SR-80 and US-191 Oversize Load Study

ADOT MPD Task Assignment 028-13
Contract ADOT-11-00000507

Final Report and Executive Summary

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Study Purpose

The purpose of the SR-80 and US-191 Oversize Load Study is to identify roadway conditions that restrict travel by oversize vehicles on the SR-80 and US-191 study routes. The study also recommends infrastructure and related improvements that will eliminate or mitigate restrictions to the safe and efficient flow of oversize vehicles. Restrictions on I-10, as well as destinations in the SouthEastern Arizona Governments Association (SEAGO) region and in Mexico, require oversize vehicles to use SR-80 and US-191 in Cochise County in southeastern Arizona. In addition, restrictions on SR-80 and US-191 result in detours onto county roads that are not designed to accommodate oversize vehicles. As a result, the county roads experience damage to pavement and infrastructure and disruption of traffic flow.

Study Routes

The designated study routes include SR-80 from the New Mexico state line to I-10, including B-10 in Benson, and US-191 from I-10 to SR-80, including US-191B/Pan American Avenue to the Douglas/Agua Prieta Port of Entry.

Study Documents

The study was documented in two working papers and a Final Report and Executive Summary.

Working Paper No. 1 – Current and Future Conditions and Deficiencies

The purpose of Working Paper No. 1 was to locate and analyze potential restrictions along the study routes by reviewing weight, width, height, and geometric characteristics of the routes. In addition, Working Paper No. 1 examined other regional characteristics such as traffic flow, crash data, and economic factors. Investment strategies for eliminating and mitigating restrictions to oversize vehicles were developed and evaluated.

Working Paper No. 2 – Evaluation Criteria and Plan for Improvements

The purpose of Working Paper No. 2 was to identify projects that, if implemented, could improve efficiency and mobility of vehicles carrying oversize loads as well as the general traffic on the study routes.

Final Report and Executive Summary

The Final Report and Executive Summary compile and summarize the information contained in the two working papers. Additionally, a benefit-cost analysis was performed to evaluate the identified improvement projects. This Final Report documents study recommendations for moving forward.

Recommended Investment Strategy and Improvement Projects

Based on the existing and future conditions documented in Working Paper No. 1, investment strategies were considered by the Technical Advisory Committee (TAC) for facilitating the movement of oversize vehicles. A strategy was supported by the TAC to invest in upgrading

the US-191 study route as an Oversize Vehicle Freight Corridor (OVFC) between I-10 and the Douglas Port of Entry. The goals of the US-191 OVFC included the following:

- Contribute to improving the regional, state, national, and international economic conditions by facilitating truck freight flow within and through the SEAGO and Cochise County region.
- Reduce the miles driven, travel time, and operating costs for truck freight operations in the region.
- Develop and implement corridor improvements that improve the efficiency and safety for all truck freight with a focus on accommodating oversize vehicles on US-191 between I-10 and the Douglas/Agua Prieta Port of Entry.
- Minimize detours of oversize vehicles to county and local roads.
- Minimize disruptions to traffic flow on state, county, and local roads in the region.
- Minimize the expenditures by state, county, and local agencies involved in managing and enforcing oversize vehicle policies and regulations.
- Measure the return on investments in the corridor.

Six projects were identified to create incentives for the use of the US-191 OVFC.

Table ES-1: Summary of Projects

Project Number	Project Name	Year Built	On Route	Project Cost
1	Glance Creek Bridge (ADOT Structure No. 237)	1920	SR-80	$3.7M
2	Reconstruct Westbound Ramps I-10/US-191 Interchange, Phase 1 under design (Exit 331)	1958	US-191	$3.7M**
3	Reconstruct US-191/UPRR Overpass, (ADOT Structure No. 157)	1936	US-191	$15M
4	Reconstruct San Pedro River Bridge (ADOT Structure No. 403)	1913	SR-82	$7.7M
5	Chino Road	n/a	US-191	$3.2M
6	US-191 Shoulder Widening	1992-2005*	US-191	$47M

*Indicates the range of years improvements were made to segments of the roadway

**In a revised draft Initial Project Assessment dated August 2013, the cost for Phase 1 was updated to $2.25 million.

If these projects are implemented, restrictions for most oversize loads will be strategically removed to create incentives for using the OVFC corridor to facilitate the efficient flow and safety of vehicles carrying oversize loads. Project information sheets containing additional project details and planning level cost estimates were developed. The recommended projects should be refined with further scoping and design analysis.

Study Conclusions

The conclusions for the SR-80 and US-191 Oversize Load Study are summarized below.

- This report and the recommended designation of US-191 as an OVFC should be considered by the Governor's Transportation and Trade Corridor Alliance (TTCA) as a strategy for improving freight-related economic conditions in Southern Arizona. The TTCA should consider whether to forward the recommendations of the study to the Arizona State Board of Transportation for designation of US-191 as an OVFC.
- Design criteria were established for an OVFC based on a limited sample oversize load dimensions. Further development of design criteria for an OVFC should be the responsibility of the ADOT Roadway Design Group. Considerations in further development of design criteria should include design vehicle designation, axle loadings for the design of travel lane and shoulder pavement structures, lane and shoulder width, overhead clearance, pull-off locations, cross-slope design, clear zones, and bridge and culvert design.
- Six improvement projects were identified that would potentially improve the flow and efficiency and safety of traffic along the study routes if implemented. The projects are focused on creating US-191 as an OVFC.
- The benefit-cost analysis resulted in a benefit-cost ratio of 0.17, indicating that it may not be cost-effective to implement all of the identified improvement projects. However, it should be noted that some projects are already proceeding or are programmed. The Chino Road project (Project #5) is nearing the completion of Phase 1. The reconstruction of I-10/US-191 Interchange (Project #2) is programmed and under design. Additionally, shoulder widening between milepost 38 and milepost 46 on US-191 is underway.
- The scope and associated costs of the identified projects are at the planning level. Further scoping and refinement of the projects are recommended along with consideration of programming and construction phasing.
- Funding of the projects should take into consideration the prioritization of the projects as defined in the Performance Evaluation Matrix.

1 INTRODUCTION

1.1 Study Purpose

The purpose of the SR-80 and US-191 Oversize Load Study (study) is to identify roadway conditions that restrict travel by oversize vehicles on the SR-80 and US-191 study routes. The study also recommends infrastructure and related improvements that will eliminate or mitigate restrictions to the safe and efficient flow of oversize vehicles. Restrictions on I-10, as well as destinations in the SouthEastern Arizona Governments Association (SEAGO) region and in Mexico, require oversize vehicles to use SR-80 and US-191 in Cochise County in southeastern Arizona. In addition, restrictions on SR-80 and US-191 result in detours onto county roads that are not designed to accommodate oversize vehicles. As a result, the county roads experience damage to pavement and infrastructure and disruption of traffic flow.

For this study, an emphasis has been placed on oversize vehicles that obtain Class C permits. The Arizona Administrative Code (AAC) Title 17, Chapter 6 states that loads that exceed any one of the following criteria must apply for a Class C permit: 250,000 pounds, 120 feet in length, 16 feet in height, and 14 feet in width. In addition, if a structure or roadway segment on the identified route of an oversize load has special restrictions (for instance, a specific bridge has a height restriction of 14-foot or a stretch of highway has a width restriction), a Class C permit would also be required. Elimination and mitigation of restrictions to oversize vehicles are intended to improve safety, traffic operations, and commodity flow for all freight-hauling vehicles and for the general traffic on the study routes.

Oversize loads use the US-191 and SR-80 study routes for a variety of reasons. Some vehicles travel on the study routes to avoid restrictions on I-10 or other state highways located near the study routes. Some of these vehicles are through traffic with origins and destinations in other States. Other oversize vehicles on the study routes have either an origin or a destination in the region or in Mexico.

In some cases, restrictions on the study routes require detouring onto county roads, which are not designed to accommodate oversize vehicles. For example, Cochise County representatives have stated that significant investments have been made over the years by the County to manage permitting and maintain the structural strength of roads such as Davis Road to accommodate oversized vehicle travel. The County is currently coordinating with ADOT on studies to address these issues on Davis Road. The cities of Benson and Douglas provide police personnel in support of traffic control along study routes in their respective jurisdictions and the County commits resources for managing oversize loads and repairing damage to county roads.

The efficient movement of freight is critical to any economy, including that of the SEAGO region and Cochise County. Freight transportation represents the economy in motion – virtually all businesses and industries in the region are supplied to one degree or another by goods movement, most often by truck. In an effort to ease the travel of oversize loads, oversize loads are allowed to cross the international border to deliver loads within 20 miles of the border with a special permit authorized under Arizona Revised Statute (ARS) 28-1103. Identifying a route that can facilitate efficient travel of oversize load vehicles will make business operations in the region more efficient and reduce unnecessary wear and tear on county roads.

1.2 Study Objectives

Objectives of the SR-80 and US-191 Oversize Load Study are:

- Collect and geo-code data on roadway features and other relevant information needed to quantify the restrictions to oversize vehicles
- Interview stakeholders to obtain data and perspectives on oversize vehicle restrictions and justification/benefits for eliminating or mitigating restrictions
- Summarize the Class C permitting process. Collect and quantify Class C permitting activities
- Develop geometric turning requirements for typical oversize vehicles
- Project future freight flow activities on study routes
- Document restrictions to oversize vehicles by type, location, opportunities, and constraints
- Develop and apply criteria for establishing strategies and priorities for eliminating documented restrictions
- In accordance with the strategies and priorities, develop project descriptions and cost estimates to eliminate or mitigate the restrictions
- Document the study process and recommendations in a 'reader-friendly' report and executive summary

1.3 Study Routes

As illustrated in **Figure 1**, the study routes include SR-80 from the New Mexico state line to I-10, including B-10 in Benson (approximately 125 miles), and US-191 from I-10 to SR-80,

including US-191B/Pan American Avenue to the Douglas/Agua Prieta Port of Entry (approximately 70 miles).

1.4 Study Documentation Overview

The Oversize Load Study was documented in two working papers, as described below.

1. **Working Paper No. 1 – Current and Future Conditions and Deficiencies**

   The purpose of Working Paper No. 1 was to locate and analyze potential restrictions along the study routes by reviewing weight, width, height, and geometric characteristics of the routes. In addition, Working Paper No. 1 examined other regional characteristics such as traffic flow, crash data, and economic factors. Investment strategies for eliminating and mitigating restrictions to oversize vehicles were developed and evaluated.

2. **Working Paper No. 2 – Evaluation Criteria and Plan for Improvements**

   The purpose of Working Paper No. 2 was to identify projects that, if implemented, could improve efficiency and mobility of vehicles carrying oversize loads as well as the general traffic on the study routes. To this end, Working Paper No. 2 covered three main topics:

   a) **Identify Dimension Criteria** – Using data obtained from ADOT, dimensions for oversize loads were determined, which resulted in development of design criteria and a cross-section based on those dimensions. The criteria and cross-section were used to evaluate and identify improvement projects.

   b) **Identify Projects** – Based on the restrictions identified in Working Paper No. 1, Technical Advisory Committee (TAC) input, and engineering analysis, a list of improvement projects were developed to improve travel efficiency and mobility for oversize loads and the general traffic on the study routes.

   c) **Establish Project Priorities** – Performance evaluation criteria were developed to evaluate and prioritize the improvement projects.

The Final Report and Executive Summary compile and summarize the information contained in the two working papers. Additionally, a benefit-cost analysis is prepared to evaluate the identified improvement projects. This Final Report documents study recommendations for moving forward.

1.5 Technical Advisory Committee

A Technical Advisory Committee (TAC) was established to participate in the study process. TAC responsibilities included meeting at key study milestones to review and comment on study documentation and key findings. The following individuals participated on the TAC:

- Mark Hoffman, ADOT Multimodal Planning Division, ADOT Project Manager
- Bill Harmon, P.E., ADOT Safford District, District Engineer and Local Contact
- Paul David, P.E., ADOT Safford District, Development Engineer

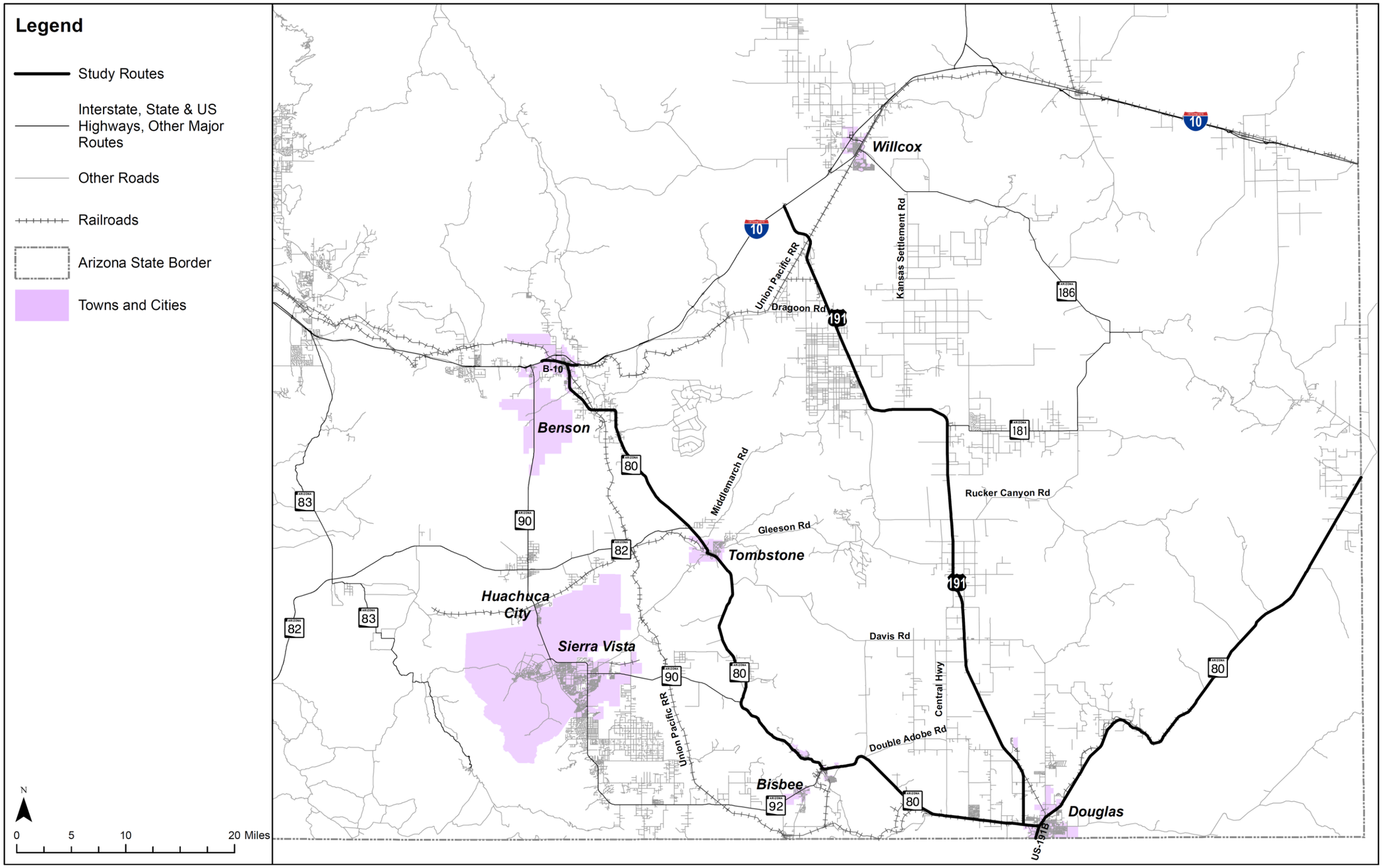


Figure 1: Study Routes Map

- Scott Beck, P.E., ADOT Southern Region, Regional Traffic Engineer
- Dee Crumbacher, ADOT Southern Region, Traffic Engineering Specialist
- Chris Pippin, ADOT Intermodal Transportation Department, Engineering Permits Tech
- Chris Vertrees, SouthEastern Arizona Governments Organization (SEAGO) Transportation Planner
- Karen Lamberton, Cochise County Transportation Planner
- Brad Hamilton, P.E., Benson City Engineer
- Lauren Ortega, P.E., Douglas Public Works Director

Five TAC meetings were held at key milestones or decision points during the study. The purpose of the meetings was to communicate study progress, provide opportunities for discussion, and present study findings and documents (Work Plan, Working Papers, and the Final Report) for review and comment.

2 OVERVIEW OF WORKING PAPER NO. 1

Working Paper No. 1 reviewed and analyzed the current conditions on the study routes to identify structures and conditions that may be restrictive to oversize loads. Oversize loads are those that meet the criteria for a Class C permit: 250,000 pounds, 120 feet in length, 16 feet in height, and 14 feet in width. The analysis consisted of the following steps:

1) Review and summarize related studies and their findings to establish a knowledge base of the study routes and surrounding area.

2) Interview stakeholder to identify issues on the study routes that are of concern to the different jurisdictions.

3) Obtain general understanding of the study routes by reviewing land use information, economic characteristics and roadway characteristics.

4) Review and document the Class C permitting process

5) Identify and evaluate strategies for removing or mitigating restrictions for oversize loads.

6) Develop criteria for developing improvement projects.

2.1 Existing and Future Conditions

Based on a review of available databases on oversize load restrictions on the study routes and interviews with stakeholders, the following existing and future conditions were identified.

2.1.1 General

- Freight flow in the SEAGO/Cochise County region contributes to the regional, state, national, and international economies, particularly during times of high mining activities in the region when freight flow increases.
- Freight travel by trucks in the region and on the SR-80 and US-191 study routes is projected to grow in the future. Class C vehicles on study routes range from 600 to 700 per year. Future volumes are difficult to predict but are expected to grow as the regional

economy improves and Class C vehicles are projected to increase by up to 3.5 percent per year.

- Restrictions to freight flow create operational and safety inefficiencies for freight transporters and the traveling public.
- Truck freight detours to county roads that are not designed to accommodate trucks, especially oversize vehicles, results in expenditures in staff, enforcement, and infrastructure repair.
- Investments to eliminate and mitigate restrictions for the safe and efficient flow of truck freight and oversize vehicles in the region are justified.

2.1.2 SR-80

- SR-80 receives the highest volumes of oversize vehicles between Benson and Davis Road and between US-191 and the New Mexico state line. To a lesser extent, oversize vehicles use SR-80 between Davis Road and US-191 because of restrictions northwest of and in Bisbee.
- SR-80 restrictions for oversize vehicles (see **Figure 2**) are frequent and present significant challenges for the cost-effective elimination or mitigation of restrictions.
- Vertical restrictions on I-10 in the vicinity of Willcox and the San Simon port of entry contribute to detours of westbound oversize vehicles to SR-80 via NM-80 in New Mexico. These restrictions are:
    - Airport Rd. (MP 339.46): 15.98-foot clearance for eastbound travel
    - San Simon West Interchange (MP 378.93): 15.83-foot clearance for eastbound travel and 15.92-foot for westbound travel
    - San Simon East Interchange: (MP382.35): 15.83-foot clearance for eastbound travel and 16.40-foot for westbound travel.

  The same restrictions contribute to detours of eastbound oversize vehicles to SR-80 via B-10 in downtown Benson.
- Class C vehicles are not permitted by ADOT on approximately 10 miles of SR-80 between SR-90 and east of downtown Bisbee because of restrictions including the Mule Pass Tunnel (MP 343.24-332.88); 14.77-foot clearance for westbound travel and 14.83-foot for eastbound, the Lowell Railroad (MP 343.01); 14.85-foot clearance for westbound travel and 15.23-foot for eastbound travel), West Boulevard (MP 339.81); 14.23-foot clearance, and Brewery Gulch (MP 341.42; 13.72-foot clearance overpass structures in Bisbee. Elimination of these restrictions is cost-prohibitive.
- The prohibition of oversize vehicles on SR-80 in and northwest of Bisbee contributes to oversize vehicle detours to Davis Road between SR-80 and US-191 which is not designed to accommodate oversize vehicles. Similarly, weight restrictions on three SR-80 bridges (Glance Creek Bridge at MP 352.38, bridge structures 235 at MP 349.28, and 238 at MP 355.05) west of US-191 contributes to detours to Double Adobe Road, Central Highway, and Davis Road. County resource expenditures for permitting and repairing damage to county roads has resulted in studies to assess the feasibility of upgrading Davis Road to state design standards.
- Vertical restrictions from overhead communications utilities on SR-80 in Tombstone require communication utility providers to raise overhead utilities for vehicle heights over 15-feet.

- Oversize vehicles on SR-80 result in traffic disruptions and increase crash potential in the urbanized areas of Benson, St. David, Tombstone, and Douglas.
- The rating of the SR-82 San Pedro Bridge as structurally deficient increases the use of B-10 by oversize vehicles in downtown Benson.
- Of the 43 bridges on SR-80, 29 bridges are either 24 feet in width or weight-restricted for loads greater than 36 tons which present restrictions for oversize vehicles.

2.1.3 US-191

- US-191 receives very limited use by oversize vehicles north of Davis Road because of restrictions on I-10 and restrictions on US-191 at the I-10 interchange and the Cochise UPRR structure.
- US-191 receives comparatively higher use by oversize vehicles south of Davis Road.
- US-191 restrictions for oversize vehicles are significantly less frequent in comparison to SR-80 restrictions. Elimination or mitigation of US-191 restrictions will be less costly in comparison to SR-80.
- The most significant restrictions for US-191 include (1) geometric and vertical clearance restrictions at the I-10/US-191 interchange and (2) width restrictions for the US-191 Cochise UPRR overpass. Design is underway to reconstruct the westbound ramps at the interchange which eliminates the geometric restriction and mitigate the vertical clearance restriction. Alternatives for reconstruction of the Union Pacific Railroad (UPRR) overpass have been studied by ADOT.
- Oversize vehicles on US-191 result in less traffic disruptions and less crash potential because of the rural, low traffic volume environment along US-191.
- Only four bridges exist on US-191 between I-10 and Douglas. Three of the 4 bridges on US 191 between I-10 and Douglas are multi-cell box culverts.

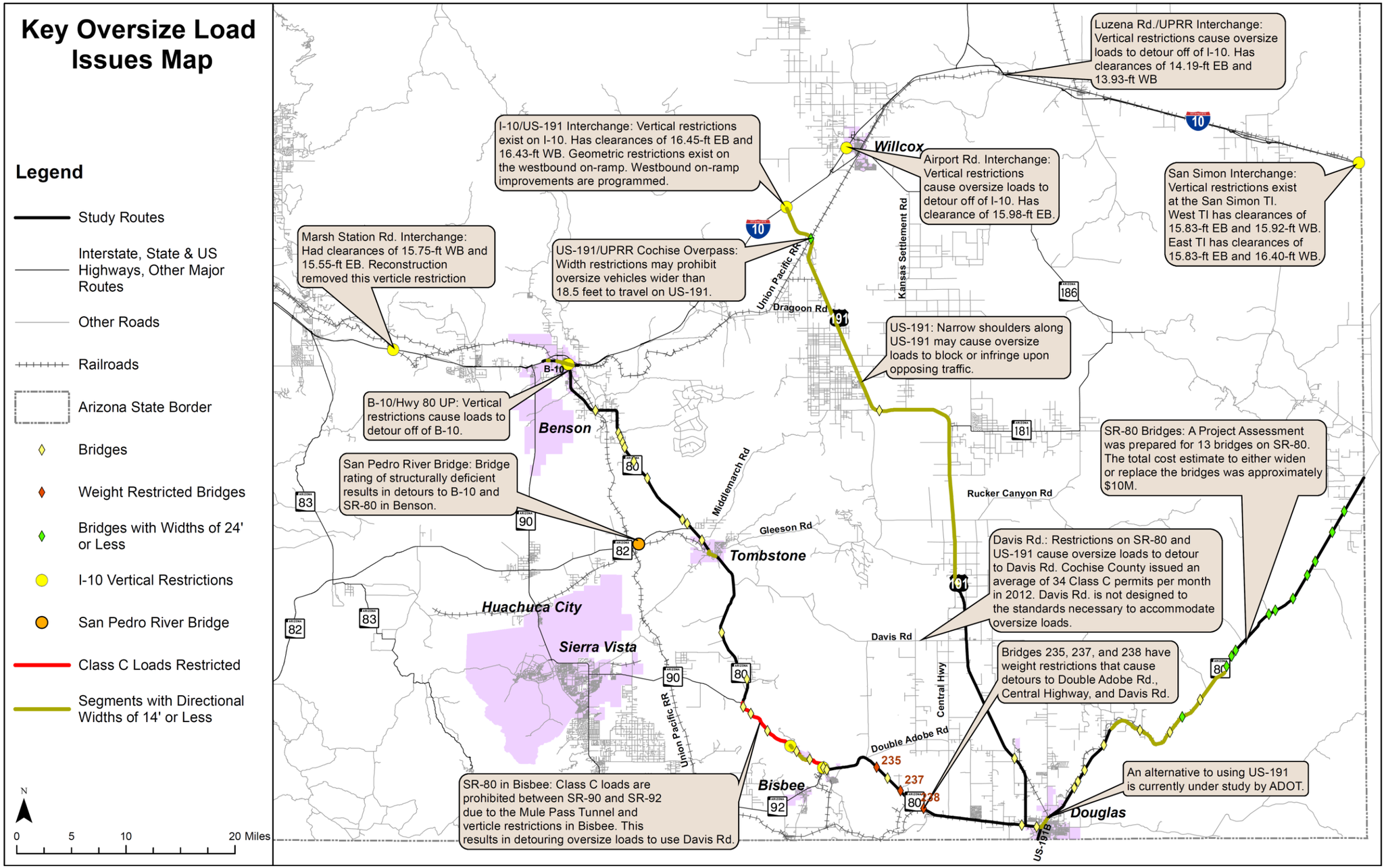


Figure 2: Issues Map

2.1.4 Investment Strategies

Based on the existing and future conditions documented in Working Paper No. 1, investment strategies were considered by the TAC for facilitating the movement of oversize vehicles. A strategy was supported by the TAC to invest in upgrading the US-191 study route as an Oversize Vehicle Freight Corridor (OVFC) between I-10 and the Douglas Port of Entry. The goals of the US-191 OVFC include the following:

- Contribute to improving the regional, state, national, and international economic conditions by facilitating truck freight flow within and through the SEAGO and Cochise County region.
- Reduce the miles driven, travel time, and operating costs for truck freight operations in the region.
- Develop and implement corridor improvements that improve the efficiency and safety for all truck freight with a focus on accommodating oversize vehicles on US-191 between I-10 and the Douglas/Agua Prieta Port of Entry.
- Minimize detours of oversize vehicles to county roads.
- Minimize disruptions to traffic flow on state, county,and local roads in the region.
- Minimize the expenditures by state, county, and local agencies involved in managing and enforcing oversize vehicle policies and regulations.
- Measure the return on investments in the corridor.

3 OVERVIEW OF WORKING PAPER NO. 2

Working Paper No. 2 focused on identifying and prioritizing projects that would create incentives for increasing oversize vehicle use of US-191 as an OVFC by improving the flow, efficiency, safety, and operating costs for oversize loads and general traffic along the US-191 study route. Project descriptions and cost estimates are summarized in **Chapter 4**.

Working Paper No. 2 documented oversize load dimensions in support of project scoping. Data on the dimensions of "larger" (but not all) Class C oversize loads were obtained from the ADOT Permit Unit. Larger oversize loads are those that warrant coordination with ADOT Districts that the load is passing through including loads that exceed 18 feet in width, 17 feet in height, and 250,000 pounds. A summary of that data is provided in **Table 1** below.

Table 1: Summary of Oversize Load Dimensions

Load Dimension	Sample Size	Range	Average	85th Percentile
Length (ft)	20	70 – 215	137.6	192.1
Width (ft)	20	12.5 – 23.5	17.7	20.0
Height (ft)	20	13.5 – 19.8	16.5	18.0
Weight (lbs)	20	80,000 – 583,700	292,000	468,000
Weight/Axle (lbs)*	20	1,600 – 36,481	25,540	29,270

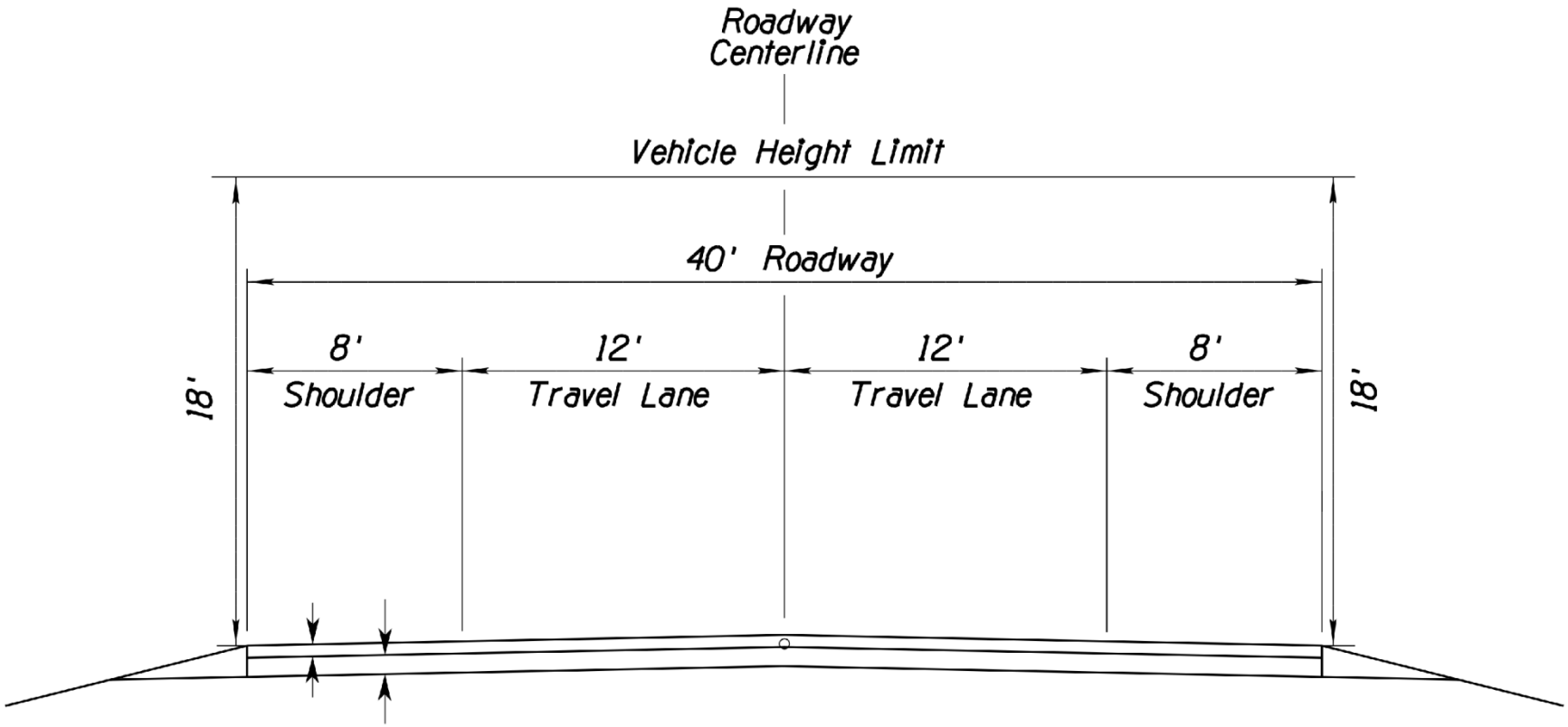
*The weight/axle values were determined based on the 20 larger oversize loads. The standards for pavement design are typically lower, ranging from 18,000 pounds to 20,000 pounds. During the process of refining design criteria for an oversize load corridor, all pavement design standards should be considered.

The oversize load dimensions for the 85th percentile were used to develop a working definition for a typical cross-section for an OVFC, shown in **Figure 3**. The typical OVFC cross-section

was presented to ADOT Roadway Group representatives as a starting point for the development of typical cross-sections and design criteria for OVFCs. It should be noted that the 85th percentile design criteria were intended to accommodate many but not all oversize vehicles. For example, some oversize vehicles will continue to require the removal of traffic signal equipment and some overhead utilities, even though most of the Sulfur Springs Cooperative utilities have reported clearances of up to 20 feet.

It is recommended that further development of design criteria for the recommended OVFC be the responsibility of the ADOT Roadway Design Group. Considerations in further development of design criteria should include axle loadings for the design of travel lane and shoulder pavement structures, lane and shoulder width, overhead clearance, pull-off locations, cross-slope design, clear zones, and bridge and culvert design. ADOT design staff recommended the preparation of a benefit-cost analysis to quantify the benefits derived from an OVFC in terms of reduced operation costs and crash savings in relationship to the investments to improve the corridor to accommodate oversize vehicles.

The 19-axle heavy haul trailer design vehicle which is being used to design geometric improvements at the I-10/US-191 interchange was recommended and supported by the TAC as the design vehicle for improvements to the US-191 OVFC (refer to **Figure 4**).



Note: Clear zone and side slopes should be included in established design criteria for an oversize load corridor.

Figure 3: Oversize Vehicle Freight Corridor Draft Cross-Section for Rural 2-Lane State Highways

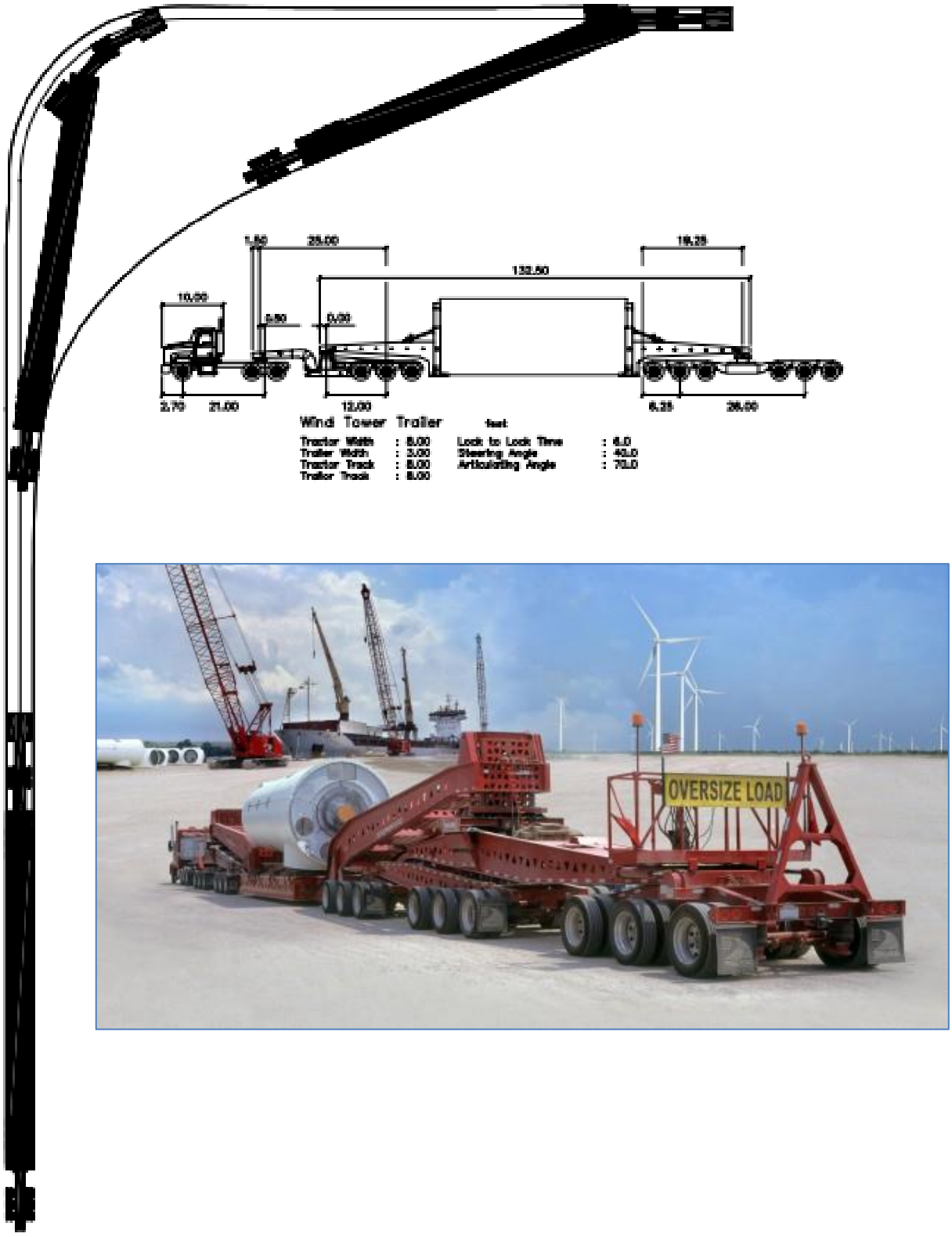


Figure 4: 19-Axle Heavy Haul Trailer Design Vehicle

4 IMPROVEMENT PROJECTS

Six projects were identified that, if implemented, could improve efficiency, safety, and operating costs for vehicles carrying oversize loads, as well as the general traffic, along the study routes. Detailed project information sheets were developed for each project and are provided in **Appendix A**. The following sections discuss the projects and the process for identifying those projects.

4.1 I-10 Improvements

Table 2 presents I-10 locations that cause oversize loads to detour off of I-10 onto SR-80 and US-191. Improvements at these locations, if implemented, could facilitate travel of oversize loads on I-10 and reduce the volume of vehicles carrying oversize loads on the study routes. Detailed project descriptions and cost estimates for I-10 were not developed in the study.

Table 2: I-10 Potential Improvements

Name	On Road	Location	Restriction	Project Feature
I-10 / Airport Rd.	I-10	MP 339.46	Vertical Restriction (15.98-ft EB)	Reconstruct structure to mitigate oversize vehicle restriction
W. San Simon TI UP	I-10	MP 378.93	Vertical Restriction (15.83-ft EB and 15.92-ft WB)	Reconstruct existing ramps as needed to facilitate oversize vehicles on diamond ramps
E. San Simon TI UP	I-10	MP 382.35	Vertical Restriction (15.83-ft EB and 16.40-ft WB)	Reconstruct existing ramps as needed to facilitate oversize vehicles on diamond ramps

4.2 Project Development Process

Improvement projects were identified based on restrictions documented in Working Paper No. 1 and supported by the TAC. Some projects have been programmed and some are under design and/or construction. Initial project scoping was developed by a multi-disciplinary engineering team to determine project features and planning-level cost estimates. These planning-level costs include general costs for items typically associated with similar types of projects. Project information sheets for each project are provided in **Appendix A**.

4.3 Projects

Six projects were identified from the processes described above. Project sheets were created to provide planning level information for each project. **Table 3** provides a summary of the six projects.

Table 3: Summary of Projects

Project Number	Project Name	Year Built	On Route	Project Cost
1	Glance Creek Bridge (ADOT Structure No. 237)	1920	SR-80	$3.7M
2	Reconstruct Westbound Ramps I-10/US-191 Interchange, Phase 1 under design (Exit 331)	1958	US-191	$3.7M**
3	Reconstruct US-191/UPRR Overpass, (ADOT Structure No. 157)	1936	US-191	$15M
4	Reconstruct San Pedro River Bridge (ADOT Structure No. 403)	1913	SR-82	$7.7M
5	Chino Road	n/a	US-191	$3.2M
6	US-191 Shoulder Widening	1992-2005*	US-191	$47M

*Indicates the range of years improvements were made to segments of the roadway

**In a revised draft Initial Project Assessment dated August 2013, the cost for Phase 1 was updated to $2.25 million.

If these projects are implemented, restrictions for most oversize loads will be strategically removed to create incentives for using the OVFC corridor to facilitate the efficient flow and safety of vehicles carrying oversize loads. Project information sheets containing additional details for each project are provided in **Appendix A** along with a map showing ADOT mileposts. The information presented in the project information sheets were developed as planning level cost estimates. The recommended projects should be refined with further scoping and design analysis.

It should be noted that during the project identification process, Bridges 235 and 238 (located on SR-80, west of US-191) were considered a restriction due to weight limitations. The ADOT inventory rating for both bridges is under the standard 36 tons. However, improvements to these bridges were not identified as projects because the weight restrictions could be addressed with the addition of more axles to distribute the weight of the load on the structure. When improvements to the bridges are made, however, the weight limitations could be addressed to better accommodate oversize loads.

Figure 5 illustrates the location of each project.

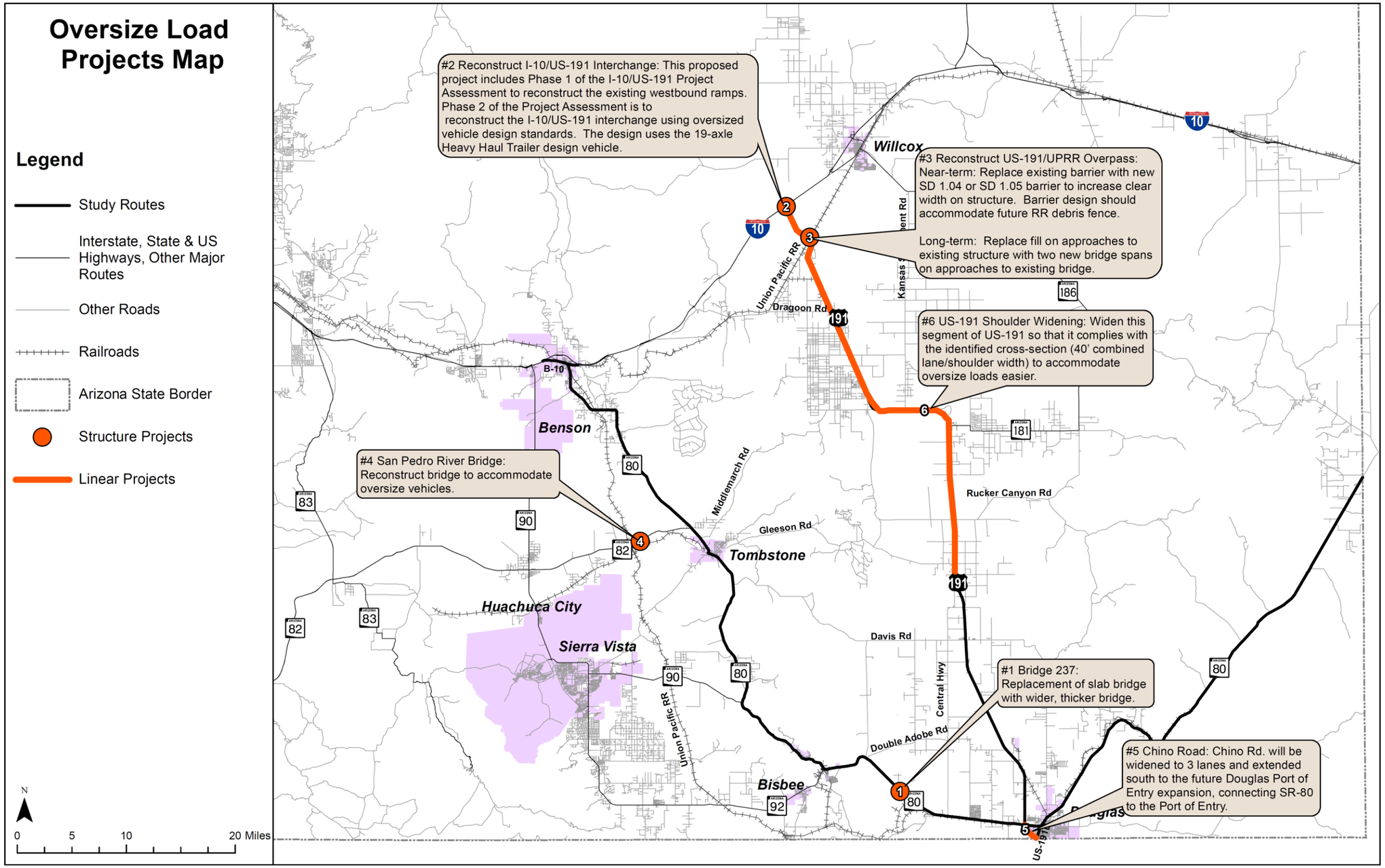


Figure 5: Projects Map

5 PROJECT PERFORMANCE EVALUATION

Project performance criteria were developed to provide a means of evaluating and comparing the six projects. The performance criteria were measurable factors for the goals of the OVFC investments. The following performance criteria were used for project evaluations.

- **Reduces miles, time, and cost of freight operations** – Improvement projects were evaluated on their potential for reducing miles and time traveled and costs associated with freight operations. It is time consuming and costly for trucks to detour from the interstate or state routes. These costs translate into higher costs for business owners and ultimately consumers.

- **Improves general freight flow** – Identification of projects was not limited to only those projects that provide benefits for oversize loads. Therefore, projects were evaluated based their potential to improve the flow of general freight traffic.

- **Improves Class C flow efficiency** – Identification of projects was not limited to only those projects that provides benefits for oversize loads. Therefore, projects were evaluated based their potential to improve efficiency for vehicles that apply for a Class C permit.

- **Improves general traffic efficiency** – Identification of projects was not limited to only those that provide the benefits for vehicles carrying oversize loads. Improving overall flow of traffic is important to maintaining the efficiency of the study routes for all travelers. Projects were evaluated based on their potential to improve general traffic flow.

- **Improves safety** – Oversize vehicles operate at slower speeds than the typical traffic and create traffic delays during intersection turning maneuvers. The travel characteristics of oversize vehicles therefore create the potential for crashes. Projects were evaluated on their potential to improve safety for all travelers.

- **Minimizes detours to county and/or local roads** – Restrictions along the study routes often force oversize loads to detour from the study routes onto county or local roads. Since county and local roads are not built to accommodate oversize loads, this causes roadway damage. The identified improvement projects were evaluated on their potential to minimize detours to county and/or local roads.

- **Minimizes traffic disruptions** – Because of restrictions on the study routes, oversize loads often force other vehicular traffic onto shoulders and disrupt regular flow of traffic in order to accommodate the oversize load.

- **Minimizes oversized loads in urbanized areas** – Oversize loads in urban areas disrupt traffic and cause safety concerns. The improvement projects were evaluated based on their potential to reduce oversize load traffic in urbanized areas along the study routes.

- **Minimizes enforcement and management expenditures** – Oversize vehicle travel on state highways and county roads require staff resources for permitting, traffic control,

and enforcement. Projects were therefore evaluated on the basis of reducing costs associated with managing and enforcing oversize vehicle regulations.

Each project was evaluated and prioritized based on the performance criteria described above. A project evaluation matrix was developed to evaluate and compare each of the projects in relation to the performance criteria. Each project was evaluated against each performance criteria based on the relative degree of benefit that would be realized as a result of implementation. Three benefit levels were used for this evaluation: maximum benefit, marginal benefit, and limited benefit. Based on how each project performed against the criteria, a ranking was assigned to each project for prioritization purposes. Those projects that were determined to result in maximum benefits for the performance criteria ranked higher, with 1 being the highest ranking. **Table 4** presents the project Performance Evaluation Matrix.

Table 4: Project Performance Evaluation Matrix

Projects					Performance Criteria									
Project No.	Project	On Route	Location	Estimated Cost (2013)	Project Ranking	Reduces Miles, Time, Costs of Freight Operations	Improves General Freight Flow Efficiency	Improves Class C Flow Efficiency	Improves General Traffic Efficiency	Improves Safety	Minimizes Detours to County/Local Roads	Minimizes Traffic Disruptions	Minimizes Oversized Loads in Urbanized Areas	Minimizes Enforcement and Management Expenditures
1	Glance Creek Bridge Improvements (ADOT Structure No. 237)	SR-80	MP 352.38	$3.7M	6	●	◑	●	○	◑	●	◑	◑	◑
2	Reconstruct Westbound Ramps at the I-10/US-191 Interchange (Exit 331)	US-191	I-10 MP 331/US-191 MP 66	$3.7M	3	●	●	●	◑	●	●	●	●	●
3	Reconstruct US-191/UPRR Overpass, (ADOT Structure No. 157)	US-191	MP 62.8	$15M	2	●	●	●	●	●	●	●	●	●
4	Reconstruct San Pedro River Bridge (ADOT Structure No. 403)	SR-82	MP 61.2	$7.7M	4	●	●	●	●	◑	●	●	●	●
5	Chino Road	US-191	Proposed Douglas Port of Entry expansion to US-191/SR-80 interchange (US-191 MP 0)	$3.2M	1	●	●	●	●	●	●	●	●	●
6	US-191 Shoulder Widening	US-191	MP 66 to MP 25	$47M	5	●	●	●	◑	◑	●	●	○	●

● Maximum Benefits
◑ Marginal Benefits
○ Limited Benefits

6 BENEFIT – COST ANALYSIS

A benefit-cost analysis (BCA) was prepared for recommended projects presented in **Chapter 5**. This BCA assessed the overall costs associated with implementing the recommended projects on the study routes and requisite improvements to I-10 restrictions to allow oversize vehicles to access US-191. These costs are weighed against expected benefits (state of good repair, livability, carrier cost savings, and safety) to arrive at a benefit-cost ratio. The following sections summarize the methodology used for the BCA, provide the overall results, and offer some conclusions. A detailed presentation of the BCA is presented in **Appendix B**.

6.1 Development of Costs

6.1.1 Cost Assumptions

A foundational aspect of the BCA was to develop a forecast of future Class C vehicles in the region. This forecast feeds directly into several of the benefit categories described later. The forecast considered the following factors:

- Truck traffic growth rates
- Travel patterns of the trucks, including a split between escorted and unescorted loads and origin and destination pairs
- Estimated truck vehicle miles traveled

A forecast of Class C vehicles was developed through 2033, which is the planning horizon for the BCA (details on forecasted volumes are provided in **Appendix B**). The results are provided in **Table 5**.

Table 5: Class C Vehicle Miles Traveled by Direction and Destination

	2012	2033
Eastbound		
Through - escorted	1,509	2,586
Through - unescorted	23,635	40,518
Douglas - escorted	217	372
Douglas - unescorted	3,404	5,835
Total	28,765	49,312
Westbound		
Through - escorted	2,514	4,310
Through - unescorted	39,392	67,531
Douglas - escorted	301	516
Douglas - unescorted	4,714	8,081
Total	46,921	80,438
Grand Total	**75,686**	**129,750**

Next, in order to calculate travel time savings for oversize load carriers, some assumptions were made about likely routing of oversize vehicles and about travel times on the study routes with and without the recommended projects.

Distances and travel times were developed for unescorted and escorted oversize vehicles for the "Base Year" (no improvements) and the "Post-improvement Years". Distances for these routings were derived from Google Maps. It was determined that implementation of the improvement projects would result in the following trip distances and travel times:

- Trucks traveling eastbound to Douglas can expect an average increase of 24 miles traveled and an average decrease of 128 minutes of travel time.
- Trucks traveling westbound to Douglas can expect an average increase of approximately 80 miles traveled and an average decrease of 53 minutes of travel time.
- Trucks traveling through the region can expect a average decrease of approximately 28 miles traveled and an average decrease of approximately 247 minutes of travel time.

6.1.2 Project Costs

The costs for each project, shown in **Table 3**, were applied to the other BCA components. Using these cost estimates, the total cost input for the analysis comes to $91.4 million. For purposes of the BCA, it was assumed that all projects would be constructed in 2015. Costs were discounted to net present value (NPV) using a discount factor of 3 percent, which corresponds to USDOT guidance for the use of government funds in Transportation Investments Generating Economic Recovery (TIGER) benefit-cost analyses. This gives a total NPV of $80,915,763.

6.2 Development of Benefits

Benefits can be categorized into four groups:

- **State of Good Repair**: is the value of avoided pavement damage from routing oversize vehicles on the proposed OVFC rather than on SR-80 and county roads. After discounting to NPV using the same 3 percent discount rate as applied to the project costs, the total state of good repair benefit through 2033 is $313,872.
- **Livability**: is estimated in terms of the value of highway user travel time savings. The resulting value of travel time saved was then discounted to NPV, again using the same 3 percent discount rate, to arrive at a total livability benefit of $459,145.
- **Carrier Cost Savings**: Carriers who move Class C loads in the study area will benefit from the proposed improvements, which will allow them to save time through improved routing. The hourly operating cost was multiplied by the annual time savings in hours for escorted and unescorted loads, discounted to net present value to arrive at a total carrier cost savings benefit of $3,658,088.
- **Safety**: Estimated annual safety benefits were developed using Highway Safety Manual (HSM) practices. Summed across the forecast horizon and discounted to net present value, the estimated safety benefit is $9,724,660.

The overall benefits are summarized in **Table 6**.

Table 6: Total Benefits in Net Present Value Terms (Discounted at 3 Percent)

Benefit Type	Discounted Benefit
State of Good Repair	$313,872
Livability	$459,145
Carrier Cost Savings	$3,658,088
Safety	$9,724,660
Total	**$14,155,766**

6.3 BCA Results and Conclusions

A summary of the results are provided in **Table 7**. All benefits and costs have been discounted to net present value (NPV) using a 3 percent discount rate.

Table 7: Summary of Benefit-Cost Analysis Results

Benefits	
State of Good Repair	$313,872
Livability	$459,145
Carrier Cost Savings	$3,658,088
Safety	$9,724,660
Total Benefits (A)	*$14,155,766*
Costs	
Planning-level Cost Estimate (B)	*$80,915,763*
Benefit-Cost Ratio (A/B)	**0.17**

The benefit-cost ratio of 0.17 indicates that, based on the benefits assessed in this analysis, the package of improvements may not make sense from an economic standpoint. It should be noted here that this seems to be the case even under the most generous assumptions, such as the assumption that all Class C traffic will divert to the OVFC. Moreover, this analysis did not account for the fact that diverting some or all of these loads to the OVFC would effectively transfer some infrastructure wear and tear from one facility to another. Although it is recognized that this would likely carry some benefit since the OVFC is designed to handle Class C vehicles. In addition, to the extent that the project would relieve local authorities of some of the financial burden of repairing the roads currently being used by these vehicles, it would create a benefit for them but a potential negative benefit to ADOT. Another perspective that could impact the BCA results is that some of the recommended projects have been programmed or are under construction, reducing the cost outlays for project implementation.

Since the benefit-cost ratio is less than 1.0, the proposed improvements may not pay for themselves in a strictly economic sense. ADOT may therefore wish to develop alternative improvement phasing strategies over time.

7 CONCLUSIONS

The conclusions for the SR-80 and US-191 Oversize Load Study are summarized below.

- This report and the recommended designation of US-191 as an OVFC should be considered by the Governor's Transportation and Trade Corridor Alliance (TTCA) as a strategy for improving freight-related economic conditions in Southern Arizona. The TTCA should consider whether to forward the recommendations of the study to the Arizona State Board of Transportation for designation of US-191 as an OVFC.
- Design criteria were established for an OVFC based on oversize load dimensions. Further development of design criteria for an OVFC should be the responsibility of the ADOT Roadway Design Group. Considerations in further development of design criteria should include design vehicle designation, axle loadings for the design of travel lane and shoulder pavement structures, lane and shoulder width, overhead clearance, pull-off locations, cross-slope design, clear zones, and bridge and culvert design.
- Six improvement projects were identified that would potentially improve the flow and efficiency and safety of traffic along the study routes if implemented. The projects are focused on creating US-191 as an OVFC.
- The benefit-cost analysis resulted in a benefit-cost ratio of 0.17, indicating that it may not be cost-effective to implement all of the identified improvement projects. However, it should be noted that some projects are already proceeding or are programmed. The Chino Road project (Project #5) is nearing the completion of Phase 1. The reconstruction of I-10/US-191 Interchange (Project #2) is programmed and under design. Additionally, shoulder widening between milepost 38 and milepost 46 on US-191 is underway.
- The scope and associated costs of the identified projects are at the planning level. Further scoping and refinement of the projects are recommended along with consideration of programming and construction phasing.
- Funding of the projects should take into consideration the prioritization of the projects as defined in the Performance Evaluation Matrix.

APPENDIX A: IMPROVEMENT PROJECT SHEETS

The following project sheets were developed to provide detail pertaining to each of the projects identified in Working Paper No. 2. Since the project locations are referred to by milepost (MP), a map showing the MP locations is provided in **Figure A-1**. The project information sheets follow **Figure A-1**.

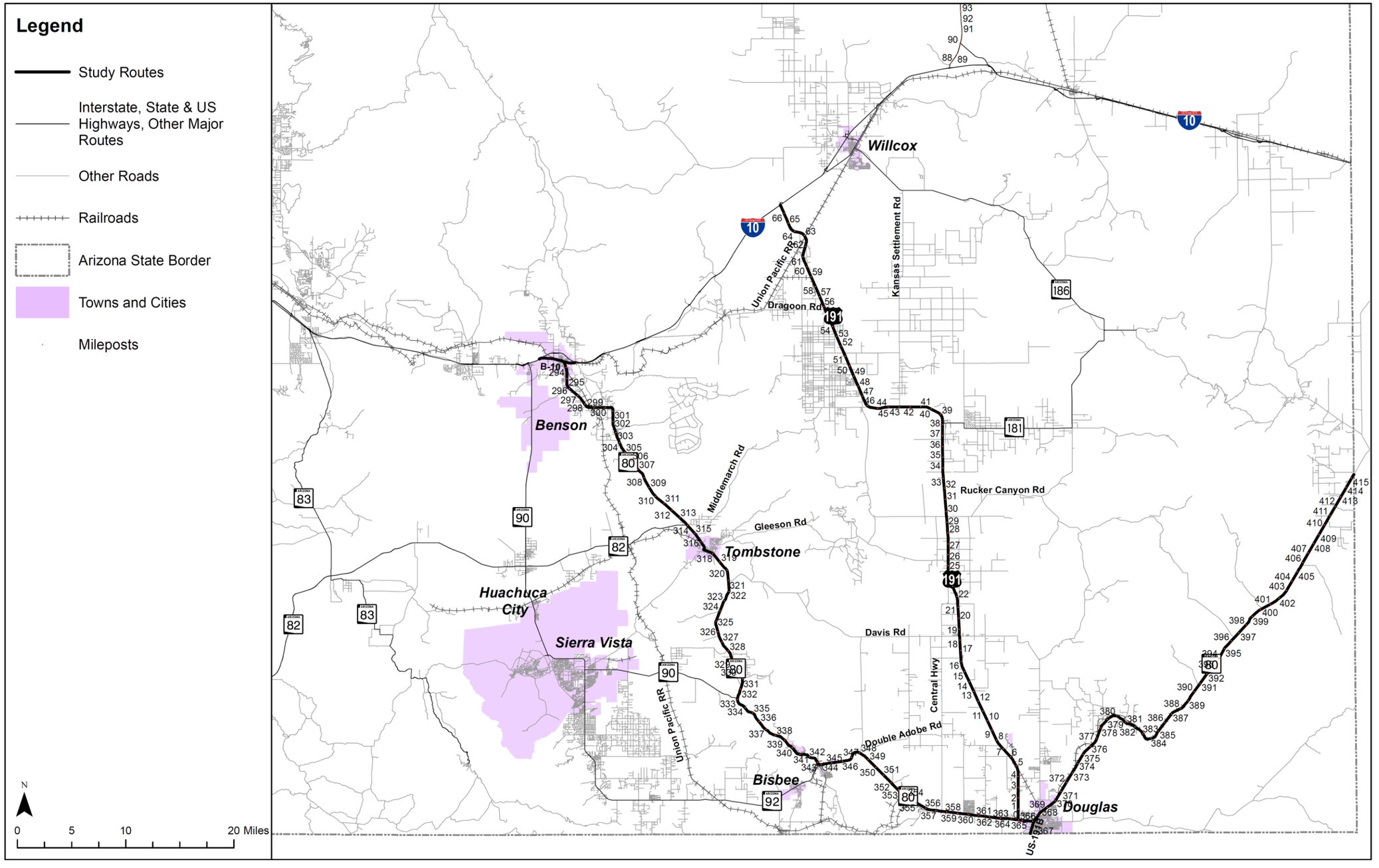


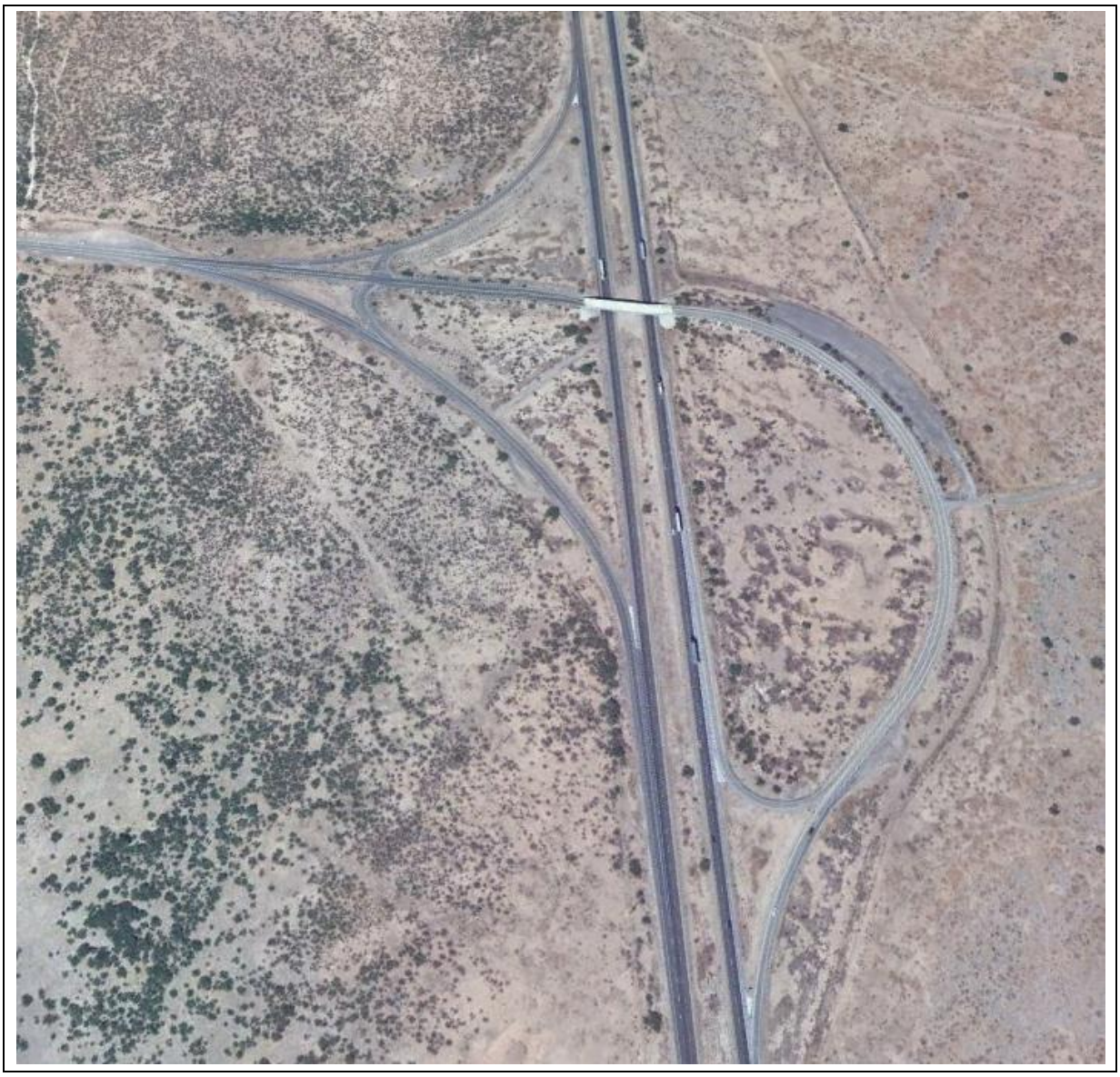
Figure A-1: Milepost Map

Project Information Sheet: Project #1
SR-80 – Glance Creek Bridge, ADOT Structure 237
Weight Restriction Issue

Route	SR-80
Project Location	MP 352.38
Project Description *(to be confirmed with further scoping and design analysis)*	This project includes the following components: • Replace existing slab bridge • Construction of 2-12' lanes, 2-10' shoulders and 2-1.42'barriers (46.83' total width) • Includes bridge and approach slabs • Assumed phased construction • 250' of guardrail on each side of road and on both sides of the new bridge • 1,000' of road replacement on both sides of the bridge Includes assumptions for clearing and grubbing, traffic maintenance, erosion, surveying, and water supply/dust palliative, mobilization, AC quality incentive, pavement smoothness, construction engineering and contingencies, and design
Project Justification	This bridge has a weight restriction, regardless of the axles, which causes oversize loads to detour to Double Adobe Road.
Cost Estimate	$3.7M
Comments	• Structure is a box culvert bridge constructed in 1920 and widened in 1936. • Inventory rating (24 tons) does not meet minimum standard (36 tons). • Top is in fair condition (rating is 5). • Spalling and exposed rebar on ceiling. • Superstructure is in fair condition (rating is 5) • Substructure is in fair condition (is 5). • Current clear roadway width is 36'. • Sufficiency rating is 62.44.

Project Information Sheet: Project #2
I-10 / US-191 – Interchange, Exit 331
Reconstruct Interchange (information was taken from the draft Initial Project Assessment dated March 2013 and does not reflect August 2013 draft or Final Project Assessment)

Route	I-10/US-191 Interchange (Exit 331)
Project Location	I-10 MP 331 / US-191 MP 66
Project Description *(to be confirmed with further scoping and design analysis)*	This proposed project includes Phase 1 of the I-10/US-191 Project Assessment to reconstruct the existing westbound ramps. Phase 2 of the Project Assessment (not included in cost estimate) is to reconstruct the I-10/US-191 interchange using oversized vehicle design standards. The design uses the 19-axle Heavy Haul Trailer design vehicle.
Project Justification	The purpose of this project is to improve the safety of this interchange and to reduce impediments for permitted over-dimensional vehicle loads.
Cost Estimate (Phase 1 only)	$3.7M (Per 010 CH 331 H8534 01 D, I-10 Cochise TI (Exit 331) MP 331 Initial Project Assessment March 2013)



Project Information Sheet: Project #3
US-191 – Cochise RR Overpass, ADOT Bridge Structure 157
Bridge Width Restrictions and Settlement Issues

Route	US-191/Cochise RR Overpass
Project Location	MP 62.88
Project Description *(to be confirmed with further scoping and design analysis)*	Near-term: Replace existing barrier with new SD 1.04 or SD 1.05 barrier to increase clear width on structure. Barrier design should accommodate future RR debris fence. Long-term: Replace fill on approaches to existing structure with two new bridge spans on approaches to existing bridge. Scoping: Update 2007 Alternatives Study to evaluate near and long-term alternatives to increase clear width on structure. This project includes the following components: • Replace existing bridge with three span bridge • Construction of 2-12' lanes, 2-10' shoulders and 2-1.42'barriers (46.83' total width) • Includes bridge and approach slabs • Assumed phased construction • 250' of guardrail on each side of road and on both sides of the new bridge • 1,000' of road replacement on both sides of the bridge • Drainage Improvement • Includes assumptions for clearing and grubbing, traffic maintenance, erosion, surveying, and water supply/dust palliative, mobilization, AC quality incentive, pavement smoothness, construction engineering and contingencies, and design. Alternative: Construct a 625' new wider bridge and approach roadway. This widening should minimize the settlement effect on the tracks. The $3 Million for drainage could be saved. We can eliminate most of the embankment weight by constructing longer bridge with minimal roadway work. The bridge cost will be about $5 Mil and the roadway improvement will be $3 Mil. This alternative was not addressed in the 2007 study.
Project Justification	Bridge width is too narrow to accommodate oversize loads. Additionally, the track settlement is an issue due to embankment loads.
Cost Estimate	$15M for bridge replacement, new approach roadway

	and new drainage improvement
Comments :	• The bridge deck is in fair condition (rating is 5). • The superstructure is in satisfactory condition (rating is 6). • Substructure was listed in good condition (rating is 7). • The current clear width on structure is 24'. • Update 2007 Final Alternative Study to consider alternatives to address settlement and increase clear width on structure. • Cost estimate for the alternative: The bridge cost will be about $5 Million and the roadway improvement will be $3 Million.
	
• Currently Union Pacific Railroad (formerly SPRR)	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ARIZONA DEPARTMENT OF TRANSPORTATION

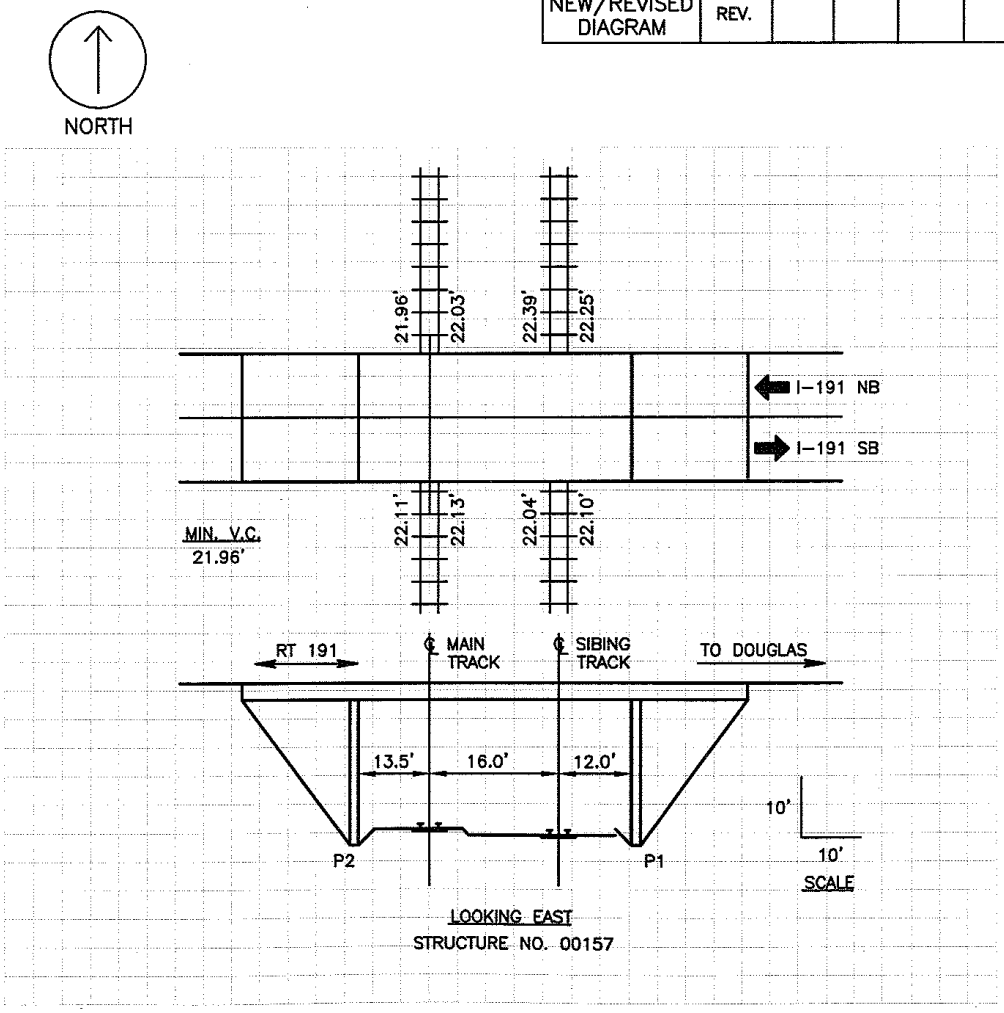
BRIDGE GROUP
SUPPLEMENTAL PAGE TO BRIDGE INSPECTION REPORT
VERTICAL & HORIZONTAL CLEARANCE DIAGRAM

STRUCTURE NAME: COCHISE RR OP

STRUCTURE NO.: 157

LOCATION: 191 (ROUTE) 62.88 (MILEPOST)

INSPECTION	25				
DATE	7/21/11				
INITIAL	MEB/ EVB				
NEW/REVISED DIAGRAM	REV.				



Project Information Sheet: Project #4
SR-82 – San Pedro River Bridge, ADOT Bridge Structure 403
Structure Condition and Scour Issues

Route	SR-82
Project Location	MP 61.20
Project Description *(to be confirmed with further scoping and design analysis)*	Reconstruct bridge (structures condition and scour issues may rule out bridge retrofit). Phased construction is appropriate. This project includes the following components: • Replace existing bridge • Construction of 2-12' lanes, 2-10' shoulders and 2-1.42'barriers (46.83' total width) • Includes bridge and approach slabs • Assumed phased construction • 250' of guardrail on each side of road and on both sides of the new bridge • 1,000' of road replacement on both sides of the bridge • Includes assumptions for clearing and grubbing, traffic maintenance, erosion, surveying, and water supply/dust palliative, mobilization, AC quality incentive, pavement smoothness, construction engineering and contingencies, and design
Project Justification	Bridge condition and settlement issues restrict the use of this structure by oversize vehicles and result in detours of oversize loads through Benson on B-10 and SR-80. Although this bridge is not located on a study route, improvements will directly impact travel on the study routes.
Cost Estimate	$7.7M
Comments	• Bridge deck is in satisfactory condition (rating is 6). • Superstructure is in satisfactory condition (rating is 6). • Substructure is in poor condition (rating is 4). • Foundations are not stable due to scour issues. • Current clear roadway width is 26'. • Sufficiency rating is 51.8. • Inventory rating is below standard rating. • Traffic volume is 700 ADT.

Project Information Sheet: Project #5
US-191 – Chino Road
Phased Construction of Alternative Route

Route	US-91
Project Location	Chino Rd. – Future Douglas Port of Entry expansion to SR-80/US-191 (US-191 MP 0).
Project Description *(to be confirmed with further scoping and design analysis)*	Chino Rd. is being widened to 3 lanes and extended south to the future Douglas Port of Entry expansion, connecting SR-80 to the Port of Entry.
Project Justification	Alleviate traffic congestion on US-191B (Pan American Ave.) by removing international traffic and heavy commercial trucks from US-191B.
Cost Estimate	$3.2M
Comments	• Project is in the final stages of design. • Project is expected to be completed in 2014.

Project Information Sheet: Project #6
US-191 Shoulder Widening
Shoulder Widening

Route	US-191
Project Location	US-191: MP 66 to MP 25
Project Description *(to be confirmed with further scoping and design analysis)*	Widen this segment of US-191 so that it complies with the cross-section identified in this working paper (40' combined lane/shoulder width) to accommodate oversize loads easier. This project includes the following components: • Existing 2' shoulder • Sawcut 2' of existing AC • 8' of new AC to achieve 40' roadway cross-section with 8' shoulder • Structural section 4" AC over 12" AB, with chip seal driving surface per page 50 of US-191 Cochise Overpass DCR • Extension of box culverts • Includes Project No. 5 (Bridge No. 157) • Includes assumptions for clearing and grubbing, milling, excavation, traffic maintenance, erosion, surveying, and water supply/dust palliative, mobilization, AC quality incentive, pavement smoothness, construction engineering and contingencies, and design
Project Justification	Narrow shoulders along US 191 may cause oversize loads to block or infringe upon opposing traffic.
Cost Estimate	$47M

MP 66

MP 56

APPENDIX B: BENEFIT – COST ANALYSIS

Kimley-Horn and Associates, Inc.

ADOT

Memorandum

TO: Dave Perkins

FROM: Roger Schiller

DATE: October 22, 2013

RE: Oversize Freight Vehicle Corridor Benefit-Cost Analysis (includes editorial revisions)

Summary

This memo provides a sketch planning level benefit-cost analysis (BCA) for a package of proposed infrastructure and operational improvements described in Chapter 4, to facilitate the movement of oversize vehicles in the region. Using data gathered during the Study and interviews with the Specialized Carriers and Rigging Association and two regional haulers that operate Class C loads in the region. Summary results are provided in **Table B-1**. All benefits and costs have been discounted to net present value (NPV) using a 3 percent discount rate.

Table B-1: Summary of Benefit-Cost Analysis Results

Benefits	
State of Good Repair	$313,872
Livability	$459,145
Carrier Cost Savings	$3,658,088
Safety	$9,724,660
Total Benefits (A)	*$14,155,766*
Costs	
Planning-level Cost Estimate (B)	*$80,915,763*
Benefit-Cost Ratio (A/B)	**0.17**

Since the benefit-cost ratio is less than one, the proposed improvements may not pay for themselves in a strictly economic sense. ADOT may therefore wish to consider the benefits associated with economic development in the region and the benefits of reducing oversize loads on Cochise County roads by creating incentives for using US-191 as a regional oversize vehicle freight corridor (OVFC) as recommended in Chapter 7.

Introduction

A benefit-cost analysis (BCA) was prepared for recommended improvements described in Chapter 4. The BCA assessed the overall costs associated with implementing a package of capital projects on the study routes, and designating US-191 in the region as an OVFC. Costs were compared to expected benefits (state of good repair, livability, carrier cost savings, and safety) to arrive at a benefit-cost ratio. The following sections explain the data and methodology used for the BCA, provide the overall results, and offer conclusions.

Methodology

Class C Vehicle Volume Forecasts

A foundational aspect of the BCA was to develop a simple forecast of future Class C traffic in the region. This forecast feeds directly into several of the benefit categories described later. For the BCA, a forecast of Class C truck traffic was generated through 2033, which is the planning horizon for the BCA. The step-by-step oversize vehicle forecast approach is described in the following sections.

Step 1: Develop Basic Class C Vehicle Volume Forecast

Base year (2012) data was provided by the ADOT permit office. The data provided by ADOT covers Class C permits granted in the first half of 2012 (January through June). During this time, a total of 356 such permits were issued for loads which traveled on SR-80 and/or US-191. This total was doubled to arrive at 712 permits for all of 2012. This figure was used to represent base year Class C traffic volumes.

The next step was to apply a growth rate to the base year volumes and derive a forecast. Several forecasts and data sources were reviewed and are summarized in **Table B-2**. The first two came from Working Paper No. 1, which included a forecast for truck volume growth in Cochise County on the study routes. These growth rates were developed by disaggregating the Federal Highway Administration (FHWA) Freight Analysis Framework version 3 (FAF3) to provide truck flow estimates for roads in Cochise County. Another source of freight flow projections are the U.S. Freight Forecast developed by the American Trucking Associations (ATA). According to this forecast, truckload freight will grow by 3.2 percent annually through 2018, then a more modest 1.1 percent annually through 2024[1].

For this analysis, the low growth rate (2.6 percent) was selected because it is closer to the ATA forecast, which was developed more recently than the FAF3 database and therefore incorporates more recent economic trends affecting the industry, chiefly the economic recession and the ensuing recovery. Moreover, an interview with Empire Transport (which operates oversize vehicles in the region) indicated that the oversize load market generally grows in line with the

[1] http://www.prnewswire.com/news-releases/ata-releases-latest-freight-forecast-projecting-strong-trucking-growth-213126601.html

rest of the trucking industry. Given these factors, the low-growth rate was deemed to be the best approximation of likely oversize vehicle traffic growth in the region over the next 20 years. By applying this growth rate to the base year volume of 712, 1,221 Class C vehicles were estimated in 2033.

Table B-2: Truck Traffic Growth Rates

Forecast	Data Source	Growth Rate	2033 Forecast
Working Paper #1 low-growth rate	Freight Analysis Framework – Cochise County, all commodities	2.6%	1,221
Working Paper #1 high-growth rate	Freight Analysis Framework – Cochise County, all commodities	4.0%	1,622
U.S. Freight Forecast	American Trucking Associations	3.2% through 2018 1.1% 2018-2024	1,014 (extrapolated from 2024)

Step 2: Split the Forecast into Escorted and Unescorted Class C Loads

Next, the base year/forecast data were split into "escorted" and "unescorted" oversize loads. Escorted loads are those that require coordination with the ADOT Safford District when routing through Cochise County – these tend to be very large and/or very heavy loads. Approximately 6 percent of the Class C loads in the 2012 ADOT sample data were of this type, with the remaining 94 percent being unescorted; these percentages were therefore applied to the forecast to arrive at estimated escorted and unescorted loads in the out years. For the purposes of this analysis, two generalized oversize vehicle types were assumed to represent escorted and unescorted loads: unescorted loads are approximately 85 tons in weight and have 9-13 axles; and escorted loads weigh between 100 and 200 tons and have 11-19 axles.

Oversize vehicle loads vary tremendously by weight and dimension, which makes it hard to generalize about vehicle characteristics. Nonetheless, these configurations were confirmed as reasonably typical within the region through interviews with Precision Heavy Haul, a Phoenix-based company that operates Class C vehicles in the region.

Step 3: Analyze Class C Travel Patterns and Develop Forecast Estimates by Destination and Direction

It was also necessary to make some assumptions regarding travel patterns for Class C loads in the region. Class C trip data provided by ADOT was summarized by trip type (destined for Douglas or through trips) and direction (eastbound or westbound). Although the ADOT data do not provide origins and destinations for every trip, they do provide typical origins and destinations for all of the trips, so these were used as a proxy for all Class C trips in the region.

There were 21 origin-destination (O-D) pairs in the ADOT data. Each pair was classified as either through or going to Douglas, and eastbound or westbound, and the count of each of those

four categories was compared against the total number of O-D pairs to develop a matrix of trip patterns in the region as shown in **Table B-3**[2]. These patterns were assumed to hold steady throughout the forecast horizon. The percentages shown in **Table B-3** were then multiplied by the escorted and unescorted volumes developed in Step 2, yielding the disaggregated Class C truck volumes shown in **Table B-4**.

Table B-3: Oversize Load Trip Pattern Matrix

	Through	Douglas
Eastbound	6 (29%)	2 (10%)
Westbound	10 (48%)	3 (14%)

Source: ADOT Permit Office.

Table B-4: Escorted and Unescorted Class C Truck Volumes by Direction and Destination

Year	2012	2033
Eastbound		
Through - escorted	12	21
Through - unescorted	191	328
Douglas - escorted	4	7
Douglas - unescorted	64	109
Total	271	465
Westbound		
Through - escorted	20	35
Through - unescorted	319	546
Douglas - escorted	6	10
Douglas - unescorted	96	164
Total	441	756
Grand Total	**712**	**1,221**

Step 4: Estimate Truck Vehicle Miles Traveled

Using the above information, truck vehicle-miles of travel (VMT) estimates were developed for each load configuration, direction, and destination (through trips and those going to Douglas). VMT was estimated by multiplying the Class C volume for each configuration and direction combination by the miles associated with that trip (derived from Google Maps). The results are provided in **Table B-5**.

[2] One O-D pair was a trip from Tucson to Bisbee. Since there was only one of these, it was classified as eastbound, headed for Douglas.

Table B-5: Escorted and Unescorted Class C Truck Vehicle Miles of Travel (VMT) by Direction and Destination

Year	2012	2033
Eastbound		
Through - escorted	1,509	2,586
Through - unescorted	23,635	40,518
Douglas - escorted	217	372
Douglas - unescorted	3,404	5,835
Total	28,765	49,312
Westbound		
Through - escorted	2,514	4,310
Through - unescorted	39,392	67,531
Douglas - escorted	301	516
Douglas - unescorted	4,714	8,081
Total	46,921	80,438
Grand Total	**75,686**	**129,750**

Routing and Travel time Assumptions

In order to calculate travel time savings for oversize vehicles, assumptions were made about likely routing of trucks and about travel times on the routes in question, both before and after the recommended improvements. **Figure B-1** shows the study routes. Currently, Class C vehicles use a combination of SR-80, US-191, and Davis Road to move between the New Mexico state line and the I-10/SR-80 interchange in Benson, and to and from the Douglas port of entry (POE).

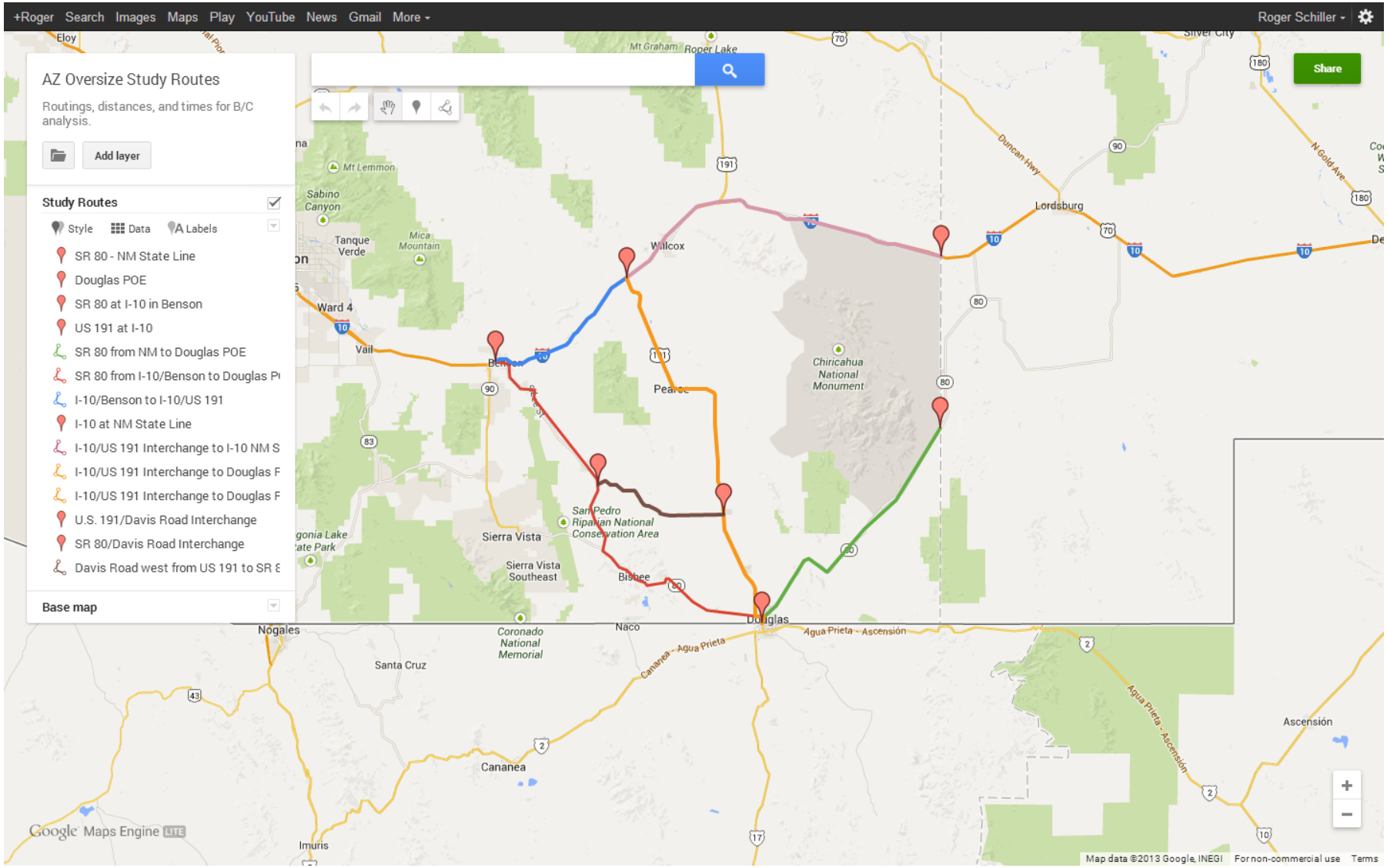


Figure B-1: SR-80/US-191 Oversize Vehicle Study Routes

Distances and travel times were developed for unescorted and escorted vehicles for the "base year" with no improvements and the "post-improvement years" after constructing projects to encourage the use of US-191 as an OVFC. Distances for these routings were derived from Google Maps. The routes that were assessed are:

Base Year – SR-80 from the New Mexico border to the Douglas POE, SR 80 from the I-10 interchange in Benson to the Douglas POE, and a through trip using SR 80 and Davis Road to travel between Benson and the New Mexico line.

Post-improvement Years – Trucks would use I-10 to either the New Mexico state line to US-191, or from Benson to US-191, and then travel south to the Douglas POE, or through trucks would simply use I-10 to move through the region.

The distances and assumed travel times for these routes are presented in **Table B-6** by load type (unescorted and escorted). Base year travel times were obtained from Precision Heavy Haul; scenario travel times were calculated based on assumed average trip speeds of 55 mph for unescorted loads and 40 mph for escorted loads (also provided by Precision Heavy Haul) and known travel distances. As the table shows, the proposed new route actually adds distance for trucks traveling to Douglas, and also adds travel time in the westbound direction; however, for eastbound trucks going to Douglas and for through trips, the new routes would save significant time, by avoiding sharp curves and grades along SR-80 west of Douglas and allowing for higher speeds on I-10.

These estimated travel times were validated by Precision Heavy Haul as being reasonable based on their experience.

Table B-6: Trip Distances and Travel Times for Class C OS/OW Loads

	Distance (miles)	Unescorted Travel Time (minutes)	Escorted Travel Time (minutes)
Base Year			
SR-80 from NM State Line to Douglas POE	49.3	95	135
SR-80 from I-10 Interchange at Benson to Douglas POE, via Davis Road/US-191	74.3	150	360
Through Trip (SR-80 from Benson to NM Line)	123.6	245	495
Post-improvement Years - I-10/US-191/SR- 80 Projects to Eliminate Restrictions, encourage use of I-10 and US-191 over SR-80			
I-10 from NM State Line to US-191, thence to Douglas POE	129.2	141	194
I-10 from SR-80 Interchange at Benson to US-191, then to Douglas POE	98.3	107	147
Through Trip (I-10 all the way through the region)	95.5	104	143
Differences			
Eastbound to Douglas	24	-43	-213
Westbound to Douglas	79.9	46	59
Through	-28.1	-141	-352

Project Costs

Planning-level costs for the BCA are documented in Chapter 4. The proposed projects and associated cost estimates are shown in **Table B-7**. Note that projects involving I-10 interchange improvements were developed using cost estimates for similar I-10 interchange improvements.

Table B-7: Summary of Projects

Project Number	Project Name	Route	Project Cost
1	Glance Creek Bridge (ADOT Structure #237)	SR 80	$3,700,000
2	Reconstruct Westbound I-10/US-191 Interchange Ramps (Exit 331)	US 191	$3,700,000
3	Reconstruct US-191/UPRR Overpass (ADOT Structure #157)	US 191	$15,000,000
4	San Pedro River Bridge (ADOT Structure #403) Improvements	SR 82	$7,700,000
5	Chino Road	US 191	$3,200,000
6	US-191 Shoulder Widening	US 191	$47,000,000
-	I-10/Airport Road Interchange	I-10	$3,700,000
-	West San Simon TI UP	I-10	$3,700,000
-	East San Simon TI UP	I-10	$3,700,000
		Total	**$91,400,000**

Source: Kimley-Horn.

Using these cost estimates, the total cost input for the BCA totals $91.4 million. For purposes of the BCA, it was assumed that all projects would be constructed in 2015. Costs were discounted to net present value (NPV) using a discount factor of 3 percent, which corresponds to USDOT guidance for the use of government funds in Transportation Investments Generating Economic Recovery (TIGER) benefit-cost analyses. This gives a total NPV of $80,915,763.

Project Benefits

Benefits were categorized into four groups: state of good repair, livability, carrier cost savings, and safety. The data and methodology used for each is described below.

State of Good Repair

In this analysis, state of good repair means the value of avoided pavement damage from routing oversize vehicles on the proposed OVFC rather than on SR-80 and county roads. The state of good repair benefits were estimated using a unit value of avoided pavement damage approach, adjusted for the larger size and weight of Class C permitted vehicles.

A basic unit value of avoided pavement damage was obtained from the Government Accountability Office[3]. This figure was $0.13 per mile (converted to 2012 dollars using the Consumer Price Index), for a standard five axle tractor-trailer combination. The figure was adjusted based on equivalent single axle load factors (ESALs). Use the concept of ESALs to measure the effects of heavy vehicles on pavements. ESALs can be used to relate various axle configurations and weights to a standard 18,000 pound single axle load. Any truck axle configuration and weight can be converted to this common unit of measurement. Calculating ESALs used the rule of thumb is that ESALs vary as the ratio of any given axle load to the

[3] Government Accountability Office, *A Comparison of the Costs of Road, Rail, and Waterways Freight Shipments That Are Not Passed on to Consumers*, January 2011. Available at http://www.gao.gov/new.items/d11134.pdf.

standard 18,000 pound single axle load, raised to the fourth power[4]. Using this rule, some basic factors were established to calculate ESALs, as shown in **Table B-8**.

Table B-8: Basis for Estimating Equivalent Single Axle Load (ESAL) Factors

Axle Configuration	Basic Load (pounds)	Flexible Equivalency Factor	Rigid Equivalency Factor
Single	18,000	1	1
Tandem	34,000	1.09	1.95
Tridem	48,000	1.03	2.55

Source: NCHRP Web Document 13: *Developing Measures of Effectiveness for Truck Weight Enforcement Activities: Final Report, 1998.*

Using this information, ESALs were developed for the following vehicles/configurations:

- Standard 5-axle 18-wheeler at 80,000 pounds;
- 19-axle escorted oversize vehicle at 290,000 pounds (the approximate average weight of the 20 escorted vehicles in the ADOT sample data for 2012); and
- 12-axle unescorted oversize vehicle at 170,000 pounds (a typical weight for such configurations according to Precision Heavy Haul).

Based on these calculations, the unit value of avoided pavement damage was adjusted for escorted and unescorted loads proportional to the ratio of their ESAL to that of the standard tractor-trailer. The ESAL calculations and associated pavement damage adjustments are shown in **Table B-9**.

[4] NCHRP Web Document 13: *Developing Measures of Effectiveness for Truck Weight Enforcement Activities: Final Report, 1998.*

Table B-9: ESAL Calculations and Pavement Damage Adjustment Factors

5-axle 18-wheeler (80,000 lbs)	
Steering axle @ 14,000 lbs	0.37
Drive axle @ 34,000 lbs (tandem)	1.09
Rear axle @ 32,000 lbs (tandem)	0.86
Total	2.31
Damage Adjustment Factor	1.00
Adjusted Unit Value of Pavement Damage (per mile)	$0.13
19-axle Escorted Vehicle (290,000 lbs)	
Steering axle @ 14,000 lbs	0.37
6 tridem axles @ 46,000 lbs each	5.21
Total	5.58
Damage Adjustment Factor	2.41
Adjusted Unit Value of Pavement Damage (per mile)	$0.32
12-axle Unescorted Vehicle (170,000 lbs)	
Steering axle @ 14,000 lbs	0.37
1 tandem axle @ 39,000 lbs	1.89
3 tridem axles @ 39,000 lbs each	1.80
Total	4.05
Damage Adjustment Factor	1.75
Adjusted Unit Value of Pavement Damage (per mile)	$0.23

The adjusted unit values were multiplied by the forecast truck VMT for escorted and unescorted loads in the forecast years to estimate the value of avoided pavement damage, on the assumption that all Class C trucks would use I-10 and US-191 rather than SR 80.[5] Since eastbound trucks going to Douglas would continue using US-191 between Douglas and Davis Road, those VMT were subtracted from the analysis. After discounting to NPV using the same 3 percent discount rate as applied to the project costs, the total state of good repair benefit through 2033 is $313,872.

Livability

Livability is estimated in terms of the value of highway user travel time savings. Commercial vehicles have different operational characteristics than passenger cars, since they do not accelerate as quickly and often do not travel as fast. Therefore, they impact traffic flows in different ways than automobiles. The travel time savings per truck was derived from the Highway Economic Requirements System (HERS) model, applied to the national network during peak 8-hour truck windows. This assessment assumes that the national network results

[5] It is probable that at least some Class C trucks would continue using SR-80, especially those coming from the east and destined for Douglas. However, interviews with haulers indicated that in most cases, they would elect to use the improved OVFC even if it adds miles and travel time, because it would be easier for them to travel on a higher classification roadways.

are applicable to the study corridors. It was further assumed that the delay caused by Class C oversize loads is similar to that caused by conventional trucks, because although it is likely that Class C vehicles travel more slowly than regular tractor-trailers, there are also far fewer of them.

Using a travel time savings of 0.0178 hours per truck VMT avoided, an annual estimate of highway user travel time savings was developed by multiplying that factor by the annual forecast truck VMT, again assuming that all Class C trucks would utilize the US-191. The result was then multiplied by an hourly value of travel time savings obtained from USDOT guidance[6] and converted to 2012 dollars using the Consumer Price Index. The resulting value of travel time saved was then discounted to NPV, again using the same 3 percent discount rate, to arrive at a total livability benefit of $459,145.

Carrier Cost Savings

Carriers who move Class C loads in the region will benefit from the recommended improvements, which will allow them to save time through improved routing. Travel time savings in hours were computed for both escorted and unescorted Class C trucks. The total travel time savings are a function of the assumed travel time savings for eastbound, westbound, and through trucks (from **Table B-6**) multiplied by the forecast volumes for that direction and trip type.

In order to estimate carrier cost savings benefits, it was necessary to make assumptions about average daily operating costs for the loads being modeled. Officials from the Specialized Carriers and Rigging Association (SC&RA) were interviewed to gather input on operating costs. Operating costs for oversize vehicles vary widely. According to SC&RA, the average daily operating cost for a 19-axle oversize vehicle including driver/escort labor, fuel, overhead, permits, and vehicle-related expenses like tires and repairs can range from about $2,000 per day for a relatively uncomplicated load requiring a two person crew to $5,500 per day for a dual lane configuration requiring a four person crew. For this analysis, the midpoint of this range was used ($3,750 per day), on the assumption that this would capture the broad average of Class C vehicles using the study routes. This produces an operating cost of $156.25 per hour, or $153.39 in 2012 dollars.

The hourly operating cost was multiplied by the annual time savings in hours for escorted and unescorted loads, and then discounted to net present value to arrive at a total carrier cost savings benefit of $3,658,088.

Safety

Estimated annual safety benefits were developed using Highway Safety Manual (HSM) procedures. The estimated annual safety benefit of $750,000 was incorporated into the BCA to account for the benefits of improving US-191 to the design standard specified in Working Paper #2 (two-lane highway with eight-foot shoulders). Summed across the forecast horizon and discounted to net present value, the estimated safety benefit is $9,724,660.

[6] USDOT, Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, 2011.

Summary of Benefits

The overall benefits are summarized in **Table B-10**.

Table B-10: Total Benefits in Net Present Value Terms (Discounted at 3 Percent)

Benefit Type	Discounted Benefit
State of Good Repair	$313,872
Livability	$459,145
Carrier Cost Savings	$3,658,088
Safety	$9,724,660
Total	**$14,155,766**

Results and Conclusions

Dividing the total discounted benefit of $14,155,766 by the total discounted project cost of $80,915,763 yielded a benefit-cost ratio of 0.17. This indicated that, based on the benefits assessed in this analysis, the package of recommended improvements may not make sense from an economic standpoint. It should be noted here that this seems to be the case even under the most generous assumptions, such as the assumption that all Class C traffic will divert to the US-191 OVFC. Moreover, this sketch planning level analysis did not account for the fact that diverting some or all of these loads to US-191 would effectively transfer some infrastructure wear and tear from one facility to another. Although it is recognized that this would likely carry some benefit since the OVFC will presumably be better equipped to handle Class C vehicles. In addition, to the extent that the project would relieve local authorities of some of the financial and resource burdens of repairing the roads currently being used by these trucks, it would create a benefit for them but a potential negative benefit to ADOT.