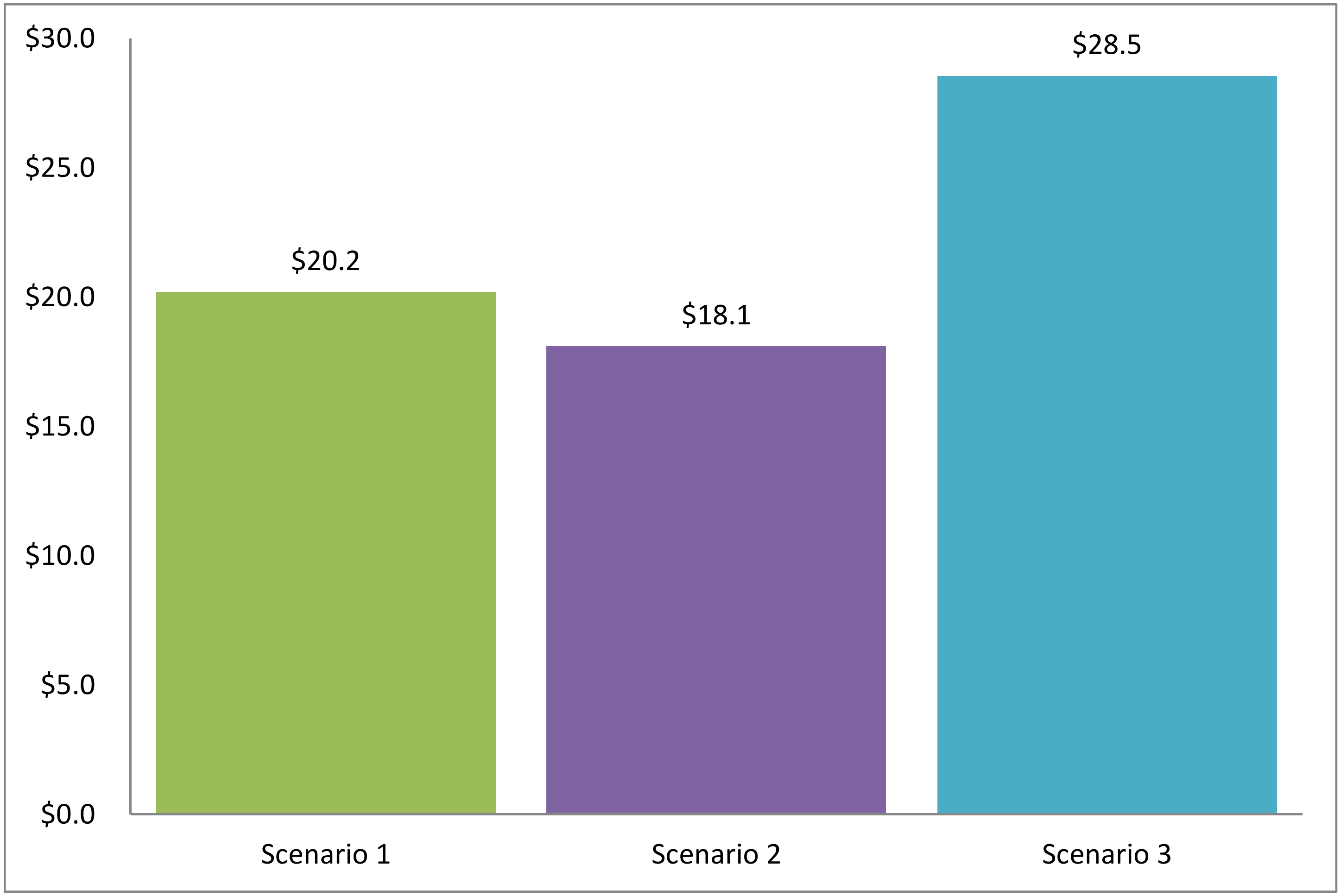
Roadway O&M Costs (2016 $)



Undiscounted Millions of 2016 $

Transit O&M Costs

- Some scenarios include increased transit services (Scenario 2 and 3)
- Transit O&M costs are the additional costs per year to operate transit services (wages, operations, etc.)
- Allocated according to when transit projects are built during project phasing
- Estimated using travel demand model outputs and UTA annual operating costs

Transit O&M Costs

- 2014 Travel Demand Model Revenue-Miles
  - Local Bus
  - BRT
  - Express Bus
  - Light Rail
  - Commuter Rail

Operation Characteristics

Mode	Operating Expenses
Commuter Bus	$7,509,767
Commuter Rail	$43,094,542
Demand Response	$21,339,132
Light Rail	$51,621,346
Bus	$107,806,577
Vanpool	$3,675,858
Total	$235,047,222

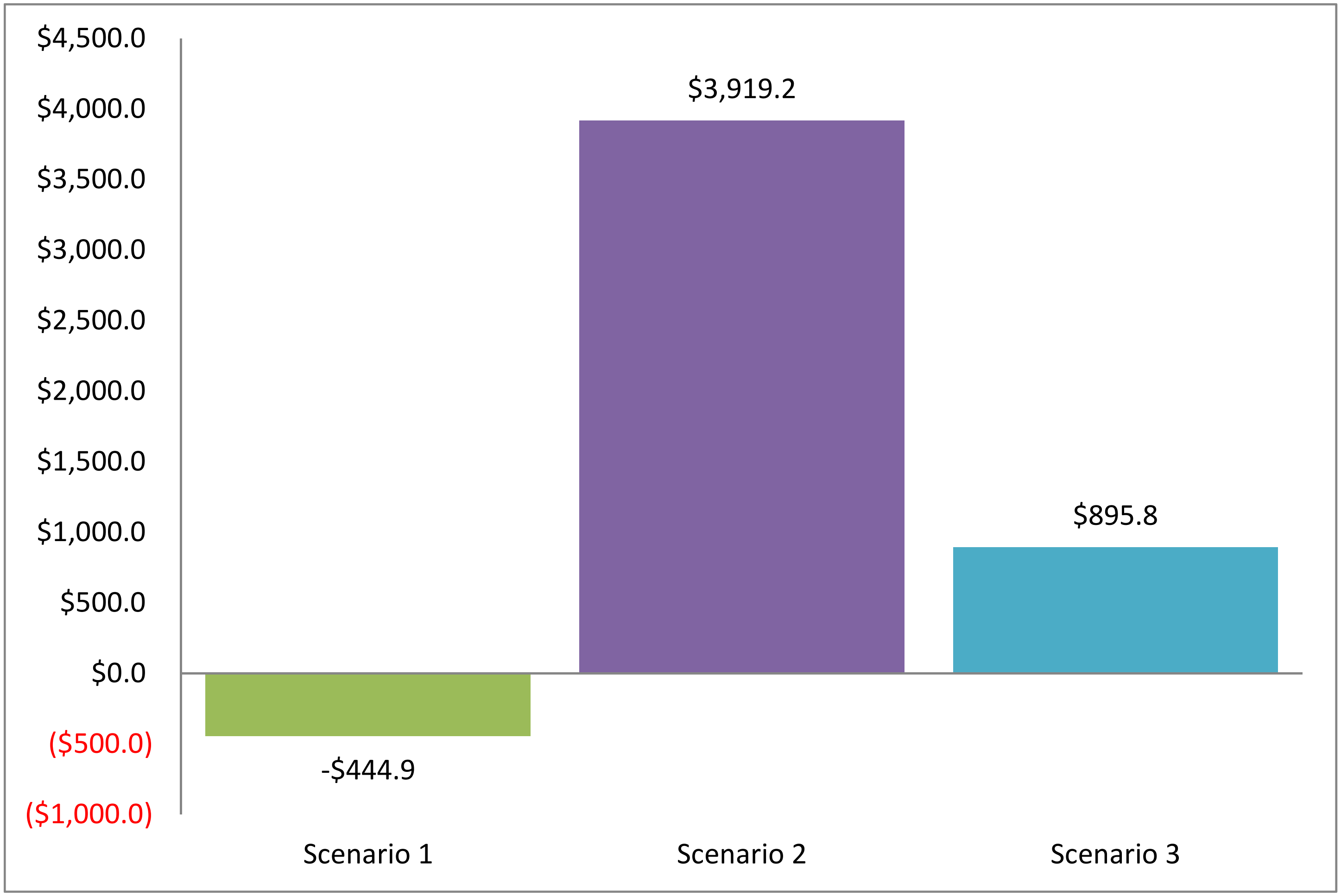
Source: National Transit Database – Utah Transit Authority 2014 Annual Agency Profile

Transit O&M Costs Assumptions

Mode	Operating Cost per Revenue-Mile (2016 $ / mile)
Local Bus	$6.39
BRT	$6.79
Express Bus	$6.79
Light Rail	$21.07
Commuter Rail	$36.28

Source: 2014 WFCCS Travel Demand Model and 2014 UTA Agency Profile, inflated to 2016 $ using BLS data

Transit O&M Costs Summary (2016 $)



Undiscounted Millions of 2016 $

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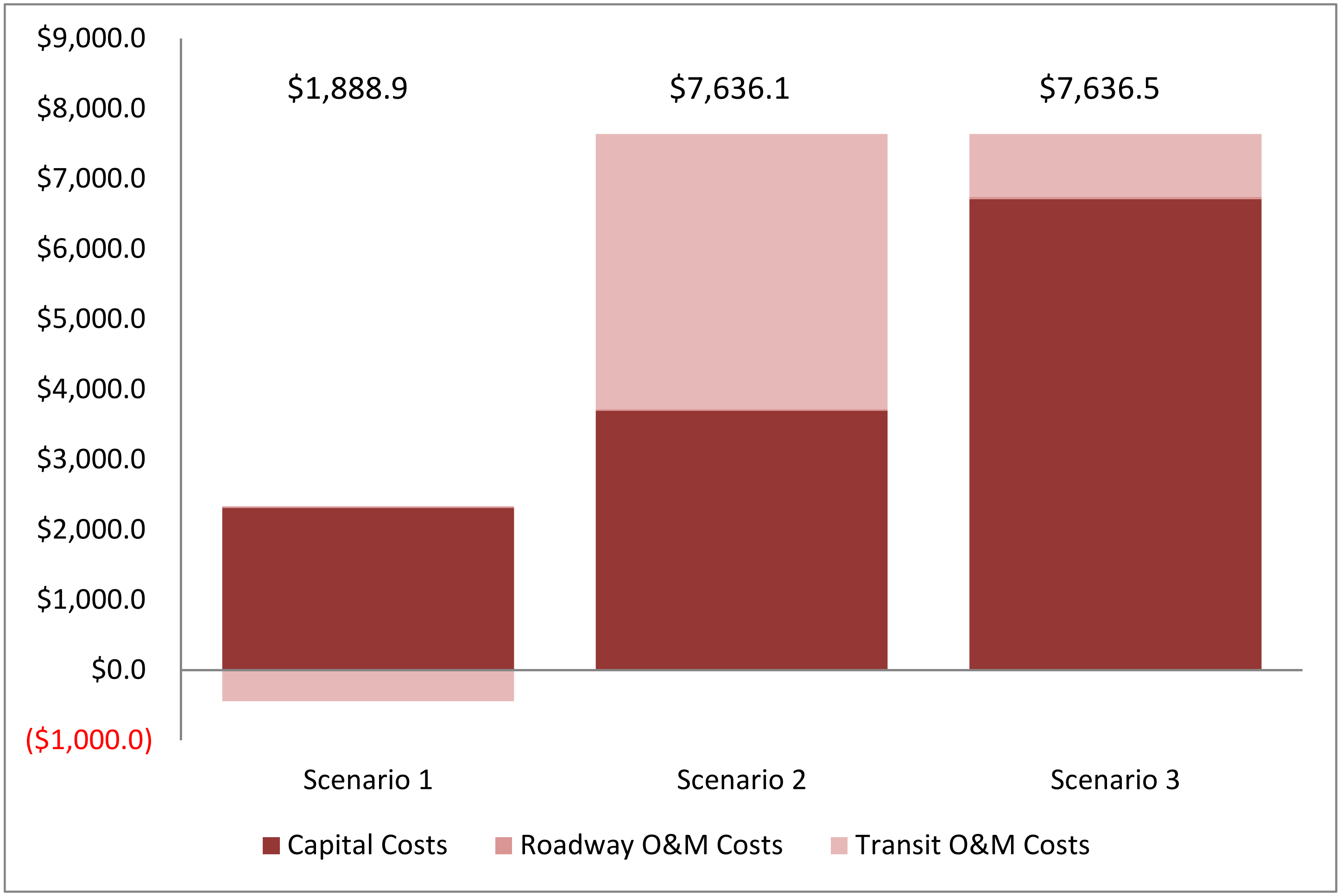
Project Lifecycle Costs (2016 $)

Phase	Scenario 1	Scenario 2	Scenario 3
Capital Costs	$2,313.6	$3,698.7	$6,712.1
Roadway O&M Costs	$20.2	$18.1	$28.5
Transit O&M Costs	($444.9)	$3,919.2	$895.8
Total Costs	**$1,888.9**	**$7,636.1**	**$7,636.5**

Undiscounted Millions of 2016 $

Project Lifecycle Costs (2016 $)



Undiscounted Millions of 2016 $

Appendix B: Scenario Costs Part 2

WASATCH FRONT CENTRAL
CORRIDOR STUDY
2050

Technical Memorandum

To: Wasatch Front Central Corridor Study Management Team

From: Wasatch Front Central Corridor Study (WFCCS) Technical Team

Date: February 2017

Subject: Capital Cost Assumptions Memorandum

Purpose of this Memorandum

This Capital Cost Assumptions Memorandum includes information related to assumptions made during the process of developing capital costs for the different projects included in Long Term Solutions Matrix of Scenarios. Capital costs related to previous studies are also included with references to the specific studies that were used.

Projects with Capital Costs from Previous Studies / Estimates

Several previous studies already provide capital cost estimates for select WFCCS key elements. These are outlined below:

- I-15 Elevated
    - Costs from I-15 Elevated Freeway Feasibility Study[1]
- C/D Expansion (I-15)
    - Costs from Sandy City Frontage Road Study[2]
- Active Transportation Elements
    - Costs for the Priority Bicycle Routes from the Wasatch Front Regional Council 2015-2040 Regional Transportation Plan[3]
    - Costs for the preferred alternatives from the Salt Lake County East-West Trails Plan[4]

WFCCS Capital Cost Assumptions

The WFCCS Technical Team developed capital cost assumptions for many infrastructure projects contained within the three WFCCS scenarios. These assumptions are outlined below.

Capital Cost Assumptions for Grid 2.0 projects

[1] HDR, 2012
[2] Horrocks, 2016
[3] http://www.wfrc.org/publications/RTP-publications/RTP_2015_FINAL.pdf
[4] http://slco.org/recreation/planning/PDFdocs/EWTrailsMP.pdf

Grid 2.0 involved refining the surface street grid network. This was accomplished by creating new crossings over I-15 in the primary WFCCS study area. Some crossings were intended only for bicyclists and pedestrians, while others were intended for all modes of transportation. The crossing locations are identified by type below.

Bike/Pedestrian Structures:

- Hillwood Way (east) to Jordan Canal Rd. (west) [over I-215]
- 8375 South (east) to 8360 South (west) [over I-15 & UPRR/UTA]

Roadway bridges with bicycle and pedestrian accommodations:

- 1250 West to I-15 Frontage Road [over Legacy Parkway & I-15]
- 7500 South to 7500 South [over I-15 and UPRR/UTA]
- 9400 South to 9400 South [over I-15]
- Automall Drive to 11000 South [over I-15]
- 11800 South to Frontage Road [over I-15]
- 13200 South to Ikea Way/Frontage Road [over I-15]
- Southfork Drive to Pony Express Way [over I-15]

Each crossing was assessed by looking at the bridge length needed to span the Interstate (and railroads where necessary), as well as fill needed to build up frontage including retaining walls, pavement section, and other incidentals. Current unit costs for these major items were used to come up with a total cost for each crossing.

Capital Cost Assumptions for Cycle Superhighway

The cycle superhighway routes were originally going to be along 700 West and 500 East. After evaluating these routes and after discussions with the management team, the routes were moved to the Jordan River Parkway corridor and State Street. This revision was largely due to the 700 West and 500 East routes being cost prohibitive, creating substantial impacts to local neighborhoods, parks, churches, and businesses, and not providing comparative increases to connectivity related to impacts and costs.

The Jordan River Parkway Trail corridor was evaluated looking at a parallel trail system from 12300 South to 800 South. A cost per mile of trail was used plus right-of-way (ROW) to accommodate the trail. Each roadway and river crossing was calculated by assuming a parallel crossing structure or tunnel would be added where the existing Jordan River Parkway Trail incorporated a structure or tunnel. These three elements (cost per mile, ROW, and structures) were added together to come up with the total cost.

The State Street corridor was evaluated using a cost per mile and ROW. Per discussions with the management team, the cycle superhighway was incorporated into the median area of State Street since placing on either side would conflict with crossing traffic at every intersection and would make signal timing difficult without significantly increasing commuter delays.

Capital Cost Assumptions for Grid 3.0 projects

Grid 3.0 involved the following:

Dedicate existing travel lane for HOV/Transit/Toll (to create "reliability lanes") on:

- US-89 in Davis County
- 3500 South between State Street and 900 West
- 5400 South between Redwood Road and Bangerter Highway
- Porter Rockwell Boulevard
- Mountain View Corridor extension to 2100 North Freeway
- 2100 North Freeway
- SR-92

Dedicate a reversible lane to accommodate same number of peak direction through lanes plus an exclusive HOV/transit/toll lane ("reversible/reliability lanes") on:

- Redwood Road from SR-201 to Bangerter Highway in Salt Lake County
- Redwood Road from I-80WB to 500 South in Salt Lake and Davis Counties
- State Street from 1300 South to 12300 South
- 3500 South from 900 West to I-215
- 5400 South from State Street to Redwood Road
- 9400 South from Highland Drive to Bangerter Highway
- 10600 South from I-15 to Bangerter Highway
- 12300 South from I-15 to Bangerter Highway

A value of $1,500,000 per mile was used for these arterial upgrades to accommodate costs of design, restriping, signage, and overhead sign structures at frequencies consistent with other similar arterial sections already converted. Grid 3.0 also includes the new freeway overpasses identified in Grid 2.0.

Capital Cost Assumptions for Barrier Separated HOV, toll, and express bus lanes on I-15 and Reversible Lanes (Davis County)

This key element included converting existing I-15 lanes to barrier-separated special use lanes for HOT, HOV, and transit, with limited access to the barrier separated portions. Lane configurations on I-15 for the three WFCCS scenarios (compared to the lane configurations shown in the 2015-2040 Regional Transportation Plan) are shown in Tables 1 and 2 below. In order to accommodate the barriers for the barrier separation, additional width was also required for shoulders adjacent to the barriers.

Table 1: Barrier-Separated Lane Configurations for WFCCS Scenarios 1 and 2								
	In 2040 RTP network				For Barrier separated concept			
I-15 Segment	NB GP	NB HOV	SB GP	SB HOV	NB GP	NB HOT/ Transit*	SB GP	SB HOT/ Transit*

Legacy to I-215 Interchange	4	1	4	1	3	2	3	2
I-215 interchange to 2300 North	4	1	3	1	3	2	3	2
2300 North to 600 North	3	1	3	1	3	2	3	2
600 North to I-80 WB	4	2	4	2	4	2	4	2
I-80 WB to 800 South	3	2	3	2	3	2	3	2
800 South to 12300 South	4	2	5	2	3	3	4	3
12300 South to Bangerter Highway	5	2	5	2	4	3	4	3
Bangerter to 2100 North Freeway	5	1	5	1	4	2	4	2
***Barrier separated, limited access lanes for use by carpool, transit, and tolled vehicles**								

Table 2: Lane Configurations for WFCCS Scenario 3

	In 2040 RTP network				reversible and elevated*				
I-15 Segment	NB GP	NB HOV	SB GP	SB HOV	NB	NB HOV	Center rever-sible	SB GP	SB HOV
Legacy to I215/89 Interchange	4	1	4	1	4		2	4	
I215/89 interchange to 2300 N	4	1	3	1	4		2	3	
2300N to 600N	3	1	3	1	3		2	3	
600N to I80 WB	4	2	4	2	5		2	5	
I80WB to 800S	3	2	3	2	3	2		3	2
800S to I80 EB	4	2	5	2	4	2		5	2
I80EB to 12300 South	4	2	5	2	6	2		7	2
12300S to Bangerter	5	2	5	2	7	2		7	2
Bangerter to 2100N Freeway	5	1	5	1	5	1		5	1
***Cost estimates for I-15 Elevated costs were addressed separately under the above section "Projects with Capital Costs from Previous Studies / Estimates".**									

A cost per mile plus ROW costs were used to calculate the total capital costs for these key elements. Per discussions with the WFCCS Management Team, the WFCCS Technical Team assumed that I-15 will have been reconstructed to accommodate the lane configurations as depicted in the 2040 RTP shown in the tables above. Therefore the Technical Team only accounted for the difference in width between 2040 RTP lane configurations and proposed lane configurations to obtain capital costs.

In addition to the cost per mile and ROW costs, bridges along the corridor not associated with an interchange were evaluated for costs to widen in order to meet the new roadway width for the proposed lane configurations.

Capital Cost Assumptions for HOV & BRT with Grade Separated Intersections (Redwood Road and State Street)

This project included expanding the footprint to add an HOV/transit lane on two major transit corridors: Redwood Road from 500 South (Bountiful) to Bangerter Highway, and State Street from 1300 South to 12300 South. It also included grade separating transit/HOV lanes at 4500 South, 5400 South, 7000 South, 9000 South, and 10600 South (the sections of Redwood Road and State Street between 4500 South and 10600 South generally have the highest levels of cross-street volumes which contribute to delay for north/south traffic).

A cost per mile (from RTP project costs) plus ROW costs were used to calculate the total capital costs for this project. Also included was a cost per grade separated crossing (5 crossings for each roadway corridor) which totaled $50,000,000 for each roadway corridor.

Capital Cost Assumptions for Doubletracking FrontRunner

The capital costs for this project include providing doubletrack where feasible along the FrontRunner corridor. Electrification costs were not included due to difficulty in finding comparable projects with associated costs. Initially, each bridge (Length X Width) was evaluated to get a cost for widening, extending, and/or reconstructing, including a cost per mile of track construction and ROW needed. It was found that comparing that analysis with the RTP cost per mile of track (including ROW) of $31,000,000 was pretty close so the RTP cost was used going forward.

Length of track to be doubletracked was looked at next. The approximate length of FrontRunner is 87.63 miles, of which 19.78 miles are already double track. That leaves 67.85 miles of single track currently along the FrontRunner corridor.

Some locations would be extremely difficult to construct doubletrack. These locations are:

- 3 miles near Bluffdale and the Point of the Mountain area
- 1 mile just north of Shields Lane
- 0.5 miles from 10000 South to 9600 South
- 0.7 miles from 7800 South to 7200 South

- 1.1 miles from 6825 South to 5900 South
- 0.6 miles from 5300 South to 5100 South
- 1.5 miles from 4500 South to I-15
- 1.6 miles from 2890 South to 1700 South
- 1 mile from 1300 South to 600 South
- 0.5 miles @ Parrish Lane

Removing these areas from the total remaining single track length of 67.85 miles leaves 56.35 miles to be doubletracked.

Project Scenario Configuration & Capital Cost Scenario Project Assignments

The scenario project assignments identify which phase each capital cost feature is constructed within (Table 3). These phases correspond with the RTP phases, with Phase 4 representing the 10-year period after the end of the currently-adopted RTP. All WFCCS projects were assumed for completion in the middle of the RTP phase to which they were assigned: 2029 for Phase 2, 2037 for Phase 3, and 2045 for Phase 4. No projects were identified for construction in the RTP's Phase 1 due to the planning, design, and construction time required to implement projects. Table 4 identifies which capital costs are included in each scenario.

Table 3: Construction Timing of Key Elements in WFCCS Scenarios

Phase 2: 2024-2034	Phase 3: 2034-2040	Phase 4: 2040-2050
Grid 2.0 - refine the surface street grid network	Barrier separated HOV, toll, and express bus lanes on I-15	Grid 3.0 - HOV/HOT lane conversions on major arterials
Free transit	Doubletrack/electrify FrontRunner commuter rail	New arterial HOV and BRT lanes with grade-separated intersections
Increased transit frequency during peak period	Fully priced freeway lanes	I-15 elevated
Mobility Hubs	Increased transit frequency during peak period	Reversible lanes on I-15
Expanded C/D system along I-15	Add infill rail transit stations	Active Transportation Networks
Cycle Superhighway		

Table 4: Capital Costs by WFCCS Scenario

Scenario 1	Scenario 2	Scenario 3
Grid 2.0	Doubletrack/Electrify FrontRunner commuter rail	Doubletrack/Electrify FrontRunner commuter rail
Barrier separated HOV, toll, and express bus lanes on I-15	Barrier separated HOV, toll, and express bus lanes on I-15	Infill FrontRunner stations
Active Transportation Networks	Grid 2.0	Mobility Hubs
Cycle Superhighway	Grid 3.0	HOV & BRT lanes on select arterials with grade separated intersections
		Cycle Superhighway
		I-15 Elevated
		C/D Expansion I-15
		I-15 Reversible Lanes (Davis County)
		Active Transportation Networks

Construction Costs by Scenario and Phase

Tables 5, 6, and 7 show construction costs broken into scenarios and phases.

Table 5: Scenario 1 Construction Costs		
Phase 2		
Item	Total Cost	Cost per year 2025-2034
Grid 2.0	$218,380,000	$21,838,000
Cycle Superhighway	$319,280,000	$31,928,000
Phase 2 Total	$537,660,000	$53,766,000
Phase 3		
Item	Total Cost	Cost per year 2035-2040
Barrier separated HOV, toll, and express bus lanes on I-15	$1,565,805,000	$260,967,500
Phase 3 Total	$1,565,805,000	$260,967,500
Phase 4		
Item	Total Cost	Cost per year 2041-2050
Active Transportation Elements	$193,040,000	$19,304,000
Phase 4 Total	$193,040,000	$19,304,000
Total Scenario 1	**$2,296,505,000**	

Table 6: Scenario 2 Construction Costs		
Phase 2		
Item	Total Cost	Cost per year 2025-2034
Grid 2.0	$218,380,000	$21,838,000
Phase 2 Total	$218,380,000	$21,838,000
Phase 3		
Item	Total Cost	Cost per year 2035-2040
Doubletrack FrontRunner	$1,746,850,000	$291,141,667
Barrier separated HOV, toll, and express bus lanes on I-15	$1,565,805,000	$260,967,500
Phase 3 Total	$3,312,655,000	$552,109,167
Phase 4		
Item	Total Cost	Cost per year 2041-2050
Grid 3.0	$140,370,000	$14,037,000
Phase 4 Total	$140,370,000	$14,037,000
Total Scenario 2	**$3,671,405,000**	

Table 7: Scenario 3 Construction Costs		
Phase 2		
Item	Total Cost	Cost per year 2025-2034
Mobility Hubs	$1,500,000,000	$150,000,000
Cycle Superhighway	$319,280,000	$31,928,000
C/D Expansion I-15	$416,900,000	$41,690,000
Phase 2 Total	$2,236,180,000	$223,618,000
Phase 3		
Item	Total Cost	Cost per year 2035-2040
Doubletrack FrontRunner	$1,746,850,000	$291,141,667
Infill Stations	$20,000,000	$3,333,333
I-15 Reversible Lanes (Davis Co.)	$234,535,000	$39,089,167
Phase 3 Total	$2,001,385,000	$333,564,167
Phase 4		
Item	Total Cost	Cost per year 2041-2050
HOV & BRT with Grade Separated Intersections (Redwood Rd. and State St.)	$531,905,000	$53,190,500
I-15 Elevated	$1,700,000,000	$170,000,000
Active Transportation Networks	$193,040,000	$19,304,000

Phase 4 Total	$2,424,945,000	$242,494,500
Total Scenario 3	**$6,662,510,000**	

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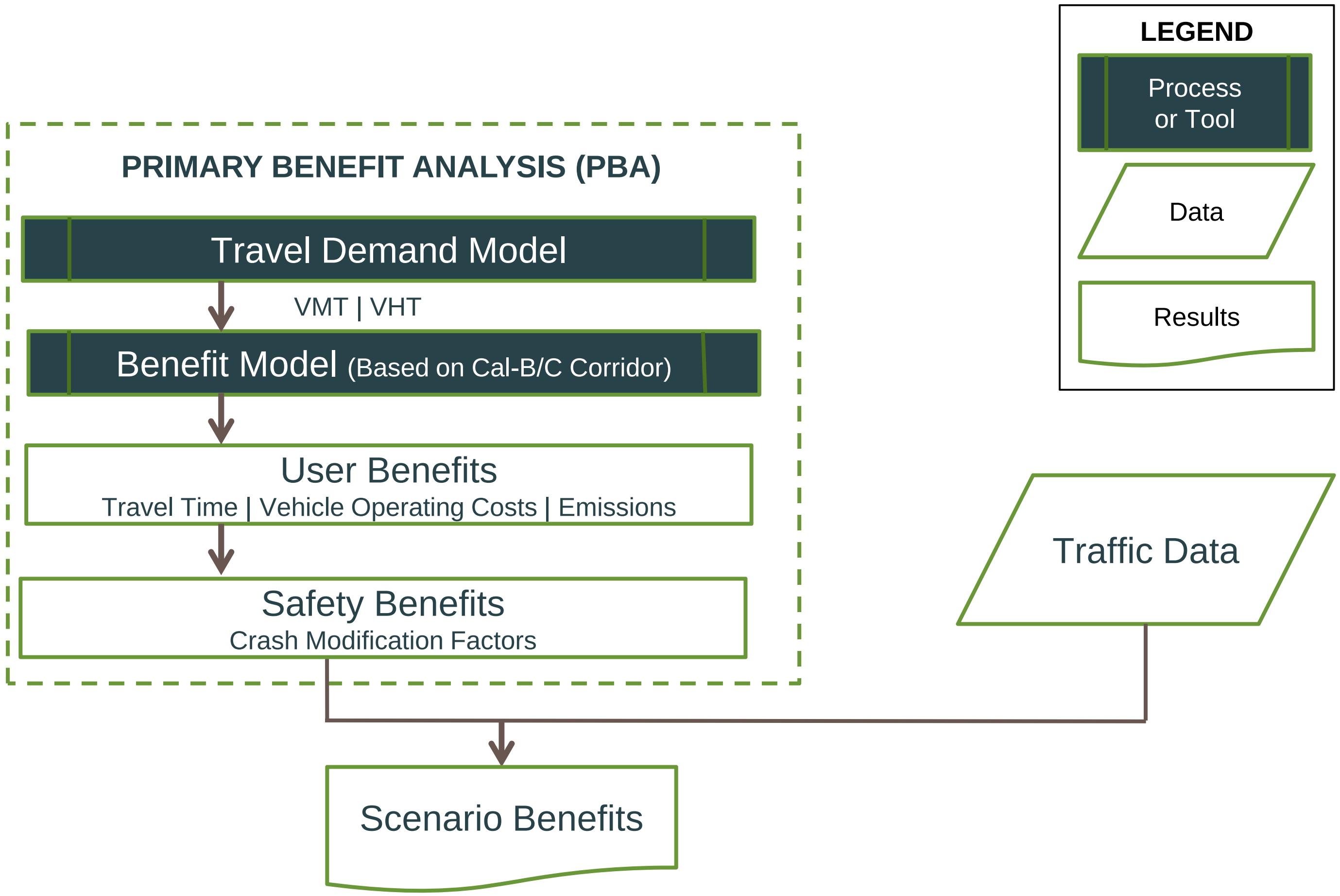
Appendix C: Travel Demand Model Outputs

Modeling Scenario Benefits



Travel Demand Model Scenarios

Scenario	Description
2014 Base Year	Base Year of Model
2050 Scenario 0	‘No Build’ Horizon Year with all Vision projects
2050 Scenario 1	‘Build’ Horizon Year for Scenario (several Vision projects excluded)
2050 Scenario 2	‘Build’ Horizon Year for Scenario 2 (some Vision projects excluded)
2050 Scenario 3	‘Build’ Horizon Year for Scenario 3

Model Data Needed for BCA

- Vehicle-Miles Traveled (VMT)
- Vehicle-Miles Traveled (VHT)

by speed bin for each scenario

- Speeds by Speed Bin

  Speed = VMT/VHT

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Inputs from Travel Demand Model

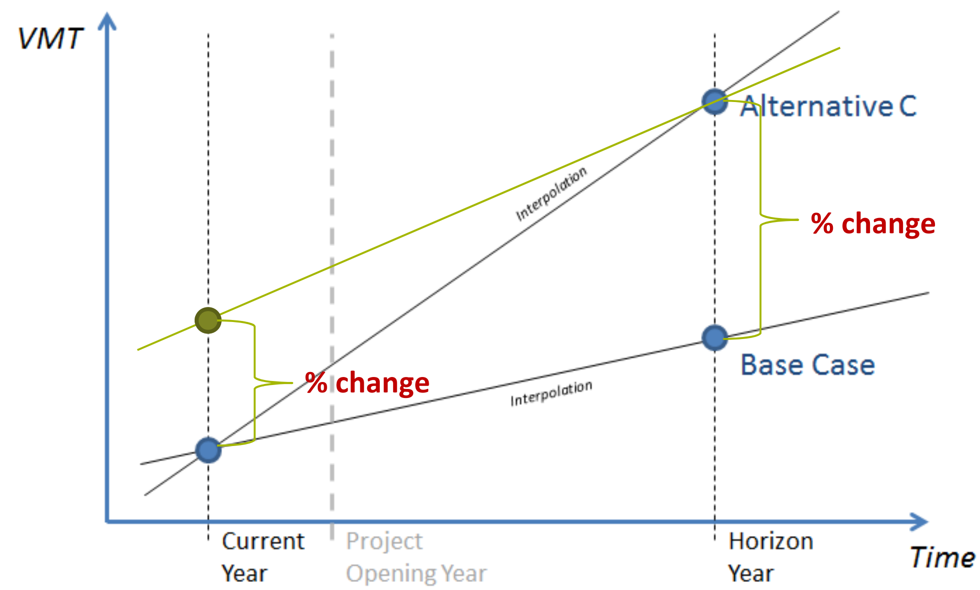
- Vehicle Benefits
  - Passenger Vehicles (Autos)
    - Vehicle-Miles Traveled by Speed Bin
    - Vehicle-Hours Traveled by Speed Bin
    - Number of Trips
  - Freight Vehicle (Trucks)
    - Vehicle-Miles Traveled by Speed Bin
    - Vehicle-Hours Traveled by Speed Bin
    - Number of Trips

Inputs from Travel Demand Model (cont'd)

- Transit Benefits
  - Transit Modes
    - Local Bus
    - BRT
    - Express Bus
    - Light Rail (TRAX)
    - Commuter Rail (FrontRunner)
  - Transit Data
    - Vehicle Revenue-Miles
    - Vehicle Revenue-Hours
    - Passenger-Hours Traveled
    - Person-Trips

Lifecycle Benefits Estimated from Model Data

- Estimated 'Build' for current year
- Interpolated data for intermediate years
- Adjusted 2050 'Build' Scenario to compare equivalent number of trips with Base Case



Adjustment Factors for Equivalent Trips

- Travel Demand Model data for each WFCCS scenario is adjusted to compare the same number of person trips as Scenario 0
- Passenger data was adjusted according to the total number of auto and transit trips
- Freight data was adjusted according to total number of truck trips
- These adjustment factors are presented in the table below:

Scenario	Auto & Transit	Trucks
S0	-	-
S1	0.9973	1.00073
S2	0.9849	0.99997
S3	0.9975	0.99991

2050 Daily VMT and VHT by Scenario (Passenger Vehicles)

Scenario	2050 Auto VMT	VMT Difference (S0 - scenario)	2050 Auto VHT	VHT Difference (S0 - scenario)
S0	66,726,774	-	1,909,702	-
S1	65,559,619	1,167,155	1,874,089	35,613
S2	62,569,594	4,157,180	1,754,578	155,124
S3	66,842,215	-115,440	1,877,785	31,917

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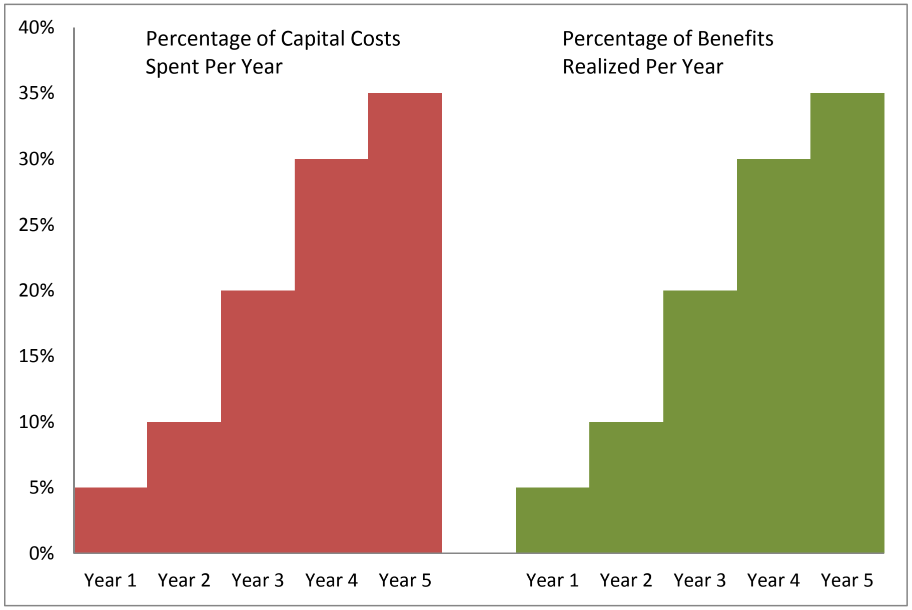
2050 Daily VMT and VHT by Scenario (Freight Vehicles)

Scenario	2050 Truck VMT	VMT Difference (S0 - scenario)	2050 Truck VHT	VHT Difference (S0 - scenario)
S0	11,417,406		314,083	
S1	11,208,319	209,087	309,833	4,250
S2	11,314,250	103,156	299,569	14,514
S3	11,503,330	-85,924	311,772	2,311

Appendix D: Scenario Benefits

Ramp-Up in Benefits

- Results from model data assume all projects built, but only a portion built each year, so… assume:
  - Benefits grow in proportion to capital expenditures for a given year
  - For example, if 5% of all project costs are spent in Year 1, then 5% of the potential benefits for that year are realized



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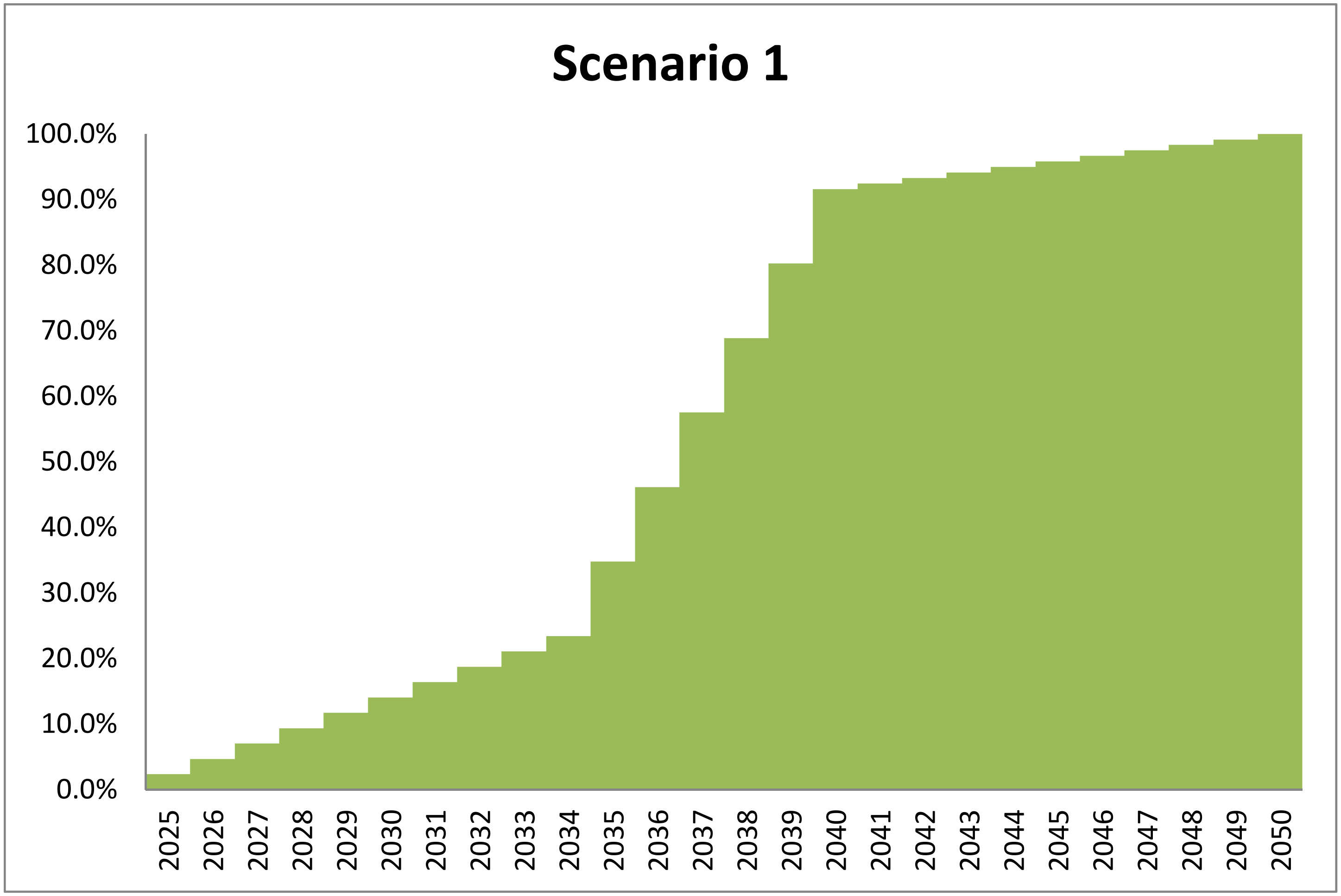
Ramp-Up in Benefits (cont'd)



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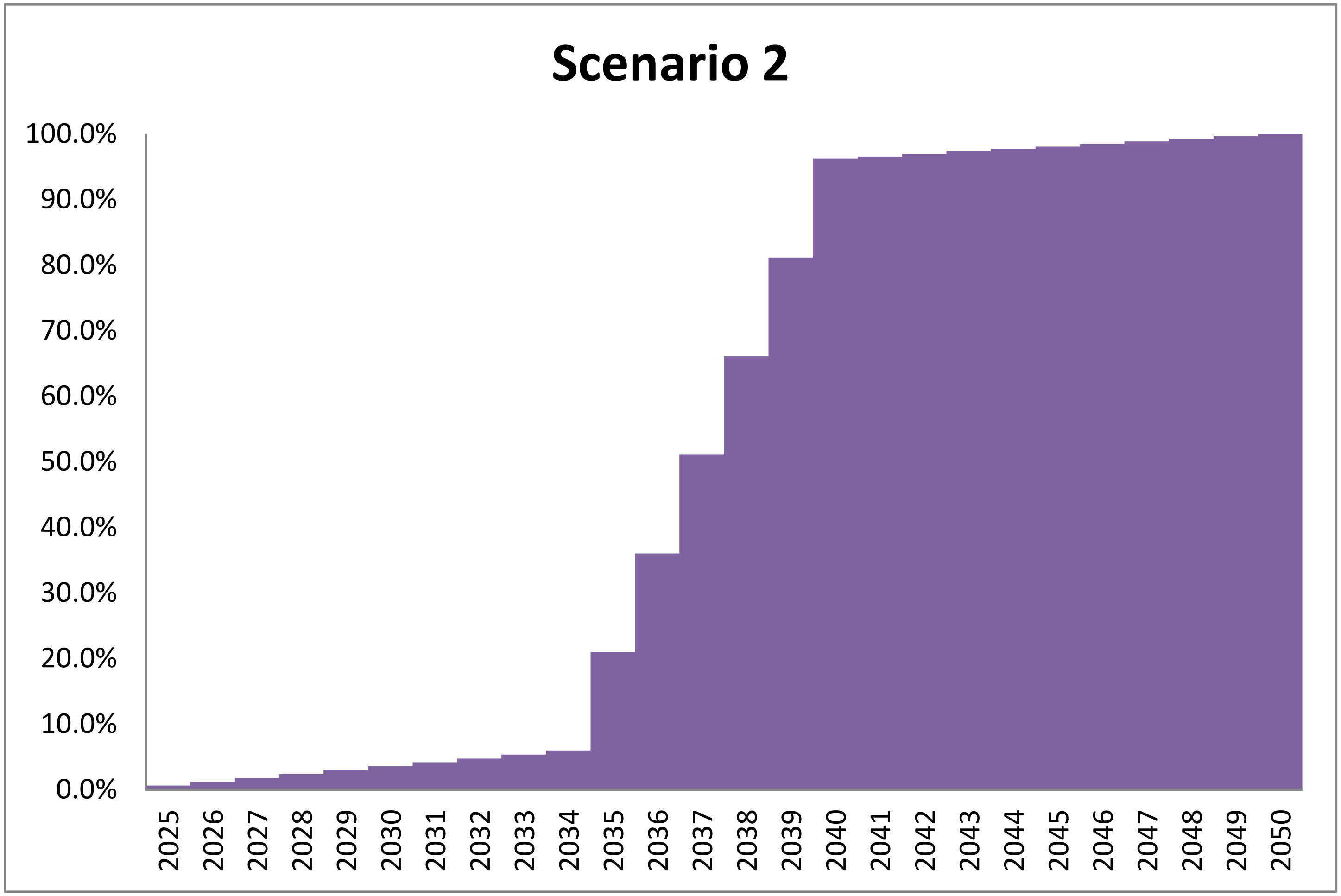
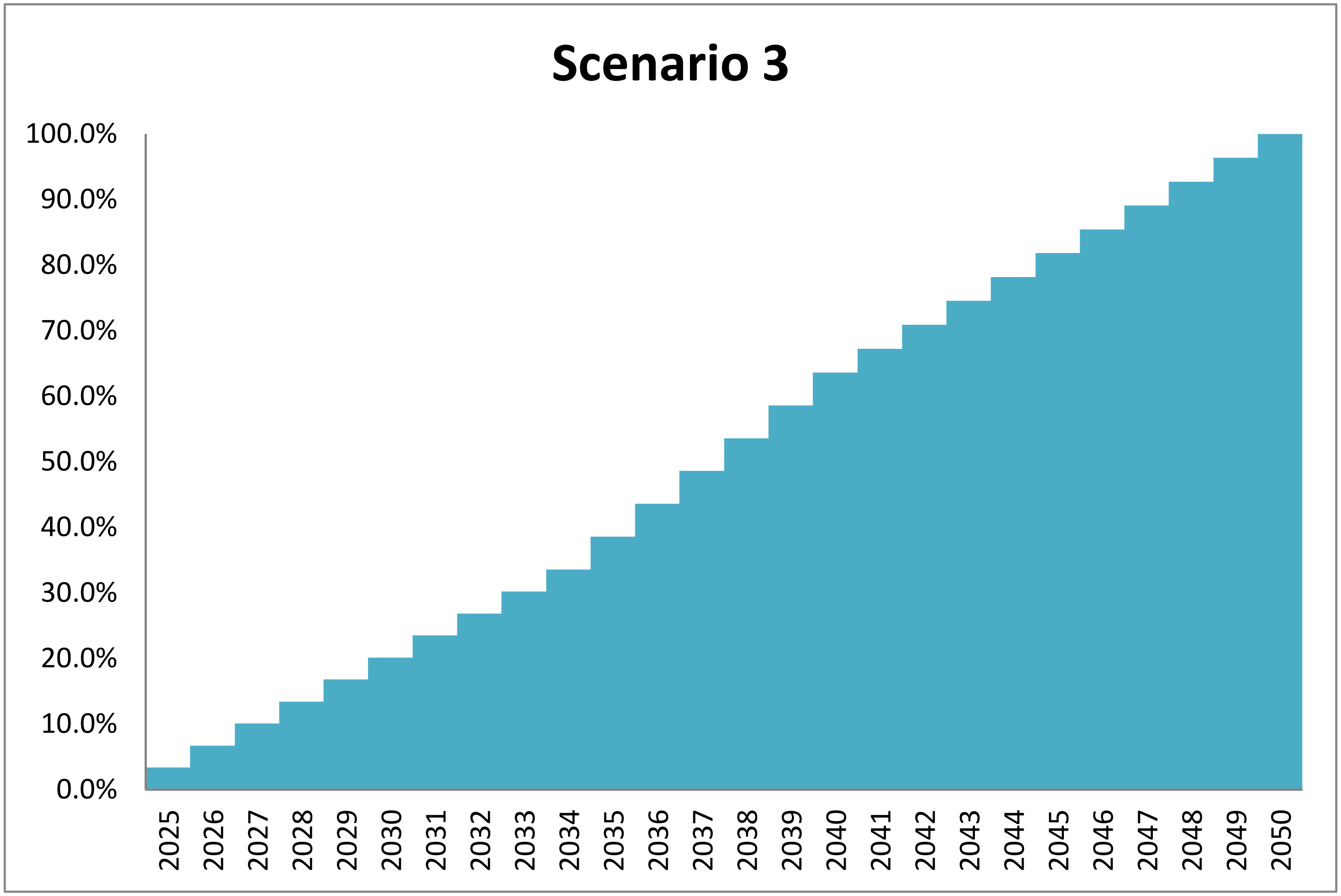
Ramp-Up in Benefits (cont'd)



Ramp-Up in Benefits (cont'd)



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Economic Benefits

- Travel Demand Model outputs are interpreted into economic benefits (VMT, VHT)
- Benefits are calculated separately for:
  - Passenger Vehicles (Autos)
  - Freight (Trucks)
  - Transit (Bus, Light Rail, Commuter Rail)
- Compare ‘Scenario 0’ and ‘WFCCS’ Scenarios to determine project impact

Types of Economic Benefits

- **Travel Time Savings**
  - Reduced travel times due to project improvements.
- **Vehicle Operating Cost Savings**
  - Fuel consumption and other out-of-pocket costs.
- **Crash Cost Savings**
  - Safety improvements estimated by reduced crashes
- **Emissions Cost Savings**
  - Value of reduced emissions from vehicles in study area

Vehicle Travel Time Savings

Scenario 0 vs. WFCCS Scenario Difference in VHT (Hours)

×

Vehicle	Average Vehicle Occupancy (Persons per Vehicle)
Passenger	1.55
Freight	1.00

Source: Travel Demand Model

=

Total Person Hours Saved (Hours)

Total Person Hours Saved (Hours)

×

Vehicle	Value of Time ($ / hour)
Passenger	$16.45
Freight	$26.11

Sources: US Census Bureau, Bureau of Labor Statistics Data, Utah 2015. USDOT Guidance for Economic Analysis, 2014.

=

Total Vehicle Travel Time Savings ($)

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Transit Travel Time Savings

Scenario 0 vs. WFCCS Scenario Passenger Hours Traveled by Mode (Hours)

×

Vehicle	Value of Time ($ / hour)
Passenger	$16.45

Sources: US Census Bureau, Bureau of Labor Statistics Data, Utah 2015. USDOT Guidance for Economic Analysis, 2014.

=

Total Transit Travel Time Savings ($)

Travel Time Savings

- Key Drivers
  - Vehicle Hours Traveled
    - Changes in Vehicle Speeds
    - Shorter Vehicle Trips
    - Less Congestion and Improved Traffic Flow
  - Passenger Hours Traveled
    - Note that mode shifts from auto to transit increase transit passengers hours, which impact transit travel time savings

Travel Time Savings Sources

- U.S. Census Bureau (2015), Table H-8. Median Household Income by State, Utah
  - https://www.census.gov/hhes/www/income/data/historical/household/2015/h08.xls
- Utah BLS data, May 2015 Survey
  - http://www.bls.gov/oes/
- US DOT, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, 2014
  - http://www.dot.gov/office-policy/transportation-policy/guidance-value-time

Vehicle Operating Cost Savings

Scenario 0 vs. WFCCS Scenario VMT by Speed Bin (miles)

× Fuel Consumption Rates for Passenger and Freight Vehicles (gallons/mile) × Gasoline and Diesel Costs for Utah ($ / gallon) = **Total Fuel Operating Cost Savings ($)**

Source: California Air Resources Board, EMFAC2011, 2011 & 2031 average

Source: Fuel Gauge Report, American Automobiles Association (AAA)

× Non-Fuel Operating Costs for Passenger and Freight Vehicles ($ / mile) = **Total Non-Fuel Operating Costs ($)**

Source: AAA, Your Driving Costs, How much are you really paying to drive?, 2016 Edition, American Transportation Research Institute (ATRI), An Analysis of the Operational Costs of Trucking: 2016 Update

Vehicle Operating Cost Savings

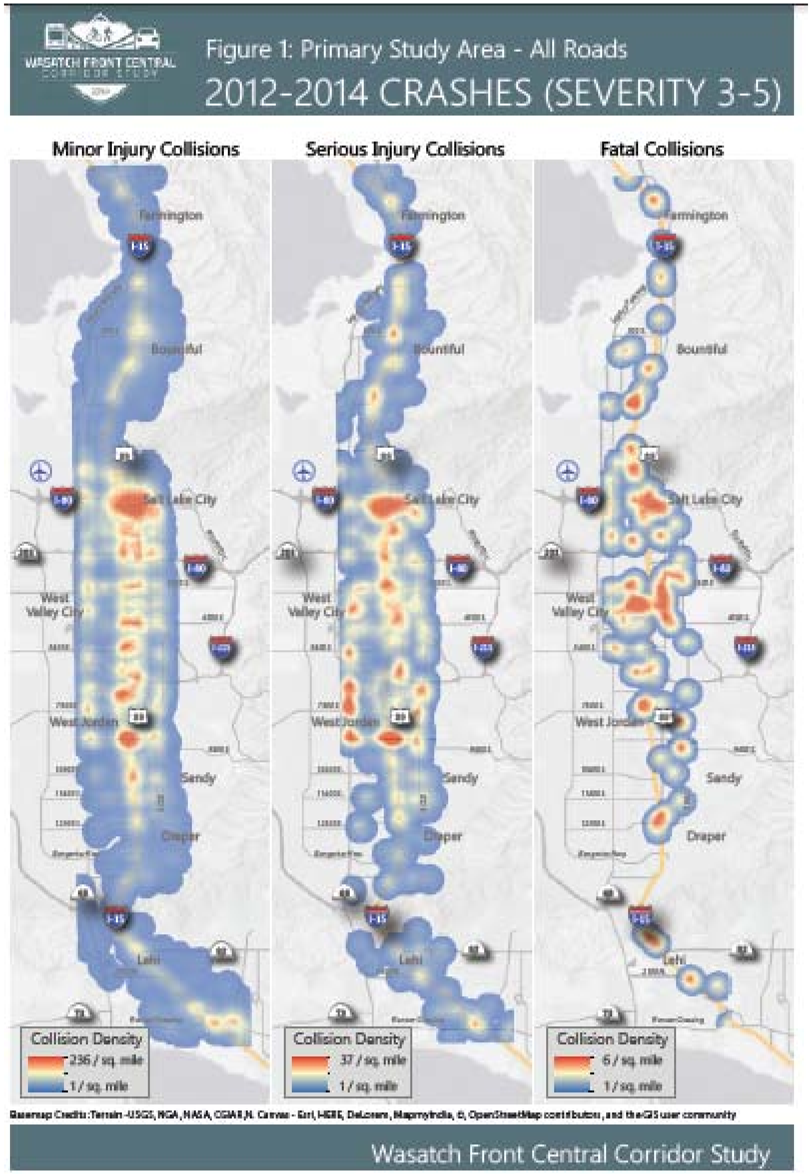
- Key Drivers
  - Vehicle Miles Traveled
    - Impacts both Fuel and Non-Fuel Operating Costs
  - Shifts to Transit Modes
    - Lower Operating Costs per Passenger on Bus, Light Rail, Commuter Rail
  - Changes in Vehicle Speeds and Fuel Consumption Rates
    - Vehicles traveling at less fuel efficient speeds

Vehicle Operating Cost Savings Sources

- Fuel Gauge Report, American Automobiles Association (AAA), Utah
  - http://fuelgaugereport.aaa.com/todays-gas-prices/
- AAA, *Your Driving Costs, How much are you really paying to drive?*, 2016 Edition
- American Transportation Research Institute (ATRI), An Analysis of the Operational Costs of Trucking: 2016 Update, September 2016
- California Air Resources Board, *EMFAC2011, 2011 & 2031 average* fuel consumption rates

Crash Cost Savings

- Safety Analysis conducted for WFCCS
- Crash reduction factors calculated for each scenario
  - Speed Reduction
  - Added Lighting
  - Pedestrian Hybrid Beacon (HAWK)



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Crash Cost Savings

- Crash reduction factors used to estimate number of accidents
- Scenario 1 has most significant safety improvement (Vision Zero strategies)

Severity	Scenario 1	Scenario 2	Scenario 3
Fatal Injury	12.7%	1.0%	0.0%
Major Injury	6.3%	0.1%	1.2%
Minor Injury	3.4%	0.0%	0.7%

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Crash Cost Savings

VMT in Scenario 0 and WFCCS Scenarios (miles) × Crash Rates by Severity (crashes / mile) × Crash Reduction from Improvements (%) = Number of Crashes Prevented from Improvements (crashes)

Number of Crashes Prevented from Improvements (crashes) ×

Crash Severity	Cost Per Accident (2016 $)
Fatality	$9,691,426
Major Injury	$463,492
Minor Injury	$126,241

USDOT Guidance on Treatment of the Economic Value of a Statistical Life, 2015

= **Total Crash Cost Savings ($)**

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Crash Cost Savings

- Key Drivers
  - Vehicle Miles Traveled
    - Longer Vehicle Trips Increases Exposure and Crash Risk
  - Shifts to Modes with lower crash rates
    - (Bus, Light Rail, Commuter Rail)
  - Crash Reduction Factors

Crash Cost Savings Sources

- WFCCS Safety Analysis (Crash Reductions)
- USDOT Guidance on Treatment of the Economic Value of a Statistical Life, 2015

Emissions Cost Savings

VMT by Speed Bin in No Build and Build Scenarios (miles) × Emission Rates by Vehicle Type (grams per mile) = **Total Vehicle Emissions (tons)**

MOVES Model Emissions for Salt Lake County Utah

Total Vehicle Emissions Saved (tons) ×

Emission Type	$ / US ton
CO	$0
CO_2e	$39
NO_X	$7,267
$PM_{2.5}$	$332,406
SO_X	$42,947
VOC	$1,843

= **Total Vehicle Emissions Savings ($)**

US DOT, TIGER BCA Resource Guide 2010

Emissions Cost Savings

- Key Drivers
  - Vehicle-Miles Traveled
  - Changes in Vehicle Speeds
    - More vehicles traveling at fuel efficient speeds
    - Less congestion
  - Shifts to Transit Modes with lower emissions rates per passenger
    - (Bus, Light Rail, Commuter Rail)

Emissions Cost Savings Sources

- Environmental Protection Agency (EPA) Motor Vehicle Emissions Simulator (MOVES), Salt Lake County
- US DOT, TIGER BCA Resource Guide and Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks (August 2012)

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2050

Appendix E: Benefit-Cost Analysis (BCA) Results

Discounted Project Benefits ($ millions)

Results Summary	Scenario 1	Scenario 2	Scenario 3
Travel Time Savings	$1,268.6	$6,054.9	$1,219.7
Vehicle Operating Costs	$921.4	$2,453.8	($75.0)
Crash Cost Savings	$940.7	$247.0	$10.6
Emissions	$63.5	$108.3	$1.3
Total Benefits	**$3,194.2**	**$8,864.1**	**$1,156.6**

Bike/pedestrian benefits not included

Scenario 1 Discounted Project Benefits

Year	Travel Time Savings	Vehicle Operating Costs - Fuel	Vehicle Operating Costs - Non-Fuel	Crash Cost Savings	Emissions	Total Economic Benefits
2025	$1,062,914	$308,574	$1,701,468	$1,860,284	$168,928	**$5,102,169**
2026	$2,325,847	$579,687	$3,328,946	$3,682,563	$327,088	**$10,244,132**
2027	$3,769,588	$987,039	$4,883,420	$5,465,678	$505,257	**$15,610,982**
2028	$5,376,043	$1,326,228	$6,365,994	$7,208,612	$697,589	**$20,974,466**
2029	$7,128,182	$1,574,198	$7,777,876	$8,910,489	$858,619	**$26,249,364**
2030	$9,009,989	$1,961,555	$9,120,366	$10,570,558	$1,017,042	**$31,679,510**
2031	$11,006,412	$2,301,383	$10,394,843	$12,188,191	$1,179,962	**$37,070,791**
2032	$13,103,321	$2,687,031	$11,602,753	$13,762,872	$828,133	**$41,984,110**
2033	$15,287,455	$3,304,343	$12,745,603	$15,294,192	$953,789	**$47,585,383**
2034	$17,546,389	$3,922,416	$13,824,948	$16,781,841	$1,078,904	**$53,154,498**
2035	$26,829,256	$5,881,050	$20,042,297	$24,610,799	$1,579,139	**$78,942,541**
2036	$36,529,321	$7,733,221	$25,947,486	$32,230,583	$2,063,561	**$104,504,173**
2037	$46,589,649	$9,390,029	$31,548,156	$39,640,067	$2,562,162	**$129,730,063**
2038	$56,956,895	$10,973,475	$36,852,097	$46,838,534	$3,038,491	**$154,659,492**
2039	$67,581,125	$12,727,095	$41,867,215	$53,825,655	$3,523,966	**$179,525,056**
2040	$78,415,647	$14,097,184	$46,601,502	$60,601,457	$3,991,754	**$203,707,545**
2041	$80,277,751	$13,848,440	$45,843,971	$60,301,384	$4,015,238	**$204,286,784**
2042	$82,034,247	$14,308,346	$45,086,680	$59,985,937	$4,037,849	**$205,453,060**
2043	$83,687,928	$13,855,501	$44,330,312	$59,655,790	$3,899,155	**$205,428,686**
2044	$85,241,556	$13,603,998	$43,575,512	$59,311,599	$3,896,128	**$205,628,794**
2045	$86,697,865	$13,554,930	$42,822,892	$58,954,011	$3,901,872	**$205,931,570**
2046	$88,059,558	$13,151,732	$42,073,028	$58,583,654	$3,883,228	**$205,751,199**
2047	$89,329,303	$12,653,191	$41,326,461	$58,201,145	$3,860,927	**$205,371,027**
2048	$90,509,738	$12,553,772	$40,583,703	$57,807,086	$3,849,964	**$205,304,263**
2049	$91,603,461	$12,569,291	$39,845,234	$57,402,066	$3,900,607	**$205,320,659**
2050	$92,613,037	$12,383,703	$39,111,504	$56,986,659	$3,904,449	**$204,999,353**
Total	**$1,268,572,479**	**$212,237,412**	**$709,204,270**	**$940,661,708**	**$63,523,800**	**$3,194,199,669**

Scenario 2 Discounted Project Benefits

Year	Travel Time Savings	Vehicle Operating Costs - Fuel	Vehicle Operating Costs - Non-Fuel	Crash Cost Savings	Emissions	Total Economic Benefits
2025	$3,736,276	$348,675	$1,252,549	$136,392	$91,954	**$5,565,846**
2026	$7,335,414	$686,382	$2,453,519	$269,845	$183,899	**$10,929,060**
2027	$10,800,172	$1,013,474	$3,603,303	$400,286	$274,853	**$16,092,089**
2028	$14,133,313	$1,308,021	$4,702,406	$527,655	$361,621	**$21,033,017**
2029	$17,337,608	$1,602,099	$5,751,434	$651,896	$448,757	**$25,791,795**
2030	$20,415,826	$1,884,424	$6,751,082	$772,967	$532,366	**$30,356,664**
2031	$23,370,731	$2,151,490	$7,702,124	$890,830	$615,083	**$34,730,258**
2032	$26,205,085	$2,428,148	$8,605,405	$1,005,459	$403,739	**$38,647,836**
2033	$28,921,635	$2,671,873	$9,461,832	$1,116,831	$444,562	**$42,616,733**
2034	$31,523,118	$2,965,815	$10,272,364	$1,224,933	$496,444	**$46,482,674**
2035	$109,092,884	$10,241,574	$35,403,940	$4,265,139	$1,745,834	**$160,749,371**
2036	$183,669,396	$17,139,474	$59,351,796	$7,223,777	$2,933,227	**$270,317,671**
2037	$255,321,426	$24,038,050	$82,140,399	$10,100,554	$4,201,390	**$375,801,820**
2038	$324,117,291	$30,709,150	$103,795,219	$12,895,324	$5,335,346	**$476,852,329**
2039	$390,124,797	$36,885,089	$124,342,565	$15,608,079	$6,478,995	**$573,439,525**
2040	$453,411,190	$42,831,479	$143,809,450	$18,238,942	$7,626,029	**$665,917,089**
2041	$446,303,076	$42,098,643	$140,845,824	$18,048,716	$7,639,910	**$654,936,170**
2042	$439,267,947	$41,356,179	$137,912,799	$17,856,826	$7,661,435	**$644,055,187**
2043	$432,306,449	$40,631,729	$135,011,813	$17,663,458	$7,658,811	**$633,272,260**
2044	$425,419,155	$39,608,969	$132,144,172	$17,468,793	$7,649,427	**$622,290,516**
2045	$418,606,572	$38,809,872	$129,311,057	$17,273,004	$7,639,900	**$611,640,404**
2046	$411,869,143	$38,030,458	$126,513,528	$17,076,254	$7,607,925	**$601,097,308**
2047	$405,207,249	$37,237,338	$123,752,534	$16,878,703	$7,617,666	**$590,693,490**
2048	$398,621,212	$36,479,481	$121,028,916	$16,680,502	$7,571,707	**$580,381,817**
2049	$392,111,294	$35,736,647	$118,343,418	$16,481,796	$7,545,577	**$570,218,732**
2050	$385,677,707	$34,987,608	$115,696,686	$16,282,723	$7,529,636	**$560,174,360**
Total	**$6,054,905,965**	**$563,882,142**	**$1,889,960,133**	**$247,039,685**	**$108,296,094**	**$8,864,084,020**

Scenario 3 Discounted Project Benefits

Year	Travel Time Savings	Vehicle Operating Costs - Fuel	Vehicle Operating Costs - Non-Fuel	Crash Cost Savings	Emissions	Total Economic Benefits
2025	$4,239,399	($36,778)	($406,030)	$29,187	($23,746)	**$3,802,032**
2026	$8,323,816	($59,431)	($792,745)	$58,394	($43,100)	**$7,486,933**
2027	$12,256,326	($118,086)	($1,160,572)	$87,550	($59,140)	**$11,006,078**
2028	$16,040,018	($36,754)	($1,509,950)	$116,591	($55,977)	**$14,553,927**
2029	$19,677,988	($130,267)	($1,841,332)	$145,457	($116,789)	**$17,735,056**
2030	$23,173,333	($4,763)	($2,155,177)	$174,094	($134,190)	**$21,053,297**
2031	$26,529,150	$41,698	($2,451,951)	$202,450	($131,617)	**$24,189,730**
2032	$29,748,533	$97,514	($2,732,128)	$230,480	($103,569)	**$27,240,830**
2033	$32,834,563	$164,367	($2,996,182)	$258,140	($106,765)	**$30,154,122**
2034	$35,790,311	$484,500	($3,244,591)	$285,392	($62,652)	**$33,252,959**
2035	$40,344,988	$905,686	($3,633,283)	$326,155	($32,749)	**$37,910,797**
2036	$44,709,388	$1,045,212	($3,999,285)	$366,274	($5,518)	**$42,116,070**
2037	$48,888,027	$1,192,566	($4,343,307)	$405,702	$8,357	**$46,151,346**
2038	$52,885,392	$1,326,572	($4,666,054)	$444,396	$8,116	**$49,998,423**
2039	$56,705,928	$1,495,123	($4,968,225)	$482,318	$27,816	**$53,742,959**
2040	$60,354,043	$1,656,461	($5,250,517)	$519,433	$62,389	**$57,341,810**
2041	$62,562,350	$1,771,690	($5,403,769)	$544,640	$97,030	**$59,571,941**
2042	$64,656,749	$1,916,657	($5,544,366)	$569,172	$128,972	**$61,727,184**
2043	$66,640,309	$2,093,144	($5,672,788)	$593,017	$158,008	**$63,811,690**
2044	$68,516,059	$2,219,922	($5,789,510)	$616,164	$168,477	**$65,731,112**
2045	$70,286,990	$2,341,751	($5,894,996)	$638,602	$188,515	**$67,560,862**
2046	$71,956,051	$2,460,150	($5,989,702)	$660,324	$220,997	**$69,307,820**
2047	$73,526,145	$2,574,847	($6,074,074)	$681,324	$271,107	**$70,979,349**
2048	$75,000,136	$2,142,470	($6,148,549)	$701,599	$239,154	**$71,934,810**
2049	$76,380,839	$2,256,679	($6,213,553)	$721,145	$264,194	**$73,409,304**
2050	$77,671,026	$2,350,664	($6,269,503)	$739,961	$317,424	**$74,809,572**
Total	**$1,219,697,857**	**$30,151,591**	**($105,152,140)**	**$10,597,961**	**$1,284,744**	**$1,156,580,012**

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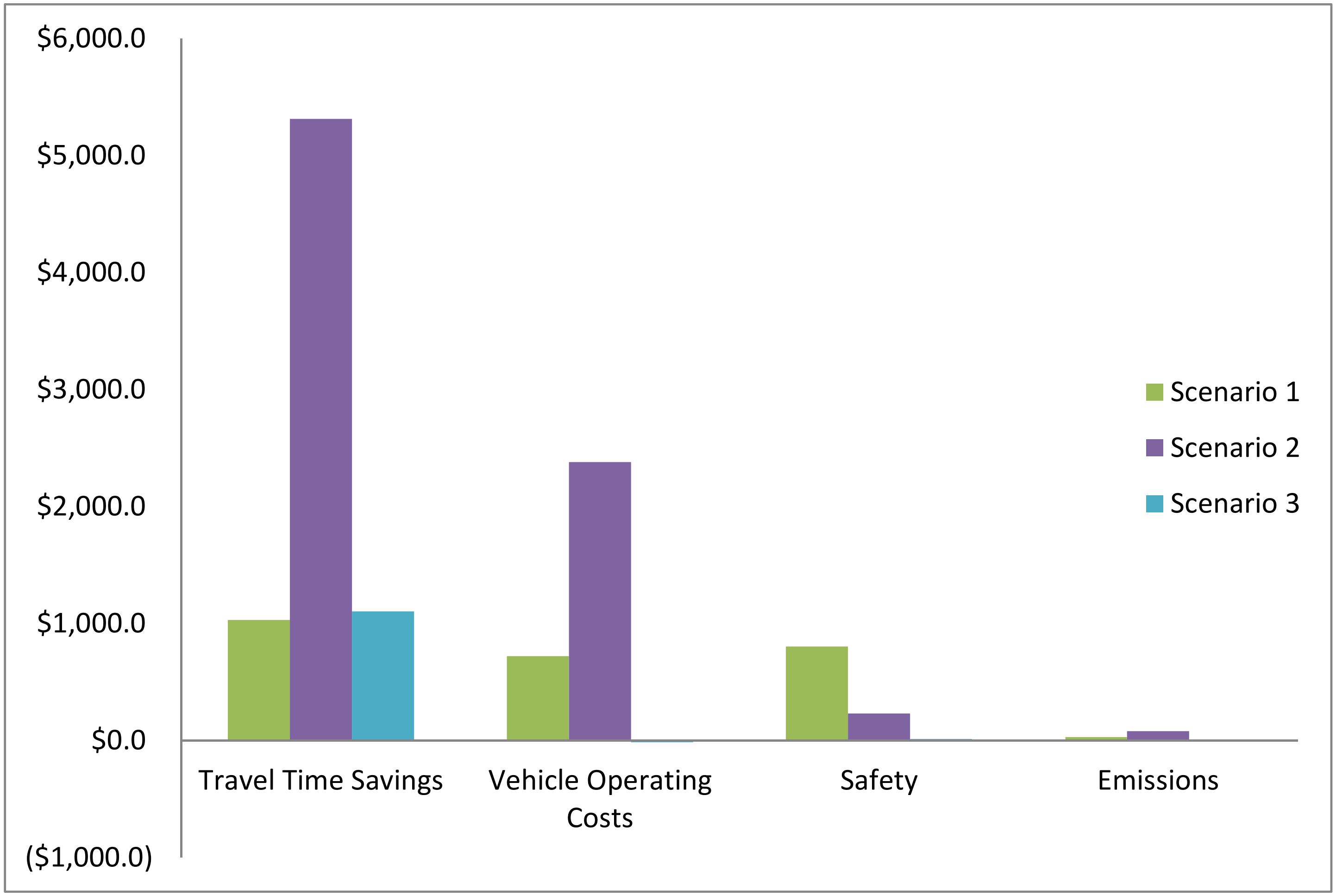
Discounted Project Benefits by Mode ($ millions)

Results Summary	Scenario 1	Scenario 2	Scenario 3
Passenger Benefits (Autos and Transit)	$2,583.6	$8,002.7	$1,108.0
Freight Benefits (Trucks)	$610.6	$861.4	$48.6
Total Benefits	**$3,194.2**	**$8,864.1**	**$1,156.6**

Bike/pedestrian benefits not included

Passenger Benefits ($ millions)



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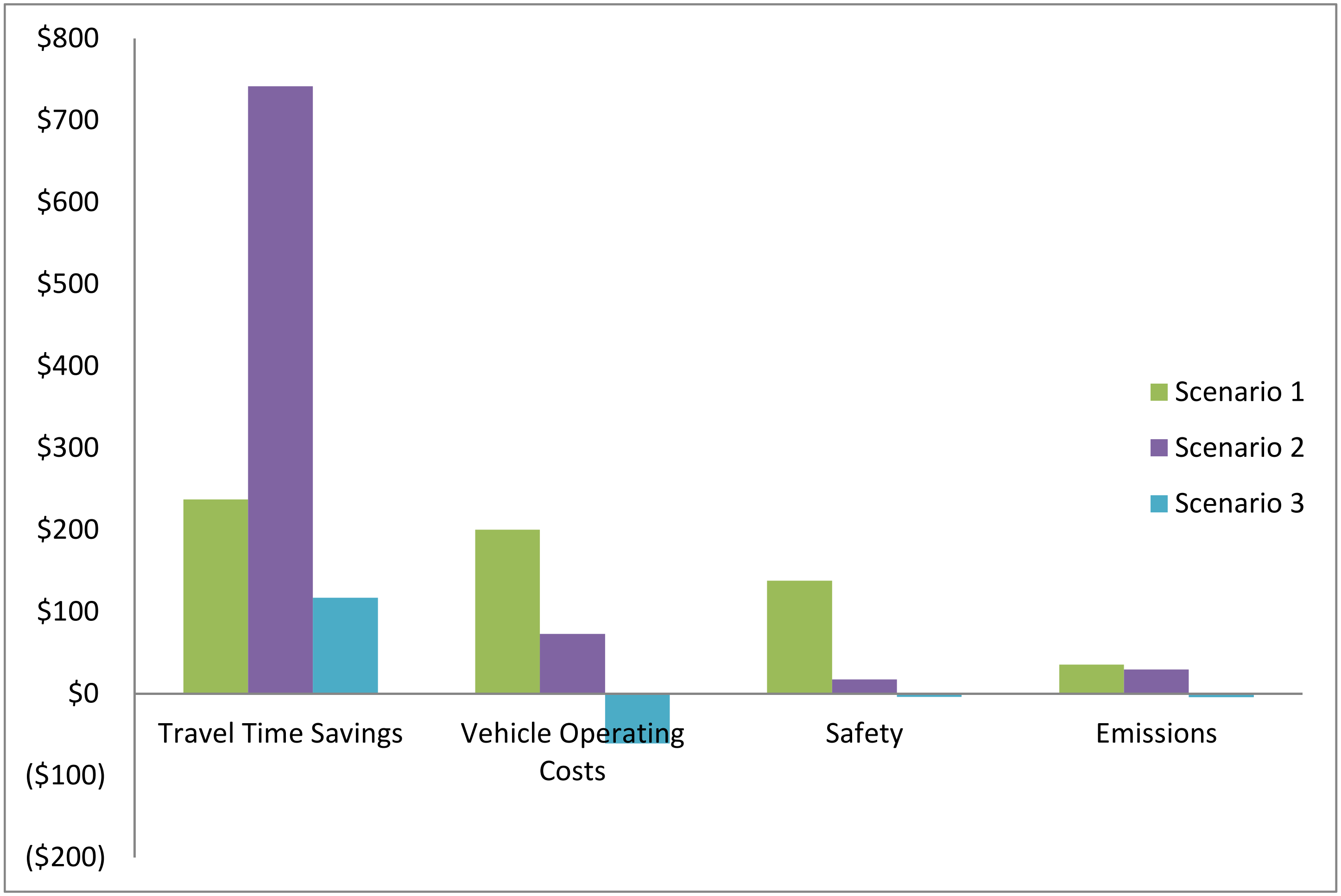
Freight Benefits ($ millions)



Discounted Project Costs ($ millions)

Project Costs	Scenario 1	Scenario 2	Scenario 3
Capital Costs	$1,062.9	$1,614.4	$2,977.8
Roadway O&M Costs	$6.9	$5.8	$9.5
Transit O&M Costs	-$159.5	$1,349.2	$339.3
Total Costs	**$910.2**	**$2,969.5**	**$3,326.5**

Scenario 1 Discounted Project Costs

Year	Capital Costs	Roadway O&M Costs	Transit O&M Costs	Total Scenario Costs
2025	$38,056,580	$0	($477,965)	**$37,578,615**
2026	$36,592,866	$14,491	($939,117)	**$35,668,240**
2027	$35,185,448	$27,867	($1,383,273)	**$33,830,041**
2028	$33,832,161	$40,192	($1,810,322)	**$32,062,032**
2029	$32,530,924	$51,529	($2,220,212)	**$30,362,241**
2030	$31,279,735	$61,933	($2,612,950)	**$28,728,719**
2031	$30,076,668	$71,462	($2,988,592)	**$27,159,538**
2032	$28,919,873	$80,165	($3,347,243)	**$25,652,796**
2033	$27,807,571	$88,094	($3,689,046)	**$24,206,618**
2034	$26,738,049	$95,294	($4,014,184)	**$22,819,158**
2035	$124,788,644	$254,181	($4,822,171)	**$120,220,654**
2036	$119,989,081	$126,161	($5,620,552)	**$114,494,691**
2037	$115,374,117	$143,053	($6,406,619)	**$109,110,550**
2038	$110,936,651	$158,459	($7,177,977)	**$103,917,132**
2039	$106,669,856	$172,468	($7,932,515)	**$98,909,809**
2040	$102,567,169	$534,639	($8,668,386)	**$94,433,423**
2041	$7,295,178	$196,631	($8,878,411)	**($1,386,603)**
2042	$7,014,595	$230,988	($9,070,111)	**($1,824,529)**
2043	$6,744,802	$262,411	($9,244,174)	**($2,236,960)**
2044	$6,485,387	$291,076	($9,401,279)	**($2,624,816)**
2045	$6,235,949	$2,020,906	($9,542,095)	**($1,285,240)**
2046	$5,996,105	$340,783	($9,667,278)	**($3,330,390)**
2047	$5,765,485	$362,131	($9,777,471)	**($3,649,855)**
2048	$5,543,736	$381,333	($9,873,307)	**($3,948,238)**
2049	$5,330,515	$398,522	($9,955,402)	**($4,226,364)**
2050	$5,125,496	$450,248	($10,024,361)	**($4,448,617)**
Total	**$1,062,882,643**	**$6,855,018**	**($159,545,015)**	**$910,192,646**

Scenario 2 Discounted Project Costs

Year	Capital Costs	Roadway O&M Costs	Transit O&M Costs	Total Scenario Costs
2025	$15,457,345	$0	$1,151,192	**$16,608,537**
2026	$14,862,832	$6,669	$2,261,887	**$17,131,388**
2027	$14,291,184	$12,825	$3,331,649	**$17,635,659**
2028	$13,741,523	$18,498	$4,360,207	**$18,120,228**
2029	$13,213,003	$23,716	$5,347,438	**$18,584,157**
2030	$12,704,811	$28,504	$6,293,357	**$19,026,672**
2031	$12,216,164	$32,890	$7,198,101	**$19,447,155**
2032	$11,746,312	$36,895	$8,061,920	**$19,845,127**
2033	$11,294,530	$40,545	$8,885,162	**$20,220,237**
2034	$10,860,125	$43,858	$9,668,266	**$20,572,250**
2035	$264,005,880	$199,228	$26,324,507	**$290,529,615**
2036	$253,851,808	$73,322	$42,148,001	**$296,073,131**
2037	$244,088,277	$92,246	$57,160,367	**$301,340,890**
2038	$234,700,266	$109,606	$71,383,476	**$306,193,348**
2039	$225,673,333	$125,495	$84,839,374	**$310,638,202**
2040	$216,993,589	$353,305	$97,550,215	**$314,897,109**
2041	$5,304,725	$153,201	$96,465,747	**$101,923,674**
2042	$5,100,697	$157,919	$95,362,760	**$100,621,376**
2043	$4,904,517	$162,047	$94,242,651	**$99,309,215**
2044	$4,715,882	$165,624	$93,106,803	**$97,988,309**
2045	$4,534,501	$1,872,445	$91,956,578	**$98,363,524**
2046	$4,360,098	$171,268	$90,793,313	**$95,324,678**
2047	$4,192,402	$173,402	$89,618,319	**$93,984,122**
2048	$4,031,155	$175,118	$88,432,881	**$92,639,154**
2049	$3,876,111	$176,445	$87,238,252	**$91,290,808**
2050	$3,727,030	$1,406,861	$86,035,654	**$91,169,545**
Total	**$1,614,448,100**	**$5,811,934**	**$1,349,218,077**	**$2,969,478,111**

Scenario 3 Discounted Project Costs

Year	Capital Costs	Roadway O&M Costs	Transit O&M Costs	Total Scenario Costs
2025	$158,281,003	$0	$1,548,881	**$159,829,884**
2026	$152,193,272	$19,823	$2,994,421	**$155,207,517**
2027	$146,339,685	$38,121	$4,341,672	**$150,719,477**
2028	$140,711,235	$54,982	$5,595,470	**$146,361,687**
2029	$135,299,265	$70,490	$6,760,449	**$142,130,203**
2030	$130,095,447	$84,723	$7,841,046	**$138,021,216**
2031	$125,091,776	$97,758	$8,841,510	**$134,031,044**
2032	$120,280,554	$109,664	$9,765,907	**$130,156,124**
2033	$115,654,379	$120,510	$10,618,126	**$126,393,015**
2034	$111,206,133	$130,359	$11,401,892	**$122,738,384**
2035	$159,502,697	$1,580,999	$13,182,066	**$174,265,762**
2036	$153,367,978	$137,537	$14,829,397	**$168,334,913**
2037	$147,469,210	$135,033	$16,350,664	**$163,954,907**
2038	$141,797,317	$132,518	$17,752,353	**$159,682,188**
2039	$136,343,574	$129,996	$19,040,666	**$155,514,237**
2040	$131,099,591	$263,640	$20,221,534	**$151,584,764**
2041	$91,641,143	$124,951	$19,539,343	**$111,305,438**
2042	$88,116,484	$179,663	$18,879,716	**$107,175,863**
2043	$84,727,388	$229,982	$18,241,925	**$103,199,295**
2044	$81,468,643	$276,164	$17,625,266	**$99,370,073**
2045	$78,335,233	$1,422,296	$17,029,057	**$96,786,586**
2046	$75,322,340	$357,082	$16,452,637	**$92,132,059**
2047	$72,425,327	$392,267	$15,895,367	**$88,712,961**
2048	$69,639,737	$424,218	$15,356,625	**$85,420,580**
2049	$66,961,286	$453,131	$14,835,811	**$82,250,228**
2050	$64,385,852	$2,529,437	$14,332,343	**$81,247,631**
Total	**$2,977,756,550**	**$9,495,345**	**$339,274,142**	**$3,326,526,037**

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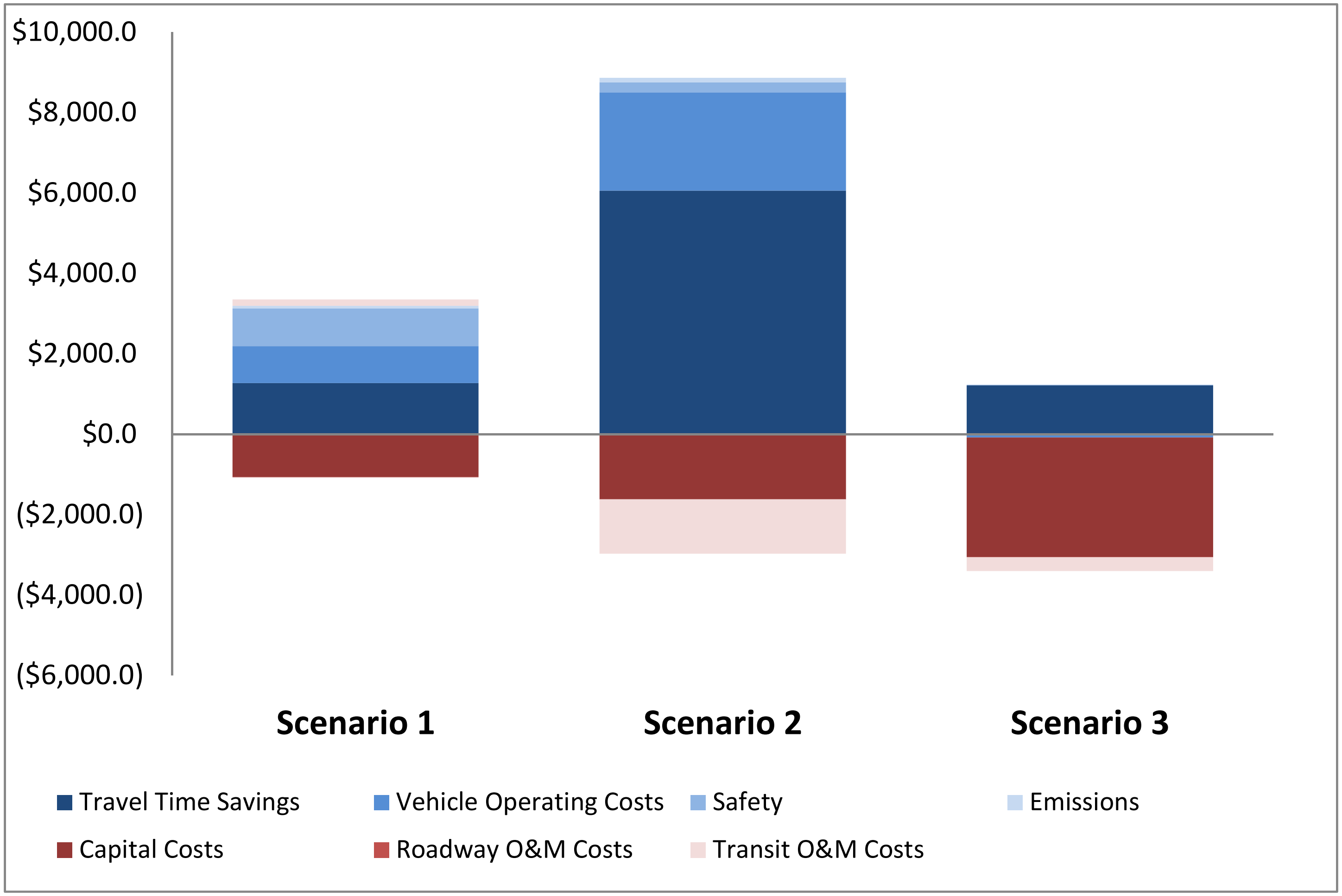
BCA Results by Scenario ($ millions)

Project Costs	Scenario 1	Scenario 2	Scenario 3
Lifecycle Benefits	$3,194.2	$8,864.1	$1,156.6
Lifecycle Costs	$910.2	$2,969.5	$3,326.5
Net Present Value	$2,284.0	$5,894.6	($2,169.9)
B/C Ratio	**3.51**	**2.99**	**0.35**

BCA Results by Scenario (cont'd)



Vision Projects in WFCCS Scenarios

	Element	Cost $ (millions)	Vision Projects	Scenario 1	Scenario 2	Scenario 3
WFRC Road	14600 South - Widen from 2-4 lanes	$9.5	✓			✓
WFRC Road	Redwood Road – Widen from 4-6 lanes	$27.0	✓			✓
WFRC Road	Mountain View Corridor, Widen from 4 to 6 lanes	$195.0	✓			✓
WFRC Transit	State Street Corridor- BRT/Enhanced Bus	$67.0	✓		✓	✓
WFRC Transit	Cottonwood/Kearns Corridor	$46.0	✓		✓	✓
WFRC Transit	East Sandy Daybreak Corridor	$55.0	✓		✓	✓
WFRC Transit	Draper Town Center / Riverton Corridor	$22.0	✓		✓	✓
MAG Transit	TRAX from Lehi to Orem	$622.4	✓		✓	✓
MAG Transit	TRAX from Lehi to Eagle Mountain	$544.6	✓			✓
MAG Transit	BRT from American Fork to Eagle Mountain	$30.2			✓	

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Sensitivity Analysis with Vision Projects
($ millions)

Project Costs	Scenario 1	Scenario 2	Scenario 3
Lifecycle Benefits	$3,524.5	$9,007.5	$1,156.6
Lifecycle Costs	$910.2	$2,959.8	$3,326.5
Net Present Value	$2,614.3	$6,047.7	($2,169.9)
B/C Ratio	**3.87**	**3.04**	**0.35**

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Appendix F: Economic Impact Analysis (EIA) Results

WFCCS Economic Impact Analysis

- Short-term (construction) and long-term (transportation efficiency) gains
  - **Construction:** construction and lifecycle operating and maintenance costs
  - **Transportation efficiency:** production cost savings, amenity benefits, consumption reallocation (related to fuel expenditures)
- Impacts estimated separately for:
  - Davis County
  - Salt Lake County
  - Utah County
- Total results sum up county results
- Economic impacts assessed in terms of GRP, personal income, and employment

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Overview of Economic Impact Findings

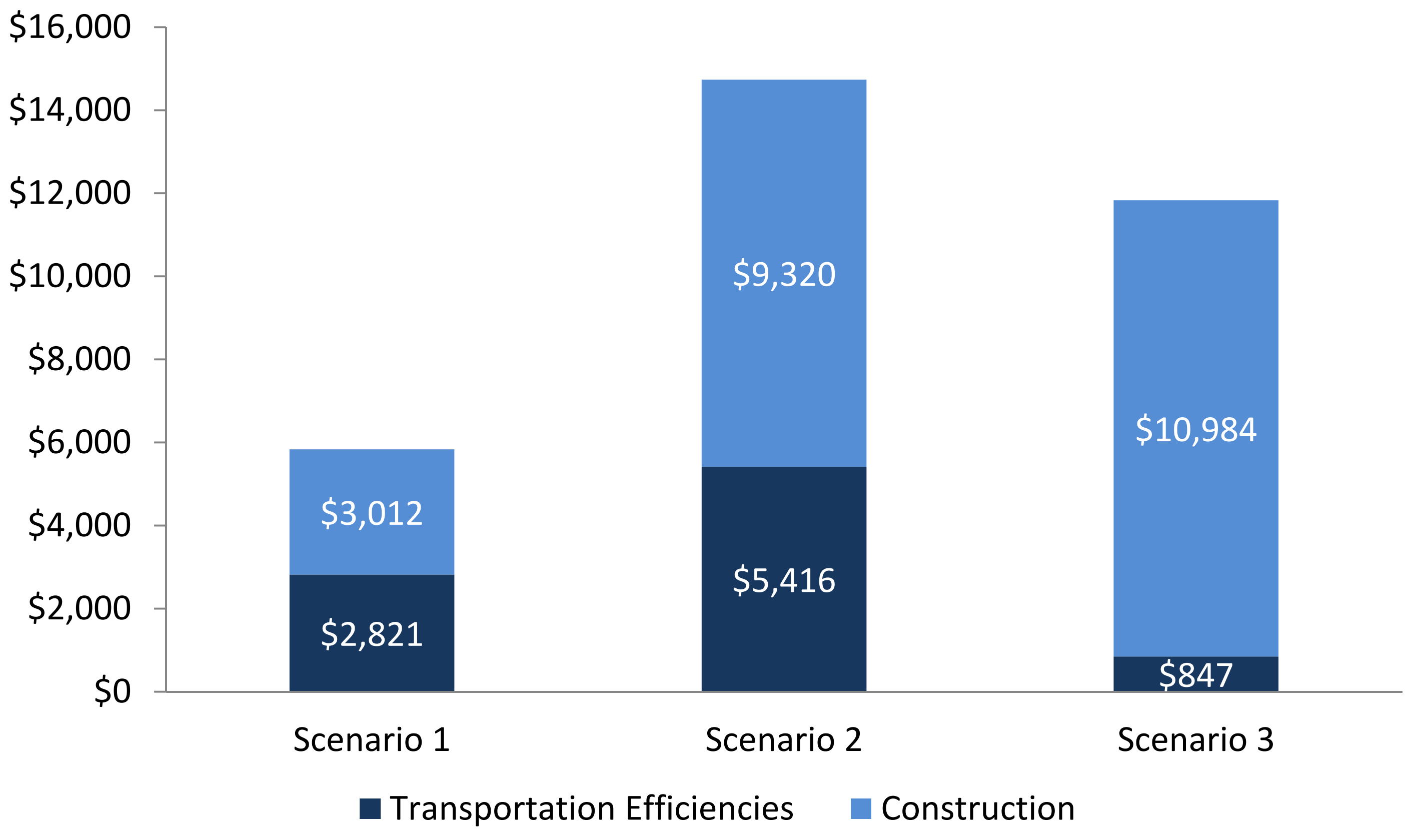
- Transportation efficiency impacts are smaller than construction impacts, but will continue to grow after 2050
- Scenarios 2 and 3 have the largest economic impacts
  - Scenario 2 will have longer lasting impacts due to transportation efficiency gains
  - Scenario 1 economic impacts are half the size of other scenarios, but transportation efficiency gains are larger than in Scenario 3
- Project phasing affects economic impacts
  - Reductions in construction spending cause negative impacts as economy restructures
  - Even construction spending is better than uneven spending
- Three-fifths of the economic impacts are in Salt Lake County
- Largest economic impacts in construction, followed by health care, government, and professional services
  - Reflects infrastructure construction and personal consumption
  - Distribution similar across scenarios

Summary of Total Economic Impact Analysis Results, 2025-2050

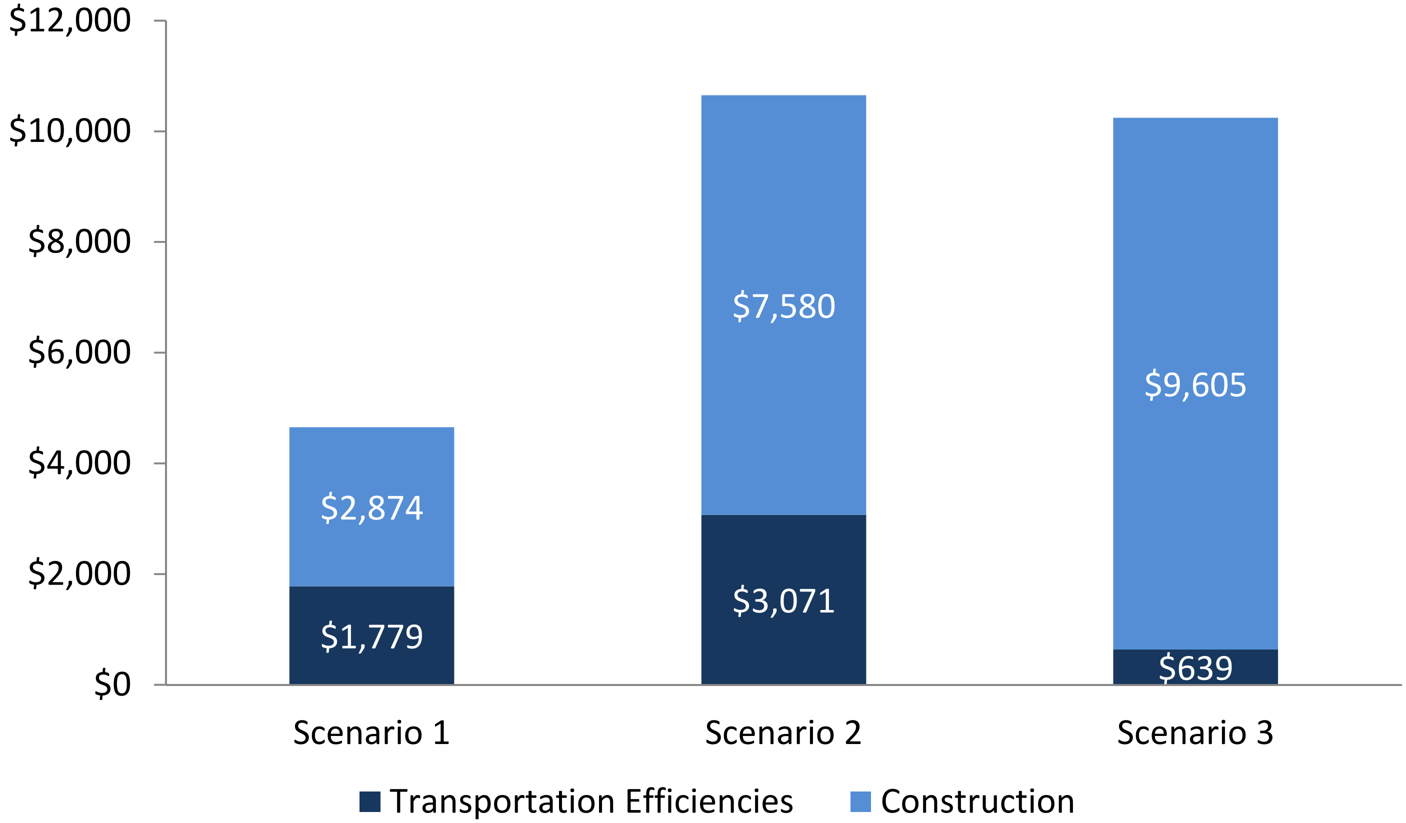
(includes construction and transportation efficiency gains)

Impact Metric	Scenario 1	Scenario 2	Scenario 3
Gross Regional Product ($ Millions)	$5,833.3	$14,735.9	$11,831.8
Personal Income ($ Millions)	$4,652.9	$10,650.7	$10,244.6
Employment (Job-Years)	44,242	103,263	103,615

GRP Impacts by Scenario, 2025-2050
($ millions)



Personal Income Impacts by Scenario, 2025-2050
($ millions)



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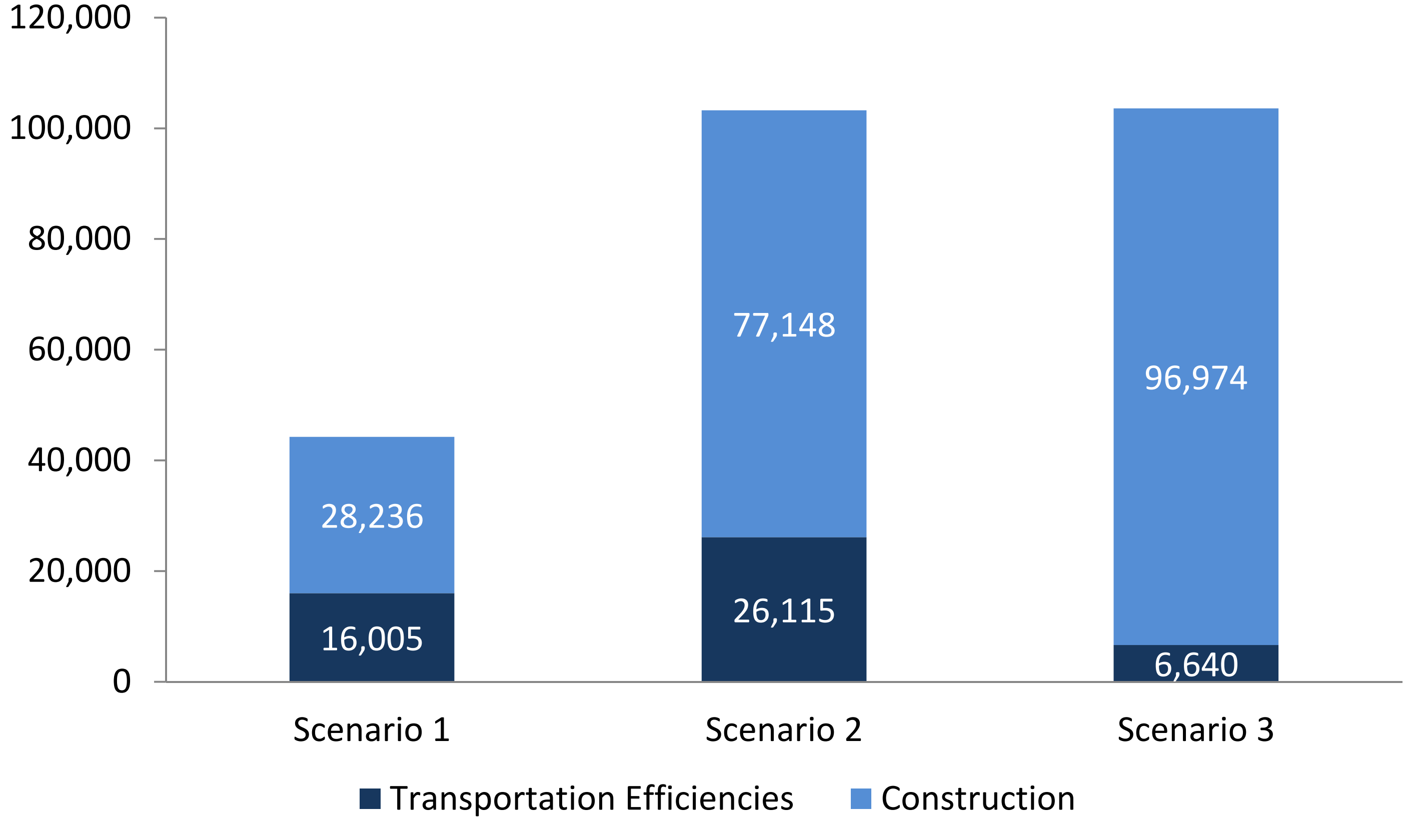
Employment Impacts by Scenario, 2025-2050
(job-years)



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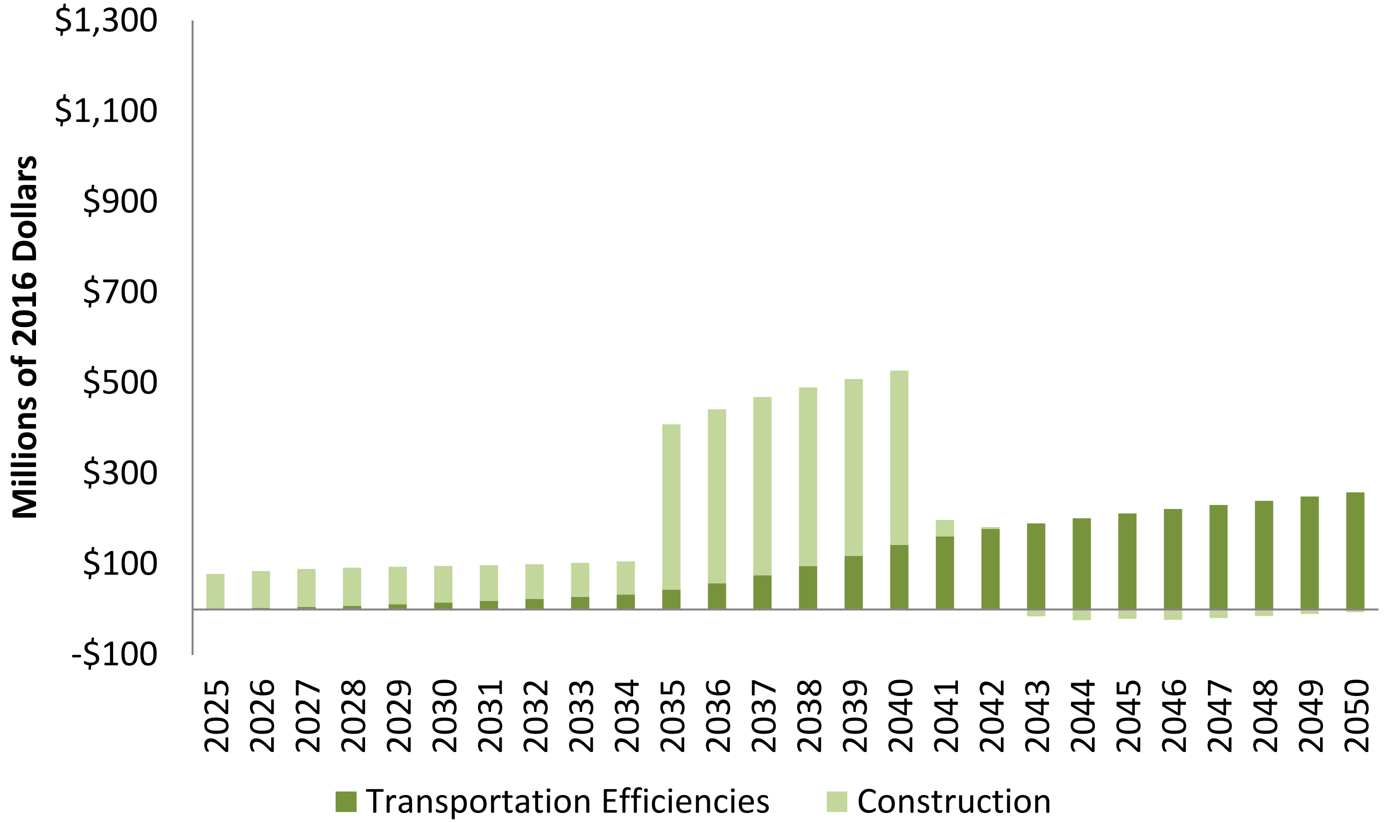
GRP Impacts by Type, 2025-2050
Scenario 1



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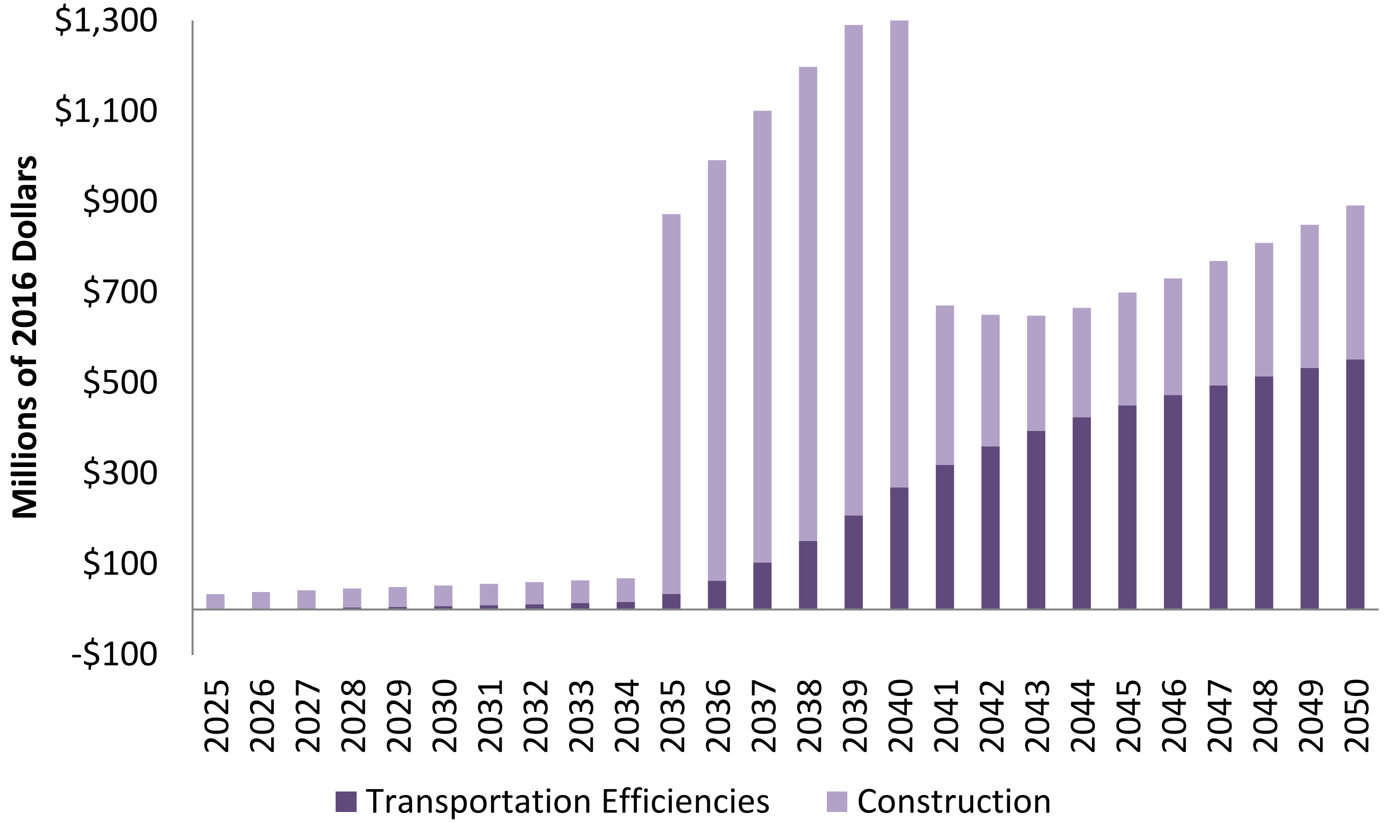
GRP Impacts by Type, 2025-2050
Scenario 2



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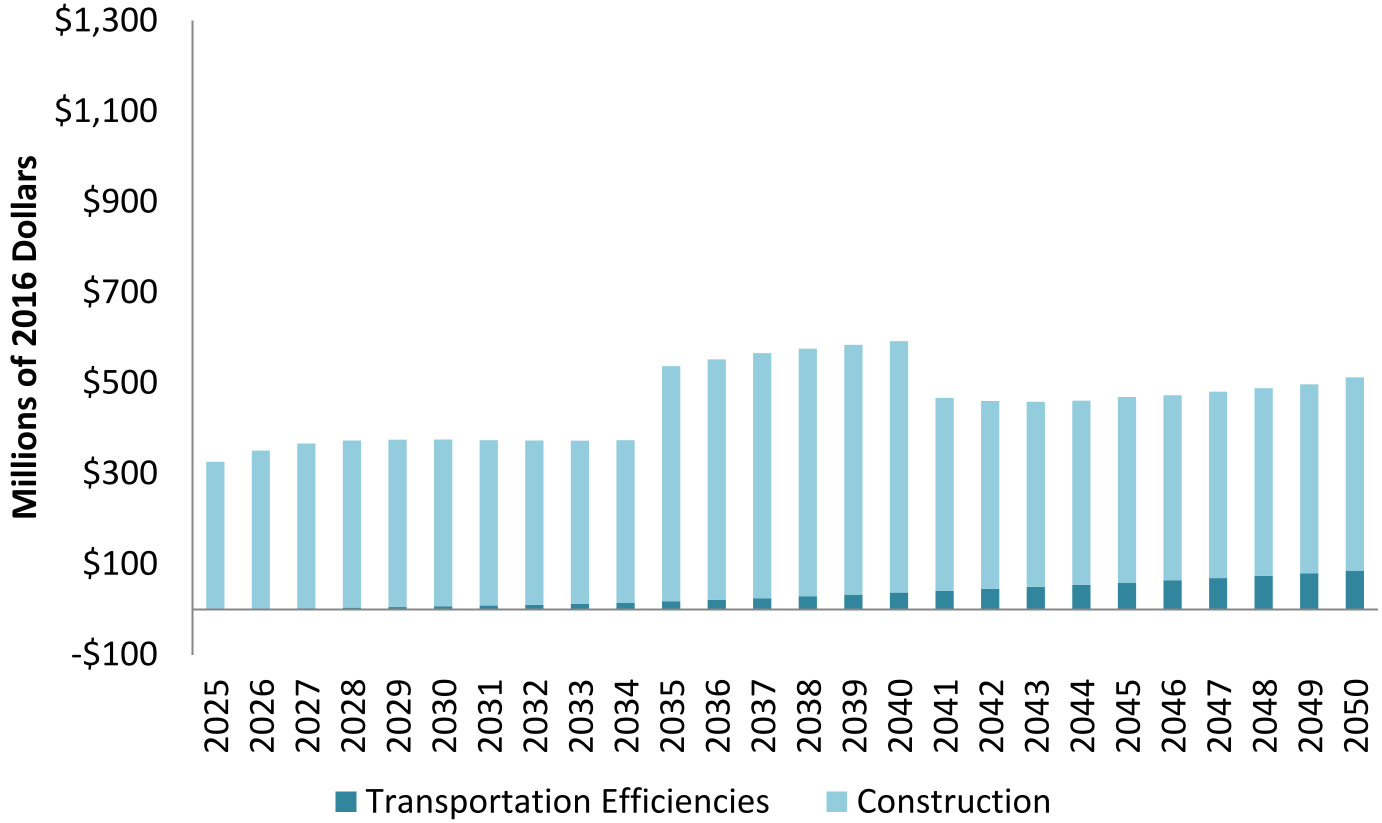
GRP Impacts by Type, 2025-2050
Scenario 3



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GRP Impacts of Construction, 2025-2050
Scenario 1

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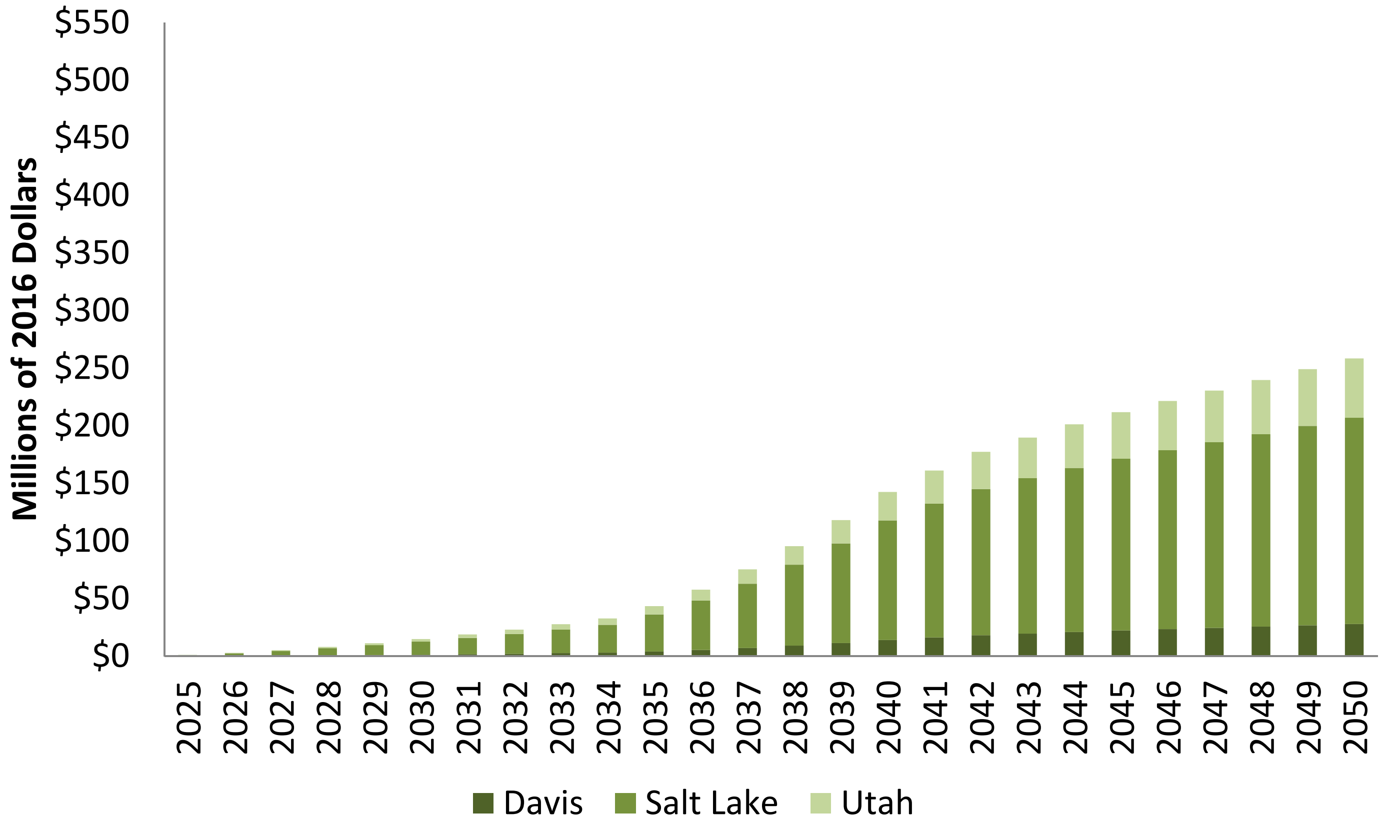
GRP Transportation Efficiencies Impacts, 2025-2050
Scenario 1



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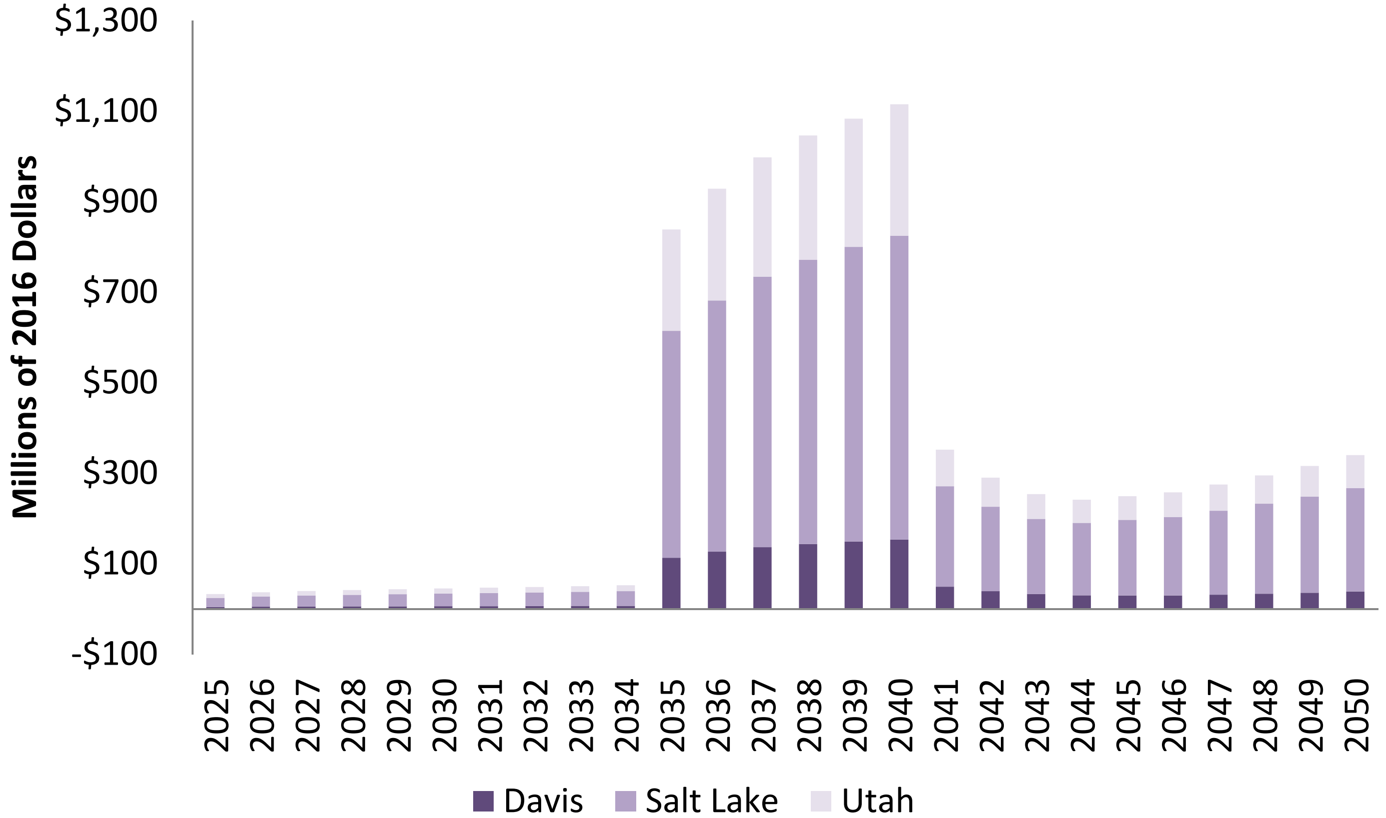
GRP Impacts of Construction, 2025-2050
Scenario 2



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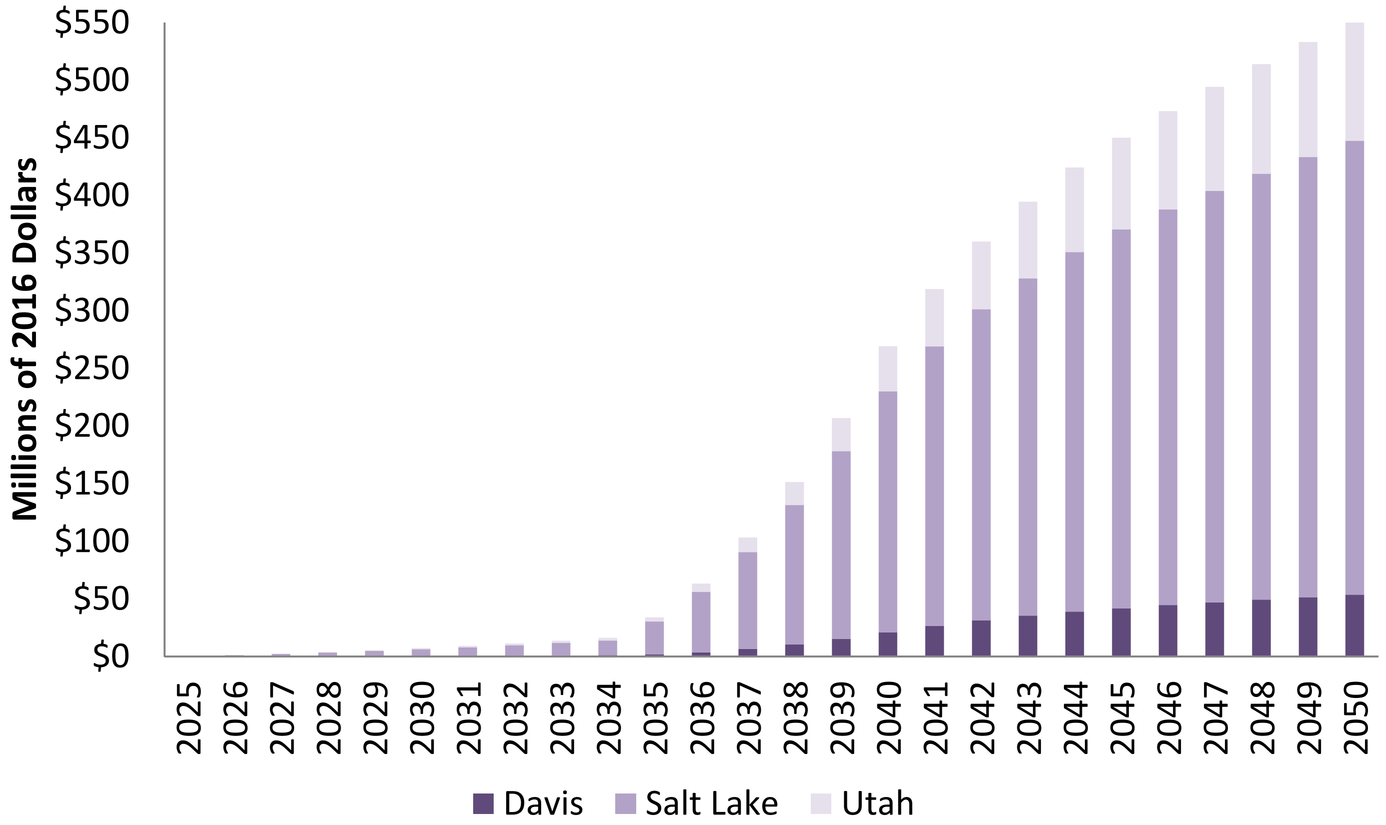
GRP Transportation Efficiencies Impacts, 2025-2050
Scenario 2



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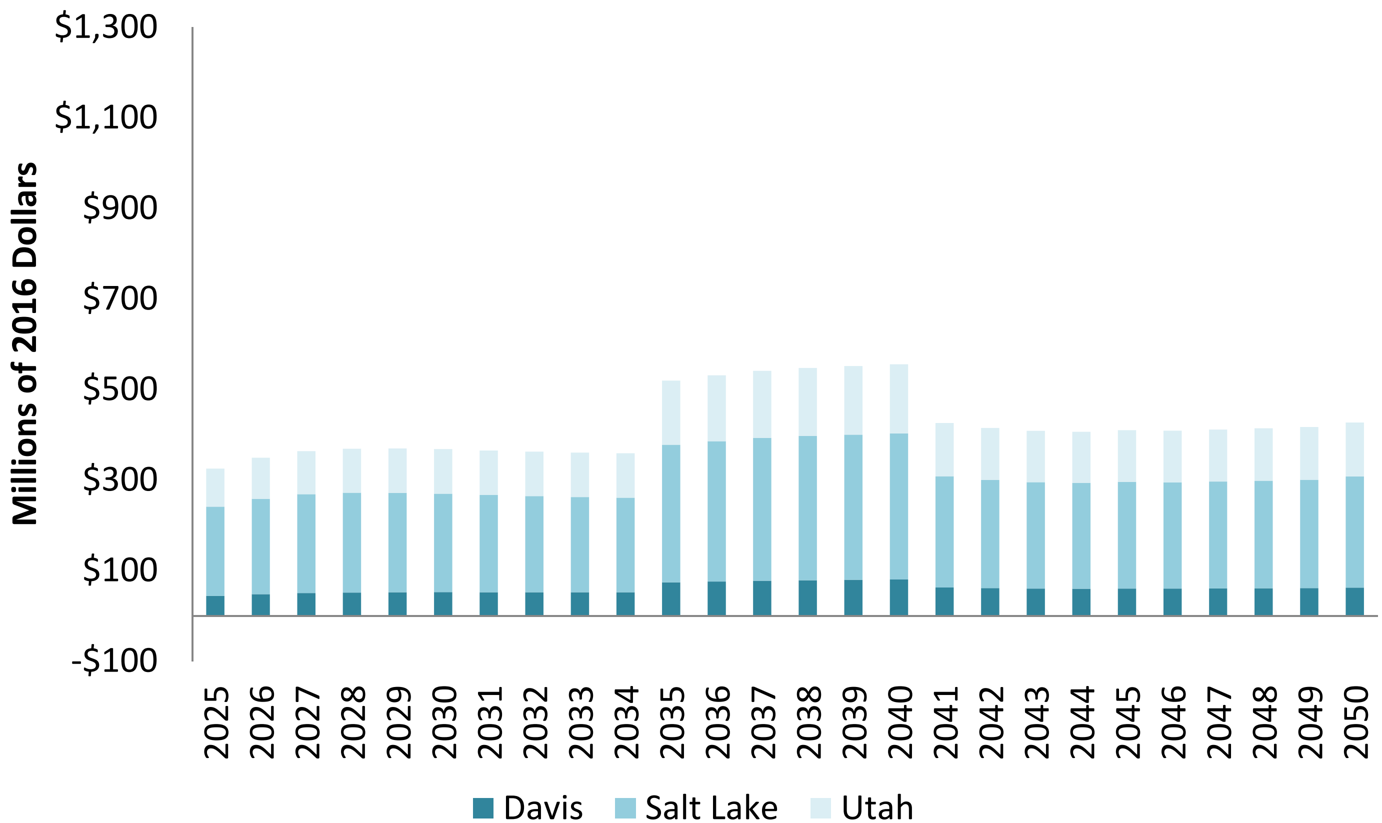
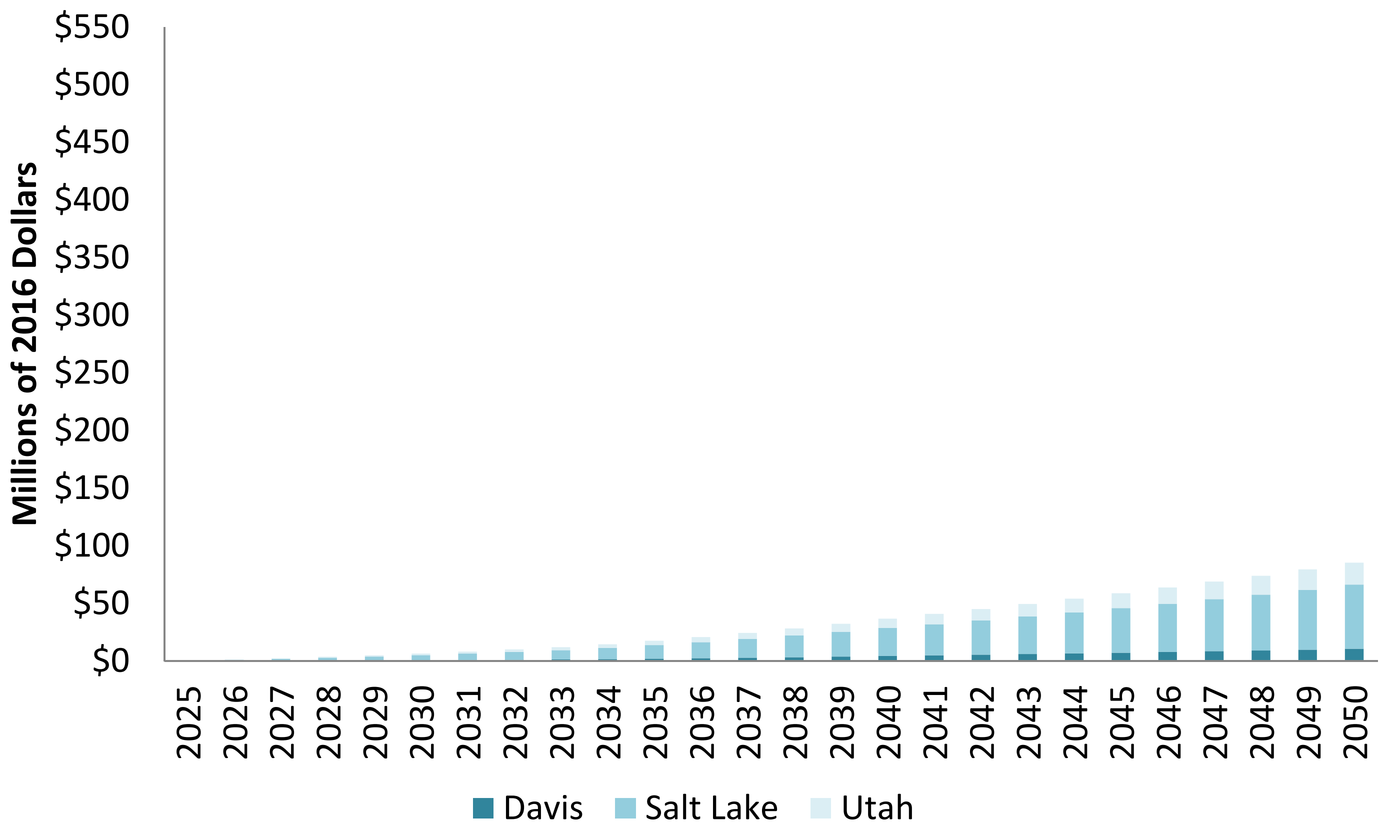
GRP Impacts of Construction, 2025-2050

Scenario 3



GRP Transportation Efficiencies Impacts, 2025-2050
Scenario 3



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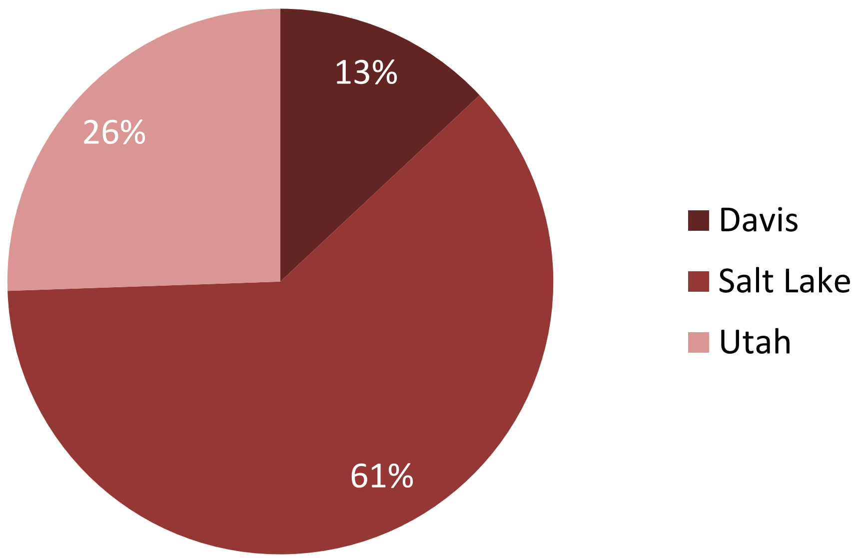
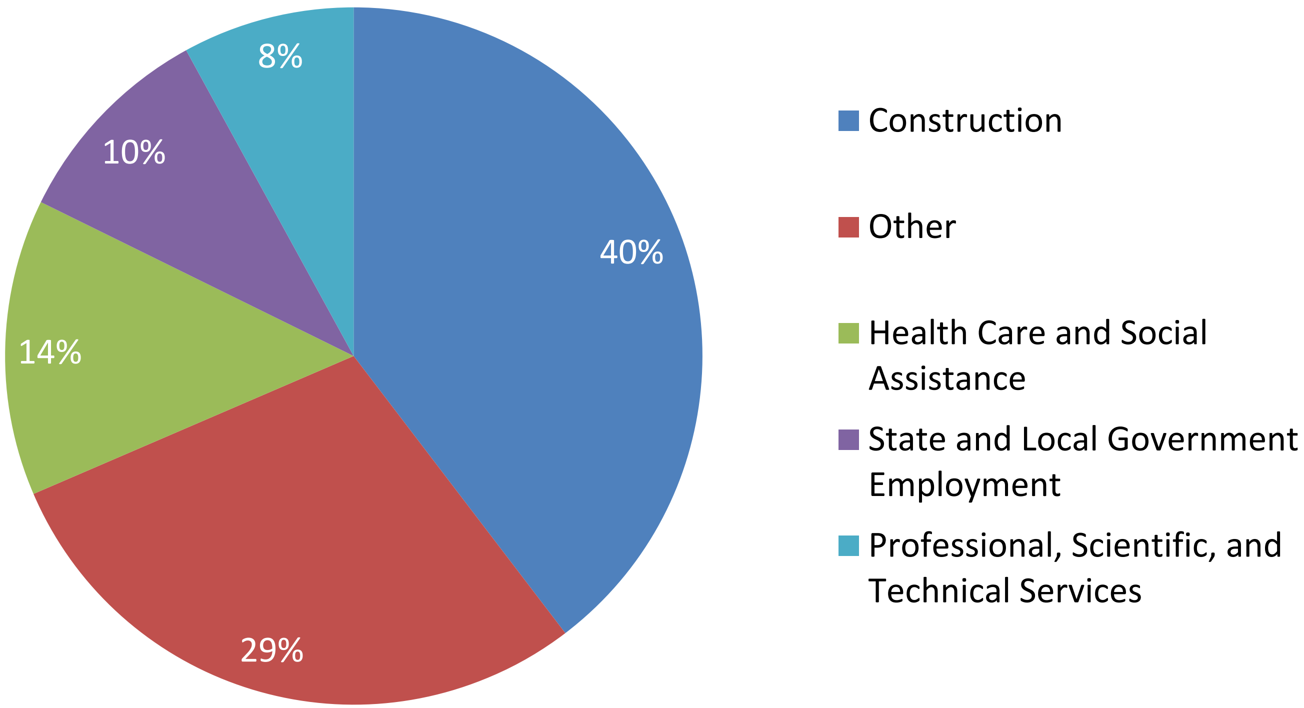
Distribution of Employment Impacts by County



- Similar distributions
  - Across scenarios
  - Across performance measures

Distribution of Employment Impacts by Industry



Note: Differences across counties are small

Summary of Employment Impacts

- Salt Lake County accounts for about three-fifths of employment impacts in study area
  - Reflects relative size of county economy
  - Distribution similar across scenarios
- Largest employment impacts in construction, followed by health care, government, and professional services
  - Reflects infrastructure construction and personal consumption
  - Distribution similar across scenarios
- Project phasing affects employment impacts
  - Uneven construction spending hurts the economy

Appendix G: Fiscal Sustainability Analysis Results

Financial Sustainability Analysis

- Compare estimated lifecycle costs to revenues available
- Estimate ability to fund projects and maintain state of good repair

Assumptions and Limitations

- All calculations are in constant (2016) dollars
- Current fiscal situation is from the 2015 Unified Plan Model (Lewis Young Robertson & Burningham)
- 2015 Unified Plan (UP) is fiscally constrained through Phases 1-3 (2015-2040)
- All calculations are presented for WFRC and MAG only
- Future revenues include new tax revenues implemented in Phase 4 (next slide)

New Tax Revenues in Addition to Funding Sources Identified in the 2015 Unified Plan

Total Tax Revenues (2041-2050)	Year Added	Amount	WFRC	MAG
Fuel Tax			**$118,427,056**	**$51,177,580**
Motor Fuel Tax	2045	$0.05		
Special Fuel Tax	2045	$0.05		
WFRC Sales Tax			**$507,386,292**	**-**
Salt Lake County Sales Tax	2045	0.25%		
Davis County Sales Tax	2045	0.25%		
Weber County Sales Tax	2045	0.25%		
Box Elder County Sales Tax	2045	0.25%		
Tooele County Sales Tax	2045	0.25%		
MAG Sales Tax			**-**	**$189,218,661**
Utah County Sales Tax	2045	0.25%		
UDOT Vehicle Registration Tax	2048	$10.00	**$32,075,536**	**$13,998,300**
Total			**$657,888,885**	**$254,394,540**

Total values in 2016 constant dollars

Phase 4 (2041-2050) Estimates

- **Revenues = $11.36B**
  - Forecast based on UP model
    - $10.5B in existing revenue streams and $912M in new tax revenues
    - Roadway using the same cost escalation rates
    - Transit based on average annual revenues in Phase 3
- **Existing Preservation Needs = $6.91B**
  - Existing needs forecast based on UP model
  - Assumed to account for all projects included in “total needs”
- **WFCCS Investment Packages**
  - Toll Revenues
  - Capital costs
  - Preservation needs
  - Operations

Toll Revenue Estimates

Tolls generated by HOV/HOT lane improvements will be a critical source of revenue for new capital investments

Net Present Value of Future Toll Revenues (2016 $ millions)

	Scenario 1	Scenario 2	Scenario 3
General Purpose (GP) Lanes			
AM	$169	$74	$192
PM	$210	$96	$248
Off-Peak	$0	$0	$0
HOT Lanes			
AM	$164	$379	$97
PM	$299	$1,920	$199
Off-Peak	$65	$362	$57
Total	**$907**	**$2,831**	**$793**

- Drivers in the GP lanes would pay 24 cents per mile in the peak period, peak direction
- Drivers in the barrier-separated, limited-access HOT lanes would pay 48 cents per mile in the peak period and peak direction (but carpools and transit pay no fee)
- No tolls will be charged to vehicles traveling in the GP lanes during non-peak periods and directions
- Drivers in the barrier-separated, limited-access HOT lanes would pay 5 cents per mile during the non-peak periods

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WFCCS Investment Scenarios (million 2016 $)

Scenario 1

(Million 2016 $)	Phase 2 (2025-2034)	Phase 3 (2035-2040)	Phase 4 (2041-2050)	Total
New Toll Revenues	$0	$145	$763	**$907**
Capital Costs	($542)	($1,577)	($194)	**($2,314)**
O&M Savings	$41	$93	$291	**$425**
Total	**($500)**	**($1,340)**	**$859**	**($981)**

Scenario 2

(Million 2016 $)	Phase 2 (2025-2034)	Phase 3 (2035-2040)	Phase 4 (2041-2050)	Total
New Toll Revenues	$0	$708	$2,123	**$2,831**
Capital Costs	($220)	($3,337)	($141)	**($3,699)**
O&M Costs	($102)	($909)	($2,926)	**($3,937)**
Total	**($322)**	**($3,538)**	**($945)**	**($4,805)**

Scenario 3

(Million 2016 $)	Phase 2 (2025-2034)	Phase 3 (2035-2040)	Phase 4 (2041-2050)	Total
New Toll Revenues	$0	$97	$696	**$793**
Capital Costs	($2,253)	($2,016)	($2,443)	**($6,712)**
O&M Costs	($126)	($244)	($554)	**($924)**
Total	**($2,379)**	**($2,163)**	**($2,301)**	**($6,844)**

Funding Summary

Other considerations:

- $2.6B highway needs outside area
- Some Vision Projects must be built.

Phase 4 WFRC & MAG Forecast (2041-2050)	Billions, $2016
Revenues based on Unified Plan	$10.45
New Tax Revenues	$0.91
Preservation Needs based on Unified Plan	($6.91)
Capital Funding Available	$4.46

Scenario 1	Billions, $2016
Capital Funding Available	$4.46
New Toll Revenues	$0.91
Capital Costs	($2.31)
O&M Savings	$0.42
Funding Available for Vision Projects	$3.48

Scenario 2	Billions, $2016
Capital Funding Available	$4.46
New Toll Revenues	$2.83
Capital Costs	($3.70)
O&M Costs	($3.94)
Funding Available for Vision Projects	($0.35)

Scenario 3	Billions, $2016
Capital Funding Available	$4.46
New Toll Revenues	$0.79
Capital costs	($6.71)
O&M Costs	($0.92)
Funding Available for Vision Projects	($2.39)