MOVE AZ Long Range Transportation Plan

Executive Summary

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

with

Lima & Associates
Partners for Strategic Action, Inc.
BJ Communications, Inc.

September 2004

ADOT

MoveAZ Plan

Executive Summary

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

September 2004

MoveAZ Executive Summary

The Arizona Long-Range Transportation Plan, *MoveAZ*, provides planning guidance for the Arizona Department of Transportation (ADOT) for 20 years. MoveAZ builds on numerous planning studies conducted by ADOT and fits within a larger set of activities used by the agency to identify transportation needs, develop solutions, and deliver specific projects to address these solutions.

MoveAZ is a unique planning process for ADOT, providing the department with policy directions, analytical tools, and performance evaluations of specific capital transportation projects. MoveAZ helps ADOT address the many transportation challenges that Arizona will face over the next 20 years by providing the department with tools to help evaluate and prioritize solutions.

This executive summary provides an overview of MoveAZ. It covers the three phases of the plan, including the development of a strategic direction; the application of performance-based analytics to evaluate actual transportation projects; and the coordination with other agencies, transportation stakeholders, and the public. The following sections describe each of the nine chapters of the plan. Each of these chapters is supported, in turn, by technical appendices that provide detailed information about every aspect of MoveAZ. Table ES.1 provides an overview of the nine chapters and their links to the technical appendices.

The executive summary covers:

- The development of the strategic direction;
- Coordination with the general public, transportation stakeholders, ADOT, and other public transportation planning agencies;
- The development and implementation of a performance-based planning process;
- The analysis of Arizona's transportation modes, including highway, rail, transit, aviation, and bicycle/pedestrian modes; and
- Connections between planning and programming.

Table ES.1 MoveAZ Plan Chapters and Appendices

Document Chapter	Supporting Technical Appendices
Chapter 1. Guiding Principles – Strategic Direction	A. Phase I Summary Report B. Issues Papers
Chapter 2. Coordination and Public Partnering	C. Public Partnering
Chapter 3. Policy Directions	A. Phase I Summary Report C. Public Partnering
Chapter 4. Performance Based Analysis Process	D. Performance Factors and Measures F. Project Process Evaluation
Chapter 5. Base and Future Performance	D. Performance Factors and Measures E. Demand and System Performance
Chapter 6. Project Evaluations	D. Performance Factors and Measures F. Project Process Evaluation
Chapter 7. Transportation Modes; and Chapter 8. Goods Movement	A. Phase I Summary Report E. Demand and System Performance F. Project Process Evaluation G. Goods Movement in Arizona
Chapter 9. Implementation	

ES.1 Strategic Direction

The strategic direction is the foundation for the MoveAZ Plan, providing a base on which all elements of the plan are built. It was based on a thorough review of transportation issues in Arizona, as well as a review of other issues that impact the transportation system, including population growth, economic change, and increased security concerns. The strategic direction is linked to all stages of the planning process and connected to previous planning efforts conducted by ADOT, as well as by other state, regional, and local agencies.

The elements of the strategic direction include a mission statement and long-range goals and objectives. The mission statement, shown in Figure ES.1, is a brief description of the desired future for transportation in Arizona.

Figure ES.1 MoveAZ Mission Statement

To support Arizona's quality of life, the MoveAZ Plan will provide a safe, reliable, and efficient transportation system for people and goods that strengthens our economic vitality; assures access to services and recreational opportunities; preserves the beauty and health of our natural environment; and blends into our urban and rural landscapes.

To achieve these ends, the Move AZ Plan will:

- *Be fiscally responsible;*
- *Provide citizens with transportation choices;*
- *Emphasize accountability;*
- *Be responsive to change;*
- *Harmonize with Arizona's proud heritage and unique diversity;*
- *Encourage coordination of transportation and land use planning at the state, regional, and local level; and*
- *Address air, transit, rail, highway, bicycle, and pedestrian travel.*

The mission statement provides a guide to transportation planning in Arizona. From this statement, five more specific planning goals were developed that formed the basis of the strategic direction:

1. **Access and mobility –** A reliable and accessible multimodal transportation system that provides for the efficient mobility of people and goods throughout the State;

2. **Economic vitality –** A multimodal transportation system that improves Arizona's economic competitiveness and provides access to economic opportunities for all Arizonans;

3. **Safety –** Provide safe transportation for people and goods;

4. **Stewardship –** A balanced, cost-effective approach that combines preservation with necessary expansions and coordinates with local and regional transportation and land use planning; and

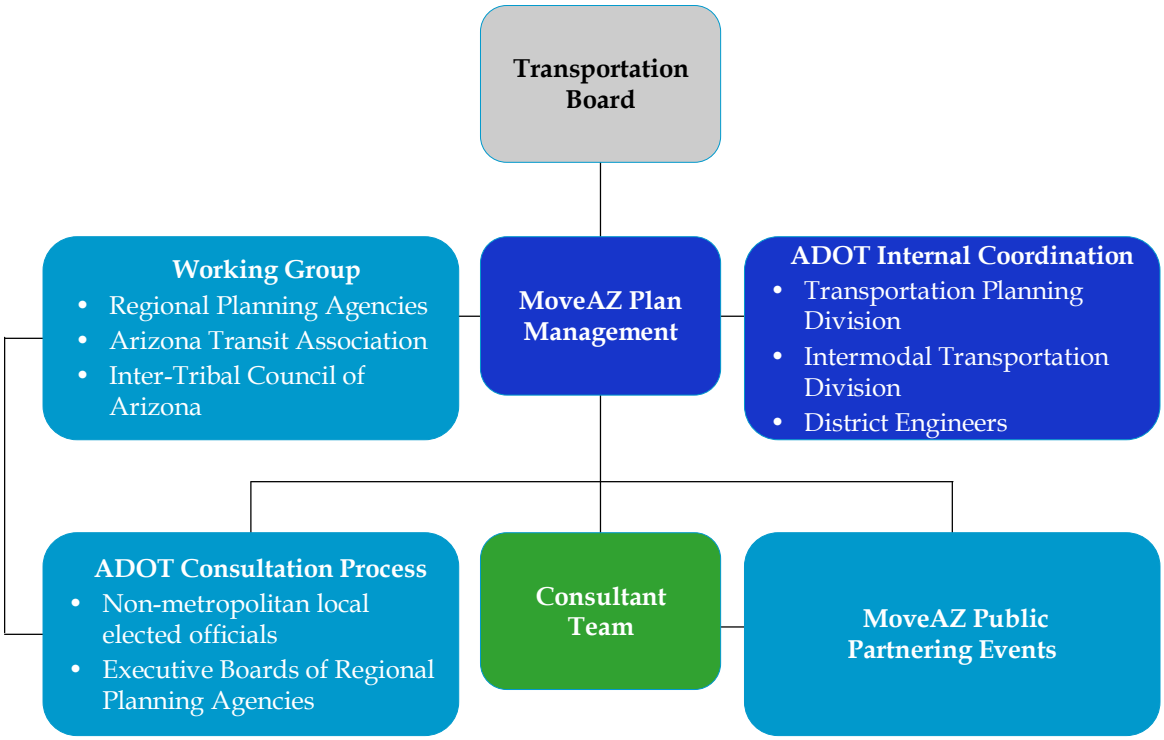
5. **Environmental sensitivity –** A transportation system that enhances Arizona's natural and cultural environment.

From these goals, even more detailed long-range objectives were identified, describing specific means to achieve the long-range goals. These goals and objectives were carried through the entire MoveAZ process, providing a basis for performance factors and measures that were used to evaluate the expected benefits of specific transportation projects.

ES.2 Coordination

One important goal of the MoveAZ plan was to develop a thorough coordination process that provided opportunities for other transportation agencies, stakeholder groups, and the general public to participate in the planning process. The overall coordination process is diagramed in Figure ES.2, including efforts to coordinate with internal ADOT staff, other external transportation planning agencies and groups, transportation stakeholders, and the public.

Figure ES.2 MoveAZ Coordination Process

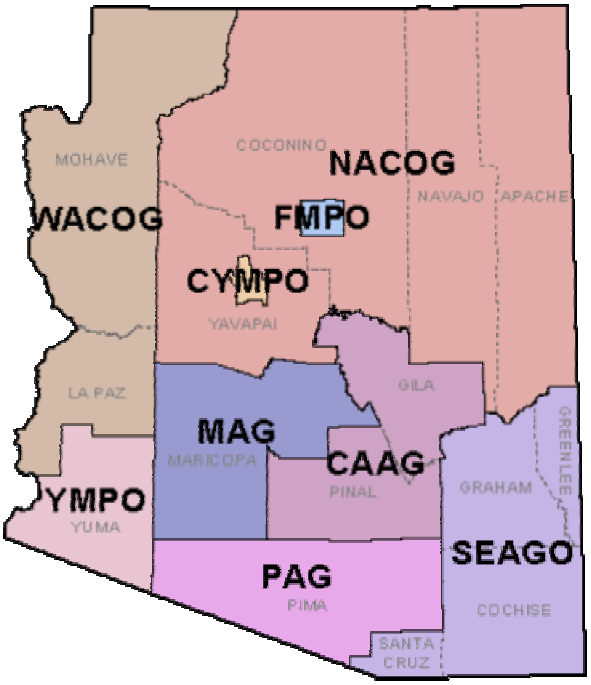


- **External coordination** was conducted primarily through the Working Group, composed of representatives of each of the regional planning agencies in the State (Figure ES.3), the Arizona Transit Association, and the Inter-Tribal Council of Arizona. This group reviewed all products developed for MoveAZ and provided direction for the plan.

- **Internal coordination** occurred through two bodies – a steering committee and a continuity team. The steering committee, comprised of Transportation Planning Division (TPD) staff representing planning, programming, air quality, data and asset management, and each of TPD's regional planners, provided key planning data and analytical resources to the consultant team. The Continuity Team ensured continuity between the MoveAZ planning process and internal department policy and practice. This body included the ADOT Deputy Director, the State Engineer, a District Engineer, and other staff from ADOT's Intermodal Transportation Division. In addition, TPD staff made several presentations to ADOT senior management and the Transportation Board to keep them up-to-date on the development of the plan.

- **Public partnering** took place through a concerted public involvement process. Fifty public meetings were held across three phases, starting in the fall of 2002 and completing in the spring of 2004. The meetings included focus groups, regional forums, and open houses; and were designed to provide information to and solicit feedback from both the general public and stakeholders. These meetings are described in greater detail below.

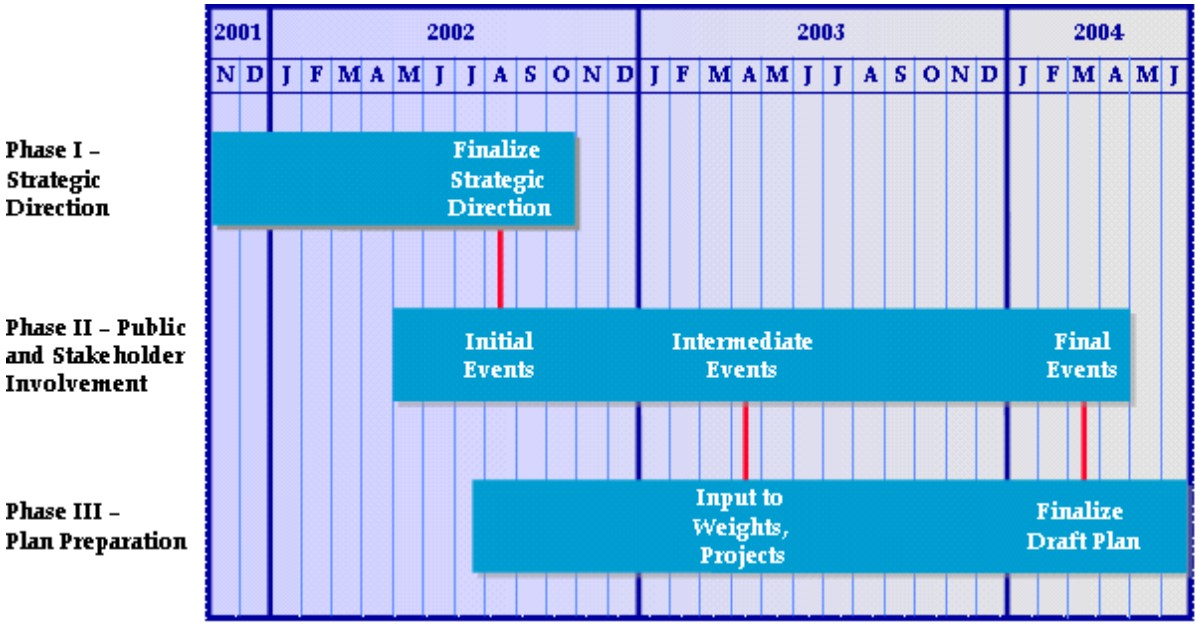
Figure ES.3 Regional Planning Agencies in Arizona



Public Partnering

MoveAZ included three rounds of partnering events designed to help ADOT build stronger relationships with key public and stakeholder groups. Each round provided specific connections to the development of the strategic direction and performance-based analysis process. Figure ES.4 indicates the connections between public involvement and the other phases of the MoveAZ plan.

Figure ES.4 Connections Between Public Partnering and the MoveAZ Plan



The goals of the three rounds of public partnering events were as follows:

1. The **initial partnering phase** of public involvement provided public input to confirm and refine the strategic direction, and to help prioritize the long-range goals and objectives developed during Phase I. In addition, ADOT gained a greater understanding of the transportation issues facing Arizona through the concerns and suggestions presented by stakeholders and the general public.

2. The **intermediate partnering phase** was used to evaluate the acceptability of policies and strategies developed in response to issues, concerns, and ideas expressed during the initial partnering phase and as a result of technical analysis completed for the plan.

3. The **final partnering phase** consisted of 20 open houses held across the State. These events presented material from the draft MoveAZ Plan to the public. From the strategic direction through the analysis of projects, participants had an opportunity to

review information about the plan through display boards, copies of MoveAZ documents, and informal discussions with ADOT representatives.

Figure ES.5 identifies the cities and towns visited during MoveAZ as part of the public involvement process. In addition to these public events, MoveAZ included ongoing communication through newsletters, mailings, and a web site.

Figure ES.5 MoveAZ Public Event Locations

ES.3 Performance-Based Planning

The MoveAZ Plan is performance-based, providing ADOT with tools to help decision-makers select transportation projects to build in the future. The plan provides a process to evaluate the long-term impacts of capital projects that grows logically from the strategic

direction. The long-range goals and objectives developed as a part of the strategic direction were connected to a set of seven performance factors that provide one-word descriptions (such as mobility or safety) that capture the spirit of one or more of the goals. Using these factors as a framework, performance measures were selected that capture the spirit of the specific long-range objectives. Table ES.3 lists the performance factors and measures used to support the MoveAZ plan. Performance-based planning and the selection of performance measures are described in Chapter 4 of the final MoveAZ plan.

Table ES.3 MoveAZ Performance Factors and Measures

Performance Factor	Performance Measures
Mobility and economic competitiveness	• Improvement in vehicle-to-capacity (V/C) ratio (weighted average by Person Miles Traveled) • Reduction in hours of delay
Connectivity	• Ability to pass in major two-lane corridors • Travel time improvement on ADOT high-priority corridors
Safety	• Improvement in crash rate (crashes per 100 million Vehicle Miles Traveled) • Reduction in injuries
Preservation	• Reconstruction for older roads
Reliability	• Reduction in hours of incident-related delay
Accessibility	• Improvement in bike suitability (from bicycle/pedestrian plan) • Added bus turnouts
Resource conservation	• Reduction in mobile source emissions • Reduction in fuel consumption • Added sound walls • Project consistency with local plans

At the core of the MoveAZ Plan evaluation process is an analysis of the system performance impacts of major capital projects on the state transportation system. The primary goal of this process is to guide, assess, and prioritize long-range transportation investments. The steps of this analysis process include:

- Identifying potential projects on the state transportation system;
- Calculating performance on each measure and factor for each of these projects; and
- Weighting performance factors to reflect the greater value attached to some factors.

Projects were identified from several sources, including Corridor Profile studies and Small Area Transportation Plans that ADOT has conducted since the 1994 long-range plan; the Governor's Transportation Vision 21 Task Force; regional and local planning efforts; and others. The individual elements of these plans (such as highway widenings, new interchanges, shoulder widenings, and other projects) were grouped into project bundles for analysis. The purpose of using bundles is to provide consistent corridor-level projects that can be analyzed over the timeframe of the MoveAZ Plan.

Each of the bundles was evaluated using the measures described above. Performance results were designed to show the improvement that a given project would provide over a base scenario for the year 2025. This base scenario included all the projects that ADOT has already committed to through the most recent *Five-Year Transportation Facilities Construction Program*. To develop consistency in the measures, raw scores on each measure were converted into a normalized score between zero and 10 points. A zero score indicated that a given project bundle did nothing to improve a particular measure. The remaining points were assigned to project bundles relative to the raw scores of all project bundles analyzed for MoveAZ.

Project bundles received a final score on each performance factor as a function of their score on one or more performance measures. Similar to the measures, each of the performance factors also used a 10-point scale. The reliability factor had only one measure, so the factor score was the same as the measure score. For all other factors, multiple measures contributed to the factor score. For most factors, the final score was calculated as the average of the measures making up that score, though there were some exceptions. Chapters 4 and 6 of the final MoveAZ plan describe the project evaluation process.

Finally, the process included the development of performance factor weights. These weights indicated the relative priority of performance factors. Though each factor was important, certain factors were more closely connected to the issues and concerns raised in public involvement sessions, previous planning studies, and by ADOT's advisory bodies. Three descriptive weights were selected to describe the relative priorities of the factors:

1. **Enhance** was used for factors with the highest priority for ADOT. These are factors that ADOT should focus on to improve system performance.

2. **Sustain** was used for factors for which ADOT should try to maintain current performance levels.

3. **Neutral** was used for all other factors. These factors represent issues that are important, but somewhat less so than other factors.

Table ES.4 lists descriptive and numeric weights used to support MoveAZ. Chapter 4 of the final MoveAZ plan provides additional information on the weighting process.

Table ES.4 Performance Factors Weights

Performance Factor	Descriptive Weight	Weight
Mobility	Enhance	1.4
Reliability	Neutral	1.0
Connectivity	Neutral	1.0
Accessibility	Sustain	1.2
Safety	Enhance	1.4
Preservation	Sustain	1.2
Resource conservation	Neutral	1.0

Performance Evaluation Results

Performance evaluations were conducted for over 100 potential projects bundles. The results generated by this analysis were organized by funding scenario and region. MoveAZ follows current Board policy by dividing funding and conducting performance analysis independently for three major regions of the State: 1) Maricopa County, 2) Pima County, and 3) the 13 other counties. In addition, MoveAZ used three investment scenarios based upon estimates of state and Federal funds available to Arizona, as determined by ADOT Financial Management Services:

1. **Constrained –** A projection of currently available funding sources through the year 2025;

2. **Additional revenues –** An increase above the constrained scenario based on a reasonable increase in revenues that could be derived from Federal and/or state sources; and

3. **Unconstrained –** No financial constraints, including all projects that address specific needs on the state highway transportation system, as identified in previous planning processes.

Table ES.5 presents the total funding available to each region for the constrained and additional revenues scenarios. The scenarios described here include funding for major capital projects only. Funding for ADOT subprograms (such as pavement maintenance, safety, and others) are provided through existing systems used by each subprogram to identify projects. The results of the project evaluations are presented here by three groups of roadways – interstates, other roads on the National Highway System (NHS), and other roads off the NHS. These three classifications are used because many Federal programs explicitly require states to use funds on either interstates or the NHS.

Table ES.5 Funding for Major Projects by Scenario and Region

County	Constrained ($M)	Additional Revenue ($M)
Maricopa	2,830	626
Pima	870	192
13 Other Counties	1,750	387
Total	**5,450**	**1,205**

Figures ES.6 presents the locations of interstate projects in the 13 other counties.

Figure ES.6 Interstate Project Locations for the Thirteen Other Counties.

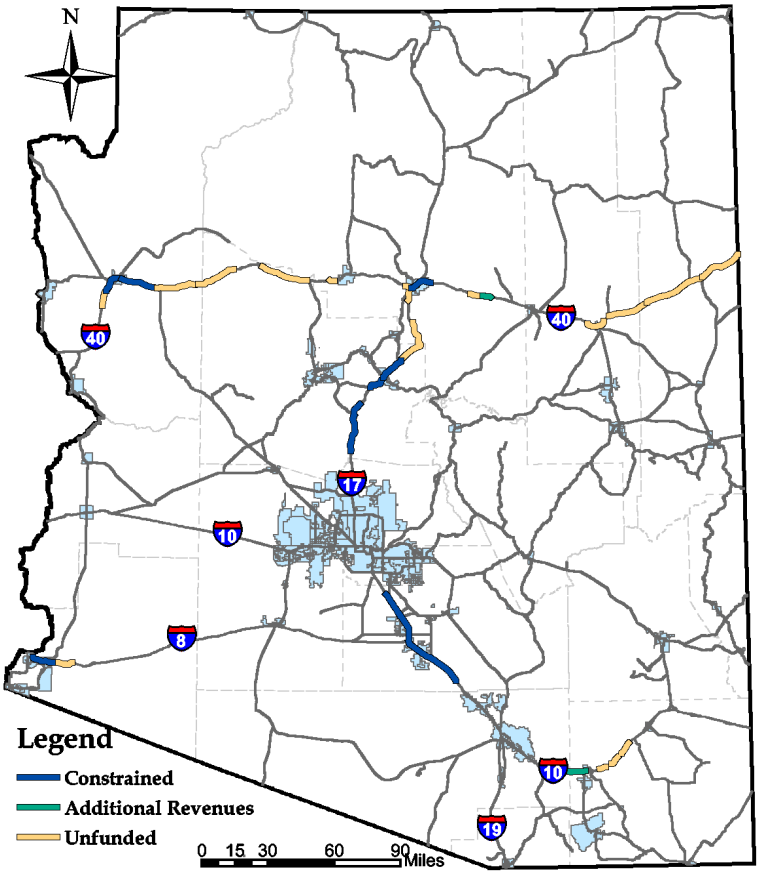


Figure ES.7 presents the location of NHS projects in the 13 other counties.

Figure ES.7 NHS Project Locations for the Thirteen Other Counties

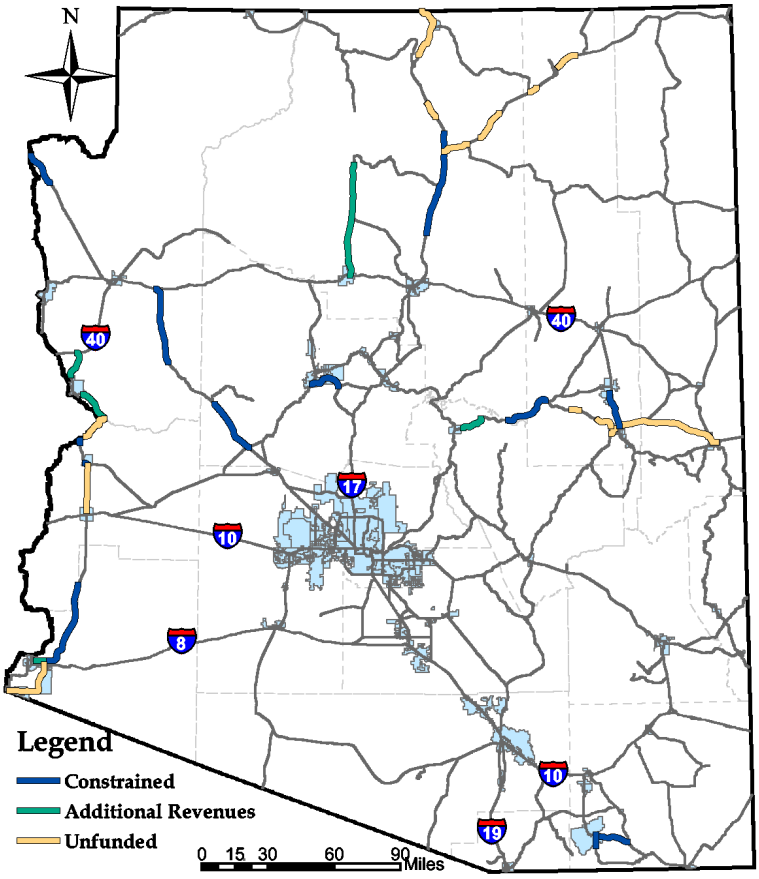


Figure ES.8 presents the location of projects off the NHS in the 13 other counties. Figure ES.9 presents the constrained scenario projects for Pima County. All projects identified in Pima County were fundable under the MoveAZ plan constrained scenario, so these are presented together.

In Maricopa County, the State Transportation Board has incorporated the MAG Regional Transportation Plan (RTP) into MoveAZ. The state highway projects recommended in the MAG RTP are shown in Figure ES.10. These projects will be funded by a combination of Federal, state, and regional sources. A complete list of project bundles for all regions can be found in Chapter 6 of the final MoveAZ plan. Detailed information about these project bundles (i.e., the specific project elements) is available in Appendix F.

Figure ES.8 Non-NHS Projects for the Thirteen Other Counties

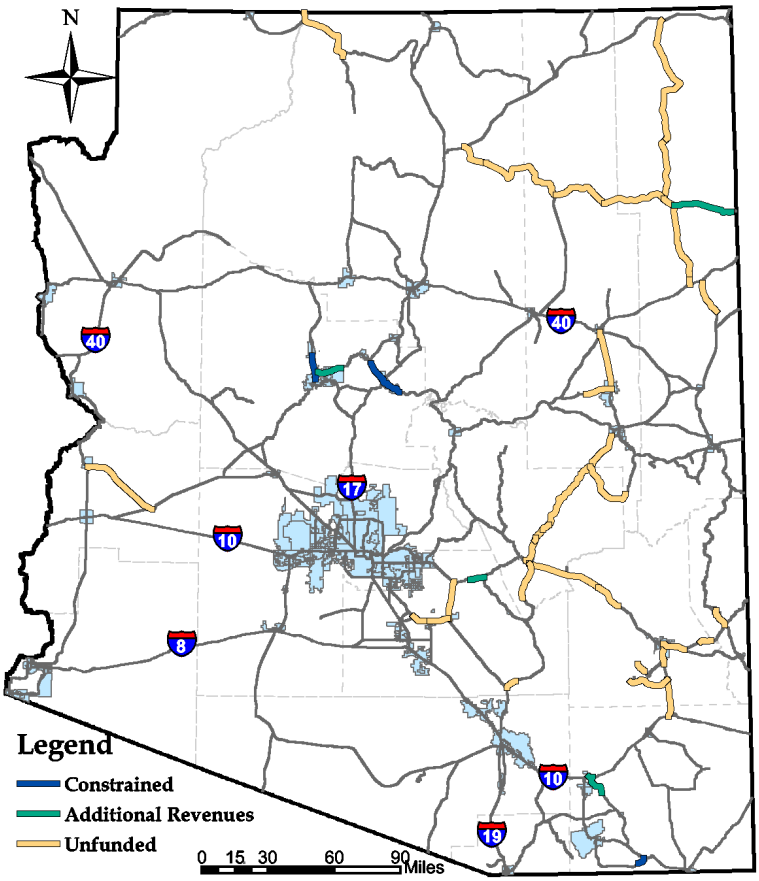


Figure ES.9 Pima County Project Locations for the Constrained Scenario

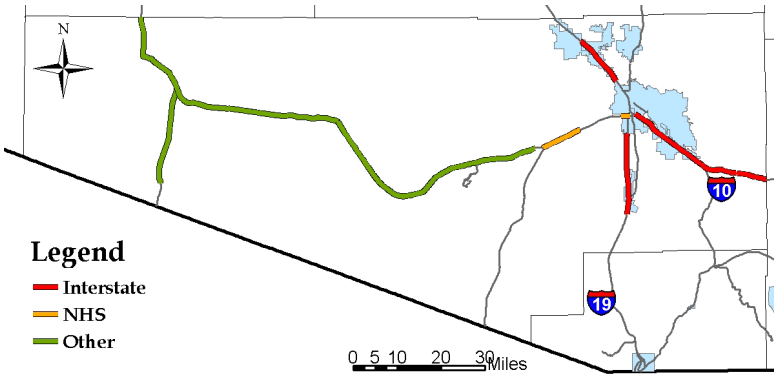
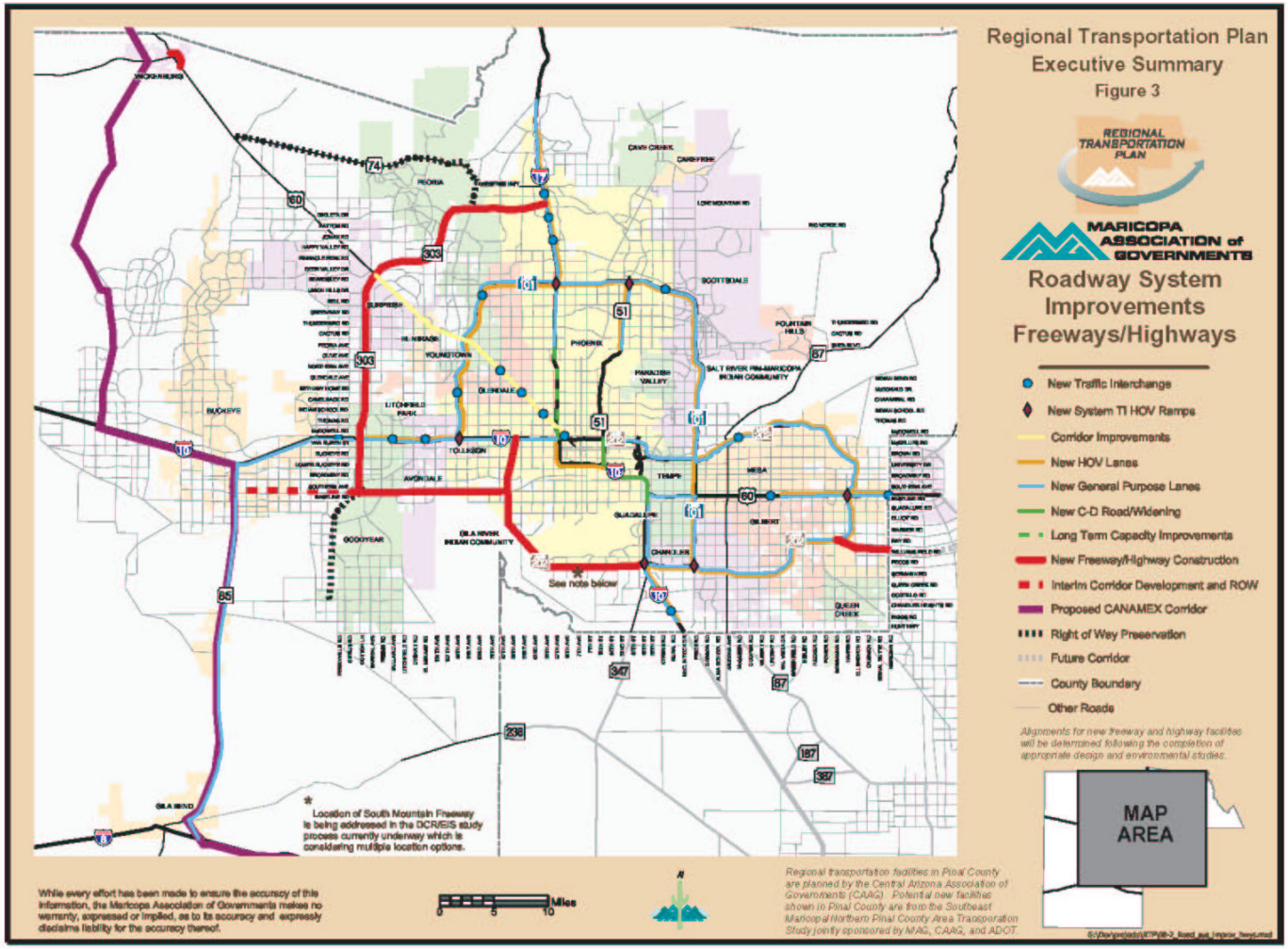


Figure ES.10 Maricopa County Projects Identified in the MAG RTP.

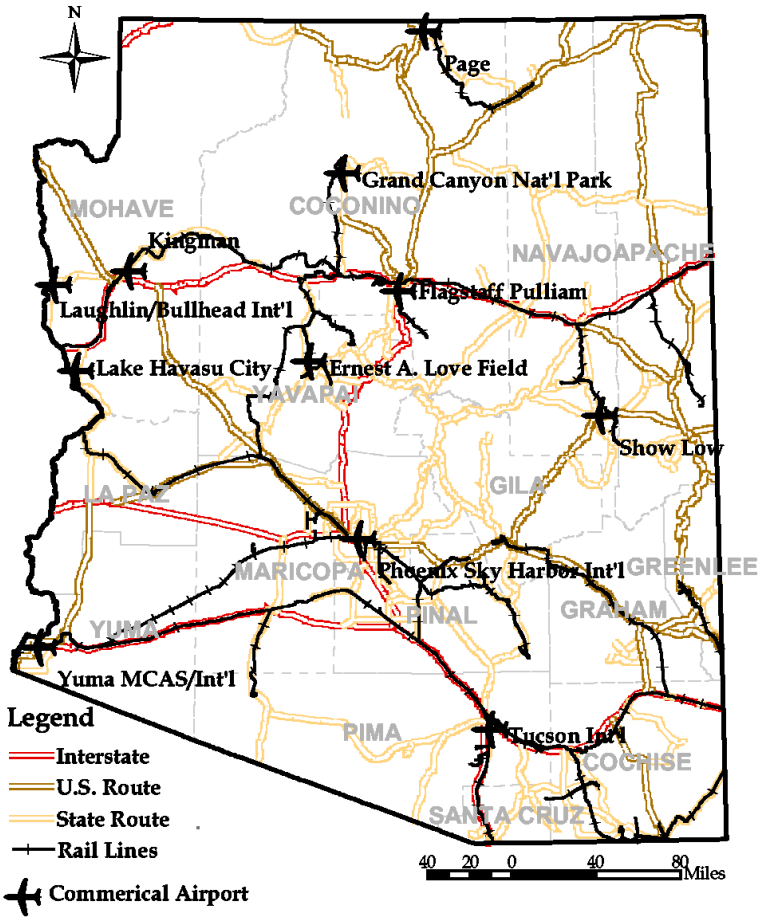


Source: Adapted from Maricopa Association of Governments' Regional Transportation Plan, 2003. Includes projects funded from Federal, state, and regional sources.

ES.4 Transportation Modes

As a multimodal long-range transportation plan, MoveAZ addresses six modes of personal travel in Arizona – highway, rail, transit, air, bicycling, and pedestrian – and four modes of freight transportation – truck, rail, air, and pipeline. Chapters 7 and 8 of the final MoveAZ plan provide detail on the extent of each the mode in Arizona, including location of facilities, types of systems, and other pertinent information; the demand for travel or utilization of the mode; and the role of ADOT in providing funding, operations, research, and other support for the mode. Figure ES.11 identifies the locations of Arizona's highways, railroads, and airports with commercial service. Chapter 7 of the final MoveAZ plan provides additional information about each of these modes, as well as transit and bicycle/pedestrian modes.

Figure ES.11 Arizona's Highway, Rail, and Air Transportation System



Demand and Utilization of Transportation Modes

MoveAZ included a detailed assessment of the total travel that takes place on Arizona's transportation modes both for current conditions (2002) and in the future (2025). Table ES.6 provides a summary of the total demand or utilization of each of these modes. Results of these analyses by county are shown in Chapter 7 of the final MoveAZ plan.

Table ES.6 Demand/Utilization of Transportation Modes

Mode	Metric	Demand/Utilization	
		2002	2025
Road	Vehicle Miles of Travel (VMT)	150,000,000	276,000,000
Rail	Daily boardings	207	409
Transit			
Intercity Bus	Daily boardings	670	910
Urban Transit	Daily boardings	271,000	429,000
Rural Bus	Daily boardings	4,100	7,400
Aviation	Daily enplanements	47,600	104,100
Bicycle	Daily trips	310,300	501,100
Pedestrian	Daily trips	976,400	1,597,500

ADOT's Role in Providing Transportation

ADOT has an important role to play in each transportation mode. Though these roles vary from one mode to another, ADOT is committed to working with the providers of each mode – whether highway, transit, rail, bicycle, or other – to ensure that each works within the state transportation system. Some of the key roles that ADOT plays in each mode include:

- **Highways –** ADOT is responsible for developing and maintaining the highway system and works with regional and local jurisdictions across the State to identify needs and the projects to address them.

- **Rail –** ADOT does not build or operate rail systems in Arizona, but works with rail providers, including Amtrak, other passenger rail companies, and freight rail operators. ADOT has supported the rail system by sponsoring key studies, such as a high-speed rail feasibility study, integrating rail issues into planning studies, evaluating the

preservation of abandoned rail right of way for possible future uses, and examining the need to improve and/or upgrade highway grade crossings.

- **Transit –** ADOT administers Federally-funded transit grant programs that provide demand responsive and targeted service to the elderly and persons with disabilities (Section 5310) and to rural public transportation organizations (Section 5311). These programs provide $13.5 million, $6.5 million of which ADOT flexes from other funding sources to help maintain these services in the State. ADOT planning studies include an examination of transit issues and ADOT will sponsor several studies to specifically examine rural transit issues through the ADOT Public Transportation Division, which was formed in 2004.

- **Aviation –** ADOT owns the Grand Canyon Airport. The ADOT Aeronautics division is responsible for planning activities related to aviation. Excise taxes on airplane fuel, aircraft license and registration fees, and other fees are collected in an Aviation fund that is used for a variety of aviation projects across the State.

- **Bicycle/pedestrian –** Though ADOT does not provide specific facilities for cyclists or pedestrians on state highways, many of the improvements that ADOT makes can benefit these road users as well. ADOT also supports bicycle and pedestrian travel through planning studies, such as the recent State Bicycle/Pedestrian Plan.

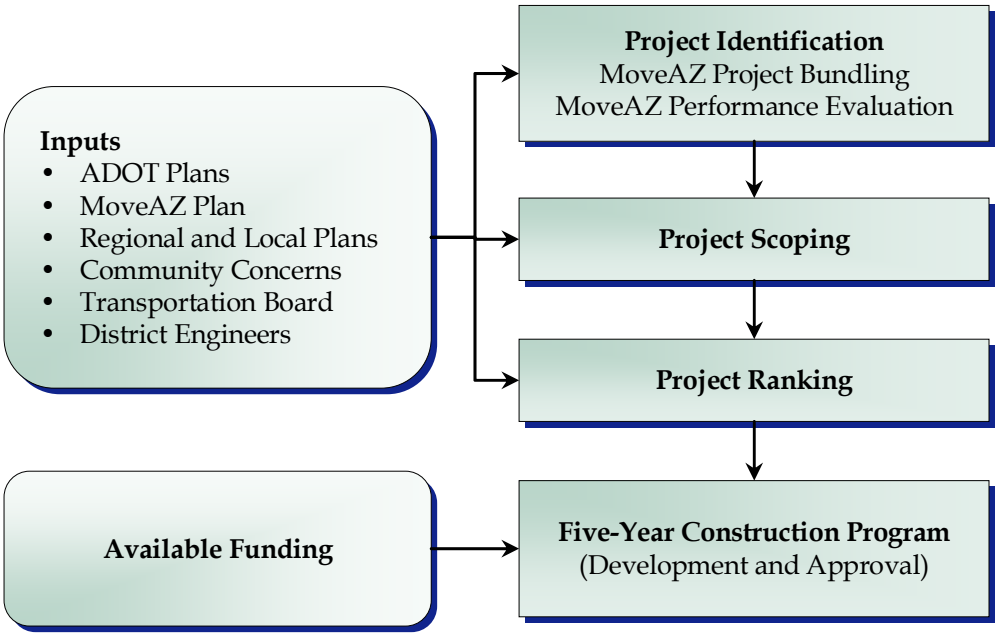
ES.5 Planning to Programming

In addition to providing ADOT with tools to analyze the performance impacts of capital transportation projects, MoveAZ also addresses the relationship between these analyses and the process ADOT uses to identify specific transportation projects for funding in the *Five-Year Transportation Facilities Capital Program* (Five-Year Program). The ADOT programming process is designed to fund projects that will help ADOT meet its responsibilities to maintain and expand the transportation system in Arizona. These responsibilities include a wide variety of activities, such as repaving highways, providing funding to special needs transit operators, developing ADOT construction capabilities, and expanding capacity on the highway system.

MoveAZ will provide information for use in developing the five-year program, primarily in the area of system improvements that address capital expansion of the transportation system. Other projects, such as pavement maintenance, safety, and others, are delivered through specific ADOT subprograms that have existing tools to identify expected improvements for specific projects. For major capital projects, MoveAZ provides tools to identify these performance improvements. As shown in Figure ES.12, MoveAZ is intended to supplement the existing programming process by providing additional information to ADOT and the State Transportation Board to help with decision-making. As such, MoveAZ provides several processes that ADOT will use for planning and programming in the future:

- A set of decision rules used to bundle projects into corridor-level projects that can be evaluated over a long timeframe, such as the 20-year MoveAZ plan;
- An evaluation process that estimates the performance benefits of capital transportation projects; and
- Detailed information about travel demand, utilization, and other data that will support these evaluations in the future.

Figure ES.12 ADOT Updated Priority Programming Process



Detailed information about the relationship between planning and programming can be found in Chapter 9 of the final MoveAZ plan.

MOVE AZ Long Range Transportation Plan

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

September 2004

ADOT

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

September 2004

Table of Contents

1. Guiding Principles – Strategic Direction 1-1
1.1 Why Develop a Strategic Direction 1-1
1.2 How the Strategic Direction Was Developed 1-2
1.3 Mission Statement, Goals, and Objectives 1-8

2. Coordination and Public Partnering 2-1
2.1 Coordination Process 2-1
2.2 Public Partnering Process 2-3
2.3 Public Partnering Results 2-7

3. Policy Directions 3-1
3.1 ADOT Transportation Policies 3-1
3.2 Key Policies Related to MoveAZ 3-3
3.3 Policy Recommendations from Public Partnering 3-9

4. Performance-Based Evaluation Process 4-1
4.1 Identifying Performance Measures 4-2
4.2 Identifying Projects and Creating Project Bundles 4-5
4.3 Calculating Project Performance 4-7
4.4 Establishing Thresholds to Evaluate Projects 4-9
4.5 Assessing Project Needs 4-9
4.6 Normalizing Performance Measures 4-11
4.7 Scoring Performance Factors 4-11
4.8 Weighting Performance Factors 4-12

5. Base and Future System Performance 5-1
5.1 Mobility and Economic Competitiveness 5-2
5.2 Connectivity 5-3
5.3 Preservation 5-5
5.4 Reliability 5-5
5.5 Safety 5-6
5.6 Accessibility 5-8
5.7 Resource Conservation 5-9

6. Project Evaluations 6-1
6.1 Funding 6-1
6.2 Project Performance Results 6-4
6.3 State Performance Results 6-13

Table of Contents
(continued)

7. Transportation Modes 7-1
7.1 Highways 7-1
7.2 Railroads 7-6
7.3 Transit 7-9
7.4 Aviation 7-16
7.5 Bicycle and Pedestrian 7-19
7.6 Summary 7-23

8. Goods Movement 8-1
8.1 Goods Movement System 8-1
8.2 Goods Movement and the Domestic Economy 8-5
8.3 Goods Movement and the International Economy 8-9

9. MoveAZ and the Five-Year Program 9-1
9.1 Existing Priority Programming Process 9-1
9.2 Integrating MoveAZ into the Five-Year Program 9-7
9.3 Next Steps 9-8

Appendix A
Phase I Summary Report

Appendix B
Issues Papers

Appendix C
Public Partnering

Appendix D
Performance Factors and Measures

Appendix E
Demand and System Performance

Appendix F
Project Evaluation Process

Appendix G
Goods Movements in Arizona

List of Tables

1.1 Elements of Past Strategic Direction Efforts 1-4

1.2 MoveAZ Goals and Objectives 1-10

2.1 MoveAZ Public Partnering Events 2-3

3.1 Comparison of HB2660 and MoveAZ Performance Factors 3-2

3.2 Transportation Board Financial, Procedural, and Coordination Policies 3-4

3.3 Transportation Board System Policies and Their Relationship to the MoveAZ Goals 3-4

4.1 MoveAZ System Performance Measures 4-8

4.2 MoveAZ Performance Measure Thresholds 4-10

4.3 Performance Factor Scoring Methodology 4-12

4.4 Performance Factors Weights 4-16

5.1 Measures Not Used in System Performance Analysis 5-1

5.2 Percent of PMT by LOS and District 5-2

5.3 Average Delay Per Vehicle Trip by District 5-3

5.4 Passing Ability by District (Ratio of AADT to Passing Service Volume) 5-4

5.5 Intercity Travel Time by Corridor 5-5

5.6 Unexpected Delay by District (Hours Per 1,000 VMT) 5-6

5.7 Crashes Per 100 Million VMT by District 5-7

5.8 Anticipated Change in Injuries/Fatalities by District 5-8

5.9 Percent of State Road Miles Moderately/Highly Bike Suitable by District 5-9

5.10 Total Mobile Source Emissions by District (Metric Tons) 5-10

5.11 Daily Fuel Consumption by District (Gallons) 5-11

List of Tables
(continued)

6.1 Available Funding for MoveAZ by Scenario 6-2

6.2 Annual Funding for Subprograms by Region 6-3

6.3 Total Funding for Major Projects and Subprograms by Region, 2010-2025 (Constrained Scenario) 6-3

6.4 MoveAZ Plan Projects – Constrained Scenario 6-4

6.5 Total Funding for Major Projects and Subprograms by Region, 2010-2025 (Additional Revenue Scenario) 6-7

6.6 MoveAZ Plan Projects – Additional Revenue Scenario 6-8

6.7 MoveAZ Plan Projects (Unconstrained Scenario) 6-10

6.8 System Performance Results for Constrained and Additional Revenue Scenarios 6-14

7.1 Annual Passenger Rail Counts in Arizona, 2000 7-8

7.2 Estimated Daily Intercity Rail Boardings for 2002 and 2025 7-8

7.3 Estimated Annual Urban Bus Ridership, 2002 and 2025 7-14

7.4 Estimated Daily Rural and Intercity Bus Ridership for 2002 and 2025 7-15

7.5 Airport Enplanements in Arizona, 2000 7-18

7.6 Estimated Daily Commercial Enplanements and General Aviation Operations by County 7-19

7.7 Bicycle Suitability on the State Highway Network 7-20

7.8 Arizona-Sonora Pedestrian Border Crossings, 2000 7-21

7.9 Estimated Daily Bicycle and Pedestrian Trips, 2002 and 2025 7-22

8.1 Estimated Daily Truck VMT, 2002 and 2025 8-2

8.2 Cargo and Passenger Volumes at Arizona Airports, 2000 8-4

List of Tables
(continued)

8.3 Economic Output and Employment by Sector for Arizona in 1997 8-6

8.4 High-Tonnage Commodities Produced in Arizona, 1998 8-7

8.5 Value of Arizona Shipments by Commodity, 1997 8-8

8.6 Forecast of Tons Shipped by Trip Type, 1998 and 2020 8-8

8.7 Total Tons Moved by Mode, 1998 and 2020 8-9

8.8 Destinations for Arizona's Exports in 2002 8-10

8.9 Arizona-Sonora Vehicle, Passenger, and Freight Border Crossings 8-10

8.10 Inputs for Maquiladoras, 1997 (in Millions of Dollars) 8-11

9.1 Program Resource Allocation Categories and Project Selection Method 9-3

List of Figures

1.1 Regional Planning Agencies in Arizona 1-3

1.2 Historic Population Growth and Future Estimates 1-5

1.3 Projected Age Distribution of Arizona's Population 1-6

1.4 Arizona Employment by Industry 1-7

1.5 MoveAZ Mission Statement 1-9

2.1 MoveAZ Coordination Process 2-2

2.2 MoveAZ Regional Public Forum Locations 2-4

2.3 MoveAZ Regional Solutions Forum Locations 2-5

2.4 MoveAZ Open House Locations 2-7

2.5 Connections Between Public Partnering and the MoveAZ Plan 2-8

2.6 Distribution of Participant Concerns Across All Forums 2-9

2.7 Response to Survey Statement: "Cities Should Take the Lead in Planning and Developing Transit" 2-9

2.8 Responses to the Statement: "The Overall Maintenance of State Roadways in this Region Is Good" 2-10

2.9 Strategic Recommendations by Performance Factor 2-11

2.10 Acceptance of Changes to Transportation Services 2-12

2.11 Primary Subject of Comments Received at MoveAZ Open Houses 2-13

3.1 Transportation Board Funding Regions 3-6

3.2 Corridor Definition Study Locations 3-8

4.1 MoveAZ Plan Project "Bundling" Decision Guidelines 4-7

4.2 Sources of MoveAZ Factor Weights 4-14

List of Figures
(continued)

6.1 Constrained Scenario Project Locations (Pima County and the 13 Other Counties) 6-6

6.2 Constrained Scenario Project Locations (Maricopa County) 6-7

6.3 Additional Revenue Scenario Project Locations (13 Other Counties Only) 6-9

7.1 Arizona State Highway System by Route Type 7-2

7.2 Federal and Tribal Land Ownership 7-3

7.3 Historical and Projected VMT in Arizona 7-5

7.4 ADOT Five-Year Program Investments, 2004 to 2008 7-6

7.5 Railway Network in Arizona 7-7

7.6 Transit Services in Arizona 7-10

7.7 Phoenix Approved Light-Rail System 7-11

7.8 Aviation Network in Arizona 7-17

7.9 Bicycle Network in Arizona 7-20

8.1 Average Daily Truck Traffic on Arizona Highways in 2002 8-2

8.2 Arizona International Ports of Entry 8-3

8.3 Phoenix Region Freight Infrastructure 8-6

9.1 ADOT'S Existing Priority Programming Process 9-5

9.2 ADOT Updated Priority Programming Process 9-7

9.3 Regional Corridor Study Areas 9-10

1. Guiding Principles – Strategic Direction

Chapter 1. Guiding Principles – Strategic Direction

The Arizona Long-Range Transportation Plan (MoveAZ) provides planning guidance for the Arizona Department of Transportation (ADOT) for 20 years. MoveAZ is one of several planning activities conducted by ADOT and fits within a larger set of activities used by the agency to identify transportation needs, develop solutions, and deliver specific projects to address these solutions. The plan has three main goals:

1. To provide a **strategic direction** for transportation planning in the State;
2. To conduct in-depth analysis of actual projects and programs using **performance-based planning** techniques; and
3. To **coordinate** with regional planning agencies and the general public throughout the planning process.

MoveAZ helps ADOT address the many transportation challenges that Arizona will face over the next 20 years. The plan provides ADOT with tools to help evaluate and prioritize solutions to these challenges.

1.1 Why Develop a Strategic Direction

The strategic direction is the foundation for the MoveAZ Plan, providing a base on which all elements of the plan are built. It includes a process to understand transportation issues in Arizona, as well as the larger context in which the transportation system must operate. It is linked to all stages of the planning process and connected to previous planning efforts conducted by ADOT, as well as by other state, regional, and local agencies.

The elements of the strategic direction include a mission statement and long-range goals and objectives. The mission statement is a general, brief description of the desired future for transportation in Arizona. The long-range goals provide additional specificity, defining several goals for ADOT to focus on in the development of MoveAZ. The objectives are statements that describe the specific means to achieve these goals.

In addition to identifying a desired future for transportation in the State, the strategic direction guides the evaluation of projects and programs. The MoveAZ Plan is performance-based, providing ADOT with several tools to understand the use of the transportation system and the impact that specific projects will have upon that system.

The strategic direction process included grouping the long-range objectives into broad performance factors. These factors – one-word descriptions such as mobility, safety, and others – capture the spirit of one or more of the objectives. The performance factors provide the basis for developing performance measures used to conduct specific project evaluations. The long-range objectives also inform the selection of performance measures. Performance-based planning and the selection of performance measures are described in Chapter 4.

1.2 How the Strategic Direction Was Developed

The MoveAZ Plan has not been developed in a vacuum. Instead, it has been integrated with previous planning efforts conducted both by ADOT and other agencies in the State. The strategic direction provides one clear link between previous planning and MoveAZ.

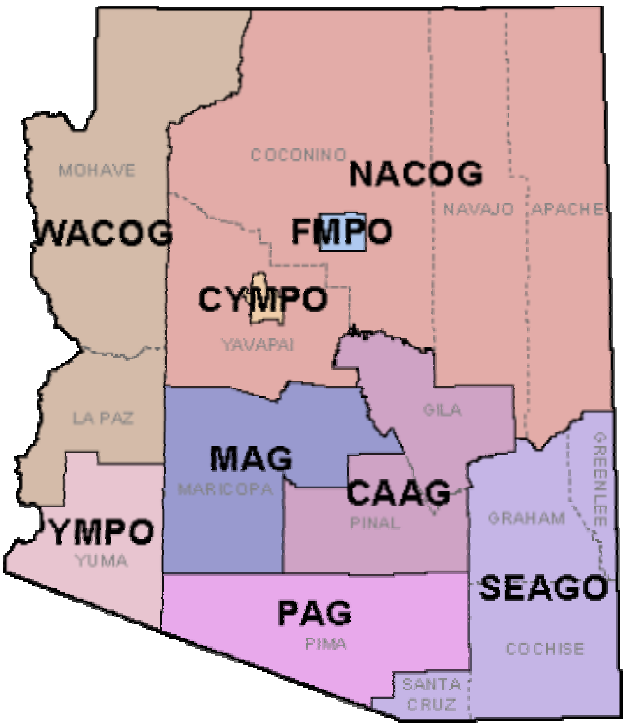
The strategic direction is based on a review and evaluation of previous planning processes in Arizona and similar experiences from other states. ADOT identified recurrent themes and issues from these sources and, through review with internal and external advisory bodies and the general public, developed a mission statement and long-range goals and objectives that constitute the strategic direction.

The first step in developing the strategic direction involved reviewing the following major planning efforts:

- Transportation and vision-based plans conducted by ADOT and regional and local transportation entities in Arizona;
- Planning documents and policy analyses conducted by state agencies and research institutes with mandates other than transportation, such as economic development, land use, and commerce;
- Similar transportation planning activities in Southwestern and Rocky Mountain states, as well as in states that have pioneered vision-based planning efforts; and
- Four papers commissioned for the MoveAZ Plan that examined specific issues relevant to the future of transportation in Arizona.

The second step in the development of the strategic direction was a review of this material by ADOT and the Working Group, an advisory committee convened for the MoveAZ development process. The Working Group consisted of the chief executives and head transportation planner for each of the regional planning agencies in the State (Figure 1.1), as well as a representative of the Arizona Transit Association (AZTA) and the Inter-Tribal Council of Arizona (ICTA). The Central Yavapai Metropolitan Planning Organization was formed in December 2003 and joined the Working Group at that time. This group was consulted throughout the planning process and reviewed all key documents produced for the plan, including the strategic direction.

Figure 1.1 Regional Planning Agencies in Arizona



The final step in the development of the strategic direction was public review of the assembled material and draft strategic direction. Chapter 2 describes the public partnering process used by MoveAZ.

The material produced for review by the Working Group and the public covered two subjects: 1) the key transportation issues to be addressed in a long-range plan, and 2) the general issues and trends that shape the overall environment within which the transportation system operates. The remainder of this section provides a summary review of these subjects. Appendix A contains a more comprehensive review of previous planning efforts.

Summary Review of Transportation Plans

One source of the strategic direction was previous planning efforts, including plans developed by ADOT, the Governor's Office (notably the Transportation Vision 21 Task Force), metropolitan planning organizations, councils of governments, and American-Indian reservations. These plans provided raw material that was shaped into the mission statement, goals, and objectives.

MoveAZ included a review of over 100 plans that revealed several important factors that must be part of the strategic direction for Arizona. Table 1.1 presents a summary of the

elements raised in previous planning efforts by the type of agency that produced the plan (ADOT statewide and corridor plans, ADOT small area transportation plans, regional plans, tribal plans, and other plans). For each cell of the table, a mark indicates how frequently plans of a given type mentioned particular transportation issues or concerns, such as mobility, safety, and funding.

Table 1.1 Elements of Past Strategic Direction Efforts

Element	ADOT	Small Area	MPO	Tribal	Other
General Elements					
Balanced/multimodal	◆	◆	◆		◆
Transportation Elements					
Accessibility, mobility		◆	■	◆	■
Safety		■	◆	◆	
Funding flexibility, local control					■
Stable, equitable funding	◆	◆		■	■
Connection to Other Factors					
Land use connection	◆	◆	■	■	◆
Environmental	◆	■	◆	√	■
Economic development	◆	√		√	
Tourism, recreation		◆		◆	
Social issues				√	
Community character		■		◆	■

■ – A few mentions; ◆ – Several mentions; and √ – All or nearly all plans mention.

Source: Cambridge Systematics, 2002.

Plans from most levels of government encouraged the development of a balanced, well-integrated multimodal transportation system. The features of this system clearly included connections to land use, environmental planning, and economic planning. Additionally, past efforts make note of the need to provide a safe, accessible system that ensures easy mobility in both urban and rural areas. Rural areas often have different needs than urban areas, and the MoveAZ Plan is sensitive to these differences. American-Indian reservation plans, in particular, tended to raise somewhat different, though overlapping, concerns than other plans.

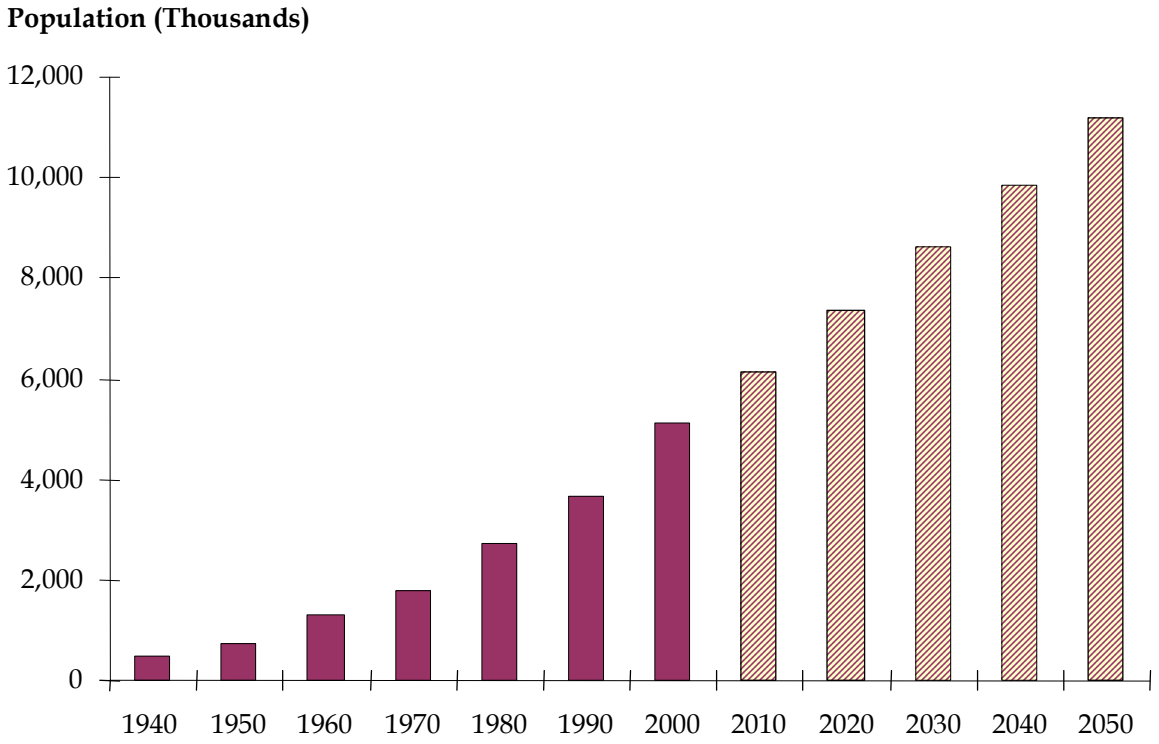
The Arizona Context

In addition to reviewing past transportation and other planning efforts in Arizona and other key states, the MoveAZ strategic direction drew from an assessment of major trends and issues facing the State, including population growth and change, economic change, environmental issues, quality of life, and urban-rural differences in Arizona.

Population Growth and Change

Arizona has been among the fastest growing states in the U.S. every decade since the 1960s. The State has grown from only 250,000 people in 1950 to over five million in 2000. The Phoenix region has added over two million new residents since 1970, and is currently home to nearly three million people. Population projections developed by the Arizona Department of Economic Security show Arizona adding another 2.5 million people by 2020 (Figure 1.2). Future population growth will continue to be centered in Phoenix, but the number of metropolitan areas in Arizona is growing. With the Prescott area recently certified as the Central Yavapai Metropolitan Area, continued growth in Yuma and Flagstaff, and several other areas likely to achieve metropolitan status by 2025, Arizona will face a host of new and emerging transportation needs and concerns.

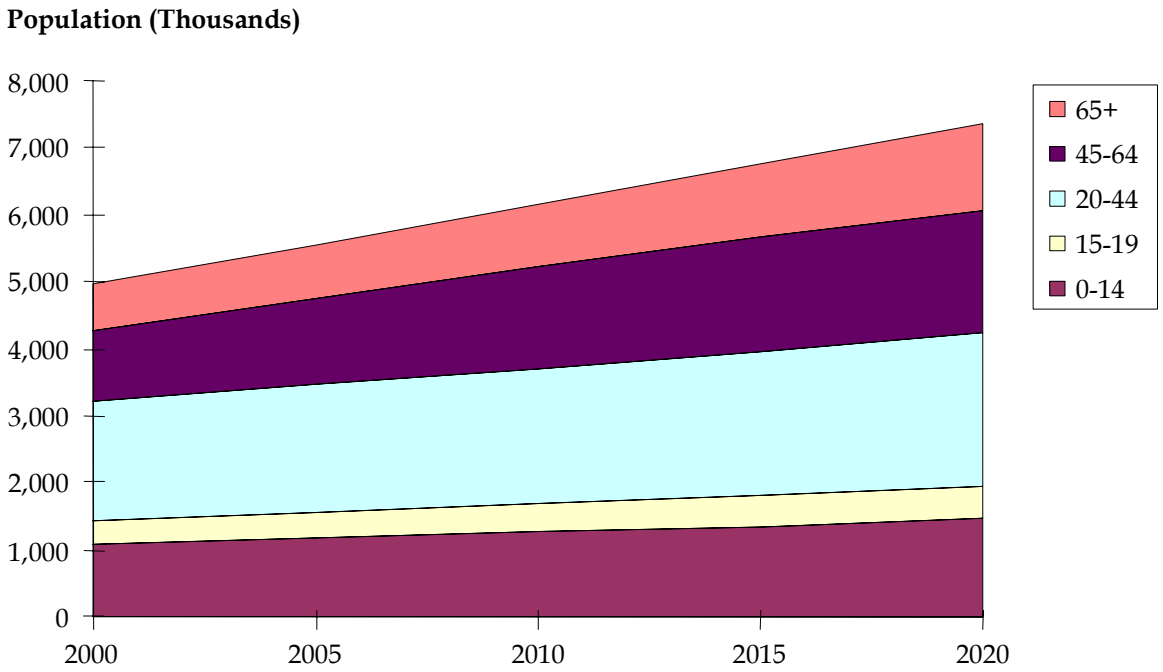
Figure 1.2 Historic Population Growth and Future Estimates



Source: Arizona Department of Economic Security, 2002.

The composition of Arizona's population is changing as well. Like many states in the southwest, Arizona is a major destination for Mexican and other Latin American immigrants. On average, these immigrants have somewhat less education, are younger, and have larger average household sizes than Arizona's historical population base. In addition, Arizona's population has been aging, a trend that is expected to continue in the future (Figure 1.3).

Figure 1.3 Projected Age Distribution of Arizona's Population



Source: Arizona Department of Economic Security, 2002.

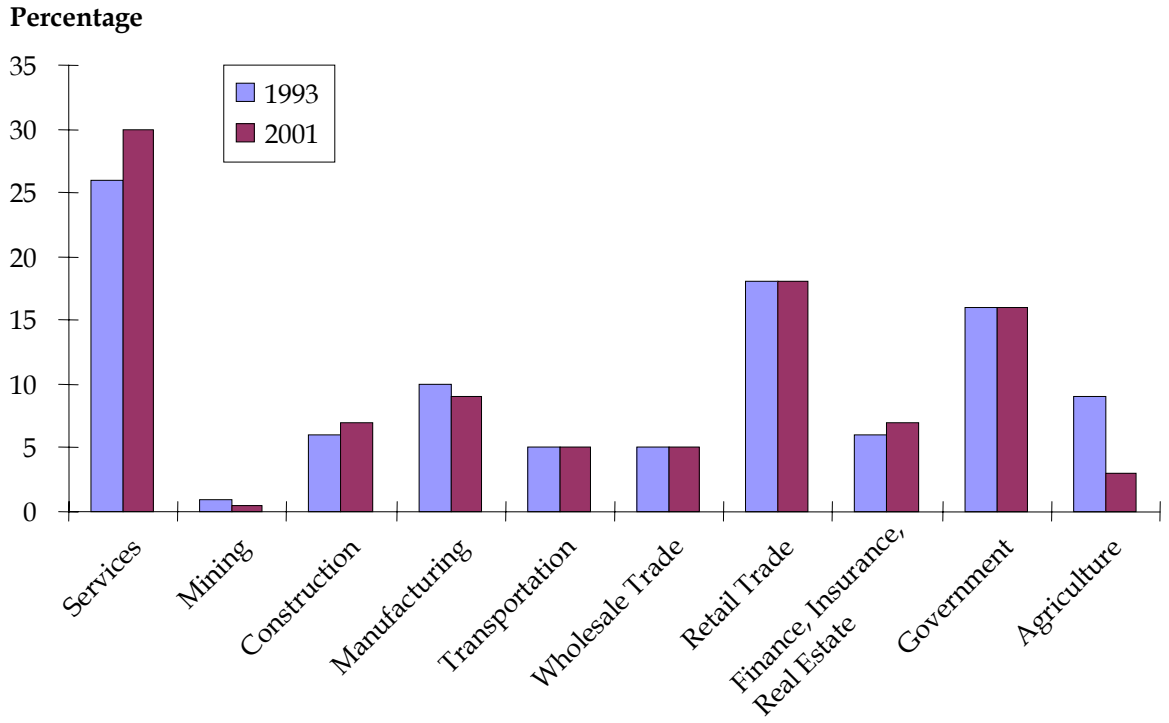
Population growth and change have significant implications for land use planning and its relationship with the transportation system in Arizona. Encouraging coordination between land use and transportation planning could improve Arizona's ability to address the transportation needs of millions of new residents over the next 20 years. Population growth puts pressure on all aspects of government, not least the transportation system. Phoenix already faces serious congestion problems that may intensify over the next 20 years. As other areas of the State grow, new problems will emerge.

A Changing Economy

Economic growth has largely maintained pace with population growth in Arizona. As with population, over 70 percent of jobs, personal income, and sales are generated in the Phoenix metropolitan area; an additional 15 percent is generated in the Tucson metropolitan area. Phoenix and Tucson are manufacturing centers attempting to attract high-technology development. Other urban areas, such as Flagstaff and Sierra Vista, are also

pursuing high-technology and "new economy" knowledge-intensive jobs. Economic development elsewhere in the State, in contrast, is generally quite different. Outside of the major urban areas, recreation-based employment, tourism, and services for retirees are key. Agriculture and mining also continue to play important roles, as they have throughout the State's history. The opportunities for international trade are growing, both along the Mexican border and also with major partners overseas. Figure 1.4 provides an overview of recent shifts in employment by industry.

Figure 1.4 Arizona Employment by Industry



Source: Arizona Department of Economic Security, 2002.

Population and economic growth, combined with national and international changes in goods production and movement, make freight movement a major issue for Arizona. Arizona is positioned to capture a large share of North American Free Trade Agreement (NAFTA) traffic, and could develop strategic linkages of suppliers to Maquiladora factories in Mexico. Maquiladora factories manufacture or assemble products for sale in the U.S., using inputs to their manufacturing processes from the U.S. At the same time, Arizona's largest trading partners are overseas, making Arizona (like all U.S. states) heavily reliant on the state and national transportation system to supply Arizonans with commodities. In addition, growth in small parcel shipments and overnight shipping means different types and numbers of trucks on the road.

Environmental Pressures

One of Arizona's greatest assets is its varied natural setting. The Arizona Department of Environmental Quality has actively pursued programs to improve the State's environment. Since the early 1990s, air quality has improved; and, today, few areas of the State are out of compliance with Federal air and water quality standards.

The continuing influx of residents and economic activity will increase pressure on Arizona's environmental resources. As the population center of the State, the Phoenix region faces the greatest challenge to maintaining air and water quality. The main markers of poorer environmental conditions are in Phoenix, where air pollution has reduced visibility in the region over the past several years. However, there has been no violation of the carbon monoxide and one-hour ozone standards since 1996. The state and local governments have implemented a wide variety of air quality measures to keep pace with growth.

Land preservation and sustainable growth are also major concerns in Arizona. The State has passed several laws in recent years aimed at preserving open space and improving the planning process, implementing a form of "smart growth" that has become increasingly popular in the United States.

The Urban/Rural Dichotomy in Arizona

Nearly two-thirds of Arizona's population live in metropolitan Phoenix. Arizona's five established metropolitan areas (Phoenix, Tucson, Yuma, Flagstaff, and Prescott) account for over 85 percent of the State's population. Compared to other similarly-sized Western states, Arizona's population is much more highly concentrated. Only Nevada, with over three-quarters of the population in Las Vegas and 95 percent in Las Vegas and Reno combined, is more centralized. Similarly-sized states in the South and Midwest exhibit different development patterns, with only 20 to 30 percent of their populations living in the largest metropolitan area.

State transportation planners should remain cognizant of two fundamentally different sets of issues and challenges facing urban and rural Arizona – persistent challenges to rural transportation systems and evolving challenges to existing and emerging urban areas. Mobility and other issues in rural Arizona remain on the agenda, and the State will need to be aware of its efforts to address them.

■ 1.3 Mission Statement, Goals, and Objectives

The strategic direction is an attempt by MoveAZ to address the major transportation issues and concerns facing the State. The review described above presented key themes that are reflected in the mission statement, goals, and objectives. These include a focus on

quality of life; the need for mobility; and an attempt to address the variety of issues raised by previous plans, the general public (see Chapter 2), and the Arizona context.

The strategic direction consists of three basic elements:

1. The **mission statement** provides a brief description of a desired future condition or set of conditions that is dependent on the outcomes of transportation policies and decisions, usually among a broader set of policies.

2. The **long-range goals** reflect the spectrum of major goals or desired outcomes expressed by both the mission statement and numerous planning efforts from around the State.

3. Performance factors may help describe multiple goals, but suggest different, more specific **long-range objectives** and strategies for action. These objectives are grouped into broad **performance factors** (e.g., "reliability" or "equity") that can be described and evaluated with more detailed performance measures (see Chapter 4).

This section of Chapter 1 provides the final strategic direction that resulted from the review of plans, analysis of major issues, consultation with internal and external advisory committees, and public involvement.

Figure 1.5 MoveAZ Mission Statement

To support Arizona's quality of life, the MoveAZ Plan will provide a safe, reliable, and efficient transportation system for people and goods that strengthens our economic vitality; assures access to services and recreational opportunities; preserves the beauty and health of our natural environment; and blends into our urban and rural landscapes.

To achieve these ends, the Move AZ Plan will:

- *Be fiscally responsible;*
- *Provide citizens with transportation choices;*
- *Emphasize accountability;*
- *Be responsive to change;*
- *Harmonize with Arizona's proud heritage and unique diversity;*
- *Encourage coordination of transportation and land use planning at the state, regional, and local level; and*
- *Address air, transit, rail, highway, bicycle, and pedestrian travel.*

Table 1.2 MoveAZ Goals and Objectives

Long-Range Goal	Long-Range Performance Objectives
Access and Mobility. A reliable and accessible multimodal transportation system that provides for the efficient mobility of people and goods throughout the State.	**Mobility Factor** • Maintain and enhance levels of circulation (e.g., reduced congestion) on highways, arterials, and major collectors. • Maintain and enhance the ability of goods to move through and around urban areas with minimal delay. • Encourage the development of transit options for economically-disadvantaged populations.
	Reliability Factor • Improve the availability and quality of real-time information to increase the ease of use and attractiveness of both highways and public transportation. • Reduce delay caused by at-grade highway-railroad crossings. • Develop and implement an access management program to preserve the reliability of the state highway system.
	Accessibility Factor • Encourage the development of effective public transportation, ride share, and related options, where appropriate, and cost effective. • Support Title 6 Americans with Disabilities Act (ADA) compliance for access by disadvantaged groups to all transportation services. • Integrate transit, bicycle, and pedestrian facilities into highway improvements, where feasible. • Maintain and enhance connections to major commercial, residential, and tourist destinations by both highways and public transportation. • Maintain and expand border crossing facilities.
	Connectivity Factor • Maintain and enhance intermodal passenger connections between air and surface (highway and transit) transportation modes. • Maintain and enhance intermodal freight linkages for truck-rail and truck-air transfers. • Continue necessary expansion and connection of Arizona's metropolitan highways and high-occupancy vehicle (HOV) lanes. • Ensure the connection of rural communities to the state highway network.
Economic Vitality. A multimodal transportation system that improves Arizona's economic competitiveness and provides access to economic opportunities for all Arizonans.	**Economic Competitiveness Factor** • Maintain and expand freight transportation and intermodal linkages. • Increase coordination of transportation planning with the economic development activities of state, regional, and local governments. • Equitably distribute transportation to all areas of the State.
	Accessibility Factor • Maintain and improve truck linkages between Arizona, other states, and Mexico. • Maintain and improve access to major tourist destinations. • Encourage the development of transit services that provide access to job centers.

Table 1.2 MoveAZ Goals and Objectives (continued)

Long-Range Goal	Long-Range Performance Objectives
Safety. Provide safe transportation for people and goods.	**Safety Factor** • Reduce the rate of crashes, fatalities, and injuries for motor vehicles, bicycles, and pedestrians. • Design new transportation facilities to minimize accidents. • Improve the safety of commercial vehicles, public transportation vehicles and facilities, and where modes intersect. • Upgrade at-grade railroad crossing protection. • Increase ADOT's support and use of incident management on the state highway system. • Coordinate with Federal, regional, local, and tribal officials to provide redundancy of access for emergency response and evacuation situations (e.g., bridge crossings, multiple access routes to airports and other key transportation facilities, etc.) • Improve safety and security for rural area travelers.
Stewardship. A balanced, cost-effective approach that combines preservation with necessary expansions and coordinates with local and regional transportation and land use planning.	**Preservation Factor** • Preserve and maintain existing transportation infrastructure. • Develop and implement an access management program to preserve the functionality of the state highway system. • Coordinate planned transportation system expansions with future funding capabilities. • Increase efficient coordination of state transportation planning and programming processes with local and regional land use planning processes.
	Mobility Factor • Increase and/or protect capacity of the existing transportation system through increased use of traffic operation and management strategies, including Intelligent Transportation Systems (ITS) methods.
Environmental Sensitivity. A transportation system that enhances Arizona's natural and cultural environment.	**Resource Conservation Factor** • Increase energy conservation and the use of recycled materials and cost-effective alternate energy sources. • Give preference to use of native or indigenous species in transportation-related landscaping projects. • Encourage the development of smart growth policies in coordination with state, regional, local, and tribal planning processes. • Increase proactive coordination of transportation planning with Federal, state, and regional environmental agencies. • Minimize the contribution of transportation investments to air, water, and noise pollution in all areas of the State. • Ensure that negative environmental impacts of transportation investments do not fall disproportionately on disadvantaged groups. • Minimize the impact of transportation investments on natural habitats, animal travel corridors, historic sites, and endangered species

2. Coordination and Public Partnering

Chapter 2. Coordination and Public Partnering

Coordinating with the public and stakeholders affected by transportation decisions is critical to the success of any transportation planning effort. Planning is the first stage in the development of transportation projects that can have major impacts on communities. As such, it is vital that the public be involved throughout the entire process.

MoveAZ included extensive coordination with regional planning agencies, local elected officials, transportation stakeholders, and the general public. This chapter describes the overall coordination and public partnering process and the links between public partnering and the other phases of the MoveAZ plan.

2.1 Coordination Process

As shown in Figure 2.1, the MoveAZ Plan included extensive coordination within ADOT, between ADOT and other regional and local planning agencies, and between ADOT and the general public. The coordination process included meetings with advisory bodies and other groups. The following four coordination techniques were used to support the MoveAZ plan:

1. **External Coordination –** The Working Group is a body composed of each of the regional planning agencies in the State, the Arizona Transit Association, and the ITCA. This group met throughout the development of MoveAZ and reviewed all material produced for the plan. The Working Group met 15 times between late 2001 and spring of 2004 to review deliverables and provide guidance in the development of the plan.

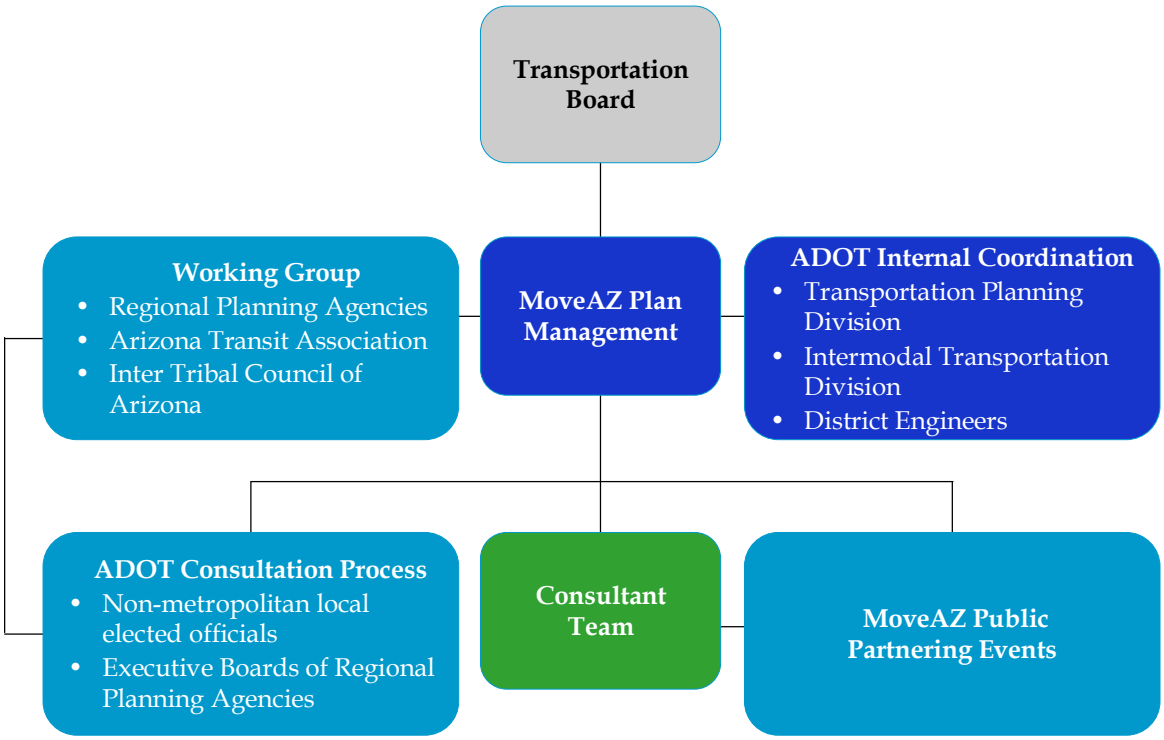
2. **Internal Coordination –** MoveAZ included internal coordination through two bodies – a steering committee and a continuity team. The steering committee was comprised of Transportation Planning Division (TPD) staff representing planning, programming, air quality, data and asset management, and each of TPD's regional planners. This group met 15 times in coordination with the Working Group meetings described above. The Continuity Team is a body composed of internal ADOT staff (including the ADOT Deputy Director, the state engineer, and a district engineer) and other staff from ADOT's Intermodal Transportation Division. This group helped ensure that MoveAZ was consistent with existing ADOT policy and practice. The Continuity Team met six times over the period beginning in 2002 through spring of

2004 for progress briefings and to ensure coordination of the plan with other ongoing ADOT activities.

3. **Public Partnering –** Fifty public meetings were held across three phases, starting in the fall of 2002 and completing in the spring of 2004. The specific meetings are described in detail in this chapter.

4. **Consultation Process –** ADOT consults with the executive boards of regional planning agencies and other agencies that request information about ADOT planning and other activities. In addition, the Federal Highway Administration (FHWA) requires ADOT to consult with non-metropolitan, local-elected officials regarding planning. These activities occur independently of the MoveAZ Plan, but were also used during the MoveAZ process to provide information to these groups. ADOT conducted over 20 meetings with local-elected officials and the boards of regional planning agencies to discuss MoveAZ. These meetings are part of an ongoing coordination process that overlaps the MoveAZ plan.

Figure 2.1 MoveAZ Coordination Process



2.2 Public Partnering Process

Partnering events were opportunities to build stronger partnerships with key public and stakeholder groups. These events were formulated around three key phases of the MoveAZ Plan:

1. The definition of strategic directions, goals, and objectives;
2. The evaluation of alternative policies and projects; and
3. The creation of the draft plan.

Each of the three phases included multiple partnering events, as shown in Table 2.1. The following subsections describe the purpose of each phase and event.

Table 2.1 MoveAZ Public Partnering Events

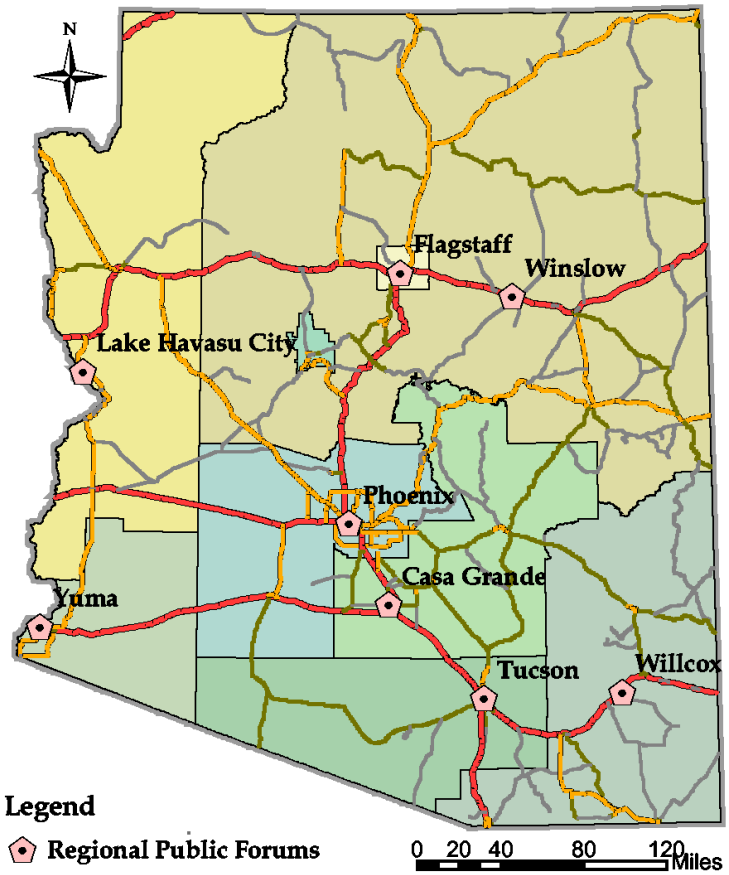
Partnering Phase	Dates	Events
Initial	Fall 2002	Regional Public Forums Focus Groups
Intermediate	Spring 2003	Regional Solutions Forums Focus Groups
Final	Spring 2004	Open Houses

Initial Partnering Events

The initial partnering phase of public involvement provided public input to confirm and refine the strategic direction, and to help prioritize the long-range goals and objectives developed during Phase I. In addition, ADOT gained a greater understanding of the transportation issues facing Arizona through the concerns and suggestions presented by stakeholders and the general public. Two events were held in this phase:

1. **Regional Public Forums**, intended to assess the transportation issues and concerns of the general public (Figure 2.2); and

Figure 2.2 MoveAZ Regional Public Forum Locations



2. **Focus Groups**, providing targeted assessment of the perspectives of specific stakeholders. These groups included:

   a. Aviation;

   b. Transit providers and users;

   c. Bike and pedestrian interests;

   d. Commercial vehicle operators, railroads, and distribution firms;

   e. Economic development interests (economic development organizations, industry associations, chambers of commerce);

   f. Health and human services providers;

   g. Native American communities;

   h. Pipeline and utility representatives; and

   i. Environmental concerns (state and national parks and forest service, air quality planners).

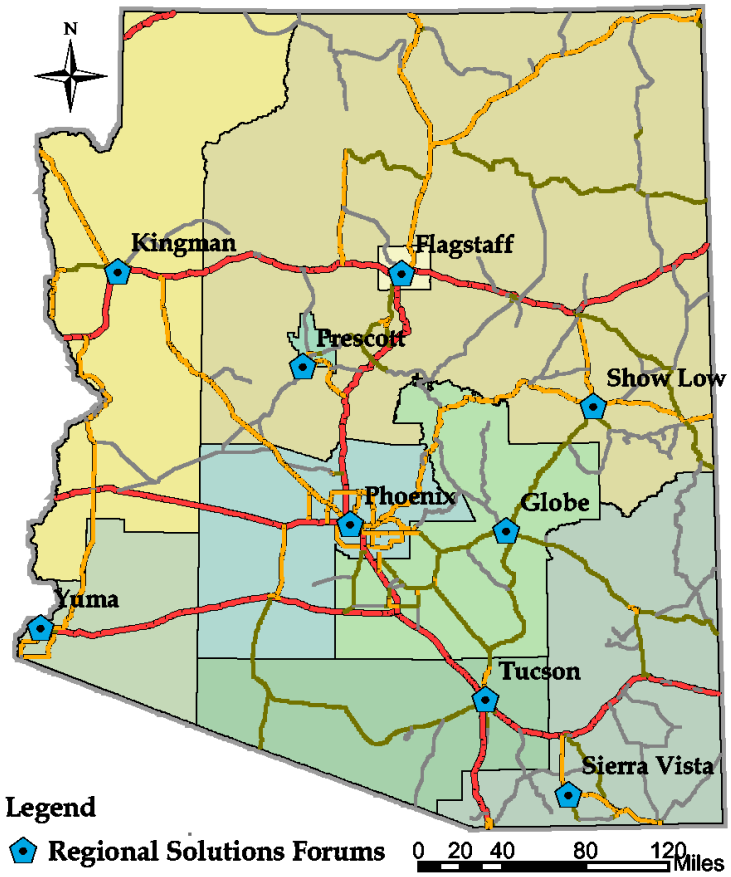
A detailed report describing the initial partnering events can be found in Appendix B.

Intermediate Partnering Events

The intermediate partnering phase was used to evaluate the acceptability of policies and strategies developed in response to issues, concerns, and ideas expressed during the initial partnering phase and as a result of the research completed. The intermediate phase provided additional public input and built a level of confidence to move forward in the development of the draft plan. Nine regional solutions forums were held throughout the State, as shown in Figure 2.3. A second round of stakeholder focus groups was also held with the following groups:

- Native American communities;
- Transit providers and users; and
- Commercial vehicle operators, economic development, and aviation interests.

Figure 2.3 MoveAZ Regional Solutions Forum Locations



The insight gained as a result of the focus groups and forums will be used in discussions and debates regarding potential policies and strategies to improve the performance of the overall system.

The intermediate partnering phase provided important input for the development of weights that were applied in the performance analysis process (described in Chapter 4). Participants at the forums also had the opportunity to identify potential projects and policies for the State's future transportation system. Chapter 3 includes a review of the key policy suggestions received during these and other events.

A detailed report describing the intermediate partnering events can be found in Appendix C.

Final Partnering Events

The final partnering events consisted of 20 open houses held across the State, as shown in Figure 2.4. These events presented material from the draft MoveAZ Plan to the public. From the strategic direction through the analysis of projects, participants had an opportunity to review information about the plan through display boards, copies of MoveAZ documents, and informal discussions with ADOT representatives. The open houses provided a forum to discuss the performance-based analysis process with the public, as well as gauge public response to the overall planning process.

A detailed report describing the final partnering events can be found in Appendix D.

Communication Plan

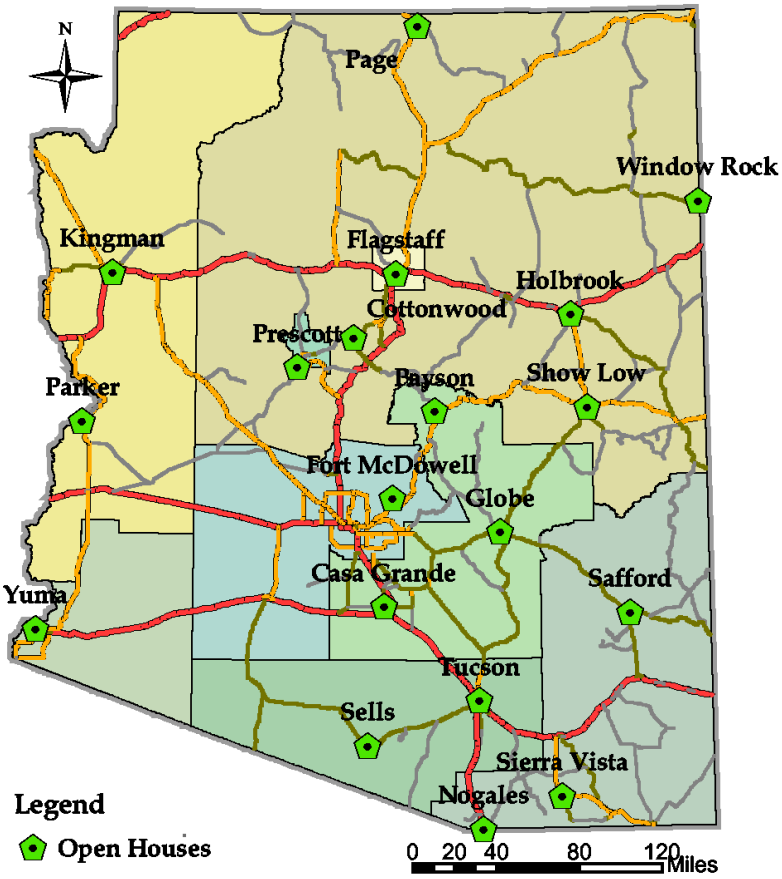
In addition to the three rounds of public events, MoveAZ included an ongoing communication plan. Regular communication through newsletters, mailings, and a web site provide additional avenues for the public to learn about planning and to comment on MoveAZ. The communication plan included the following strategies:

- **Press releases** were provided to newspapers, chamber of commerce newsletters, radio stations, and other local and regional publications. This provided broad media coverage of the events and a general invitation to the events.

- **Direct mailings** provided an opportunity to specifically invite interested individuals to the public partnering events. Individuals who participated in early events were invited to subsequent events in their area.

- A **brochure** was created to describe the overall purpose of the plan and the basic outline of the strategic direction. This brochure was available at all public partnering events.

Figure 2.4 MoveAZ Open House Locations

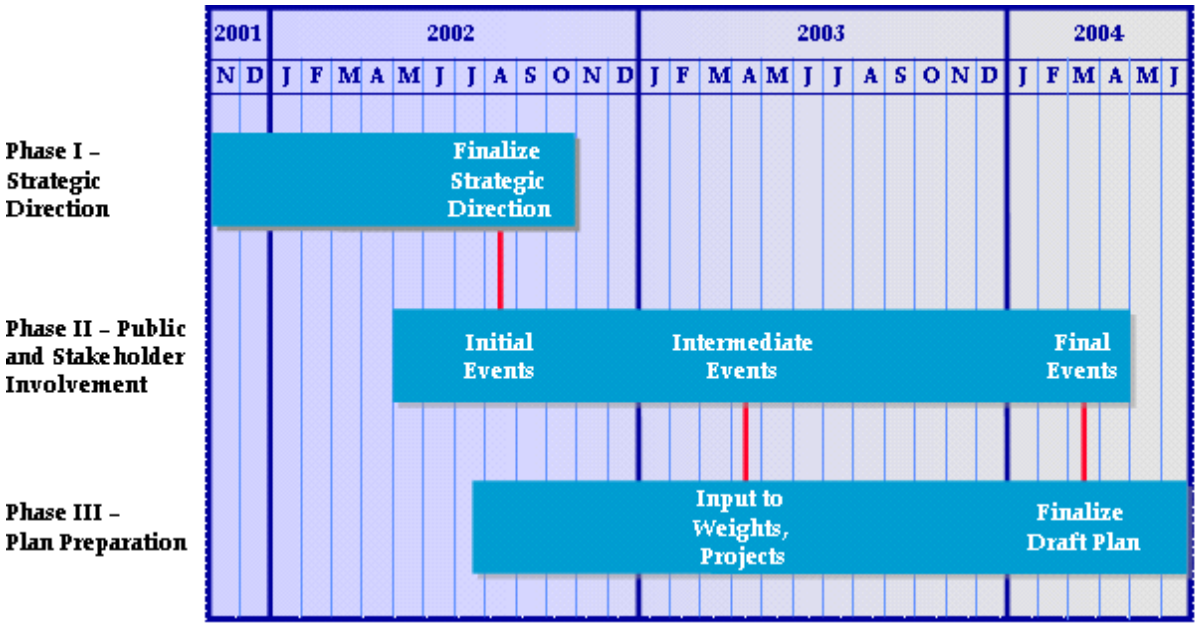


- A **newsletter** was produced to provide information to the public about the plan.
- Finally, a **web site**, http://www.moveaz.org, was regularly updated to provide information on the plan to the public. The web site was also the central repository for all planning documents.

2.3 Public Partnering Results

This section describes key results from the public partnering events. These events provided two main benefits: they helped educate the public about transportation planning in Arizona and they helped ADOT understand the general priorities and strategies the public preferred. Each round of public partnering events was intended to inform a particular phase of the MoveAZ Plan, as shown in Figure 2.5.

Figure 2.5 Connections Between Public Partnering and the MoveAZ Plan



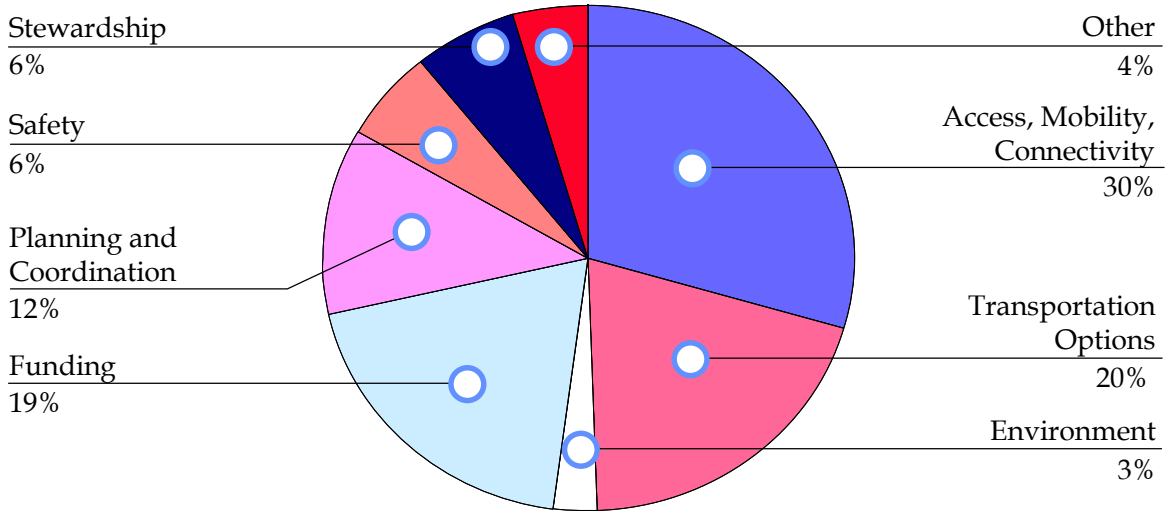
Initial Partnering Results

The initial partnering events focused primarily on finalizing the strategic direction. Participants provided information about their best transportation experience, major transportation issues in their region and the State as a whole, and reacted to a preliminary set of long-range goals. In addition to the interactive discussion, each participant received a survey with 15 questions that provided another opportunity for participants to describe their concerns about transportation in Arizona.

As shown in Figure 2.6, comments received during the initial partnering phase reflect many of the long-range goals identified for the plan. Participants also identified issues outside the scope of the plan, such as the availability of funding. In addition, the priorities of Arizonans began to emerge in this first phase. Several of the key concerns expressed in the first phase warrant closer attention.

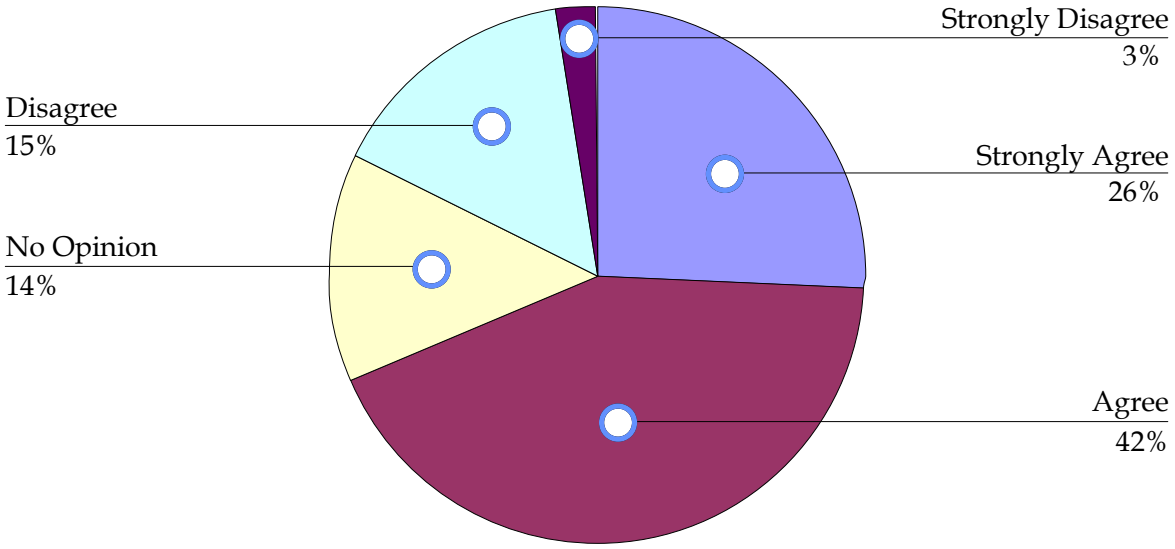
Mobility was a key issue in the regional public forums and all other events. Arizonans understand that the State is growing rapidly and must address congestion and mobility issues. Similarly, participants at public forums expressed considerable concern about their ability to move easily between major cities.

Figure 2.6 Distribution of Participant Concerns Across All Forums



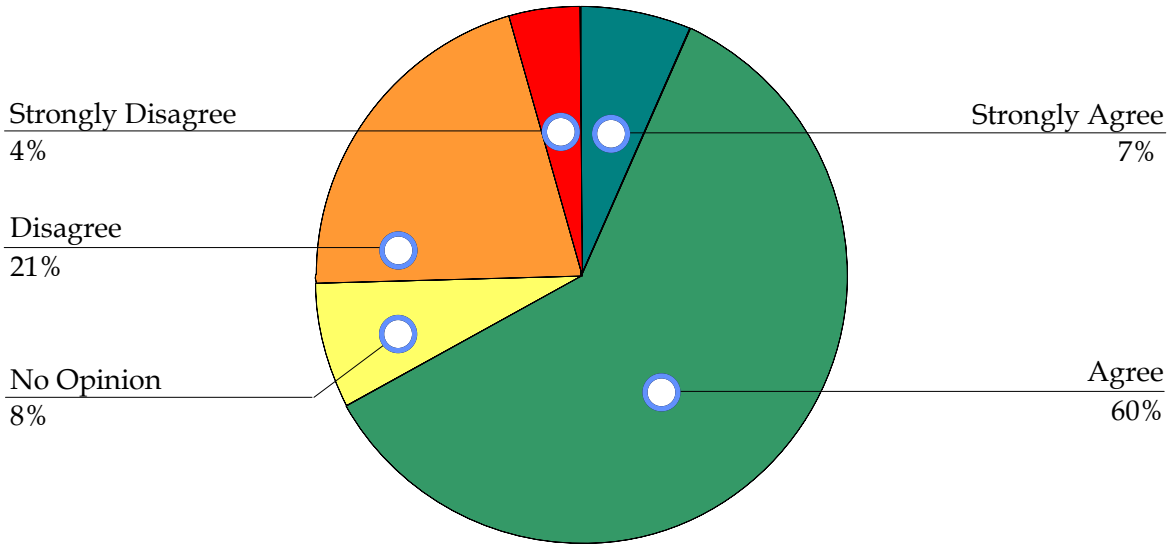
A second major issue that arose in the forums and focus groups was the need for transportation options, such as transit or improved air service. These concerns were spread across several modes and reflected a growing interest in alternatives to the automobile. As shown in Figure 2.7, most participants felt that cities should take the lead in planning and developing transit options. (ADOT's role in transit, air service, and other modes is discussed in detail in Chapter 7.)

Figure 2.7 Response to Survey Statement: "Cities Should Take the Lead in Planning and Developing Transit"



Stewardship and preservation issues were not mentioned as frequently as other issues in the public forums, but this may reflect the existing quality of Arizona's road system. When surveyed about the maintenance of the roads in Arizona, two-thirds of participants believed the system was well maintained (Figure 2.8).

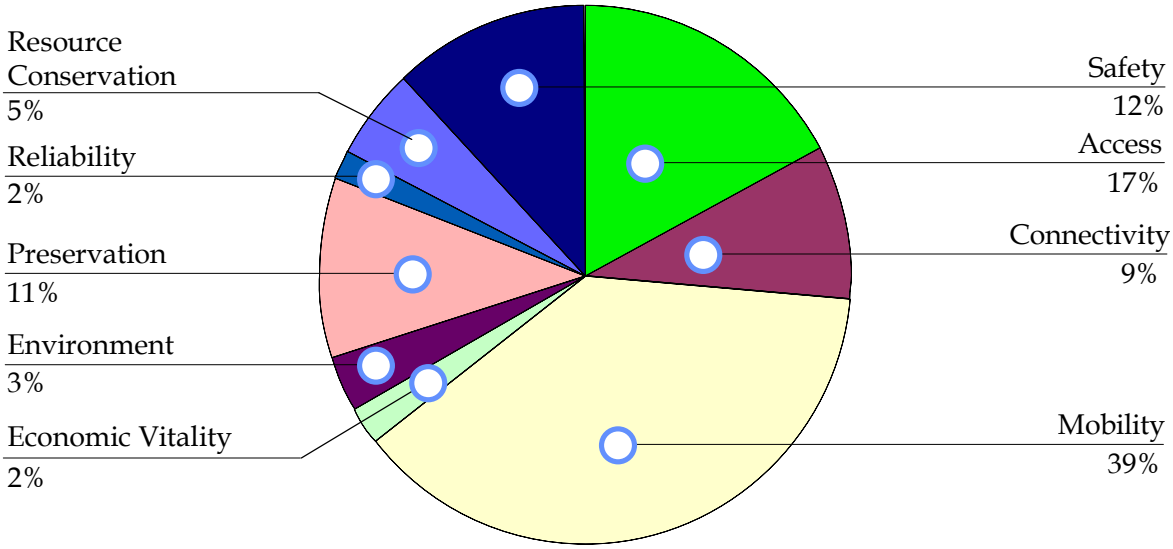
Figure 2.8 Responses to the Statement: "The Overall Maintenance of State Roadways in this Region Is Good"



Intermediate Partnering Results

In the intermediate phase, participants suggested strategies and solutions related to the performance factors that are part of the strategic direction. Participants identified their preferred project and policy solutions through facilitated discussions, and then voted on all comments together. Participant statements were coded by the relevant performance factor, and these results were tabulated to provide a rough understanding of priorities of Arizonans. Strategic recommendations by performance factor are shown in Figure 2.9.

Figure 2.9 Strategic Recommendations by Performance Factor



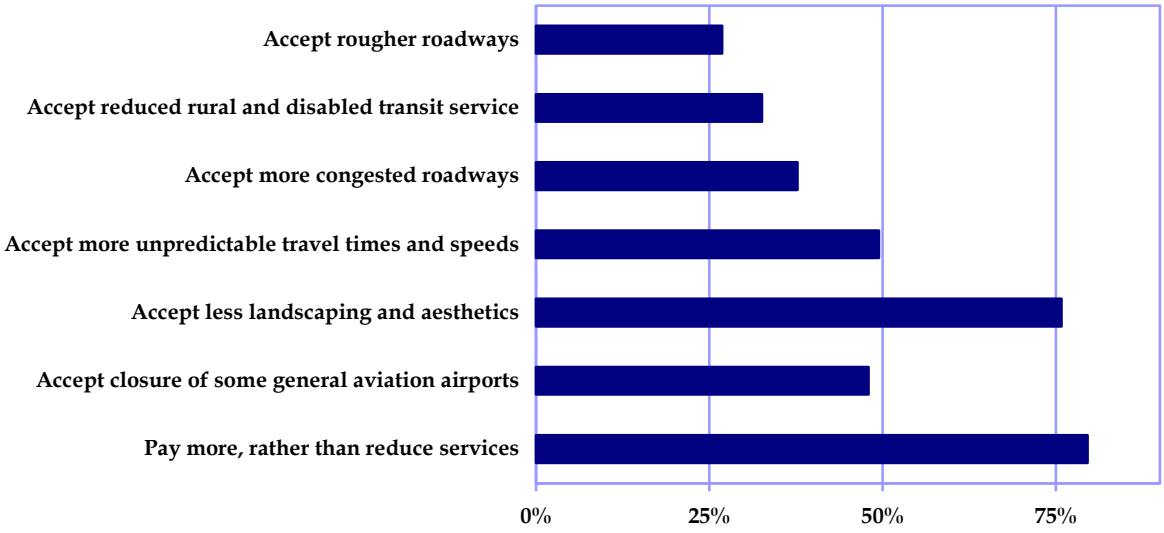
Source: Cambridge Systematics, Inc., 2003.

The priorities gathered from the regional forums supported the development of performance factor weights. Participant comments suggested that mobility was the primary concern, with other major concerns including accessibility, safety, and preservation. The process for developing weights used participant ranked priorities, as well as information from ADOT and the Transportation Board. Chapter 4 provides a more detailed description of the development of performance factor weights.

To provide additional information about priorities, the regional solutions forums included a survey that asked participants to make tradeoffs between different policy and project solutions. One of the key questions asked what changes participants would most likely accept if less funding were available (Figure 2.10).

Overall, participants were reluctant to accept reductions in services, with over three-quarters of respondents indicating they would prefer to pay more, through taxes or user fees, to retain services and maintain system performance. Funding issues were also frequently raised during facilitated discussions. Policy issues related to funding and other issues are described in detail in Chapter 3.

Figure 2.10 Acceptance of Changes to Transportation Services

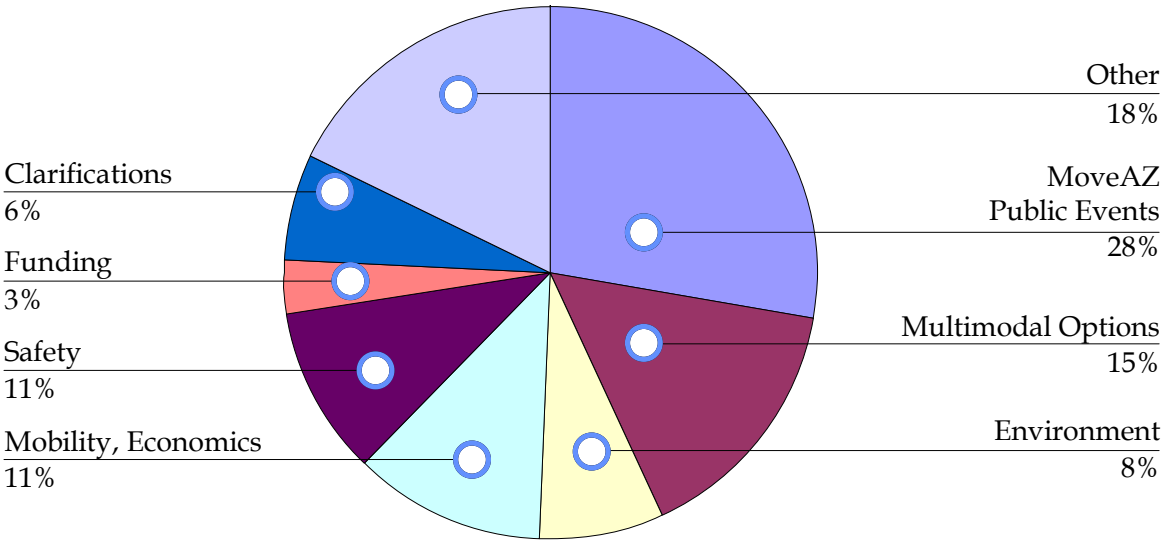


Reaction to the Draft Plan

The final partnering phase provided open house participants with an opportunity to react to the draft plan. At the open houses, a series of stations, or booths, were set up to address the various aspects of the plan, including the strategic direction, public partnering, performance-based analysis, and project evaluations. Participants had an opportunity to provide comments at each of the stations, as well as general comments about MoveAZ. In addition, ADOT representatives held informal discussions with open house attendees.

ADOT received over 200 comments at the open houses. Over one-quarter of these comments were made in reference to either the MoveAZ planning process or public involvement process. These comments largely thanked ADOT holding open houses and other events in their communities. Many of the other comments received at the open houses reflected concerns raised during the initial and intermediate partnering events (Figure 2.11). These concerns include the need to pursue multimodal transportation options, such as improved transit and increased air service to rural areas of the State; the need to improve the safety of the state transportation system; and the importance of mobility to support the economic well being of the State and its residents.

Figure 2.11 Primary Subject of Comments Received at MoveAZ Open Houses



3. Policy Directions

Chapter 3. Policy Directions

The MoveAZ Plan was developed to be consistent with policies and procedures adopted by the Arizona legislature and the Arizona Transportation Board, the two bodies that set policy for transportation in the State. This chapter describes the relationship between ADOT's current transportation policies and the MoveAZ Plan, identifies key policy decisions made during the development of the plan, and discusses the policy suggestions received during MoveAZ public partnering events.

3.1 ADOT Transportation Policies

Both the legislature and the Transportation Board provide policy direction for the MoveAZ Plan. Although the legislature vests the Board with ultimate authority over the projects and programs to be funded in Arizona, key laws identify specific procedures that ADOT must follow in planning and delivering projects. This section describes the legislative requirements that shape the plan and the relationship between Transportation Board policies and MoveAZ.

Legislative Requirements

Both Federal and state legislation require ADOT to develop a long-range transportation plan. For the State, House Bill 2660, adopted into law in the 2002 legislative session, sets several guidelines on the development of a long-range plan:

- The updated law governing ADOT explicitly requires the use of performance-based planning in both the long-range plan and the five-year capital program. The five-year program is the mechanism ADOT uses to identify specific capital projects to be constructed.

- The updated law identifies several performance factors that ADOT must address in planning. These are discussed in more detail below.

- The updated law requires consistency with local planning, including requiring the long-range plan to use local and regional land use plans; to facilitate, not direct, growth; and to coordinate with regional planning efforts. It also requires local and regional agencies to submit a standardized report of their transportation needs to ADOT each year.

MoveAZ was designed to be consistent with these requirements. It is a 20-year plan that uses performance measures to evaluate major capital projects, as described in Chapter 4. It uses official population projections from the Arizona Department of Economic Security. It includes a process to coordinate with regional planning agencies, including a procedure for using estimates of land-use patterns and traffic growth developed by regional planning organizations, where these were available. Finally, MoveAZ incorporates the specific performance factors required by House Bill 2660. These performance factors are described below.

Performance Factors

The updated law now requires ADOT to address specific performance factors. The relationship between these required factors and the MoveAZ performance factors is shown in Table 3.1.

Table 3.1 Comparison of HB2660 and MoveAZ Performance Factors

HB 2660 Performance Factor	Relevant MoveAZ Performance Factor(s)
• System preservation	• Preservation
• Congestion relief	• Mobility
• Accessibility	• Accessibility
• Integration and connectivity with other modes	• Connectivity; accessibility
• Economic benefits	• Economic competitiveness; accessibility
• Safety	• Safety
• Air quality and other environmental impacts	• Resource conservation
• Cost effectiveness of a project or service	• See Note 1
• Operational efficiency	• Mobility; reliability; preservation (see Note 2)
• Project readiness	• See Note 3

Notes:

[1] Although MoveAZ does not include a specific factor for cost effectiveness, it uses tools that allow for basic cost/benefit analyses. In addition, cost estimates were made for each project that allow a comparison of the "cost per performance gained" of each project.

[2] Operational efficiency may be defined in several ways, including 1) the efficient movement of people and goods, 2) the ability to reliably plan a trip on the transportation system, and 3) the minimization of replacement costs through proactive maintenance. These three definitions of operational efficiency are addressed, respectively, by the mobility, reliability, and preservation performance factors.

[3] Project readiness is more applicable to the programming process than to the development of a 20-year plan. This factor is used in transitioning from MoveAZ to the five-year program, as described in Chapter 9.

Transportation Board Policies

The Transportation Board also adopts policies that guide transportation-related activities in the State. The Board has an existing policy statement, updated periodically, that is relevant to transportation planning. This statement, most recently updated in August 2003, addresses four basic types of policies:

1. **System policies**, which describe the functional goals that ADOT would like to achieve and are similar to the goals outlined in the MoveAZ strategic direction. More detail on the overlap of the system policies and the strategic direction is provided below.

2. **Coordination policies**, which propose improved coordination with Federal, state, regional, tribal, and local agencies. These policies are reflected in the coordination effort that was part of the MoveAZ development process (see Chapter 2).

3. **Procedural policies**, which describe the process that ADOT should use for planning, as opposed to the specific substantive outcomes addressed by the system policies. These policies include requirements for public involvement, performance-based planning, and non-discrimination in contracting.

4. **Financial policies**, which state the Board's position on financial matters. They include recommendations on ways to acquire additional funds for transportation investments and requirements that ADOT follow Governmental Accounting Standards Board accounting principles.

ADOT's coordination, procedural, and financial policies, shown in Table 3.2, helped guide the development of the MoveAZ Plan. They provided general guidelines for coordinating with other agencies, working with the public, identifying funding constraints, and addressing other relevant policies and procedures. In addition, MoveAZ addresses each of the system policies. Table 3.3 describes the relationship between the system policies and the MoveAZ long-range goals.

3.2 Key Policies Related to MoveAZ

During the MoveAZ process, several specific policies were adopted or refined that affected the development of MoveAZ. These policies included a new statewide transportation planning policy, a regional funding policy, a Maricopa Association of Governments (MAG) Regional Transportation Plan (RTP), and specific corridor definition studies to support future planning in and adjacent to the MAG region. Each of these policies is examined in more detail below.

Table 3.2 Transportation Board Financial, Procedural, and Coordination Policies

Policy Type	Short Policy Description (Policy Number)
Financial	• Increase funding, issue debt (19, 32) • Practice fiscal restraint (27, 31, 32) • Encourage local and private funding (28) • Comply with GASB standards (35)
Procedural	• Transfer bypassed road segments to local control (16) • Consider requests to name or rename highway features (17) • Develop a performance-based, long range plan and five-year program (2, 20, 21, 22) • Ensure non-discrimination in contracts (33, 34) • Encourage public participation in transportation decisions (2, 36)
Coordination	• Coordinate with regional governments, stakeholders (3, 21, 37) • Work with Federal, state, and international agencies (3, 37, 38)

Table 3.3 Transportation Board System Policies and Their Relationship to the MoveAZ Goals

MoveAZ Goal	Short Policy Description (Policy Number)
Access and mobility	• Prioritize highways that connect Arizona, its regions, and population centers with other states and with Mexico (5) • Provide HOV lanes and related facilities, consider congestion pricing and high-occupancy toll (HOT) lanes (14) • Facilitate and encourage public transportation, bicycling, walking, and the interconnection of modes (1, 4, 6, 7, and 24) • Encourage effective and efficient operation at ports of entry (23) • Support regional and interregional public and special needs transportation planning (23)
Stewardship	• Establish minimum standards, make investments based on classification of highways by purpose and importance to the system (11) • Preserve the functional integrity of the state highway system through a comprehensive access management program (12) • Implement effective and efficient planning and construction processes, including value engineering, design build, and other mechanisms (29) • Implement asset management systems and methods (30)

Table 3.3 Transportation Board System Policies and Their Relationship to the MoveAZ Goals (continued)

MoveAZ Goal	Short Policy Description (Policy Number)
Economic vitality	• Facilitate goods movement throughout the State to maintain a strong state and national economy; work with rail, truck, and shipping industries to identify opportunities to increase efficient transport (8) • Consider preserving rail corridor property threatened by abandonment as an important resource for future transportation purposes (9) • Support effective and efficient operations at Arizona's ports of entry to ensure enforcement of Federal and state laws (15)
Environmental sensitivity	• Integrate air quality concerns in all processes (10) • Use Congestion Mitigation and Air Quality (CMAQ) improvement funds for transportation projects and programs in non-attainment and maintenance areas that reduce transport-related emissions and congestion (25) • Support early partnering with resource agencies in planning, design, and construction of transportation facilities and services (38) • Promote projects that provide amenities beyond roadway projects (26)
Safety	• Provide a safe, efficient, and effective transportation system (3) • Encourage public transit that improves the safety and efficiency of the state transportation system (6) • Provide rest areas for motorist services and safety (13)

Statewide Transportation Planning Policy

The law updated by House Bill 2660 requires the Transportation Board to adopt a long-range planning policy for the State. Working with ADOT, the Board reviewed and adopted the MoveAZ strategic direction as this long-range transportation planning policy. The strategic direction addresses the key goals and objectives that ADOT would like to achieve through long-range planning. It also identifies performance factors consistent with those required by House Bill 2660. The policy statement is the same as the strategic direction presented at the end of Chapter 1.

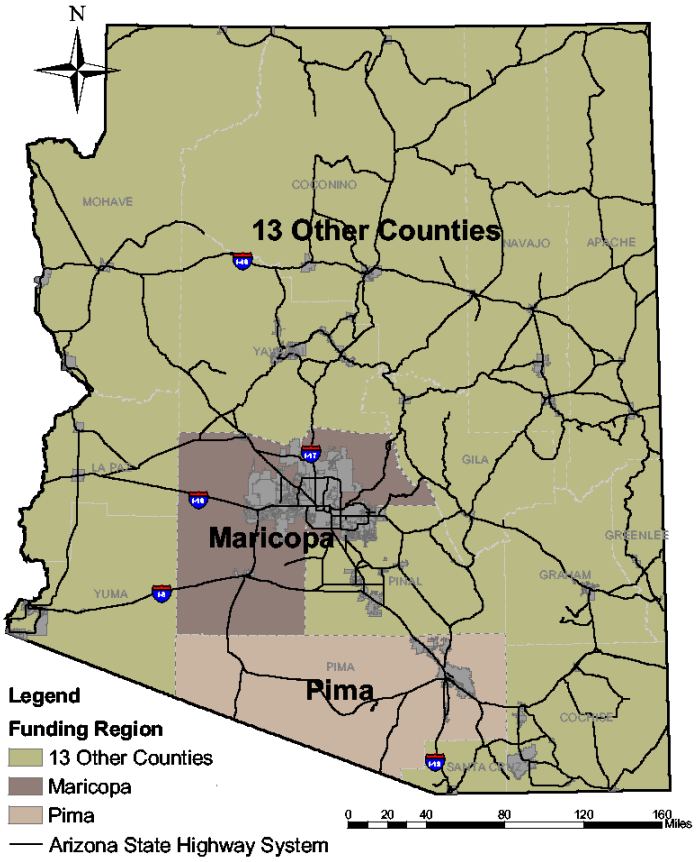
Regional Funding Policy

For several years, the Transportation Board has distributed funding around the State in accordance with recommendations from its Resource Allocation Advisory Committee (RAAC). As shown in Figure 3.1, the RAAC recommended that capital funding used for

the last several cycles of the five-year Transportation Facilities Construction Program be split among three major regions of the State: 37 percent for Maricopa County, 13 percent for Pima County, and 50 percent for the 13 other counties.

This funding split has been adopted for the MoveAZ Plan. The financial forecasts, described in Chapter 4, utilize this split among the three regions.

Figure 3.1 Transportation Board Funding Regions



Maricopa Association of Governments Regional Transportation Plan

As described in Chapter 2, the MoveAZ process included close coordination with regional planning agencies throughout the State. In the Maricopa region, this meant working with MAG, the metropolitan planning organization for Maricopa County.

In November of 2003, MAG completed a comprehensive 20-year RTP. Both the MAG plan and MoveAZ use performance-based planning methods to evaluate transportation conditions in their respective jurisdictions. The methods developed were overlapping and complimentary, each one tailored to its specific situation. MoveAZ covers the entire State,

but addresses state-owned transportation facilities and services only. The MAG plan covers Maricopa County only, but addresses all transportation facilities and services, including arterial streets, transit, bicycle paths, and other systems, as well as state highways. As a result, MAG includes several performance measures that are tailored to specific transportation modes or roadway functional classes.

As part of the coordination process designed for MoveAZ, the Transportation Board voted in November 2003, to support the MAG RTP. The funding available to Maricopa County (37 percent of ADOT capital funds) will be available to support the RTP. Like MoveAZ, MAG used a performance-based process to be consistent with the requirements of the law, as updated by House Bill 2660.

Corridor Definition Studies

MAG has authority over regional transportation planning in Maricopa County, but the Phoenix metropolitan area is rapidly growing to include portions of Pinal County. House Bill 2292 requires the MAG RTP to consider the impact of growth on roads in contiguous counties, such as Pinal. To support this effort, MAG, the Central Arizona Association of Governments (CAAG), and ADOT conducted a *Southeast Maricopa/Northern Pinal County Area Transportation Study*, published in September 2003. This study identified four potential corridors extending from within the MAG region into Pinal County for additional study:

1. **The U.S. 60 Freeway Extension** would extend the freeway portion of U.S. 60 from its current terminus at Goldfield/Baseline Road in Maricopa County to Ray Road in Pinal County. Built on state-owned land, this seven-mile highway would parallel the current U.S. 60 to the south. Projected traffic volumes range from an average of 35,000 to 65,000 vehicles per day in 2025. The cost of constructing the freeway extension is estimated at $117 million.

2. **The Williams Gateway Freeway** would connect Loop 202 in Maricopa County eastward to U.S. 60 in Pinal County. This corridor would extend for approximately 15 miles, with traffic volumes ranging from an average of 60,000 to 100,000 vehicles per day in 2030. Construction costs are estimated at $750 million, of which $325 million has been identified in the MAG RTP for the six-mile segment in Maricopa County.

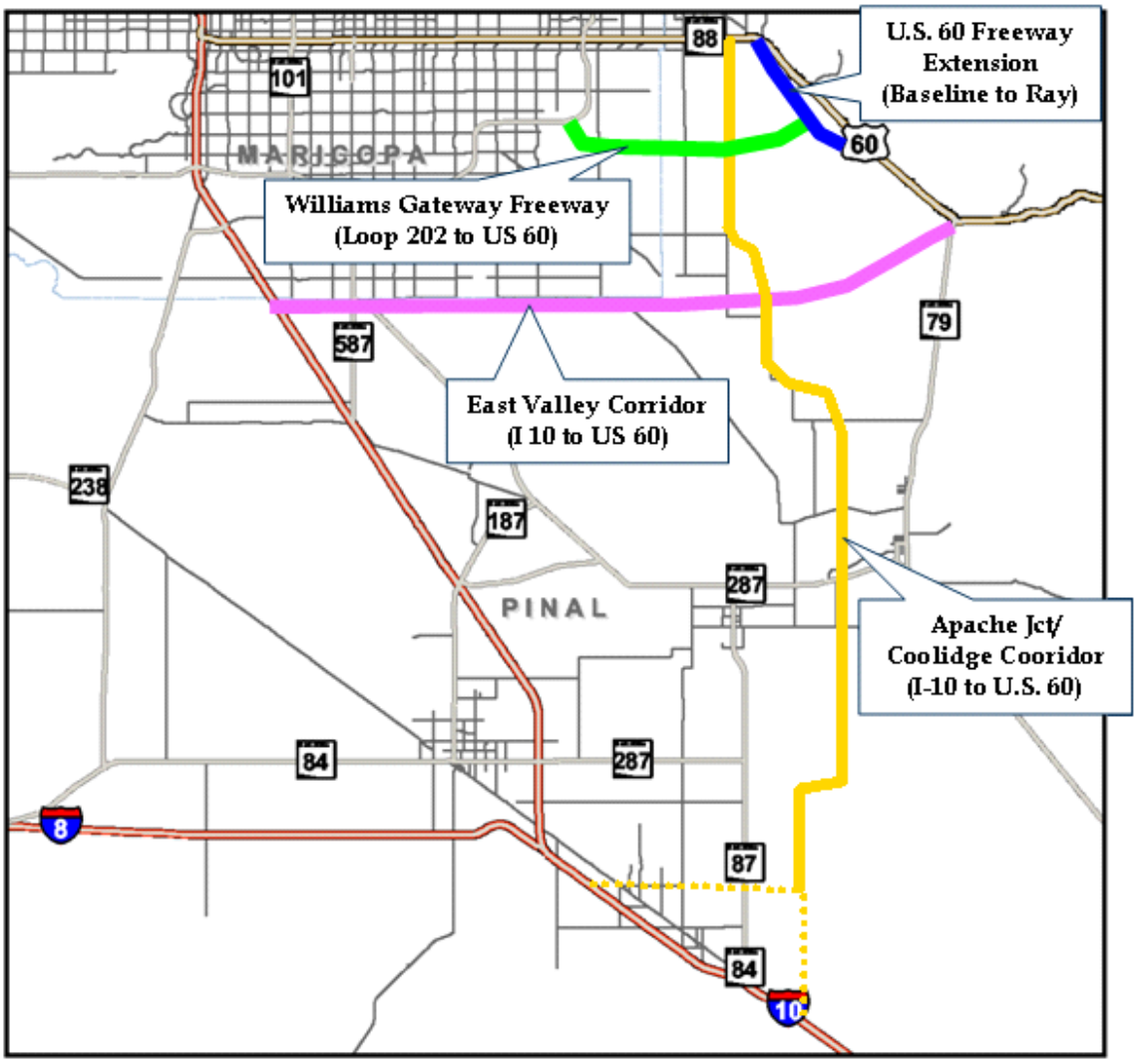
3. **The East Valley Corridor** would be a new corridor that parallels or overlaps the Hunt Highway along the southern boundary of Maricopa County. Extending approximately 31 miles from I-10 eastward to U.S. 60 in Pinal County, it would carry between 64,000 and 110,000 vehicles per day in 2030. The cost of the new facility would be $1.4 billion, if constructed as a freeway; and $310 million, if constructed as an expressway/controlled access arterial.

4. **The Apache Junction/Coolidge Corridor** would be a new corridor, entirely in Pinal County, that would follow SR 87 about 36 miles from Coolidge northward to U.S. 60 in

the vicinity of Apache Junction. If built as a freeway, the corridor would carry between 46,000 and 110,000 vehicles per day in 2030 and cost $1.6 billion to construct.

The Transportation Board has directed ADOT to develop studies to examine the need for each of the four proposed corridors, their ability to accommodate anticipated future growth, and the performance impacts of each corridor on other regional and state roads. The four corridors for future studies are shown in Figure 3.2. The figure shows the general location of the four corridors, not the precise route. The studies will identify the need for the corridor and potential alternative routes. The studies are expected to begin in the summer of 2004, and will be conducted by ADOT in conjunction with MAG, CAAG, Pinal County, and the local communities concerned.

Figure 3.2 Corridor Definition Study Locations



3.3 Policy Recommendations from Public Partnering

At each of the public partnering events, ADOT received suggestions for updated and transformed transportation policies. During the intermediate partnering events, participants were explicitly asked to identify policy solutions to their transportation concerns, and were provided with an opportunity to vote and rank the key policy solutions they suggested.

ADOT received nearly 300 individual policy suggestions at these forums. The policy suggestions covered a wide range of issues, but several key policy issues emerged more frequently than others, including funding, transportation options, and system stewardship. This section documents the policy suggestions received at the intermediate partnering events. The policies suggestions described are for informational purposes, and are not endorsed by ADOT.

Policies Related to Funding

More than 60 percent of the policy recommendations were related to funding. Participants showed great concern over how Arizona's transportation projects and programs will be funded during the next 20 years. Multiple comments suggested that current funding methods will not be adequate in the future. Participants encouraged ADOT to identify creative new ways for funding transportation projects, examine the distribution of funding throughout the State, and support funding of various modes of transportation.

Many similar recommendations were reiterated across forums:

- To generate funding, participants recommended policies, such as instituting toll roads and vehicle-related user fees (e.g., mileage-based user fees and fees for commercial vehicles). Of the funding recommendations made, over 10 percent supported increasing the state gas tax.

- Several participants suggested that Highway User Revenue Funds (HURF) should only be allotted to capacity projects, and not be made available to other agencies, such as the Department of Public Services.

- Participants also suggested that HURF funds not be restricted to highways only (as they currently are), but also be available to fund alternate modes, especially transit.

- A number of participants recommended that additional funding opportunities be available for Indian tribes.

Policies Related to System Stewardship

Many participants noted that roads currently are well preserved and maintained, and that preservation and sustainability of current resources should be a major priority for the state transportation system. At the Sierra Vista forum, over one-half of the policy recommendations were related to preservation. Many participants across the State agreed that a certain level of funding should be earmarked annually to maintain the current system.

Participants throughout the State also identified the need for more coordination between transportation and land use planning, and encouraged increased cooperation between state and local governments as a way of meeting that need. Several participants suggested giving regional governments control over both land use and transportation to provide more consistent development.

Policies Related to Transportation Options

Many of the policy recommendations, as well as issues identified during the initial partnering phase, called for increased transportation options. Participants supported policy developments that would encourage increased mobility throughout Arizona for both people and goods. Participants in Prescott and throughout the other forums urged ADOT to take the lead in advocating and developing alternate modes of transportation, and to develop a separate transit department within ADOT. Some of the specific recommendations included:

- Studying rail as a viable transportation option for the State;
- Restoring funding to the Local Transportation Assistance Fund, a mechanism to provide operating funding to rural transit operators;
- Supporting additional bicycle and pedestrian services by increasing regional funding for bicycle facilities and considering bicyclist and pedestrian needs in roadway design;
- Developing multimodal corridors with right of way provided for transit, rail, and bicycles;
- Protecting the Aviation Trust Fund from other uses; and
- Ensuring that rural airports be able to provide emergency response and evacuation services.

Many participants suggested that the key to creating a multimodal system that serves the entire State depends upon securing legislative support. Participants in the Phoenix forum, for example, strongly recommended that funding in urban areas be reallocated toward transit development, suggesting this could be handled at the legislative level, possibly through the development of a regional transit authority. Participants in rural areas recommended that Congressional changes be pursued to increase the percentage of funding

allocated to transportation funding and, specifically, the amount designated for rural transportation infrastructure.

Other Policy Recommendations

Various policy recommendations were made that either did not fall under the categories of funding, transportation options, or preservation; or that were not broadly supported across all forums.

- Many policy recommendations referred to increased safety measures, such as increased coordination with the Office of Homeland Security for evacuation routes and additional public education and outreach;
- Some participants suggested improved coordination with Arizona Department of Game and Fish in the development of roadways to address wildlife issues;
- Several comments were made regarding the structure of ADOT and the state transportation board, usually supporting the current structure of the ADOT Board;
- Participants in several forums mentioned the need for increased cooperation and communication between state organizations and communities;
- Participants encouraged ADOT to be the leader in facilitating communication with the State's council of governments, regional planning organizations, and Indian tribes; and
- During the consultation process, conducted concurrently with MoveAZ public events, several non-metropolitan, local-elected officials raised concerns about litter along state highways, and suggested that the legislature increase funding for roadside maintenance.

4. Performance-Based Evaluation Process

Chapter 4. Performance-Based Evaluation Process

At the core of the MoveAZ Plan evaluation process is an analysis of the system performance impacts of major capital projects on the Arizona transportation system. While the primary goal of this process is to guide, assess, and prioritize long-range transportation investments, several other important goals were identified by ADOT for incorporation. These included:

- **Building accountability and political support in the planning process by streamlining the management and associated decision-making about the allocation of resources for transportation investments.** Performance-based planning ensures accountability in decision-making, not only from the ADOT technical perspective, but also from the perspective of the Arizona Transportation Board.

- **Providing better, more accurate information to decision-makers with defensible, robust, and consistent analytical tools using system performance outcomes as the basis for identifying transportation investments.** This process provides ADOT and the Arizona Transportation Board with a rigorous technical method that prioritizes projects based on system performance impacts and benefits.

- **Providing a mechanism to monitor and track the success of transportation projects in meeting stated system performance goals and objectives.** Once projects are constructed and operational, this process provides ADOT and its Board with a mechanism to monitor the actual effects of performance on the transportation system. ADOT will then be able to refine and adjust the process to better meet transportation system performance goals.

- **Developing linkages between short- and long-range major capital project investments.** The initial MoveAZ Plan evaluation process provides ADOT with a list of prioritized capital projects that forms the basis of the State's long-range capital program. By 2010, this process will be integrated into both the short-range, Five-Year Capital Program and ADOT's planning to programming (including scoping) process.

- **Refining the methods used by ADOT to allocate resources among programs and capital projects and to potentially assess the tradeoffs of allocating funds by program and project area.** The process provides ADOT an opportunity to conduct tradeoff analysis to better utilize and allocate funds.

The MoveAZ Plan evaluation process involves identifying the expected future performance improvements of projects on the transportation system. The basic components of the process include:

- Identifying performance measures;
- Identifying projects and creating project bundles;
- Calculating system performance;
- Establishing thresholds to evaluate projects;
- Assessing project needs;
- Normalizing performance measures;
- Scoring performance factors; and
- Weighting performance factors.

Because the process was implemented with the understanding that all currently programmed projects (through 2008) would be built, programmed projects were not considered for evaluation. Each component of the MoveAZ Plan evaluation process is presented in the following sections.

4.1 Identifying Performance Measures

Performance measures used to support the MoveAZ Plan were selected to identify and monitor system performance and gauge the ability of proposed projects to satisfy ADOT's goals. These goals can be described by the following performance factors:

- Mobility;
- Economic competitiveness;
- Connectivity;
- Preservation;
- Reliability;
- Safety;
- Accessibility; and
- Resource conservation.

Performance measures were organized according to the performance factors to which they apply (mobility and economic competitiveness were grouped together, as performance measures for those factors apply to both). Performance measures were identified, assessed, and finalized using input from the MoveAZ Steering Committee, MoveAZ

Working Group, and the MoveAZ Performance Measures and Factors input team. The measures are summarized below by performance factor.

Mobility and Economic Competitiveness

Mobility and economic competitiveness are captured by similar measures, because mobility is a key component to the economic well-being of Arizona. As Chapter 8 describes in greater detail, goods movement on the state transportation system is a major component of the State's economy. Providing for mobility will increase the economic competitiveness of the State.

These factors considered two measures:

1. Percent of person-miles traveled (PMT) by level of service (LOS); and
2. Average delay per trip.

Percent of PMT by LOS provides a broad systemwide perspective of how much travel is occurring under congested conditions. It also provides a visual representation of system conditions by different roadways (interstates and arterials) and areas (urban and rural). Average delay per trip measures the additional travel time the average traveler requires to reach a given destination. It measures mobility from the traveler's perspective, rather than from the systemwide perspective.

Connectivity

The following two connectivity measures consider the availability of efficient highway connections between Arizona cities and towns, particularly in more rural areas of the State:

1. Passing ability; and
2. Intercity travel time connectivity.

Passing ability identifies the ability to overtake slower moving vehicles on two-lane state highways. Passing ability is a function of sight distances, roadway grades, traffic volumes, and other related factors. Intercity travel time connectivity evaluates the circuitousness and travel time of existing state routes in the Arizona's high-priority corridors. The evaluation considers assessing the potential for travel time savings in these priority corridors associated with the project improvements.

Preservation

ADOT uses pavement and bridge management systems to determine future pavement and bridge conditions. As pavement and bridge maintenance and construction are

funded separately within ADOT, only the reconstruction need measure was computed in the MoveAZ Plan evaluation process. This measure can be updated by more detailed measures of pavement and bridge conditions as ADOT implements more advanced management systems. The preservation performance measures include:

- Reconstruction need;
- Pavement condition;
- Vehicle miles of travel (VMT) by pavement condition;
- Bridge condition; and
- Vehicle trips by bridge condition.

Reconstruction need assesses roadway segments requiring total reconstruction, with an average year of last reconstruction before 1970. This measure is used in the MoveAZ Plan to evaluate projects that improve deteriorating roadways, but do not affect roadway capacity.

The pavement condition and VMT by pavement condition measures rate the smoothness of state highway lane miles and associated vehicle movements on a scale from zero ("very poor") to five ("excellent"). The bridge condition and vehicle trips by bridge condition measures identify the number or percentage of deficient bridges on state highways and the vehicular movements on those deficient bridges. A seven-point rating is used, with seven being excellent.

Reliability

Additional unexpected delay was examined to understand how incident-related delay (e.g., vehicular-related crashes, spills) and non-recurring delay (e.g., special events) impact vehicle movements and travel times on state roadways.

Safety

The safety performance factor includes two measures:

1. Crashes per million VMT by roadway type; and
2. Anticipated reduction in fatalities and injuries.

Crashes per million VMT identifies the likelihood that crashes will increase as the number of vehicles on Arizona's roads increases. The anticipated reduction in fatalities and injuries identifies specific locations that have a high absolute number of crashes and the types of projects that could be implemented to reduce these crashes.

Accessibility

The following measures were used to examine accessibility by bus, bicycle, and HOV:

- Park-and-ride spaces;
- Bus turnouts; and
- Bike suitability.

The number of park-and-ride spaces helps determine access to the state transportation system for carpoolers and bus riders. The number of bus turnouts on state highways with transit or school bus service determines bus accessibility. Bike suitability considers the percent of state roadways suitable for bike usage based on ADOT definitions of bike suitability in the recently completed Bicycle/Pedestrian Plan. Existing roadways can often be made more suitable for bicycle travel without the need for costly new construction projects.

Resource Conservation

Resource conservation considers the following measures:

- Total mobile source emissions;
- Percentage of air quality improvement projects selected;
- Noise exposure;
- Projects listed in RTPs; and
- Fuel consumption.

Total mobile source emissions gauge systemwide environmental performance, as well as the environmental impact in areas where air quality is already a critical concern. Percentage of selected air quality improvement projects identifies air quality projects designed to reduce mobile source emissions. Noise exposure measures residential area exposure to transportation-related noise. Projects listed in RTPs examine the level of coordination between the MoveAZ Plan and regional plans in order to ensure that transportation decisions (and, indirectly, land-use decisions) are consistent across different tiers of government. Fuel consumption is a function of fleet fuel economy, as well as the specific projects ADOT chooses to build in the future.

4.2 Identifying Projects and Creating Project Bundles

The 1994 ADOT long-range transportation plan identified 33 high-priority corridors for further evaluation. Since that time, ADOT has created at least one profile for each of these

major corridors. These profiles were prepared to analyze the transportation deficiencies and needs of a particular corridor, and to identify projects that could alleviate these deficiencies. ADOT also conducted small area transportation studies that focused on the short- and long-term transportation needs of smaller regions. The corridor profiles and the small area studies were a source of projects for MoveAZ Plan evaluations.

Another source of projects was the Vision 21 Plan, developed by the Governor's Office. Vision 21 included a major effort to identify all transportation needs in the State. The effort identified transportation needs from ADOT's corridor profiles and small area transportation studies, as well as regional and local transportation plans and studies. The resulting database of projects was merged with the projects described above to generate a list of proposed projects for consideration and evaluation in MoveAZ.

Because of its broad geographic scope and 20-year planning horizon, the MoveAZ Plan focuses only on large transportation projects. In contrast, ADOT corridor profiles and other studies cover a variety of both large and small projects. To ensure that the performance impacts of these projects were accurately measured, smaller projects were bundled together with appropriate large and small projects and analyzed in the MoveAZ Plan evaluation process.

As shown in Figure 4.1, ADOT has adopted a set of decision guidelines to bundle projects for evaluation. These guidelines are general rules of thumb intended to allow ADOT the flexibility to design bundles appropriate to the circumstances of a particular district or project type. These decision guidelines were applied to the available ADOT project list generated through corridor profile and other studies to develop the project bundles. These bundles were then reviewed and approved by ADOT planning staff and district engineers prior to full analysis in the MoveAZ Plan evaluation process. Bundles were not prepared in Maricopa County, because the MAG RTP identifies project needs in the MAG area and is incorporated by reference into MoveAZ (see page 3-7).

In addition to bundling projects for evaluation, cost estimates for the individual project elements of each bundle were checked for validity and consistency. Because corridor profiles and other studies were conducted over several years using numerous sources of financial data, there were inconsistencies in the cost estimates. A two-part process was used to develop consistent cost estimates. First, unit costs were estimated for types of projects from ADOT's corridor profiles. Project types included highway widening, interchange construction, bridge replacement, and others. Second, these "typical" unit cost estimates were compared to the original cost estimates in meetings with each of the ADOT district engineers to determine the appropriate cost for a particular project.

Figure 4.1 MoveAZ Plan Project "Bundling" Decision Guidelines

1. Small cost items within a widening project that are not part of a subprogram will be grouped with the widening.

2. Bridge and pavement preservation projects will be analyzed using management systems and not as capital projects.

   a. Exception: If a bridge must be replaced due to a road widening or other project, then it will be included in the project bundles.

3. Short widening segments will be grouped together in a corridor if they are nearly adjacent (less than two miles apart).

4. Interchanges and bridge replacement projects will be grouped with widening (or other projects) whenever they overlap or are very close (within two miles).

   a. Exception: If a corridor study specifies the interchanges or bridges to be altered as part of the widening project, only those interchanges or bridges within the project area will be included.

5. Projects on different roadways that are tightly aligned and have been planned together (according to existing sources) will be grouped as a single project. (Example: Widening projects in downtown Yuma on I-8, B-8, and SR 280.)

6. A group of similar projects that are more than two miles apart may be grouped together if they have been planned to address a single problem. (Example: Climbing lanes that are one to three miles apart.)

7. Total combined project costs will be kept within a reasonable range of about $50 million. This serves as a guide only, not as a rule. For example, three widenings in a corridor at a cost of $40 million each will be treated separately, rather than combined into a single $120 million project.

Source: Cambridge Systematics, Inc., and ADOT, 2003.

4.3 Calculating Project Performance

Fourteen specific system performance measures are shown in Table 4.1. Several measures presented in Section 4.1 could not be calculated to support the MoveAZ Plan evaluation process, because they lacked a natural baseline to measure against. These included bus turnouts, noise barriers, and consistency with regional transportation plans. Some preservation measures, primarily the bridge and pavement conditions measures, were also not used into the evaluation process, because pavement preservation and bridge maintenance work is funded through subprograms that use independent processes to evaluate the

performance benefits of particular projects. Though many of the projects analyzed by MoveAZ have an impact on pavement conditions (e.g., widening a highway over several miles typically includes resurfacing the entire highway over that segment, yielding overall improved pavement conditions), this impact is not captured intentionally. For the remainder of the discussion of performance measures, MoveAZ only addresses the reconstruction need measure. More detail on ADOT's use of subprograms can be found in Chapter 6.

Table 4.1 MoveAZ System Performance Measures

Performance Factor	Performance Measures
Mobility and economic competitiveness	• Improvement in vehicle-to-capacity (V/C) ratio (weighted average by PMT) • Reduction in hours of delay
Connectivity	• Ability to pass in major two-lane corridors • Travel time improvement on ADOT high-priority corridors
Safety	• Improvement in crash rate (crashes per 100 million VMT) • Reduction in injuries
Preservation	• Reconstruction for older roads
Reliability	• Reduction in hours of incident-related delay
Accessibility	• Improvement in bike suitability (from Bicycle/Pedestrian Plan) • Added bus turnouts
Resource conservation	• Reduction in mobile source emissions • Reduction in fuel consumption • Added sound walls • Project consistency with local plans

Source: Cambridge Systematics, 2004.

The measures were calculated at the district level to determine the "district base performance." These base performance values were calculated using the 2025 estimates of travel volumes for a given district. After calculating the district base performance, the performance for the districts was recalculated with the new project bundles to identify system performance impacts. This was referred to as the "district plus project performance scenario." The improvement from the district base performance to the district plus project performance showed the performance gains that resulted from a particular project bundle. This process was repeated for each of the project bundles in each district to calculate the system performance.

4.4 Establishing Thresholds to Evaluate Projects

The performance measures described in Section 4.3 provided a raw assessment of the estimated performance improvement that a given project bundle would produce. The MoveAZ Plan evaluation process also accounted for the "need" of a particular project bundle by applying upper and lower ranges to some performance measures. These threshold value ranges ensured that the transportation system improved by a project bundle included needs analysis. Project bundles above or below a particular threshold were unlikely to show a need for the particular improvement.

Thresholds were used for several of the performance measures to help ensure that the evaluation process captured the need for a given project, in addition to the performance improvement. Not all of the performance measures used thresholds. For example, the reduction in injuries was measured without a threshold, because each additional crash eliminated was as beneficial as the previous. Table 4.2 presents the thresholds used for each measure.

4.5 Assessing Project Needs

A second method was used to account for the "need" of a particular project bundle. For several of the measures, the MoveAZ Plan evaluation process accounted for volume of traffic using the segments of roadway affected by the project. The performance improvement was multiplied by the project bundle average annual daily traffic (AADT) to generate this performance assessment.

There were several exceptions to this process. The delay and incident delay measures, which were calculated as hours of delay saved, were not multiplied by the project bundle AADT. Similarly, the number of injuries reduced by a project was already calculated using the project bundle AADT. Bike suitability, bus turnouts, noise barriers, and regional plan consistency also did not use the project bundle AADT.

Table 4.2 MoveAZ Performance Measure Thresholds

Performance Measure	Threshold
Mobility and Economic Competitiveness	
• Improvement in V/C	Uses existing ADOT standards: 0.71 for rural highway segments and 0.8 for urban highway segments. A segment that is already below the given threshold scores zero points; segments that are improved below the threshold value receive the portion of their improvement to the threshold.
• Reduction in hours of delay	Total delay for a given district in 2002. If a project reduces delay in a given district below the 2002 level, it receives that portion of the improvement down to the 2002 level.
Connectivity	
• Ability to pass in major two-lane corridors	One, the value at which AADT is equal to passing-lane weighted service volume. Improvements that reduce the ratio below one are scored only to this threshold.
• Travel time improvement on ADOT high-priority corridors	The 2002 travel time in the affected corridor. If a project reduces the travel time to below the 2002 level, it only receives that portion of the improvement to the 2002 level.
Safety	
• Improvement in crash rate • Reduction in injuries	No threshold used.
Preservation	
• Reconstruction need	Road last reconstructed before 1970.
Reliability	
• Reduction in hours of incident-related delay	The total incident delay for a given district in 2002. If a project reduces incident delay below the 2002 level, it only receives that portion of the improvement to the 2002 level.
Accessibility Factor	
• Improvement in bike suitability • Added bus turnouts	No threshold used.
Resource Conservation Factor	
• Reduction in mobile source emissions	The distribution of emissions rates is U-shaped, with peaks at low and high speeds. Projects score on this measure only if they reduce emissions.
• Reduction in fuel consumption	The distribution of fuel consumption rates is U-shaped, with peaks at low and high speeds. Projects score on this measure only if they reduce fuel consumption.
• Added sound walls • Project consistency with local plans	No threshold used.

Source: Cambridge Systematics, Inc., 2004.

4.6 Normalizing Performance Measures

To develop consistency in the measures, raw scores on each measure were converted into a normalized score between zero and 10 points. A zero score indicated that a given project bundle did nothing to improve a particular measure. The remaining points were assigned to project bundles relative to the scores of all project bundles analyzed for MoveAZ.

The scores were normalized on a 10-point scale, based on their position in the distribution of all project bundles on that score. This process is referred to as the percent rank. A project bundle with a score that was better than X percent of all project bundles on a given measure received a normalized score of X/10. For example,

- A project bundle that performed better than 80 percent of all other project bundles scored eight points;
- A project bundle that performed better than one-half of other projects scored five points;
- A project bundle that performed better than only 10 percent of other projects scored a single point; and
- A project bundle that provided no performance improvement scored zero point.

This method was applied to reduce the influence of outliers on the scoring method. If one or two projects performed much better on a given measure than all other projects, they would not skew the scale. For example, if the third best project scored better than 92 percent of all projects, it received 9.2 points, even if the performance score for the top two projects were substantially larger (i.e., double or greater) than the third best project.

4.7 Scoring Performance Factors

Project bundles received a final score on each performance factor as a function of their score on one or more performance measures. Similar to the measures, each of the performance factors was also scored on a 10-point scale. The reliability factor had only one measure, so the factor score was the same as the measure score. For all other factors, multiple measures contributed to the factor score. For most factors, the final score was the average of the measures making up that score, with some exceptions. Table 4.3 describes the procedure for combining each set of measures into a single factor score.

Table 4.3 Performance Factor Scoring Methodology

Performance Factor	Measure Methodology
Mobility and economic competitiveness	Average of the two measures
Connectivity	Average of the two measures
Safety	Average of the two measures
Preservation	Single measure
Reliability	Single measure
Accessibility	Score of bike suitability measure, plus a single point for any added bus turnouts; maximum of 10 points
Resource conservation	Average of emissions and fuel consumption measures, plus a point each for a project with sound walls or a project that is consistent with local plans; maximum of 10 points

Source: Cambridge Systematics, Inc., 2004.

4.8 Weighting Performance Factors

The final step in the MoveAZ Plan evaluation process was the application of performance weights to each of the factor scores to generate a total score for each project bundle. Weights provided a means to formalize the priorities of the long-range goals and performance factors of MoveAZ. The legislation directing ADOT to develop a long-range plan (House Bill 2660) also required a system of weights to be applied to the performance factors. A system of weights for each of the seven performance factors used in project analysis was developed through public and stakeholder involvement for the plan in coordination with existing ADOT policies and technical concerns.

Weighting Methodology

A three-step process was used to develop performance factor weights:

1. First, performance factors were identified;
2. Second, each factor received one of three descriptive weights that represented the relative priority assigned to that factor; and

3. Finally, each of the descriptive weights was assigned specific quantitative values that were then applied to the factor scores resulting from the evaluation process.

Three descriptive weights were selected to describe the relative priorities of the factors:

1. **Enhance** was used for factors with the highest priority for ADOT. These are factors that ADOT should focus on to improve roadway performance, possibly at the expense of other factors.

2. **Sustain** was used for factors for which ADOT should try to maintain current performance levels.

3. **Neutral** was used for all other factors. These factors represent issues that are important, but somewhat less so than other factors.

During the evaluation process, the descriptive weight categories were translated into numerical weights. The final weights were subject to extensive sensitivity testing during the planning process.

Sources for Weights

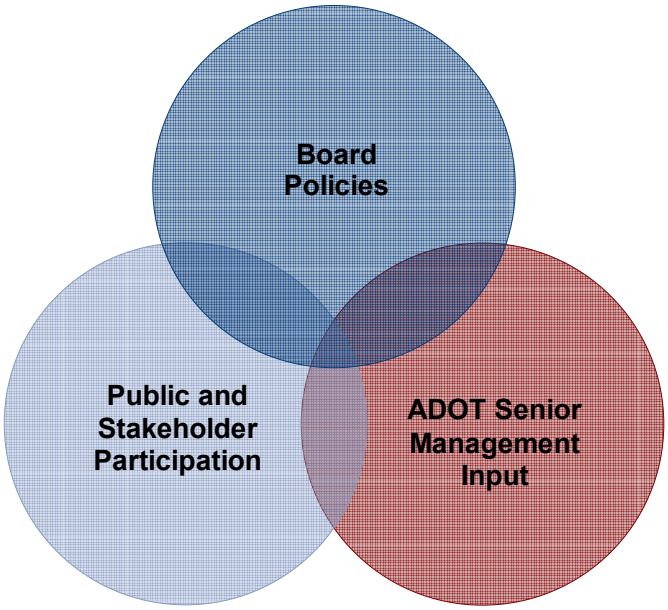
The major sources used to develop the performance factor weights are described below and shown in Figure 4.2:

- **Currently adopted board policies.** The Arizona Transportation Board policy document describes the current vision and commitments that the Board makes for transportation in Arizona. It also outlines a set of policies to help meet these commitments.

- **Public input conducted as part of the MoveAZ planning process.** MoveAZ included three phases of public and stakeholder involvement. Through focus groups and regional forums, members of the public were able to help shape the MoveAZ strategic direction. MoveAZ included an analysis of comments made at all of these public events, as well as through previous planning processes.

- **Consistency with departmental goals.** The MoveAZ Continuity Team is an internal ADOT committee consisting of representatives of ADOT's major divisions. This group provided guidance on the selection of weights to ensure that the weights fit with existing departmental goals.

Figure 4.2 Sources of MoveAZ Factor Weights



MoveAZ Descriptive Weights

Overall, each of the performance factors received support at all of the regional public forums and in the Arizona Transportation Board policy statement. During the intermediate partnering phase of the MoveAZ Plan, participants were asked to select the most important key findings from the initial phase. Across all of the forums, each of the key findings received nearly the same level of support.

Enhance

- **Mobility and economic competitiveness** is one of the primary goals of both ADOT and the traveling public. Consultation with ADOT staff and public partnering events revealed that mobility is consistently a high-priority issue. For example, participants at the regional public forums cited concerns and strategies related to mobility more frequently than all other performance factors during both the initial and intermediate partnering events.

- **Safety** is extremely important to ADOT, various Federal agencies, and the traveling public. ADOT is committed to reducing crashes involving motor vehicles and making the roads safer for all users. In public partnering sessions, safety was consistently raised as an issue. For these reasons, safety received an enhance rating.

Sustain

- **Accessibility** or providing access to the transportation system for users is an important goal for ADOT. This goal received relatively strong support during the public partnering events. It was also consistent with ADOT policy to develop a multimodal transportation system that provides opportunities for all Arizonans to use the transportation system.

- **Preservation** or investing in the maintenance of the transportation system is important to ADOT and Arizonans alike. Pavement condition in Arizona is substantially better than for the U.S. as a whole. This commitment to preservation was supported by participants at public partnering events. Because the quality of maintenance is already quite high, this factor receives a sustain, instead of an enhance.

Neutral

- **Resource conservation**, as with all of the other factors, is an important goal for ADOT. Compared to some of the issues raised by other factors, however, resource conservation is somewhat less important. Providing for travel mobility and improving roadway safety form the core of ADOT policy. Similarly, public partnering sessions were less likely to point to resource conservation issues. For these reasons, the resource conservation factor receives a neutral rating.

- **Reliability** taps the public's desire for predictability of travel. As a growing state with a rapidly growing transportation system, reliability concerns are somewhat less important than overall mobility. As the Arizona transportation system matures, however, reliability concerns will likely grow. For the MoveAZ Plan, reliability received a neutral rating.

- **Connectivity** is a goal supported by ADOT and at the MoveAZ public partnering sessions. Again, however, it received overall less support than other related issues. Connectivity is closely related to other issues, such as mobility and accessibility. But where these issues received substantial public support, the support for connectivity was much more varied. Connectivity received relatively less support across all of the forums, compared to other performance factors. This strategy, therefore, was weighted as neutral, because it is important, but not more so than other strategies.

MoveAZ Numeric Weights

The final set of weights developed for the MoveAZ performance factors was based on consultations with the ADOT advisory bodies and detailed sensitivity analyses. The objective of using weights in the evaluation process was to provide additional support to projects that perform well on higher-priority factors, such as safety and mobility. However, ADOT recognized that each performance factor is important for the transportation system. Weights were not intended to cause a radical redistribution of performance to

projects. As a result, the weights shown in Table 4.4 provide a moderate boost to project bundles that improve mobility, safety, accessibility, and preservation.

Table 4.4 Performance Factors Weights

Performance Factor	Weight
Mobility	1.4
Reliability	1.0
Connectivity	1.0
Accessibility	1.2
Safety	1.4
Preservation	1.2
Resource Conservation	1.0

Source: Cambridge Systematics, Inc., 2004.

5. Base and Future System Performance

Chapter 5. Base and Future System Performance

Performance of the state transportation system was quantified using the factors and measures described in Section 4.0. These measures establish the existing (year 2002) and future 2025 "base-line" conditions on state roadways. This analysis was conducted prior to evaluation and analysis of specific project bundles for the MoveAZ Plan evaluation process.

Both existing (2002) projects and financially committed projects (specified by ADOT) to be constructed by 2025 were considered. As shown in Table 5.1, several of the roadway performance measures were not applied to identify base and future performance. Some were omitted because of a lack of data; others because they were useful for comparative purposes only; and still others because they focused on the programming process, rather than project analysis.

Table 5.1 Measures Not Used in System Performance Analysis

Performance Measure	No System Performance Calculations		Reasons for Not Including These Measures in Systems Analysis
	2002	2025	
Reconstruction need	●	●	Relevant only for project comparison (interim measure)
Pavement condition		●	Separate programming area
VMT by pavement condition		●	Separate programming area
Bridge condition	●	●	Separate programming area
Vehicle trips by bridge condition	●	●	Separate programming area
Park-and-ride spaces	●	●	Data unavailable
Bus turnouts	●	●	Data unavailable
Percentage of air quality improvement projects selected	●	●	Relevant only for project comparison
Noise exposure	●	●	Data unavailable
Projects listed in RTPs	●	●	Relevant only for project comparison

Results of the existing and future year system performance analysis are presented below by factor for the state highway system only. This analysis was used as a benchmark for evaluating the performance benefits of each project bundle analyzed in the MoveAZ Plan evaluation process, as presented in Chapter 4.

5.1 Mobility and Economic Competitiveness

Percent of Person-Miles of Travel by Level of Service

This measure considers the percentage of PMT that occur at acceptable levels of congestion. Congestion is measured on the highway system using a LOS grading system. Roadway segments with LOS A have substantial excess capacity. Segments with LOS F are gridlocked. ADOT has defined acceptable congestion in Arizona as LOS C or better in rural areas, and LOS D or better in urban areas. As shown in Table 5.2, this measure predicts that, statewide, Arizonans will be half as likely to find acceptable congestion levels on state routes in 2025 as in 2002. PMT under congested conditions are projected to nearly double in the Tucson district and to more than double in the Safford, Phoenix, and Prescott districts. In the Yuma, Holbrook, Kingman, and Flagstaff districts, which currently experience a very low percentage of total PMT at unacceptable congestion levels, the proportion of travel in unacceptable congested conditions is projected to increase by tenfold or more.

Table 5.2 Percent of PMT by LOS and District

	% PMT at LOS A-C Rural, LOS A-D Urban	
District	**2002**	**2025**
Flagstaff	97	54
Globe	84	79
Holbrook	100	82
Kingman	98	59
Phoenix	64	20
Prescott	73	40
Safford	93	68
Tucson	68	38
Yuma	100	39
State Total	**77**	**38**

Source: Cambridge Systematics, Inc., October 2003.

Average Delay Per Trip

As shown in Table 5.3, motorists will see the length of their average delay rise six fold between 2002 and 2025, from about one minute to seven minutes per trip. While the Phoenix district contributes significantly to the overall increase in roadway delay, other urban and rural districts also are expected to show significant increases in average delay. For example, the residents of the Yuma, Prescott, and Kingman districts will experience trip delays of about two additional minutes per motor vehicle trip.

Table 5.3 Average Delay Per Vehicle Trip by District

	Average Delay Per Trip (Hours:Minutes)	
District	**2002**	**2025**
Flagstaff	0:56	1:40
Globe	0:44	1:34
Holbrook	0:15	0:27
Kingman	0:35	2:39
Phoenix	1:56	9:16
Prescott	0:43	2:29
Safford	0:27	1:08
Tucson	0:37	3:16
Yuma	0:54	2:49
State Total	1:17	6:58

Source: Cambridge Systematics, Inc., October 2003.

5.2 Connectivity

Ability to Overtake in Major Two-Lane Corridors

The ability to pass is measured as the ratio of the existing or projected traffic volume (AADT) to the passing service volume. The passing service volume is calculated as a function of terrain, curves, percent of vehicles that are heavy trucks, and other factors. A value of 1.0 respresents a traffic volume that is equal to the passing service volume. In most cases, it should be possible to pass other vehicles in a reasonable amount of time at this level. A value of 1.5 indicates that there are 50 percent more vehicles than in the acceptable passing situation.

As shown in Table 5.4, most two-lane state roadways are currently operating at acceptable levels of passing ability, without substantial need for additional passing lanes. However, the analysis predicts that, by 2025, most districts across the State will be approaching values at which passing on a two-lane segment becomes undesirably difficult. The state average passing ability measure will be 1.23 by 2025, indicating that almost 25 percent more vehicles are using roadways than can be accommodated with easy passing. Though all districts across Arizona will suffer, rural areas in districts such as Prescott, Globe, and Flagstaff will be particularly impacted relative to existing conditions.

Table 5.4 Passing Ability by District (Ratio of AADT to Passing Service Volume)

District	2002	2025
Flagstaff	1.01	1.51
Globe	1.23	1.51
Holbrook	0.59	0.74
Kingman	1.06	1.25
Phoenix	0.39	1.11
Prescott	1.26	1.81
Safford	0.63	0.88
Tucson	0.64	1.35
Yuma	0.38	0.87
State Total	**0.82**	**1.23**

Source: Cambridge Systematics, Inc., October 2003.

Intercity Travel Time Connectivity

As shown in Table 5.5, driving time in important travel corridors across Arizona is expected to increase an average of 32 percent between 2002 and 2025. Driving times in the Phoenix to Hoover Dam, Phoenix to Lukeville, Phoenix to Mogollon Rim, and Prescott to Cordes Junction corridors will increase even more; an indication that traffic volumes in these corridors will reach or exceed roadway capacities. For example, travel time is projected to increase 68 percent in the Prescott to Cordes Junction corridor, and 82 percent in the Phoenix to Hoover Dam corridor.

Table 5.5 Intercity Travel Time by Corridor

Corridor	2002	2025
Douglas – Benson	2:10	2:30
Phoenix – Hoover Dam (Nevada State Line)	4:50	8:00
Flagstaff – Page (Utah State Line)	2:30	2:30
Phoenix – Globe	1:00	1:00
Phoenix – Lukeville	2:30	4:40
Phoenix – Mogollon Rim (Show Low)	3:20	4:50
Prescott – Cordes Junction	0:50	1:20
Yuma – Bullhead City	3:50	4:00
Tucson – Holbrook	4:30	4:50

Source: Cambridge Systematics, Inc., October 2003.

5.3 Preservation

ADOT uses pavement and bridge management systems to evaluate pavement and bridge conditions and identify projects to maintain these conditions at levels established by the Transportation Board. These management systems provide a very detailed form of performance measurement for particular types of projects. Because the MoveAZ plan only evaluates major capital projects, most of the pavement and bridge measures are not calculated here. The only measure used by MoveAZ in the project evaluation is the "reconstruction need" measure. Currently, however, reconstruction need was used to support the project bundle evaluations only, not to assess base and future roadway performance. Base and future year performance for the reconstruction need measure is not relevant at an aggregate district level, but is relevant at the project level.

5.4 Reliability

Unexpected delay that does not recur on a daily basis at predictable times and locations is a major detriment to reliability and predictability. Additional unexpected motorist delay, caused by events such as crashes and other more or less random events, is expected to nearly quadruple between 2002 and 2025, from less than one hour per 1,000 VMT to over three hours per 1,000 VMT (Table 5.6). This equates to almost 450,000 hours of unexpected delay per day in 2025.

Table 5.6 Unexpected Delay by District (Hours Per 1,000 VMT)

District	2002	2025
Flagstaff	0.62	0.53
Globe	0.06	0.06
Holbrook	0.04	0.20
Kingman	0.07	2.15
Phoenix	2.01	6.07
Prescott	0.20	1.25
Safford	0.07	0.22
Tucson	0.46	2.55
Yuma	0.12	2.57
State Total	**0.81**	**3.19**

Source: Cambridge Systematics, Inc., October 2003.

In the Globe district, unexpected delay is not projected to increase; and in the Flagstaff district, it is expected to decline slightly. In all other Arizona districts, however, unexpected delay will increase significantly over the next two decades. The Yuma and Kingman districts are projected to have the most significant percent increase in unexpected delays, which will rise by about 15 minutes and 10 minutes per 1,000 VMT, respectively. The Tucson, Prescott, and Holbrook districts will all see five-fold increases in unexpected delay. In the Phoenix district, unexpected delays are projected to increase at a somewhat slower pace, but Phoenix's overall level of unexpected delay – about two hours in 2002 and about six hours in 2025 per 1,000 VMT – is by far the highest in the State.

5.5 Safety

Crashes Per 100 Million VMT

Crash rates distinguish between those involving injuries, fatalities, or only property damage. Crash rates in Arizona are projected to change over time as a result of factors such as changing average vehicle speeds, or improvements to the highway facilities (e.g., improved from two-lane undivided to a four-lane divided highway.) As shown in Table 5.7, the number of motor vehicle crashes involving injuries per 100 million VMT is projected to decrease slightly between 2002 and 2025, statewide. Some individual districts' crash and injury rates will increase, while others will decrease. However, every

district's fatality rate is expected to stay the same or increase slightly by 2025. Crash and injury rates in the Kingman and Prescott districts are projected to increase by over 10 percent, the most significant increase of any district. In contrast, crash and injury rates in the Yuma district are projected to decline by almost 20 percent, though the fatality rate is still expected to increase by 10 percent.

In the Holbrook district, overall crash rates are relatively low, but fatality rates are the highest in Arizona; three in every 100 crashes involving motor vehicles in Holbrook involve a fatality, a number that is not projected to change by 2025. Both the Tucson and Phoenix districts have the lowest number of fatalities as a percent of total crashes, with less than one fatality-related crash per 200 crashes involving motor vehicles in both 2002 and 2025. In the Yuma district, nearly 30 of every 100 crashes involve an injury, the highest number of injuries as a percent of total crashes for both 2002 and 2025. In the Flagstaff district, however, only 21 of every 100 crashes involve an injury.

Table 5.7 Crashes Per 100 Million VMT by District

	2002			2025		
District	**Crash**	**Injury**	**Fatality**	**Crash**	**Injury**	**Fatality**
Flagstaff	165.0	44.5	1.9	172.9	46.8	2.1
Globe	151.6	54.6	3.2	148.1	60.7	3.5
Holbrook	56.0	20.0	2.4	59.3	19.4	2.4
Kingman	132.4	45.9	2.3	149.5	51.7	2.3
Phoenix	761.6	287.3	3.5	776.9	292.7	3.6
Prescott	154.3	51.7	2.2	171.0	58.3	2.3
Safford	132.9	43.5	2.3	137.0	47.0	2.4
Tucson	472.5	184.2	3.1	469.2	183.2	3.2
Yuma	132.6	55.1	3.0	106.2	46.1	3.3
State Total	**421.0**	**157.1**	**2.9**	**415.7**	**155.8**	**3.1**

Source: Cambridge Systematics, Inc., October 2003.

Anticipated Change in Injuries/Fatalities

Even in cases where injury rates remain constant or decrease between 2002 and 2025, the total *number* of annual injuries and fatalities is projected to increase due to the overall rise in VMT. This trend is shown in Table 5.8. In percentage terms, most districts will see the number of motor vehicle-related injuries and fatalities double. The Yuma and Prescott districts will see the largest increases in percentage terms: 228 percent and 138 percent, respectively, for injuries; and 333 percent and 121 percent, respectively, for fatalities. In absolute terms, the Phoenix district will see the largest increase in injuries and fatalities,

with 26,000 additional annual motor vehicle-related injuries and 330 additional annual motor vehicle-related fatalities projected to occur there in 2025. The Phoenix and Tucson districts have – and will continue to have in 2025 – the highest VMT in the State and the highest numbers of annual injuries and fatalities related to motor vehicles. Currently, the Flagstaff district has the third highest number of annual injuries (almost 1,000) in 2002, but will be surpassed by the Yuma district by 2025 as a result of the latter's projected three-fold increase in injuries. The Globe district has the fewest number of fatalities and the Holbrook district has the fewest injuries, both now and in the future.

Table 5.8 Anticipated Change in Injuries/Fatalities by District

	2002-2025 Change in Injuries		2002-2025 Change in Fatalities	
District	**Absolute Change**	**Percent Change**	**Absolute Change**	**Percent Change**
Flagstaff	911	94%	40	95%
Globe	404	83%	23	81%
Holbrook	230	80%	30	89%
Kingman	1,039	139%	41	108%
Phoenix	26,367	107%	330	110%
Prescott	1,262	138%	48	121%
Safford	617	103%	31	99%
Tucson	7,400	109%	134	118%
Yuma	1,894	228%	150	333%
State Total	**40,124**	**111%**	**827**	**123%**

Source: Cambridge Systematics, Inc., October 2003.

5.6 Accessibility

Table 5.9 shows the percentage of state roadway miles estimated to be moderately and highly suitable for bicycling in 2002 and 2025. Increasing traffic volumes will cause the percentage of state roads estimated highly bike suitable to decrease from 23 percent to 14 percent, and the percentage estimated moderately suitable to decrease from 56 percent to 48 percent. Bike suitability is projected to decline the fastest in percentage terms in the Kingman and Tucson districts. In Kingman, the percentage of state roads highly suitable and moderately suitable for cycling will fall from 10 percent to five percent and from 71 percent to 45 percent, respectively. In the Globe, Phoenix, and Prescott districts, the

percentage of state roads moderately suitable will grow slightly as conditions worsen on roads currently estimated highly suitable.

Table 5.9 Percent of State Road Miles Moderately/Highly Bike Suitable by District

District	2002		2025	
	Percentage of State Road Miles Moderately Bike Suitable	Percentage of State Road Miles Highly Bike Suitable	Percentage of State Road Miles Moderately Bike Suitable	Percentage of State Road Miles Highly Bike Suitable
Flagstaff	59%	24%	48%	14%
Globe	50%	30%	52%	21%
Holbrook	63%	22%	49%	15%
Kingman	71%	10%	45%	5%
Phoenix	58%	19%	61%	12%
Prescott	49%	21%	50%	15%
Safford	56%	35%	56%	23%
Tucson	52%	9%	37%	4%
Yuma	49%	28%	41%	16%
State Total	**56%**	**23%**	**48%**	**14%**

Source: Cambridge Systematics, Inc., October 2003.

The Safford district has – and is projected to have in 2025 – the greatest percentage of bike suitable state roads. Combined, the percentage of roads estimated to be highly and moderately suitable was 91 percent in 2002 and will fall only slightly to 79 percent in 2025. The Tucson district has and is projected to have the lowest percentage of bike suitable state roads: 61 percent highly and moderately suitable in 2002, and 41 percent highly and moderately suitable in 2025.

5.7 Resource Conservation

Total Mobile Source Emissions

As shown in Table 5.10, vehicle emissions due to travel on the state roadway system in Arizona are projected to increase by 67 percent between 2002 and 2025. Mobile source

emissions in the Phoenix and Yuma districts are expected to grow the fastest over this period by 123 percent in Phoenix and 129 percent in Yuma. Arizona's remaining districts will also show increases in transportation-related emissions ranging from 10 to 65 percent, with Prescott showing the highest increase within the range.

Table 5.10 Total Mobile Source Emissions by District (Metric Tons)

District	2002	2025
Flagstaff	83	91
Globe	25	34
Holbrook	55	68
Kingman	60	73
Phoenix	251	560
Prescott	60	99
Safford	50	55
Tucson	131	181
Yuma	56	128
State Total	**771**	**1,288**

Note: This includes emissions from travel on the state road system.
Source: Cambridge Systematics, Inc., October 2003.

The Phoenix and Tucson districts account for about one-half of all mobile source emissions on the state transportation system in Arizona, both currently and in 2025. The Yuma district, while responsible for only a moderate amount of mobile source emissions compared to other districts (56 tons in 2002), is expected to have the third highest emissions of all Arizona districts in 2025 (128 tons) due to its high projected increase in VMT.

Fuel Consumption

As shown in Table 5.11, fuel consumption due to travel on state roads is projected to increase by 176 percent between 2002 and 2025, from over four million gallons to about 12 million gallons of gasoline each day. Although VMT on the state highway system is projected to increase at only one-half this rate between 2002 and 2025, measures such as "percent PMT by LOS" and "average delay per trip" indicate that motor vehicle congestion and delay are increasing substantially, and average travel speed will decline. This causes vehicles to consume more fuel per mile traveled in 2025 than they did in 2002, on average.

Table 5.11 Daily Fuel Consumption by District (Gallons)

District	2002	2025	Percent Change
Flagstaff	436,235	846,999	94%
Globe	155,092	242,377	56%
Holbrook	276,347	617,528	123%
Kingman	309,992	767,568	148%
Phoenix	1,555,214	5,090,310	227%
Prescott	327,844	765,393	133%
Safford	259,819	555,306	114%
Tucson	695,671	1,697,151	144%
Yuma	288,042	1,305,129	353%
State Total	**4,304,257**	**11,887,762**	**176%**

Source: Cambridge Systematics, Inc., October 2003.

Fuel consumption is projected to double in most districts, and more than triple in the Yuma district. Only the Globe and Flagstaff districts will see fuel consumption increases of less than 100 percent.

6. Project Evaluations

Chapter 6. Project Evaluations

This chapter describes the funding scenarios and the results of the MoveAZ performance analysis. As described in Chapter 5, individual projects were packaged into corridor-level bundles for evaluation in the MoveAZ plan. Using base and future year system performance results as a benchmark, the MoveAZ Plan evaluated the benefits of each project bundle on future year system performance, reported by each performance measure and factor. Bundles were then packaged into funding scenarios based on the ADOT estimates of available funding and the total performance score received by a bundle.

6.1 Funding

The MoveAZ performance evaluation process begins with an examination of the total funding available to construct major state transportation projects. Identifying available funding sets the ultimate constraint on the projects identified in MoveAZ. This section describes the process used to estimate funding available for major projects over the course of the plan from 2010 through 2025. The plan begins in 2010 to accommodate ADOT's existing funding commitments to specific projects that are described in the *Five-Year Transportation Facilities Construction Program* (five-year program).

The five-year program is a list of capital transportation projects for which ADOT has identified funding. This program is generated through the coordinated efforts of several ADOT divisions and adopted by the Arizona Transportation Board each year. Each year, new projects are added to the fifth year of the five-year program. The next program cycle, 2006 to 2010, will include projects analyzed in MoveAZ. The process of transitioning from MoveAZ to the five-year programming process is described in more detail in Chapter 9.

To estimate the available funding for projects, three funding scenarios for three funding regions were evaluated. Funding levels were also estimated separately for subprograms and major projects in each region, in accordance with existing ADOT programming practice.

Funding Scenarios

The MoveAZ Plan used three investment scenarios based upon estimates of state and Federal funds available to Arizona, as determined by ADOT Financial Management Services. The three scenarios were:

1. **Constrained –** A projection of currently available funding sources through 2025;

2. **Reasonably anticipated revenues –** An increase above the constrained scenario based on a reasonable increase in revenues that could be derived from Federal and/or state sources; and

3. **Unconstrained –** No financial constraints, including all projects that address specific needs on the state highway transportation system, as identified in previous planning processes.

The constrained scenario represented funding that will likely be available to the State for future programming through 2025. The reasonably anticipated revenues provide a means to describe the additional performance gains that could be derived from a modest increase in transportation funding. Table 6.1 shows total funding available in each of these two scenarios.

Table 6.1 Available Funding for MoveAZ by Scenario

Scenario	Funding ($M 2004)
Constrained	$8,975
Reasonably Anticipated Revenues	$10,958
Potential Increase in Funding	**$1,983**

Source: Arizona Department of Transportation, 2004.

Funding Regions

MoveAZ follows current Board policy by dividing funding and conducting performance analysis independently for three major regions of the State: 1) Maricopa County, 2) Pima County, and 3) the 13 other counties. Maricopa County receives 37 percent of state funding, Pima receives 13 percent, and the 13 other counties receive 50 percent. MoveAZ used this existing funding split to determine the level of funding for each region through 2025.

Subprogram and Major Project Funding

The final step for identifying funding available for project bundles involves estimating the split between subprogram and major project funding. ADOT funds many transportation improvements through subprograms that address key functional areas, such as pavement and bridge maintenance, safety, district-identified minor projects, and others. These sub-programs are funded as a whole, with the relevant projects identified by individual

subprogram managers and analyzed using subprogram-specific tools and performance measures. For example, the ADOT pavement management system identifies roadway segments that require repaving and estimates the cost to maintain a particular pavement condition standard.

The Arizona Transportation Board sets the level of funding available to each subprogram. In recent years, these funding levels have been fairly stable. For the purpose of the MoveAZ Plan, the total funding available for subprograms was assumed to be constant each year and consistent with established funding levels. Table 6.2 shows funding for subprograms for each of the three major regions.

Table 6.2 Annual Funding for Subprograms by Region

County	Yearly Funding ($M)
Maricopa	$30.5
Pima	$18.5
13 Other Counties	$171.0
Total	**$220.0**

Source: Arizona Department of Transportation, 2004.

The total funding available for major projects for each region from 2010 to 2025 was derived by estimating total funding, allocating it among the three major regions using the regional distribution described above, and subtracting total subprogram funding in each region over the same period. The total major project funding identified using this process is shown in Table 6.3.

Table 6.3 Total Funding for Major Projects and Subprograms by Region, 2010-2025 (Constrained Scenario)

County	Funding for Major Projects ($M)	Funding for Subprograms ($M)	Total ($M)
Maricopa	2,832.7	488.0	**3,320.7**
Pima	870.7	296.0	**1,166.7**
13 Other Counties	1,751.7	2,736.0	**4,487.7**
Total	**5,455.1**	**3,520.0**	**8,975.1**

Source: Arizona Department of Transportation, 2004.

6.2 Project Performance Results

MoveAZ project bundles were evaluated on the seven performance factors described in Chapter 4. Projects were evaluated separately for Pima County and the 13 other counties to be consistent with the separate funding streams identified for each region. The plan does not include an evaluation of projects for Maricopa County. These projects are identified as part of the State Transportation Board adopted by MAG RTP. The results of the MoveAZ analysis, as well as the projects identified in the MAG RTP, are organized here by the three funding scenarios described above.

Constrained Revenue Scenario

The constrained revenue scenario presents projects that performed the best in the analysis process. Table 6.4 presents the projects in this scenario for each of the regions. Except for Maricopa County, these projects were analyzed using MoveAZ performance measures and factors. Maricopa projects were analyzed as part of MAG RTP and not using the MoveAZ process. The locations of the constrained scenario projects in Pima County and the 13 other counties are shown in Figure 6.1. Planned state highway improvements for Maricopa County are shown in Figure 6.2.

Table 6.4 MoveAZ Plan Projects – Constrained Scenario

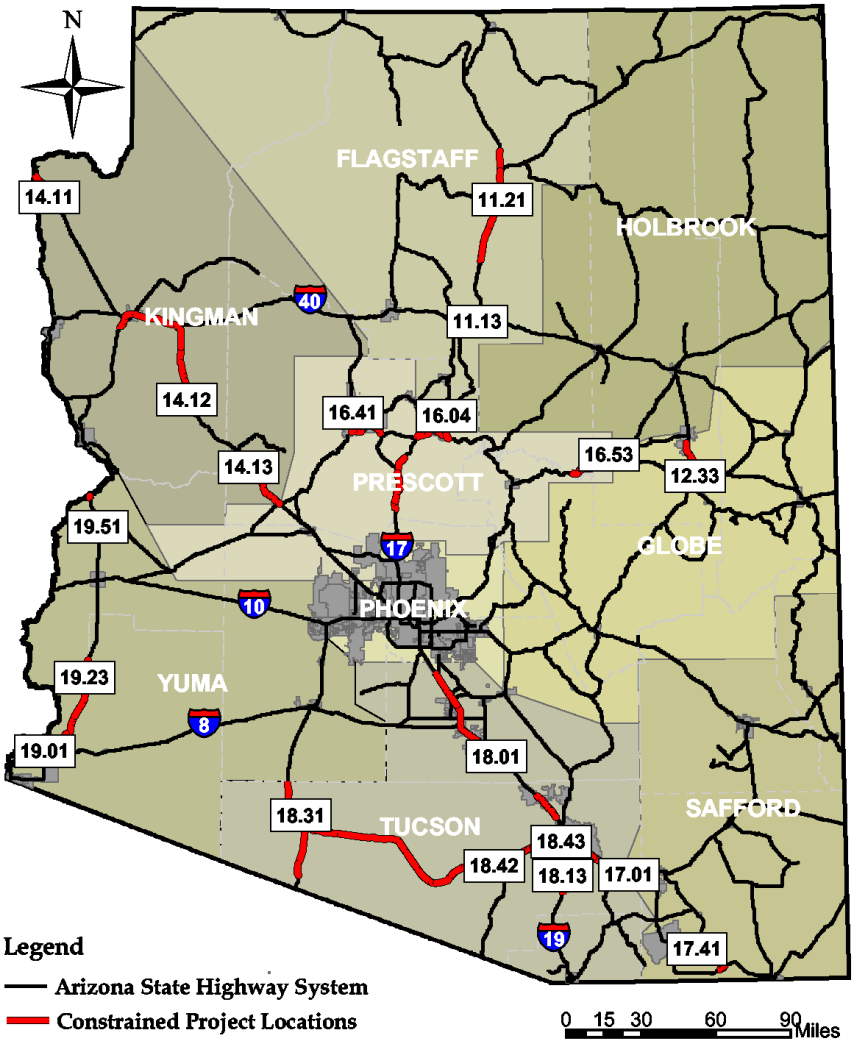
Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in Pima County						
18.02	I-10	240	252	Widen roadway to 8 lanes, construct interchanges	38	$159
18.04	I-10	262	275	Widen roadway to 6 lanes	24	$43
18.43	SR 86	150	171	Widen roadway to 4 lanes (10 miles) and 6 lanes (11 miles)	21	$22
18.13	I-19	63	91	Widen roadway to 6 lanes (16 miles), add auxiliary lanes (12 miles)	19	$300
18.03	I-10	275	288	Widen roadway to 6 lanes, reconstruct bridge	19	$36
17.01	I-10	288	303	Widen roadway to 6 lanes	18	$23
18.42	SR 86	92	141	Reconstruction roadway to standards	16	$61
18.41	SR 86	52	92	Reconstruct roadway to standards	15	$122
18.31	SR 85	32	80	Reconstruct roadway to standards	12	$86

Table 6.4 MoveAZ Plan Projects – Constrained Scenario (continued)

Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in the 13 Other Counties						
16.21	SR 69	281	296	Widen to 6 lanes	47	$49
14.02	I-40	44	45	Widen to 6 lanes, reconstruct or improve 3 interchanges, noise barriers	42	$142
14.11	U.S. 93	2	17	Widen to 4 lanes	36	$47
17.51	SR 92, SR 90	321	325	Widen to 6 lanes, raised median	36	$14
14.12	U.S. 93	92	121	Reconstruct as a 4-lane divided roadway, new interchanges	36	$250
19.23	U.S. 95	31	70	Widen to 4 lanes, replace bridge	35	$117
14.13	US 93	161	182	Reconstruct as a 4-lane divided roadway	33	$85
14.03	I-40	55	71	Widen to 6 lanes, reconstruct two interchanges	32	$107
16.51	SR 260	208	228	Widen to 4 lanes, raised median (14 miles), reconstruct (6 miles)	31	$122
16.41	SR 89	314	330	Widen to 4 lanes, some segments with turn lanes	31	$44
17.52	SR 92	352	354	Widen to 4 lanes, some segments with turn lanes	30	$6
11.13	I-40	195	205	Reconstruct roadway, widen some segments to 6 lane, noise barriers	30	$41
16.04	I-17	286	298	Widen to 6 lanes	28	$82
18.01	I-10	175	226	Widen to 6 lanes	28	$163
16.03	I-17	278	286	Widen to 8 lanes	26	$80
17.41	SR 90	322	336	Widen to 4 lanes, some segments with turn lanes	26	$45
12.33	SR 77	342	358	Widen to 4 lanes, implement Rural ITS system	26	$51
19.51	SR 95	131	147	Construct passing lane segments, widen a one-mile segment to 6 lanes	25	$7
16.53	SR 260	282	302	Reconstruct roadway, widen a 5-mile segment to 4 lanes	25	$104
16.02	I-17	244	262	Widen to 6 lanes, implement ITS system	22	$61
11.21	U.S. 89	442	482	Widen to 4 lanes, raised median, 3 new interchanges, some segments with turn lanes	21	$130
19.01	I-8	2	12	Widen to 6 lanes, reconstruct interchanges and bridges	21	$55

Note: Projects in Maricopa County include projects funded from both state and regional sources.

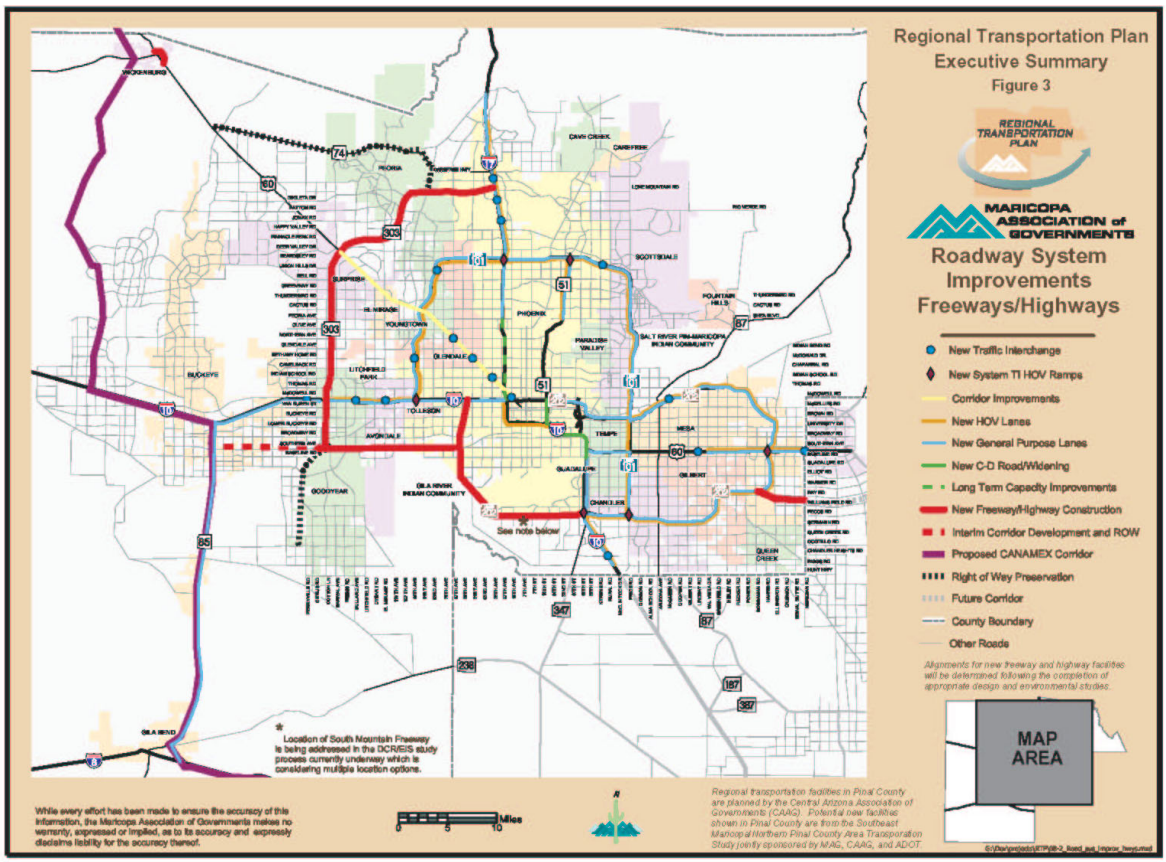
Figure 6.1 Constrained Scenario Project Locations (Pima County and the 13 Other Counties)



Additional Expected Revenues

The second scenario examines the additional projects that might be built if ADOT were to identify new state or Federal funding sources. This scenario was estimated at roughly $2 billion in additional funding. This funding was split between major projects and sub-programs, as described in Section 6.1. Table 6.5 shows the additional funding that would be available to each region in this scenario.

Figure 6.2 Constrained Scenario Project Locations (Maricopa County)



Source: Adapted from Maricopa Association of Governments' Regional Transportation Plan, 2003. Includes projects funded from Federal, state, and regional sources.

Table 6.5 Total Funding for Major Projects and Subprograms by Region, 2010-2025 (Additional Revenue Scenario)

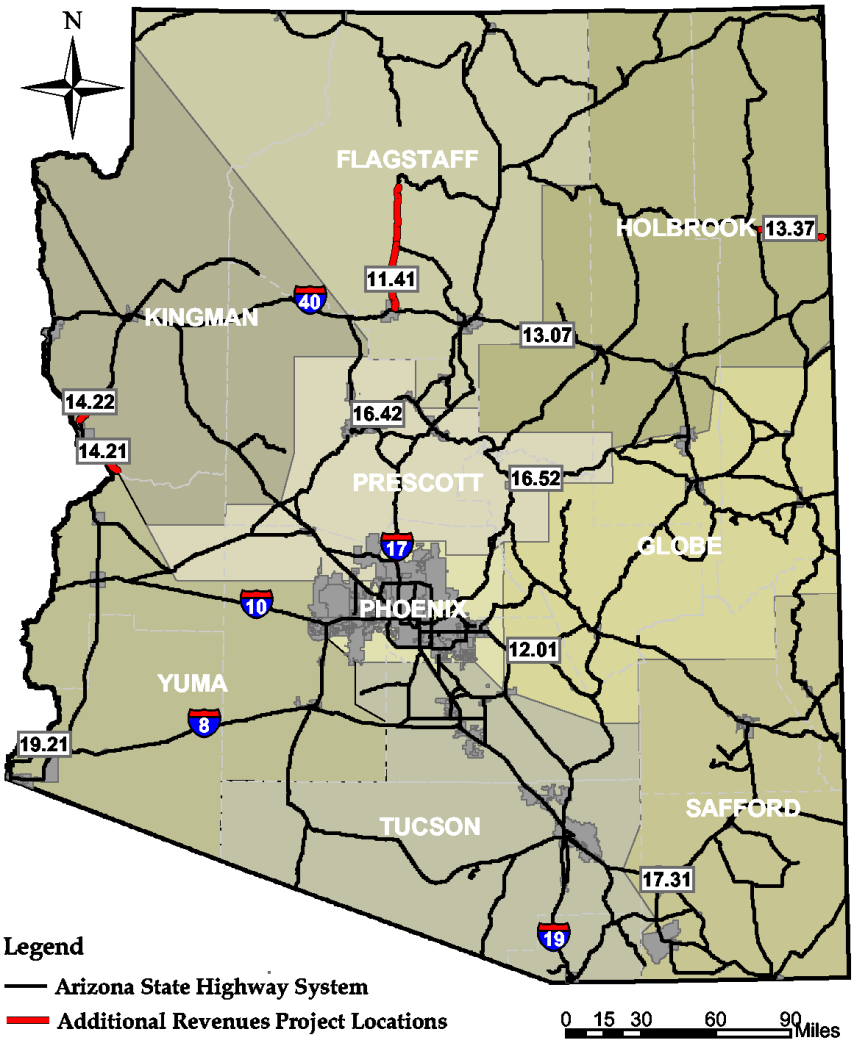
County	Funding for Major Projects ($M)	Funding for Subprograms ($M)	Total ($M)
Maricopa	626	108	**734**
Pima	192	65	**258**
13 Other Counties	387	605	**992**

The additional projects funded in this scenario are shown in Table 6.6. The locations of the additional revenue scenario projects are shown in Figure 6.3.

Table 6.6 MoveAZ Plan Projects – Additional Revenue Scenario

Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in the 13 Other Counties						
16.42	SR 89A	320	329	Widen to 4 lanes	20	$29
13.07	I-40	230	233	Reconstruct, widen to 6 lanes, reconstruct 3 interchanges	20	$52
13.37	SR 264	446	473	Widen to 4 lanes, raised median, some segments with turn lanes, replace bridge, construct bus turnout	19	$52
16.52	SR 260	256	282	Widen to 4 lanes	18	$15
17.01	I-10	288	303	Widen to 6 lanes	18	$23
12.01	U.S. 60	212	226	Widen to 5 lanes (2 miles), construct new bypass (2 miles), construct 2 interchanges	17	$51
17.31	SR 80	294	299	Add turning lanes, widen some segment s to 4 lanes, reconstruct SR 80/ I-10 interchange	17	$38
14.22	SR 95	175	202	Widen to 4 lanes at selected locations (14 miles total)	16	$42
19.21	U.S. 95	26	31	Widen to 6 lanes	16	$19
11.41	SR 64	185	235	Add paved shoulders, widen some segments to 4 lanes (5 miles) and add turn lanes (1 mile), construct several passing lanes	15	$47
14.21	SR 95	163	172	Construct passing/climbing lanes, new signage	14	$2

Figure 6.3 Additional Revenue Scenario Project Locations (13 Other Counties Only)



Unconstrained Scenario

The MoveAZ performance analysis process is based on an assessment of a large number of projects intended to address transportation needs across the State. Because funding is limited, not all of these projects can realistically be constructed in the timeframe of a long-range plan. The unconstrained scenario is designed to identify projects that did not perform, as well as other major projects, but were identified through previous needs assessments conducted by ADOT. Table 6.7 presents the projects in the unconstrained scenario.

Table 6.7 MoveAZ Plan Projects (Unconstrained Scenario)

Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in the 13 Other Counties						
19.31	SR 72	13	49	Add paved shoulders, improve vertical/horizontal curves on some segments	14	$59
13.35	SR 264	411	439	Construct climbing lane segments, add passing lanes (1 mile), improve intersection, construct bus turnout	13	$27
11.02	I-17	333	340	Widen to 6 lanes, reconstruct interchange	13	$35
11.24	U.S. 89A	579	613	Construct passing lane segments, widen some segments to 4 lanes (3 miles), construct bus turnout	13	$14
17.22	U.S. 191	111	121	Widen to 5 lanes	13	$34
18.51	SR 87	134	141	Widen to 4 lanes, reconstruct interchange	13	$38
13.24	U.S. 191	420	446	Reconstruct roadway, add shoulders (14 miles), and widen some segments to 4 lanes (5.5 miles)	13	$62
13.41	SR 77	362	387	Construct climbing lanes, rehabilitate 4 bridges	12	$14
19.53	SR 95	110	131	Reconstruct roadway to standards	12	$11
13.03	I-40	282	289	Widen some segments to 6 lanes, construct noise barriers	12	$19
19.61	SR 195			Construct 3 interchanges to make SR 195 a controlled access facility	12	$30
13.36	SR 264	441	446	Widen to 4 lanes, raised median (3 miles), turn lanes (3 miles), construct bus turnout	12	$16
13.25	U.S. 191	446	510	Add paved shoulders, widen some segments to 4 lanes (14 miles) with turn lanes in several locations (2 miles)	12	$94
12.04	U.S. 60	336	402	Add paved shoulders, widen some segments to 4 lanes, with some turning lanes	12	$49
14.04	I-40	71	89	Reconstruct roadway (8 miles), add climbing lanes on some segments	11	$34
12.31	SR 77	153	171	Improve shoulders and construct climbing lane segments	11	$11
13.32	SR 264	340	388	Add paved shoulders, construct climbing lanes (6 miles), turn lanes (2 miles), improve curves at 14 locations, and 4 intersections	11	$51

Table 6.7 MoveAZ Plan Projects (Unconstrained Scenario) (continued)

Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in the 13 Other Counties (continued)						
11.01	I-17	298	322	Construct climbing lanes on some segments, reconstruct interchanges and bridges	11	$110
12.43	SR 260	331	338	Widen to 5-lane cross-section	11	$12
13.34	SR 264	386	411	Add paved shoulders, construct climbing lane segments, widen some segments to 4 lanes (5 miles), add turning lanes (6.5 miles), construct bus turnout	11	$32
11.23	U.S. 89	531	556	Improve shoulders, construct passing lane segments (2 miles) and 4 lane segments (2 miles)	11	$18
14.05	I-40	91	120	Reconstruct roadway, widen some segments to 6 lanes (18 miles), reconstruct two interchanges	11	$111
17.23	U.S. 191	130	144	Construct climbing lane segments, construct bypass (5 miles)	11	$22
13.04	I-40	292	311	Reconstruct roadway	10	$75
17.12	U.S. 70	335	349	Widen to 4 lanes, raised median, some segments with turn lanes	10	$19
13.21	U.S. 191	344	365	Reconstruct roadway, add passing lane	10	$52
11.32	U.S. 160	321	323	Widen to 5 lanes, add paved shoulders (1 mile)	10	$27
12.61	SR 79	132	150	Widen to 4 lanes	10	$60
12.11	U.S. 70	253	287	Add shoulders, widen some segments to 4 lanes with occasional turning lanes, lengthen passing lane (0.5 mile)	9	$66
11.51	SR 264	322	340	Add paved shoulders, widen some segments to 5 lanes (1 mile), construct climbing lane segments and bus turnout	9	$18
13.05	I-40	311	339	Reconstruct roadway and one interchange	9	$127
13.23	U.S. 191	379	412	Reconstruct roadway, add passing lane (1 mile)	9	$133
13.06	I-40	339	360	Reconstruct roadway, reconstruct 2 interchanges	9	$113
18.22	SR 77	92	95	Construct climbing/passing lanes at selected locations	9	$1
11.31	U.S. 160	336	343	Construct passing and climbing lanes	8	$2

Table 6.7 MoveAZ Plan Projects (Unconstrained Scenario) (continued)

Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in the 13 Other Counties (continued)						
17.24	U.S. 191	154	165	Widen shoulders, raise bridge	8	$25
17.25	U.S. 191	23	27	Reconstruct roadway, widen to 4 lanes	8	$14
11.11	I-40	155	165	Reconstruct segments (2 miles)	8	$14
17.61	SR 266	104	123	Widen shoulders	8	$5
12.21	SR 73	310	335	Widen shoulders	8	$13
14.01	I-40	37	44	Reconstruct and widen to 6 lanes, reconstruct two interchanges	7	$63
14.06	I-40	123	144	Reconstruct roadway	7	$86
13.11	U.S. 160	361	384	Add passing lanes at selected locations	7	$7
18.61	SR 287	134	142	Widen to 4 lanes, construct 2 new interchanges	7	$56
12.06	U.S. 60	252	337	Construct selected passing and climbing lane segments	7	$28
11.22	U.S. 89	498	504	Construct passing lanes	6	$2
13.22	U.S. 191	370	379	Reconstruct roadway	5	$24
17.26	U.S. 191	45	65	Reconstruct roadway	5	$77
12.03	U.S. 60	260	273	Construct selected passing and climbing lane segments	3	$2
12.51	SR 277	331	336	Widen to 5 lanes	3	$26
11.16	I-40	226	233	Reconstruct roadway, add some climbing lane segments, reconstruct traffic interchange	2	$25
17.02	I-10	310	325	Construct selected climbing lane segments	2	$21
17.11	U.S. 70	287	329	Repair shoulder segments, move headwalls	2	$11
19.02	I-8	17	20	Add paved shoulders	2	$2
19.52	SR 95	147	161	Add turn lane, new signage	2	$32
12.42	SR 260	317	335	Construct selected passing/climbing lane segments, add paved shoulders	1	$3
17.21	U.S. 191	87	104	Widen shoulders	1	$9
11.12	I-40	167	196	Construct climbing lane (1 mile), reconstruct 4 interchanges, widen 2 bridges, construct noise barriers	0	$84
17.71	SR 366	136	143	Reconstruct as a paved roadway	0	$15

6.3 State Performance Results

In addition to analyzing the performance impact of project bundles, ADOT assessed the overall system performance of the constrained and additional revenue scenarios. These assessments are based on a slightly more limited set of the same performance measures used to evaluate project performance. Some measures, such as project consistency with RTPs, lack natural baselines and, therefore, cannot be included in the state performance analysis. The purpose of these results is to measure how much can be done to maintain system performance at current levels, the general threshold specified in the MoveAZ Plan. Table 6.8 shows expected system performance for the 2002 base, 2025 base (without MoveAZ projects), the constrained scenario, and the additional revenue scenario.

From 2002 to 2025, Arizona will face significant challenges to its ability to maintain system performance. Rapid population growth will fuel demand for travel in the State, creating mobility, connectivity, environmental, and other concerns. Some of the greatest impacts are expected in the area of mobility. Without new investment, less than 40 percent of all motor vehicle travel will occur in free-flow conditions in 2025, compared to nearly three-quarters of all motor vehicle travel in 2002. Delay per trip will jump from just over a minute per trip to seven minutes per trip. Although this may seem insignificant, motorists will experience greater delays at peak periods in urbanized areas. Delay resulting from incidents, such as crashes, will more than triple.

On high-priority corridors in the State, increases in travel time will vary. Some corridors, such as Flagstaff to Page and Phoenix to Globe, will see only moderate increases. Others, such as Phoenix to the Hoover Dam along U.S. 93, will see travel times nearly double. The ability to pass in major two-lane corridors – the other measure of connectivity – will become roughly 50 percent more difficult in 2025 than in 2002.

Increased traffic will also substantially increase fuel consumption and vehicle emissions, and reduce the bicycle suitability of many of Arizona's roadways.

Using the performance measures designed to address the safety factor, safety will actually improve from 2002 to 2025. Although small increases in vehicles on a given roadway will increase the potential for crashes to occur, the massive volume of traffic expected in 2025 will reduced speeds enough to actually reduce the number of crashes that occur on the state system, as well as reducing the rate of injuries.

Constrained Scenario System Performance

Under the constrained scenario, system performance improves significantly across the State. This improvement is evident from every ADOT performance measure. Mobility improves substantially, with over one-half of all traffic expected to take place in free-flow conditions. Delay per trip is reduced to almost one-third of the 2025 level at 2.5 minutes per trip, and unexpected delay is reduced by more than one-half.

Table 6.8 System Performance Results for Constrained and Additional Revenue Scenarios

Measure	2002 Base	2025 Base	Constrained Scenario	Additional Revenue Scenario
Mobility factor				
% PMT at LOS A-C or D (rural or urban)	77%	38%	54%	55%
Average delay per trip (minutes:seconds)	1:17	6:58	2:29	2:28
Reliability factor				
Unexpected delay (minutes:seconds)	0:48	3:11	1:27	1:27
Safety				
Crash rate per 100 million VMT	421.0	415.7	411.2	411.4
Injury rate per 100 million VMT	157.1	155.8	153.7	153.8
Accessibility				
Average bike suitability (24-point scale)	12.9	11.6	12.0	12.2
Moderate bike suitability (12-18%)	56%	48%	40%	39%
High bike suitability (19-24%)	23%	14%	16%	17%
Resource conservation				
Emissions (tons per day)	771	1,288	1,265	1,265
Fuel consumption (1,000 gallons per day)	4,304	11,888	10,747	10,747
Connectivity				
Passing ability (LOS ratio)	0.82	1.23	1.16	1.13
Intercity connectivity (total travel time by corridor)				
Douglas – Benson (SR 80)	2:12	2:34	2:32	2:32
Phoenix – Hoover Dam	4:48	7:57	7:46	7:46
Flagstaff – Page	2:26	2:27	2:27	2:27
Phoenix – Globe	1:03	1:04	1:04	1:03
Phoenix – Lukeville	2:31	4:35	4:30	4:30
Phoenix – Mogollon Rim	3:14	4:48	4:48	4:48
Prescott – I-17 (Cordes Junction)	0:47	1:20	0:42	0:42
Yuma – Bullhead City	3:47	4:00	3:59	3:59
Tucson – Holbrook	4:33	4:45	4:45	4:45

Base (2002) to Base Future (2025) System Performance

Under the constrained scenario, both the crash and injury rates are reduced below the 2025 baseline. This slower increase – not an absolute reduction – likely results from the reconstruction of several roadways as divided highways and the addition of shoulders to other roads.

Average bike suitability of state routes improves moderately, although this improvement is concentrated at the low and high ends of the bike suitability scale. An additional two percent of roadway miles move into the highly suitable category, while the average suitability in the low category improves.

Emissions and fuel consumption are also both reduced slightly by the constrained scenario, relative to the 2025 base scenario. With thousands of new vehicle miles traveled everyday, however, it is difficult to provide substantial improvements to these measures. Furthermore, when speeds are improved substantially (e.g., above 45 miles per hour), both fuel consumption and emissions begin to increase.

Finally, both measures of connectivity improve under the constrained scenario. Passing ability shows a roughly six percent improvement, while several of the corridors show small improvements in travel time. One corridor, from Prescott to I-17 (Cordes Junction), is expected to improve to better than the 2002 travel time. This corridor, the shortest of the corridors evaluated, would be affected by major improvements to SR 69, including widening the roadway to six lanes. Roadway widening will substantially reduce congestion in the corridor.

Additional Revenue Scenario

Under the additional revenue scenario, roadway performance improves moderately over the constrained revenue scenario. The additional revenue scenario differs in an important aspect from the constrained scenario, however, in that it includes only projects outside Maricopa and Pima Counties. For Maricopa, the MAG RTP included only a constrained scenario in compliance with Federal regulations. However, if funding in the additional revenue scenario becomes available, needs exist in the MAG area to fully utilize the new funding. In Pima County, all projects identified by previous planning studies were fundable under the constrained scenario. Although the region will undoubtedly have additional needs by 2025, no specific projects have been identified at this time and consequently no additional projects are included for the Pima Association of Goverments (PAG) region in the additional revenue scenario. Future planning efforts by ADOT, MAG, and PAG will be used to identify specific projects that would be considered for this scenario.

7. Transportation Modes

Chapter 7. Transportation Modes

As a multimodal long-range transportation plan, MoveAZ addresses six modes of personal travel in Arizona: highway, rail, transit, air, bicycling, and pedestrian. It also addresses four modes of freight and commodity movement: truck, rail, air, and pipeline. This chapter presents the following basic data for the six passenger modes:

- The extent of the mode in Arizona, including location of facilities, types of systems, and other pertinent information;
- The demand for travel or utilization of the mode; and
- The role of ADOT in providing funding, operations, research, and other support for the mode.

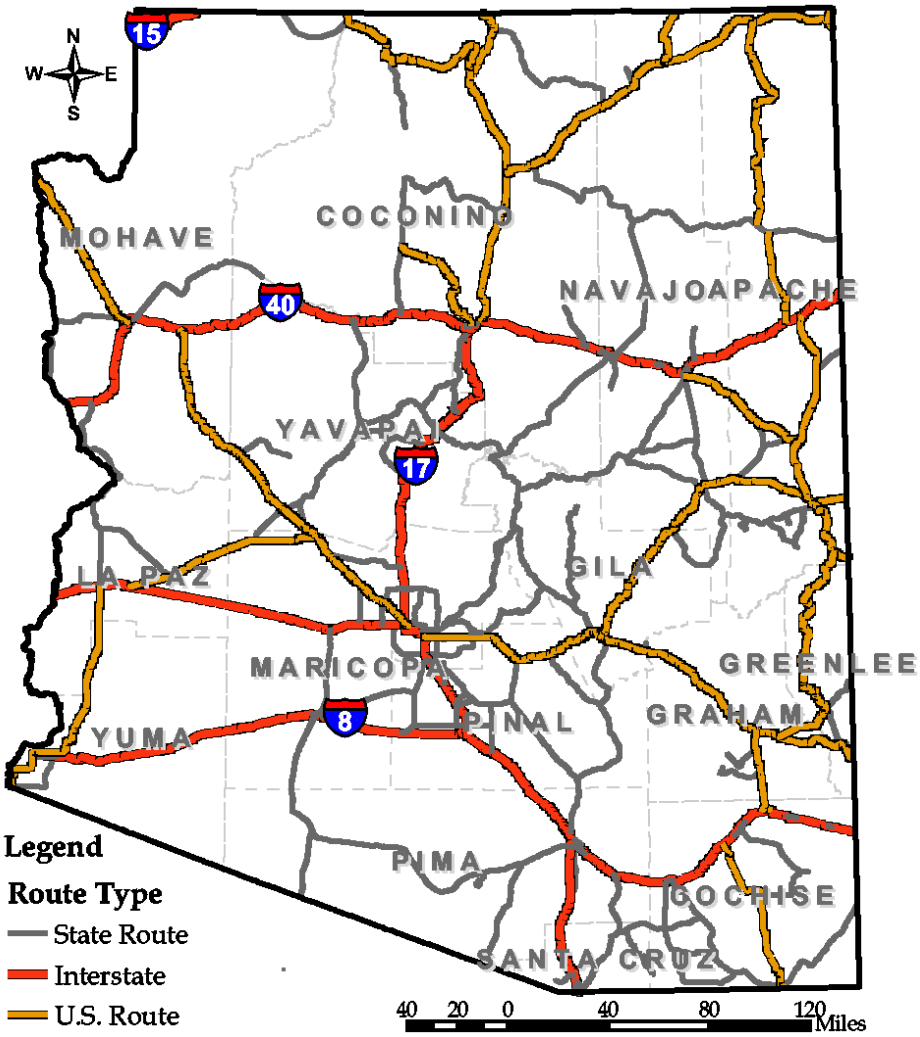
Chapter 8 provides similar information for freight modes in the context of the integrated transportation system.

7.1 Highways

Extent of the Highway System

The Arizona highway system consists of over 58,000 miles of roadway, of which two percent are interstates, three percent are U.S. routes, and nearly six percent are state routes. Although only 12 percent of the total highway network are state facilities, over 57 percent of the daily VMT occur on these roads. The Interstate System – which is part of the state highway system – carries 28 percent of all daily VMT.

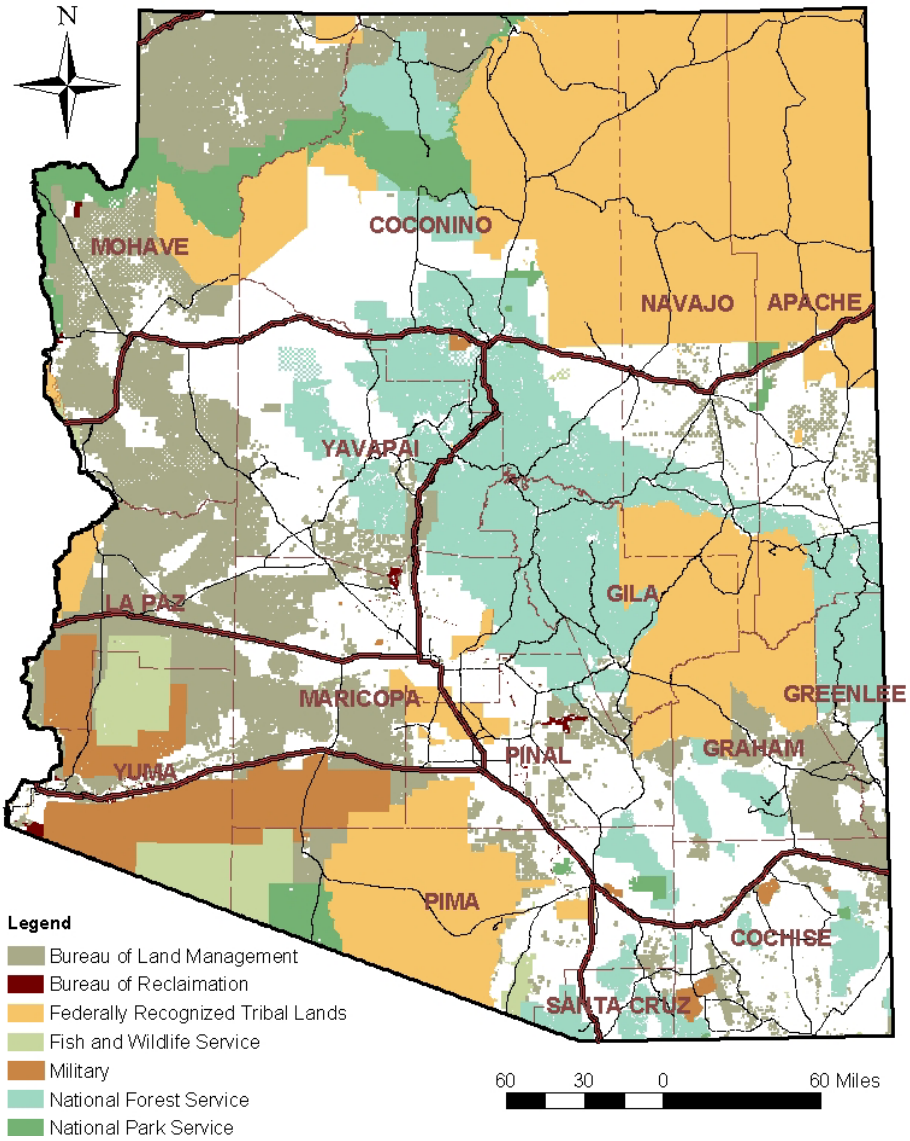
Figure 7.1 Arizona State Highway System by Route Type



Federal and Tribal Lands

Much of the Arizona State Highway System passes through lands owned by Federal agencies and Federally-recognized tribes. Federal agencies and Federally-recognized tribes own 70 percent of the land in Arizona. Federal lands agencies, including the U.S. Forest Service, the Bureau of Land Management, and others, own 42 percent of the land in Arizona, with over 2,000 miles of state highway passing through these lands. Arizona's 21 Federally-recognized tribal nations own 28 percent of Arizona land. An additional 1,200 miles of state highway pass through these lands, with over one-half of these road-miles in the Navajo Nation. The Navajo Nation is the largest tribal reservation in the State, covering nearly 16,000 square miles in Arizona and extending into Utah, New Mexico, and Colorado. Arizona's Federal and tribal lands and their relationship to the state highway network are shown in Figure 7.2.

Figure 7.2 Federal and Tribal Land Ownership



Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) refers to a set of strategies that can improve the management of roadway operations, and provide additional capacity and efficiency of state roads at reduced cost. ITS solutions and strategies often provide safety and law enforcement benefits as well. ITS is extensively used throughout Arizona, particularly in the Phoenix and Tucson metropolitan areas.

In the Phoenix-Mesa metropolitan area, ADOT operates 50 miles of freeway management system on eight corridors, including vehicle detection stations, variable message signs, closed-circuit television cameras, and a 24-hour traffic operations center. Information

collected through the ITS infrastructure is shared with the public via radio, telephone, Internet, and public kiosks operated as part of the AZTech™ public-private partnership. Several jurisdictions in the Phoenix-Mesa metropolitan area, including the Maricopa County DOT and the Cities of Phoenix, Chandler, Gilbert, Glendale, Mesa, Peoria, Scottsdale, and Tempe, have implemented ITS infrastructure, including synchronized signalization and signal preemption for emergency vehicles.

ADOT also provides incident management through its Arizona Local Emergency Response Team (ALERT). The Road Closure and Restriction System allows the reporting of conditions on arterial streets. Local, county, and state government agencies involved in traffic management and emergency response share information through operations centers and the AZTech™ partnership.

In the Tucson metropolitan area, three components of the ITS infrastructure provide service to highways: the Arterial Traffic Management System, the Freeway Management System, and the Regional Traveler Information Center. The City of Tucson's Traffic Control Center uses video detection cameras to coordinate signals and operate the Arterial Traffic and Freeway Management Systems. The Regional Traveler Information Center gathers roadway conditions information into a central clearing house for dissemination to the public.

ITS infrastructure for transit has also been implemented in both the Phoenix and Tucson metropolitan areas. Those technologies are described in the transit section of this chapter.

Demand for Roadway Travel

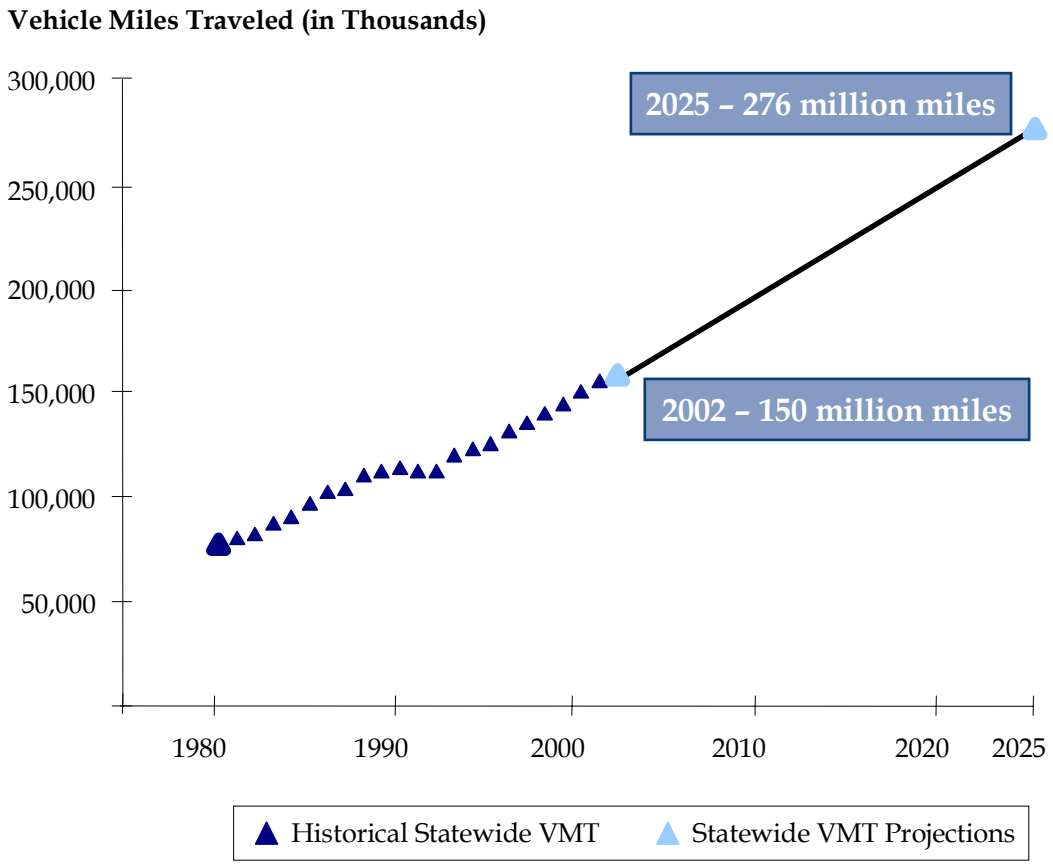
Of all the components of Arizona's transportation system, the road network (including state and local roads) is the largest and most extensively used. Most residents and visitors travel these roads by private automobile. MoveAZ included a process to estimate and forecast total highway travel in Arizona. As described in Chapter 4, the estimate and forecast were used to support the performance analysis of specific transportation projects. Two sources were used for the estimate and forecast:

1. For urbanized areas of the State (Phoenix, Tucson, Yuma, and Flagstaff metropolitan areas), regional travel demand models provided traffic estimates and forecasts; and

2. For the remaining counties or portions of counties not covered by these models, VMT was estimated and forecast using projections of population and employment in the county.

As shown in Figure 7.3, approximately 150 million vehicle miles were traveled on Arizona's state and local roads in 2002. This total is projected to grow to 276 million vehicle miles in 2025.

Figure 7.3 Historical and Projected VMT in Arizona



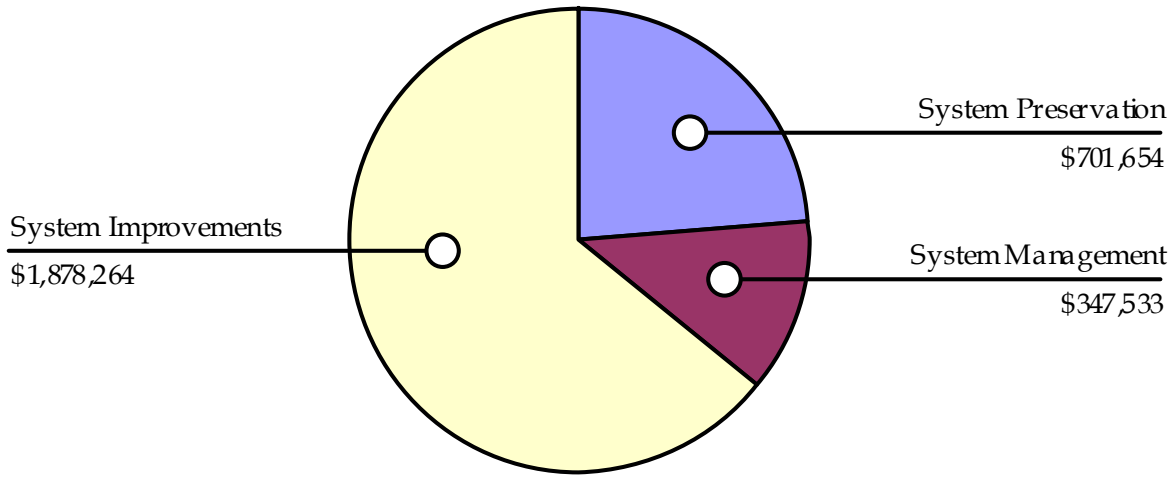
Source: Cambridge Systematics, Inc., and Lima and Associates, 2003.

ADOT's Role in Highway Transportation

The MoveAZ Plan deals extensively with the highway system. ADOT is responsible for developing and maintaining this system, and works with regional and local jurisdictions across the State to identify needs and the projects to address them.

Each year, ADOT updates the *Five-Year Transportation Facilities Construction Program* that identifies all of the projects that ADOT will build on the state transportation system over the next five years. In the 2004 to 2008 five-year program, ADOT will invest close to $3 billion in total in all facilities (Figure 7.4). Over $700 million will be invested in system preservation activities, such as pavement maintenance, bridge maintenance, and safety projects over this timeframe. Nearly 350,000 will be invested in system management activities, such as operating support and contingency funding. An additional $1.9 billion will be invested in system improvements, such as roadway widening, new interchanges, and other capital expansion projects.

Figure 7.4 ADOT Five-Year Program Investments, 2004 to 2008



7.2 Railroads

Extent of Arizona's Rail System

As shown in Figure 7.5, there are 2,654 miles of railroad track in Arizona, including mainline, spurs, and yards. Railroads operate 1,909 route-miles of track in the State, primarily for freight movement (described in Chapter 8). Two freight railroad operators, the Union Pacific (UP) and the Burlington Northern-Santa Fe (BNSF), own 70 percent of the track-miles, while small local railways or the Federal government own the rest. There are 1,639 highway-rail crossings in the State of Arizona, 940 public and 692 private.

Passenger Rail Utilization and Demand

Amtrak provides three intercity rail services: the Southwest Chief, the Sunset Limited, and the Texas Eagle. The first of these services provides daily stops in Winslow, Flagstaff, Williams, and Kingman. The latter two each provide service three days per week, with stops in Benson, Tucson, Maricopa, and Yuma. The Grand Canyon Railway and Resort operates one round trip per day between Williams and Grand Canyon National Park. Annual rail passenger boardings at passenger stations in Arizona are shown in Table 7.1. Current year (2002) and future forecasts (2025) of intercity rail utilization were generated using population and employment estimates and projections (Table 7.2).

Figure 7.5 Railway Network in Arizona

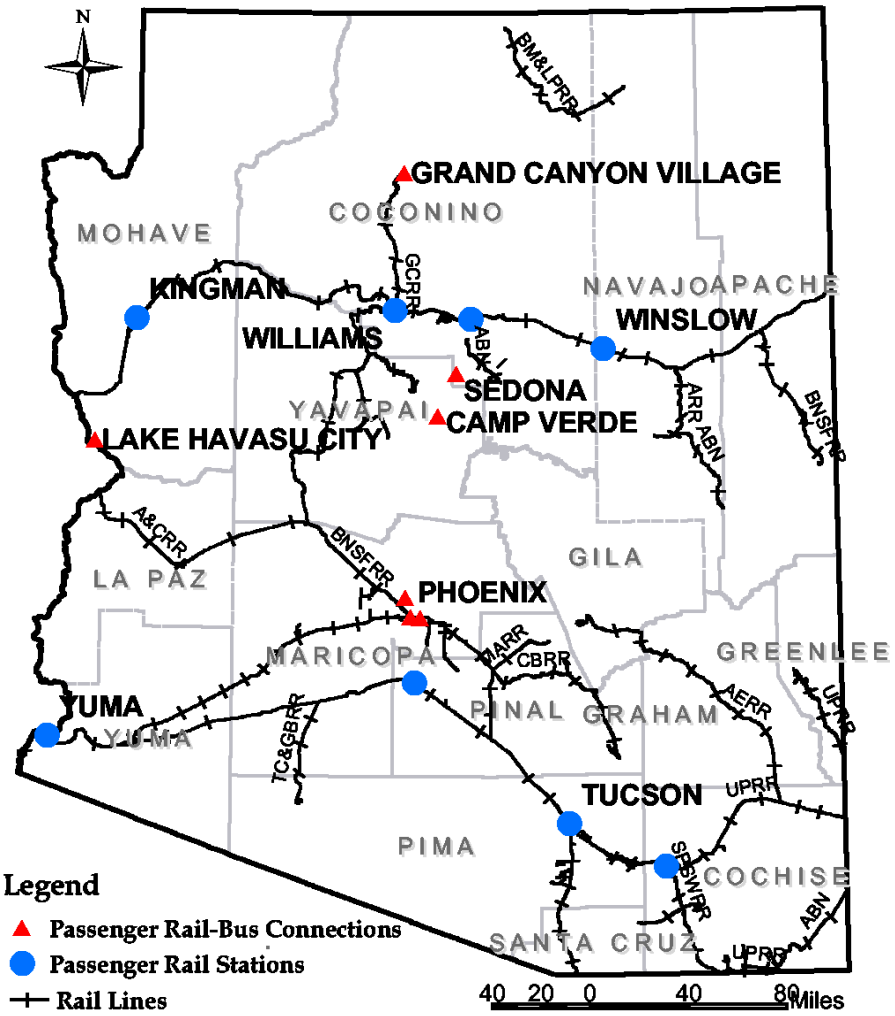


Table 7.1 Annual Passenger Rail Counts in Arizona, 2000

Railway	Station	Boardings
Sunset Limited & Texas Eagle (UP)	Benson	1,900
	Tucson	25,700
	Yuma	2,500
	Phoenix (connecting bus service)	7,950
Southwest Chief (BNSF)	Flagstaff	44,900
	Williams	5,000
	Kingman	3,100
	Winslow	2,200
	Grand Canyon (connecting bus service)	400
	Phoenix (connecting bus service)	450
Grand Canyon Railroad	Grand Canyon	19,000
Arizona Central Railway	Clarkdale	7,200
Total		**120,300**

Source: Arizona Department of Transportation, 2000.

Table 7.2 Estimated Daily Intercity Rail Boardings for 2002 and 2025

County	2002	2025
Maricopa	24	39
Mohave	9	15
Pima	73	105
Navajo	6	9
Cochise	5	8
Coconino	146	222
Yuma	7	11
Total	**270**	**409**

Source: Cambridge Systematics, Inc., 2003.

Higher-speed passenger rail service has been a subject of considerable discussion in Arizona. In 1998, ADOT completed a *High-Speed Rail Feasibility Study* for high-speed passenger rail service in the Phoenix-Tucson corridor. A system capable of operating at an average speed of 120 miles per hour was estimated to attract 3.2 million annual passengers in the year 2020, with a capital construction cost of $3.8 billion. By comparison, similar capacity could be added in the Phoenix-Tucson corridor by widening I-10 from a four- to a six-lane facility. According to ADOT's 1999 *Phoenix to Tucson Multimodal Corridor Profile Study*, this would cost between $300 million and $400 million, and would provide sufficient capacity for at least four million additional automobile trips each year.

ADOT's Role in Rail Transportation

ADOT does not build or operate rail systems in Arizona. Across the United States, very few state DOTs own or operate rail systems. Tracks are typically owned by freight rail operators; and passenger rail systems, such as Amtrak, pay to use the track. ADOT provides support to the rail system by sponsoring key studies, such as the high-speed rail feasibility study described above and studies of goods movement, of which rail is a key component. ADOT's Regional Transportation Profiles and other studies will continue to support the evaluation of rail alternatives to improve mobility, reduce congestion and emissions on the state highway system, and provide transportation options to Arizonans. ADOT evaluates the preservation of abandoned rail right of way for possible future uses, including restored rail service and bicycle or mixed-use trails. In addition, ADOT examines the need to improve and/or upgrade highway grade crossings at key locations where safety concerns exist.

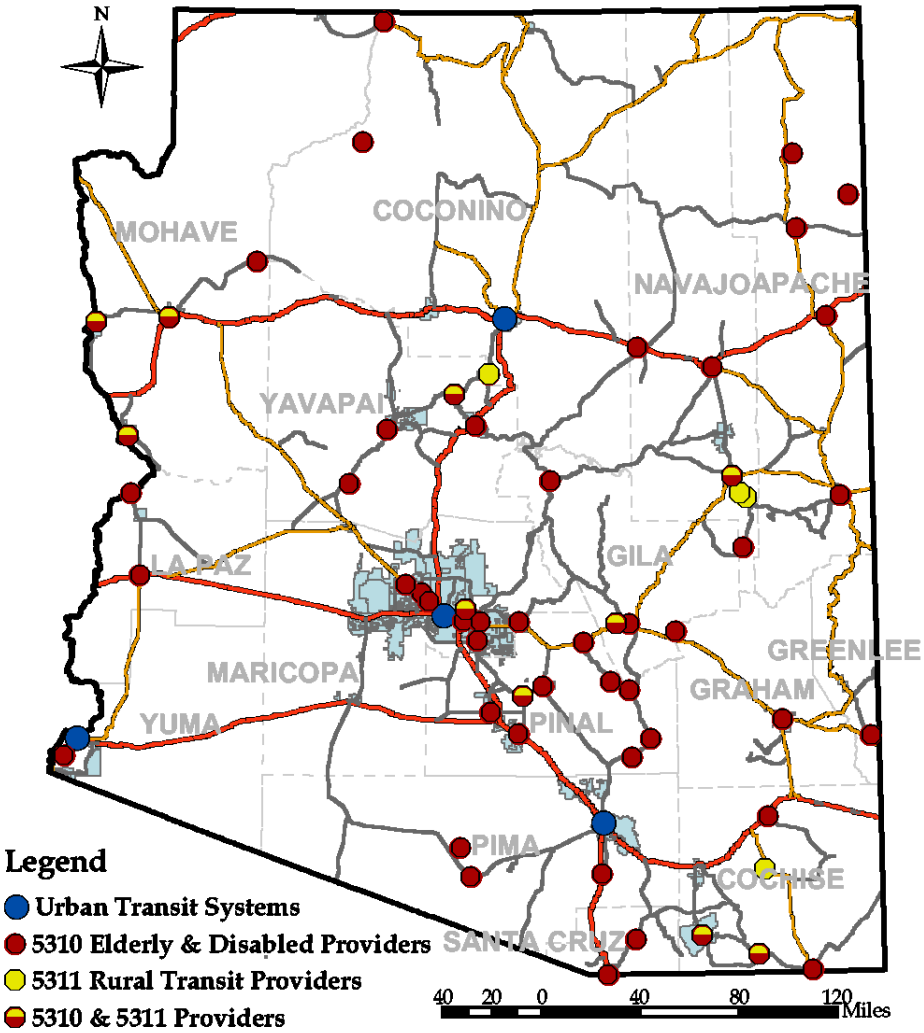
More detail on the freight rail transportation system is provided in Chapter 8.

7.3 Transit

Extent of Arizona's Transit Systems

Although the majority of passenger travel in Arizona takes place by private automobile, public transportation provides an important mobility alternative for those who cannot or choose not to drive or do not have access to an automobile. Arizona is served by a variety of local, regional, and intercity public transportation services that connect homes with jobs, schools, shopping centers, medical complexes, and other destinations (i.e., purposes not dissimilar to those traditionally provided by the private automobile trip). In addition to these general services, Arizona has numerous services for "transit-dependent" populations, such as the elderly, disabled, and economically disadvantaged. Communities that had the following three types of transit services are shown in Figure 7.6:

Figure 7.6 Transit Services in Arizona



Source: Arizona Department of Transportation, and Cambridge Systematics, Inc., 2004.

1. Urban transit systems;

2. Rural transit systems funded by the Federal 5311 program; and

3. Transit systems for special needs populations (elderly and disabled) funded by the Federal 5310 program.

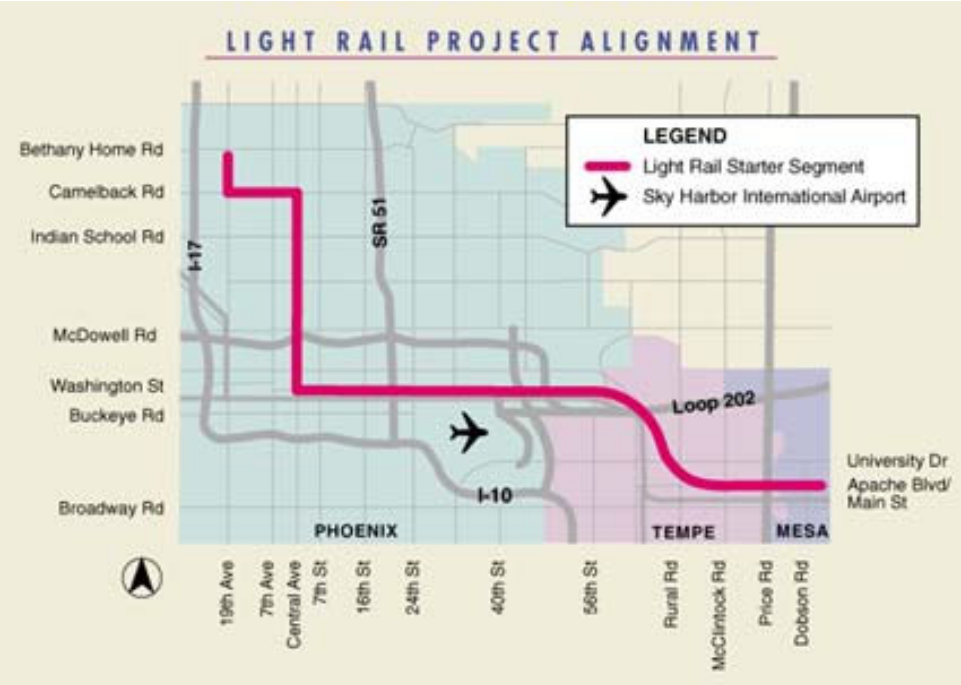
Local and Regional Urban Transit

As shown in Figure 7.6, Arizona has urban public transportation systems in four metropolitan areas with populations over 50,000: Phoenix, Tucson, Flagstaff, and Yuma. The

Prescott region, which was declared the Central Yavapai Metropolitan Area following the 2000 Census, currently does not operate an urban transportation system.

In the Phoenix metropolitan area, Maricopa County and the Cities of Phoenix, Mesa, Tempe, Scottsdale, Chandler, Peoria, Gilbert, Glendale, Avondale, and El Mirage have formed the Regional Public Transportation Authority (RPTA) to provide a unified structure for transit services operating under the Valley Metro brand. The Valley Metro system includes 60 fixed routes that operate primarily on arterial streets, 20 limited-stop express routes (including four RAPID commuter express routes), six circulator and shuttle routes, and 11 demand-response services that provide door-to-door service on request. Most Valley Metro buses are equipped with electronic fare payment systems. All buses and most demand-response vehicles in the Valley Metro system are equipped with a state-of-the-art vehicle management system that includes a computer-aided dispatch system, vehicle location system with real-time information on bus locations, upgraded radios, and internal stop and public information announcement systems. Valley Metro is designing and building the State's first light-rail transit system, shown in Figure 7.7, and scheduled to open in late 2008. ADOT will perform an important safety and security role for the light-rail system, establishing program standards and guidelines through the Federal Transit Administration (FTA).

Figure 7.7 Phoenix Approved Light-Rail System



Source: Regional Public Transportation Authority.

Several municipalities, such as Glendale, Phoenix, and Tempe, operate circulator services in their central business districts. Arizona State University operates two shuttle routes

between its campuses. The Salt River Transit System provides rural-based route deviation transit services on three routes, and demand-response service in rural areas on the fringe of the Phoenix metropolitan area.

In Tucson the City operates SunTran with 28 fixed routes and nine limited-stop express routes. The City's VanTran operation provides demand-response service to persons with disabilities. The City also operates three circulator routes in the downtown Tucson area, known as Tucson Inner City Express Transit. The University of Arizona operates five CatTran shuttle routes in the vicinity of its Tucson campus. The Town of Oro Valley provides the CoyoteRun demand-response service for the elderly, disabled, and low-income population. Pima County operates fixed-route transit service in rural areas and Tribal communities surrounding Tucson and intercity service from Ajo into Tucson. In Tucson, a Transit Management System is integrated with other regional ITS, and includes automatic vehicle locator technology, as well as electronic fare collection systems on SunTran buses.

In Flagstaff, Coconino County operates four fixed routes supported by Federal transit grants, known as Mountain Line Transit. The County also operates the VanGo demand-response service for persons with disabilities, as well as for the general public when space is available. Northern Arizona University operates Mountain Campus Transit on four fixed routes on and near its campus.

The Yuma Metropolitan Planning Organization (YMPO) currently operates two fixed routes as Yuma County Area Transit (YCAT). These routes currently provide between six and eight round trips per day on the two routes. The YMPO also operates a demand-response service for persons with disabilities. These systems are also supported by Federal transit grants.

Rural and Small Town Transit Services (Section 5311)

Fourteen communities in rural areas and in small urban areas with populations under 50,000 provide transit services that are eligible for Federal funding under the ADOT Section 5311 program. Transit services in these areas generally operate less frequently and more flexibly than their counterparts in urban areas. Cottonwood, Lake Havasu City, and the Town of Miami provide door-to-door demand-response services with advance reservation. Bisbee, Coolidge, Sierra Vista, Kingman, Salt River Indian Community, Bullhead City, and Sunsites provide services on established routes that deviate on request to pick up or drop off customers at locations within a specified service area. The Hopi and Navajo Nations both provide service between cities on and around their reservations. The Show Low Transit System Four Seasons Connection and Pima County provide fixed-route service on two connected routes, one each in Show Low, Pinetop-Lakeside, and Hon Da Casino. In addition, the National Park Service operates free shuttles between parking areas and attractions in Grand Canyon National Park.

Transportation for the Elderly and Disabled (Section 5310)

More than 100 private non-profit and public agencies that provide transportation to the elderly and disabled are eligible for Federal funding for vehicle purchases under the ADOT Section 5310 program (see Figure 7.6 above).

Intercity Passenger Bus

Greyhound Lines provides the majority of long-distance bus service in Arizona, both in terms of destinations served and service frequency. Greyhound serves 48 communities, including the Phoenix Sky Harbor International Airport and the Benson and Tucson Amtrak stations. Most of its routes operate in interstate highway corridors, with the greatest service frequency in the I-10 corridor between Phoenix and Tucson (18 one-way trips per day).

In addition to Greyhound, five regional bus operators provide scheduled service, tours, and/or charters in Arizona. K-T Services operates shared route service with Greyhound between Phoenix and Las Vegas. Some rural transit operators in the ADOT-sponsored Section 5311 program, such as Hopi Senom Transit System, Navajo Transit System, Sunsites Transportation, and Pima County, provide scheduled service to major cities. Some tour companies, such as Gray Line Tours, operate scheduled tours to major attractions from larger cities.

Transit Demand and Utilization in Arizona

Transit demand was estimated for most of the types of transit service described above. Because many demand-responsive transit systems do not record passenger boardings, it was not possible to estimate demand or utilization for these systems. The methods for estimating demand or future utilization for the remaining systems use a combination of historical data on transit ridership and existing methodologies employed in other states to develop estimates of transit demand and utilization. The detailed procedures required to estimate demand or future utilization for each type of transit are provided in Appendix F.

Urban bus ridership estimates were prepared by scaling the historical ridership data for MAG, PAG, and the Flagstaff Metropolitan Planning Organization (FMPO) regions. Because the urban bus service provided in YMPO was not operating when the MoveAZ Plan was completed, no forecast was prepared. A scaling factor was developed for 2025 from population and employment growth. In the MAG region, these forecasts were adjusted to reflect planned service expansion as described in the MAG RTP. Planned service expansion for the PAG region was already included in the existing ridership projections. The forecasts represent utilization of the existing or planned transit system. Predicted bus ridership in the four metropolitan regions is shown in Table 7.3.

Table 7.3 Estimated Annual Urban Bus Ridership, 2002 and 2025

County	2002	2025
MAG Region	43,524,000	67,101,000
PAG Region	15,925,000	27,015,000
FMPO Region	143,000	202,000
Total	**59,592,000**	**94,318,000**

Source: Cambridge Systematics, Inc., 2003.

Rural bus forecasts were based on population and employment growth, as well as on methodologies used in other similar planning efforts. Key statistics required to implement these approaches include annual revenue vehicle-miles (RVM); catchment area within the county; and population by age, mobility limitations, and income. Future transit studies conducted by ADOT and other agencies will provide an opportunity to update these demand estimates, and also improve upon the methods used to estimate transit demand in rural Arizona.

Intercity bus forecasts were estimated from existing planning methods used by the U.S. DOT's *Planning Techniques for Intercity Transportation Services Report*. This report estimates ridership of various lengths from round trip frequency, total population served along a route, and fare per mile. The forecasts do not reflect the potential for route deletions, schedule modifications, new service, or travel time changes due to highway congestion. Total estimates of rural and intercity bus ridership by county are shown in Table 7.4.

ADOT's Role in Transit

ADOT administers two Federally-funded transit grant programs:

1. The Elderly and Persons with Disabilities Program (Section 5310) that provides nearly $3 million annually to special needs transportation providers; and

2. The Rural Public Transportation Program (Section 5311) that provides up to $4 million annually aimed primarily at 14 rural transportation providers.

In recent years, these programs were administered by the Transit Section of the Transportation Planning Division. In 2004, the Transit Section became a separate Public Transportation Division within ADOT. The Transit Division will have primary responsibility for conducting transit studies and working with municipalities and transit operators to ensure quality service and identify funding for transit programs in Arizona. The Transit Division will take responsibility for the 5310 and 5311 programs.

Table 7.4 Estimated Daily Rural and Intercity Bus Ridership for 2002 and 2025

	Rural Bus		Intercity Bus	
County	**2002**	**2025**	**2002**	**2025**
Apache	183	248	<1	<1
Cochise	278	428	<1	<1
Coconino	105	186	31	38
Gila	144	220	1	1
Graham	75	122	1	1
Greenlee	13	18	<1	<1
La Paz	58	102	2	2
Maricopa	393	789	495	685
Mohave	470	922	17	24
Navajo	247	381	2	2
Pima	787	1,404	94	117
Pinal	436	786	6	8
Santa Cruz	84	145	1	1
Yavapai	480	944	9	12
Yuma	366	661	15	21
Total	**4,119**	**7,356**	**674**	**913**

Source: Cambridge Systematics, Inc., 2003.

Over the last several years, the ADOT Transportation Board has approved $1.5 million in Surface Transportation Program "Flex Funds" to address additional capital needs for Section 5310 agencies, and has approved $5 million statewide for Rural Transit Programs (Section 5311) and Urban Transit Programs (Section 5307), or approximately $1 million and $4 million, respectively.

ADOT also supports transit through a variety of transportation planning efforts. All multimodal corridor profile studies and numerous small area transportation studies conducted by the Transportation Planning Division include an examination of transit needs in the region studied. MoveAZ included a detailed analysis of the extent of transit services and demand for transit, as shown in this chapter. In addition, the Transportation Board has adopted the MAG RTP as the official state plan for the MAG region. The RTP offers MAG a high degree of flexibility in funding its regional transit system.

In addition to identifying transit needs and alternatives in the multimodal corridor profiles, ADOT has also committed to examining public transportation needs in rural Arizona. ADOT intends to conduct rural transit needs analyses in each Council of Government area in the State. ADOT will also work with the Arizona Transit Association to ensure that transit representatives have the opportunity to participate on the Technical

Advisory Committees of studies conducted by the Transportation Planning Division, including multimodal corridor profiles, small area transportation studies, and modal studies, such as the transit studies described above and the State bicycle/pedestrian plan.

As described in Chapter 3, numerous participants at the public meetings identified transit funding as a major concern in the State. Current state law requires the Highway User Revenue Fund (funded from gas taxes and vehicle license fees) to be spent on highways. One clear suggestion raised by the Arizona Transit Association was to reestablish the Local Transportation Assistance Fund II (LTAF II). The original LTAF provided local funding assistance from lottery games and the state vehicle license fee. LTAF II was funded from the state general fund and was required, for most communities, to fund transit. Due to pressure on the general fund from the recent economic recession, funding through LTAF II has been limited since 2002. In 2000, $30 million was provided to support transit in local areas through LTAF II. Reestablishing this funding mechanism for rural transit would help improve mobility in rural areas, especially for disadvantaged and mobility-challenged populations.

7.4 Aviation

Extent

As shown in Figure 7.8, there are 83 public-use airports in Arizona, 11 of which are certified to handle scheduled commercial air service. The remaining 72 airports provide general aviation and emergency response services. Another 236 airports across the State are private-use and accommodate airplanes, gliders, helicopters, and other forms of aviation.

There were over four million take-offs and landings at Arizona airports in 2002, nearly 3.5 million of which were general aviation operations. Sky Harbor in Phoenix is the State's busiest commercial airport, with over 480,000 commercial take-offs and landings in 2002. Other airports with substantial commercial operations include Tucson International, Yuma International, and the Grand Canyon National Park airports. Sky Harbor and Tucson airports are qualified to handle cargo planes in addition to passenger planes.

Aviation Demand in Arizona

Almost 21 million passenger enplanements were reported across 39 of Arizona's public-use airports in 2000, most at the Phoenix Sky Harbor and Tucson International Airports. Sky Harbor was the fifth busiest airport in the nation in 2001 in terms of operations, with over 550,000 take-offs and landings. Tucson was ranked 45th. As shown in Table 7.5, Grand Canyon National Park Airport and Laughlin/Bullhead International were the third and fourth busiest airports in the State in terms of passenger enplanements.

Figure 7.8 Aviation Network in Arizona

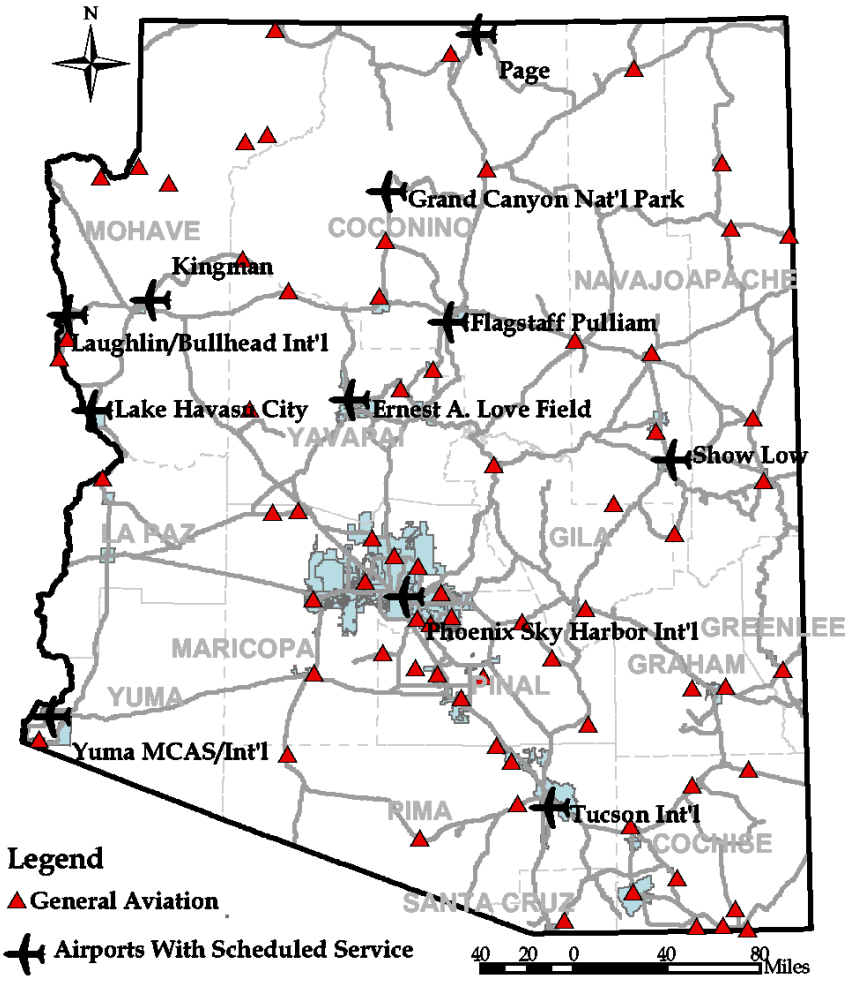


Table 7.5 Airport Enplanements in Arizona, 2000

Airport	City	Enplanements
Phoenix Sky Harbor International	Phoenix	17,568,900
Tucson International	Tucson	1,816,400
Grand Canyon National Park	Grand Canyon	411,400
Laughlin/Bullhead International	Bullhead City	75,000
Yuma International	Yuma	50,300
Flagstaff Pulliam	Flagstaff	33,400
Lake Havasu City	Lake Havasu City	8,600
Sierra Vista	Sierra Vista	6,100
Earnest A. Love Field	Prescott	4,700
Show Low Municipal	Show Low	2,900
Page Municipal	Page	2,100
Kingman	Kingman	1,700
Total		**19,981,500**

Source: Arizona Department of Transportation, 2002.

Between 1999 and 2000, passenger enplanements in Arizona rose overall. Though many major airports saw only modest increases over that period (enplanements at Denver International Airport increased by less than two percent, for example), Sky Harbor saw nearly an eight percent rise.

Commercial and general aviation enplanements were estimated and forecasted using a combination of the *2000 Arizona State Aviation Needs Study* and Federal Aviation Administration adjustments for the September 11th, 2001 terrorist attacks. Table 7.6 presents 2002 estimates and 2025 forecasts of daily commercial and general aviation air passenger enplanement forecasts by county.

ADOT's Role in Aviation

ADOT owns a single airport, the Grand Canyon Airport. ADOT also has a separate division – Aeronautics – which is responsible for planning activities related to aviation. ADOT maintains an Aviation Fund that includes revenues from excise taxes on airplane fuel, aircraft license and registration fees, and other fees collected by the Aeronautics Division. This fund is dedicated to a variety of aviation projects across the State. The Aeronautics Division develops the State Aviation Plan, a parallel but independent process to MoveAZ. The State Aviation Plan identifies long-range aviation needs and planning in the State.

Table 7.6 Estimated Daily Commercial Enplanements and General Aviation Operations by County

	Commercial Enplanements		General Aviation Operations	
County	**2002**	**2025**	**2002**	**2025**
Apache			74	96
Cochise	23	51	310	366
Coconino	876	1,916	742	999
Gila			239	262
Graham	0	12	42	54
Greenlee			21	21
La Paz			39	49
Maricopa	41,717	91,191	5,212	8,089
Mohave	126	275	403	595
Navajo	5	22	220	267
Pima	4,660	10,186	1,217	1,581
Pinal			322	402
Santa Cruz			64	118
Yavapai	20	44	1,179	1,739
Yuma	165	361	109	145
Total	**47,592**	**104,058**	**10,193**	**14,783**

Source: Arizona Statewide Aviation Needs Study, 2000 and Cambridge Systematics, Inc., 2003.

7.5 Bicycle and Pedestrian

Extent

As shown in Figure 7.9 and Table 7.7, over 3,000 miles of the Arizona state highway network – including interstates, U.S. routes, and state routes – are considered suitable for bicycle traffic. Bike suitability is a function of traffic congestion, roadway speed limit, shoulder width, and truck volumes. Using standards identified in the Arizona Bicycle/ Pedestrian Plan recently completed by ADOT, nearly 60 percent of the state systems is of medium or high suitability. Individual metropolitan areas, such as Tucson, Phoenix, and Flagstaff, have their own bicycle networks as well. These networks include off-street

paths and trails, on-street bikeways delineated by painted white lines, signed on-street bike routes, and paved shoulders that can accommodate bicycles.

Figure 7.9 Bicycle Network in Arizona

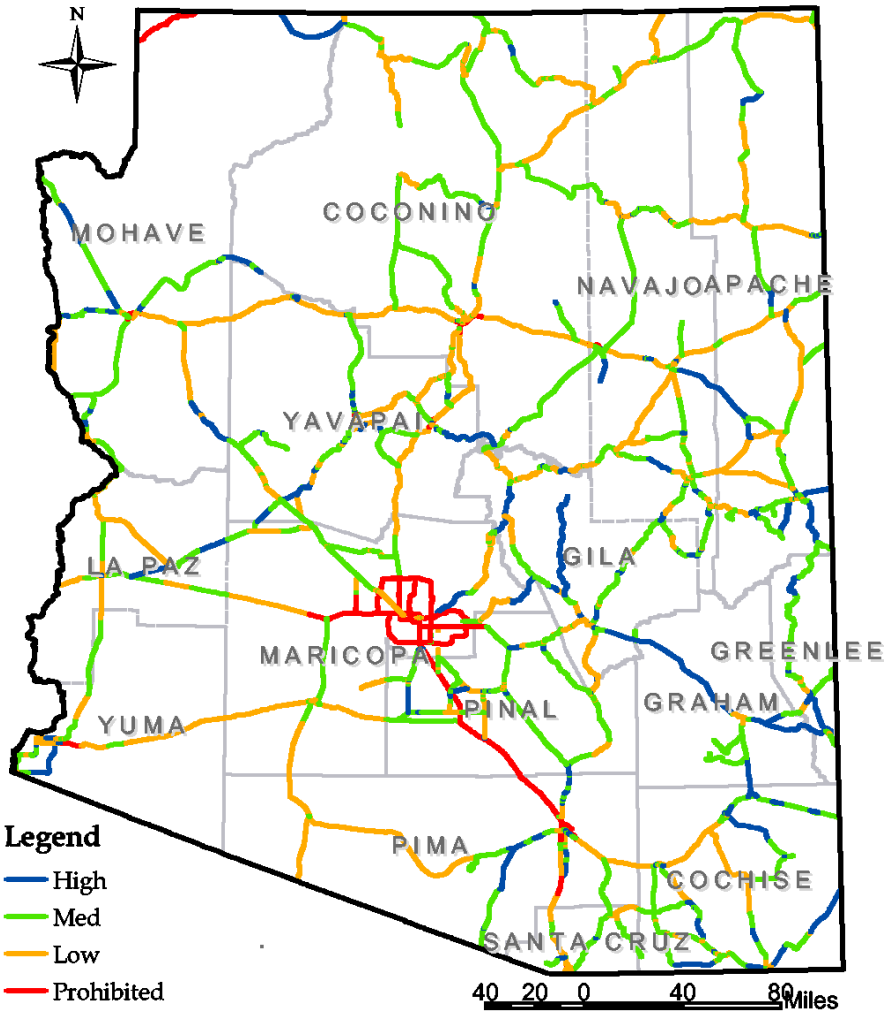


Table 7.7 Bicycle Suitability on the State Highway Network

Category	Percent Suitable
High	15%
Med	43%
Low	34%
Unsuitable	7%

Nearly every trip made in the State has a pedestrian component. Though these are often short trips from parking spaces to final destination, providing for safe pedestrian traffic is clearly an important function of the transportation system. Except for some undivided highways, the state highway system is generally not intended for pedestrian traffic. Some of the highest pedestrian flows on state-owned facilities are at the ports of entry between Arizona and Mexico. As shown in Table 7.8, a total of 8.4 million people crossed the border on foot in 1999, with the heaviest volumes at Nogales and San Luis.

Table 7.8 Arizona-Sonora Pedestrian Border Crossings, 2000

Port of Entry	Pedestrians Entering Arizona
Douglas	705,000
Lukeville	78,600
Naco	64,700
Nogales	4,806,100
Sasabe	3,600
San Luis	2,721,600
Total	**8,379,600**

Source: Bureau of Transportation Statistics.

Regional and local governments across the State have examined pedestrian issues as part of their planning efforts. At the regional level, MAG has developed a pedestrian plan for the Phoenix region that identifies locations for pedestrian-friendly roadway design, based on the level of expected pedestrian activity in that area, the desired pedestrian level of service, and operational and design characteristics of roadways. The Tucson metropolitan area has shared-use paths, as well as sidewalks along most streets. Existing Tucson standards require four-foot wide sidewalks in residential developments and up to eight-foot wide sidewalks for commercial and industrial developments.

Bicycle and Pedestrian Demand

Pedestrian and bicycle trips were estimated using data from the National Personal Transportation Survey, the Census Journey to Work, the FHWA, and the Bureau of Transportation Statistics. These estimates are for trips where the pedestrian portion or bicycle portion was the primary mode of travel for the trip. However, most trips include a pedestrian component, even when the primary mode of travel is the automobile. Table 7.9 presents estimates and forecasts of daily bicycle and pedestrian utilization by county for 2002 and 2025.

Table 7.9 Estimated Daily Bicycle and Pedestrian Trips, 2002 and 2025

County	Bicycle Trips		Pedestrian Trips	
	2002	2025	2002	2025
Apache	377	634	26,431	44,477
Cochise	3,991	6,401	35,580	57,063
Coconino	11,534	19,876	82,392	141,988
Gila	771	1,133	9,906	14,570
Graham	395	559	6,399	9,054
Greenlee	26	32	1,370	1,690
La Paz	729	1,227	7,626	12,836
Maricopa	200,779	331,412	498,001	822,014
Mohave	3,618	6,610	26,669	48,716
Navajo	288	479	9,161	15,209
Pima	72,656	106,416	164,007	240,215
Pinal	3,664	6,733	26,673	49,010
Santa Cruz	305	469	8,209	12,651
Yavapai	4,497	8,172	39,717	72,181
Yuma	6,715	10,947	34,261	55,859
Total	**310,345**	**501,100**	**976,402**	**1,597,533**

Note: Trips represent all purposes, but reflect primarily recreational trip making.
Source: Cambridge Systematics, Inc., 2003.

ADOT's Role in Bicycle and Pedestrian Travel

Though ADOT does not provide specific facilities for cyclists or pedestrians on state highways, many of the improvements that ADOT makes can benefit these road users as well. For example, wider shoulders on state routes in small towns and rural areas provide a location for bicyclists to commute and recreate safely. Where state routes pass through towns and function as both a through highway and a local road, design standards require ADOT to develop facilities, such as sidewalks, that benefit pedestrians.

ADOT also supports bicycle and pedestrian travel through planning studies. The Transportation Planning Division of ADOT recently completed a state bicycle and pedestrian plan. One result of this plan was a measure of bicycle suitability that was adopted by MoveAZ as the bicycle suitability performance measure. ADOT can also participate in

the design and construction of transit passenger facilities, including pull outs and shelters on state routes that benefit both pedestrians and bicyclists.

7.6 Summary

This chapter presented an overview of transportation modes in Arizona. Each of these modes is an important component of the overall transportation system in Arizona, and ADOT has significant and varied roles to play in the development and operation of each mode. Chapter 8 provides additional information on the transport of freight on these modes.

Several appendices provide additional detail regarding transportation modes in Arizona. Appendix A, the *Phase I Summary Report*, provides general background information on the extent of each mode of travel. This information was developed in 2002, and was updated for this Chapter. Appendix F, the *Demand and System Performance Analysis Technical Memorandum*, provides information on the demand for travel and the utilization of each of the modes. Appendix J, the *Goods Movement in Arizona Technical Memorandum*, provides additional detail regarding the freight system.

8. Goods Movement

Chapter 8. Goods Movement

This chapter presents information on four modes of goods movement in Arizona: truck, rail, air, and pipeline. The chapter provides an overview of the goods movement system and identifies the key links between goods movement and the Arizona economy. Appendix J, the *Goods Movement in Arizona Technical Memorandum*, provides additional detail regarding freight transportation.

8.1 Goods Movement System

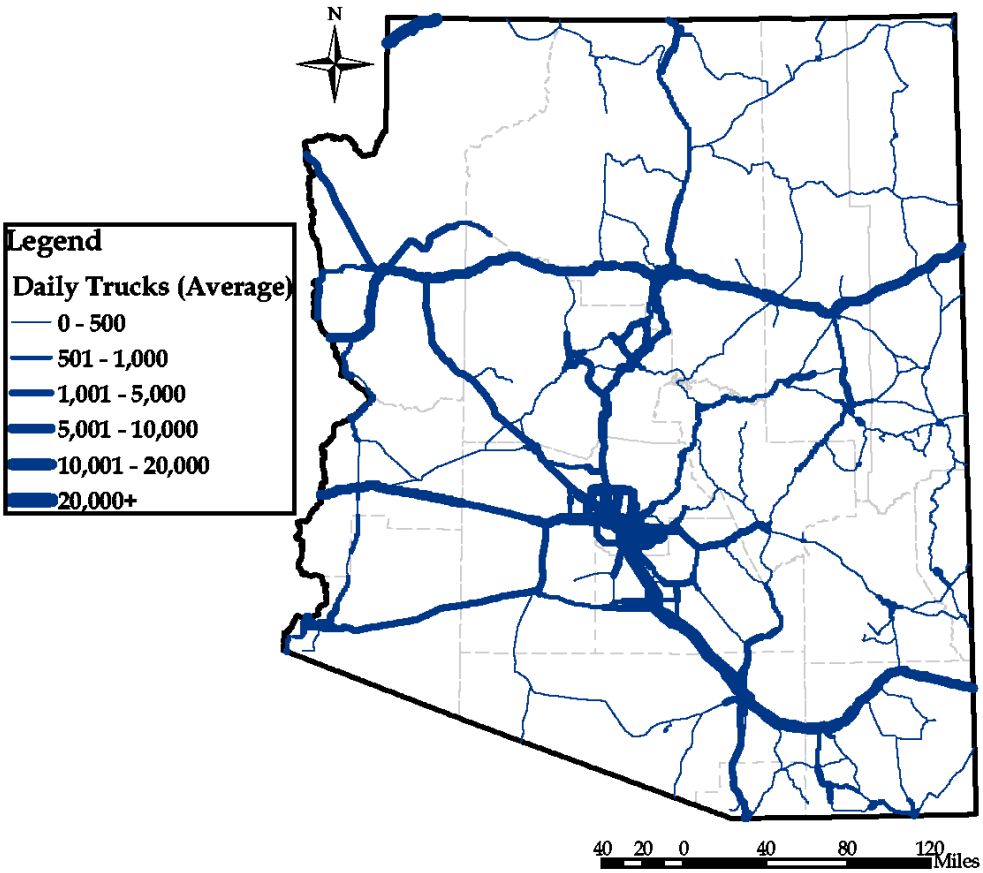
The freight transportation system in Arizona includes commodity movements by truck, rail, air, and pipeline. Major individual components on the freight system include interstates and major U.S. and state routes, the BNSF and UP railroads, and Phoenix and Tucson International Airports. This section describes each of the components of the goods movement system, including highways, rail, airports, pipeline, and intermodal facilities to transfer goods between modes.

Highways

The freight highway system includes interstates, U.S. routes, and selected state routes. Local truck routes are also an important part of the freight system, providing access to collection and distribution points. Freight-hauling trucks account for about 12 percent of total VMT in Arizona. The highest truck volumes are found on the interstate system, particularly along a 100-mile stretch of I-10 between Phoenix and Tucson. Figure 8.1 shows daily truck volumes on Arizona's state highway system. As Arizona's economy changes, truck volumes on the state highway system are expected to grow from nearly 15 million miles per day to over 33 million miles per day (Table 8.1). Trucks traffic is expected to grow faster than automobile traffic over this period, increasing from 19 to 23 percent of total traffic on the state highway system.

Arizona has identified several key freight traffic routes, including the CANAMEX Corridor, a major corridor initiative to link Canada to Mexico through Arizona, Nevada, Utah, Idaho, and Montana. In Arizona, the CANAMEX Corridor route operates on I-19, I-10, and U.S. 93, with a bypass of the Phoenix metro area along I-8 and SR 85. Two segments of this corridor – I-10 from Tucson to Phoenix and U.S. 93 – have been designated by the Arizona Transportation Board as high-priority corridors for the State. Another major freight corridor in Arizona is the I-10 Coast-to-Coast Corridor from California to Florida.

Figure 8.1 Average Daily Truck Traffic on Arizona Highways in 2002



Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 8.1 Estimated Daily Truck VMT, 2002 and 2025

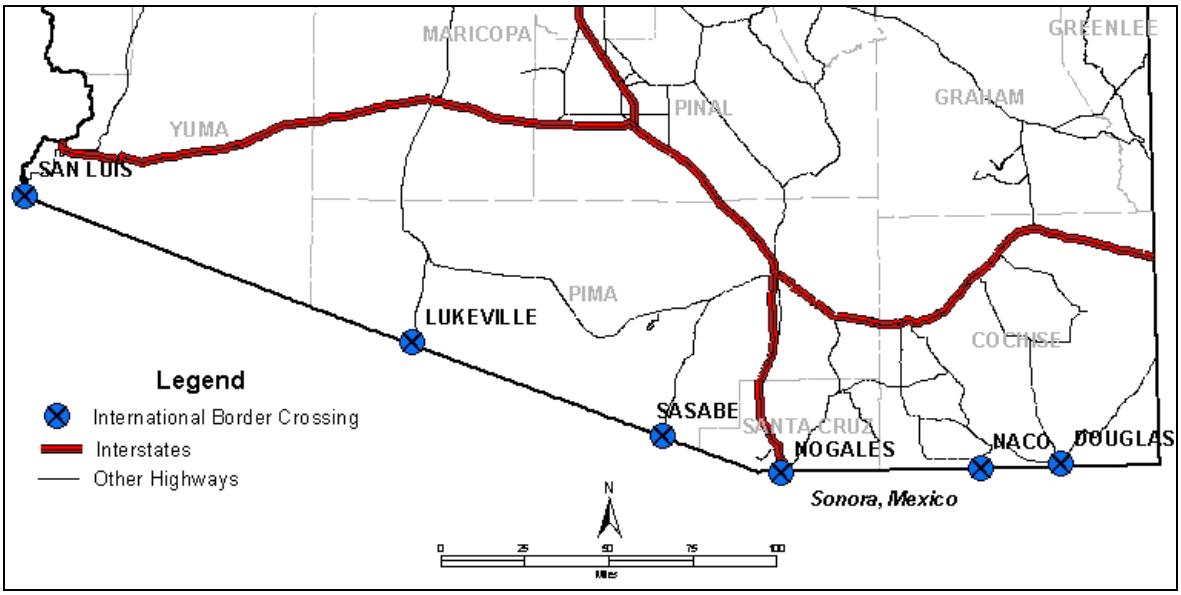
	2002	2025
Total VMT (State System)	77,879,600	142,551,400
Truck VMT (State System)	14,518,800	33,376,900
Truck Percentage of Total VMT	**19%**	**23%**

Source: Cambridge Systematics, Inc., 2003

Six ports of entry provide truck access between Arizona and Mexico: Douglas, Naco, Nogales, Sasabe, Lukeville, and San Luis (Figure 8.2). The Port of Nogales enjoys the most convenient highway access, with I-19 and SR 82 on the Arizona side and Mexican Federal

Highway 15 on the Sonora side. San Luis is served by U.S. 95 in Arizona and Mexican Federal Highway 2 in Sonora. Douglas is served by U.S. 191, SR 80, and Mexican Federal Highway 2. The remaining border crossings are served by undivided state highways, except for Naco, which is served only by local roads.

Figure 8.2 Arizona International Ports of Entry



Rail

As described in Chapter 7, Arizona's freight rail network consists of approximately 2,700 miles of track, including mainline, spurs, and yards. Freight and intercity passenger rail service share the same track in Arizona, but most of the tracks are owned and maintained by the UP and BNSF railroads.

Important segments of Arizona's rail network serve international freight traffic between Arizona and Mexico. UP's Nogales Branch, which runs between Tucson and Nogales parallel to I-19, connects with Grupo Ferroviaria Mexicana (GFM) at the Arizona-Mexico border. GFM operates a north-south line linking Nogales with Hermosillo, and ultimately Mexico City. Shipments through Nogales include double-stack containers of automobile parts bound for the Ford/Mazda assembly plant in Hermosillo, and assembled automobiles from Hermosillo bound for the U.S.

Aviation

Of the 83 public-use airports in Arizona, Phoenix Sky Harbor and Tucson International Airports are the primary facilities used to transport air cargo. Sky Harbor International is the largest airport in the Phoenix/Mesa metropolitan area that maintains active schedules for inbound and outbound air freight. Sky Harbor provides nearly 200,000 square feet of space and over 100 air cargo bays for air cargo services.

Air cargo operations at Williams Gateway Airport include specialized services and unscheduled charter flights. To meet the growing demands of the east valley of metropolitan Phoenix and to relieve pressure at Sky Harbor, cargo service improvements are planned at Williams Gateway Airport. These include dedicated air cargo facilities, a cargo ramp, additional warehousing facilities, and a runway extension to accommodate air cargo aircraft. Table 8.2 shows the freight cargo volumes at Arizona airports for 2000.

Table 8.2 Cargo and Passenger Volumes at Arizona Airports, 2000

Airport	City	Cargo Gross Landed Weight (Tons)
Phoenix Sky Harbor International	Phoenix	920,400
Tucson International	Tucson	142,400
Total		**1,062,800**

Source: Federal Aviation Administration, 2000.

Pipeline

Pipelines provide an important conduit for energy resources in the State. Though pipelines provide transportation exclusively for selected commodities, they have an impact on other modes by reducing long-distance truck or rail trips for natural gas, petroleum, gasoline, and other petroleum-based products.

Arizona imports all of the petroleum products and natural gas used in the State. In 2002, nearly 126,000 barrels of refined petroleum products were imported from California refineries each day. Roughly one-half of this is gasoline, with the other one-half splits between jet fuel and diesel fuel. An additional 87,000 barrels of refined petroleum products were imported from El Paso and Gulf Coast refineries, of which over 85 percent were gasoline. The transportation sector uses almost 88 percent of petroleum products, compared to 66 percent nationally. Arizona uses almost no petroleum-based heating fuels.

Natural gas in Arizona is provided by 11 separate companies serving 900,000 customers. Three pipelines transmit natural gas around and through the State. Two pipelines

provide service in the north of the State, with service to Window Rock, Flagstaff, Kingman, and into California. A third pipeline provides service in the south through Willcox, Tucson, Casa Grande, Ehrenberg, and into California, with extensions to Nogales, Safford, Globe, Phoenix, and Yuma. All natural gas flows originate outside of the State and enter Arizona from New Mexico. Through service is also provided to California, Nevada, and Mexico on Arizona's natural gas pipelines. Arizona currently lacks major natural gas storage facilities, though several are being explored by private interest. Storage helps balance loads, avoiding shortages and price spikes in times of high demand.

In recent years, pipeline capacity has become an issue both for petroleum-based products and natural gas. In the summer of 2003, a pipeline rupture in the Phoenix region created supply issues and caused a rapid escalation of gasoline prices. Similarly, a lack of pipeline capacity through Arizona and other Western states contributed to California's natural gas shortage and power crisis of 2000 to 2001.

Intermodal Facilities

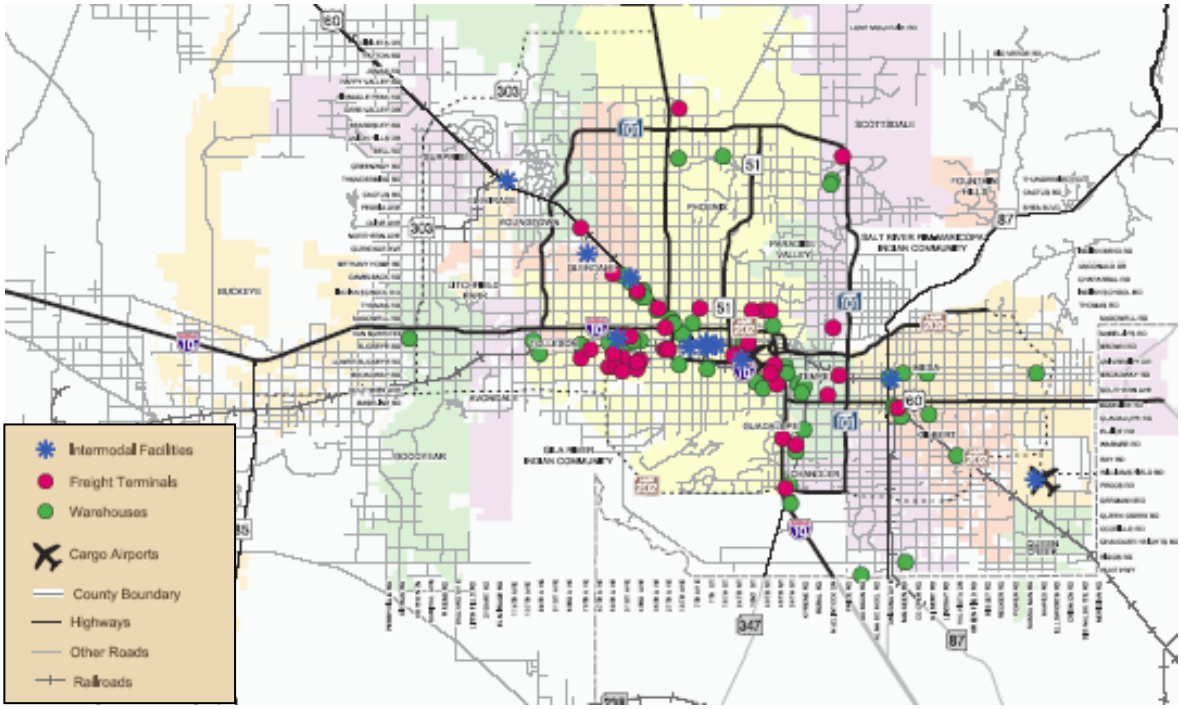
Intermodal facilities, such as airports, seaports, and train stations, provide transfer points and coordinate movements between various modes. There are 10 major freight highway-rail intermodal facilities in Arizona. Three are container cargo facilities, three are auto vehicle transfer points, three accommodate transfer of chemicals and chemical products, and one transfers liquid edibles. Seven of the facilities are located in the Phoenix metropolitan area, one is located in Parker, and two are located in Tucson.

MAG has worked extensively to document the freight infrastructure in the Phoenix metropolitan area, including intermodal facilities, freight terminals, and warehouses. Figure 8.3 shows that the majority of the freight-related facilities are located along the I-10 corridor, with another concentration of facilities along State Highway 60 northwest and east of downtown.

8.2 Goods Movement and the Domestic Economy

Goods movement is a critical part of the Arizona and national economy, both in terms of output and employment. Based on the most recent (1997) U.S. Economic Census, the percentage of output in the goods-related sectors of the economy was nearly three-fourths of the output of the entire economy in Arizona (Table 8.3). The largest goods-related sectors are wholesale trade, retail trade, and manufacturing. These three sectors combined to account for over 60 percent of sales in 1997. Overall, the goods-related sector accounts for two-thirds of sales and 42 percent of total employment in the State.

Figure 8.3 Phoenix Region Freight Infrastructure



Source: Adapted from Maricopa Association of Governments Regional Transportation Plan, 2003.

Table 8.3 Economic Output and Employment by Sector for Arizona in 1997

Sector	Arizona Sales ($1,000)	Percent of Total		Arizona Employees	Percent of Total	
		AZ	U.S.		AZ	U.S.
Wholesale trade	45,899,000	21%	23%	80,000	5%	6%
Retail trade	43,961,000	20%	14%	232,000	14%	14%
Manufacturing	43,030,000	20%	22%	194,000	12%	17%
Construction	19,115,000	9%	5%	132,000	8%	6%
Transportation, warehousing	4,086,000	2%	2%	45,000	3%	3%
Mining	3,069,000	1%	1%	13,000	1%	1%
All goods-related sectors	159,161,000	74%	66%	696,000	42%	45%
All services	56,121,000	26%	34%	945,000	58%	55%
All sectors	**215,282,000**	**100%**	**100%**	**1,641,000**	**100%**	**100%**

Source: U.S. Bureau of the Census, U.S. Economic Census, 1997

Goods Produced in Arizona

The FHWA created the Freight Analysis Framework (FAF) database to provide goods movement data by commodity and origin-destination pair at the state level. The top commodities, in terms of tonnage moved in Arizona, are shown in Table 8.4. The top four commodities represent 72 percent of the total tonnage produced in the State.

Table 8.4 High-Tonnage Commodities Produced in Arizona, 1998

Commodity	Internal	Outbound	Total (Produced in AZ)	Percent of Total
Clay, concrete, glass products	21,901,000	1,418,000	**23,319,000**	**19%**
Petroleum or coal products	21,114,000	2,055,000	**23,169,000**	**19%**
Nonmetallic minerals	22,976,000	69,000	**23,045,000**	**19%**
Secondary flows	15,486,000	2,280,000	**17,765,000**	**15%**
Food products	2,776,000	3,924,000	**6,700,000**	**6%**
Farm products	3,823,000	2,610,000	**6,433,000**	**5%**
Other commodities	7,780,000	13,278,000	**21,058,000**	**17%**
All commodities	**95,856,000**	**25,634,000**	**121,490,000**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Another way to examine the importance of particular commodities to Arizona is to examine the value of goods shipped. Though high-tonnage commodities have a disproportionate impact on the state transportation system, high-value commodities tend to add the most to the State's economy. The most recent data on the value of goods shipped comes from the 1997 Bureau of Transportation Statistics' Commodity Flow Survey (CFS). Table 8.5 shows the value of major commodities originating in Arizona, including shipments with destinations in Arizona. The electronics industry ships over 30 percent of the total value of goods shipped in Arizona. The five next largest commodities constitute 26 percent of the total value of goods shipped.

Table 8.5 Value of Arizona Shipments by Commodity, 1997

Commodity	Value ($ mil)	Value %
Electronics, electrical equipment, office equipment	27,600	32%
Base metal in primary or semi-finished forms	4,700	6%
Miscellaneous manufactured products	4,400	5%
Motorized and other vehicles (including parts)	4,300	5%
Transportation equipment, not elsewhere classified	4,100	5%
Other prepared foodstuffs and fats and oils	4,000	5%
Machinery	3,800	4%
Other commodities	33,300	39%
All commodities	**86,300**	**100%**

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

Direction and Mode of Goods Movement

Arizona is a net importer of goods. Table 8.6 shows that the tons shipped into the State are nearly twice that of the tons shipped out of State. This indicates that Arizona's domestic goods movement is focused on end consumption by the growing population. Over one-half of Arizona's total tonnage is shipped internally within the State. Looking to 2020, the overall tonnage shipped into, out of, and within Arizona is forecast to increase by 87 percent. Outbound commodity flows show the largest increase of all trip types, but Arizona will remain a net importer of goods (more inbound flows than outbound). Internal trips will continue to dominate the directional flow of goods.

Table 8.6 Forecast of Tons Shipped by Trip Type, 1998 and 2020

Trip Type	Thousand Tons (1998)	Thousand Tons (2020)	Percent Growth (1998-2020)
Internal	95,800	213,200	122%
Outbound	25,600	59,800	133%
Inbound	47,900	84,000	75%
Total	**169,500**	**357,000**	**111%**

Source: Federal Highway Administration Freight Analysis Framework, 1998.

The majority of goods in Arizona currently move by truck, and that trend is expected to be sustained into the future. Of commodities that originate or terminate in Arizona, approximately 143 million tons were shipped by truck (Table 8.7) – a considerable strain on the highway network. This total is expected to grow by 120 percent from 1998 to 2020, with over 300 million tons shipped by truck in 2020. Air freight is expected to be the fastest growing mode for goods movement in Arizona between 1998 and 20202. In 2020, however, air freight will still transport less than one percent (by tonnage) of all goods moved.

Table 8.7 Total Tons Moved by Mode, 1998 and 2020

Transportation Mode	Thousand Tons (1998)	Thousand Tons (2020)	Percent Growth (1998-2020)
Highway	143,200	314,700	120%
Rail	25,800	41,000	59%
Air	400	1,360	240%
Total	**169,500**	**357,000**	**111%**

Source: Federal Highway Administration Freight Analysis Framework, 1998.

8.3 Goods Movement and the International Economy

In 2002, Arizona exported $11.9 billion worth of goods (Table 8.8). This is a significant quantity, relative to the $86 billion of domestic goods originating in Arizona in 1997. Arizona's largest export commodity is electrical machinery, accounting for over one-third of the total exports. Mexico is the largest single export country for Arizona, with $3 billion of goods received. However, the shipments to all Asian countries exceeded the value of shipments to Mexico, with $3.9 billon of goods received from Arizona. Access to port facilities in Southern California is crucial to the Asian export market and, thus, to Arizona's economy.

Trade between the United States and Mexico is an integral part of both countries' economies, particularly since the signing of NAFTA in 1993. Over 348,000 trucks crossed the U.S.-Mexican border into Arizona in 1999, carrying 242,000 loaded containers of freight. Nearly three-quarters of these trucks passed through Nogales (Table 8.9). This volume of trucks marks a 50 percent increase over the Sonora-Arizona traffic reported in 1991 to 1992.

Table 8.8 Destinations for Arizona's Exports in 2002

Region	Exports (Millions of Dollars)	Percent of Total
Asia (top 9 countries only)	3,900	33%
Mexico	3,000	26%
Europe (top 4 countries only)	2,100	18%
Canada	1,200	10%
Total (top 15 countries)	*10,200*	*86%*
Other	1,600	14%
Arizona Total	**11,900**	**100%**

Source: U.S. Census Bureau, Foreign Trade Division, 2002.

Much of the Arizona-Mexico border trade is related to the Maquiladora activity in the Sonora region of Mexico. The term Maquiladora refers to a manufacturing or processing firm that assembles component parts in Mexico that are temporarily imported from other countries, and returned to the origin country for final processing and sale. Maquiladora inputs include components, parts, and packaging materials used in the assembly or manufacturing process. As shown in Table 8.10, total inputs in 1997 for all of Mexico from all home countries were valued at $36.4 billion, with 97 percent of all inputs imported. The industry mix of the Maquiladoras is similar to the industry mix in Arizona, including the electronics industry and transportation equipment.

Table 8.9 Arizona-Sonora Vehicle, Passenger, and Freight Border Crossings

Port of Entry	Personal Vehicles	Personal Vehicle Passengers	Buses	Bus Passengers	Trucks	Loaded Freight Containers
Douglas, AZ	2,150,100	5,912,800	NA	3,700	32,600	14,700
Lukeville, AZ	501,300	1,373,700	500	17,800	4,300	500
Naco, AZ	326,600	849,300	NA	1,400	7,800	5,900
Nogales, AZ	4,187,000	10,489,100	5,800	34,500	256,400	200,400
Sasabe, AZ	34,900	90,800	NA	NA	2,400	900
San Luis, AZ	2,687,400	6,505,800	100	700	44,800	13,700
Total	**9,887,400**	**25,221,500**	**10,000**	**58,100**	**348,300**	**242,100**

Notes: NA = Not available. Numbers may not add to total due to rounding.
Source: Bureau of Transportation Statistics.

Table 8.10 Inputs for Maquiladoras, 1997 (in Millions of Dollars)

Industry	Total Inputs 1997	Imported Inputs 1997	Percent of Inputs That Are Imported
Electronics	13,700	13,500	99%
Transportation equipment	7,800	7,700	99%
Machinery and equipment	5,200	5,200	99%
Apparel	3,200	2,700	83%
Other manufacturing	3,100	3,000	98%
Wood and metal furniture	1,100	1,100	94%
Other	2,200	2,000	93%
Total	**36,400**	**35,300**	**97%**

Source: Arizona-Mexico Commission, 1999.

9. MoveAZ and the Five-Year Program

Chapter 9. MoveAZ and the Five-Year Program

The previous chapters of the MoveAZ plan discussed its three primary objectives: 1) to develop a strategic direction for transportation in the State of Arizona, 2) to coordinate with stakeholders and the public, and 3) to identify specific transportation projects for ADOT to deliver over the long term. This chapter addresses the transition from MoveAZ (planning) to ADOT's Priority Programming Process, the method used to identify specific transportation projects for funding in the *Five-Year Transportation Facilities Capital Program* (Five-Year Program). The chapter presents ADOT's existing programming process, as well as an updated process that incorporates MoveAZ.

9.1 Existing Priority Programming Process

The State Transportation Board has the authority to prioritize individual airport and highway projects in Arizona. Prioritization is accomplished through programming – the process of identifying individual transportation needs, defining projects to address those needs, and determining the order in which these projects receive funding. The Five-Year Program is the result of this process. It is updated each year to address changes in cost and scope to projects programmed in previous years and to add new projects into the fifth year of the program.

This section provides an overview of the programming process, including:

- The responsibilities of the Transportation Board, several committees, and ADOT in developing the Five-Year Program;
- Key project identification and funding differences between subprograms and major capital projects;
- The process of allocating resources to subprograms and projects and among regions of the State; and
- The process for programming major capital projects.

Key Committees and Responsibilities

The Transportation Board has ultimate responsibility for adopting the Five-Year Program. This is accomplished by working with ADOT and several advisory committees that help to identify the appropriate funding for projects across the State. The committees that help the Board develop the program include:

- **Priority Program Advisory Committee (PPAC) –** The PPAC consists of the State Engineer; the Deputy State Engineers in charge of Program Development, the Valley Transportation System, and Operations; and the ADOT Directors of Transportation Planning, Aeronautics, and Motor Vehicles. This group assists the Transportation Board in setting overall priorities for the program.

- **Technical Advisory Committee (TAC) –** The TAC includes representatives from ADOT's Transportation Planning and Intermodal Transportation Divisions, including district engineers. This group reviews and evaluates programming requests and recommends the priority program to the PPAC.

- **Project Review Board (PRB) –** The PRB is comprised of Development Group Managers from ADOT's Intermodal Transportation Division. This group addresses cost and schedule changes for projects under design.

- **Resource Allocation Advisory Committee (RAAC) –** The RAAC is comprised ADOT officials, Directors of MAG and PAG, Directors of two MPOs and/or councils of governments (COG), and Director of either the Regional Public Transit Association in Maricopa County or SunTran in Pima County. This group operates on a consensus decision-making basis to recommend how funding should be distributed among both the regions of the State and particular resource allocation categories (e.g., pavement preservation, safety, etc.).

Subprograms and Major Capital Projects

The programming process is designed to fund projects that will help ADOT meet its responsibilities to maintain and expand the transportation system in Arizona. These responsibilities include a wide variety of activities, such as repaving highways, providing funding to special needs transit operators, developing ADOT construction capabilities, and expanding capacity on the highway system. ADOT has identified three broad system categories that capture all of these activities:

1. **System preservation** includes projects that maintain the physical condition of the transportation system, such as pavement and bridge preservation;

2. **System management** includes funding for project and program development, such as scoping projects, testing materials, and conducting environmental reviews; and

3. **System improvements** include projects to address capital expansion of the transportation system, such as adding new lanes to existing highways, building new interchanges, and other similar projects.

Table 9.1 lists the key resource allocation categories within each of these three broad system categories. It also indicates which method is used to select and fund projects and activities.

Table 9.1 Program Resource Allocation Categories and Project Selection Method

System Category	Resource Allocation Category	Project Selection Method
System Preservation	• Bridge preservation	• Subprogram
	• Operational facilities	• Subprogram
	• Pavement preservation	• Subprogram
	• Public transit	• Subprogram
	• Roadside facilities	• Subprogram
	• Safety program	• Subprogram
System Management	• Development support	• Subprogram
	• Operating support program	• Subprogram
	• Operating contingency	• Subprogram
System Improvements	• Corridor improvements	• Major capital process
	• Major capacity/operational spot improvements	• Major capital process
	• Minor capacity/operational spot improvements	• District priorities
	• Roadside facilities improvements	• Subprogram

The process of selecting projects for inclusion in the Five-Year Program varies by resource allocation category. For many categories, a subprogram identifies the projects to be built in a given year. These subprograms typically use management systems to identify projects that help ADOT meet standards established by the Transportation Board. For example, the pavement preservation subprogram uses a pavement management system to determine the level of funding needed to maintain pavement quality at an acceptable level, and identify the highest priority projects in a given year. The Transportation Board allocates a pool of funding to each subprogram as a whole, based on an estimate of the total need for that subprogram. In general, most subprograms have identified greater needs than available funding. The State Transportation Board works with its advisory committees to set funding levels for each subprogram. Funding is then provided to

particular projects using management systems and other tools, as well as Transportation Board input, to select the projects that are most clearly needed in a given year.

Major capital projects go through a different, but complimentary process, described in more detail below. Because the subprograms use management systems that have their own performance measures or related evaluation methodologies to select projects, the MoveAZ plan, as well as this discussion of programming, focuses entirely on major capital projects. The remainder of this chapter is focused only on major capital projects. Subprograms are expected to use their existing processes to identify program projects.

Resource Allocation

Resource allocation is a combined process of financial forecasting and determining the distribution of these resources to major projects and subprograms and to major regions of the State. ADOT Financial Management Services (FMS) identifies the total funding available to the Five-Year Program (as well as the MoveAZ plan) from state and Federal sources. These estimates are based on projected receipts of fuel taxes, vehicle license fees, and other taxes and fees collected by Arizona and the Federal government. These estimates are updated at regular intervals to provide the most current and accurate assessment of available funding, as periodic economic changes can impact ADOT's ability to fund particular projects.

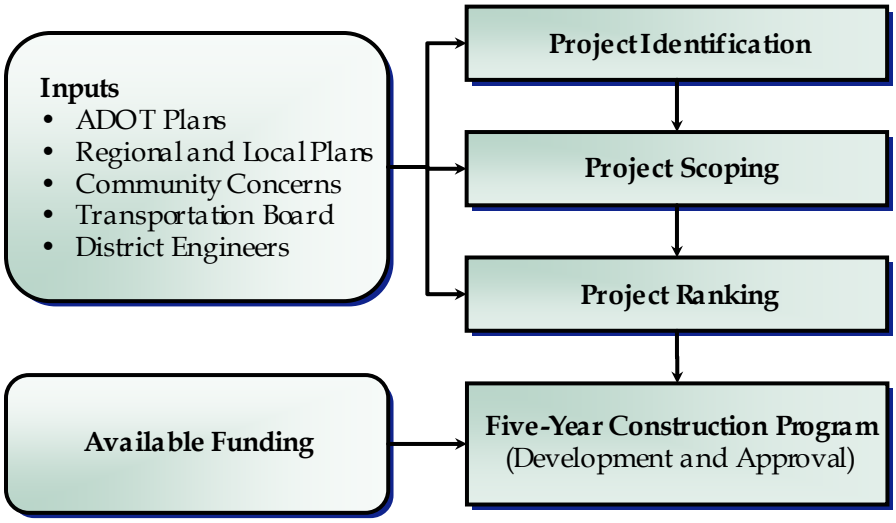
The RAAC provides guidance on allocating available funds among the regions of the State. For the last several years, the Transportation Board has divided funding among three regions of the State: Maricopa County, Pima County, and the 13 other counties. Maricopa receives 37 percent of the funding, Pima 13 percent, and the 13 other counties 50 percent.

In addition, funding is allocated to major projects and subprograms. The Transportation Board identifies funding levels for each subprogram as a whole, reserving funding each year to be programmed for major capital projects. As described in Chapter 6, the historical split between major capital projects and subprograms was used to estimate funding available to major capital projects over the course of the MoveAZ plan.

Programming Major Capital Projects

This section describes ADOT's process for identifying major capital projects and moving them through the programming process. This process is a joint effort of ADOT, MPOs, COGs, and the State Transportation Board. Though subprograms undergo a similar process, the discussion here is concerned exclusively with major capital projects. Figure 9.1 provides a graphic overview of the existing programming process. The steps of this process are described below.

Figure 9.1 ADOT'S Existing Priority Programming Process



Project identification – Project submittals come from several sources, including ADOT studies, regional, local, or tribal studies, district engineer recommendations, and community concerns. District engineers typically help identify major corridor and spot projects in their districts in consultation with local and regional officials and the public.

Project scoping – Once projects have been identified, a preliminary study (called a project scope) is conducted to estimate project need, potential impacts, preliminary design, and cost. Project scoping identifies whether a project requires more detailed environmental review or has fatal flaws that prevent it from being constructed. The scoping process ensures that a project meets the criteria of project readiness required by State statute (see Chapter 3 for additional detail). With hundreds of projects requested each year, the selection of projects to be scoped is the first stage of prioritization in the analysis of projects.

Project ranking – Once a scope is completed for a major project, it enters the pool of programmable projects. However, many more projects are identified each year than can be programmed in that year. The ranking process determines which projects ADOT will recommend to the Technical Advisory Committee and the Transportation Board for inclusion in the Five-Year Program. ADOT's Priority Programming Team recently implemented an updated project ranking methodology that compares projects on several quantitative and qualitative measures. Three overall measures are evaluated for each major project:

1. **Safety –** Number of crashes and the crash rate (crashes per million vehicle miles traveled) on the affected highway segments.

2. **Mobility –** Existing and future traffic volumes on the affected roadway segments and existing and future levels of service (LOS).

3. **Strategic/planning –** Project location on the National Highway System, Strategic Highway Network, and CANAMEX Corridor; system operating classification of the roadway; and functional class of the roadway.

Each major capital project that is considered for programming is scored on these three measures. After scoring and ranking the projects on the three measures, they are grouped into high, medium, and low priority lists of projects. These lists are used in the development of the program.

Program Development – The draft Five-Year Program is assembled from major projects and subprograms (see Table 9.1). The ranked pool of projects identified in the previous step is assembled into a Five-Year Program based on available resources and Transportation Board priorities. The first four years of the program are committed to projects identified in previous cycles, with new projects added to the fifth year of the program. At the programming stage, ADOT seeks to answer several questions that are not asked at the planning level, including:

- Is a project ready to be developed (i.e., project readiness)?
- Is there a local funding match for particular projects that might accelerate their delivery in the program?
- Are there operational constraints to delivering projects – such as a project already being developed in a corridor – that make it difficult to deliver a particular project?

The answers to these questions affect the specific projects that get included in the draft program. Using the lists described in the Project Ranking stage, the Technical Advisory Committee develops a recommended program. The Board reviews this program and makes changes to it using the same lists of projects identified in the project ranking stage. After the recommended program has been reviewed and refined by the Board, ADOT compares the program of projects against current budget estimates developed by ADOT Financial Management Systems. The recommended program is also reviewed by the State Engineers Office to ensure that the projects can be constructed in the timeframe outlined by the program. After all the reviews are completed, the Board adopts the draft program to be presented to the public.

Program approval – Public comments are gathered at public hearings held in Phoenix, Tucson, and Flagstaff. In addition, ADOT's consultation process with non-metropolitan, local-elected officials will be used to provide information about the programming process to these groups. Once public comments are incorporated, the State Transportation Board approves the final *Five-Year Transportation Construction Program*.

9.2 Integrating MoveAZ into the Five-Year Program

Integrating MoveAZ into the Priority Programming Process will occur over several programming cycles. Because ADOT is just beginning to undertake both performance-based planning and programming, it will take time to identify to implement a performance-based program. The purpose of this section is to outline that process.

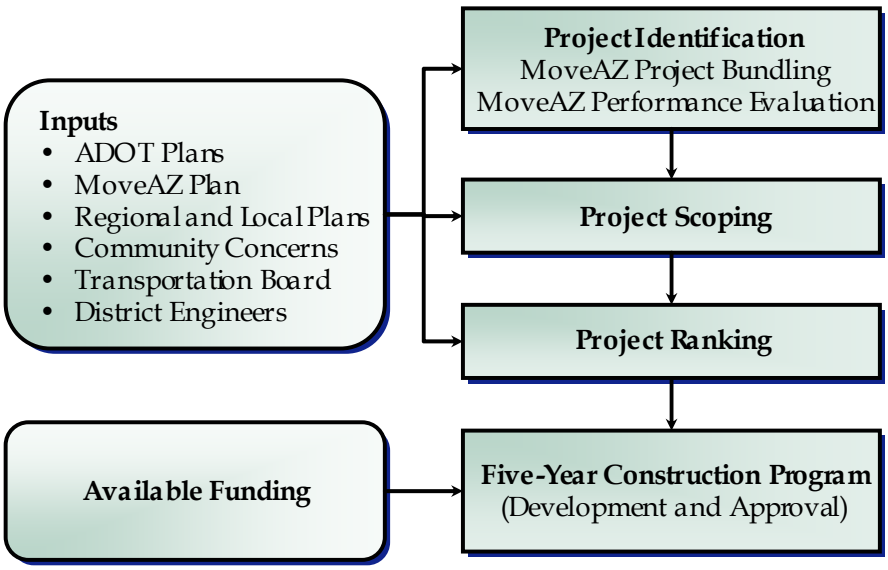
MoveAZ supports programming by providing quantitative information to ADOT to evaluate the performance benefits of major capital projects. MoveAZ does not supplant the current method used to develop the Five-Year Program or change the roles of ADOT staff and the Transportation Board. Instead, it provides additional project performance and benefit information to help support decision-making by these agencies.

This section describes two key aspects of the integration of MoveAZ into the programming process: 1) project identification and 2) scoping.

Project Identification

MoveAZ will interface with the programming process primarily at the project identification level. MoveAZ includes two key processes that affect the method of project identification. The relationship between these processes and MoveAZ are illustrated in Figure 9.2.

Figure 9.2 ADOT Updated Priority Programming Process



First, MoveAZ includes a process for examining the long-range impacts of projects. To do so, individual project elements were bundled into larger projects. This bundling process can be applied to needed improvements identified from any of a number of sources, including future planning studies, community concerns, projects identified by board members, and regional and local studies. As needs and projects are identified, they will be transmitted through this bundling process.

Second, MoveAZ includes a quantitative process for evaluating the performance impacts of these bundles. Each bundle that is identified for potential programming will pass through this process.

The result of these analyses will be a set of bundled projects scored and ranked according to performance measures for consideration in the programming process. Project bundles will then be considered for scoping.

Scoping

Before project identification transitions completely to the MoveAZ process, ADOT will need to clear the pipeline of already-scoped projects. The existing scoping pool includes hundreds of millions of dollars of projects. Some of these projects will have fatal flaws or other considerations that prevent them from being programmed. Due to the sheer volume of projects already scoped, ADOT will need multiple programming cycles to work through these previously scoped projects before the project bundling and evaluation process developed for MoveAZ is used for all projects.

ADOT has limited funding to pay for scoping studies. In 2003, only two new scoping studies were completed at a cost of close to $1 million each. With additional projects under consideration from the MoveAZ process, additional funding will be necessary to be able to scope all of these projects. As described above, selecting projects for scoping is the first stage in the project prioritization process. ADOT, the Transportation Board, and its committees will use the performance analysis from MoveAZ and other information to identify projects that are first in line for scoping.

9.3 Next Steps

The approaches presented above highlight how ADOT's priority programming process will utilize the performance evaluations developed for MoveAZ. The process of capital programming is based not only on technical evaluation, but also using a variety of policy considerations and qualitative factors, such as timing and funding. The next step is to apply and continually refine the methodology to integrate MoveAZ project bundles into future programming cycles.

MoveAZ used a number of important inputs to identify projects and evaluate them. Over the next several years, ADOT will continue to update and refine these inputs, including:

- Conducting new multimodal regional transportation profiles all across the State. Figure 9.4 presents the approach ADOT will take to conduct these profiles in the future. The profiles will cover large geographic regions of the State than the corridor profiles ADOT has conducted over the past 10 years, and will provide information about the state highway system within the area. The transportation profiles will be the primary source of needs assessment and project identification for planning.

- Continue developing Small Area Transportation Studies (SATS) in small towns and communities across the State. SATS are another means to identify potential projects for evaluation and consideration.

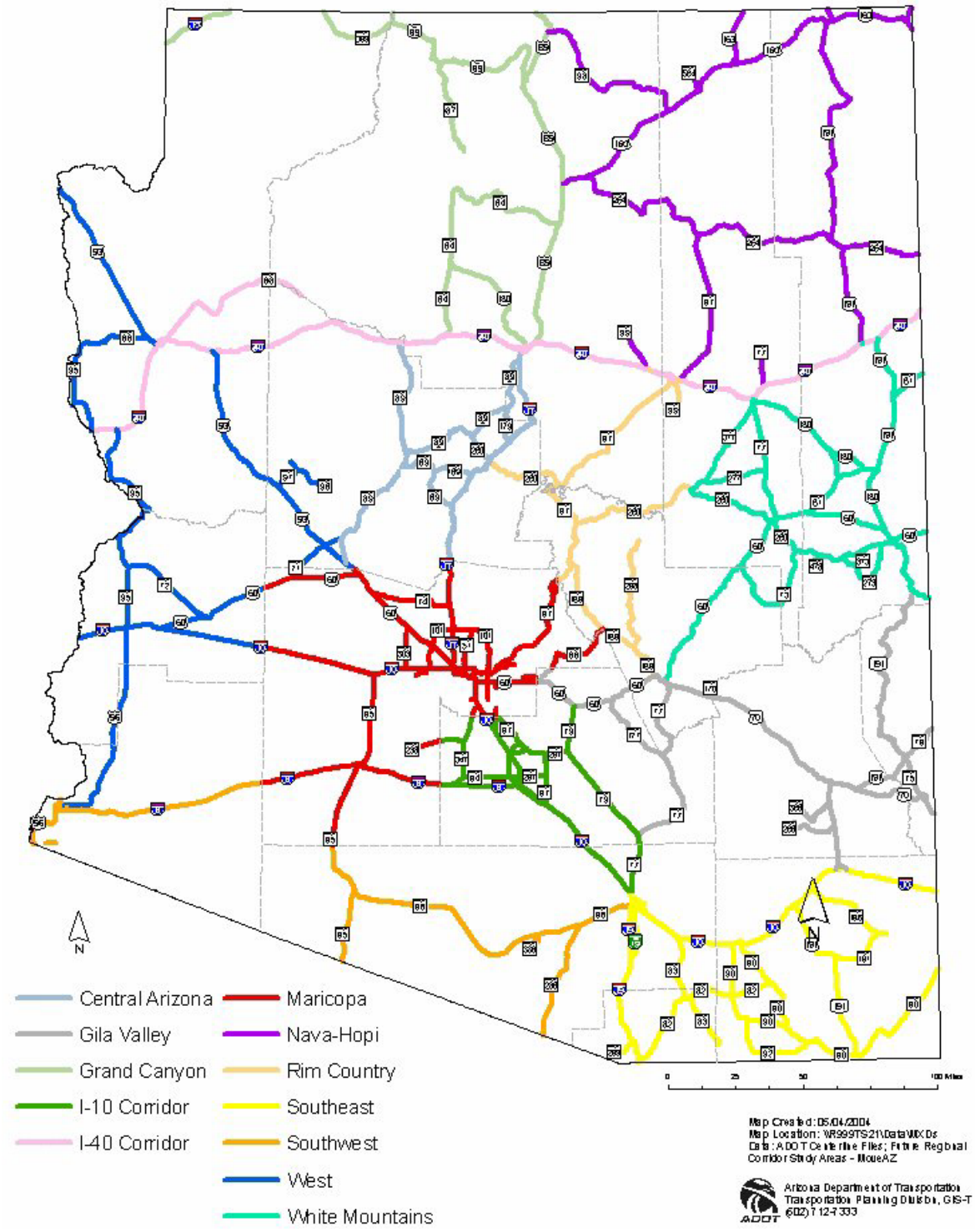
- Updating the State Bicycle/Pedestrian Plan, building on the plan that was completed in 2003.

- Conducting a freight and goods movement study. This study will focus on the economic impacts of goods movement and the infrastructure critical to support the freight system.

- Conducting regional transit plans for each of the four COGs in Arizona (Northern, Western, Central, and Southeastern).

These inputs, as well as studies conducted by regional planning agencies, will be used to identify deficiencies on the state transportation system, suggest projects to improve transportation, and be evaluated in the updated long-range transportation plan every five years, as required by state law. The process to develop an updated plan will build on the work completed for MoveAZ, advancing ADOT's use of performance-based planning and programming.

Figure 9.3 Regional Corridor Study Areas



MOVE AZ
Long Range Transportation Plan

Appendix A. Phase I Summary Report

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

with

Lima & Associates
Partners for Strategic Action, Inc.
BJ Communications, Inc.

August 2002

ADOT

MoveAZ Plan

Appendix A. Phase I Summary Report

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
1300 Clay Street, Suite 1010
Oakland, California 94612

August 2002

Table of Contents

1.0 A Strategic Direction Process for MoveAZ 1-1
1.1 Definition and Purpose of the Mission Statement 1-1
1.2 Principles and Guidelines 1-2
1.3 A Mission Statement for Arizona 1-3
1.4 Goals and Objectives 1-3

2.0 Creating the Arizona Context 2-1
2.1 Summary of Review of Transportation Plans 2-1
2.2 Summary of Other Arizona Context Items 2-3
2.2.1 A Growing State 2-4
2.2.2 A Changing Economy 2-5
2.2.3 Environmental Pressures 2-7
2.2.4 Quality of Life 2-8
2.2.5 The Link to Transportation 2-8
2.2.6 The Urban/Rural Dichotomy in Arizona 2-9
2.2.7 Threats and Opportunities 2-10
2.3 Examples of Other Statewide Vision Processes 2-12
2.3.1 Review of Peer States 2-12
2.3.2 Vision-Based Planning Pioneers 2-14

3.0 Data and Modal Profiles to Support the MoveAZ Plan 3-1
3.1 Modal Profiles 3-2
3.1.1 Highway 3-2
3.1.2 Transit 3-5
3.1.3 Railroads 3-10
3.1.4 Aviation 3-14
3.1.5 Bicycle and Pedestrian 3-17
3.2 System Elements 3-20
3.2.1 Intermodal Facilities 3-20
3.2.2 International Ports of Entry 3-22
3.2.3 Intelligent Transportation Systems 3-24
3.3 Special Land Areas 3-26
3.3.1 Federally-Managed Lands 3-26
3.3.2 Tribal Lands 3-26

Table of Contents
(continued)

Appendix A
Review of Existing Transportation Visioning Efforts

Appendix B
Summary of Arizona Issues Papers

Appendix C
Review of Pioneer States' Visioning Efforts

Appendix D
Review of Data to Support MoveAZ

List of Tables

1.1. MoveAZ Plan Strategic Direction – Draft Goals and Objectives 1-4

2.1 Elements of Past Strategic Direction Efforts 2-2

3.1 Highway Miles and DVMT by Ownership 3-4

3.2 Truck-Hauled Commodities Originating in Arizona 3-4

3.3 Highway Data in Inventory 3-5

3.4 Arizona Communities with Transit 3-6

3.5 Transit Data in Inventory 3-10

3.6 Commodities Originating and Terminating in Arizona (2000) 3-12

3.7 Annual Passenger Rail Counts in Arizona 3-13

3.8 Rail Data in Inventory 3-14

3.9 Airport Enplanements in Arizona 3-16

3.10 Aviation Data in Inventory 3-17

3.11 Arizona-Sonora Pedestrian Border Crossings 3-19

3.12 Bicycle and Pedestrian Data in Inventory 3-20

3.13 Intermodal Data in Inventory 3-22

3.14 Arizona-Sonora Vehicle, Passenger, and Freight Border Crossings 3-24

3.15 Border Crossing Data in Inventory 3-24

3.16 ITS Data in Inventory 3-25

3.17 Federal Land Data in Inventory 3-28

3.18 Federal Land Data in Inventory 3-29

List of Figures

2.1 Historic Population Growth with Future Estimates 2-4

2.2 Projected Age Distribution of Arizona's Population 2-5

2.3 Arizona Employment by Industry 2-6

3.1 Arizona State Highway System by Functional Class 3-3

3.2 Arizona Transit Services 3-8

3.3 Arizona Rail Lines and Passenger Stations 3-11

3.4 Arizona Public Airports 3-15

3.5 State Highways Suitable for Bicycling 3-18

3.6 Intermodal Facilities in Arizona 3-21

3.7 Arizona International Ports of Entry 3-23

3.8 Federal Land Ownership in Arizona 3-27

3.9 Tribal Lands in Arizona 3-28

1.0 A Strategic Direction Process for MoveAZ

1.0 A Strategic Direction Process for MoveAZ

The first phase of work on the Arizona Long-Range Transportation Plan (MoveAZ Plan) provides a strategic direction for state transportation goals and objectives. This was accomplished through review and evaluation of existing documents, previous planning processes, Arizona-specific plans and processes, and similar experiences from other states. From these sources, recurrent themes and issues were identified and used to guide the development of the mission statement and strategic directions for transportation investment in Arizona. The mission statement and broader strategic direction will be the subject of review and comment by stakeholders and the general public in Phase II of the MoveAZ Plan.

This report presents a review of the process used to create the strategic direction. It is intended as a supplement to the MoveAZ Phase I brochure. This section provides additional information describing the creation of the mission statement. Section 2.0 provides a summary review of planning documents and reports that were used to understand the Arizona context. Section 3.0 reviews the key data used to support the plan. Several appendices present detailed information about the supporting material used for this document.

1.1 Definition and Purpose of the Mission Statement

A mission statement is a brief description of a desired future condition or set of conditions that is dependent on the outcomes of transportation policies and decisions, usually among a broader set of policies. It is a description of where citizens will be in terms of overall quality of life if the goals and objectives of the mission statement are implemented through specific policies.

A mission statement is policy oriented. Its primary purpose is to frame the development of goals and objectives that, in turn, will drive the development of transportation investments that can be implemented to achieve the strategic direction for the MoveAZ Plan. Those logical linkages between policy and strategic direction need to be clearly evident. In the end, if the mission statement is not regularly used as a reference point in the policy arena, it has little value.

1.2 Principles and Guidelines

The following principles and guidelines were used to craft the mission statement for Arizona.

It needs to be realistic. The mission statement should not be an unattainable transportation nirvana, but rather a realistic target that is achievable through the implementation of a set of outcome-driven policies and strategies over a reasonable period of time, say, 15 to 25 years. Such a timeframe is important, because impacts of major transportation policies and investments on major quality-of-life issues, such as development and land use, typically take many years to unfold. Mission statements that are, or are widely perceived to be, hopelessly unrealistic are not useful for policy- or decision-making purposes and will generally be ignored.

It needs to be integrated with clear goals and objectives. Mission statements need to be viewed as part of a coherent vision-goals-objectives package. Collectively, they describe the ultimate destination, provide the guidance to developing policies that move toward a realistic direction for transportation, and specify the means to help measure progress toward that destination. Mission statements tend to have little practical value as stand-alone documents.

It needs to be fiscally responsible. Mission statements should openly acknowledge the fact that substantial resources will be required to achieve the direction for transportation. Consequently, a mission statement should also assume reasonable and realistic funding elements for a desirable future scenario. The revenue plan prepared for the Vision 21 Task Force was quite explicit and specific about this frequently ignored, but vitally important issue.

It needs to be flexible. A mission statement should be part of the overall process that will result in the strategic decisions needed to move stakeholders and citizens toward the defined direction for transportation. As such, it should acknowledge, or at least imply, that the realization of the mission statement will require the selection of discrete policy options – and, of course, the rejection of others.

It needs to be functional and practical. The preceding observations point toward a mission statement that is functional for policy-making purposes and one that will be used in practice. As such, it should raise eyebrows, questions, and possibly objections. A mission statement with which virtually no one could possibly disagree is also one that will have virtually no value in helping stakeholders and citizens achieve it.

1.3 A Mission Statement for Arizona

To support Arizona's quality of life, the MoveAZ Plan will provide a safe, reliable, and efficient transportation system for people and goods that strengthens our economic vitality; assures access to services and recreational opportunities; preserves the beauty and health of our natural environment; and blends into our urban and rural landscapes.

To achieve these ends, the Move AZ Plan will:

- *Be fiscally responsible;*
- *Provide citizens with transportation choices;*
- *Emphasize accountability;*
- *Be responsive to change;*
- *Harmonize with Arizona's proud heritage and unique diversity;*
- *Encourage coordination of transportation and land use planning at the state, regional, and local level; and*
- *Address air, transit, rail, highway, bicycle, and pedestrian travel.*

1.4 Goals and Objectives

The long-range goals reflect the spectrum of major goals or desired outcomes expressed by both the mission statement and numerous planning efforts from around the state.

These goals, in turn, suggest broad performance factors (e.g., "reliability" or "equity") that can be described and evaluated with more detailed performance measures. Performance factors may help describe multiple goals, but suggest different, more specific objectives and strategies for action. For example, "mobility" as a performance factor might be linked to objectives in both the Access and Mobility and Stewardship goal areas, because there are objectives in each towards improving the mobility of Arizonans.

Table 1.1 presents the draft long-range goals and performance objectives for the MoveAZ Plan. The objectives are presented at a level of generality that applies broadly to the entire state. These are not intended to be the final objectives for the MoveAZ Plan, but rather an interim step towards developing a refined and final set of long-range objectives. Public review of these goals and objectives will refine and clarify them and ensure they are tracking the themes that are important to Arizonans.

Table 1.1. MoveAZ Plan Strategic Direction – Draft Goals and Objectives

Long-Range Goal	Arizona Performance Factors	Long-Range Performance Objectives
Access and Mobility. A reliable and accessible multimodal transportation system that provides for the efficient mobility of people and goods throughout the state.	Mobility	• Maintain and enhance levels of circulation (e.g., reduced congestion) on highways, arterials, and major collectors. • Maintain and enhance the ability of goods to move through and around urban areas with minimal delay. • Encourage the development of transit options for economically disadvantaged populations.
	Reliability	• Improve the availability and quality of real-time information to increase the ease of use and attractiveness of both highways and public transportation. • Reduce delay caused by at-grade highway-railroad crossings. • Develop and implement an access management program to preserve the reliability of the state highway system.
	Accessibility	• Encourage the development of effective public transportation, ride share, and related options where appropriate and cost effective. • Support Title 6 ADA compliance for access by disadvantaged groups to all transportation services. • Integrate transit, bicycle, and pedestrian facilities into highway improvements where feasible. • Maintain and enhance connections to major commercial, residential, and tourist destinations by both highways and public transportation. • Maintain and expand border crossing facilities.
	Connectivity	• Maintain and enhance intermodal passenger connections between air and surface (highway and transit) transportation modes. • Maintain and enhance intermodal freight linkages for truck-rail and truck-air transfers. • Continue necessary expansion and connection of Arizona's metropolitan highways and HOV lanes. • Ensure the connection of rural communities to the state highway network.

Table 1.1. MoveAZ Plan Strategic Direction – Draft Goals and Objectives (continued)

Long-Range Goal	Arizona Performance Factors	Long-Range Performance Objectives
Safety. Provide safe transportation for people and goods.	Safety	• Reduce the rate of crashes, fatalities, and injuries for motor vehicles, bicycles, and pedestrians. • Design new transportation facilities to minimize accidents. • Improve the safety of commercial vehicles, public transportation vehicles and facilities, and where modes intersect. • Upgrade at-grade railroad crossing protection. • Increase ADOT's support and use of incident management on the state highway system. • Coordinate with federal, regional, local, and tribal officials to provide redundancy of access for emergency response and evacuation situations (e.g., bridge crossings, multiple access routes to airports and other key transportation facilities, etc.) • Improve safety and security for rural area travelers (e.g., build an emergency call box systems).
Economic Vitality. A multimodal transportation system that improves Arizona's economic competitiveness and provides access to economic opportunities for all Arizonans.	Economic competitiveness	• Maintain and expand freight transportation and intermodal linkages. • Increase coordination of transportation planning with the economic development activities of state, regional, and local governments. • Equitably distribute transportation to all areas of the state.
	Accessibility	• Maintain and improve truck linkages between Arizona, other states, and Mexico. • Maintain and improve access to major tourist destinations. • Encourage the development of transit services that provide access to job centers.
Stewardship. A balanced, cost-effective approach that combines preservation with necessary expansions and coordinates with local and regional transportation and land use planning.	Preservation	• Preserve and maintain existing transportation infrastructure. • Develop and implement an access management program to preserve the functionality of the state highway system. • Coordinate planned transportation system expansions with future funding capabilities. • Increase efficient coordination of state transportation planning and programming processes with local and regional land use planning processes.
	Mobility	• Increase and/or protect capacity of the existing transportation system through increased use of traffic operation and management strategies, including Intelligent Transportation Systems (ITS) methods.

Table 1.1. MoveAZ Plan Strategic Direction – Draft Goals and Objectives (continued)

Long-Range Goal	Arizona Performance Factors	Long-Range Performance Objectives
Environmental Sensitivity. A transportation system that enhances Arizona's natural and cultural environment.	Resource conservation	• Increase energy conservation and the use of recycled materials and cost-effective alternate energy sources. • Give preference to use of native or indigenous species in transportation-related landscaping projects. • Encourage the development of smart growth policies in coordination with state, regional, local, and tribal planning processes.
	Environmental protection	• Increase proactive coordination of transportation planning with federal, state, and regional environmental agencies. • Minimize the contribution of transportation investments to air, water, and noise pollution in all areas of the state. • Ensure that negative environmental impacts of transportation investments do not fall disproportionately on disadvantaged groups. • Minimize the impact of transportation investments on natural habitats, animal travel corridors, historic sites, and endangered species
	Context sensitive solutions	• Establish and meet design standards that maximize the visual harmony of and minimize the noise produced by transportation system investments.

2.0 Creating the Arizona Context

2.0 Creating the Arizona Context

The Arizona Department of Transportation (ADOT) consulted several sources to provide context for the development of a strategic direction for the MoveAZ Plan. These included:

- A comprehensive review of transportation planning and visioning efforts in the state;
- A review of additional official planning documents from Arizona agencies and research institutes with mandates other than transportation, such as economic development and commerce;
- A focused survey of Southwestern and Rocky Mountain states that could be considered peers of Arizona;
- A review of planning activities in states that have pioneered vision-based transportation planning; and
- The commission of four papers that examine specific issues relevant to the future of transportation in Arizona.

These sources were used to articulate the concise mission statement above and to create an initial strategic direction that will guide development of the MoveAZ Plan. This section provides a summary review of each of these key sources.

2.1 Summary of Review of Transportation Plans

Previous planning efforts have already considered the strategic direction for transportation in Arizona, including the *Arizona Transportation Asset Management System Study* and the *State Planning and Research 542 Study* (Congestion Management Strategies) currently under development by ADOT. Several previous planning efforts developed a transportation vision for the state. These attempts included work by ADOT, the Governor's Office (notably the Transportation Vision 21 Task Force), metropolitan planning organizations, councils of governments, small area studies, and American-Indian reservations. These vision statements provided the raw material that was shaped into the mission statement, goals, and objectives.

This section summarizes our review of over 100 plans produced by ADOT and other agencies, including numerous statewide planning efforts, 33 corridor-specific and various small area plans, metropolitan plans, and Native American plans. Of the plans identified, 27 had identified some element of a vision statement. The review revealed several

important factors that can help to shape the transportation strategic direction for Arizona. Although most of these plans are concerned with smaller areas of the state, the review of them together presents factors that are relevant at the state level. Many of these plans did not include development of a vision statement as their primary task, but each has elements that can be used to inform the development of a strategic direction for transportation in Arizona. This review was also conducted to ensure the coordination of the MoveAZ Plan with current ADOT planning studies, including the *Arizona Transportation Asset Management System Study*.

Table 2.1 presents a summary of the elements discussed in the reviewed planning efforts by different agencies. For each agency level, several planning efforts were examined to determine the relevant set of factors for a mission statement as well as goals and objectives. For each cell of the table, a mark indicates how many of a given type of plan (ADOT, small area, regional, tribal, or other) mentioned a particular element.

Table 2.1 Elements of Past Strategic Direction Efforts

Element	ADOT	Small Area	MPO	Tribal	Other
General Elements					
Balanced/multimodal	◆	◆	◆		◆
System inventory	◆	■		■	
Transportation Elements					
Accessibility, mobility		◆	■	◆	■
Safety		■	◆	◆	
Funding flexibility, local control					■
Stable, equitable funding	◆	◆		■	■
Connection to Other Factors					
Land use connection	◆	◆	■	■	◆
Environmental	◆	■	◆	√	■
Economic development	◆	√		√	
Tourism, recreation		◆		◆	
Social issues				√	
Community character		■		◆	■

■ – A few mentions; ◆ – Several mentions; and √ – All or nearly all plans mention.

Plans from most levels of government encouraged the development of a balanced, well-integrated multimodal transportation system. The features of this system clearly included connections to land use, environmental, and economic planning. Additionally, past efforts make note of the need to provide a safe, accessible system that provides for easy

mobility in both urban and rural areas. Rural areas often have different needs than urban areas and the MoveAZ Plan will be sensitive to these differences. American-Indian reservation plans, in particular, tended to raise somewhat different, though overlapping, concerns than other plans. A more detailed review of how each type of plan described the major themes presented in Table 2.1 can be found in Appendix A.

2.2 Summary of Other Arizona Context Items

In addition to the review of transportation plans, a more general understanding of the Arizona context was determined through the review of plans from non-transportation agencies in Arizona. This review describes the major issues that will face the state in the coming years. The larger context was created from reviews of the following sources:

- An analysis of statewide planning documents prepared by Arizona departments (Commerce, Economic Security, Land, and Environmental Quality). These included yearly strategic vision statements that each agency produces for the Governor's Office of Strategic Planning, as well as current long-term planning efforts.
- Discussions with key staffs of the above agencies on current long-range planning efforts and issues facing these departments.
- Reviews of current policy analyses focused on Arizona produced by the Morrison Institute of Arizona State University in Tempe, the Office of Economic Development of the University of Arizona, and the Economic and Business Research Program of the Eller Business School at the University of Arizona.
- A set of four papers contracted specifically for the MoveAZ Plan that addressed current issues in the areas of security, national and global trade, land use, and a general examination of future trends. Each of these papers reflects upon key issues that may likely affect Arizona's future transportation system and transportation planning. An overall synthesis of these papers can be found in Appendix B.

This section presents a summary of these items consolidated into the following themes:

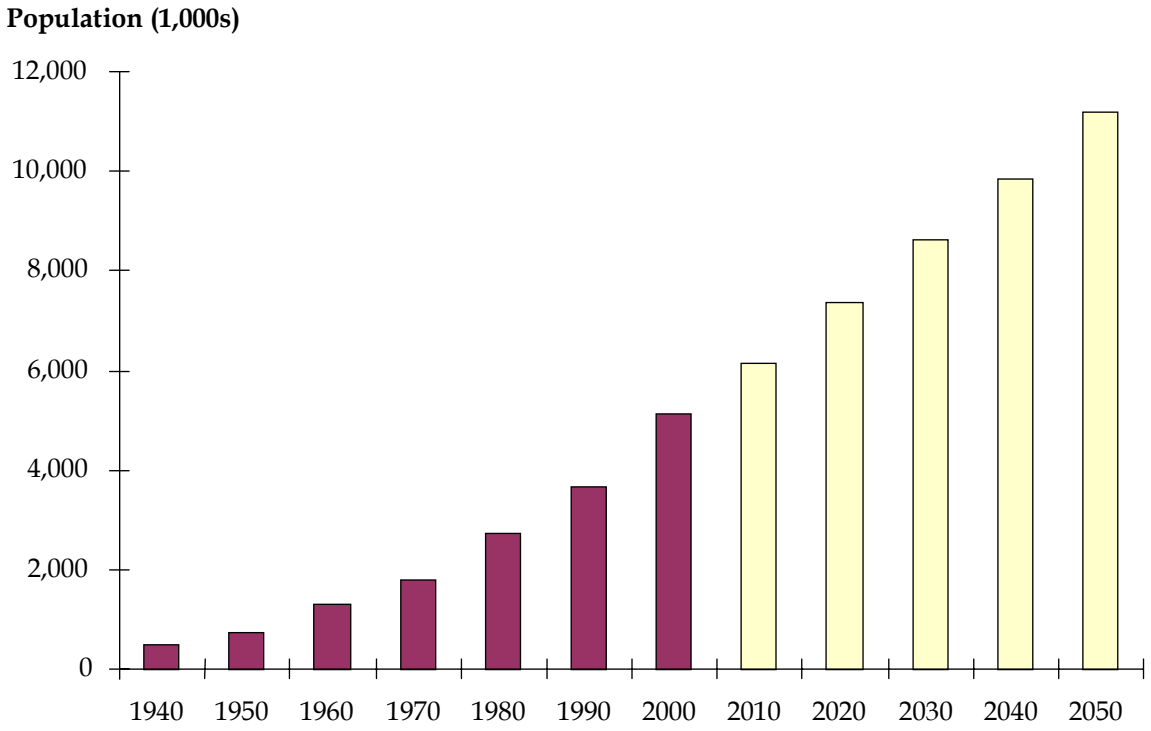
- Population growth;
- Economic change;
- Environmental pressures; and
- Quality of life.

This section presents an analysis of each of these key themes, suggests links to transportation issues, and provides a list of "threats and opportunities" that Arizona's transportation system will face in the coming years.

2.2.1 A Growing State

Arizona has been among the fastest growing states in the U.S. every decade since the 1960s. The state grew from 250,000 people in 1950, to over five million as reported by the 2000 census. Current population projections by the Arizona Department of Security show an increase of another 2.5 million people by 2020. Much of this growth is anticipated to take place in the Phoenix metropolitan area, which has added over two million people since 1970; and is currently home to nearly three million.

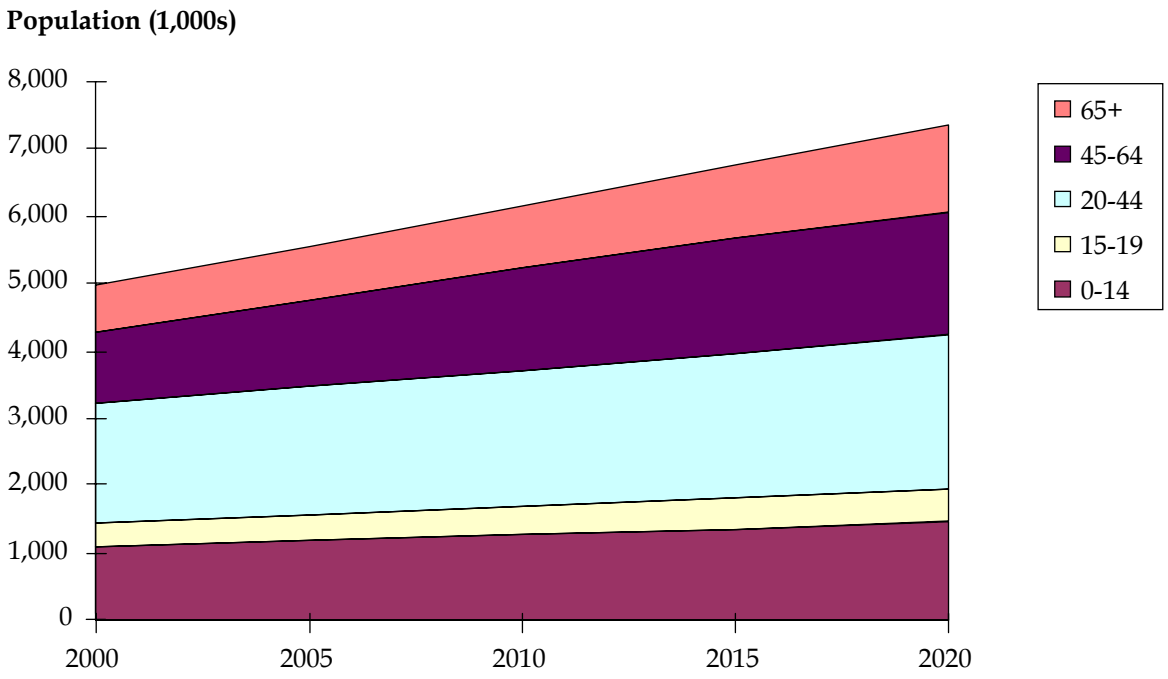
Figure 2.1 Historic Population Growth with Future Estimates



The composition of Arizona's population is changing as well. Like many states in the southwest, Arizona is a major destination for Mexican and other Latin-American immigrants. On average, these immigrants have somewhat less education, are younger, and have larger average household sizes than Arizona's historical population base.

Population growth and change have significant implications for land use planning and its relationship with the transportation system in Arizona. Encouraging coordinated planning between land use and transportation planning could improve Arizona's ability to address the transportation needs of millions of new residents over the next 40 years.

Figure 2.2 Projected Age Distribution of Arizona's Population



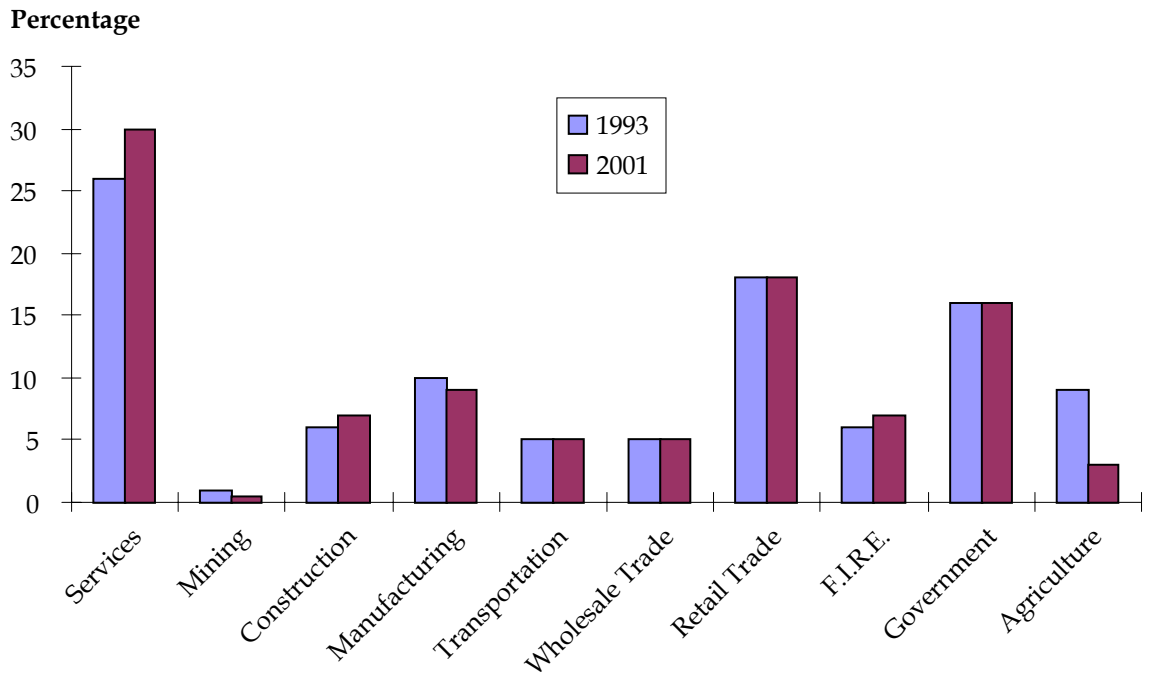
2.2.2 A Changing Economy

Economic growth has largely maintained pace with population growth in Arizona. The University of Arizona Economic and Business Research Program projects a four percent annual growth in jobs over the next several years. Over 70 percent of jobs, personal income, and sales take place in the Phoenix metropolitan area and an additional 15 percent in the Tucson metropolitan area. The economic development needs of most of the rest of the state are quite different than these primary metropolitan areas. Phoenix and Tucson are manufacturing centers and attempt to attract high-tech development. Other areas, including Flagstaff, the I-17 Phoenix-Flagstaff corridor, and Sierra Vista are pursuing high technology and "new economy," knowledge-intensive jobs. Much of the rest of the state relies upon recreation-based employment, tourism, and services for retirees. Agriculture and mining also continue to play important roles in the economy as they have throughout Arizona's statehood. The opportunities for international trade are growing.

The Arizona Department of Commerce has developed several planning efforts in recent years to help guide economic development in the state. The Arizona Strategic Planning for Economic Development turned state economic planning towards the development of clusters of related businesses that rely upon the same technologies, inputs, employees, and infrastructure. The Arizona Partnership for the New Economy looked at how technological change affects the Arizona economy and identified ways to incorporate these changes.

Outside of the Arizona Department of Commerce, the Arizona Mexico Commission developed a framework to improve cross-border economic linkages through increased trade and supply chains.

Figure 2.3 Arizona Employment by Industry



The Arizona Strategic Planning for Economic Development process identified 11 key industrial clusters that represent the potential strengths of the Arizona economy. These can be grouped into three basic types:

1. Technology and knowledge-based work;
2. Service intensive industries focused on tourism and retirees; and
3. Agricultural and mining industries.

These industry clusters are regionally specific and point the state in different directions. On the one hand, the technology-related clusters strive to make connections to research, attract talented 'knowledge' workers, and provide fertile locations for new cutting edge business to develop. On the other hand, the service and other clusters rely heavily upon manual labor and produce numerous, relatively lower-wage jobs.

Through the Arizona Partnership for the New Economy and other efforts, the state has solidified its commitment to understanding how technology has changed business in Arizona. This effort is aimed at developing Arizona as a leader in the new economy. The focus of the Arizona Partnership for the New Economy is on the way technology changes

how regular business is done in Arizona and what it takes to attract these businesses and workers to Arizona. Studies by the Arizona Partnership for the New Economy and the Morrison Institute note that knowledge workers are highly mobile and sophisticated consumers of place. They choose places with a high quality of life, including schools, mobility, and access to recreation, and other social, cultural, and physical amenities. This increases the pressure on designing cities and regions in ways that attract people who make many of their location decisions (e.g., residence, work place, and recreation) based on quality of life.

The other major economic planning effort in the state, the Arizona Mexico Commission, has worked to encourage Arizona as a location for increased trade with Mexico. Arizona is positioned to capture a large share of NAFTA traffic and to develop strategic linkages of suppliers to Maquiladora factories in Mexico. The Arizona Sonora project at the University of Arizona Office of Economic Development notes that an important window of opportunity is open to develop these relationships.

A related economic issue for Arizona is the movement of freight. Population and economic growth, combined with national and international changes in goods production and movement, make freight movement a major issue for Arizona. At the same time, freight growth is following new patterns. Growth in small parcel shipments means more additional less-than-truckload shipments and possibly different types and numbers of trucks on the road. One of the largest components of growth in freight traffic in recent years has been an increased number of small parcel delivery trucks moving over regional highway and arterial networks.

2.2.3 Environmental Pressures

The Arizona Department of Environmental Quality, the agency responsible for regulating and enhancing environmental quality, has been active in pursuing programs to improve the environment of Arizona. Throughout the state, air quality has improved considerably. Few areas of the state are out of compliance with federal air and water quality standards, and the state has made significant improvements in many areas.

The anticipated continuing influx of people and economic activity will inevitably increase pressure on Arizona's environmental resources, however. As the population center of the state, Phoenix and the Maricopa region face the greatest challenge to maintaining air and water quality. The main markers of poorer environmental performance are in Phoenix, where visibility has decreased due to air pollution over the past several years. Phoenix also has a well-known heat island effect; the Morrison Institute reports that average summer night temperatures have increased by 10 degrees over the past 30 years.

Arizona also faces important concerns about land preservation. Arizona has passed several laws in recent years aimed at preserving open space and improving the planning process. The following laws implement a form of Smart Growth that has become increasingly popular in the United States:

- The Arizona Preserve Initiative (1996) created a fund for the purchase of urban open space. Proposition 303 (1998) added $20 million to this fund.

- The Growing Smarter (1998) and Growing Smarter Plus (2000) Acts sought to improve the local land use process by requiring regular re-adoption of general plans, citizen review of rezoning, coordinating local and state land use planning, and adding several new planning elements to most local general plans (open space preservation, growth areas, environmental planning, water resources, and cost of development). The later act also required the establishment of infrastructure service boundaries and limited the powers of annexation.

2.2.4 Quality of Life

Changes to the population, economy, and environment all put attention on what the Morrison Institute refers to as the new emphasis on quality of life. Employees are becoming more conscious of the places they choose to work, with location as important as other traditional job selection criteria. Residents also want more out of the towns and regions they live in, including access to open space, recreational opportunities, and cultural amenities. More recent retirees of the baby boom generation also tend to be better educated and want more from the places they live. Overall, quality of life issues sit in the forefront of policy decisions and provide a guiding principle for strategic planning initiatives for all departments.

2.2.5 The Link to Transportation

Each of the above areas of concern bears significant relationships to transportation. Population influx puts pressure on all aspects of government, not least the transportation system. Phoenix already faces serious congestion problems that are likely to intensify. A Morrison Institute report, *Hits and Misses: Fast Growth in Metropolitan Phoenix*, notes that Phoenix is consuming land at a rapid rate and running into problems with the transportation system, access to open space and environmental resources, and economic and racial inequality. This report also notes that key transportation and land use decisions will be made for Phoenix in the next several years as the city decides where to locate businesses and residences and how to connect people to their jobs.

Further, the changing makeup of the population affects the evaluation of transportation needs in the state. With many immigrants less well off than the average Arizonan, the right mix of public transit and highway services will be a more prominent consideration than in the past.

Infrastructure investment plays a key role in economic development. Each of Arizona's economic planning initiatives highlights the important role of transportation for maintaining and enhancing Arizona's business environment:

- One of the Arizona Department of Commerce's strategic planning goals is "To contribute coordinated resources to enhance the state's physical infrastructure, increase the availability of affordable housing, and promote the intelligent use of resources."

- The Arizona Strategic Planning for Economic Development process includes physical infrastructure as one of seven key foundations for developing industrial clusters, citing "The fundamental public facilities such as roads and mass transit … which transform raw land into a quality place to live and do business."

- A recent Arizona Partnership for the New Economy briefing note, "A well-maintained infrastructure, from airports to roads – for the movement of goods and people – is an important element of the new economy. Entrepreneurial activity is often more concentrated around areas with accessible and efficient airports."

- The University of Arizona Office of Economic Development lists advanced transportation infrastructure as one of five key areas for evaluating Arizona's competitiveness in capturing increased trade and economic development opportunities with Mexico.

2.2.6 The Urban/Rural Dichotomy in Arizona

Nearly two-thirds of Arizona's population live in metropolitan Phoenix. Arizona's four largest metropolitan areas (Phoenix, Tucson, Yuma, and Flagstaff) account for over 85 percent of the state's population. Compared to other similarly-sized Western states, Arizona's population is much more highly concentrated. Only Nevada, with over three-quarters of the population in Las Vegas and 95 percent in Las Vegas and Reno, is more concentrated. Utah, Colorado, and Washington all are somewhat less concentrated, though nearly 60 percent of these states' residents live in the largest metropolitan area. Idaho and New Mexico have much lower concentrations of residents in their largest urban areas (33 and 40 percent, respectively). Similarly-sized states in the South and Midwest are much less concentrated, with only 20 to 30 percent of their populations living in the largest metropolitan area.

State transportation planning should remain cognizant of two fundamentally different sets of issues and challenges facing urban and rural Arizona – persistent challenges to rural transportation systems and evolving challenges to urban areas. The future threats to the system listed above are largely urban threats. Continuing issues with mobility and other issues in rural Arizona remain on the agenda, and the state will need to be aware of its efforts to deal with them. But we believe the issues in rural areas are much less dynamic, that is, will change far less over the timeframe of the plan. Similarly, we need to consciously address the question of what is the appropriate level of attention, effort, and resources to assign to the rural (non-interstate) transportation system.

2.2.7 Threats and Opportunities

As a state undergoing substantial changes to its population, economy, and environment, Arizona faces a series of challenges to its transportation infrastructure. These changes and challenges create threats to the transportation system that ADOT will likely face as it undertakes any major planning effort. While the discussion above outlines these threats in general terms, the following points offer more specific examples of threats and challenges facing Arizona in the future. This information will be used to help craft generalized goals (e.g., "Protect functionality and performance of freight corridors") and objectives (e.g., "Minimize the impact of local congestion on highways that serve major intrastate and interstate freight movements").

- The I-10 corridor is the major corridor for the movement of domestic freight from Texas to California. Passing through Phoenix, this corridor will be substantially affected by increases in population, trade, and traffic congestion in the Phoenix metropolitan area.

- Arizona's largest trading partner (by value) is Asia (32 percent), not Mexico and Latin America (combined 26 percent). Continued growth of Southern California ports has a direct effect on Arizona's economic position.

- U.S. Route 95 in Yuma County and I-19 near Nogales represent potential major corridors for the movement of international trade. As Arizona pursues a strategy to connect manufacturing in Sonora, Mexico to suppliers in Arizona, these facilities will face increasing strains.

- International goods movement through these corridors will also put additional strains on roadways in and around Phoenix and Tucson as they make their way to destinations in other states.

- A joint planning effort by Arizona, several other U.S. states, Canada, and Mexico identified the CANAMEX corridor as a major north-south route NAFTA-related goods movements between the Mexico, the United States, and Canada. This passes through Arizona and provides important opportunities for the development of international and national freight movements and economic development in Arizona.

- The Phoenix metropolitan area is the most populous area of the state and is growing rapidly. Phoenix will face major challenges on its ability to maintain the efficient movement of residents to and from their jobs. To a somewhat lesser extent, residents of Tucson, Flagstaff, and Yuma face similar issues.

- Phoenix was chosen in 1996 as one of four ITS Model Deployment Initiative sites. Through several planning efforts, ADOT and the Maricopa Association of Governments have developed a strategic plan for ITS deployment. These planning efforts and the resulting ITS architecture provide opportunities for enhancing the movement of automobiles and freight in the Phoenix metropolitan area.

- Changing technologies and oil production could have massive effect on the use of Arizona's primary mode of transportation, the automobile. An oil shock could substantially impair the ability of Arizonans to get around the state. At the same time, improving fuel technologies can lower the financial and environmental costs of using automobiles.

- Natural features and American-Indian reservations put constraints on the growth in the Phoenix metropolitan area. Most new development will likely occur to the west and north along the I-17 corridor. This new development may cause increased strain on the current transportation system as access to certain major destinations – downtown Phoenix for example – becomes more congested.

- Arizona's metropolitan areas, Phoenix in particular, have relatively limited transit services. Phoenix has a one-half or a one-third the per capita miles of transit service as other similarly-sized western cities, according to a recent Morrison Institute report. As a major destination for immigrants with somewhat less education, income, and lower rates of auto ownership, urban Arizona will feel increased pressure to improve its current transit system. Some notable steps are being made to improve transit service. The new light-rail line in Phoenix is an example of this, though its service catchment area does not include many lower-income neighborhoods.

- Arizona's smaller metropolitan areas also face growth constraints and challenges from a changing economy. According to current economic planning efforts, Flagstaff, the I-17 corridor between Phoenix and Flagstaff, and Sierra Vista in Southeastern Arizona are seen as viable destinations for high-tech, back office, and related industries. (A major call center was recently located in Sierra Vista.) Transportation facilities in these areas may require some special attention to cope with a changing economy.

- Growth in Arizona's metropolitan areas presents threats to the desert ecosystem that is one of the major factors of Arizona's high quality of life. Arizona's transportation infrastructure can play an important role in preserving quality of life through linkages with effective land use planning and open space preservation efforts.

- Three-quarters of Phoenix residents drive single-occupant vehicles (SOVs) to work. Similar SOV usage occurs in the Tucson region. With explosive population and economic growth likely to continue over the next several decades, these habits will create serious threats to the improvements in air quality realized over the last several decades. Phoenix and other metropolitan areas will have to evaluate policies on transportation demand management strategies, including ridesharing, land use development, and parking management policies, as central business districts become more congested.

- New standards for air quality – an eight-hour ozone standard and a fine 2.5-micron particulate meter standard – will create compliance issues for Phoenix and some other areas of the state, presenting a challenge to the transportation system and to funding.

- All of Arizona's governmental programs face threats from the narrowness of the tax base. Sales tax revenues comprise 62 percent of Arizona's local tax base, compared to over 27 percent nationally. A Morrison Institute report, *Five Shoes Waiting to Drop on Arizona*, notes that reduced income taxes and vehicle license fees, combined with numerous exemptions, have created substantial challenges for every Arizona state department.

- Arizonans see serious threats to their quality of life. In a 1999 survey by the Morrison Institute, nearly one-half of all Phoenix metropolitan area residents said they would leave the metropolitan area if they could. Residents give poor marks to many aspects of the region's infrastructure, including the transit system; and a majority of residents think that the quality of life has worsened in recent years. Though transportation is only one piece of this puzzle, it points towards the importance of paying attention to quality of life issues.

- Arizona, like other states, faces increased concerns about security and terrorist threats. These threats have not taken concrete form in Arizona, but they will continue to shape the face of planning over the next several years.

These key threats and opportunities provide the context for the long-range plan. A synthesis of the information that comes directly from the synthesis of the issues papers can be found in Appendix B.

2.3 Examples of Other Statewide Vision Processes

In addition to building a strong understanding of the context for planning inside Arizona, we sought to understand the larger planning context within which the state is operating. Because every state in the U.S. must produce a long-range transportation plan and update it regularly, there are numerous possible states to use as benchmarks for statewide planning. We chose to look at two groups of states for their relevance to the MoveAZ Plan:

1. States that, geographically speaking, are peers of Arizona and may face some of the same general issues with population growth, economic change, and others described above; and

2. States that have pioneered vision-based transportation planning and may provide examples that Arizona would like to emulate.

This section presents a review of both of these exercises.

2.3.1 Review of Peer States

A survey of other Southwestern and Rocky Mountain states revealed that most states are thinking about or starting to develop vision-related planning processes. Only Idaho has

already completed a visioning process, and both New Mexico and Utah are in the early stages of developing strategic visions for their states.

Each of these states has a different process for creating a strategic vision. Utah is at an early stage of plan development; they have nearly completed an internal review of past studies and developed a preliminary vision statement that will undergo public review in the next several months. In this respect, the process used in Utah is similar to that selected by ADOT. New Mexico is using a decentralized process, in which each of seven regions will develop separate vision statements in the process of updating the New Mexico statewide plan.

Utah

Utah is currently in the process of updating their statewide plan. Part of this process involves developing a strategic vision for transportation. At this point, they have completed an internal process to develop a vision that involves the Utah Department of Transportation (UDOT) employees and representatives from regional planning organizations and traffic safety groups. No documents are publicly available yet, but once the internal work on the vision is complete, the UDOT will start a public involvement process. The vision was developed from previous public involvement processes.

The basic elements of the vision include mobility and access, safety, and a maintenance first approach with additional projects planned based on realistic funding possibilities. They also have developed at the center of their vision a "context sensitive solutions initiative." This initiative is part of a federal pilot project on context-sensitive design, which the UDOT has expanded to include the entire planning process. The UDOT involved stakeholders at the beginning of given planning process to enable more efficient planning development.

New Mexico

New Mexico is currently in the process of updating their statewide plan. They plan to include a vision development process in this update, but are still preparing that process. The update of the plan will take place regionally, with each of seven regional planning organizations undertaking its own public involvement and visioning processes. This process is at an early stage of development.

Idaho

Idaho has a transportation planning effort dating from 1995 that develops a transportation vision, goals to reach that vision, and objectives and strategies to achieve those goals. The plan also required the development of performance measures to assess the attempt to reach the goals.

Three basic issues guided the development of the Idaho transportation vision – economic development (increased trade, tourism, travel, and communication); growth management (coordination of transportation and land use); and air quality. The Idaho's process was

bottom up – they relied on work already done by regional planning organizations that was then used to develop the issues, vision, and goals.

The vision statement developed by the Idaho DOT: *Idahoans in the future will see a modern, balanced, and integrated multimodal transportation network that is efficient, safe, and protects and enhances the environment. This system will be managed to address future traffic growth, improve air quality, and use energy more efficiently.*

2.3.2 Vision-Based Planning Pioneers

Four states were chosen as examples of different ways to conduct vision-based planning. These states used a process similar to that of Arizona, involving the development of a strategic direction that forms the foundation for the plan. These states provide different ideas about the best way to develop a vision or mission statement. The four state plans selected for this review included:

1. Washington State Transportation Plan (2001);
2. Pennsylvania DOT: Strategic Performance Measurement (2000);
3. Florida Transportation Plan (1995); and
4. Oregon Transportation Plan: Policy and Multimodal System Elements (1992).

These four states each had fairly different experiences developing their vision-based plans.

Washington used the vision process to produce multiple alternative visions that were presented to regional planning organizations, the governor's office, key stakeholders, the business community, and residents. WashDOT produced two alternate scenarios: 1) a trend scenario that allowed development to continue as it was and 2) a livable future that identified a balance of key elements that statewide planning should consider. For Washington, the key elements included "vibrant communities," a "vital economy," and "a sustainable environment." These three vision principles formed the structure of a strategic direction and were used to develop vision outcomes and service objectives.

Pennsylvania's performance measurement system includes a relatively simple vision statement that requires PennDOT to provide a transportation system and services that "exceed the expectations of those who use them." To achieve this, PennDOT identified eight strategic focus areas – maintenance, quality of life, mobility and access, customer focus, innovation and technology, safety, leadership at all levels, and relationship building. Each of these eight areas has specific goals for the department to achieve. These include both internal management considerations and external facility conditions concerns.

Florida developed a mission statement that more clearly identifies the specific goals that the Department of Transportation should achieve, including safety, interconnection, mobility, economic prosperity, and environmental quality. Elements of the mission

statement are directly mapped to more specific long-range goals and even more specific long-range objectives.

The Oregon Transportation Plan used a tiered approach that started from a general and became more specific. This includes a policy element, a multimodal system element, a series of modal and multimodal plans, and a series of multimodal corridor plans. The policy element included a fairly general vision statement that acts as the framework for all other components of these plans. The mission statement is further linked to broad goals. The other elements of the plan provide greater specificity for these goals, linking them to more specific objectives, as well as programs and projects.

Each of these states has developed some version of a strategic direction process that provided useful examples for the Arizona statewide plan. The success of these planning efforts is that they provide a relatively clear and concise structure for the organization of long-range planning activities in the state. A more detailed review of each of these states planning processes can be found in Appendix C.

3.0 Data and Modal Profiles to Support the MoveAZ Plan

3.0 Data and Modal Profiles to Support the MoveAZ Plan

In addition to developing the strategic direction, Phase I included the review and synthesis of relevant transportation data sources that will be used to support the development of the MoveAZ Plan. The results of the data synthesis will be used to build a comprehensive multimodal transportation system inventory to support the development and analysis of the programs and projects evaluated as part of the MoveAZ planning process.

The MoveAZ plan will utilize data from ADOT, metropolitan planning organizations and councils of government (MPOs/COGs), and other relevant agencies. A detailed review of the data sources used to create the modal system inventory can be found in Appendix D.

This section also presents the Task 4 modal and system profiles for the MoveAZ Plan. The inventory presents the current Arizona transportation system by the following categories:

- Modal profiles;
- System element profiles; and
- Special land area profiles.

Modal profiles relevant to the movement of passengers and freight are presented below for highway, transit, railroad, aviation, and bicycle and pedestrian modes. Three other key elements of the state's system – international ports of entry, intermodal facilities, and intelligent transportation systems – are presented in the section describing system element profiles. Finally, a summary of transportation systems on federally-owned and federally-recognized tribal-owned lands is presented.

Each summary presents a description of the existing network or system conditions, the utilization and demand of that system, and its performance under the current conditions. The types of data in the inventory used to create the summaries, their sources, and their formats are described in each mode. These data are currently maintained and available for use in the planning process, and will serve as the foundation to prepare the MoveAZ Plan.

3.1 Modal Profiles

Modal profile summaries for Arizona's highway, transit, rail, air, and bicycle and pedestrian modes and the transportation system inventory and data for each are presented in this section.

3.1.1 Highway

Of all the components of Arizona's transportation system, the roadway network is the largest and most extensively used: most residents and visitors of Arizona travel by private automobile. On average, over 125 million vehicle-miles are traveled per day on Arizona roads.

The system consists of over 58,000 miles of roadway, or over 82,000 lane-miles. Two percent of the entire state network are interstate highways, three percent of the road-miles are U.S. routes, and nearly six percent are state routes. Though only 12 percent of the total highway network are owned by ADOT, over 57 percent of the daily vehicle miles of travel (DVMT) occur on these roads. The Interstate System – also owned by ADOT – carries 28 percent of all DVMT. Over the last 10 years, DVMT has nearly doubled on the Arizona state highway system, including interstates. Most of the remaining travel occurs on municipally-owned roads. Figure 3.1 shows the state-owned highway network by functional class, and Table 3.1 lists DVMT and mileage by jurisdiction ownership (federal, ADOT, county, and city).

The roadways in Arizona are in excellent condition. About 79 percent of the ADOT-owned highway network have pavement that is in good or excellent condition, compared to only 52 percent in Colorado. Approximately 99 percent of the Interstate System are in good condition or better; and about 86 percent of other freeways have comparable pavement conditions. Approximately 80 percent of principal arterials are also in good or excellent condition.

In rural Arizona, four percent of DVMT occurred on roads with a level of service (LOS) of "D" or worse. In urban areas, though, almost 14 percent of daily vehicle miles were traveled on congested roads with a LOS of "D" or worse. The Phoenix metropolitan area has some of the highest traffic volumes in the state, with average annual daily traffic (AADT) on some segments of Interstate 10 reaching 265,000 vehicles. This is a significant increase in 193,221 vehicles per day traveling along Interstate 10 in Tempe only 10 years ago. Other western cities, such as Denver, experience highway traffic of a similar magnitude – segments of Interstate 25 in Colorado experienced up to 243,000 vehicles per day.

Figure 3.1 Arizona State Highway System by Functional Class

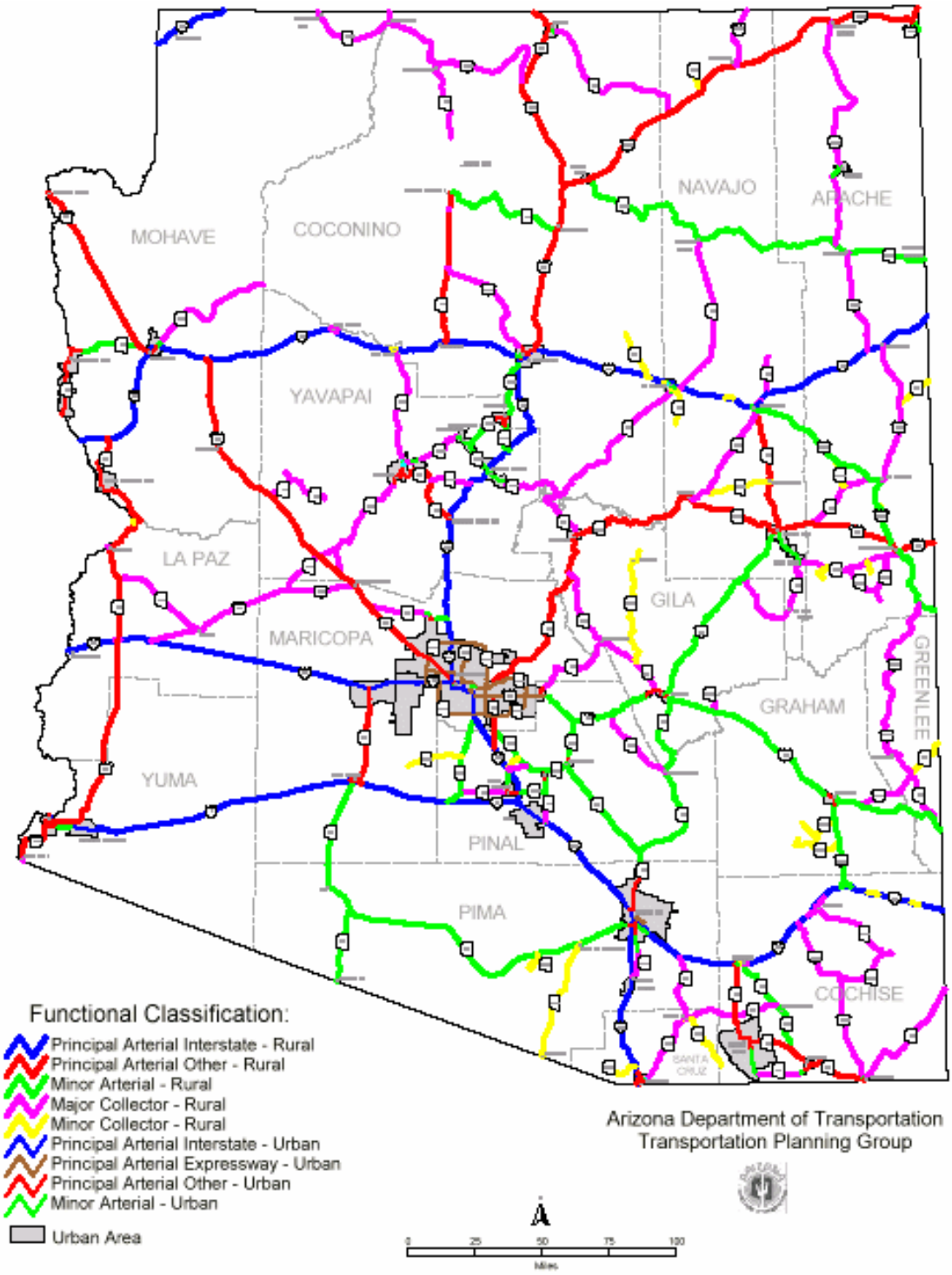


Table 3.1 Highway Miles and DVMT by Ownership

Highway Owner	Miles of Highway	DVMT	% of DVMT
Federal (BLM, NFS)	14,744	1,622,509	1.3
State DOT	6,696	71,671,458	57.3
County DOT	19,158	10,792,387	8.6
Municipal DOT	17,499	41,025,676	32.8
Total	**58,097**	**125,112,030**	**100.0**

Source: ADOT HPMS.

About 12 percent of the DVMT in Arizona were a result of truck traffic. Approximately 96 million tons of cargo originating in Arizona were shipped by truck in 1997 (79 percent of all cargo originating in the state), resulting in 10.6 billion ton-miles traveled: a considerable strain on the highway network. As shown in Table 3.2, non-metallic minerals constituted the largest type of commodity moved by truck in Arizona.

Table 3.2 Truck-Hauled Commodities Originating in Arizona

Commodity	Tons	Percentage
Non-metallic minerals	18,806,000	19.6
Natural sands	8,430,000	8.8
Foodstuffs, fats, and oils	6,432,000	6.7
Gasoline and aviation turbine fuels	5,611,000	5.8
Gravel and crushed stone	5,000,000	5.2
Other	51,789,000	53.9
Total	**96,068,000**	**100.0**

Source: ADOT and BTS.

In 1999, 62,411 injuries and 842 fatalities were reported as a result of highway crashes that occurred in the state. This results in an injury rate of almost 500 per million vehicle miles (MVM), and a fatality rate of about six per MVM.

Table 3.3 presents the sources of information used to prepare the highway modal profile prepared in this report. Additional information obtained in the MoveAZ Plan's technical tasks will be used to supplement this database of current information. For example, the Reebie Transearch Database that considers current commodity movements by truck will be used to supplement the freight data from the Bureau of Transportation Statistics (BTS) used to prepare this inventory. The other primary sources used to develop this modal

profile and system inventory included the Highway Performance Monitoring System (HPMS), Safety Management System, and the Arizona Transportation Information System (ATIS).

Table 3.3 Highway Data in Inventory

Data	Source	Format
Highway physical condition, operations, performance	HPMS	Database
Highway accidents	ADOT Safety Management System	Database
Highway network	ATIS	GIS
Truck-hauled commodities	BTS	Table

Source: ADOT and Cambridge Systematics, Inc.

3.1.2 Transit

While the majority of passenger travel in Arizona takes place by private automobile, public transportation provides an important mobility alternative for those who cannot or choose not to drive. In major cities, such as Phoenix and Tucson, public transportation helps to reduce traffic congestion and improve air quality. Arizona is served by public transportation services ranging from intercity services connecting cities to local services connecting homes with jobs, shopping, medical services, and other destinations. All communities with current transit services are listed in Table 3.4.

Intercity Passenger Bus

Greyhound Lines provides the majority of long-distance bus service in Arizona in terms of both destinations served and service frequency. Greyhound serves 48 communities, including airport connections at Phoenix Sky Harbor and rail connections at Benson and Tucson. Most of its routes operate in interstate highway corridors, with the greatest frequency of service in the I-10 corridor. Greyhound operates approximately 18 one-way trips per day between Phoenix and Tucson.

There are also five regional bus operators that provide scheduled service, tours, and/or charters. For example, K-T Services operates interline service with Greyhound between Phoenix and Las Vegas. Some rural transit operators, such as Hopi Senom Transit System, Navajo Transit System, and Sunsites Transportation, provide scheduled service to major cities. Some tour companies, such as Gray Line Tours, operate scheduled tours to major attractions from larger cities.

Table 3.4 Arizona Communities with Transit

Community	Urban and Regional	Rural and Small Town	Elderly and Disabled	Map Label in Figure 3.2
Apache Junction			X	51
Bisbee		X	X	9
Bullhead City		X	X	6
Camp Verde			X	26
Casa Grande			X	53
Chandler			X	36
Chinle			X	21
Coolidge		X	X	5
Cottonwood		X		13
Douglas			X	17
Duncan			X	43
Eloy			X	54
Flagstaff	X		X	4
Florence			X	52
Ganado			X	22
Globe			X	20
Grand Canyon		X		15
Green Valley			X	30
Hayden			X	40
Holbrook			X	18
Hopi Reservation		X	X	57
Kearny			X	49
Kingman			X	24
Lake Havasu City		X		12
Lakeside		X		14
Mammoth			X	48
Mesa			X	35
Miami		X	X	8
Nogales			X	45
Oracle			X	47
Parker			X	28
Patagonia			X	46
Payson			X	41
Peach Springs			X	55
Peoria			X	37

Table 3.4 Arizona Communities with Transit (continued)

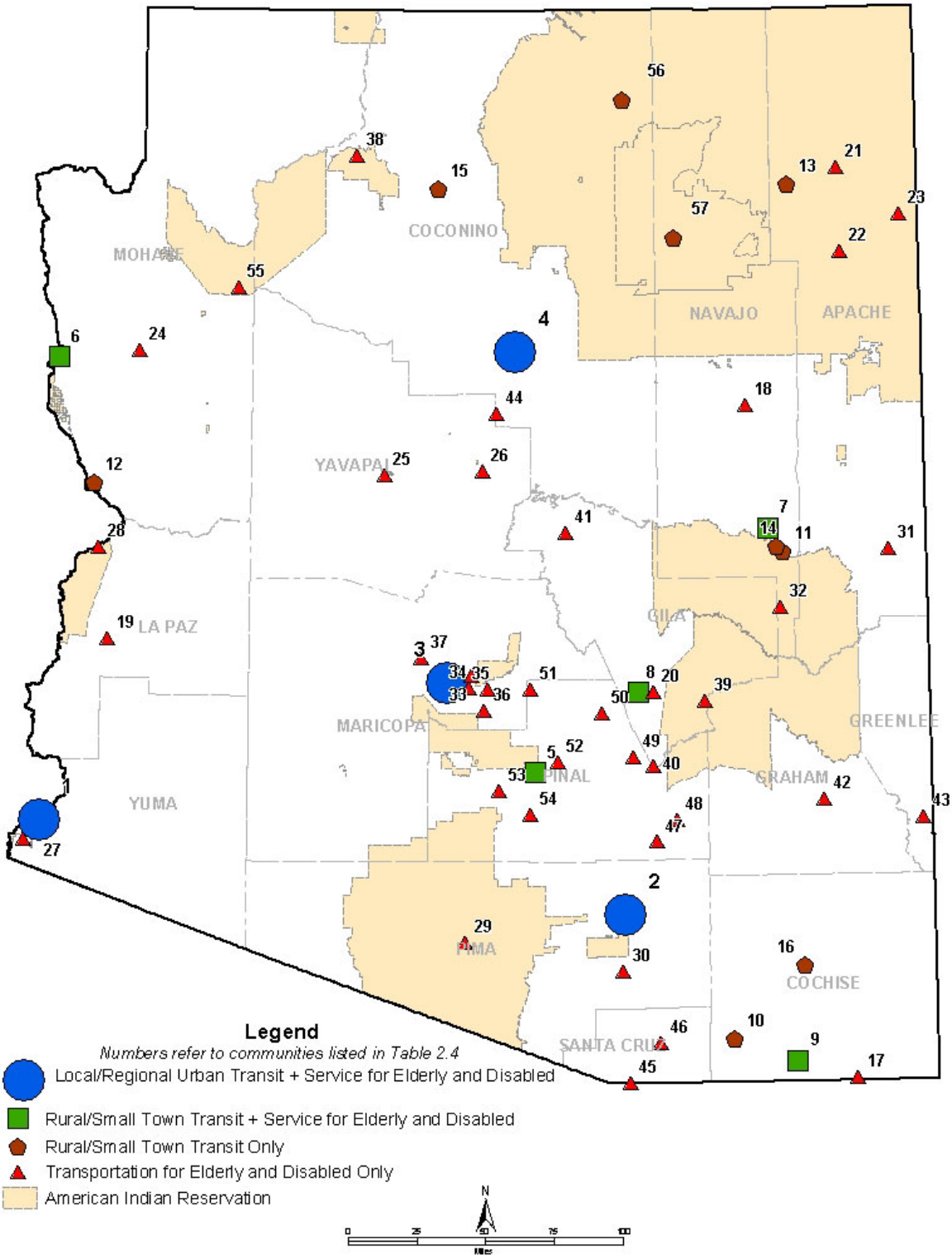
Community	Urban and Regional	Rural and Small Town	Elderly and Disabled	Map Label in Figure 3.2
Phoenix	X		X	3
Pinetop		X		11
Prescott			X	25
Quartzsite			X	19
Safford			X	42
San Carlos			X	39
San Luis			X	29
Sawmill			X	23
Scottsdale			X	33
Sedona			X	44
Show Low		X	X	7
Sierra Vista		X		10
Somerton			X	27
Springerville			X	31
Sunsites		X		16
Supai			X	38
Superior			X	50
Tempe			X	34
Tucson	X		X	2
Whiteriver			X	32
Yuma	X		X	1

Source: Cambridge Systematics, Inc.

Local and Regional Urban Transit

As shown in Figure 3.2, Arizona has urban public transportation systems in four metropolitan areas with populations over 50,000: Phoenix, Tucson, Flagstaff, and Yuma. In Phoenix, the Regional Public Transportation Authority (RPTA) provides a unified structure for numerous municipal transit services, while operating various services of regional significance. The cities of Phoenix, Mesa, Tempe, Scottsdale, Chandler, Peoria, Gilbert, Glendale, Avondale, and El Mirage participate in the RPTA with Maricopa County. Municipal transit services funded by these cities and regional transit services funded through the RPTA operate under the Valley Metro brand. The Valley Metro system includes 59 fixed routes that operate primarily on arterial streets, 21 limited-stop express routes, and 11 demand response services that provide door-to-door service on request.

Figure 3.2 Arizona Transit Services



The RPTA is also sponsoring the design of the state's first light-rail transit system, scheduled to open in late 2006. Municipalities, such as Glendale, Phoenix, and Tempe, also operate circulator services in their central business districts. Arizona State University operates two shuttle routes between its campuses. The Salt River Transit System provides route deviation transit services on three routes and demand response service in rural areas on the fringe of the Phoenix metropolitan area.

The city of Tucson, under the SunTran brand, operates 28 fixed routes and nine limited-stop express routes. Under the VanTran name, the city also provides demand response service to persons with disabilities. The city also operates three circulator routes in the downtown Tucson area known as Tucson Inner City Express Transit (TICET). The University of Arizona operates five CatTran shuttle routes in the vicinity of its Tucson campus. The town of Oro Valley provides the CoyoteRun demand-response service for the elderly, those with disabilities, and those with low income. Pima County operates fixed route transit service on four fixed routes in rural areas surrounding Tucson.

In Flagstaff, Coconino County operates four fixed routes known as Mountain Line Transit. The county also operates the VanGo demand response service for persons with disabilities, but serves the general public when space is available. Northern Arizona University operates Mountain Campus Transit on four fixed routes on and near its campus.

The Yuma Metropolitan Planning Organization (YMPO) operates two fixed routes under the Valley Transit name. The YMPO also operates a demand response service for persons with disabilities.

Rural and Small Town Transit Services

Thirteen communities in rural and small urban areas of Arizona with under 50,000 people provide transit services that are eligible for federal funding under the Section 5311 program. Transit services in these areas generally operate less frequently and in a more flexible manner than their counterparts in urban areas. Demand response services that provide door-to-door service with advance reservations are provided in Cottonwood, Lake Havasu City, and Miami. Route deviation services in Bisbee, Coolidge, Sierra Vista, and Sunsites operate on established routes, but deviate on request to pick up or drop off customers at locations within a specified service area. The Hopi and Navajo Nations both provide fixed-route service between cities on and around their reservations. The Four Seasons Connection provides fixed-route service on two connected routes, one each in Showlow and Pinetop-Lakeside. In addition, the National Park Service operates free shuttles between parking areas and attractions in the Grand Canyon National Park.

Transportation for the Elderly and Persons with Disabilities

More than 100 private non-profit and public agencies that provide transportation to the elderly and persons with disabilities are eligible for federal funding for vehicle purchases under the Section 5310 program. Locations of these agencies are shown in Figure 3.2.

Table 3.5 presents the sources of information used to prepare the transit modal profile presented in this report. Additional information obtained in the MoveAZ Plan's technical tasks will be used to supplement this database of current information. For example, the recent analysis of high-speed rail between Phoenix and Tucson and the statewide passenger rail feasibility study will be used to supplement the transit data contained in this profile. The other primary sources used to develop this transit modal profile and system inventory included the National Transit Database (NTD), the American Public Transportation Association (APTA), and information provided by various local agencies and transit operators.

Table 3.5 Transit Data in Inventory

Data	Source	Format
Vehicle data, system ridership, system expenses	NTD	Database
Transit systems by service area	APTA	Database
Routes, service type, frequency, fare, other operational data	ADOT, city, and transit agency web sites	Database

Source: ADOT and Cambridge Systematics, Inc.

3.1.3 Railroads

Arizona currently contains 2,654 miles of actual track, including mainline, spurs, and yards. Railroads operate 1,909 actual route-miles of track. Approximately 738 miles of this network are owned and/or operated by the Union Pacific railway; the Burlington Northern Santa Fe railway owns and/or operates 595 route-miles of Arizona track; and the majority of remaining route-miles are operated by various local and switching and terminal railways. A very small amount of track is operated by the U.S. government or is recreational in nature. All current Arizona rail lines are shown in Figure 3.3. According to the Federal Railroad Administration, there are 1,639 highway-rail crossings in the state of Arizona: 940 of these are public and 692 are private.

In 2000, Arizona freight railways, operated by 2,528 in-state employees, carried 103 million tons of cargo in 4.2 million carloads. The most prominent commodities were glass and stone products, constituting 25 percent of all freight rail commodities originating in Arizona; and coal, constituting 46 percent of all freight rail commodities terminating in Arizona. Actual tonnages for all major freight rail commodities originating or terminating in the state are listed in Table 3.6.

Figure 3.3 Arizona Rail Lines and Passenger Stations

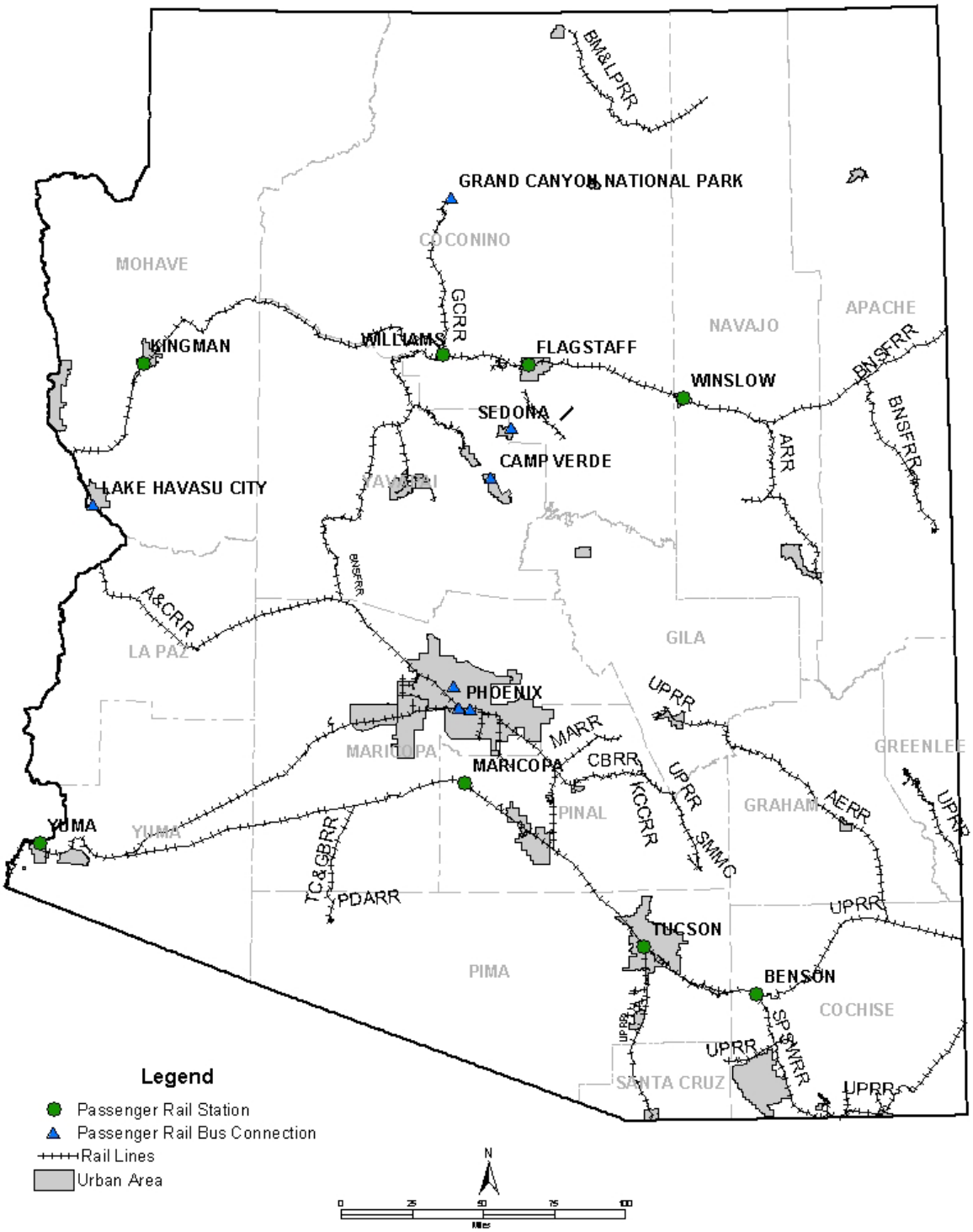


Table 3.6 Commodities Originating and Terminating in Arizona (2000)

Tons Originated			Tons Terminated		
Commodity	**Tons**	**%**	**Commodity**	**Tons**	**%**
Glass & Stone Products	1,433,216	25	Coal	11,351,213	46
Metallic Ores	935,096	16	Glass & Stone Products	1,895,112	8
Primary Metal Products	847,620	15	Chemicals	1,804,376	7
Waste & Scrap Material	544,928	9	Farm Products	1,506,564	6
Chemicals	423,472	7	Lumber & Wood Products	1,358,880	6
Other	1,647,591	28	Other	6,787,972	27
Total	**5,831,923**	**100**	**Total**	**24,704,117**	**100**

Source: American Association of Railroads.

Amtrak provides intercity rail services on two east-west routes through Arizona. The Southwest Chief provides daily service between Chicago and Los Angeles with stops in Winslow, Flagstaff, Williams, and Kingman. The Sunset Limited between Orlando and Los Angeles and the Texas Eagle between Chicago and Los Angeles each provide service three days per week with stops in Benson, Tucson, Maricopa, and Yuma. Eight other Arizona locations are also accessible to these lines via bus connections.

The majority of passenger rail stations in terms of facilities are in Tucson and Flagstaff. Total annual passengers passing through these stations were 25,700 and 44,900, respectively, in 2000. Annual passenger counts for all Arizona rail stations are listed in Table 3.7. Station locations are depicted in Figure 3.3.

The Grand Canyon Railway and Resort operates one round trip per day between Williams and the Grand Canyon National Park. The service connects with Amtrak at Williams, but its schedule is not coordinated with the national trains.

Higher-speed rail has been a subject of study for more than a decade. In 1998, ADOT completed a feasibility study for rail services in the Phoenix-Tucson corridor that would be faster than highway travel. The study recommended a phased introduction of passenger service along the existing Union Pacific freight railroad alignment that includes minor track upgrades and trains running at up to 100 miles per hour with conventional diesel-electric locomotives in the short term. Over time, a partially elevated electric railway would be constructed that would minimize conflicts with freight trains and permit operating speeds as high as 125 miles per hour.

In 2000, 60 rail-related accidents occurred in the state of Arizona, three of them at highway-rail crossings. As a result of these accidents, six people died and another 10 people were injured.

Table 3.7 Annual Passenger Rail Counts in Arizona

Railway	Station	Passenger Count
Sunset Limited (UP)	Benson	1,900
	Tucson	25,700
	Yuma	2,500
	Phoenix (connecting bus service)	7,950
Southwest Chief (BNSF)	Flagstaff	44,900
	Kingman	3,100
	Winslow	2,200
	Grand Canyon (connecting bus service)	400
	Phoenix (connecting bus service)	450
Grand Canyon Railroad	Grand Canyon	19,000
	Williams	5,000
Arizona Central Railway	Clarkdale	7,200
Total		**120,300**

Source: ADOT.

Table 3.8 presents the sources of information used to prepare the railroad modal profile prepared in this report. Additional information obtained in the MoveAZ Plan's technical tasks will be used to supplement this database of current information. For example, as with the highway mode, the Reebie Transearch Database will be used to supplement the railroad freight data used to create this profile. The other primary sources used to develop this modal profile and system inventory included the Bureau of Transportation Statistics, ADOT, Amtrak, Federal Railroad Administration, and the American Association of Railroads.

Table 3.8 Rail Data in Inventory

Data	Source	Format
Amtrak station locations	BTS	GIS
Amtrak ridership	ADOT	Table
Amtrak route information	Amtrak web site	Text
Rail line locations	BTS	GIS
Rail-highway intersections	FRA	Table
Rail ownership	AAR	Table
Rail accidents	FRA	Table
Rail-hauled commodities	AAR	Table
High-speed rail proposal characteristics	Arizona High-Speed Rail Feasibility Study	Text

Source: Cambridge Systematics, Inc.

3.1.4 Aviation

Arizona contains 83 public-use airports: 65 of these are publicly owned, one is owned by the U.S. Army, one is owned by the U.S. Navy, and the remainder are privately owned. Of this total, 11 airports are certified to handle scheduled air carrier service, including Phoenix Sky Harbor International Airport. These airports are shown in Figure 3.4. This number of airports is similar to other states of similar size, such as Colorado. Another 236 facilities across Arizona are private-use, and accommodate airplanes, gliders, helicopters, and other forms of aviation.

Sky Harbor has three runways, two of which are over 10,000 feet long. Tucson International Airport has three runways, with one being over 10,000 feet long. Yuma International Airport has the longest runway of any public-use aviation facility in the state with a length of 13,300 feet.

Approximately 20.6 million passenger enplanements were reported across 39 of Arizona's public-use airports in 2000, with the majority of that traffic occurring at Phoenix Sky Harbor and Tucson International Airports. Sky Harbor was the fifth busiest airport in the nation in 2001 in terms of operations, with 553,310 total aircraft movements; Tucson was ranked 45th. As shown in Table 3.9, Grand Canyon National Park Airport and Yuma International Airport were the third and fourth busiest airports in the state in terms of passenger enplanements.

Figure 3.4 Arizona Public Airports

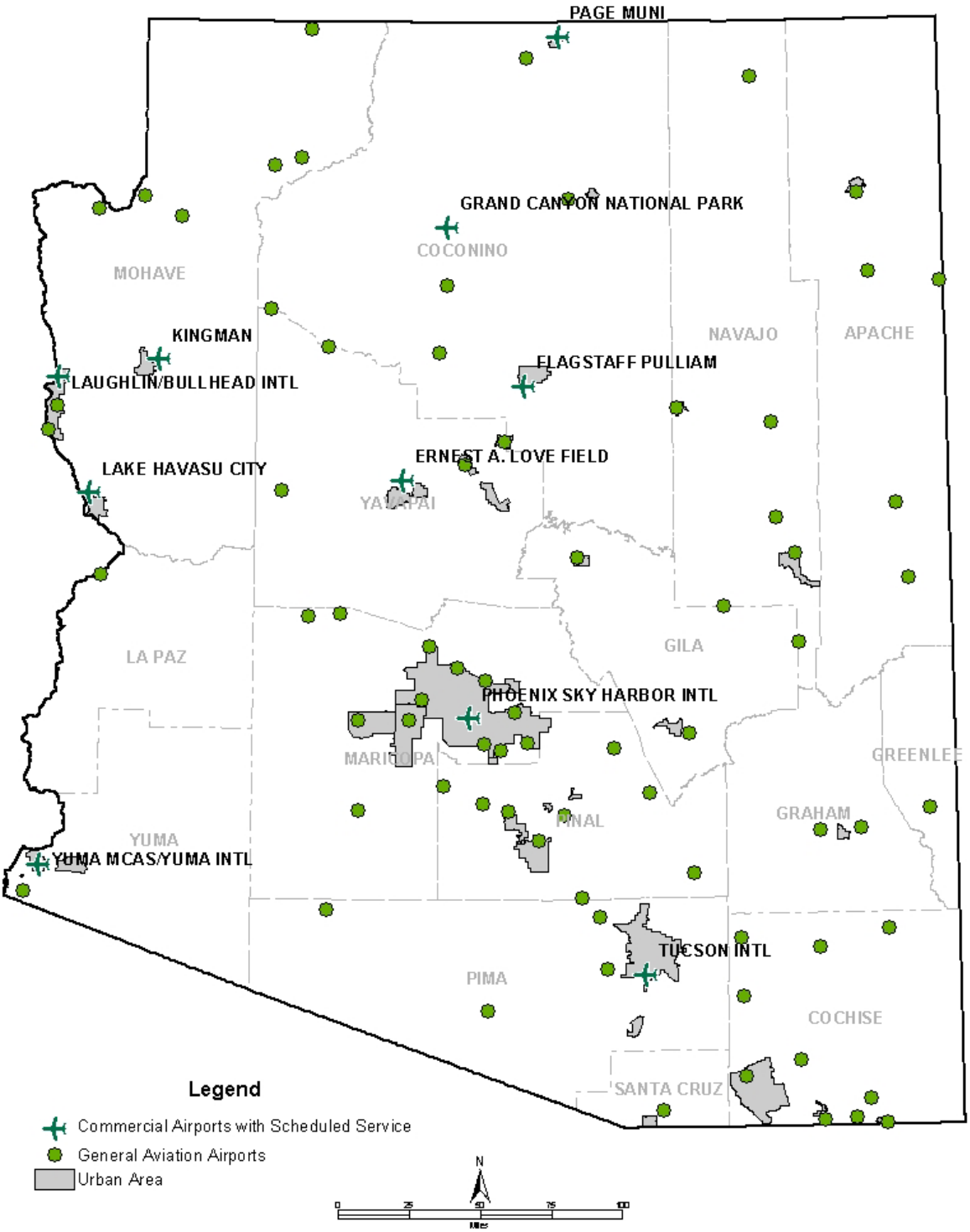


Table 3.9 Airport Enplanements in Arizona

Airport	City	Enplanements	Cargo Gross Landed Weight (lbs)
Phoenix Sky Harbor Intl	Phoenix	18,094,251	1,840,755,550
Tucson Intl	Tucson	1,804,086	284,842,400
Grand Canyon National Park	Grand Canyon	524,995	–
Yuma MCAS/Yuma Intl	Yuma	63,987	–
Laughlin/Bullhead Intl	Bullhead City	45,444	–
Flagstaff Pulliam	Flagstaff	31,603	–
Grand Canyon West	Peach Springs	18,898	–
Page Muni	Page	18,768	–
Lake Havasu City	Lake Havasu City	8,569	–
RRA Sierra Vista Muni-Libby AAF	Fort Huachuca SIE	7,559	–
Ernest A. Love Field	Prescott	6,337	–
Show Low Muni	Show Low	4,059	–
Kingman	Kingman	3,420	–
Other	–	10,771	–
Total		**20,642,747**	**2,125,597,950**

Source: Federal Aviation Administration.

Passenger enplanements in Arizona increased overall from 1999 to 2000. While many major airports realized only modest increases in that period (Denver International Airport increased by only 1.9 percent, for example), Sky Harbor's enplanements increased by 7.8 percent.

Arizona has two airports that are qualified to handle cargo planes in addition to passenger planes: Sky Harbor and Tucson International. Table 3.9 shows that Sky Harbor had 1.8 billion pounds of gross landed weight in 2000, while 285 million pounds of cargo landed at Tucson International.

Sky Harbor operates efficiently relative to other major airports of its size across the nation. In 2000, 71 percent of the flights departed their gates within 15 minutes of their scheduled departure time. On average, it took 29 minutes from the scheduled departure time to takeoff. Approximately 75 percent of arriving flights landed on time, with a mere 5.7-minute taxi time on average.

Table 3.10 presents the sources of information used to prepare the aviation modal profile prepared in this report. The primary sources used to develop this modal profile and

system inventory included the Bureau of Transportation Statistics and Federal Aviation Administration.

Table 3.10 Aviation Data in Inventory

Data	Source	Format
Airport locations and characteristics	BTS	GIS
Runway locations and characteristics	BTS	GIS
Airport operations	FAA, BTS	Database
Airport performance	BTS	Database

Source: Cambridge Systematics, Inc.

3.1.5 Bicycle and Pedestrian

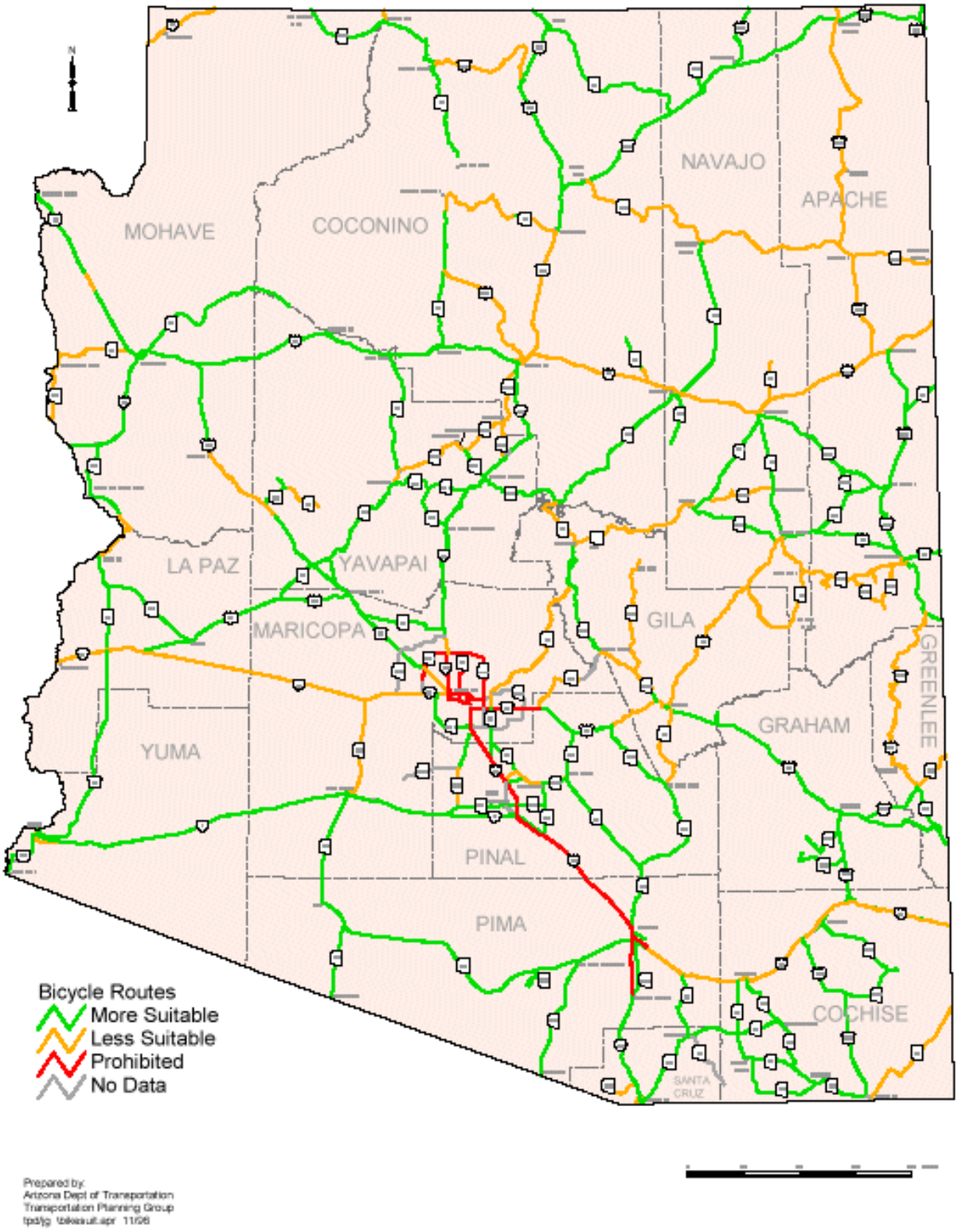
Bicycle

Over 2,000 miles of the Arizona state highway network – including Interstates, U.S. routes, and state routes – are considered suitable for bicycle traffic. Figure 3.5 depicts the bicycle suitability of the state highway network. About 60 percent of this statewide bicycle network is considered "more suitable" by ADOT classification standards. Developed in 1995, this bicycle suitability map and its corresponding classification system will be revised when the Statewide Bicycle and Pedestrian Plan is completed in 2003.

Individual metropolitan areas, such as Tucson, Phoenix, and Flagstaff, have their own bicycle networks as well. The Tucson metropolitan area has about 440 miles of on-street bikeways and 50 miles of urban and suburban paths. Almost 60 percent of the on-street bikeways are delineated by painted white lines, while 16 percent are signed bike routes, and 23 percent are simply paved shoulders suitable for bicycles. A few miles of the network are shared with bus lanes. An additional 90 miles of network are programmed to be built in the near term, and another 360 miles are planned by 2025.

There are about 22 miles of off-street bicycle paths in Flagstaff – known as the Flagstaff Urban Trail System – and another 30 miles are planned. These trails connect with surrounding recreational areas and trails. In addition, the city of Flagstaff has 21 miles of marked bicycle lanes on its street system. The Phoenix metropolitan area also has an extensive bicycle system, consisting of unpaved multi-use trails; paved multi-use paths; bike lanes on streets; and designated routes on streets.

Figure 3.5 State Highways Suitable for Bicycling



Pedestrian

Heavy pedestrian traffic exists at the ports of entry between Arizona and the state of Sonora, Mexico. A total of 8.4 million people crossed the border on foot in 1999, with the heaviest volumes at Nogales (4.8 million) and San Luis (2.7 million). See Table 3.11 for all pedestrian port of entry volumes.

Table 3.11 Arizona-Sonora Pedestrian Border Crossings

Port of Entry	Pedestrians Entering AZ
Douglas, AZ	704,973
Lukeville, AZ	78,611
Naco, AZ	64,698
Nogales, AZ	4,806,076
Sasabe, AZ	3,588
San Luis, AZ	2,721,603
Total	**8,379,549**

Source: Bureau of Transportation Statistics.

MAG has developed a pedestrian plan for the Phoenix region. Most major thoroughfares in metropolitan Phoenix currently have sidewalks. Future roadway designs will include certain pedestrian-friendly design features based on the level of expected pedestrian activity in that area, the desired pedestrian level-of-service, and roadway operational and design characteristics.

The Tucson metropolitan area has multiple shared-use paths, as well as sidewalks along most streets in Tucson and South Tucson. Existing Tucson standards require four-foot wide sidewalks in residential developments and up to eight-foot wide sidewalks for commercial and industrial developments. Subdivisions within the Tucson metropolitan area are required to build sidewalks.

Table 3.12 presents the sources of information used to prepare the bicycle and pedestrian modal profile prepared in this report. The primary sources used to develop this modal profile and system inventory included ADOT; the Bureau of Transportation Statistics; and various local and regional agencies, such as PAG. As project schedules permit, information from the ongoing Statewide Bicycle and Pedestrian Plan, to be completed by ADOT in 2003, will be incorporated into this element.

Table 3.12 Bicycle and Pedestrian Data in Inventory

Data	Source	Format
Statewide bicycle suitability network	ADOT	GIS
Tucson bicycle network	PAG	GIS
Phoenix, Flagstaff, and Tucson regional bicycle and pedestrian system characteristics	Local off-street system plans	Text
Pedestrian border movements	BTS	Database

Source: Cambridge Systematics, Inc.

3.2 System Elements

The Arizona transportation system is also comprised of several system elements not specific to any mode. A brief summary of the characteristics of each element in Arizona is presented below.

3.2.1 Intermodal Facilities

Intermodal facilities provide transfer points between different modes. Airports, which provide transfer points between air and highway, transit, or rail modes, as well as passenger rail stations, which provide for the transfer between passenger rail and highway, transit, or bicycle and pedestrian modes, are both examples of intermodal facilities. Both airports and passenger rail facilities are discussed in the "Aviation" and "Transit" modal sections, respectively; and this section will focus on freight intermodal facilities.

There are 10 major freight highway-rail intermodal facilities in the state of Arizona. Two are along Arizona & California Railway (ARZC) tracks, three are along Southern Pacific (SP) tracks (now part of the Union Pacific railway), and five service Burlington Northern Santa Fe (BNSF) tracks. Three of these facilities are container cargo facilities, three are auto vehicle transfer points (two of which allow transfer from only rail to highway), three accommodate transfer of chemicals and chemical products, and one transfers liquid edibles. These intermodal facilities are concentrated in Phoenix, with seven of them located in the metropolitan area. The remaining facilities are in Parker and Tucson. The locations of these facilities are depicted in Figure 3.6.

Figure 3.6 Intermodal Facilities in Arizona

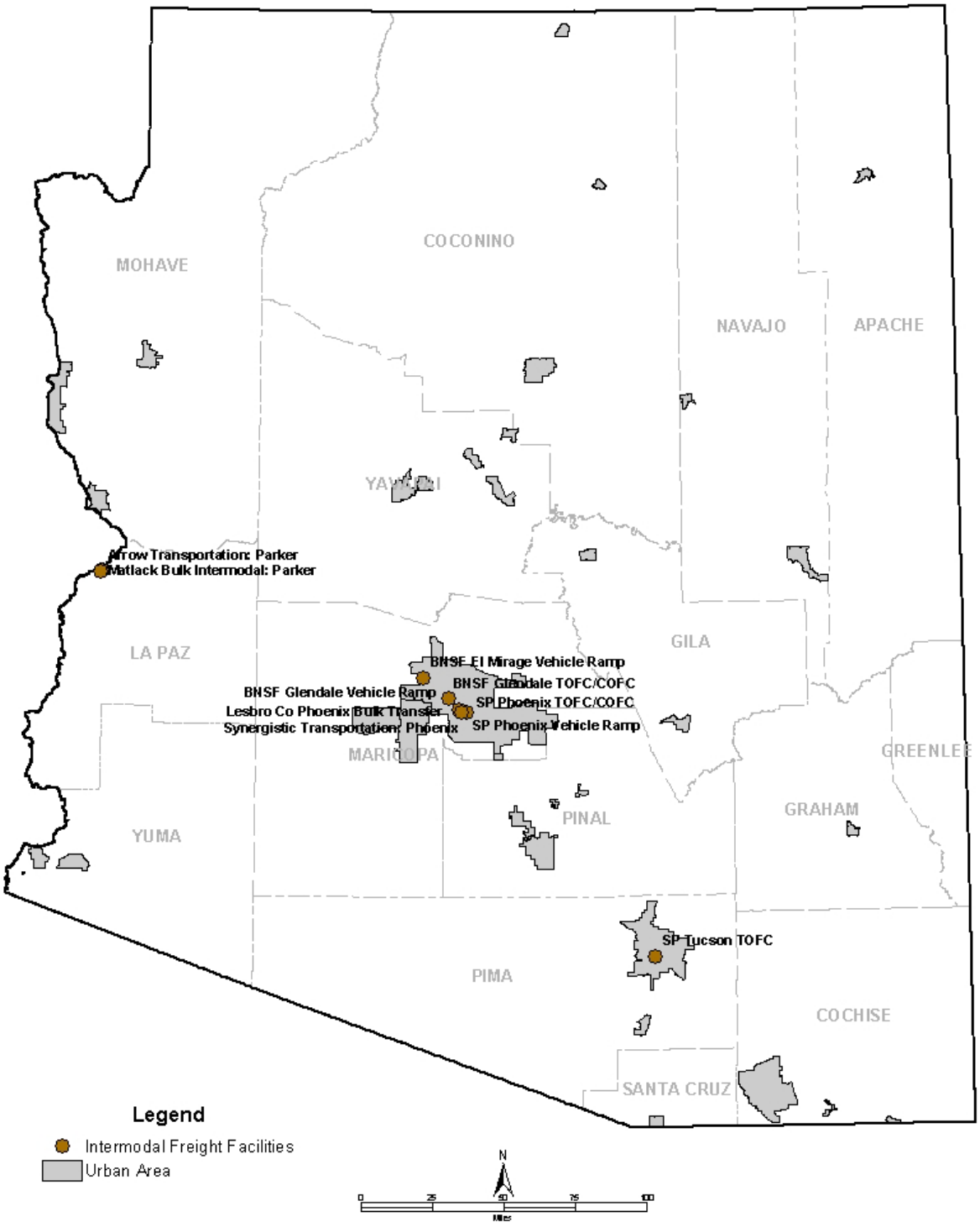


Table 3.13 shows the primary data source – Bureau of Transportation Statistics – used to prepare the intermodal facilities system inventory. As the technical analysis proceeds in Phase III of the Plan, the Reebie Transearch Data will be used to supplement the BTS data for intermodal analysis.

Table 3.13 Intermodal Data in Inventory

Data	Source	Format
Intermodal facility locations and characteristics	BTS	GIS

Source: Cambridge Systematics, Inc.

3.2.2 International Ports of Entry

Trade between the United States and Mexico is an integral part of both countries' economies, particularly after the introduction of NAFTA. Figure 3.7 shows the locations of six ports of entry between Arizona and the state of Sonora, Mexico: Douglas, Naco, Nogales, Sasabe, Lukeville, and San Luis. Nogales provides the greatest highway access, with Interstate Highway 19 and State Highway 82 on the Arizona side and a divided Mexican Federal Highway 15 on the Sonora side. San Luis can be accessed by U.S. Highway 95 in Arizona or Federal Highway 2 in Sonora. Douglas provides U.S. Highway 191, State Highway 80, and Mexican Federal Highway 2. The remaining border crossings provide only undivided state highway access.

In 1999, 9.9 million personal vehicles and 10,000 buses crossed the border into Arizona. The highest vehicular volumes occurred at Nogales, San Luis, and Douglas. Personal vehicles carried 25 million people into Arizona; buses carried 58,000; and 8.4 million people walked. This reflects an increase in traffic of all modes, except pedestrian, over the 1990s. Of the 34 million people entering Arizona, 46 percent crossed at Nogales, 28 percent crossed at San Luis, and 23 percent at Douglas. Specific volumes at each port of entry are listed in Table 3.14. Pedestrian movements are described in more detail in the "Bicycle and Pedestrian" modal profile.

As shown in Table 3.14, 348,000 trucks crossed the Mexican-American border into Arizona in 1999, with 74 percent of them passing through Nogales. This volume of trucks marks a 50 percent increase over the Sonora-Arizona traffic reported in 1991-1992. These trucks carried 242,000 loaded containers of freight. Table 3.15 shows the primary data source – BTS – used to prepare the ports of entry system inventory.

Figure 3.7 Arizona International Ports of Entry

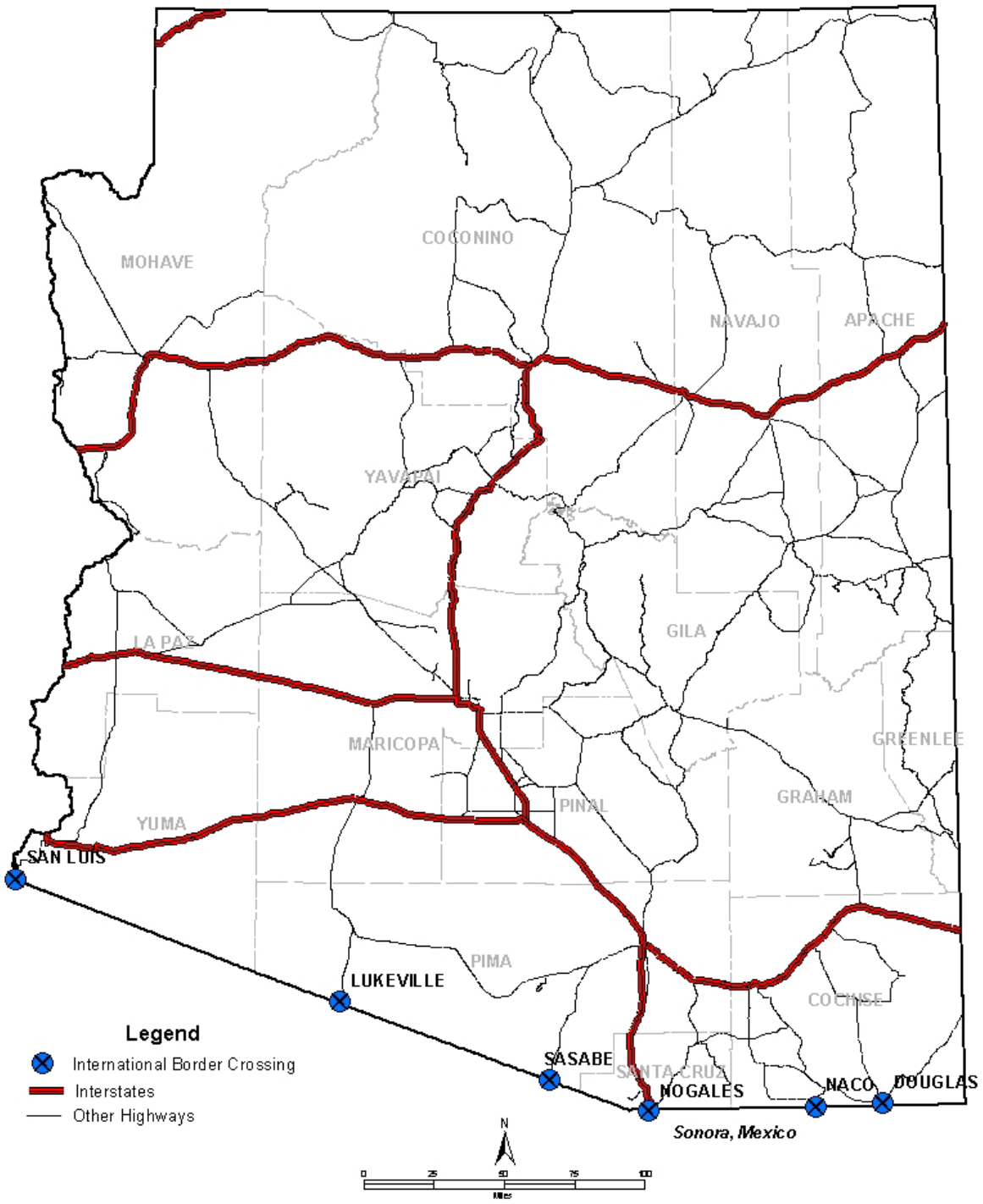


Table 3.14 Arizona-Sonora Vehicle, Passenger, and Freight Border Crossings

Port of Entry	Personal Vehicles Entering AZ	Personal Vehicle Passengers	Buses Entering AZ	Bus Passengers	Trucks	Loaded Freight Containers
Douglas, AZ	2,150,092	5,912,753	NA	3,650	32,568	14,745
Lukeville, AZ	501,345	1,373,679	495	17,796	4,291	451
Naco, AZ	326,640	849,260	NA	1,400	7,766	5,886
Nogales, AZ	4,186,962	10,489,147	5,814	34,470	256,426	200,358
Sasabe, AZ	34,942	90,848	NA	NA	2,442	891
San Luis, AZ	2,687,387	6,505,771	59	739	44,829	13,744
Total	**9,887,368**	**25,221,458**	**10,018**	**58,055**	**348,322**	**242,075**

Note: NA = Not available.
Source: Bureau of Transportation Statistics.

Table 3.15 Border Crossing Data in Inventory

Data	Source	Format
Vehicle, passenger, and freight volumes	BTS	Database
Highway characteristics at crossings	AAA	Map

Source: Cambridge Systematics, Inc.

3.2.3 Intelligent Transportation Systems

Intelligent Transportation Systems (ITS) continue to be an effective – and less expensive – alternative to construction of highways and transit lines for increasing capacity and efficiency of the existing transportation system. ITS solutions and strategies are used for safety and law enforcement issues as well. All forms of ITS are extensively used throughout Arizona, particularly in the Phoenix and Tucson metropolitan areas.

ADOT operates Sprint Ports for mobile inspections of commercial vehicles throughout Arizona, in addition to weigh-in-motion sites. The Department of Public Safety operates the ASPEN system, a roadside pen-based computer system that enables the Department to access CDLIS during roadside inspections of commercial vehicles. Other statewide commercial vehicle ITS programs include HELP/Prepass and the EPIC project.

ADOT operates 50 miles of freeway management system, 156 traffic signals, 42 vehicle message signs (VMS), and 60 closed-circuit television (CCTV) cameras in the Phoenix

metropolitan area, supported by its 24-hour traffic operations center. ADOT also provides the Arizona Local Emergency Response Team (ALERT) incident management service. Information collected through the ITS infrastructure is provided to the public via telephone or Internet.

AZTech™ is a public and private partnership designed to deploy and integrate ITS and provide real-time traveler information to the public in the Phoenix metropolitan area. Eight corridors are equipped with CCTV cameras, VMS, and vehicle detection stations. The Road Closure and Restriction System allows the reporting of conditions on arterial streets. An advanced vehicle location system was implemented on 94 buses and provides real-time information on bus location and route diversions. PHX also provides flight information to the AZTech™ database. Public information kiosks and a partnership with a local FM radio station relay collected real-time information to the public. The necessary integration of local, county, and state government agencies involved in traffic management and emergency response is completed through communications between the operations centers and the AZTech™ server, as well as an AZTech™ workstation located in every major operations center.

In addition to the city of Phoenix itself, many other jurisdictions in the Phoenix metropolitan area have implemented ITS infrastructure. The Maricopa County DOT – as well as the cities of Chandler, Gilbert, Glendale, Mesa, Peoria, Scottsdale, and Tempe – have synchronized signalization, signal preemption for emergency vehicles, and/or AZTech™ workstations. All, but Gilbert and Peoria, operate Traffic Management Centers. Most area buses are equipped with electronic fare payment systems and most demand responsive vehicles have computer-aided dispatch systems and navigation aids.

In the Tucson metropolitan area, the four main integrated components of the ITS infrastructure are the Transit Management System (TMS), the Arterial Traffic Management System (ATMS), the Freeway Management System (FMS), and the Regional Traveler Information Center (RTIC). The TMS includes AVL units, as well as electronic fare collection systems on SunTran buses. The ATMS consists of a traffic signal coordination program controlled from the city of Tucson's Traffic Control Center (TTCC) and is supported by video detection cameras. The FMS – also controlled from the TTCC – uses CCTV and VMS to collect and convey information. The RTIC gathers all information into one data center and disseminates it to the public. Table 3.16 shows the primary data sources used to prepare the ITS inventory, including MAG, PAG, and ADOT.

Table 3.16 ITS Data in Inventory

Data	Source	Format
Phoenix area and some statewide ITS systems	MAG ITS Strategic Plan	Text
Tucson area ITS systems	PAG web site	Text
Arizona ITS Plan	ADOT	Text

Source: Cambridge Systematics, Inc.

3.3 Special Land Areas

Arizona contains a significant amount of land not owned by the state or local governments or the private sector. Approximately 70 percent of state land are controlled by the federal government or federally-recognized tribes. The following sections describe the portions of the transportation system that exist on federally-managed or tribal lands.

3.3.1 Federally-Managed Lands

The federal government controls 42 percent of Arizona land. The Bureau of Land Management (BLM) and the National Forest Service (NFS) are the most prevalent agencies, each overseeing approximately one-sixth of Arizona land. The military, National Park Service (NPS), the U.S. Fish and Wildlife Service, and the Bureau of Reclamation operate the remaining portions of federal lands in Arizona. Figure 3.8 shows land ownership by federal agency.

Almost 1,100 miles (or 18 percent) of the Arizona State Highway System is on land owned by the NFS, including Apache-Sitgreaves, Coconino, Coronado, Kaibab, Prescott, and Tonto National Forests. Approximately, 771 miles are in BLM lands. In addition, 108 miles of state highway lie on NPS lands, including Grand Canyon National Park, Lake Mead National Recreation Area, and Organ Pipe Cactus National Monument. Almost 90 miles of state highway cross through land owned by the military, 37 miles pass through U.S. Fish and Wildlife Service operated land, and 21 miles of state roadway exist on Bureau of Reclamation land. The Arizona state highway network is also shown in Figure 3.8. Table 3.17 shows the primary source for describing the federal lands inventory, the Arizona Land Resource Information System.

3.3.2 Federally-Recognized Tribal Lands

The 21 federally-recognized tribes across Arizona own more than one-quarter (28%) of Arizona land. The largest is the Navajo Nation, covering nearly 16,000 square miles in Arizona and extending into Utah, New Mexico, and Colorado. These communities are shown graphically in Figure 3.9.

The federally-recognized tribal communities contain 1,268 miles of Arizona state highway. Over one-half of these road-miles are in the Navajo Nation alone. The Arizona state highway network can also be seen in Figure 3.9.

Figure 3.8 Federal Land Ownership in Arizona

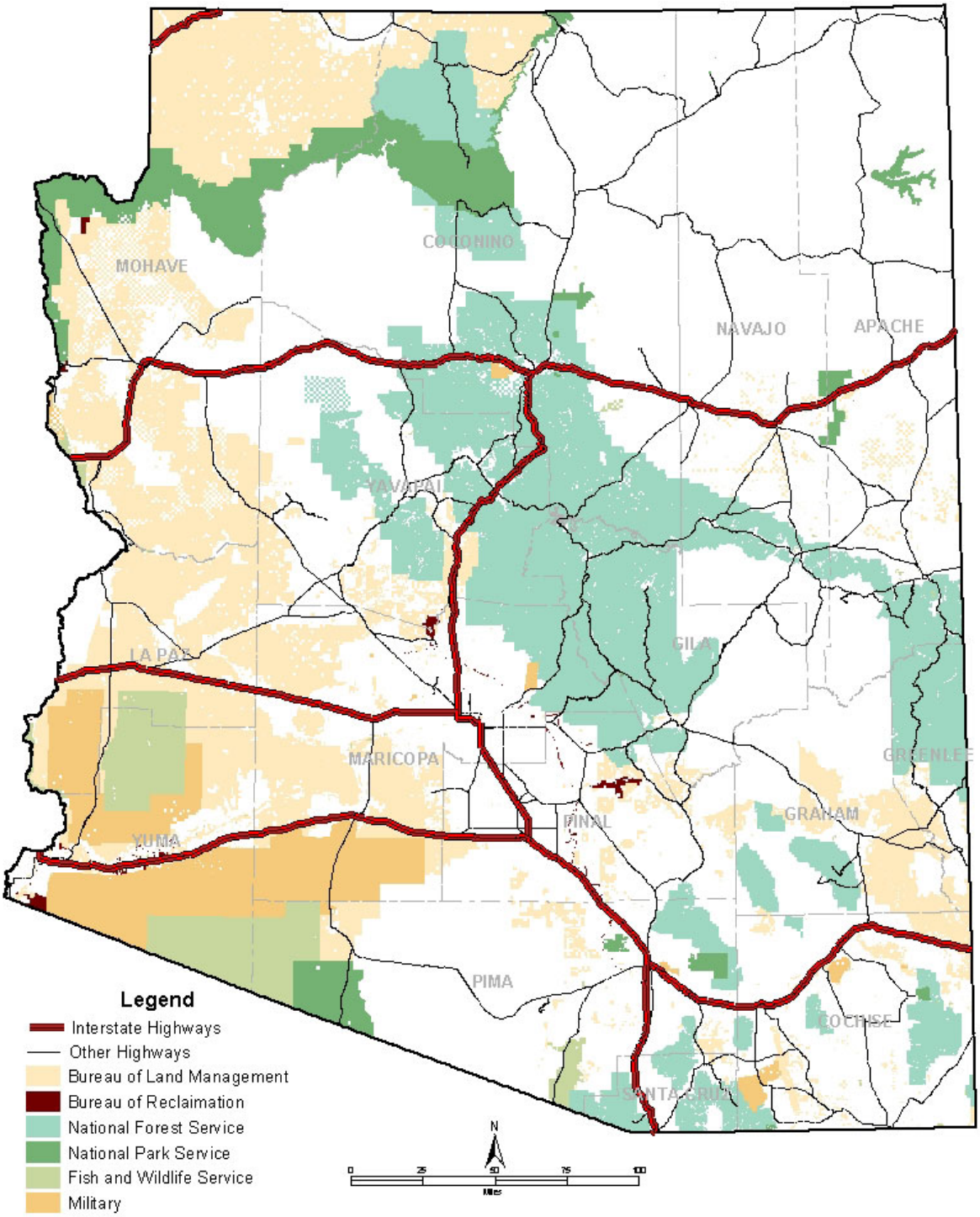
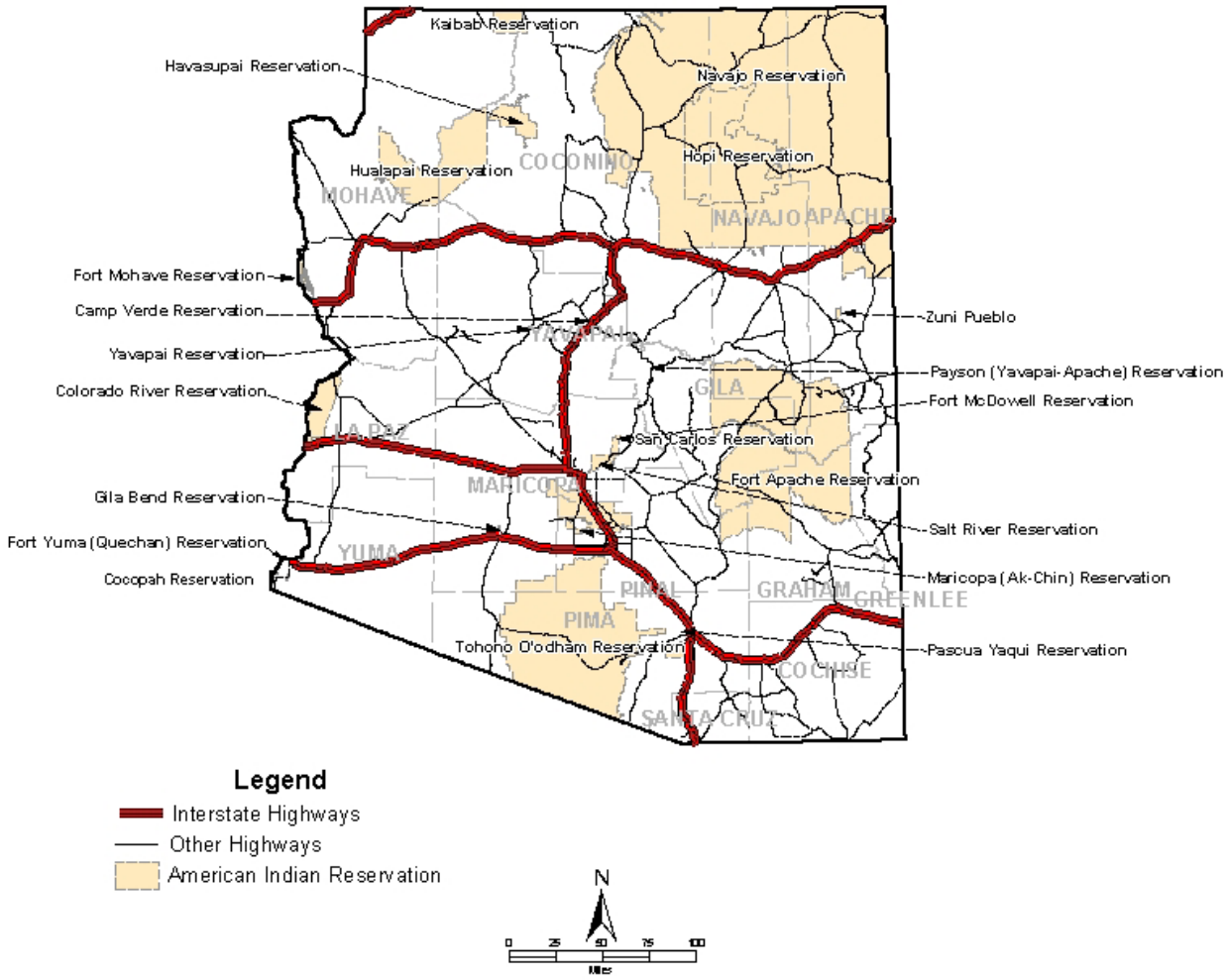


Table 3.17 Federal Land Data in Inventory

Data	Source	Format
Federal land ownership	ALRIS	GIS

Source: Cambridge Systematics, Inc.

Figure 3.9 Federally-Recognized Tribal Lands in Arizona



The Hopi and Navajo Nations both provide fixed-route service between cities on and around their reservations. The Hopi Nation operates three fixed routes between Kykotsmovi and Moencopi, Keams Canyon, and Flagstaff. The Navajo Nation operates seven fixed transit routes. Six go from Window Rock to Tuba City; Toyei; Kayenta; Fort Defiance; Crownpoint, NM; and Shiprock, NM. The seventh connects Fort Defiance with Gallup, NM. Table 3.18 shows the primary source used to develop the federally-recognized tribal lands inventory: the Arizona Land Resource Information System (ALRIS).

Table 3.18 Federal Land Data in Inventory

Data	Source	Format
Federally-recognized tribal land ownership	ALRIS	GIS

Source: Cambridge Systematics, Inc.

Appendix A

Review of Existing Transportation Visioning Efforts

Appendix A. Review of Existing Transportation Visioning Efforts

Appendix A presents additional detail of the plans reviewed from ADOT and other agencies, including numerous statewide planning efforts, corridor-specific plans, metropolitan plans, and Native American plans. The review reveals several important factors that can help to shape the statewide transportation vision for Arizona, including the following:

- Balanced, multimodal system;
- Funding;
- Transportation system performance;
- Transportation land use connection;
- Environmental issues;
- Economic issues; and
- Social issues.

The material presented in this Appendix provides a more detailed examination of the themes raised by these previous visioning efforts.

A.1 Balanced, Multimodal System

Many of the plans discuss in some manner the development of a balanced, multimodal system as a key organizing principle. The first goal of the 1994 *Arizona State Transportation Plan* was to develop and maintain an integrated, balanced, and multimodal state transportation system that meets the needs of Arizona.

This guiding principle can also be seen in several of the small area plans that ADOT has been preparing across the state for the past 15 years. The following examples from three small area plans use this guiding principle. The primary goal of the *Doney Park/Timberline-Fernwood Transportation Plan* was to develop an efficient, practical, multimodal system for its area. The *Casa Grande Small Area Transportation Plan Study* lists its overriding goal as the development of a sufficient, fundable, implementable, and politically acceptable multimodal circulation system. The *Lake Havasu City Small Area Transportation Study* also

mentions the need for balance in the development of the transportation system, though their orientation is more towards a balance of different types of users than different modes.

All three of the plans developed by councils of governments attempt to provide a vision for a multimodal system. The purpose of the *Maricopa Association of Governments: Regional Off-Street System Plan* was to develop non-motorized alternatives and integrate them into the county's transportation system. The Yuma County *1995-2025 County-wide Transportation Plan* frames their goals in terms of providing the continual development of a complete, dependable, efficient transportation system. A more recent effort in the Yuma metropolitan area (the *YMPO 2000-2025 Regional Transportation Plan*) aims to assist in providing a balanced transportation system for the rapidly growing Yuma area.

Three of the plans from other levels of government highlight the need for transportation investment to follow a balanced, multimodal path. The *Flagstaff Land Use and Transportation Plan* hopes to achieve a balanced reliance on multiple transportation modes. Public input into the *Vision 21* process listed a fully-integrated transportation system, including all aspects of multimodal planning as a key goal. One of the key findings of the *Vision 21* Task Force was that Arizona needs an integrated long-range transportation plan that includes all modes of transportation. The ADOT also undertook the *Arizona Rail Passenger Feasibility Continuation Study* to analyze commuter rail initiatives in Phoenix and a rail corridor from Phoenix to Tucson.

Planning efforts produced by American-Indian reservations were the only ones that did not use the language of intermodal, balanced transportation systems. Many of the plans make specific note of maintaining and developing the local highway and arterial system. The *Navajo Nation Long-Range Comprehensive Transportation Plan*, the *Transportation Planning Study for the Kaibab Indian Reservation*, and the *San Carlos Tribe Transportation Planning Study Update* all make specific mention of highway construction priorities, but none discuss an overall multimodal strategy.

For many rural Arizonans, the highway is now and will remain the primary or even only mode of travel. With the vast majority of state residents concentrated in just a handful of cities, building a balanced, multimodal transportation plan will apply better to these few urban areas than the large rural areas of the state. While building a multimodal system plan clearly affects the majority of the population, statewide transportation planning efforts will necessarily face different challenges in different regions of the state.

A.2 Funding

Only a handful of the plans reviewed make mention of the need for adequate funding. Though fiscal constraint is a necessary part of any planning effort, not every plan links fiscal constraints to the development of a strategic vision for transportation. The 1994 *Arizona State Transportation Plan* lists as one of six goals and policies the development of an implementation system on a stable and equitable funding basis.

A couple of the small area plans also mention the need for stable funding. One of several goals of the *Kingman Area Transportation Study* is to secure adequate funding levels for the needs of the area. The *Lake Havasu City Small Area Transportation Study* discusses funding issues in terms of minimizing costs to provide a transportation system more efficiently.

None of the councils of governments plans mention funding issues in their vision processes, and only one of the American-Indian reservation plans mentions these issues. The *North Central Area Traffic Study* for the Gila Indian reservation also mentions the need for a plan to be based on adequate funding levels.

Of the plans developed by other levels of government, only the Governor's *Vision 21* report also makes note of providing stable funding and raises an additional set of funding issues – control over funding resources. One goal of the process was to increase the flexibility of funding and provide greater local control over funding and land use decisions.

Funding constraint is clearly a major issue facing transportation planning, but its inclusion as an element of an overall transportation vision may not be appropriate. A statement of the future strategic directions might better be oriented towards the goals the state would like to achieve, while specific planning and implementation efforts deal with funding constraints.

A.3 Transportation System Performance

Most previous efforts discuss the importance of maintaining or improving the performance of transportation facilities, in particular improving accessibility, mobility, and safety. Visioning efforts at each of the five levels of government analyzed here make note of these issues. From ADOT, the 1994 *Arizona State Transportation Plan* discusses elements of mobility, access, and safety throughout the plan. The corridor-specific plans conducted across Arizona are directed at improving access and mobility in their particular corridors.

Three of the small area plans make mention of these issues. The *Kingman Area Transportation Study* mentions maintaining and enhancing mobility on roadways, transit facilities, and other transportation modes. The *Lake Havasu City Small Area Transportation Study* puts even greater emphasis on mobility as a key feature of a transportation strategy. It identifies separate mobility needs for residential and economic (commercial and tourist) users, the need for access for those who cannot or will not drive, and the provision of facilities for pedestrians and cyclists. The Lake Havasu plan also identifies safety as a key element, seeking to minimize property damage, injuries, and fatalities. The *Payson Area Transportation Study* also has a major goal to maintain and enhancing existing levels of mobility on roadways and other transportation modes.

Each of the plans developed by councils of governments plans deals with transportation elements. The Yuma County *1995-2015 Countywide Transportation Plan* makes specific note of dealing with safety concerns from hazardous materials passing through the area. The *Maricopa Association of Governments: Regional Off-Street System Plan* addresses the

importance of safety and access for non-motorized uses in regards to a system of paths and trails that are off-street and provide driving alternatives.

A couple of the plans produced by American-Indian reservations make specific note of the importance of mobility, access, and safety. The *Navajo Nation Long-Range Comprehensive Transportation Plan* puts its first priority on improving and completing the arterial network inside this very substantial reservation that covers a 26,000 square miles of the state. These goals are aimed towards increasing mobility inside the reservation and improving the efficiency of the roadway network. With fewer than one-quarter of the roads in the reservation paved, the vision of this plan is especially oriented towards enhancement of the transportation system. The *North Central Area Traffic Study*, produced for the Gila River Indian community, also makes mention of the importance of maintaining and enhancing mobility on roadways, and also mentions transit mobility and access. Each of the American-Indian reservation plans puts emphasis on improving road facilities in their areas, though often in the context of completing the road system and not specifically addressing mobility issues.

Finally, two studies from the Flagstaff area – the *Flagstaff Land Use and Transportation Plan* and the *Flagstaff Urban Mobility Study* – pay close attention to mobility and access. The latter plan was directly oriented towards improving traffic mobility for two corridors in the Flagstaff area.

Mobility, access, and safety are clearly important issues to an Arizona state transportation plan; and, as a rapidly growing state, Arizona will face constant challenges in providing the desired level of performance in these areas.

A.4 Transportation Land Use Connection

Strengthening the connection between land use planning and transportation investment was perhaps the most regularly discussed element of the previous planning and visioning efforts we reviewed. Multiple reports from every level of government discussed the importance of land use in the context of transportation planning.

The 1994 *Arizona State Transportation Plan* features a discussion of the connection between land use planning and transportation investments. One of the primary goals identified in that planning effort was to develop a transportation system that is compatible with existing and planned land uses.

Three of the eight small area planning efforts made mention of the need to better integrate transportation investment with land use planning. The *Fredonia Area Transportation Study* seeks to integrate the transportation system into the existing small town atmosphere, while providing access to prominent tourist resources. The *Kingman Area Transportation Study* lists as one of its goals to coordinate subregional land use and transportation planning and decision-making, to ensure that transportation and land use plans and policies are mutually supportive. The *Lake Havasu City Small Area Transportation Study* had a

somewhat more focused land use directive than the others. Lake Havasu City is a major destination for water recreation. Among the transportation plan elements was a requirement to ensure that transportation investments fit appropriately with the needs of water-oriented recreation. In this way, the plan attempts to integrate transportation with both the land use and economic needs of the city. The plan suggests that the transportation system should orient area visitors to recreational facilities and away from residential areas.

Two plans developed for the Yuma Metropolitan Planning Organization (YMPO), the *1995-2015 Countywide Transportation Plan* and the *YMPO 2000-2025 Regional Transportation Plan*, deal with land use issues. The 1995-2015 county-wide plan lists regional land use plans as one of eight major issues that the transportation vision should address and states that transportation facilities and services should support the achievement of adopted land use plans. The YMPO regional plan was developed in accordance with a joint city-county land use plan for the Yuma area. The land use plan considers all aspects of development, while the transportation plan zeros in more specifically on transportation issues.

Only one of the plans developed for American-Indian reservations deals with land use issues. The *North Central Area Traffic Study* sought to coordinate subregional land use and transportation planning and decision-making to ensure that transportation and land use plans and policies are mutually supportive. The other plans reviewed here did not discuss this issue directly; though one plan, the *San Carlos Tribe Transportation Planning Study Update*, did mention coordinating housing development with infrastructure availability.

Several of the other plans paid particular attention to land use issues. As its title suggests, the *Flagstaff Land Use and Transportation Plan* is a combined land use and transportation plan. This plan specifically attempts to guide growth into a compact land use pattern through both explicit land use policy and the provision of transportation and other infrastructure. The *Growing Smarter Final Report* discusses the progress of the commission set up to analyze smart growth by the Growing Smarter Act of 1998. Among the provisions of this commission was an attempt to better link city expansion to provision of infrastructure and increased involvement of citizens in the land use process.

Public involvement in the governor's *Vision 21* process highlighted numerous issues Arizonans thought important to the development of a transportation vision and plan. Among these is the interrelationship of transportation with land use and other planning processes.

Overall, the connection between transportation and land use planning appears to be one of the most significant and recurrent issues addressed by previous planning efforts. The strategic direction for transportation in Arizona should, therefore, address coordination between these very important functions.

A.5 Environmental Issues

Most of the studies that mention land use also discuss environmental issues. Two major environmental issues are connected to the transportation system in the reviewed documents: 1) the preservation of open space and 2) the maintenance and enhancement of air quality. Most plans mention at least one of these two issues and several mention both. A number also discuss the importance of preserving Arizona's environment in general terms. The 1994 *Arizona State Transportation Plan* lists as a major goal to preserve and enhance Arizona's environmental conditions and values.

The connection of transportation to both land use and environmental issues is most obvious in the preservation of open space. Open space preservation became a more visible issue in Arizona with the passage of the Growing Smarter Act of 1998. The *Growing Smarter Final Report* offers recommendations for dealing with future growth in Arizona through land preservation and planning strategies. The act also attempts to increase the amount of land set aside for open space, especially in urban areas.

Several other plans make note of the importance of land and resource preservation in developing the transportation system. The most notable of these are the American-Indian reservation plans. The *San Carlos Tribe Transportation Planning Study Update* puts a priority on preserving the natural resources of the reservation, while maintaining economic activities, particularly in agriculture and tourism. Other American-Indian reservation plans come close to this topic through a discussion of the importance of preserving cultural values. These related issues are discussed further below.

Several past visioning efforts make specific note of the connection to air quality, including the *1995-2015 Countywide Transportation Plan* for Yuma County, *Vision 21*, and the *North Central Area Traffic Study*. The *Transportation Planning Study for the Colorado River Agency* also notes that the transportation system should discourage uses that increase noise levels.

A.6 Economic Issues

Though not as prevalent as discussions of land use, many previous planning efforts pay attention to the role transportation plays in economic development. This is especially true for the American-Indian reservation plans that are concerned about improving the economic well-being of their residents. Economic concerns span a variety of issues, including encouraging economic development, managing economic growth, and dealing with specific industries, notably tourism and recreation.

The 1994 *Arizona State Transportation Plan* has as a major goal the development of a transportation system that promotes economic development. The plan specifically notes that the transportation system needs to be responsive to permanent residents, part-time

residents, and tourists; each of whom brings a different set of economic and transportation considerations to the state.

Nearly all of the small area plans considered economic development in one way or another. These plans typically deal with smaller areas of the state that may be somewhat more concerned about the stability of their economies. These are the same areas that are most concerned with the stability of their funding levels. The *Fredonia Area Transportation Study* makes note of the town's attempt to provide economic diversity in this small town on the Utah border that is largely cut off from the state by the Grand Canyon. As one of the gateways to the Grand Canyon, maintaining a link between tourism and transportation is extremely significant. The *Kingman Area Transportation Study* and the *Payson Area Transportation Study* seek to develop transportation systems that direct and support economic development. The *Lake Havasu City Small Area Transportation Study*, as noted above, attempts to bring transportation, land use, and economic planning together by connecting specific users of the area (tourists, employees, residents) to the appropriate needs.

The group of plans that most thoroughly discuss economic development issues and their relationship to transportation are those produced by American-Indian reservations in the state. No other issues received as much attention as economic development. Several of these plans focused on attracting additional investment to their areas or enhancing their images as tourist destinations. Plans that stress economic development include the *Navajo Nation Long-Range Comprehensive Transportation Plan*, the *North Central Area Traffic Study,* and the *Transportation Planning Study for the Kaibab Indian Reservation*.

Other plans developed by American-Indian reservations put more stress on the management of economic growth. Notably, the *San Carlos Tribe Transportation Planning Study Update* makes specific mention of managing the growth of tourism to protect the reservation, while still providing for economic development opportunities. The *Transportation Planning Study for the Colorado River Agency* takes a balanced approach, attempting to connect transportation to economic development, while also considering social and other needs.

Each of these plans encourages additional economic investment, but there are different visions of what that investment would look like. This review suggests the need to consider transportation investments in light of specific economic needs of different areas in the state.

Economic development is clearly a growing issue for the state. Arizona faces various economic challenges on the horizon, including developing a base for high-tech industry and providing for a growing population of residents who are less well-off. These challenges require thoughtful investments in infrastructure and coordinated planning with economic development agencies in the state.

A.7 Social Issues

Social issues refer to the impact of transportation on community development – housing, health, and education – and on community character and cultural preservation. Of the plans reviewed, only the American-Indian reservation plans made specific mention of community development issues. These issues are nearly as important as economic development to the reservation plans. Though the connection may be somewhat less clear, nearly every one of the reservation plans deals with some social consideration. The *Navajo Nation Long-Range Comprehensive Transportation Plan* and the *Transportation Planning Study for the Kaibab Indian Reservation* mention the importance of connecting transportation to general community development. The *San Carlos Tribe Transportation Planning Study Update* is particularly interested in the connection to housing. The *Transportation Planning Study for the Colorado River Agency* sees the importance of coordinating transportation investments with education, health, and housing investments.

Several of the American-Indian reservation plans also refer to the need to preserve the cultural system of the reservation and to ensure that transportation systems do not interfere with it. The *Navajo Nation Long-Range Comprehensive Transportation Plan* seeks careful planning, engineering, and environmental assessment to minimize the effect of transportation investment on Navajo society, culture, and environment.

One of the plans from other governments and one of the small area plans mention community character issues. The *Flagstaff Land Use and Transportation Plan* notes that any transportation investment or economic development should be made to conform to the character of their community. The *Fredonia Area Transportation Study* discusses connecting transportation investment to the preservation of the small town atmosphere of Fredonia.

Although these social issues are somewhat more difficult to tie directly into the statewide vision, they clearly reflect an important group of concerns that need to be addressed through coordination of transportation planning with land use, economic development, and environmental actions. In a diverse state such as Arizona, the process of determining a strategic direction should be attentive to the varying social and cultural of its numerous demographic, ethnic, and economic communities.

Appendix B

Summary of Arizona Issues Papers

Appendix B. Summary of Arizona Issues Papers

The context for the Arizona Long-Range Transportation Plan comes from several sources. Working Paper #1 reviewed Arizona's transportation planning documents and previous visioning efforts, long-range plans from other states, and planning efforts by other Arizona state agencies. In addition to these reviews, Arizona DOT contracted four issues papers that addressed broad trends and issues with potentially significant implications in the following general areas:

- Security considerations in the wake of the September 11 terrorist attacks;
- The interaction between transportation and land use policies;
- Changing global and national economic trends; and
- General future issues and trends.

This summary presents an overview of the key themes referenced by the issues papers. These are general themes that are relevant to transportation planning, land use planning, and related issues in Arizona. The summary is organized around five key points that cut across the four issue papers:

- Population growth and demographic change;
- Economic growth and change;
- Security concerns;
- Energy supply and efficiency; and
- Technological change and opportunities.

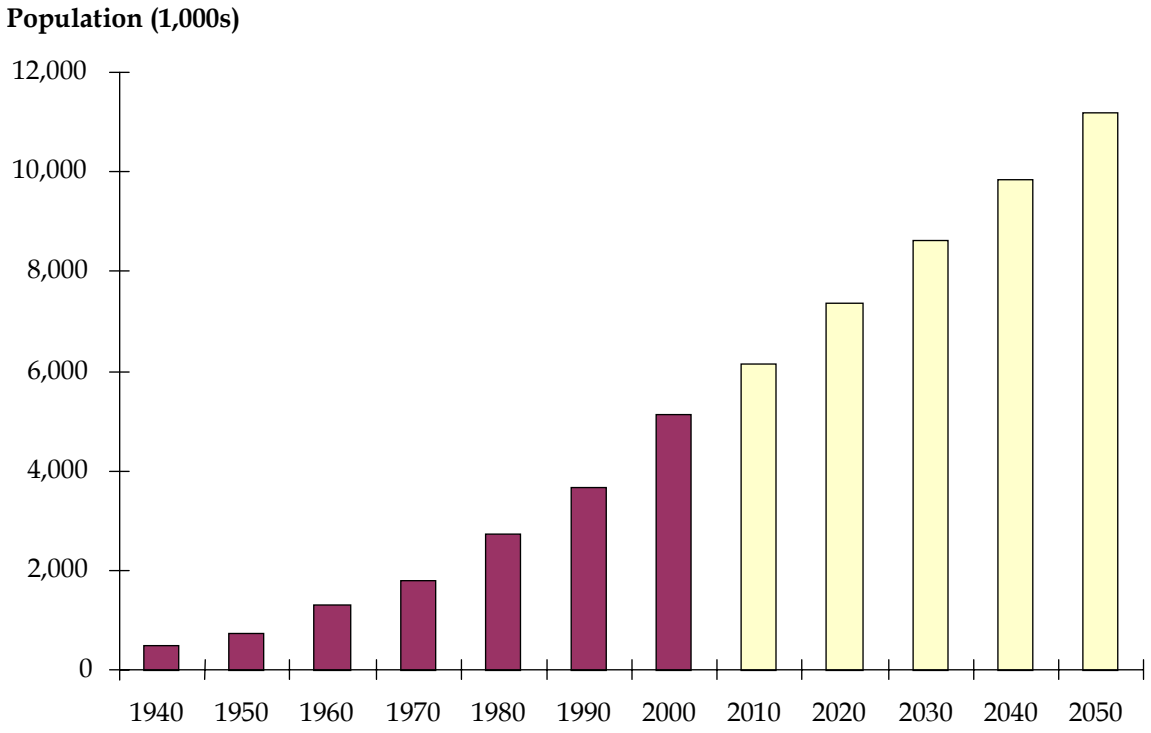
Each of the issues papers raises deals with some of these themes, often suggesting possible actions that ADOT or the state of Arizona could take to improve transportation in the state. Though some of these ideas may be inappropriate within the Arizona context, they help stretch the concept of what is possible. This exercise allows ADOT to think of the things that are "out there" without committing to a particular course of action that is unreasonable.

B.1 Population Growth and Demographic Change

The population of Arizona will double over the next 40 years, growing from five to 10 million residents. Many of these new residents will continue to locate in existing metropolitan areas, as they have for the past 40 years. The Phoenix metropolitan area has 15 times more people and the Tucson metropolitan area 10 times more people than 1940, while the non-metropolitan portion of Arizona tripled.

The importance of these changes cannot be overstated. It will require major expansions of roadway capacity and the development of transportation options and alternatives to provide acceptable levels of service on Arizona's roadways and maintain circulation. Accommodating this growth will present numerous challenges to transportation planning, as well as land use planning, economic planning, and other state planning activities.

Figure B.1 Historic Population Growth with Future Estimates



A rapidly growing population presents several serious concerns for the Arizona Department of Transportation:

- Population growth will hasten the sprawl of Arizona's major metropolitan areas. These areas. Transportation infrastructure costs are as much as four times more costly for sprawling metropolitan development than for more compact areas. Other infrastructure costs, such as utilities, can cost up to three times as much.

- Maintenance costs for transportation infrastructure will increase as the roadway network becomes more extensive.

- In expanding metropolitan areas, traffic congestion will likely increase faster than actual population growth. Arizonans will likely live further from where they work, increasing travel distances and times.

- Continued growth will present serious problems for access to the state highway system, especially in areas outside the major metropolitan areas that depend on highway facilities with limited access controls.

B.1.1 Connections Between Land Use and Transportation Policy

Rapid population growth presents special challenges at the intersection of transportation and land use planning. Arizona will have to maintain existing infrastructure while providing transportation, housing, and economic opportunities for millions of new residents. Though Arizona's geography and vast rural areas present continued opportunities for metropolitan growth, state agencies like ADOT will play an important role shaping where that growth occurs.

Fostering the connection between state, regional, and local transportation and land use planning can take many forms. The issue paper on land use planning recommends that ADOT conduct a thorough assessment of efforts to coordinate with local and regional agencies, suggesting five key arenas in which ADOT can play a role in land use policy.

1. **Education and technical assistance.** ADOT can actively work with its partners at the local level to ensure that they are knowledgeable about current land use planning techniques that will better integrate new roadways and other transportation facilities into developing cities and towns. Education efforts include everything from pamphlets that describe best practices to conferences on particular land use topics to direct assistance to communities developing land use plans.

2. **Legal land use requirements.** State-level requirements for the development of general plans require cities and towns to consider transportation and other infrastructure concerns when they develop new areas. The recent series of Growing Smarter Acts in Arizona have increased the state's role in this area. Additional efforts might require land subdivision to be based on existing or planned infrastructure or require more detailed environmental studies of planned metropolitan growth.

3. **Land use capabilities within the transportation department.** ADOT could provide assistance to local governments through in house land use planning capabilities. These capabilities can range from basic data collection to economic forecasting, to developing combined transportation/land use models.

4. **Access management.** With Arizona growing rapidly, access management can provide a set of strategies that help ensure the reliable and efficient movement of people and goods on state highways. Access control can reduce congestion and accidents caused when automobiles reduce speed to make turns.

5. **Direct land use controls.** Statewide control of land use is undoubtedly an unrealistic option for Arizona, but there are degrees of land use control that can help improve transportation planning. The Arizona State Land Department, for example, controls large sections of land and is required, through the Arizona Preserve Initiative, to conduct land use planning studies for the parcels that it owns. Coordination with this department to ensure the existence transportation infrastructure for planned zoning and related changes could be very helpful.

These ideas present possibilities for ADOT to consider. Assessing the state's role in each of these areas will help ADOT determine how to best play a role shaping urban growth. Though ADOT cannot directly control land use policy, increased coordination with the agencies who do could improve the quality of transportation investments.

B.1.2 Suggested Changes to Transportation Planning

Two of the issue papers discuss current land use planning trends that might affect how ADOT conducts transportation planning. Both the land use paper and the general futurist paper discuss current policies and planning trends that could prove useful for Arizona. These include the following:

- **Comprehensive land use and transportation planning requirements.** Florida has a program that addresses urban sprawl by requiring coordination between metropolitan planning organizations and the department of transportation. These requirements include staff members sitting on committees, comprehensive metropolitan plans to guide land use, requirements for concurrency, and regional impact analyses for large developments.

- **Improved coordination with local, state, federal, and tribal agencies.** Other agencies have greater control over the land use planning process than ADOT. Coordinating with these agencies is an important step to improving the connection between land use planning and transportation planning. It requires ADOT to consider the larger context of its actions.

- **Provide expertise and support to local and regional land use planning agencies.** Developing an image of ADOT as a service organization may help it to work with agencies that control land use planning. ADOT can provide advanced technical

assistance that many communities do not have available to them. This would enable ADOT to play a role in these communities and help it promote rational and objective planning throughout the state.

- **Transit corridor districts.** These districts focus new development in a particular area around a transit node. Combined with zoning changes that encourage mixed-use development and slightly higher densities around transit stops, these districts can help create efficient public transportation in newly developing areas of city and reduce auto dependency.

- **Access management.** Access management provides a set of tools to increase the through movement of vehicles on state highways, while decreasing the number of accidents that arise from an excess of access points.

- **Interchange area planning.** Interchange area planning can help the state ensure efficient movements in and around highway interchanges. Interchanges are typically prime sites for development. The state can set guidelines for interconnection, access spacing, shared driveways, transit service location, pedestrian movement, and internal circulation that encourage rational and effective development at highway interchanges.

- **Smart growth, transit-oriented development, and the new urbanism.** These new ideas about urban development attempt to increase the attractiveness of compact developments, encourage transit use, and improve pedestrian and bicycle circulation within towns. The application of these ideas to Arizona is an open question, requiring changes to more than just transportation planning in the state.

B.1.3 Growth Constraints

The continued rapid population growth expected in Arizona will inevitably face substantial limits. Geographical features, a limited water supply, physical infrastructure, and congestion will all increase the costs of development and growth in Arizona.

Like many states in the West, Arizona will not be able to continue its growth without obtaining additional sources of water or using its current water sources more efficiently. Arizona's current allotment of water from the Colorado River will be fully utilized by 2030. With many areas beginning to tap out groundwater supplies, Arizona may find itself unable to continue its rapid rate of growth. A major drought caused by an El Nino weather system could accelerate these problems, forcing Arizonans to make important decisions about the way that they live.

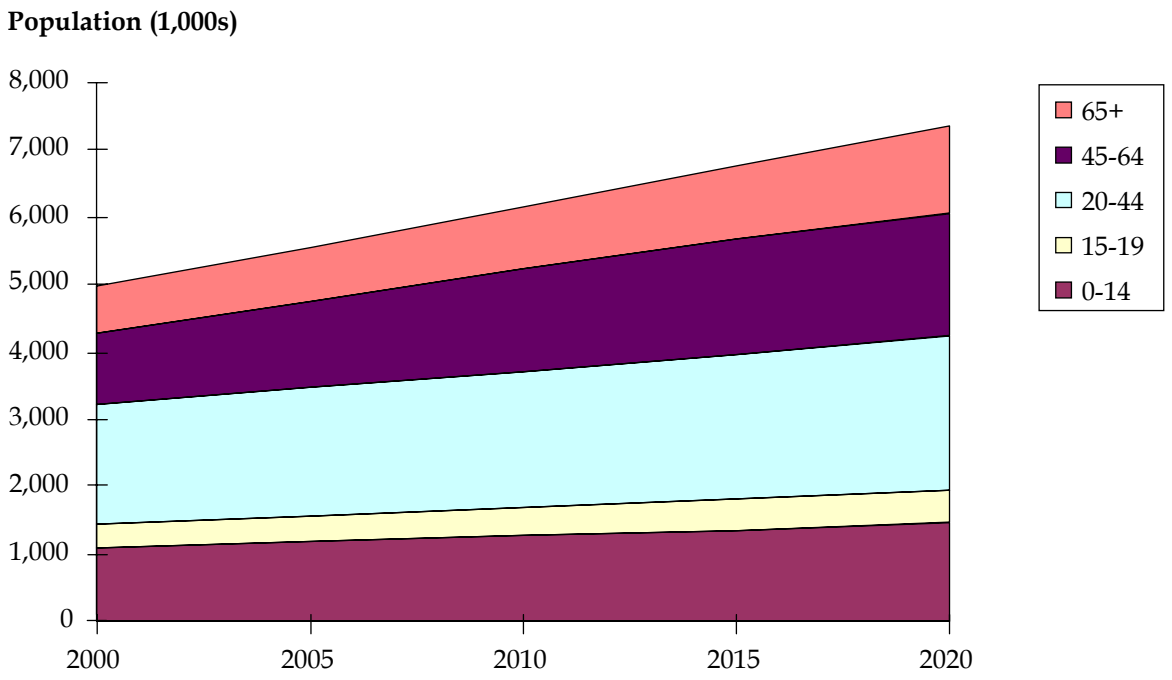
Reduced availability of key resources like water will alter the economic incentives for Arizona's residents and businesses. Water shortages may reduce the rate of population growth and discourage new businesses from locating in its metropolitan areas. Arizona may also become a less attractive retirement destination without these basic resources that

make life possible. Dealing with a declining water supply is not directly a transportation problem, but the effects of this decline will reverberate throughout the state.

B.1.4 Demographic Change

In addition to population growth, Arizona is experiencing major population change. Already a destination for retirees, Arizona's 65 and older age cohort is the fastest growing of any in the state. At the same time, the size of the minority population has grown rapidly. Arizona is 36 percent non-white now, with the sixth largest Latino population and the third largest American-Indian population in the United States.

Figure B.2 Projected Age Distribution of Arizona's Population



These changes are important to transportation considerations. Older populations will be more likely impaired by health considerations that alter their transportation needs. At the same time, the baby boom generation, just beginning to retire, is much more mobile and active than previous generations of retirees. Major surveys of new retirees suggest that a larger proportion intend to keep working into retirement, either full or part time. Other activities, such as volunteering, traveling, and education, will be important to the baby boomers as well. If Arizona continues to attract a disproportionate share of retirees, it may face additional burdens on the transportation system.

In general, a changing population may also have somewhat different land use and transportation requirements. Active retirees may desire easy access to cultural and other facilities and want to live closer to these amenities. Similarly, minority groups may have different land use development and transportation needs. To the extent that minorities groups are less well off than the average Arizonan today, they will require new and expanded transit systems. Transportation investments can also help these groups improve their economic circumstances.

Arizona's growing and changing population will present serious challenges to ADOT and other state agencies now and in the future. This rapid growth also presents an opportunity for ADOT to forge new relationships with other state and local agencies to help direct this growth in a meaningful way.

B.2 A Growing, Changing Economy

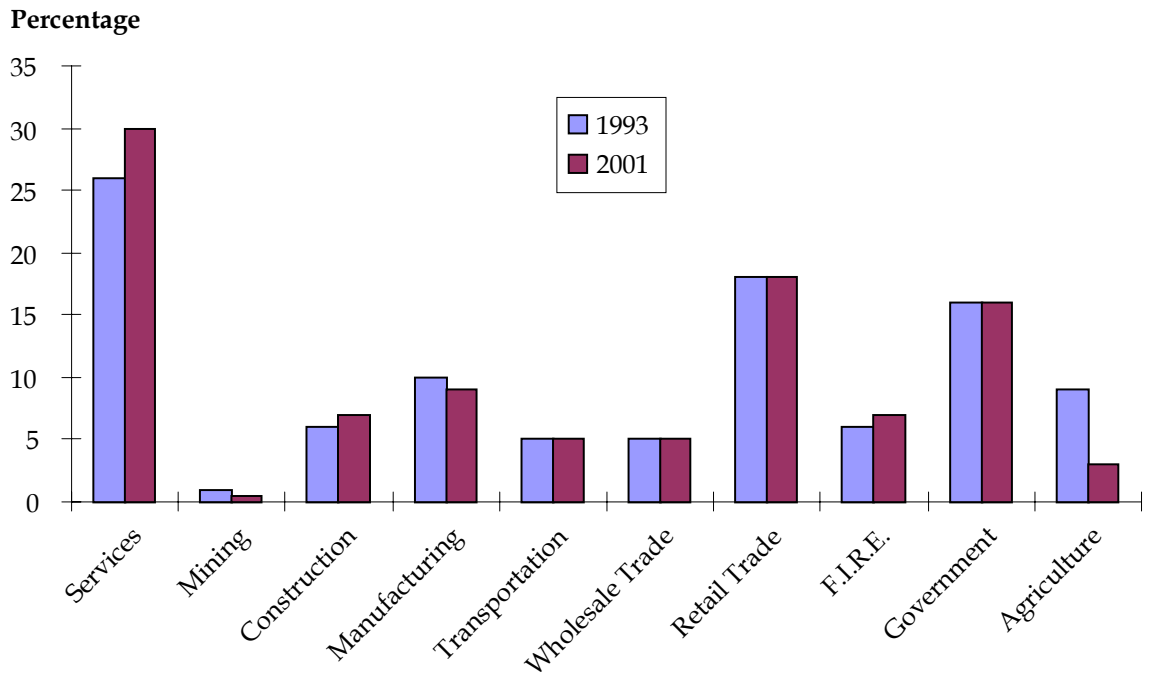
Another major consideration that arises from the issues papers concerns Arizona's economy. Famous for its agricultural and extractive industries for most of its history, Arizona now has major opportunities in high technology manufacturing, services, and international trade to consider. This changing industrial mix requires new considerations for the transportation system.

B.2.1 Declining Extraction, Growing Services

Like many states, services have become the largest employment category in Arizona. Services refer to several types of activities, including business services that typically provide support to manufacturing and information-based industries and personal services (including health services, hotels, and related industries). The former represents the growth of an information-based economy and a movement away from high-pollution manufacturing industries. The latter, in combination with a strong retail sector, is a key player in Arizona's tourist- and retiree-based economy.

The growth of services has important implications for transportation. These firms require very different types of inputs than manufacturing, agricultural, and extractive industries. They have different land and transportation needs, able to operate in more varied locations. This could substantially alter commute patterns and freight transportation needs.

Figure B.3 Arizona Employment by Industry



2.2 Growth in Freight Traffic

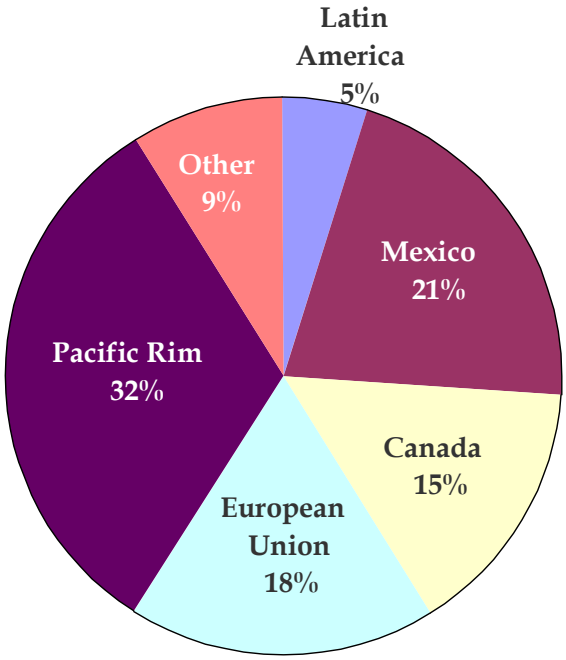
A related economic issue for Arizona is the movement of freight. Population and economic growth, combined with national and international changes in goods production and movement, make freight movement a major issue for Arizona. At the same time, freight growth is following new patterns. Growth in small parcel shipments means more additional less-than-truckload shipments and possibly different types and numbers of trucks on the road. One of the largest components of growth in freight traffic in recent years has been an increased number of small parcel delivery trucks (e.g., UPS, FedEx) moving over regional highway and arterial networks.

Arizona's most prominent corridor for freight movement is Interstate 10. In addition to the freight that travels to or from Arizona, Interstates 10 and 40 and two rail lines carry substantial freight passing through the state on its way to other areas. The ability of Arizona's transportation infrastructure to handle the bulk of this traffic requires ADOT to pay attention to major traffic generated outside of Arizona.

Remarkably, Arizona's largest trading partner (by value of goods traded) is Asia (32 percent), not Mexico and Latin America (combined 26 percent). Continued growth of Southern California ports has a direct effect on Arizona's economic position. Mexico and Latin American are becoming more important as national trading partners. Over 75 percent

of Fortune 500 companies have some production presence in Mexico. The Nogales port of entry is the major port for winter vegetables entering the United States, capturing over 60 percent of that market. NAFTA-related traffic and the CANAMEX corridor project present opportunities to capture a larger portion of increased trade with Mexico, as well as the challenges that will bring.

Figure B.4 Arizona's Trading Partners



Arizona's ability to capture economic growth depends in great part on its transportation infrastructure. Increases in highway and freight rail capacity, development of ITS systems to route freight, expansion of intermodal facilities, and other related investments could help sustain Arizona's current industries and provide opportunities for new industries. On the rail side, a major bottleneck near Kingman could present substantial freight capacity problems that decreases the competitive position of the state and increases congestion on Arizona's roads.

Rail freight also faces issues with at-grade rail crossings. Both the BNSF and UP rail lines have numerous at-grade crossings in Arizona that can cause traffic delays and accidents. These two main lines crossing Arizona are important pieces of the state's transportation infrastructure. Again, growth in port traffic in both Southern California and the Gulf Coast will put strains on these facilities that Arizona cannot control. Arizona will have to be attentive to these changes to ensure that its infrastructure is not overrun by trucks from other states.

Rail freight in Arizona also faces difficulties increasing capacity. Increased freight growth may require heavier use of rail lines in the state, but flat profits and limited rail competition has limited Arizona's rail infrastructure growth. Though ADOT does not directly plan and design freight rail infrastructure, it could work actively with the private sector to ensure the availability of freight rail options. The more freight that moves by rail in Arizona, the fewer trucks will impact the state's roadways.

B.3 Concerns Over Security

In the wake of the September 11 terrorist attacks in New York and Washington, D.C., security considerations have been at the forefront of the transportation industry. In formulating the MoveAZ plan, ADOT consciously undertook a thorough and careful assessment examination of security issues in Arizona.

The paper on security issues notes that there are three key issues that the state needs to examine when considering security issues: probability of attack, vulnerability to an attack, and damage that could result from an attack. At this time, it is not possible to accurately gauge the extent of any of these three issues in Arizona. To realistically address security concerns through statewide planning, ADOT will need to carefully assess the actual risk to its system. Though absolute certainty is probably impossible, ADOT should not commit funds to planning for security changes without a hard grounding in facts.

One immediate problem from the September 11 attacks has been the financial stability of America West airlines. Accounting for three-quarters of passenger boardings in Phoenix America West is one of the largest employers in the state. Financial collapse or bankruptcy would reverberate throughout the Arizona economy. Even if another airline were to provide this service, Arizona's economy would be hit hard by the loss.

The security issue paper sheds some light on the kinds of questions that ADOT needs to address to begin to understand how planning might change in coming years. These questions include:

- Have personal transportation behaviors been permanently altered by the September 2001 attacks or will they gradually return to normal?
- Can technology and procedures ultimately provide needed security without significant time penalties at airports, borders, and other facilities considered at risk?
- Will there be increased demand for rail service between metropolitan areas?

- Do increased security concerns present special challenges for intermodalism? For example, remote airport check-in counters at transit stations.

- Is security another goal like safety or mobility, or does it require more radical changes in organizational structure?

Though it is too early to make major changes to statewide transportation planning based on a single event, over time some changes will occur. In the short term, ADOT will likely play a role in the event of a terrorist attack or other catastrophic event. Transportation planners have significant knowledge about incident response, hazardous material transportation, and disaster response and recovery that will be important components of any response to a catastrophic event. Many of these strategies overlap with existing safety concerns of the department.

B.4 Energy Supply and Efficiency

Energy supply considerations present an additional infrastructure concern that directly and indirectly affects the transportation system. The U.S. transportation system is heavily reliant upon gas and oil for the mobility of the population. Changes in the availability and use of oil will have major implications for automobile reliance and costs.

Two very different energy considerations could change the shape of development in Arizona. A decline in oil production could significantly increase the costs of an automobile dependent society. At the same time, new technologies that increase energy efficiency could reinforce existing development patterns. The issue paper dealing with general issues for Arizona's future presents evidence on both of these phenomenons.

The earth contains a finite amount of petroleum reserves, but the question of when they will run out is an open one. Though there is sharp disagreement about how much petroleum is left, even relatively optimistic predications are suggesting that within the next 30 years, petroleum production will peak and decline. This does not mean a sudden drying up of petroleum supplies, but it will necessarily increase costs. Given the growth of the world population, even a steady level of production will mean substantially increased oil prices. If overall production declines within 20 or 30 years, fuel costs will increase astronomically. In addition to a natural decline in petroleum extraction, other human phenomenon, such as a war in the Middle East, could bring high prices about much more rapidly.

Though the United States is heavily dependent on petroleum for transportation and economic growth, automobile manufacturers and researchers have made great strides in recent years to use this fuel more efficiently. Already, several automobile manufacturers are offering electric vehicles that use no gas and hybrid vehicles that get double or triple the miles per gallon of today's cars. Starting in 2003 in Europe, Volkswagen will be selling a car that can travel over 100 miles on a single gallon of gas, though these cars may not be suitable for the United States automobile market, dominated as it is by larger and

heavier trucks and sport utility vehicles. However, the advancement of new technologies such as carbon fiber bodies and other improvements may eventually allow for a fuel efficient sport utility vehicle. One implication of greatly improved fuel efficiency may be increased automobile travel, despite increasing fuel costs.

B.5 Creative Strategies and Technology

A growing economy and population will mean many more people and trucks on the roads. Increased security considerations could amplify congestion caused by this growth. New technology and creative strategies may provide important solutions that will help Arizona deal with these issues. Most of the issues papers raised the possibility that technology could help alleviate some of these problems.

Investments in commercial vehicle operations technologies could reduce the costs of doing business in Arizona. Automated vehicle classification and identification enables trucking firms to pay registration fees and obtain permits in advance of a vehicle's entry into the state. Weigh-in-motion sensors reduce delays and lower inspection costs for the state. Simple changes like border pre-inspection for easier commodity movements could substantially decrease wait times at border crossings, strengthen Arizona's connections to Mexico.

The Arizona Department of Agriculture already conducts preliminary inspections on agriculture in Mexico before a truck reaches a border crossing. Similar inspections for other commodities could cut border crossing times by as much as eight minutes per vehicle. The Nogales Port of Entry has also installed gamma ray imaging equipment that quickly checks for contraband and narcotics without unloading entire trucks.

At the same time, increased security concerns have increased wait times at the border. Pre-inspection may compromise the ability of the United States to adequately inspect persons and commodities passing through the border. Technologies like electronically sealed containers that monitor commodities and GPS tracking that automatically transmits truck locations to shippers can also be used to enhance security checks. These technologies are potential pieces of an advanced intelligent transportation system. A full ITS deployment in metropolitan areas (already started in Phoenix) for both people and freight can help improve the dissemination of safety and security information, as well as reducing congestion and delay.

Another technological consideration raised in the issues papers is the possibility that some people will substitute communications technology for travel. Telecommuting, online shopping, and other telecommunications advances enable individuals to conduct parts of their business and personal lives without traveling. At the same time, new technologies often stimulate increased productivity and increase economic growth. For example, online shopping may contribute to increased freight traffic by shifting some goods from a few large shipments to numerous small parcel shipments. With both population and

economy growing, there will be no realistic decline in transportation in Arizona for many years.

Finally, new technologies like the Segway could change transportation behavior in cities. The Segway is a personal transporter that uses gyroscopes and a battery to transport an individual at up to 12 miles per hour. The applications for this device remain unclear, but it is being tested by the postal service in several locations (including a hot weather feasibility test in Chandler), suggesting at least an institutional use for these devices. A rapid roll-out of the Segway would create a series of challenges for urban transportation systems in many cities.

Though these technological changes may significantly impact transportation in Arizona, they will not be as significant as the overall growth in population. New and improved technologies can help increase the efficiency of the transportation system for both people and freight, but they cannot significantly reduce the increased travel that will be produced by a substantial population increase.

B.6 Conclusion

The four issues papers raise several questions and suggest possible courses of action for both ADOT and the state as whole. They deal with large-scale issues that will affect the development of the long-range plan. These issues can be summarized into four key points:

1. No issue will have more impact on the state of Arizona than the growth of its population. Each of the papers touched on this issue and all agree that population growth will necessarily mean substantial changes to transportation planning. ADOT will need to work in conjunction with other state and local agencies to ensure that future transportation planning efforts shape Arizona's growth to protect and enhance the state's quality of life.

2. Population growth will increase personal travel and goods movement throughout the state. These changes will cause serious deterioration of Arizona's highway and rail network without additional investments. ADOT will have to determine the most appropriate role to play in maintaining and enhancing rail freight to ease the burden from trucks on state highways.

3. Several external concerns will tell ADOT what it can do. Changing levels of oil production, the growth of fuel efficient technology, declining water supplies, continued growth of the Los Angeles area ports, and other large scale phenomenon may restrict or enhance mobility on Arizona's roadways. Population growth may decline as once abundant water supplies start to try up. Substantial increases in fuel prices may create a demand for much more fuel efficient means of transportation, substantially altering development patterns in Arizona's cities.

4. New technologies may play a role in making transportation more efficient in Arizona. Automated inspection of truck cargo and electronic permitting and toll collection can reduce wait times at state and national borders. New transportation technologies, such as the Segway, may reduce the need for some automotive transportation. Though these technologies may provide some increased efficiency they are poorly suited to deal with the massive increases in traffic and congestion that will result from population growth.

Appendix C

Review of Pioneer States' Visioning Efforts

Appendix C. Review of Pioneer States' Visioning Efforts

Appendix C presents examples of visioning processes and vision statements from other states that are relatively further along in the process, including Washington, Pennsylvania, Florida, and Oregon. In some cases, the examples include an integrated vision statement with goals and objectives for state long-range transportation plan development.

C.1 Washington State Transportation Plan (2001)[1]

The Washington State Department of Transportation (WashDOT) undertook a visioning process in advance of a formal update of the Washington Transportation Plan (WTP). This process produced alternative vision statements that were based on different possible future outcomes and would lead, in turn, to alternate sets of policies, actions, and investment strategies.

The visioning process was led by WashDOT, but actively included MPOs; regional transportation planning organizations; and other key stakeholders, such as the Governor's Office, legislative leadership, and the business community. The first major visioning product was called the *Trend Scenario*, which provided a view 50 years into the future if current events were "allowed to run their course unchecked." The *Trend Scenario* was based on a detailed trend analysis developed by WashDOT, combined with expert panel discussions and committee research. The vision based on the *Trend Scenario* states, in summary:

> *"The Trends Future" results when the forces of growth increase the amount of travel taking place on the transportation system in the states. Without being able to prepare for or accommodate growth in population and the economy, congestion, inadequate infrastructure, and environmental impacts are anticipated.*

WashDOT and its partners then developed an alternative vision model based on a concept that was called *Livable Future*. This alternative vision called for a change in the approach

[1] Sources: Washington State Department of Transportation, *Washington's Transportation Plan – Final Vision Development Report*, March 1999; Washington State Department of Transportation; *Washington's Transportation Plan – Directions for the Future*, Newsletter, February 1999; Washington State Department of Transportation, *WTP Outcomes and Service Objectives*, September 2000.

to planning and delivering transportation to support a balance between their three key goals of "vibrant communities," "vital economy," and "sustainable environment." The vision based on the *Livable Future* model, which was adopted as the preferred vision, states in summary:

> *"The Preferred Future" balances the needs of the community, the environment, and the economy. As a result, "The Preferred Future" is one in which individuals live in communities they like, enjoy mobility choices, protection of their environment, and a diverse and stable economy.*

WashDOT's vision documents provided detailed definitions of the key vision principles of "vibrant communities," "vital economy," and "sustainable environment." The definitions include three elements:

1. A descriptor or vision statement of what the preferred transportation future looks like;

2. Vision outcomes, which indicate goals that are to be achieved under each vision principle; and

3. Service objectives, which provide measurable targets for assessing achieving of the vision outcomes.

Table C.1 provides examples of the vision outcomes and service objectives, and displays the relationship between the vision principle and these other elements. The vision statements for each principle are quite lengthy; as an example, the vision statement for "vital economy" states:

> *It is 2050…*
>
> - *Our economy is healthy and globally competitive;*
> - *Economic activity is varied, creative, equitable, diverse, and well distributed across the state;*
> - *Our economic activities are sustainable and ensure a good quality of life for our citizens;*
> - *We have preserved land for economic activities and future development;*
> - *We have a strong agricultural industry;*
> - *We have low unemployment;*
> - *Personal income is growing in all counties; and*
> - *We have a well-educated, diverse employment base.*

Table C.1 Relationship of Vision Elements for Washington Transportation Plan

Vision Principle	Vision Outcomes	Service Objectives
Vibrant Communities	**Essential Mobility: System Operation and Maintenance** The transportation system operates effectively, efficiently, and predictably	1. Maintain the effective and predictable operation of the transportation system to meet customers' expectations 2. Increase the efficiency of operating the existing systems and facilities 3. Maintain vital transportation services in the event of a natural or other disaster
	Essential Mobility: System Preservation Transportation facilities are in sound operating condition	1. Preserve transportation infrastructure to achieve the lowest life-cycle cost and prevent failure
	Essential Mobility: Special Needs Transportation Transportation system provides all citizens access to basic services	1. Meet all basic transportation needs for special needs population
	Enhanced Mobility: Congestion Relief WTP corridors operate with minimal delay for people and freight and with continual reduction in the societal, environmental, and economic cost of congestion	1. Reduce person and freight delay on WTP Corridors 2. "Travel time" service objective to be developed in future updates 3. "Reliability" service objective to be developed in future updates
	Enhanced Mobility: Increased Travel Options Throughout the state, travelers have viable alternatives to the privately-owned automobile for their trips	1. Improve existing travel options* *This is defined as new options and better quality of existing options based on market demand.
	Enhanced Mobility: Seamless Connections The transportation system offers easy connections between different services throughout the state	1. Create links and remove barriers between transportation facilities and services

Table C.1 Relationship of Vision Elements for Washington Transportation Plan (continued)

Vision Principle	Vision Outcomes	Service Objectives
Vibrant Communities (continued)	**Improve Safety: Continuously Reduce Injury, Fatalities, and Risk** A safe transportation system without deaths or disabling injuries and with continuous reductions in societal cost of accidents	1. Reduce* and prevent deaths, and the frequency and severity of disabling injuries and societal costs of accidents * Focus on the rate of frequency and severity.
	Improve Safety: Increased Security Customers are safe and secure, while using the transportation system	1. Improve emergency response systems 2. Increase the security of the transportation system
	Livable Communities: Effective Community-Based Design Integrated community design, land use, and transportation investments improve quality of life	1. Reduce impact on communities and their resources with the development and implementation of transportation projects 2. Increase integration of state and local interests in the development and implementation of transportation services and facilities 3. Balance state and local needs in the development and implementation of multimodal transportation projects
	Livable Communities: Collaborative Decision-Making Collaboration occurs between federal, tribal, state, regional, local, and private sector partners	1. Increase stakeholder and partner satisfaction with the level of involvement in decision-making in the development and implementation of transportation projects
Vital Economy	**Effective Competitive Freight Movement** Freight movement is reliable* and transportation investments support Washington's strategic trade advantage *See congestion relief.	1. Reduce barriers that delay the effective and reliable movement of freight 2. Maintain the ability to move freight and goods in the event of alterations to the Columbia/Snake River system as a transportation right-of-way

Table C.1 Relationship of Vision Elements for Washington Transportation Plan (continued)

Vision Principle	Vision Outcomes	Service Objectives
Vital Economy (continued)	**Support General Economic Prosperity** Transportation supports general economic prosperity	1. Support statewide economic development through targeted transportation investments 2. Support economic prosperity in distressed areas through targeted transportation investments
	Support for Tourism Recreational travelers have convenient and inviting access to tourist destinations	1. Increase traveler information to tourist destinations 2. Improve the quality of tourists' travel-related experiences in Washington
Sustainable Environment	**Maintain Air Quality** Transportation services and facilities help maintain air quality by meeting air quality health standards	1. Reduce the impact of transportation facilities and services on air quality in conformance with the State Implementation Plan for Air Quality
	Meet Water Quality Standards Transportation services and facilities help maintain water quality by meeting water quality standards	1. Reduce water quality impacts caused by transportation facilities and services to comply with federal and state water quality requirements
	Maintain Habitat and Watershed Quality and Connectivity Transportation services and facilities help to maintain the quality of and contribute to the recovery of the ecological functions of watersheds and habitats	1. Reduce the impacts of past projects and avoid or minimize impacts to watershed and habitat from current and future transportation activities
	Reuse and Recycle Resource Materials Transportation services and facilities prudently use, reuse, and recycle resource materials	1. Minimize the use of resources and increase the use of recycled materials

Essentially, these elements from the vision process provide the explicit foundation for the performance-based planning system that is being finalized for use in preparing the WTP. WashDOT is currently assessing different performance measures to supplement the three vision elements identified above and complete the performance-based planning system that will be used for assessing different WTP strategies.

C.2 Pennsylvania DOT: Strategic Performance Measurement (2000)

The Pennsylvania DOT's (PennDOT's) performance measurement system is intended to be an agency wide strategic management tool that is used to align all agency business functions and activities (e.g., capital investments, preservation, routine maintenance, operations, management functions, etc.) to achieve a core set of goals and performance targets. This focus differs somewhat from the other states that are reported here in that PennDOT's system has a much broader focus that resource allocation for statewide planning activities.

PennDOT's vision, which calls for "…*[a] transportation system and services exceeding customer expectations"* is further expanded upon by its agency mission statement:

> *Through the active involvement of customers, employees, and partners, PennDOT provides a transportation system and services that exceed the expectations of those who use them.*

PennDOT intends to achieve this mission and vision through activities that will improve performance in eight "strategic focus areas":

1. Maintenance first;
2. Quality of life;
3. Mobility and access;
4. Customer focus;
5. Innovation and technology;
6. Safety;
7. Leadership at all levels; and
8. Relationship building.

Each of the eight "strategic focus areas" has specific goals or customer pledges, supplemented by specific performance objectives, measures, tools, and targets for each goal. Table C.2 displays the relationship of these elements for four of the strategic focus

Table C.2 Relationship of Goals, Objectives, and Measures for PennDOT's Strategic Performance Measurement System

Strategic Focus Area	High-Level Pledge to Customers	How Success will be Measured?	Measurement Tool	Target	
				2002	2005
Maintenance First	Smoother Roads	Better ride conditions on major (NHS) highways	International Roughness Index (IRI)	104 for NHS roads	99 for NHS roads
	Cost-effective highway maintenance investment	Reduction in outstanding maintenance needs	Condition Assessment for highways and bridges	Complete asset management system	Meet target established in 2002
Quality of Life	Balance social, economic, and environmental concerns	Timely decisions based on public and technical input on project impacts	Highway project environmental approvals meeting target dates	75% meeting target dates	90% meeting target dates
	Demonstrate sound environmental practices	Attaining world class environmental status	ISO 14001 environment criteria	Implement a pilot program	Meet ISO standards
Mobility and Access	Delivery of transportation products and services	Honoring commitments on scheduled transportation projects	Dollar value of 12-Year Program construction contracts initiated	$1.3 billion per year	$1.4 billion per year
	Efficient movement of people and goods	Reduced travel delays	2002 – Peak period work zone lane restrictions 2005 – Travel delays on selected corridors	Set baseline in 2000 for reduced 2002 lane restrictions	Meet target set in 2002 to reduce corridor travel delays
Customer Focus	Improve customer satisfaction	Competitiveness on Malcolm Baldridge Criteria for Excellence	Baldridge Organizational Review Package Scores – Customer Criteria	80 Department Average	100 Department Average
	Improve customer access to information	Prompt answers to telephone inquiries	Answer rate of calls to the Customer Call Center	94% of calls answered	94% of calls answered

areas. Importantly, the performance objectives (i.e., "How Success will be Measured") are a mix of internal (agency processes and management) and external (facility conditions, etc.) strategies. PennDOT has also developed an extensive ongoing monitoring and assessment process that includes:

- Quarterly performance reports on the achievement of performance objectives;
- Annual data audits;
- Ongoing quality control for the traffic data collection program; and
- Externally-generated report cards on customer service activities and agency work products.

Many of these monitoring and assessment processes are used to assure that the quality of data and tools used in the process is sufficient to assure that results are reporting actual conditions, rather than random fluctuations due to data inconsistency.

C.3 Florida Transportation Plan (1995)

The Florida DOT's (FDOT's) mission statement provides a policy framework, or long-term vision, for future investments in Florida's transportation system. Unlike the PennDOT example cited above, FDOT explicitly states that their mission statement (and related goals and objectives) is not intended to address administration of the DOT's programs and management efficiency objectives. The mission statement states:

> *The Department will provide a safe, interconnected statewide transportation system for Florida's citizens and visitors that ensures the mobility of people and goods, while enhancing economic prosperity and sustaining the quality of our environment.*

Within the long-term element of the Florida Transportation Plan (FTP), the mission statement is directly linked to four top-level goals, which each has three to six long-range objectives. The relationship between the mission statement, goals, and objectives is indicated in Table C.3. The investment strategy in the FTP was summarized in terms of the four long-range goals. The FTP indicated the total percentage of transportation funds that would be used to support each goal, and then indicated the types of strategies that would be supported through these investments.

FDOT also created a short-range component for the FTP that provided specific short-range objectives, performance measures, 10-year targets, and existing benchmarks. The short-range component was organized around the four long-term goals, thus providing an explicit linkage back to the mission statement. Although the FTP was originally developed in 1995, FDOT has expended considerable effort since that time in refining its performance measures (and the overall FTP), particularly for its mobility program.

Table C.3 Relationship of Long-Range Goals and Objectives to Florida DOT's Mission Statement

Element from the Mission Statement	Long-Range Goal	Long-Range Objectives
…provide a safe, interconnected statewide transportation system for Florida's citizens and visitors…	Safe transportation for residents, visitors, and commerce	• Reduce the rate of motor vehicle crashes, fatalities, and injuries and bicycle and pedestrian fatalities and injuries on highways • Improve intermodal safety where modes intersect, such as highway or railroad bridges over waterways and highway-railroad crossings • Improve the safety of commercial vehicles, rail facilities, public transportation vehicles and facilities, and airports • Improve emergency preparedness and response
… a safe, interconnected statewide transportation system…	Protection of the public's investment in transportation	• Preserve the State Highway System • Reduce the number of commercial vehicles that exceed legal weight limits on the State Highway System • Protect the public investment in aviation, transit, and rail facilities
…while enhancing economic prosperity…	A statewide interconnected transportation system that enhances Florida's economic competitiveness	• Place priority on completing the Florida Intrastate Highway System • Complete a Statewide High-Speed Rail System • Improve major airports, seaports, railroads, and truck facilities to strengthen Florida's position in the global economy • Improve connections between seaports, airports, railroads, and the highway system for efficient interregional movement of people and goods • Manage and preserve designated transportation corridors in cooperation with local governments and through advance acquisition of right-of-way
…that ensures the mobility of people and goods, … and sustaining the quality of our environment.	Travel choices to ensure mobility, sustain the quality of the environment, preserve community values, and reduce energy consumption.	• Reduce dependency on SOV • Provide accommodation for transit vehicles, bicyclists, and pedestrians, wherever appropriate, on state highways • Increase public transportation ridership • Expand public and specialized transportation programs to meet the needs of the transportation disadvantaged • Minimize the impact of transportation facilities and services on the environment • Increase energy conservation and the use of recycled materials, native vegetation, and wildflowers

C.4 Oregon Transportation Plan: Policy and Multimodal System Elements (1992)

Oregon DOT (ODOT) adopted a tiered approach to develop the Oregon Transportation Plan (OTP) in the early 1990s. Under this tiered approach, the OTP consisted of a policy element, the multimodal system element, a series of modal and multimodal plans, and a series of multimodal corridor plans. Each element was to provide increasing specificity of how the statewide transportation system was to be developed.

The policy element provided the general framework for all subsequent elements. The policy element included the following vision statement regarding long-term development of transportation in Oregon:

> *The purpose of the Oregon Transportation Plan is to develop a safe, convenient, and efficient transportation system that promotes economic prosperity and livability for all Oregonians.*

The policy element included four broad goals that more fully defined the vision through the topics of system characteristics, livability, economic development, and implementation.

The multimodal system element identified corridors and facilities of a statewide transportation system. More importantly, the multimodal system element suggested minimum modal service levels; and proposed a set of major investments, policies, a financial strategy, and implementation roles to achieve those service levels and the overarching policy element. Interestingly, there was no direct correspondence between the policy vision or goals, and the evaluation measures that were used to assess the alternative multimodal strategies. While the general framework and themes were consistent between the OTP elements, the multimodal system element presented both quantitative and qualitative measures that were somewhat loosely affiliated with the vision and goals. This loose affiliation continued with subsequent elements of the OTP; while general policy themes remained consistent, unique goals, measures, and strategies were adopted for each element that were more closely aligned to the decision-making needs of those elements. While this sort of flexibility no doubt improved the "fit" between specific strategies and measures within individual modal elements, it makes it less likely that broad system goals will be a strong driver of individual program or project decisions.

Appendix D

Review of Data to Support MoveAZ

Appendix D. Review of Data to Support MoveAZ

Appendix D presents a synthesis of the relevant transportation data sources that will be used to support the development of the Arizona Long-Range Transportation Plan (MoveAZ Plan). The results of the data synthesis will be used to build a comprehensive multimodal transportation system inventory (Task 4) to support the development and analysis of the policies and projects evaluated as part of the MoveAZ planning process.

The summary contained herein considers the review of Arizona Department of Transportation (ADOT) data sources. The review of local data from Metropolitan Planning Organizations and Councils of Government (MPOs/COGs) in Arizona is also included in this version of the working paper. The material in this appendix will be updated as additional material from the MPOs/COGs is obtained and summarized.

This appendix presents the following information:

- Data sources;
- Data review; and
- Data inventory development.

Included in this appendix are summaries for each major data source identified and reviewed in this process.

D.1 Data Sources

The data review and synthesis process was initiated to develop a comprehensive transportation system inventory for the MoveAZ Plan analysis. Several categories of data were reviewed in order to begin to develop this comprehensive database, including:

- Roadway conditions and usage data;
- Geographic coverage data;
- Roadway accident data;
- Current and future transportation projects data;

- Land use data; and
- Demographic and socioeconomic data.

The sources for these data items included the ADOT and other state of Arizona agencies, MPOs/COGs, and federal agencies. The primary sources reviewed are summarized below with the detailed descriptions of each data source provided in later sections of this working paper.

D.1.1 Arizona Department of Transportation (ADOT)

A major source of data was the Arizona Transportation Information System (ATIS) maintained by ADOT. These data included geographic coverages for roads, railways, and political boundaries, as well as the Arizona State Highway System Log data, which represents the Highway Performance Monitoring System (HPMS) reported and submitted by ADOT to the Federal Highway Administration (FHWA). ADOT also maintains an automobile accident database that was reviewed and summarized in this process.

D.1.2 Arizona State Land Department (ASLD)

The Arizona State Land Department data relevant to the development of the MoveAZ Plan were obtained from the Arizona Land Resource Information System. These data included geographic coverages of political boundaries, roads, and railways, as well as geological and other data. The Arizona Land Resource Information System (ALRIS) data were drawn from numerous sources, including the U.S. Census Tiger Line files, digital line graph files, and other information.

D.1.3 Arizona Department of Economic Security (ADES)

The Arizona Department of Economic Security (ADES) maintains a web site containing the most recent population, occupation, and employment data for the state of Arizona. This data was developed primarily from the U.S. Census, the Bureau of Labor Statistics, or the Bureau of Economic Affairs series data. ADES also provided socioeconomic projections (occupation and employment growth) that will be used to support development of the MoveAZ Plan.

D.1.4 Metropolitan Planning Organizations, Councils of Governments (MPOs/COGs)

Available data from the following MPOs/COGs have been received and reviewed:

- Central Arizona Association of Governments (CAAG);
- Northern Arizona Council of Governments;
- Pima Association of Governments (PAG)*;
- Flagstaff Metropolitan Planning Organization (FMPO)*;
- Yuma Metropolitan Planning Organization (YMPO)*; and
- Western Arizona Council of Governments (WACOG).

ADOT has requested the data from the following Arizona's remaining MPOs/COGs:

- Maricopa Association of Governments (MAG)*; and
- Southeastern Arizona Governments Organization (SEAGO).

The specific requests to each of the MPOs/COGs are presented in the last section of this working paper.

A survey of Arizona's MPOs/COGs was conducted in the summer of 2001 to determine the types of transportation data collected and maintained at the local level in Arizona that could be useful in the development of the MoveAZ Plan. The MPOs/COGs collect, maintain, and require different levels of transportation data and, in some cases, depend on data collected and maintained by ADOT to conduct transportation analyses. While some MPOs/COGs may have limited data, basic information, such as vehicle miles traveled, traffic volumes, roadway levels of service, and transit facilities and boardings were generally available and have been obtained.

Each of the MPOs/COGs maintains a list of programmed and proposed transportation projects through the Transportation Improvement Plan process. These plans were reviewed as part of Task 2, *Synthesize Transportation Vision*, and are identified in Appendix A of Working Paper #1, an annotated bibliography of all of the reviewed plans and programs.

D.1.5 U.S. Census Bureau

The U.S. Census Bureau provided both geographic coverage data in the form of Tiger Line files and numerous demographic data items for several geographic levels, including

*Indicates a federally-designated MPO.

standard political units, as well as census tracts, block groups, and blocks. The Census also maintains Tiger Line files for Interstates, U.S. highways, state highways, highway collectors, and railways.

D.1.6 Bureau of Transportation Statistics

The Bureau of Transportation Statistics provided both geographic coverage data and several data items for air, rail, and intermodal facilities and border crossings. All data were available from the BTS web site.

D.2 Data Review

A thorough review and summary of each available data source provided by ADOT were conducted. This review process involved filling out the basic review template as shown in Figure D.1. The template was created to classify the data into the following categories:

- System usage data, including roadway traffic counts and VMT, transit ridership, pedestrian and bicycle volumes, train and freight movements, and airport boardings operations.
- System performance data, including roadway levels of service, and travel speeds and times; roadway, pedestrian, bicycle, transit, and rail grade crossing accidents; and transit and airport on-time performance.
- Facility location and condition inventory, including highway and bridge conditions and ratings; ITS components; sidewalk, bicycle, rail, intermodal, airport, and recreational facility locations; transit vehicle age and conditions; and rail line conditions.
- Environmental resources, including vehicle fleet information, culturally significant land locations, and environmentally sensitive land locations.
- Demographic and land use data, including population data and components, economic indicators, and adopted land use and zoning.
- Future projects, including programmed and planned projects, project tracking systems, and funding sources and amounts.
- Miscellaneous data, including perceptions and attitudes and any other data.

Data items were also classified by geographic coverage, including individual projects and all geographic and political groupings, modal coverage, and agency type.

Figure D.1 MoveAZ – Data Summary Review Form

AzTP - Data Summary Review Form

Reviewer: _____

Organization: _____

Review Date: _____

Descriptive Name of File/Data Source: _____

Agency & Jurisdiction: _____

Document Title (if any)**:** _____

Publication Date: _____

Classification Information (check all that apply)
Data Addressed in File/Source:

SYSTEM USAGE DATA

_____ Roadway traffic counts
_____ Roadway vehicle classification
_____ Roadway VMT
_____ Transit ridership (systemwide)
_____ Transit ridership (route-level)
_____ Transit ridership profile (i.e. demographics)
_____ Pedestrian volumes
_____ Bicyclist volumes
_____ Train movements
_____ Freight movements
_____ Airport boardings/passengers
_____ Airport operations (commercial)
_____ Airport operations (general aviation)
_____ Airport operations (commercial)

SYSTEM PERFORMANCE DATA

_____ Roadway level of service
_____ Roadway travel speeds
_____ Roadway travel times
_____ Roadway accidents
_____ Pedestrian/bicycle accidents
_____ Rail grade crossing accidents
_____ Transit vehicle accidents
_____ Transit on-time performance
_____ Airport on-time performance

ENVIRONMENTAL RESOURCES

_____ Vehicle fleet information
_____ Culturally significant land location
_____ Environmental sensitive land location

FACILITY LOCATION AND CONDITION INVENTORY

_____ Highway conditions/ratings
_____ Bridge conditions/ratings
_____ ITS components
_____ Sidewalk location/condition
_____ On-road bicycle facility location
_____ Off-road bicycle facility location
_____ Transit vehicle age/condition
_____ Rail mainline location
_____ Rail mainline condition
_____ Rail branchline location
_____ Rail branchline conditions
_____ Rail/highway crossing location
_____ Location of intermodal facilities
_____ Location of airports
_____ Runway/taxiway/nav-aid condition
_____ Location of recreational attractions

DEMOGRAPHIC AND LAND USE DATA

_____ Population
_____ Employment
_____ Household income
_____ Poverty
_____ Age
_____ Ethnicity/race
_____ Adopted land use
_____ Zoning

FUTURE PROJECTS

_____ Programmed projects
_____ Planned projects
_____ Project tracking system
_____ Funding sources & amounts

Figure D.1 MoveAZ – Data Summary Review Form (continued)

Classification Information (check all that apply) - Continued

Data Addressed in File/Source (Continued):

MISCELLANEOUS DATA

_____ Perceptions and Attitudes

_____ Other (Identify: _____)

Other Classification Information

Geographic Coverage of Data	**Modal Coverage**	**Agency Type**
_____ Individual Project	_____ Highways	_____ City
_____ City	_____ Bridges	_____ County
_____ County	_____ Urban Transit	_____ COG/MPO
_____ Portion of city/county	_____ Rural Transit	_____ Tribe
_____ Small Area/Sub-regional	_____ Passenger Rail	_____ ADOT
_____ Regional	_____ Freight Rail	_____ Other State Agency
_____ Statewide	_____ Intercity Bus	_____ Other
_____ No geographic coverage	_____ Aviation	
	_____ Pedestrian	
	_____ Bicycle	
	_____ Other	

- **Synopsis**

Brief overview description of the data source, including a succinct, overall assessment of data quality. Synopsis (and following sections) should each be a few sentences in length.

- **Data Collection Methodology**
- Describe the data collection methods (e.g. telephone surveys, road tubes, visual counts, etc.) and sampling/data update frequency. Describe use of third party data sources (e.g. Census, commercial, etc.) in deriving data.
- **Data Storage**
- Describe the format (hardcopy reports, maps, Access database, etc.) in which data are stored. Identify the finest level to which each data item is aggregated. Describe the time period (e.g. e.g. yearly funding, monthly aircraft operations; daily traffic volumes, etc.) reflected by each data item; indicate if the data for this time period are directly observed or derived (e.g. factoring of daily counts to find peak-hour).
- **Forecasting and Evaluation Processes**
- Describe the approach that is used to forecast any data item; identify specific software or other analytical methods, as well as assumptions that are used. Identify any other processes used by the agency, but not necessarily reflected in the database results.
- **Relevance for AzTP**

Brief discussion of the potential applicability of the data and tools for preparation of the AzTP. Particular attention should be made in discussing how the analysis could be used to prepare a system inventory, develop demand projections, address equity, identify transportation system conditions, demand and deficiencies, and evaluate program-level or system-level alternatives.

In addition to classifying the data in these ways, brief summary descriptions of the data sources were prepared, including descriptions of the data collection methods and storage formats, descriptions of any approaches used to forecast data items, and discussions of the relevance of the data item for input into the MoveAZ Plan. Summaries of these reviews are presented in this working paper.

D.3 Data Inventory Development

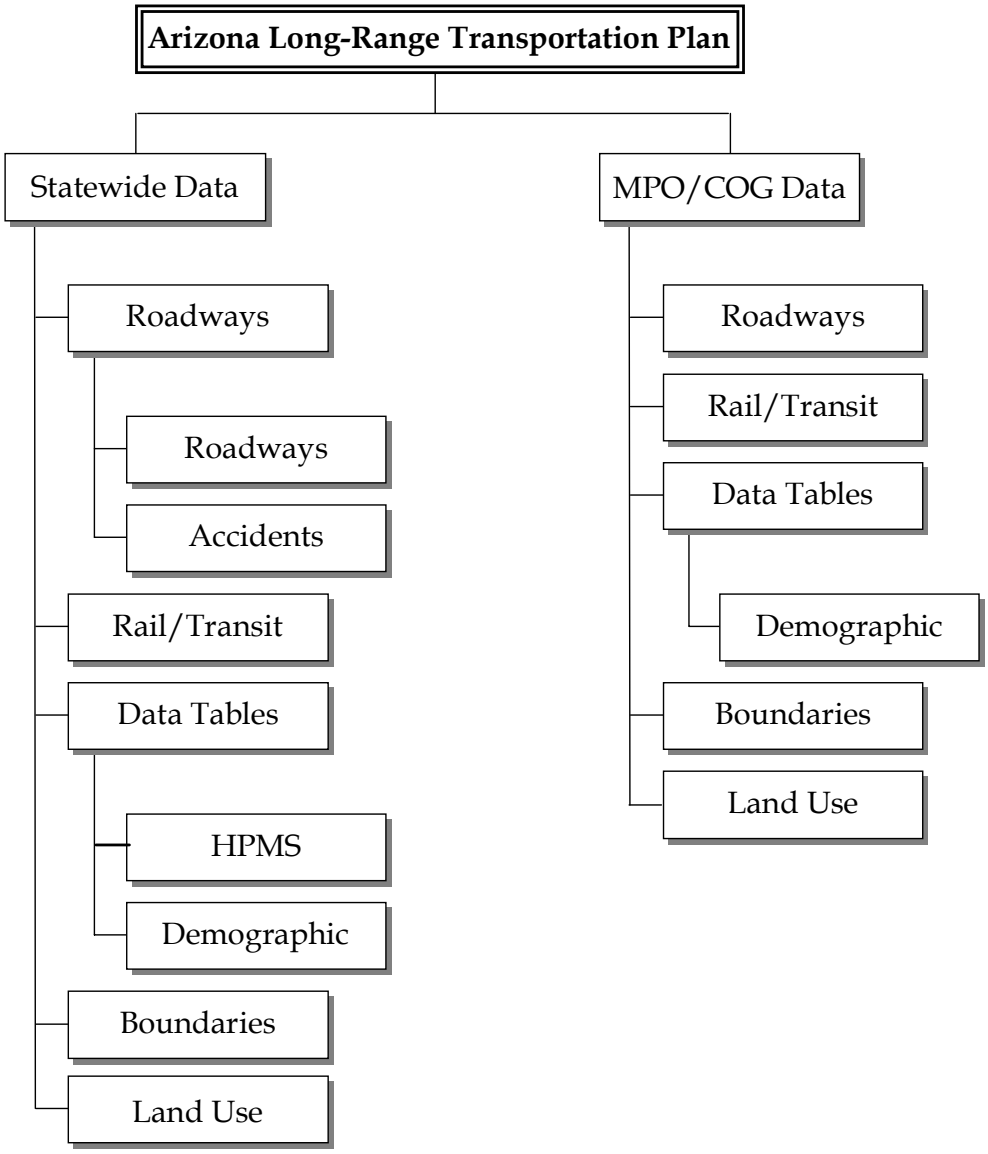
The data sources reviewed in this process were input into a directory structure for storage of all relevant data in preparation for developing the transportation system inventory in Task 4. The geographic files were input into a common structure using ArcView software, while the non-geographic files were input into a common structure using dBase software that can be linked to ArcView. ArcView is the Geographic Information System (GIS) currently used by ADOT, and it links directly with dBase software. This GIS-based system will be used as the foundation for developing the Comprehensive Transportation System Inventory in Task 4. The data inventory was structured by level and type of data as shown in Figure D.2. The geographic breakdown includes statewide, MPO/COG, city, and county levels.

The data by type was input into the specific structure identified in Figure 2. The types used included the following:

- GIS Boundary coverages showing geographic and political boundaries, including MPOs/COGs, counties, cities, urbanized areas, and American-Indian reservations;
- GIS Roadway coverages showing the locations of all major and minor roadways, including traffic accident type and location data;
- GIS Railroad and Transit coverages showing the locations of all railroads and transit systems;
- GIS Land Use files showing the land use and ownership data for major tracts of land, including federal ownership (national parks, forests, and recreation areas) and zoning data, where available; and
- Data table files, including HPMS data and demographic data from the U.S. Census and other sources.

GIS data items were converted to ArcView format using the standard ADOT formats (NAD 83 in Feet, Arizona Central). Demographic and other data came in various formats, including database and spreadsheet files, html and pdf tables, and ASCII-delimited files. These files were converted to standardized dBase files for ease of connection/linkage with ArcView.

Figure D.2 Initial Arizona LRTP GIS-Based Directory Structure



This data analysis effort will be used as the basis for building a comprehensive multimodal inventory and profile of roadways, transit, rail, air, non-motorized, and ITS infrastructure for the MoveAZ Plan. This data will be easily accessible in ArcView and will comprise a complete inventory.

D.4 Data Summaries

This section presents the data summaries of each data source reviewed in this process. The data requests for each of the MPOs/COGs are also presented later in this section.

D.4.1 Summary Reviews

1. ADOT ATIS Roads – Boundary GIS Coverages

Source: Boundary Shape files, ADOT, ATIS.

Synopsis: These files contain basic GIS coverage for urbanized areas, cities, counties, COGs, and ADOT transportation districts. The files are in ArcView shape file format and contain boundary information for each geographic aggregation. The database files contain basic identifiers for linking to tabular data. Counties and COG files also have values for the area and the perimeter of the each geographic aggregation.

2. ADOT ATIS Roads – Roadway GIS Coverages

Source: Roadway Shape files, ADOT, ATIS.

Synopsis: These data come from three files that provide basic geographic coverages for roadways in Arizona. ATIS includes ArcView point coverages for main roads – interstates, U.S. highways, and state highways – and ArcView line coverages for all major and numerous minor routes. The coverage of streets and other minor collector routes is extensive.

Roadways are defined by route segment defined by kilometer posts. These data also include database files with lists of these segments, the kilometer ranges of segments, and locations of highway intersections.

There is also an ArcView shape file that identifies the type of highway – interstate, U.S. route, state route – for each segment. This file provides a graphic representation of the type of highway using standard highway shields.

3. *ADOT ATIS Environmental Files*

Source: Environmental Non-Attainment Areas Shape files, ADOT, ATIS.

Synopsis: These files have geographic coverages for areas that are in non-attainment for carbon monoxide (CO), ozone, and particulate matter (PM-10). These data also include perimeter and area values for each area, and a measure of the concentration or days out of attainment.

4. *ADOT ATIS Land Ownership File*

Source: Arizona State Landowners file, ADOT, ATIS.

Synopsis: These data provide geographic coverages of boundary areas of various landowners in the state. The land ownership information is given statewide. The file identifies the name of the landowner for each area and the type – American-Indian nation and U.S. Forest.

5. *Highway Performance Monitoring System Data*

Source: HPMS, ADOT, ATIS.

Synopsis: This file contains the HPMS event tables with both universe and sample data. These data include extensive measures of highway design, including lanes, intersections, types of pavement, medians, shoulders, and other variables. There are also several useful performance measures, including Annual Average Daily Traffic (AADT), predicted AADT (with year of future prediction), level of service (volume/service flow ratio), use of ITS elements, and a measure of truck traffic.

The performance measures are collected for sample segments of the complete highway system. Segments are drawn from a stratified sample – urban/rural, arterial type, and volume group. Sampled data are extrapolated to the highway universe using a simple expansion factor: distance in sampling stratum divided by total distance in the sample.

6. *Arizona Land Resource Information System Geographic Coverages*

Source: Boundary Shape files, Arizona State Land Department, Arizona Land Resource Information System.

Synopsis: These files are the Arizona Land Resource Information System geographic coverages for counties, cities, and tribal areas. The files are in ArcView shape file format and contain boundary information for each geographic aggregation. The database files contain basic identifiers for linking to tabular data.

7. Arizona Land Resource Information System Roadway and Railroad Line Files

Source: Roadway and Railroad Shape Files, Arizona State Land Department, Arizona Land Resource Information System.

Synopsis: These ArcView shape files provide line coverages of roadways and railroads. There are two roadway files: 1) one just for interstates that are derived from digital line graph data and 2) one for all major road segments, including highway collectors that are derived from 1992 Tiger Line files. The railroad data are also derived from the 1992 Tiger Line files.

8. Arizona Land Resource Information System Land Ownership Data

Source: Land Ownership Files, Arizona State Land Department, Arizona Land Resource Information System.

Synopsis: This file provides land ownership data that delineates state, national forest, and American-Indian reservation ownership.

9. ADOT Accident Data

Source: Accident Database, ADOT.

Synopsis: These data provide locations of all automobile accidents from January 1997 through December 1999. The data are identified by route and milepost or street and Cross Street. The data do not identify type of accident.

10. ADES Economic Data

Source: Occupation and Employment Data, ADES, http://www.de.state.az.us.

Synopsis: The Economic Analysis section at the ADES web site provides the following occupation, employment, and income data:

- Historical labor force and occupational data by month and major industry for the state, counties, and metropolitan areas.

- 1998-2008 Occupational Forecast – Employment forecast by occupation, 10-year forecast, averaged to estimate annual change. These data are collected for the state and for certain counties and metropolitan areas. Prepared in cooperation with the U.S. Bureau of Labor Statistics.

- Personal income data for counties and metropolitan areas, with separate data for earnings, per-capita income, dividends, and transfer payments.

11. ADES Demographic Data

Source: Demographic Data, ADES, http://www.de.state.az.us.

Synopsis: The Population Statistic section within the ADES web site provides access to Census 2000 data, including the following:

- Population with sex and age breakdowns for the state and counties.
- Population projections by county through 2050 using the state of Arizona Demographic Cohort-Survival Projections Model.
- Census 2000 data for the state, counties, cities, census tracts, and congressional districts. These data are also available from the Census bureau and are described below.

12. Census Tiger Line Files

Source: 2000 Census Tiger Line files, U.S. Census Bureau, The Geography Network, http://www.geographynetwork.com/data/tiger2000/

Synopsis: The Census maintains a database of geographic boundaries and physical features for use in GIS applications. Their database is maintained as a database file with longitudes and latitudes that can be converted into any GIS format. The Geography Network has converted these files into ArcView format. These files include boundaries for census blocks, block groups, tracts, cities, urban areas, and counties.

13. Census Demographic Data

Source: 2000 Census, U.S. Census Bureau.

Synopsis: These data include summary demographic attributes (population, race, age, gender, housing units, households) for the state, counties, cities and census-designated places, metropolitan areas, and congressional districts. The data are from the data items requested from every resident in the U.S. during the 2000 Census and include population with race, age, and sex breakdowns; housing unit data; households by type; and relationship to householder data.

14. BTS Passenger Rail Stations

Source: Bureau of Transportation Statistics.

Synopsis: This ArcView point file indicates AMTRAK station locations with limited associated physical station data.

15. BTS Intermodal Data

Source: Bureau of Transportation Statistics.

Synopsis: This ArcView point file indicates locations of major intermodal facilities, with associated physical characteristics and the modes that are connected.

16. BTS Border Data

Source: Bureau of Transportation Statistics.

Synopsis: These data tables include transborder surface freight data, including dollar value of the shipments, modes of transport, and origin and destinations. The BTS also supplies data for truck, train, personal vehicle, passenger, and pedestrian border-crossing volumes.

17. BTS Airport Data

Source: Bureau of Transportation Statistics.

Synopsis: The BTS Airport Data include a point file of all commercial airport locations with limited associated physical data. An ArcView line file indicates corresponding runway locations with physical runway data. The BTS provides data tables of passenger enplanements, scheduled flights, actual flights, freight tonnage, and mail tonnage at all primary airports.

18. Airports Council International – North America

Source: Airports Council International – North America, 1999-2001.

Synopsis: These data include data tables of passenger enplanements, scheduled flights, actual flights, freight tonnage, and mail tonnage at all primary airports. Percent changes between 1999 and 2000 are also included.

19. Airport Location Data

Source: GCR & Associates, Inc. (GCR), Airport Summary and Activity Data, September 2001, www.gcr1.com/5010WEB/default.htm

Synopsis: GCR web site provides access to airport data. The airport data accessible through this site is structured in accordance with the FAA Airport Master Record (FAA Form 5010-1) and is unedited information provided by GCR with data derived from the National Flight Data Center. The data of the data set matches the date of the most recent Airport Facilities Directory (AFD). The current AFD is dated September 6, 2001 according to the information provided on this site.

Users can search for airport by name, city, state, or location identifier. Airport data is divided into the following categories: general information, services and facilities, based aircraft and operations, runway information, and remarks.

The data collection methodology corresponds to the methods used by the National Flight Data Center (NFDC), which is one of the subdivisions under the Office of Air Traffic and Airspace Management. The NFDC serves as the principal element within the FAA responsible for collecting, collating, validating, storing, and disseminating aeronautical information detailing the physical description and operational status of all components of the National Airspace System.

20. Tucson International Airport Statistics

Source: Tucson International Airport (TIA), 2001.

Synopsis: This document provides basic facts on TIA, including basic travel statistics (passenger boardings, departures and arrivals, freight traffic); facility data; employment and economic data; and history about the airport.

21. National Transit Database Data

Source: National Transit Database.

Synopsis: The National Transit Database includes data tables on overall transit ridership numbers, vehicles and operating costs, by transit type, for major Arizona transit agencies. The database also includes a listing of paratransit providers and smaller agencies across the state.

22. CAAG Safety Project Analysis Database

Source: Arizona Local Government Safety Project Analysis Model, 2001, ADOT.

Synopsis: This database is intended to address the challenges faced by local governments in determining treatment sites for safety program funding. Specifically, the model that we have access to is used to document and query incidents and accidents in the CAAG COG. Users can query crash locations, crash reports and references, specific safety-improvement project details and locations, and a cost-benefit analysis of each project.

23. NACOG TIP

Source: NACOG FY 2002-2006 TIP, 2001, NACOG.

Synopsis: The transportation improvement plan for NACOG is the five-year (2002 to 2006) funding plan that is developed as part of their regional transportation planning process. These projects are the ones that are programmed for the five-year period. The file covers all programs from every mode and gives the dollar amount programmed to each

project, dollars from the highway user revenue fund, and the length of each project segment.

24. PAG 2000 and 2025 Land Use Data

Source: 2025 Regional Transportation Plan, 2000, PAG.

Synopsis: This land use data covers traffic analysis zones in the PAG region. The data is in GIS format and includes database and shape files for both 2000 and 2025 to evaluate the long-range planning effort graphically. It includes household, population, job sector employment, and income data.

25. PAG 2001 Average Daily Traffic

Source: PAG traffic volume map, 2001, PAG.

Synopsis: This spreadsheet has average daily traffic volumes for 210 locations in the PAG region.

26. PAG 2001 Bike Counts by Location

Source: PAG database, 2001, PAG.

Synopsis: This data indicates bicycle volumes for 50 street locations in the PAG region. For each location, volumes for time period intervals in each direction and totals are given.

27. PAG 2000 and 2025 Bicycle Lane Data

Source: PAG Tucson bicycle map, 2000, PAG.

Synopsis: This data shows existing, planned, and programmed bicycle routes in the PAG region. The bicycle routes are shown graphically (in GIS) and indicate what type of lane is at each location.

28. PAG 2000 and 2025 Rail Data

Source: Federal Railroad Administration database, 2000, PAG.

Synopsis: This data shows main rail lines, spurs, and railroad crossings in the PAG region. The rail lines are shown graphically in GIS.

29. Tucson 2001 Level-of-Service Table

Source: PAG database, 2001, PAG.

Synopsis: This table has the peak hour delay and level-of-service values for the 34 highest volume intersections in the city of Tucson in 2001 and 2000.

30. PAG 2000/2001 Annual Transit Ridership Data

Source: Local transit agencies, IRRTP, 2000-2001.

Synopsis: This data gives 2000 and 2001 annual transit ridership data for all of the transit lines in the PAG region.

31. PAG Aviation Data

Source: PAG Regional Aviation System Plan Update, 2001, PAG.

Synopsis: The review covers two parts of the PAG RASP, which provides information on the PAG Aviation System. Chapter 5 contains the methodology and demand forecasts and Appendix A contains information on current approach roads to Pima County airports. Chapter 5 contains a useful chart that projects enplanements and operations out to 2030 for all Pima county airports. Appendix A has information on the speed limit; functional classification; current traffic volume; and features (shoulders, median, bicycle lanes, etc.) for major approach roads for each airport in Pima County.

32. YMPO Roadway Data

Source: Yuma Metropolitan Long-Range Transportation Plan, 2000, YMPO.

Synopsis: These data include TransCAD files with level of service, traffic speeds, and travel times from the 2000 YMPO Model, traffic counts, 2023 future Average Daily Traffic, transit ridership, and geographic coverages with land use and streets in Yuma county.

33. YMPO Land Use Files

Source: Yuma Metro Data Layer, 1998, YMPO.

Synopsis: These ArcView files give information on land use for the Yuma metropolitan area.

34. YMPO Transit Ridership

Source: Yuma Metro Data Layer, 2001, YMPO.

Synopsis: This spreadsheet gives number of passengers by transit route for the YMPO.

35. FMPO Roadway Data

Source: FMPO.

Synopsis: Multiple ArcView line layers contain data on all existing local roadways, in addition to future no-build networks through 2020. Some of these layers contain roadway names, route numbers, traffic counts, and volumes. Excel tables contain extensive traffic count data from 1999 through 2001, including both raw and calibrated data.

36. FMPO Bicycle Route Data

Source: FMPO.

Synopsis: These ArcView line files contain current and proposed Flagstaff bicycle routes.

37. FMPO Land Use Data

Source: FMPO.

Synopsis: This ArcView polygon layer displays local land use data for the year 2000 according to 16 different land use categories.

38. FMPO Additional GIS Data

Source: FMPO.

Synopsis: The FMPO GIS dataset includes extensive geospatial information for the Flagstaff region, including the following:

- U.S. Geological Survey Data;
- Monuments;
- Parks;
- Golf courses;
- Fire stations;
- Historical sites and districts;
- Schools; and
- Synchronized traffic signals.

D.4.2 MPO/COG Data Requests

The following data requests have been made to each MPO/COG. Data is currently being delivered by several of the identified MPOs/COGs and will be reviewed, summarized, and input into the data inventory structure upon delivery.

MAG Data Request

The types of data requested of MAG included:

- Local transit data, including usage, performance, and route location data;
- Local data for roadways not monitored at a statewide level, including usage, performance, and geographic location data;
- Local land use data; and
- Local data on other modes, such as bicycle facility location and pedestrian facility location data.

SEAGO Data Request

The types of data requested of SEAGO included the following:

- Local transit data, including usage, performance, and route location data;
- Local data for roadways not monitored at a statewide level, including usage, performance, and geographic location data;
- Local land use data; and
- Local data on other modes, such as bicycle facility location and pedestrian facility location data.

MOVE AZ Long Range Transportation Plan

Appendix B. Issue Papers

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

MoveAZ Plan

Appendix B. Issue Papers

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

August 2004

Impacts of Global Economic Trends on Transportation in Arizona

Impacts of Global Economic Trends on Transportation in Arizona

Executive Summary

This paper discusses the major domestic and global trade and economic trends that will affect Arizona's transportation system, and provides general guidance for Arizona's future transportation investments. While the State's economy, and thus its transportation system, has historically been geared toward mining and agriculture, changes in world trade patterns and the increasing dominance of the service economy have presented new opportunities for Arizona.

Global economic expansion and liberalization of world trade has opened up new import and export markets for the United States and for Arizona. Businesses have taken advantage of cheaper labor and materials in foreign markets, moving production facilities, and now even customer service centers and other back-room operations, across borders and overseas. The *maquiladora* industry in Northern Mexico is just one manifestation of globalization in manufacturing. Improved communications capabilities have allowed companies to establish global supply chains, which in turn has led to the consolidation and internationalization of freight shipping firms.

"Pull" logistics structures, which rely on information about customer demand and availability of supplies, have revolutionized the manufacturing process. Remnants of "push" logistics, like stockpiles of excess supplies and warehouses full of finished goods, have been replaced with just-in-time delivery and made-to-order manufacturing. Pull logistics increases the importance of less-than-truckload (LTL) and small parcel deliveries, which has translated to an increase in delivery trucks on already congested metropolitan freeways and arterials. While bulk delivery of certain raw materials and supplies will continue to be handled by rail, the fastest-growing segment of freight shipments will be handled by services like FedEx and UPS, and by other shippers that can adapt to the changing needs of their clients. As high-value, time-sensitive shipments increase in volume, air cargo is increasing in importance. In addition to providing adequate ground transportation to accommodate an increase in LTL and small parcel deliveries, Arizona will have to ensure that adequate air cargo capacity is provided at airports around the State.

Much of the improvement in productivity that led the world's and Arizona's economic expansion was made possible by advances in information and communications technology. Information technology has improved the efficiency commercial vehicle operations in the private sector, but public sector applications of IT can improve the operations of the entire transportation system. Improving travel time reliability by preclearing commercial vehicles at Arizona's ports of entry, providing real-time traffic and travel time information to commuters so they can make better route, mode, and departure time choices, and

reducing paperwork for freight shipping firms by allowing them to file information electronically are just three tangible ways that information technology can improve productivity in Arizona. Other IT applications such as Smart Cards encoded with electronic manifests and biometric information about drivers can be used to improve safety and security of transportation in Arizona.

Deregulation in the transportation industry has increased competition and profitability in some parts of the industry, but overconsolidation in other sectors may have reduced competition. The air industry was profitable before 9/11, but with ever increasing security regulations it is not certain how the industry will respond in the long term. Arizona is heavily dependant on the continued viability of America West airlines, which provides three quarters of the passenger service to Phoenix. The State should work to expand the availability of domestic and international nonstop flights from Phoenix to increase the attractiveness of Phoenix for corporate offices. Air cargo also will benefit from increased nonstop service, especially flights to Asia, Europe, and Latin America.

U.S. trade with Asian and European nations has dominated U.S. foreign trade since World War II and will continue to grow. Well-established east-west trade flows across the United States include vital links running across the state of Arizona. The increasing dominance of the Ports of Los Angeles and Long Beach will generate and increase in demand for trans-Arizona freight shipments. Interstates 10 and 40 and two main rail trunk lines cross the State from east to west, and are important to the U.S. economy and Arizona's economy. The State must maintain the flow of freight and passengers along these important arteries so that goods from U.S. ports and Arizona's factories and farms can reach their destinations without costly delays. Urban congestion in Arizona is worsened by through traffic. Freight shipments should be able to pass through metropolitan areas unimpeded, but to the greatest extent possible their interference with intraurban passenger and freight travel should be minimized.

Mexico and Latin America are relative newcomers to the global marketplace, but they promise to lead the rest of the world in growth over the next two decades, and Latin America will be Arizona's top export market for the foreseeable future. An increase in trade with Mexico will put pressure on north-south trade routes and, in particular, U.S.-Mexico border crossings. The maquiladora industry in particular has generated demand for truck shipments, rail shipments, air cargo shipments, and commuter trips many of which require a border crossing and the use of roads, rail lines, and airports within Arizona. Recent initiatives by U.S. and Mexican authorities have eased the flow of commercial and passenger vehicles across the border, and Arizona has contributed to congestion relief through agricultural preinspection programs and other initiatives. As advances in inspection and information technologies become available, Arizona should work with U.S. and Mexican authorities to reduce delays for incoming and outgoing vehicles.

The changes brought about by the rise of the service economy have influenced the way Arizonans work, play, live, and travel. Population growth and increases in regional freight traffic will require continued expansion of metropolitan highway networks. Arizona's decisions about transportation investments should be made in tandem with land use decisions. Multimodal improvements to the transportation system can be used

as a tool to influence future development patterns, providing Arizonans a variety of alternatives for living, working, and traveling. Housing affordability and environmental conservation are just two issues that can be undertaken as part of the long-range transportation and land use planning process.

1.0 Introduction

For the Native Americans living centuries ago in what is now called Arizona, transportation was as important to the civilization's culture and economy as it is to present day Arizonans. While concepts of "foreign" and "world" are much different today than in pre-Columbian times, transportation still provides the link between communities that facilitates trade and communication. Instead of the ancient trade trails used by Native Americans and, later, by newcomers from the East, airports, railroads, and interstate highways now link Arizona to trade centers. Historically, the State's economy has depended on "the Five Cs" – Copper, Cattle, Cotton, Citrus, and Climate – but in the last half-century one "S" has begun to dominate: Services. Similar economic shifts have occurred throughout the United States, as the exchange of information has overtaken manufacturing and agriculture as the industry leading the nation and Arizona's, economic expansion.

Economic expansion also is taking place around the world due to the liberalization of global trade policies. The United States and other countries have formed multi-national trade agreements with major trading partners in order to facilitate the movement of goods and information across borders. In response, corporations have established global supply chains that allow for more efficient uses of resources and personnel.

Technological advances in freight transportation have allowed for the growth in productivity that has accommodated much of the recent expansion in international trade. However, all elements of the transportation system in Arizona and the United States, from seaports to highways to the air system, are quickly approaching their physical capacity limits. Unless transportation system capacity expansions keep pace with economic expansions, transportation will become a constraint for growth rather than a facilitator of growth.

With two transcontinental interstate highways, two east-west trunk rail lines, a large hub airport, a major border crossing, and the future north-south CANAMEX trade corridor as key components of its transportation system, Arizona has the opportunity to profit from the changing global economy and the accompanying changes in the ways people and goods are moved. Rather than reacting to inevitable growth in travel demand on Arizona's highways, railroads, transit systems, and at its airports, Arizona should take proactive steps that achieve the maximum economic benefit in anticipation of economic changes.

This paper discusses the major domestic and global trade and economic trends that will affect Arizona's transportation system, and provides general guidance for Arizona's future transportation investments. The paper is divided into three sections. The first section deals with liberalization of foreign trade and how recent developments have affected global commerce and the transportation industry. The second section contains a discussion

of the effects of shifting trade patterns on Arizona's transportation system. The global shift from a manufacturing and agricultural economy to a service-based economy is discussed in the third and final section.

2.0 The World Shrinks, The Economy Grows

Foreign Trade Developments and Trends

In the post-Cold War era, foreign trade has become the most important contributor to the growth of the global economy. After the collapse of Communism, the former Soviet Union and Soviet Bloc countries opened their economies and, simultaneously, international trade with Latin America and the Pacific Rim countries increased. Since World War II, the United States has benefited tremendously from foreign trade. Between 1960 and 1999, the U.S. share retained a constant 12 to 14 percent share of global merchandise trade, but as a share of the U.S. gross domestic product (GDP) global trade grew from 10.7 percent in 1970 to 26.9 percent in 1999, in constant 1996 dollars.[1] Future worldwide growth will be fueled by further liberalization of trade policies, the spread of free market economies, and productivity growth due to advances in information and communications technologies. Corporations as well as providers of transportation services will continue to globalize in order to take full advantage of productivity gains afforded by foreign trade.

The need for unrestricted trade across borders has spawned numerous multi-national and regional trade agreements between the United States and its trading partners. The North American Free Trade Agreement (NAFTA) between Canada, the United States, and Mexico will most likely have the greatest effect on Arizona due to the State's location along the U.S.-Mexico border. However, U.S. trade agreements with Latin American, Asian, and European countries, as well as the formation of non-U.S. trade blocks such as the European Common Market, are also benefiting Arizona.

The U.S. transportation system has so far been able to adapt to changing trade patterns. The following sections describe how changes in world trade have affected business models and transportation logistics. The next section details how shifts in trade patterns between the United States and foreign countries are affecting Arizona's transportation system.

Global Supply Chains and Transportation Logistics

The liberalization of world trade policies has allowed foreign and domestic firms to develop global supply chains, operating across borders to gain access to low-cost labor and materials. Many U.S. firms have moved production facilities out of the country – in 1993, more than 75 percent of Fortune 500 companies operated production facilities in

[1] U.S. Department of Commerce, Bureau of Economic Analysis.

Mexico, and that figure has since grown. Even those products that continue to be manufactured in the United States rely on foreign parts and raw materials. To a lesser extent, foreign firms such as auto manufacturers have built manufacturing plants in the United States in order to reduce distribution costs and gain political clout.

Coinciding with these location changes, in much of the manufacturing industry there has been a shift from "push" to "pull" transportation logistics. Pull logistics systems, which are driven by customer demand rather than the manufacturing process, are made possible by improvements in the collection and use of information at all stages of production and distribution of a product. By utilizing pull logistics, a manufacturer can reduce its stockpiles of raw materials and supplies as well as its inventory of finished products. "Just-in-time" (JIT) delivery is one artifact of pull logistics, and requires a close integration of shippers' and manufacturers' operations. Based on product demand, a manufacturer must coordinate deliveries from parts suppliers, who in turn must coordinate deliveries of raw materials. With pull logistics, products such as computers and even automobiles can be manufactured to order, reducing warehousing costs for manufacturers and retailers.

While a pull logistics system allows for increased productivity and reduced manufacturing costs, reliable freight transportation systems and communication systems are critical to its viability. Travel time uncertainty arises largely due to traffic congestion in metropolitan areas, at border crossings, and at intermodal transfer points. Streamlined import/export regulations as well as capital improvements and technological advances at seaports and other intermodal facilities have increased travel time reliability for transborder and multimodal shipments, leading to reductions in transportation costs for multinational firms. In contrast, urban congestion continues to steadily intensify.

Cargo theft and unanticipated system failures or disruptions due to weather, strikes, and terrorism will always threaten the practicality of pull logistics systems. Therefore, no U.S. manufacturer has developed a pure pull system to date. Fluctuations in demand and lack of certainty in supply channels both require some reliance on traditional, inventory-based push logistics.

Along with open markets and free trade, a well-developed transportation infrastructure and advanced communications technology on a global scale are prerequisites for an efficient supply chain. However, while decisions about transportation infrastructure supply are increasingly being made at the local and MPO level in the United States, multi-national corporations have a global view of transportation needs. This ideological conflict must be resolved by Arizona DOT in cooperation with federal and local agencies so that the needs of freight shipments are not overlooked in favor of local or regional passenger trips.

Changes in transportation supply due to globalization are not limited to physical infrastructure. Providers of transportation services have adapted to the changing structure of manufacturing by internationalizing and developing multimodal relationships with other firms. They have been able to better integrate both the temporal and spatial components of global supply chains due to advances in information and communications technology, providing door-to-door service with real-time shipment tracking capabilities. As freight carriers consolidate and invest in new technology and training for their employees, barriers to entry by smaller firms will rise and competition may eventually suffer. One benefit

of industry consolidation has been the increasing standardization of communications systems and information management systems, and in particular those systems used to relay information between shippers and government agencies. The next section describes how Arizona can work with freight carriers to improve operational efficiencies through the use of information technology.

Transportation Applications of Information Technology

Although many of the costs of information and communications systems are borne by private transport firms in the form of fleet management tools, Arizona's continued investment in commercial vehicle operations (CVO) technologies will lead to further productivity gains within the State, reducing the costs of doing business in Arizona. Advances in automated vehicle classification and identification have enabled trucking firms to pay registration fees and obtain necessary permits in advance of a vehicle's entry into the State. Combined with weigh-in-motion sensors, these technologies reduce inspection delays for freight shipments while lowering inspection costs for the State. By performing preliminary inspections on agriculture in Mexico before a truck reaches a border crossing, the Arizona Department of Agriculture further reduces border delays. Wherever possible, Arizona should expand preclearance and pre-inspection programs, in concert with investments in information technology at state and international borders.

Shipment verification and driver verification technologies such as Smart Cards embedded with electronic manifests and biometric information about drivers can increase the security of deliveries, and gamma ray imaging and other "hands-off" inspection technologies can quickly detect contraband and explosives, enhancing safety while reducing inspection time for sensitive, high-risk shipments into the State. Other techniques to ensure the safety and security of high-risk shipments include the use of low-tech devices such as tamper-proof container seals or more sophisticated remote monitoring systems. Once in Arizona, shipments can be tracked using radio frequency identification (RFID) tags and global positioning satellites (GPS), along with "geofencing," to ensure that a vehicle does not stray from its preassigned route.

Many information technology applications can benefit passenger as well as freight movement. Offering real-time congestion and travel time information to the public via "511" phone services, web sites, and broadcast news media allows road users and transit users to make more informed decisions about mode choice, route choice, and departure time choice. Monitoring roadways from traffic management centers and operating roaming patrols reduces incident response times and delays due to non-recurring incidents. These and other Intelligent Transportation System (ITS) technologies allow for a more efficient use of transportation infrastructure in Arizona, which indirectly benefits the economy. As new technologies such as third generation (3G) wireless services become more widespread, Arizona should expand its information distribution capabilities. The State can also directly reduce its own costs by continuing to expand the range of government services offered over the Web.

While applications of information technology have the potential to increase transportation system efficiency, evidence exists that most of the productivity gains due to advances in technology have already been realized in the United States. When measured as a percentage of gross domestic product (GDP), total logistics expenditures, consisting of inventory expenses, transportation costs, and administrative costs, fell during the 1980s and early 1990s due in large part to decreases in inventory expenses. Over the same period, transportation unit costs have dropped, but the savings were offset by increased consumption of transportation services. In the past five years, total logistics expenditures have stalled at about 10 percent of GDP.[2]

Transportation system congestion and decreased travel time reliability for sensitive goods could cause logistics costs to start increasing if JIT manufacturers are forced to stockpile parts and supplies as a cushion against unpredictable variations in delivery times. Further, post-September 11 concerns about safety and security have triggered an increase in regulation in the transportation industry that threatens to reverse recent productivity gains. The next section discusses the combined effects of economic deregulation and safety regulation on Arizona transportation.

Economic Deregulation and Safety Regulation

Since deregulation in the U.S. transportation industry began in the 1970s, productivity and competition have both increased and a once-threatened industry has returned to profitability. Large scale mergers between passenger and freight carriers allowed firms to take advantage of economies of scale and compete on a national and global level. However, it is possible that overconsolidation in the transportation industry will work to reduce competition. For instance, there are now only two national rail carriers plus one short-line railroad serving the entire state of Arizona. Only Phoenix is served by both of the national rail carriers that operate in the State. Other communities have only one choice of a carrier – if they have rail service at all.

Despite the consolidation that has taken place in the railroad industry, profits are flat and rail carriers cannot afford to make necessary capacity expansions. The railroad industry increasingly looks to state and federal governments for assistance in financing capital improvements and capacity expansions. Intercity passenger rail is not profitable under any circumstances, as demonstrated by the performance of Amtrak's long distance, intercity routes outside the Northeast Corridor. States and the federal government may have to establish a new tax or revenue source to support freight and passenger rail similar to the Highway Trust Fund and Aviation Trust Fund, both of which are funded by direct or indirect user fees. Arizona must decide if it will treat rail, and passenger rail in particular, as a government service that requires subsidy, or as an independent, for-profit entity. The decision will shape the future of both freight and passenger rail in the State.

---

[2] Cass Information Systems Inc., *Cass/ProLogis 10th Annual State of Logistics Report*, 1998.

The air industry has performed somewhat well financially since being deregulated. After experiencing several high-profile bankruptcies and mergers, the U.S. air industry has become much more efficient and competitive. Alliances between U.S. airlines and foreign carriers have increased the ease of travel to international destinations, but so far foreign carriers have not been permitted to compete directly with U.S. airlines on domestic routes. Despite fears that monopolies would form after deregulation and the industry would not be open to competition, a relative newcomer, Southwest Airlines, has grown to be the most profitable airline in the United States, and the only U.S. airline to turn a profit in 2001.

America West Airlines, headquartered in Tempe, Arizona, is another product of deregulation. Over the course of the 1990s America West climbed from bankruptcy to profitability, but the airline was hurt by the fallout from September 11, and was forced to rely on a cash bailout from the federal government and additional federal load guarantees to avoid bankruptcy. Since America West operates 75 percent of the commercial flights at Phoenix Sky Harbor International Airport, Arizona's economy is perhaps overly reliant on one airline's survival. Although the airline appears to be on track for long-term growth, in the event that America West should fail, Arizona should ensure that other airlines can quickly step in to provide sufficient air service to Phoenix.

After September 11, heightened security at airports has increased air travel time, resulting in small but noticeable shifts in short-haul markets. For example, since September 11 Amtrak's Northeast Corridor passenger rail service has captured a majority of the market share for travel between Washington, D.C. and New York for the first time in Amtrak's history. While these shifts may not affect the demand for passenger rail in Arizona, shifts from air travel to intercity bus routes and passenger cars may persist long after the aftershocks of September 11 subside. New security procedures will require modifications to air terminals and may affect the operations of quick-turnaround airlines such as Southwest.

Heightened security also has required additional inspections for vehicles entering the country from Mexico. These inspections have increased delay and transportation costs for transborder freight shipments. Countering this trend is raising political pressure to relax weight and safety requirements for commercial vehicles entering from Mexico. Arizona must ensure the safety of its citizens, but also should be aware of tools that facilitate the flow of freight and passengers throughout the State while at the same time maintaining a high level of safety and security.

3.0 Effects of World Trade on Arizona's Transportation System

Shifts in Trade Patterns within the United States and Arizona

Regardless of where production facilities are located and which shipping firms transport freight, there will continue to be a need to distribute manufactured goods and agricultural products to consumers and businesses in Arizona and the rest of the United States.

Currently, freight and passengers pass into and out of Arizona primarily using one of three modes:

1. Along interstate highways and other roads at Arizona's borders with other U.S. states, or at one of six Arizona-Mexico international border crossings;

2. Along one of the two east-west trunk rail lines that pass across Arizona, along short lines or trunk line spurs from other states, or at a U.S.-Mexico border crossing; or

3. By air.

These three modes of entry are affected in different ways by U.S. trade with its various trading partners. Growth in trade with Pacific Rim countries, along with America's continued strong trade relationships with European countries, has increased the importance of east-west transportation infrastructure in the United States. Meanwhile, the emergence of Latin America as a strong trade partner coupled with the influence of NAFTA on the U.S. economy has begun to impact both border crossings and north-south corridors leading to the borders and to Gulf Coast ports. Finally, the technology sector has increased the flow of high-value, time-sensitive goods traveling by air cargo and less-than-truckload (LTL) shipments, which impacts both the air system and distribution routes in Arizona's metropolitan areas. The next three sections discuss the importance of east-west and north south trade, border crossings, and air cargo shipments to Arizona's economy, and how the state's transportation system must evolve so that the State can capture the most economic benefit from changing world trade patterns.

East-West Trade

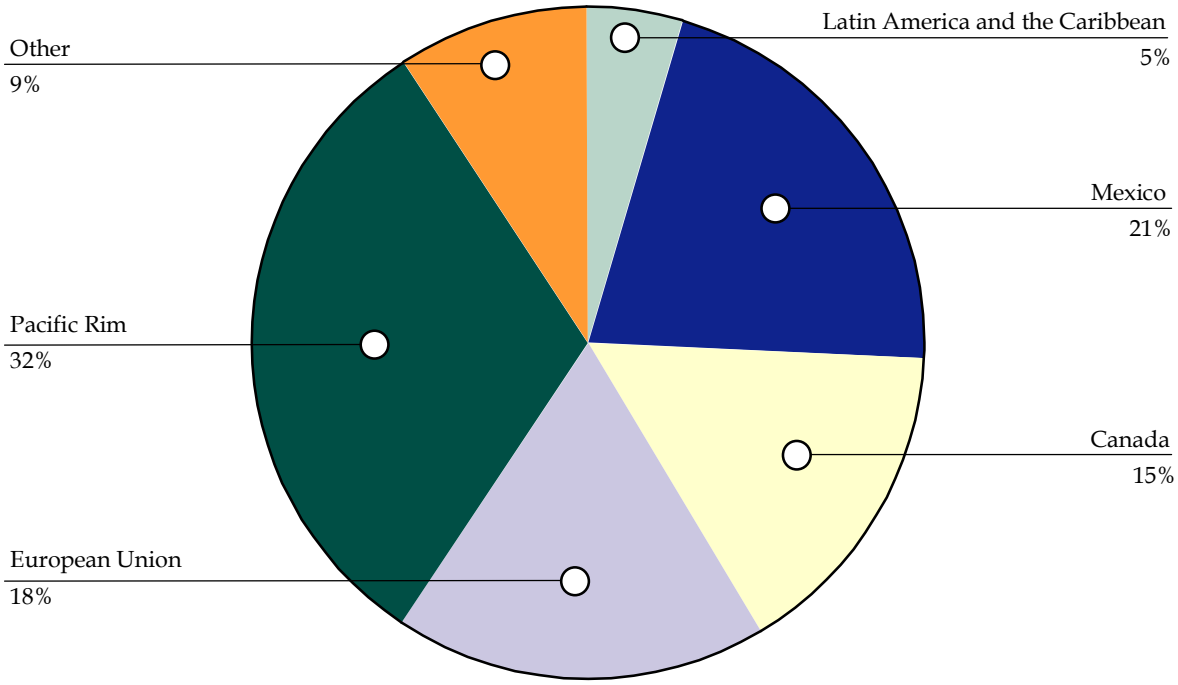
Although East Asian economies suffered from near-total collapse in the late 1990s and have yet to fully emerge from a severe depression, strong economies in the United States and Europe have continued to fuel rapid expansion of east-west trade patterns that were first established in the age of the railroads. The transportation system in the western U.S. is primarily composed of strong east-west links. The transcontinental railroads first joined regions east of the Mississippi with the Pacific coast in the 19th century and, later, the interstate highways stretched westward across the plains and cut through the Rocky Mountains on their way to western port cities.

These transportation links originally allowed goods to move between manufacturing centers on the East Coast and agricultural and mining areas in the West. Over time, as trade with Europe strengthened and Asian markets opened up to U.S. trade, east-west transportation links were essential to the upsurge of imports and exports between the U.S. and overseas markets. In just the past decade, the value of U.S. exports to Western Europe and Pacific Rim countries has more than doubled, and the value of U.S. imports from those regions has increased by 62 percent.[3] The Pacific Rim accounts for one-third of Arizona's exports by value, as shown in Figure 1. Arizona exports more goods to the

[3] U.S. Bureau of the Census, Foreign Trade Division.

Pacific Rim than to Mexico, when measured by value, and the State's exports to the European Union are just below levels of exports to Mexico.

Figure 1. Arizona Export Destinations, 2000 (by Value)



While most Asian import and export traffic passes through Arizona on its way to and from other states, Arizona must keep up with demand for freight movements on existing east-west trans-state corridors, all of which pass through the State's major metropolitan areas and impact local traffic. The most important east-west freight routes in Arizona are the two transcontinental interstate highways and the two rail trunk lines that traverse the northern and southern portions of Arizona, and around which the majority of development in the State has taken place.

Interstates 10 and 40 connect the Port of Los Angeles to the Southern and Southwestern Sunbelt states. The ports of Los Angeles and Long Beach, combined the fourth busiest port in the United States,[4] have over 50 percent of the U.S. market share for trans-Pacific shipments[5], and the sunbelt has been the most rapidly growing region in the United States for half a century. In addition, I-10 and I-40 both serve as export routes for agricultural and manufactured goods produced in Arizona and California, and the two interstates provide

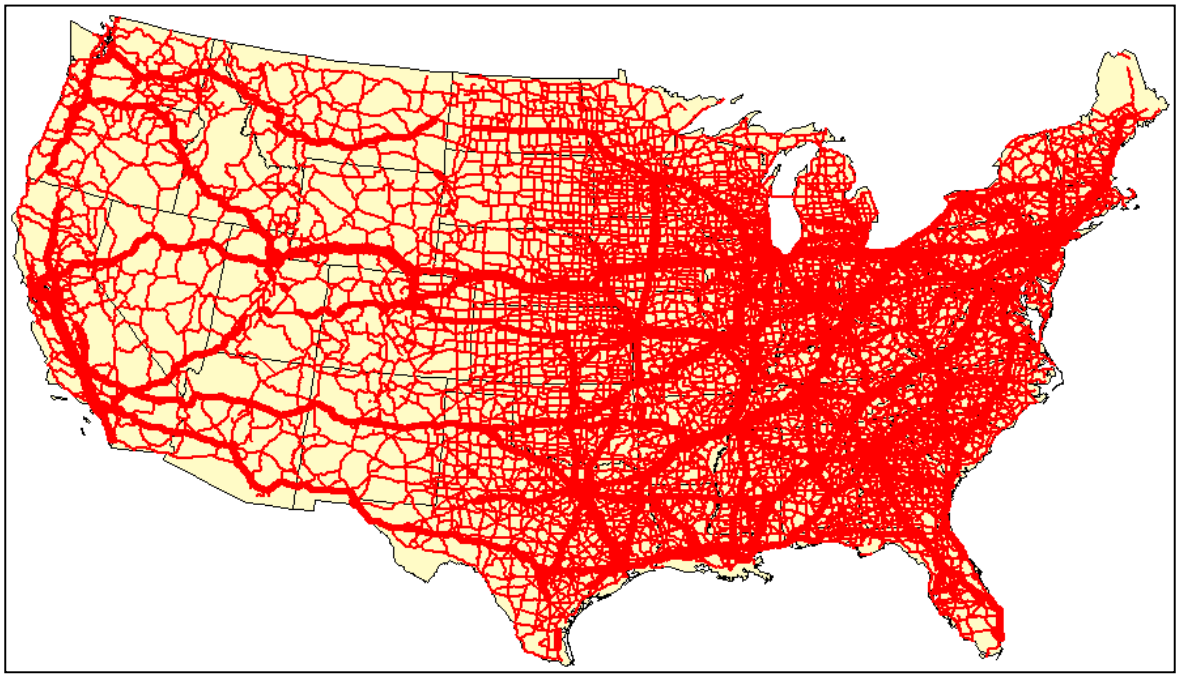
[4] U.S. Army Corps of Engineers Navigation Data Center.

[5] Los Angeles Port Authority.

direct or indirect access to ports on the Gulf Coast and the Eastern Seaboard. Seventeen percent of the truck traffic on Interstate 10 in Arizona passes directly through the State from Southern California to New Mexico and 16 percent of I-10 truck traffic originates in Arizona with a destination in either Southern California or a point east of Arizona.[6]

Figures 2 through 4 demonstrate the importance of I-10 and I-40 to the movement of freight exports from Arizona and across Arizona to other states. Figure 2 shows the relative magnitudes of truck freight flows on highways in the United States. Interstates 10 and 40 clearly stand out as thick lines on the map in the southern and northern portions of the State, respectively, with the heaviest flows in Arizona shown between Phoenix and Tucson along I-10. Figure 3 shows a forecast of U.S. truck traffic produced by overseas shipments arriving at U.S. ports. Clearly, growth at the Port of Los Angeles and other U.S. ports will have a significant impact on Arizona as traffic increases on I-10 and I-40. Finally, the destination of freight that originates in Arizona is shown in Figure 4. Interstate 10 plays a vital role in the movement of freight exports out of Arizona. Note that the thickness of a line on any of the three maps is relative to that map for maximum clarity, so each map is drawn to a different scale. Therefore, line thicknesses cannot be compared across maps.

Figure 2. Domestic Truck Freight Flows (Tons)



[6] CANAMEX Corridor Coalition, 2001, *CANAMEX Corridor Plan*, prepared by Economic Research Associates.

Figure 3. Truck Traffic Produced by Overseas Shipments Arriving at U.S. Ports, 2020 Forecast (Tons)

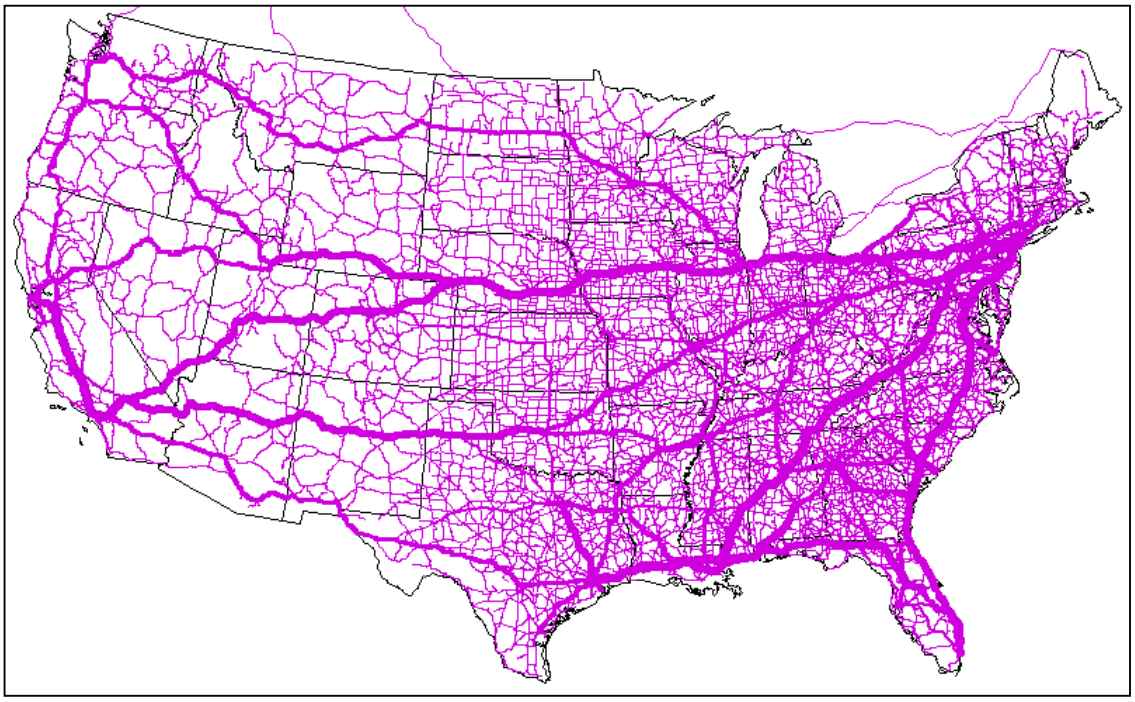
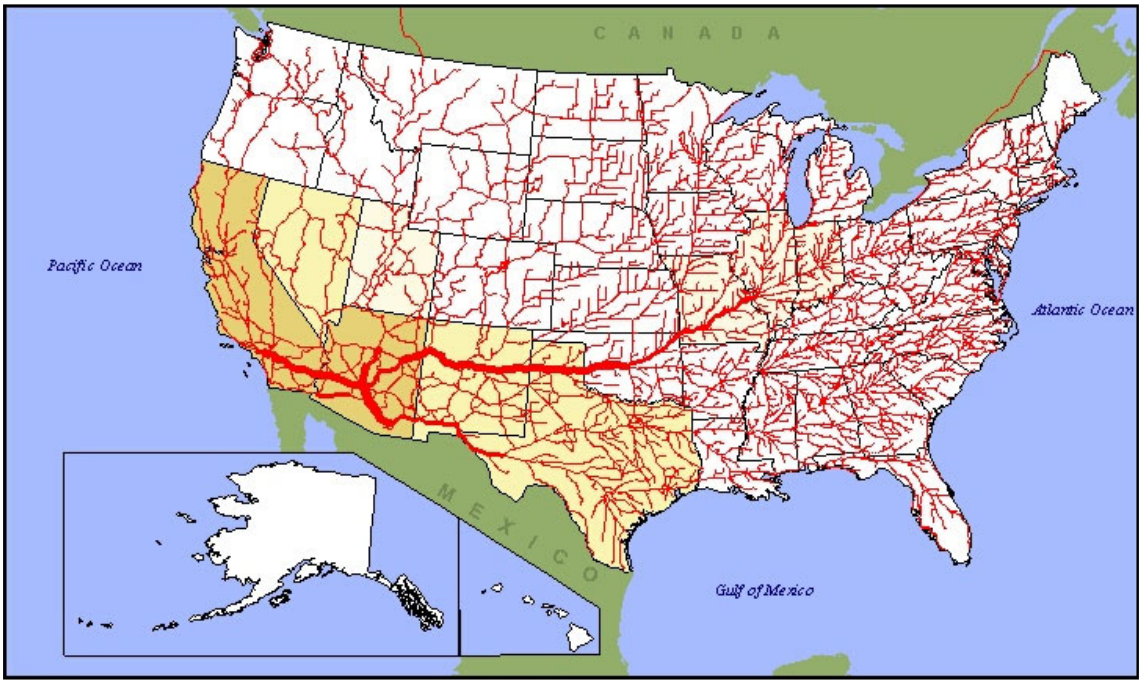


Figure 4. Domestic Truck Flows for Freight Originating in Arizona



In the future, as U.S. trade with China increases and the Asian economy rebounds from its current recession, imports through the Port of Los Angeles will continue to increase. The construction of the Alameda Corridor, coupled with Los Angeles' capability of handling "post-Panamax" supercontainer ships, further cements the port's position as a major generator of freight traffic for I-10 and I-40 for years to come.

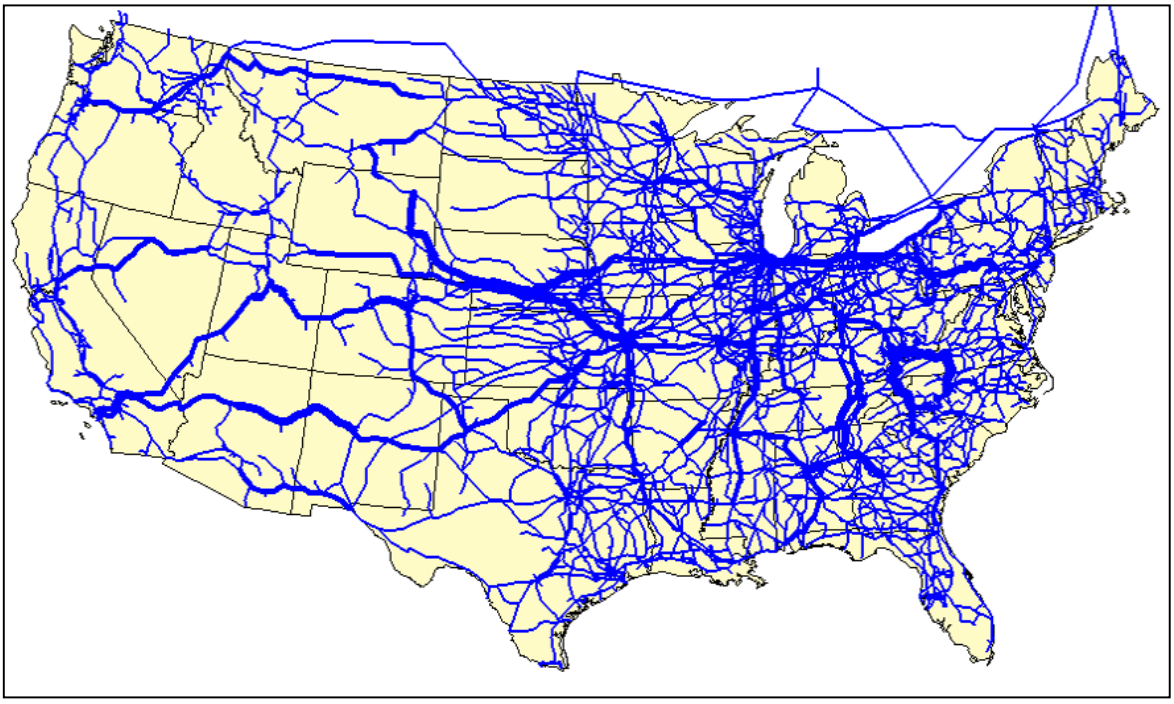
In order for Arizona to sustain economic growth, the Department of Transportation must continue to maintain or improve levels of service on the I-10 and I-40 corridors so that the flow of east-west interstate traffic is not hindered. On the I-10 corridor, the Phoenix and Tucson metropolitan areas present the biggest bottlenecks for freight traffic. As a whole, the I-40 corridor is uncongested, but sections of the interstate in Flagstaff and near Kingman could be threatened by future growth in traffic. Capital improvements such as new roadway construction and capacity expansions will be necessary, but Intelligent Transportation System (ITS) investments can improve the efficiency of Arizona's highways at a much lower cost than traditional capital improvements.

The Alameda Corridor and the rise of the supercontainer ship will not only affect interstate truck traffic. Increasingly, containers are being offloaded from ships directly onto rail cars. Improved communications and freight tracking systems combined with automated container loading and unloading systems will reduce the cost of transporting containers by rail, improve travel times by rail, and enhance the attractiveness of rail for long-distance freight traffic. Arizona's two trans-state rail lines will absorb much of the increase in rail freight traffic generated by the Ports of Los Angeles and Long Beach.

The Burlington Northern Santa Fe (BNSF) Arizona Main Line, running across northern Arizona from Topock to Dennison roughly parallel to Interstate 40, carries the majority of trans-state rail traffic in Arizona. The line has double-stack capability and is not severely constrained within Arizona. Currently, a major rail bottleneck at Cajon Pass, California, is the biggest impediment to further increases in rail traffic on the BNSF line, but growth in rail traffic from the Ports of Los Angeles and Long Beach, California, that is bound for the Midwest may eventually require a significant capital investment to expand rail capacity through Arizona, especially through Kingman Canyon. Another east-west rail line, which roughly parallels Interstate 10, is operated by Union Pacific Railroad. While the UP rail line carries significantly less freight than the BNSF line, the rise of manufacturing in Northern Mexico will fuel an increase in traffic bound for U.S. distribution centers and Pacific and Gulf ports. The implications of U.S. trade with Mexico for Arizona's transportation system will be discussed in the next section.

Figure 5 shows the freight flows by rail in the United States. The BNSF line in Northern Arizona carries the largest volume of freight, followed by the Union Pacific Line between Picacho and the New Mexico border in Southeastern Arizona.

Figure 5. Domestic Rail Freight Flows (Tons)



Both the BNSF and UP rail lines have numerous at-grade crossings in Arizona. To improve the efficiency of freight operations and eliminate traffic congestion at rail crossings, Arizona should continue to work with BNSF and UP to construct new grade separations wherever practical. Cash-strapped rail firms are increasingly looking to state governments to help fund rail improvements on privately owned rail lines, especially for grade separations and projects related to passenger rail. Any future passenger rail programs in Arizona must consider the effects of passenger rail operations on freight traffic so as not to impede the growth of rail freight. Many types of freight can be more efficiently carried across Arizona by rail rather than by truck. By increasing the attractiveness of rail as a transport mode, Arizona can draw both current and future freight traffic away from highways to the railroads.

North-South Trade and Border Crossing Issues

While American trade with Asia and Europe has added freight traffic to the nation's east-west transportation system, NAFTA and other trade agreements with Mexico and Latin America are generating increased demand for north-south travel within the United States, and international trade between the United States, Mexico, and Canada has put a strain on border crossings. In order to take full advantage of economic opportunities offered by increased trade with Latin America, Arizona must address deficiencies in its north-south corridors and, in particular, at its main U.S.-Mexico port of entry at Nogales.

U.S. trade with Mexico, Canada, and Latin America has increased dramatically over the past decade. Imports and exports to both Mexico and Latin America have tripled in value; imports and exports from Canada have doubled in value. Although Latin America as a whole has not grown as quickly as expected due to the Mexican peso crisis in 1994, among other factors, the region is expected to lead the world in economic growth over the next two decades. Arizona's ties to Mexico are already strong, and the State can expect exports to the rest of Latin American to grow rapidly with the region's economy. In 2000, Arizona exported one-fourth of its manufactured goods, by value, to Mexico and Latin America, making this region Arizona's top export destination.[7]

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the National Highway System Designation Act of 1995 (NHS), and the Transportation Equity Act for the 21st Century (TEA-21) established a high-priority transportation corridor running from the Mexican border at Nogales, Arizona, to the Canadian border at Sweetwater, Montana. Known as the CANAMEX corridor, the route follows Interstate 19, Interstate 10, and U.S. 93 from Nogales to the Hoover Dam crossing of the Colorado River at the Nevada state line, running southeast to northwest across Arizona through Tucson, Phoenix, and Kingman.[8] The CANAMEX corridor also extends south from Nogales along the Gulf of California to Mexico City in Central Mexico, and north from the Canadian border to Edmonton, Alberta. The corridor will link Arizona to manufacturing centers in the Mexican State of Sonora, just south of the border, and also to population centers in Central and Southern Mexico. To the north, the corridor connects Arizona to Las Vegas and Salt Lake City.

Although there is more international freight moving on Arizona sections of I-10 than on I-19 (the route connecting I-10 with the international border at Nogales) the U.S.-Mexico border crossings at Nogales plays an important role in the movement of freight between Arizona and Mexico. The three border crossings at Nogales on the CANAMEX corridor serve trade between Arizona and the *maquiladora* industry in Sonora. Nogales is also the largest port of entry for winter vegetables in the United States, processing over 60 percent of Mexican produce exports to the United States each year.[9]

Due to traffic congestion and lack of connectivity with Eastern and Central Mexico, the volume of freight traffic passing through Nogales has fallen from fourth place to sixth place in the United States.[10] In the weeks after September 11, 2001 delays at Nogales were severe, even though traffic levels dropped by close to 50 percent.[11] Traffic has not yet

---

[7] U.S. Department of Commerce, International Trade Administration.

[8] CANAMEX Corridor Coalition, 2001, *CANAMEX Corridor Plan*, prepared by Economic Research Associates.

[9] University of Arizona Department of Economic Development, Southwest Border Technology Project.

[10] Ibid.

[11] Araiza, A. E., 12/8/01, *Border Wait Times Back to Normal*, Arizona Daily Star, Tucson, Arizona.

returned to normal levels as of the time of this writing, but it is certain that traffic and congestion at the border will intensify as trade between Arizona and Mexico increases.

Several steps have already been taken to improve the flow of commercial vehicles through Nogales in anticipation of future increases in traffic, including a U.S. Federal Highway Administration (FHWA) demonstration project called Expedited Processing at International Border Crossings, or EPIC, which allows commercial vehicle cargo to be pre-cleared by U.S. customs before arriving at the border. EPIC is a precursor to the planned International Trade Data System (ITDS), which will allow the U.S. government to collect data on transborder shipments and allow shippers to preprocess customs forms over the Internet. In addition, advanced inspection technology, including gamma ray imaging equipment, has been installed at Nogales to quickly detect contraband and explosives before they enter the United States without requiring trucks to be unloaded and inspected manually. Advances in information technology could cut border crossing times by as much as eight minutes per vehicle, resulting in a 5.4:1 benefit/cost ratio. Arizona should continue to lobby for the latest information and inspection technology advances at the Nogales border crossings to allow passenger and freight to move across the U.S.-Mexico border as efficiently as possible, while ensuring that safety and security standards are met.

Although improvements are being made to the Nogales border crossings and to Arizona's other major international border crossings at San Luis and Douglas, further investments in transportation infrastructure will be necessary inside Arizona near the border. The State of Arizona's Safety Enforcement and Transportation Infrastructure Fund (SETIF) provides revenue for the enforcement of vehicle safety requirements by the department of public safety, and the maintenance of transportation facilities, including roads, streets and highways as approved by the Arizona Transportation Board within 25 miles of the border between Arizona and Mexico. SETIF funds can also be used for the maintenance and construction of the transportation facilities in the CANAMEX corridor. Funds are appropriated by the Arizona Legislature.

Funds in the SETIF could be used to improve access from the single commercial vehicle crossing in Nogales to I-19, for example, and to widen and improve I-19 as conditions warrant. The entire length of Interstate 19 is forecast to operate at level of service D or E by 2010 and level of service F by 2020 if only budgeted improvements are made.[12] Since there are no adequate east-west roads or railroads in Northwestern Mexico and just two minor rail lines connect Arizona with the neighboring northern Mexico State of Sonora, much of the freight traffic generated in Sonora that is bound for U.S. seaports, air cargo facilities, and truck-to-rail intermodal transfer facilities will enter Arizona by road. Improved connections from San Luis to I-8 at Yuma are also necessary, and a better access route from I-10 to the Douglas crossing would provide commercial vehicles bound for New Mexico and points east a better alternative to the Nogales port of entry.

Beyond the border, other portions of the CANAMEX corridor will need to be upgraded by 2020. Interstate 10 through Tucson and Phoenix and U.S. 60 leading northwest out of

[12] Ibid.

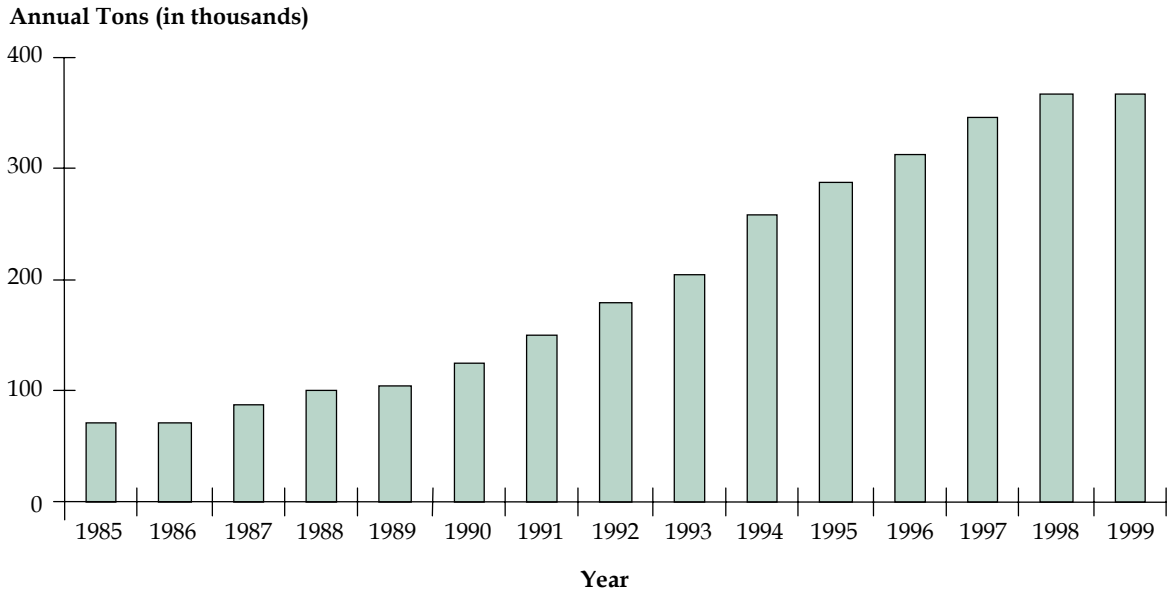
Phoenix are other predicted traffic choke points. Several widening projects to upgrade U.S. 93 from a two-lane to a four-lane highway between Wickenburg and I-40 are underway or are under study. These projects should be completed as quickly as possible. With the completion of the Hoover Dam Bypass project, a major bottleneck on U.S. 93 between Phoenix, Las Vegas, and points north will be eliminated.

There are no interstate highways or rail links between Arizona and Utah, the State's northern neighbor, aside from a tiny section of Interstate 15 that slices through the extreme northwest corner of Arizona. Currently, central Arizona traffic destined for Salt Lake City and the I-15 corridor must use U.S. 93 and face the Hoover Dam bottleneck and the congested Las Vegas metropolitan area, or drive north on U.S. 89 through Page, a two-lane, windy route. The only rail route from Nogales to Las Vegas and Salt Lake City requires a long detour through Southern California, since no direct rail routes exist between Arizona and Utah. Arizona could benefit from increased trade with other CANAMEX states by improving transportation links to the North.

Air Cargo and Air Passenger Travel

The importance of high-value, time-sensitive shipments has led to a rapid expansion of air cargo in the United States. At the same time, reductions in the cost of air travel due to deregulation and increased competition have contributed to congestion in the nation's air system due to high levels of demand and lack of supply. Each of these trends has been experienced at Arizona's main hub airport, Phoenix Sky Harbor International Airport. Figure 6 shows the growth in air cargo shipments at Sky Harbor since 1985.

Figure 6. Total Cargo Traffic at Phoenix Sky Harbor International Airport



Open skies agreements with Asian countries have enabled U.S. freight carriers to establish overseas hubs. In order to continue the healthy growth in air passenger and freight travel at Sky Harbor and its spillover effects for the State's economy, Arizona should facilitate to the greatest extent possible an increase in nonstop freight flights to Asia, and nonstop passenger flights to Europe, South America, and Asia. Nonstop passenger flights, especially to overseas destinations and U.S. cities not easily served by truck or rail, will help air cargo traffic expand at Sky Harbor. In addition, nonstop passenger flights to a wide variety of destinations will make the city more attractive to corporations seeking new locations for headquarters and regional offices.

Sky Harbor International Airport's central location in Phoenix is both a strength and a weakness. Proximity to downtown reduces average travel time to the airport for all Phoenicians, but the airport will soon run out of room for runway expansion, which will limit its long-term growth prospects. Complaints about noise from overnight freight flights and increased passenger flights will only continue to grow as the airport expands. Williams Gateway Airport in Mesa or a new airport between Phoenix and Tucson could serve as reliever airports for both passenger and freight traffic, but Arizona must act immediately to plan for a new or expanded airport and acquire sufficient land to accommodate the demand for passenger and air cargo traffic. Airports in Southern Arizona also will experience a growth in cargo traffic as the maquiladora industry across the border in Sonora, Mexico, expands. The Yuma and Tucson airports will absorb most of the additional traffic coming across the border from Mexico.

New security procedures required at U.S. airports since September 11, 2001 have affected both the capacity of the air system and the demand for travel by air. As total travel time by air increases, the competitiveness of alternative intercity travel modes increases. Meanwhile, the operations of air carriers have been affected by the new federal security requirements. Air carriers such as Southwest Airlines that depend on quick turnaround times may see their operational efficiencies suffer and their competitive advantage disappear due to the new safety procedures. The air system still has a long adjustment period ahead before the effects of September 11 on air travel are fully understood.

Sky Harbor has already begun to reconfigure its air terminals to accommodate additional baggage screening equipment and passenger security checkpoints. Federal funding for security improvements will partially offset these unanticipated costs, but the airport will be responsible for paying for additional security measures as part of any future terminal design and construction.

4.0 From "The Five C's" to "The Big S"

The Transformation of Arizona's Economy

Every Arizona schoolchild learns about the "Five Cs" of Arizona's economy: Copper, Cattle, Cotton, Citrus, and Climate. While each of these economic factors continues to

play an important role in Arizona's current economy, each has diminished in importance due to the rise of one "Big S": Services.

Globalization and the expansion of free market economies has led to worldwide productivity increases, which in turn has facilitated the rise of the service sector in industrialized and developing nations. Along with the entire U.S. economy, Arizona's economy is led by the service sector, which has added nearly a quarter of a million jobs since 1993, and now employs almost one out of every three Arizonans.[13] Arizona has witnessed one of its five Cs, the copper industry, decline as low-cost foreign imports flooded the U.S. market. Agriculture has shed more than half of its employment in the past decade, but productivity gains have contributed to this decline. Manufacturing continues to account for almost 10 percent of Arizona's employment and provides the second highest-paying jobs in the State after mining.[14] Table 1 shows the change in employment by sector in Arizona from 1993 to 2001.

Table 1. Change in Arizona Employment by Sector, 1993 to 2001

	1993		2001		1993-2001
Employment Sector	**Employment**	**Percent**	**Employment**	**Percent**	**Change**
Services	460,500	26%	699,200	30%	238,700
Mining	12,200	1%	9,100	0.4%	-3,100
Construction	98,100	6%	160,200	7%	62,100
Manufacturing	180,000	10%	202,300	9%	22,300
Transportation and Public Utilities	81,100	5%	108,300	5%	27,200
Wholesale Trade	81,000	5%	110,300	5%	29,300
Retail Trade	322,100	18%	425,000	18%	102,900
Finance, Insurance, and Real Estate	105,400	6%	151,300	7%	45,900
Government	290,600	16%	381,400	16%	90,800
Agriculture	151,536	9%	72,881	3%	-78,655
Total	**1,782,536**	**100%**	**2,319,981**	**100%**	**537,445**

Source: U.S. Department of Labor, Bureau of Labor Statistics. Figures for 2002 are preliminary.

The rise of the service sector was made possible by productivity improvements in agriculture, manufacturing, mining and other resource extraction, and communications.

[13] Ibid.

[14] Arizona Department of Economic Security, 2001.

These productivity improvements continue today as technological advances allow for more efficient manufacture and movement of goods – and now information – around the globe. The "24-hour shift," a relatively new phenomenon, allows assignments and tasks to follow the sun, passing electronically from English-speaking workers in Australia and Asia to India, Europe, America, and finally back across the Pacific. While manufacturing jobs were the first to leave America for cheap labor markets elsewhere, increasingly firms are establishing customer service and technical support centers overseas.

As described in previous sections, the advent of "pull" logistics allows manufacturers to reduce warehousing of finished products, and in some cases products are built to order. With the rise of e-commerce and the convenience of purchasing goods, customers are demanding fast, reliable, and on-time delivery of all products. These shipments are best handled by less-than-truckload (LTL) deliveries and parcel shippers such as UPS and FedEx. Demand for small package shipments is expected to rise, while business-to-business shipments via full trucks and railcars will decrease. The largest component of growth in freight traffic will be delivery trucks moving over regional highway and arterial networks.

Unfortunately for Arizona's overburdened roads, the rise of the service economy translates to more urban congestion. This is not to say that demand for high-volume transportation services will decline; instead, growth in the service economy will stimulate demand for fossil fuels, agricultural products, and bulk materials that can easily be transported by rail or sea. The demand for high-capacity transportation will continue to increase, but the share of goods transported by rail and water will level off or decrease.

Freight carriers are under intense pressure to keep their costs low while providing superior service to their customers. Carriers are working with shippers to improve logistics by consolidating shipments into larger units, which allows for more efficient transportation of goods. Integrating such tasks as moving returned items backwards through the retail supply chain has given rise to third-party and even fourth-party logistics providers.

With more information and choices at their disposal, consumers, businesses, and even transportation employees expect (and can demand) a high quality of service and a broad range of choices or incentives from freight carriers. Consumers find it easier to find information on a particular product or service and have more options as they decide where to spend their money. Businesses expect improved service from suppliers and their carriers. Employees find it much easier to change careers or jobs today than in the age of manufacturing, when each job required a specialized skill and families were much less mobile.

In Arizona, the service economy will require continued expansion of metropolitan highway networks in order to accommodate increases regional freight traffic in addition to ever-increasing passenger traffic generated by population growth. Arizona's transportation investments will be guided by residential and commercial development patterns, but the State can also use improvements to the transportation system as a tool to influence future development patterns. The next section describes changes in development patterns that can be expected as a result of the service economy.

The Service Economy's Impact on Development Patterns

The rise of the service economy has not only changed the business climate in Arizona; it also has changed the way Arizonans live, where they work, and how they travel. From an economic and quality of life standpoint, the characteristics and pattern of development in Arizona has been the most significant impact of the service economy's dominance. Migration from manufacturing states in the North and Midwest to the Sunbelt was made possible by the economic mobility and freedom offered by the service industry. Looking for a high quality of life in a warm climate, workers swarmed to Arizona over the past 20 years. As the State's population continues to increase at a rapid pace, Arizona is faced with both challenges and opportunities related to transportation and development.

Up to this point, development has occurred around major Arizona cities in a low-density, dispersed pattern. Wide open spaces and cheap land in the Southwest allows home owners to buy relatively large single-family homes on large lots, and flexible, inexpensive transportation provided by private automobiles permits residents to live as far from employment, shopping, school, and recreation as they desire. Service-oriented firms have moved their headquarters and back-room operations to office parks that offer ample parking. In the service economy, firms depend on the transfer of information, which reduces the benefits of economies of agglomeration. Firm location choices are no longer limited to central business districts or other concentrations of employment.

Even the location of production facilities has changed. Manufacturing plants for high-tech products do not generate large amounts of pollution, and they consume mostly electricity and water. These facilities are still dependent on adequate, reliable transportation for the delivery of supplies from parts manufacturers. But instead of receiving bulk supplies like coal or steel via a river barge or a train, the factories receive 24-hour deliveries by truck, typically of smaller materials, components, and sub-assemblies. Likewise, finished goods are shipped out by truck to a U.S. distribution facility, or to an air cargo facility or a seaport for overseas transport.

As population has exploded in Phoenix and Tucson, the land area consumed by development also has increased rapidly. Much of this increase in metropolitan area size can be attributed to population growth, however, as opposed to inefficient land use. In Arizona, the acres of developed land per capita actually *decreased* 13 percent between 1982 and 1997, compared to a 16 percent increase in per capita land consumption in the U.S. as a whole over the same period.[15]

Arizona's transportation infrastructure has not been able to accommodate the increased demand without added congestion. This increase in congestion has taken its toll on commuters in Arizona's largest metropolitan areas and caused several areas of Arizona to fall into nonconformity with Clean Air Act air pollution standards. To address congestion problems, Maricopa County communities have chosen to invest in light rail to serve the most dense population and employment centers in the region, while advancing an

[15] U.S. Department of Agriculture Natural Resources Inventory, 1997.

aggressive freeway expansion program. Tucson is improving its existing road network and also is considering light rail.

A range of transportation solutions, including expansions of freeways and local roads, new and expanded transit services, and pedestrian and bikeway improvements is necessary to handle projected increased in traffic demand if Arizona is to preserve its economic vitality and sought-after quality of life. Along with capital improvements, the continued implementation and expansion of Intelligent Transportation System (ITS) technologies will allow Arizona to improve the efficiency of its existing and planned transportation infrastructure. Value pricing and managed lanes are other methods of managing travel demand on congested urban roadways while providing a source of revenue for future highway capacity expansions or transit investments.

Transportation and development are inextricably linked, and decisions in both areas will impact economic vitality in the State. Any improvements in transportation made by the State will affect development patterns, and in return that development will generate demand for travel on the State's transportation system. In Maricopa County, sharp increase in residential and commercial real estate prices and new home and office park construction in anticipation of the completion of Loop 101 and Loop 202 are strong evidence of the relationship between transportation system expansion and development patterns. While the new freeway loops are currently relatively free of congestion, future development on the outskirts of the Phoenix metropolitan area will ultimately lead to traffic congestion on the new highways as well.

While transportation planning in Maricopa and Pima Counties is controlled by regional authorities, there are no corresponding authorities with the ability to regulate land use on a regional scale. Multiple jurisdictions in each area have independent land use rules and regulations. The Governor's Vision 21 Task Force has recommended that the State establish urban regional transportation and land use districts. With a regional perspective, these types of agencies can steer area-wide development to desired development zones, where existing transportation infrastructure or investments planned for the near future can best handle increases in traffic. These regional agencies may also have more influence with the State Land Department, and might reduce the incidence of large tracts of land being sold to single land owners, who then develop the land without regard for the current state of local infrastructure.

Regional agencies in other states also have the power to modify zoning laws to facilitate the construction of affordable housing. Although housing affordability is not a major concern in Arizona today, experience in other Sunbelt cities such as Austin, Texas suggests that as congestion increases, housing prices near employment centers will rise above levels that are affordable to teachers, police officers, and others who provide basic public services. Arizona must take steps to avoid future housing affordability issues, since it will not always be possible for people to simply move further out to the metropolitan fringe. Investments in mass transit will help low-to-medium income residents access jobs. Another Vision 21 Task Force recommendation calls for the State to begin coordinating transportation and land use planning. State-of-the-art travel demand models incorporate land use forecasts that allow for more accurate predictions of future travel patterns.

Development-induced demand for travel is currently the largest cause of inaccurate travel demand forecasts. Integrated transportation and land use planning also will allow Arizona to better conserve natural resources and reduce the impacts of development due to a new transportation facility on environmentally sensitive areas.

As the service economy grows and people continue to move to Arizona, the State should be prepared for expansion in all of its urban areas, including not just Maricopa, Pinal, and Pima counties, but also in areas surrounding Nogales, Yuma, and Flagstaff. With state-of-the-art tools and new perspectives on transportation and land use planning, Arizona will be in a position to shape the future growth of the State, rather than simply reacting to development patterns using spot improvement to transportation infrastructure.

5.0 Conclusions

Arizona is faced with a range of challenges and opportunities stemming from shifts in international and domestic trade patterns, transformations in business logistics, improvements in the transfer of information, and the rise of the service economy.

Liberalization of world trade policies has allowed firms to globalize their operations. Global supply chains and the advent of pull logistics have reduced manufacturing and logistics costs, but firms are increasingly reliant on predictable freight travel times. The reduced cost of storing and communicating information has made just-in-time delivery and made-to-order manufacturing a possibility for new economy and old economy firms, and as a result less-than-truckload and small parcel shipping is expected to generate the largest share growth in the freight shipping industry over the long term.

Economic deregulation has led to consolidation and expansion in many areas of the economy, including the transportation industry. Freight shippers have globalized their operations to better serve their multi-national clients. Competition in freight and passenger rail has all but disappeared, but even with near-monopolies, freight railroads and Amtrak both may require government subsidies to make future capital improvements on aging, capacity-constrained infrastructure. Airlines have fared better than railroads, but the aftereffects of 9/11 have yet to be fully realized. Stricter security regulations will impact ground transport as well as air transport. At border crossings, preinspection and improvements in technology can ease congestion and delays for passengers and freight.

In order to take advantage of the economic growth in the service economy, Arizona must address issues related to freight transport from, to, within, and through the State. The efficiency of freight transport is impacted by congestion at border crossings, at inspection facilities, on urban freeways and arterials, at rural bottlenecks, and on routes used to access intermodal transfer facilities. Improvements in communications technology promise to increase productivity for freight shipping firms while reducing Arizona's administrative costs. Well-developed transportation infrastructure is essential to the efficiency of supply chains.

Freight movement has long been overlooked by transportation planners, but the movement of passengers is no less important. Although the service economy emphasizes the movement of information rather than goods, decentralization of business has influenced business location decisions and shaped urban development patterns, which in turn has had profound impacts on urban transportation infrastructure in Arizona. Arizona has the opportunity now to integrate transportation and land use planning so that state and regional planning organizations can exert more control over future development decisions. Improved regional cooperation in land use and transportation planning can have a variety of benefits, economic and otherwise, from protecting environmentally sensitive areas to maintaining a sufficient supply of affordable housing in rapidly growing urban areas.

Although Arizona has been transformed since the days when the "Five Cs" powered the State's economy, a superior quality of life is still one of the State's strongest assets. Maintaining and improving Arizona's transportation system will be critical to preserving a high standard of living in the State and allowing the State's economy to prosper.

Transportation and Land Use

Transportation and Land Use

DRAFT

A white paper

Prepared for the

Arizona Department of Transportation

March 26, 2002

By

Edward Beimborn, Ph.D.

Transportation/Land Use White Paper

Outline

1. Introduction
2. Land Use – Transportation Interactions
   - 2.1. Overview
   - 2.2. Emerging Land Use Concerns
3. Scope of State DOT Actions that Affect Land Use
   - 3.1. Land Use/Transportation Planning Requirements
   - 3.2. State Land Use Planning Capabilities
   - 3.3. Education and Technical Assistance
   - 3.4. Access Management
   - 3.5. Land Use Policy
   - 3.6. Economic Development
4. Examples from Other States
   - 4.1. State Land Use Planning Requirements – An Example from Florida
   - 4.2. Land Use Controls – An Example from Tennessee
   - 4.3. Access Management – An Example from Kansas
5. Application to Arizona
   - 5.1. Self Assessment of Current Status
   - 5.2. Coordination With Other Government Agencies
     - 5.2.1. Coordination with Local Government
     - 5.2.2. Coordination with State, Federal and Tribal Agencies
     - 5.2.3. Relationship with Private Sector
   - 5.3. Education/Technical Assistance
     - 5.3.1. Improve State DOT Expertise
     - 5.3.2. Technical Assistance from the State DOT
   - 5.4. Access Management
   - 5.5. Smart Growth
   - 5.6. Land Use Programs
     - 5.6.1. Secondary Impact Analysis
     - 5.6.2. Connectivity
     - 5.6.3. Transit Corridor Districts
     - 5.6.4. Interchange Area Planning and Deployment Strategies
6. Conclusions

1. Introduction

Sometime in the next thirty to forty years Arizona will double in population. This will mean the addition of five million more people. For every person and building now in the state, space will be needed for another. There will be enough people for another Phoenix, another Tucson, another Quartzite, another Bisbee and a duplicate of every community in the state. All that now exists will have to be duplicated in some way to accommodate this growth. In short, the growth of the state means that a second Arizona will be needed to be created to sit beside the present one.

"Sometime in the next thirty to forty years the population of Arizona will double."

"...a second Arizona will be need to be created to sit beside the present one"

The doubling of Arizona assumes that growth will continue at a rate similar to that of the past. Arizona has been one of the fastest growing states in the country. During the last forty years the population of Arizona has increased by 380%, going from about 1.3 million people in 1960 to over 5 million people by the year 2000 census. Most of this growth has come from migration. This has been primarily from the northern and eastern parts of the United States and other countries, especially Mexico and countries in South and Central America. The population of Arizona is not only much larger, but it is also far more diverse than it has been in the past.

People move to Arizona for a variety of reasons. It is a state of extraordinary natural beauty that draws people from all over the world as tourists and as permanent residents. The climate and environment make it a top choice for people seeking a place to retire or to escape harsh winters and cold weather. To those outside the state, Arizona is a state of great opportunity as a place to get a job or start a business. Growth leads to growth as more people arrive and who need more services and who provide jobs for the next round of arrivals.

If past patterns continue, the need for additional land for a doubling of population will be far more than twice the land now used for the current population. Recent growth patterns everywhere have led to lower densities and higher rates of land consumption. For example, since 1970, the population of the Los Angeles area increased by 45%, but at the same time the land area has increased by 300%. Similar patterns occurred in other major cities around the country including those in Arizona.

The population of the state will likely differ substantially from that of today. The population will be older and much more diverse. People who migrate to the state will include large numbers of people looking at it as a place of retirement and will also include large numbers of immigrants from other countries who will see the state as a place with good opportunities to work and live.

What the state does to deal with this growth will have a profound affect on the very nature of Arizona and what it means to its citizens. The impact of future

growth in the state will be profound, irreversible, and massive. Major questions will arise about the adequacy of water resources, energy supply, and impacts on the natural environment. The open spaces that draw people to the state will become increasingly more distant to those who live in metropolitan areas. Once an area is converted to urban and suburban use, it will remain that way forever. What the growth will do to the state is not known, but unless there are significant changes in migration and life style trends in the population, the fact that it will occur is a certainty. How it happens and how the state and local governments react is a critical question, for policies that are set now will shape the state in the future.

"How the state deals with transportation and land use will be one of the most critical questions facing the state in the future"

If past trends continue, the population growth will carry with it a growth in travel at least as great and most likely greater. Travel will more than double, adding major increases in traffic and congestion to state highways. This trend will only change if there are new patterns of development such as more compact land use or if there is a shift to other modes of travel besides the single occupant automobile. Other modes of travel will only play a minor role unless there are significant changes in how they fit into land use patterns. To deal with this in the normal way of doing business will require funding levels far beyond those available today. How the state deals with transportation and land use will be one of the most critical questions facing the state in the future. The transportation of the state will affect this growth and be affected by it. The decisions made now about transportation made now will have effects that will have major long-range effects. Good policy and plans (transportation for smart growth) should be a high priority. This will involve greater understanding of land use-transportation interaction by ADOT staff and local governments and a wider set of tools and options to work with.

2. Land Use – Transportation Interactions

2.1. Overview

The connection between transportation and land use is a fundamental concept in transportation. Everything that happens to land use has transportation implications and every transportation action affects land use. Actions by transportation agencies shape land use by providing infrastructure to improve accessibility and mobility. This increases the utility of land and leads to more intensive land use. Land development generates travel, and travel generates the need for new facilities, which in turn increases accessibility and attracts further development. The question of whether transportation influences development or whether land use dictates transportation has been a matter of ongoing concern among transportation professionals since the beginning of transportation planning.[1] There is no simple answer to this question, both happen together and there is a need to consider both simultaneously.

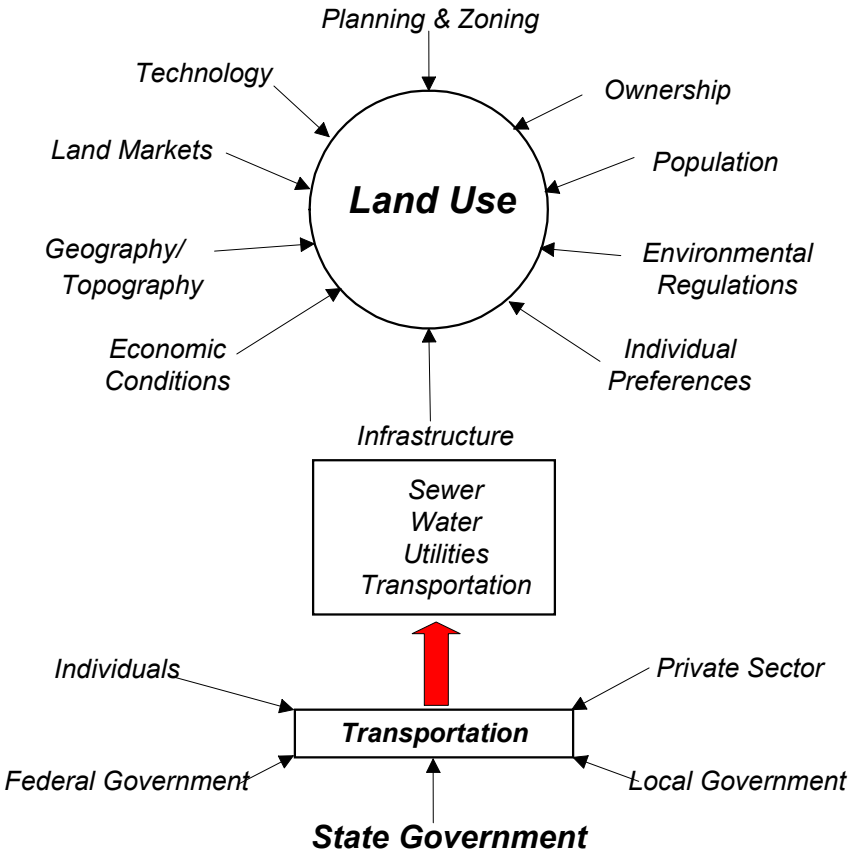
A state department of transportation is just one of the many organizations that influence land use. Land use decisions are the result of complex interaction of many forces involving individuals and organizations in both the public and private sectors. There are many factors in the land development process. These include overall population and economic growth, market

"Everything that happens to land use has transportation implications and every transportation action affects land use."

[1] This section has been adapted from "An Overview: Land Use and Economic Development in Statewide Transportation Planning," Report by the Center for Urban Transportation Studies, University of Wisconsin Milwaukee to FHWA, May 1999.

conditions, individual preferences and life style choices, other infrastructure, changing technology, local planning and zoning polices and geographic and topographic conditions.[2]

Figure 1. Transportation's Role in Land Use



[Source for Figure: Indirect and Cumulative Effects Analysis for Project Induced Land Development, WisDOT 1996]

The easy response that a transportation agency could take to this situation is to ignore the land use implications of what they do with a feeling that it is beyond their control and impossible to deal with. Such an approach is short sighted, leading to long term consequences that negate the benefits of transportation investments. Transportation and land use are closely intertwined and the implications of transportation decisions on land use cannot be ignored.

A state DOT influences land development through providing infrastructure and through transportation-related regulations. State transportation projects are normally planned to improve safety, decrease travel time by alleviating congestion, and achieve other mobility-related goals. Seldom are projects

[2] Adapted from *Indirect and Cumulative Effects Analysis for Project Induced Land Development; Technical Reference Guidance Document*. Wisconsin Department of Transportation, 1996.

planned or designed with land use issues as a primary objective. Transportation's impact on land development occurs at many levels. This ranges from simple actions such as issuing a driveway permit to overall actions such as the development of strategic plans and programs. When improved access is provided to land, it raises its potential for development, and more development generates additional travel. Once access has been provided, land patterns begin to change over a period of time. The results of these changes are, for the most part, irreversible.

2.2. Emerging Land Use Concerns

Recently, concerns about urban sprawl have arisen in many areas of the nation. Many diverse groups have common concerns about the role transportation plays in exacerbating or combating the problems associated with urban sprawl, suburban congestion, and jobs/housing mismatches. Some people have argued that efforts to expand the highway system contribute to urban sprawl by decreasing travel times from urban to exurban/rural areas and making undeveloped areas attractive for residential and commercial uses. Often new highway facilities in urban areas have driving times and levels of congestion that exceed that of the highways they replace, suggesting that new or expanded facilities may be unable to solve long-term congestion problems.[3]

Several factors can be identified as contributing to sprawl, including the movement of jobs to suburbs, lower transportation costs versus lower housing costs, preference of many people to live in remote areas away from the problems of the city, and the desire for larger residential lots and units.

Sprawl is a concern for many because of its impact on open space and agriculture. Diverse groups, including farmer organizations, inner-city community organizations, transit advocates, and environmental organizations, have worked together in some areas to deal with issues of sprawl. It can lead to adverse impacts in areas where people are moving as well as in the areas they are moving from. Of recent concern are labor shortages created by jobs/housing mismatches. Housing markets in the suburbs have excluded many skilled laborers who would traditionally be employed by the industries and commercial enterprises that develop in these areas. A combination of transportation and land use measures is needed to address this problem.

The concern about sprawl and transportation has led to a new debate in many states and communities about the relationship between transportation and land use. In some cases, local and statewide efforts are now beginning to take effect to limit sprawl in some of the nation's fastest growing urban areas. The new debate invariably involves state DOTs, whose role in land use decision-making continues to evolve.

[3] Adapted from Guiliano, Genevieve. "The Weakening Transportation Land Use Connection." *Access*, No. 6, spring 1995. University of California at Berkeley, pp. 3-11.

Perhaps one of the most useful documents about sprawl is Transit Cooperative Research Program Report 39, "The Cost of Sprawl Revisited"[4]. This report offers a comprehensive review of literature related to urban sprawl and its effects. The report provides a working definition of the term sprawl and includes an analysis of nearly 500 documents that deal with the topic. Literature on sprawl is summarized under the categories of: public/private capital and operating costs, transportation and travel costs, land/natural habitat preservation, quality of life and social issues. Under each topic area the project team determined the degree of agreement among researchers if a condition existed, if it was positive or negative and if it was linked to sprawl. Forty-one issues were identified and many of them dealt with transportation directly or indirectly. It presents one of the easiest ways to gain a quick understanding of land use issues and provides a basic background on the topic.

The researchers concluded that there is a general agreement in the literature that sprawl leads to more vehicle miles of travel, more automobile trips and less cost effective transit services. There was also some agreement that sprawl means higher household costs of travel and greater social costs. No clear outcome exists in the literature reviewed that sprawl reduces congestion, requires longer travel times or lowers the government costs of transportation.

Other work[5] compared the differences in infrastructure cost for 'sprawl' development (a tendency towards lower densities) vs. 'planned' developments (with somewhat higher densities and mixed uses) and found that costs of roadway infrastructure was about one fourth to one half lower with planned development. School infrastructure costs were similar in both cases while utility costs were also lower by one third to one tenth. Planned development can result in lower costs through more compact design and better viability for other modes, such as transit, walking, and bicycles.

"there is a general agreement in the literature that sprawl leads to more vehicle miles of travel, more automobile trips and less cost effective transit services."

One message not directly found in the literature is that how land use and transportation interact is something that is not beyond the control of local and state governments. How, where and when land use occurs is something that can be affected if there is the will to do it. If a transportation agency takes no actions that affect land use, then land use will dictate transportation. New facilities will tend to follow development and attempts will be made to provide facilities to meet population and economic growth. In such a case the transportation agency merely reacts to growth and stays out of land use issues.

On the other hand if an agency adopts a more aggressive policy towards land use, then land use will be affected. Such a policy requires cooperation and

[4] Burchel et al. "The Cost of Sprawl Revisited." *Transit Cooperative Research Program Report 39*, Transportation Research Board, 1998.
[5] R. Burchell. "Economic and Fiscal Costs and Benefits of Sprawl." *The Urban Lawyer*, Vol. 29, 1997.

agreement with local governments charged with making land use decisions. For example, if there is consensus that growth should not occur in a certain area, then local government has to take steps to direct it elsewhere or to lessen its impact. These steps might include very low-density zoning, purchase of development rights and other policies to reduce future trip making. Transportation agencies have to agree to not expand facilities in those areas and to work with local and regional organizations to implement their plans.

3. Scope of State DOT Actions that Affect Land Use[6]

There are many ways in which a state DOT is involved in land use. These include project level activities as well as systems planning and policy. Project activities relate to how a project is designed, how access is provided and managed, and how the project provides connections to other areas. Project level activities also include how provisions are made for a variety of travel modes, especially public transit, bicycles and walking. Systems level activities include land use and transportation planning, economic development and improving the capabilities of staff within the DOT as well as at the local level.

The role a state adopts in each of these areas can vary along a broad spectrum ranging from very active involvement in the coordination of transportation and land use to a very passive role, where the state leaves most of the decision-making to others. In order to help understand the spectrum of activity that states may undertake, a chart has been developed from previous work to show the range of state transportation activities that relate to land use. A state's role can be defined along a continuum from active to passive in the following six categories.

- Land Use/Transportation Planning Requirements
- State Land Use Planning Capabilities
- Education/Technical Assistance
- Access Management
- Land Use Controls
- Economic Development

Each of these categories is described below.

3.1. Land Use/Transportation Planning Requirements

At the passive end of the continuum, a state could fund regional- and local-level planning and leave the decision-making entirely to local jurisdictions. The option to do planning and how it is done is left to the local agencies. At the most active level, the state itself is responsible for planning and zoning, as is done in Hawaii. Between these two ends of the spectrum is state mandated local planning where the state sets mandatory standards for land use plans or may set guidelines reflecting the state's interests. A passive approach would require the planning to take place but not require state approval of the plans. A more active strategy

[6] "An Overview: Land Use and Economic Development in Statewide Transportation Planning," op. cit., Chapter 2.

would require that local land use decisions must have state approval and certification.

A critical issue related to this is the extent to which the state defers to local or regional planning agencies in transportation decisions. It is inconsistent on one hand to strongly believe that land use decisions should be made at the local level and then to build projects that weaken the ability to implement those plans. For example local plans may state the need to have a compact development pattern while state actions lead to the expansion of roadway capacity outside those areas.

3.2. State Land Use Planning Capabilities

The state DOT can provide a range of capabilities to assist local agencies, depending on how involved it wants to be in the planning process. As shown in the chart, these activities would range from providing data collection services for local government, at the passive end, to the utilization of sophisticated state land use models and basic research, at the active end. The purpose of transportation/land use models is to predict the future impact of transportation investments on land use. Oregon and New Jersey are two states using transportation/land use models. Intermediate state services would include providing GIS assistance, policy research, and economic forecasting.

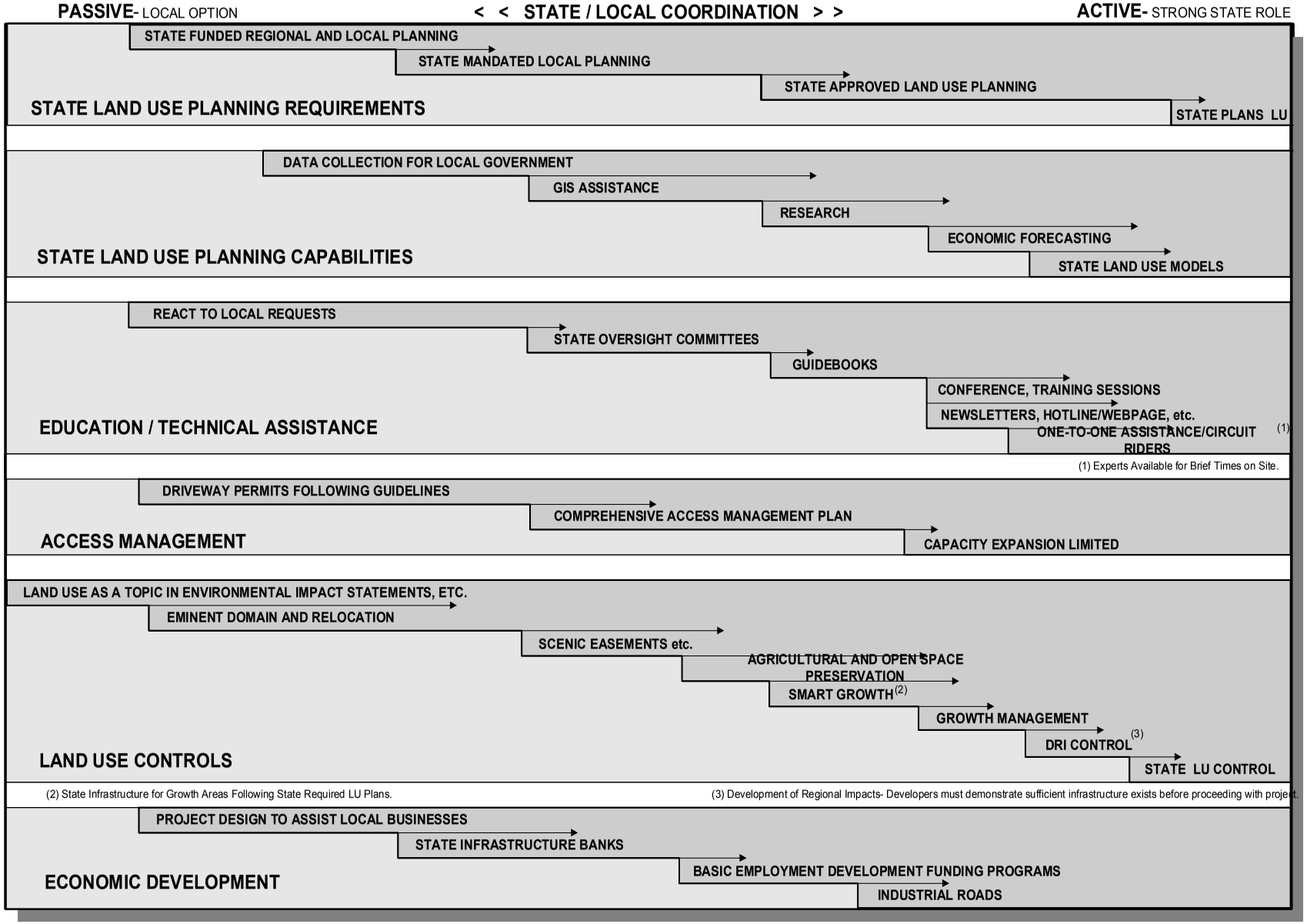
3.3. Education and Technical Assistance

State participation in education and technical assistance can take many forms. At the passive end of the continuum, states only react to local requests for assistance. A more active state participation would include formulating state guidelines, convening oversight committees, providing conferences, holding training sessions, issuing newsletters, organizing a hotline or Web site, providing public education, etc. At the most active level of participation, the state would provide one-to-one assistance to local government for the analysis of land use implications of transportation decisions.

3.4. Access Management

Access management is a systematic approach to providing appropriate access to land development on highways. The chart shows the range of access management programs that states have adopted. A passive approach is to allow unlimited access to the state highway system as long as access points follow site-specific guidelines. A more active strategy involves the development of comprehensive access management plans and policies. The most active strategy is to limit capacity expansion only to designated areas according to a statewide growth management policy.

Figure 2. State Local Coordination



3.5. Land Use Policy

Land use initiatives by a state encompass a broad range from simply including a topic in transportation plans or environmental impact statements to completely controlling land use. The various options available to a state involve different degrees of participation by state and local agencies in project-level land use policy and the project's environmental impacts, land use policy in environmentally sensitive areas, smart growth, scenic easements, agricultural and open space preservation, growth management and influences on large-scale developments. Smart growth programs bias the provision of state infrastructure to designated growth areas following land use plans done at the local level. For example, the State of Maryland restricts the expenditure of state highway funds to areas designated for development according to local plans that have been written by governmental agencies, developers, and local officials. A variety of states have adopted growth management programs. Developments of Regional Impacts (DRI) controls in some states require a developer to demonstrate that sufficient infrastructure exists before proceeding with the project.

3.6. Economic Development

Economic development spans a range of activities that includes project design assistance to local businesses, state infrastructure banks, funding programs to promote basic employment opportunities, industrial roads, and provision of road facilities by the state for developments that generate both basic and non-basic employment. Examples of state funding programs that facilitate economic development are the RISE program in Iowa and the TEA programs in Wisconsin and California. State infrastructure banks (SIB) are funds for infrastructure investment generated at the state or regional level, as pioneered in Ohio and Florida. Industrial road programs pertain to the allotment of funds by the state towards improving existing road facilities that enhance accessibility to eligible industrial and agricultural facilities.

4. Examples from Other States

Every state has a unique history and setting. What works one place may not work elsewhere because of different legal frameworks, attitudes, or population. What works elsewhere may not work in Arizona. Nonetheless, examples from other rapidly growing states provide possible land use policies that might apply to the Arizona context. Three states - Florida, Tennessee, and Kansas - provide examples of state actions linking land use and transportation.

4.1. State Land Use Planning Requirements – An Example from Florida

The state of Florida has had rapid growth for long periods of time and has been struggling to provide transportation capacity to go along with the growth. Florida's program to deal with land use transportation interactions was enacted through the Local Government Comprehensive Planning and Land Development Regulation Act. The central theme of this program, administered by the Department of Community Affairs, is to address the problem of urban sprawl.

The Florida legislation uses the following methods to address the interaction between transportation and land use:

- **Integrated planning**: Each MPO develops and updates a comprehensive plan including land use, highway, and transit elements. These plans must be locally adopted and approved by the Department of Community Affairs according to its growth management standards. Four-fifths of the state is within an MPO.
- **Compliance**: All Florida DOT roadway projects must be in compliance with the local comprehensive plan for the specific project's limits.
- **Coordination**: An FDOT district staff member sits as a nonvoting member at all MPO committee and board meetings.
- **Objectivity**: All goals, objectives, and policies, as well as the future land use and traffic circulation maps in local plans must be supported by and based on specific data and analyses.
- **Concurrency**: "Public facilities and services needed to support development shall be available concurrent with the impacts of such development." New developments are not allowed if they prevent a local government from maintaining an established level of service. This is the cornerstone of the growth management process.
- **Large Developments**: All developments of regional impact (DRI) undergo a special state planning process. A DRI includes "any development which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of

citizens of more than one county."[7] For example, for a proposed industrial park, the DRI review might be necessary for parking facilities of more than 1,500 vehicles or a minimum site extent of one square mile. Developers might be required to make contributions to the transit system that provides service to the area of development.

Experience with this process has been mixed. Developers have found ways to get around the regulations and communities sometimes find that there are unintended consequences. Developments have been sized to fit just under the limits or located just outside the boundaries of the MPO to circumvent the intent of the law. Furthermore, an initial shortage of state staff expertise led the state to rely on information provided by developers that minimized the negative impacts of their projects. Nonetheless, the legislation has changed the rules and led to a process for planning and growth in the state that considers how local communities cope with growth.

A partial solution was found in the adoption of the Florida Quality Developments Program. This provided developers with an incentive to use the DRI process, rather than design developments just below the threshold. The program allows the state to review and resolve problems early in the process, and to delegate the review of DRIs to local governments that show they have the capacity to review a DRI.[8]

4.2. Land Use Controls – An Example from Tennessee

The Tennessee Growth Boundary Policy Act was intended to influence the distribution of TEA-21 funds within the state. This act required every county in the state to write a comprehensive land use plan adopted by the local governing body.[9] These plans address transportation and public infrastructure needs in each county and must comply with the TDOT's goals.[10] Some of the goals of these plans include:

- Providing for adequate infrastructure prior to development;
- Reusing developed land within existing growth boundaries instead of adding infrastructure and annexing new areas for development;
- Redesigning the existing network of roads to revitalize urban centers;
- Avoiding exclusionary zoning; and
- Encouraging mixed-use development.

---

[7] *Ask DCA:* Development of Regional Impacts (DRIs); Community Planning, Florida Department of Community Affairs, summer 1998. Vol. 7, Number 2. p. 10.

[8] Adapted from: (a) CH 28-24 Developments Presumed to be of Regional Impact; (b) Development of Regional Impact (DRI) Review; (c) Rules of the Department Community Affairs Division of Resource Planning and Management Schedule for the Transmission and Submission of Local Government Evaluation and Appraisal Reports; (d) Development of Regional Impact Application for Development Approval under Section 380.06, Florida Statutes.

[9] Pfitzer, Jeff. "Transportation Planning and Tennessee's Growth Boundary Policy Act: A Few Issues to Consider." *Transportation Planning*, fall 1998. p. 1.

[10] Ibid., p. 2.

According to this act, each Urban Growth Boundary (UGB) should demarcate a reasonably compact region with the capacity to accommodate 20 years of residential, industrial, and commercial growth.[11] It is the responsibility of the local planning agency to manage and control urban expansion outside of such established growth boundaries.[12] The municipality must consider the impacts of urban expansion on the surrounding agricultural lands, forests, recreational areas and wildlife management areas.[13] If growth cannot be accommodated within the specified growth boundary, then the municipality should identify potential new areas adjoining the existing high growth areas so that they can easily be incorporated into the network of road, utility infrastructure, and public services.[14]

This act reinforces the need for smart growth, especially in those less-developed areas that are now growing rapidly.[15] With the implementation of Tennessee's Growth Boundary Policy Act, every county in Tennessee effectively adopted a comprehensive plan by July 2001.

4.3. Access Management – An Example from Kansas

The Corridor Management Policy adopted by the Kansas Department of Transportation (KDOT) is directed at achieving best use of the state highway system. The act establishes criteria and procedures necessary to obtain reasonable access to abutting properties while maintaining safety and efficiency in the movement of people and goods on the state highway system.[16] The policy is also meant to establish uniformity in the management of state corridors in Kansas. The provisions of this policy act do not constitute a specific set of legal requirements. Rather, the act sets minimum standards for access installations and establishment of protected corridors.[17] The main purpose of this policy is to establish methods of corridor management that lead to a minimization of vehicle conflicts, improvements in safety and traffic operations, a reduction of delays and smaller major capital expenditures.[18]

---

[11] *A Guide for Conducting County Level Land Use Plans*; Tennessee Growth Policy Act Project: Fulfilling the Potential of Law; School of Planning, University of Tennessee, Knoxville. p. 1. http://planning.cap.utk.edu/tgp/pubc1101.html.
[12] Ibid. p. 2.
[13] Loc. cit.
[14] Ibid. p. 3.
[15] *Smart Growth;* Tennessee Growth Policy Act Project: Fulfilling the Potential of Law; School of Planning, University of Tennessee, Knoxville. p. 1. http://planning.cap.utk.edu/tgp/pubc1101.html
[16] *Corridor Management Policy*; Kansas Department of Transportation. p. 1.
[17] Ibid., p. 2.
[18] Loc. cit.

The Corridor Management Policy specifies four access management objectives:

> *"The main purpose of this policy is to establish methods of corridor management that lead to a minimization of vehicle conflicts, improvements in safety and traffic operations, a reduction of delays and smaller major capital expenditures."*

- In order to minimize the number of conflicts, eliminate driveways by combining access points or providing access from other roads.
- Achieve better separation of conflict points by providing wide spacing between driveways and keeping driveways away from intersections.
- Allow for slower deceleration through geometric changes.
- Provide exclusive turning lanes so that turning vehicles and queues are separated from through traffic.[19]

KDOT can also purchase access rights to property or additional right-of-way.[20] When choosing the strategy for access control, KDOT considers a wide range of factors, such as patterns of development, travel demand, environmental issues, and efficient use of resources.[21] All issues pertaining to corridor management are reviewed and managed by the Corridor Management Committee. The KDOT coordinates its efforts with local agencies and landowners in order to effectively implement the guidelines specified in this policy.

[19] Loc. cit.
[20] *"Policy Application"; Corridor Management Policy*; Kansas Department of Transportation. p. A-1.
[21] Loc. cit.

5. Application to Arizona

Figure 2 provides a framework for the state DOT to consider in evaluating its land use and transportation policies. The state DOT can take steps to implement transportation objectives seeking to improve the link between transportation, land development, and economic development. Critical decisions about how the state DOT works with local and regional agencies and the private sector lie ahead.

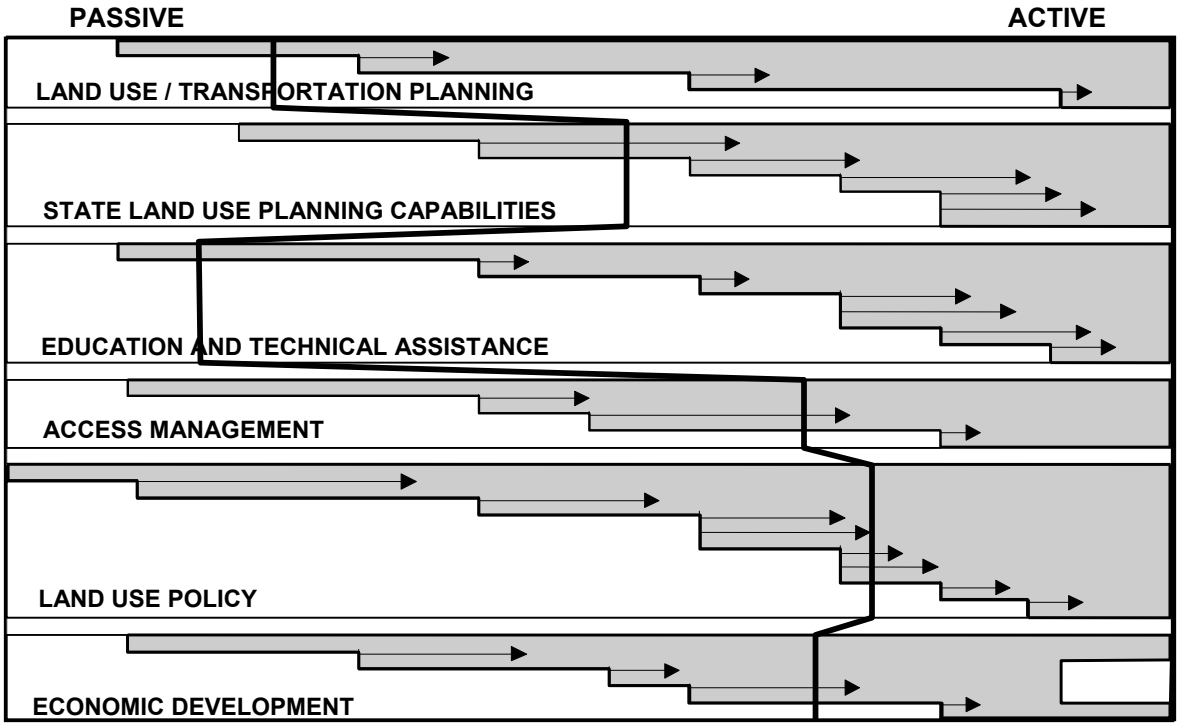
Federal Transportation Planning Regulations also require analysis of land use impacts of transportation investment decisions at the project level. These regulations represent the most far-reaching call for coordinated land use and transportation planning. However, these are very flexible as no specifications are given as to how to analyze land use impacts of transportation investments or how land use characteristics or development policies should be integrated into the transportation planning process.

The following is a series of suggestions for actions that the state should consider to improve its role in transportation and land use.

5.1. Self Assessment of Current Status

The first step that the state can take in the review of its land use and transportation policies is to conduct a self-assessment of existing policies for consistency. Existing state DOT programs activities and regulations should be reviewed to determine where they fit into Figure 2. The state can use this analysis to determine areas where they should be more active in coordination transportation and land use concerns. The state should also review the chart to determine if they need to add options to each of the categories on the chart or entire new categories based on emerging issues in Arizona.

A hypothetical example of this process is illustrated in Figure 3. The thick line plotted on the chart displays the present position of the state. A review of Figure 3 indicates that the level of activity in outreach and technical assistance appears to be inconsistent with other activities. This hypothetical state could rethink its role in providing outreach and technical assistance to local government in relation to its programs. Similarly, the state could organize oversight committees, conferences, and training programs to assist local agencies. With the implementation of these steps, the state could have a more consistent and balanced approach to land use actions.

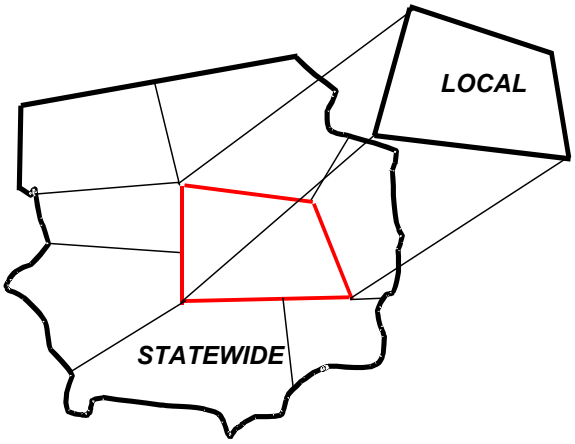


5.2. Coordination With Other Government Agencies

The key element of Figure 2 is the level of coordination between the state and other government agencies. This section provides an analysis of coordination between the state and local governments, and the state and federal agencies.

5.2.1. Coordination with Local Government

In most states land use decisions are made by local governments. Most state DOTs defer to local governments on land use issues, but may have review authority when the development involves access to or causes impacts on a state highway. By providing transportation facilities and services – be it through building highways, providing grants for local transportation improvements, or providing assistance to transit services – the state DOT affects land use patterns in many different ways. Similarly, all development and land use decisions will ultimately affect travel patterns and influence the decisions made by state transportation officials regarding project planning and programming. Transportation is irrevocably tied to land use and land development.



A critical issue the state must face is how the state deploys projects in relation to locally adopted plans. To what extent should the state promote transportation projects that may conflict with local plans? Some have argued that additions to highway capacity should not be made unless it follows the local plan. In the state of Maryland, infrastructure funds are directed to priority funding areas designated by local governments according to state criteria.[22] Funding programs are designed to provide for compact development and the state DOT follows the lead of local plans in designing its programs.

"A critical issue the state must face is how the state deploys projects in relation with locally adopted plans"

Even in states where the DOT feels it has no role in land use decisions, its staff members will find themselves heavily involved in land use concerns. These occur through the environmental review process, by issuing permits and by deciding where, when and how to expand highway capacity. Who takes the lead in planning and identifying projects at the local level is a critical decision for a state DOT in defining land use policy. It may be that there are different procedures for different areas of the state. In areas with experienced local and regional planning agencies, they can easily take the lead in identification of projects for all levels of government. In other areas of the state with less local expertise, the state may have to take more of a lead role.

No matter who takes the lead role in land use decisions, a state DOT will need to be a participant if for no other reason than to protect the state's investment in transportation services and facilities so they operate in an efficient manner.

5.2.2. Coordination with State, Federal and Tribal Agencies

"The state DOT should consider how they interact with other state, federal and tribal agencies and actively explore methods to increase coordination and consistency between agencies."

Many state and federal agencies and tribal governments take prominent roles in decisions that directly or indirectly affect land use in Arizona. Arizona is unique in that large amounts of land are under the direct jurisdiction of the state itself or a variety of federal agencies and tribal governments. This situation requires a coordinated effort to deal with future growth in a logical way while minimizing harm to the environment, preserving sensitive lands, and encouraging economic development. To do so requires a high degree of coordination and agreement on common goals and approaches. The state DOT is only one of many agencies that should take part in these coordinated efforts.

One method to increase coordination between agencies is to establish a state land council that provides a forum for discussion of state land use issues and

[22] "What you need to know about Smart Growth and Neighborhood Conservation" Maryland Office of Planning, May 1997.

works to establish consistency among agencies' programs. The success of this effort depends on the commitment of various state, federal and tribal agencies to working together on transportation and land use topics. Hot issues in one agency or area of the state may not be salient to others. The state DOT should consider how they interact with other state, federal and tribal agencies and actively explore methods to increase coordination and consistency between agencies.

5.2.3. Relationship with Private Sector

A key question for the state to address is how they will work in partnerships with the private sector. Private sector developers seldom undertake projects that they feel are not financially viable. They react quickly to shifts in market demand and are generally open to change and innovation.

Improved communication with the private sector is essential for better coordination of land use and transportation. Clear guidelines and policies are needed to assist the private sector in making decisions. Uncertainty and project delays can cause severe financial problems and quick abandonment of projects. Good procedures are needed to involve the development community in transportation decisions. As in Florida, legal solutions may be more effective if developers are brought into the planning process early, instead of seeking ways to avoid the responsibilities of the process.

The changing nature of the population presents an opportunity for better coordination and cooperation with the private sector. Market potential for transit, walking, and bicycle travel will likely increase. The future population will be older and more diverse. Older residents require places to live that provide alternatives to an automobile dependant life style. People born outside the United States often have a greater propensity to use public transit. Both groups present markets for more compact development.

5.3. Education/Technical Assistance

5.3.1. Improve State DOT Expertise

Smart growth requires smart people who make smart decisions. The state DOT should examine the level of expertise in land use policy. If the state is to develop transportation systems with an awareness of land use, staff needs to be better informed about this relationship. Coordination with local and state agencies requires more information about the policies of these agencies. Coordination with the private sector requires more information about how they make decisions.

> "*Smart growth requires smart people who make smart decisions*"

The state should examine the level of knowledge of their staff and determine how they can increase their expertise in land use. This should occur at all levels.

People who design individual projects or supervise the maintenance and operation of transportation systems should be involved. It is especially important that the state have expertise in real estate economics and development procedures to be successful.

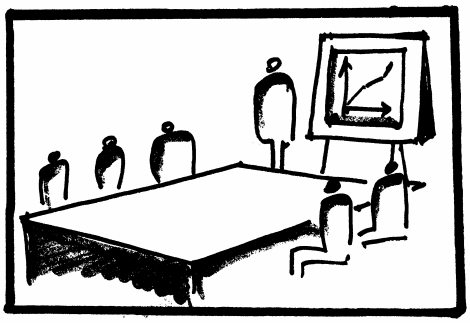
At the local level, the state DOT needs to take a more active role in examining the land use transportation interaction. Each district office of the state needs ready access to expertise in land use and transportation interactions and active participation in local land use decisions. This may be best accomplished through district land use coordinators. Such a person or persons would work with local government and ADOT to tie land use and transportation closer together. They would know early on the concerns of local governments and use this information to improve transportation policies and projects.

> *"Each district office of the state DOT needs ready access to expertise in land use…. This may be best accomplished through district land use coordinators."*

To some extent this may require a change in the self-image of the organization. If the state is to become more sophisticated in how it deals with land use, staff needs to think of the agency in a different way. It is not just a highway builder anymore, but also a service agency that provides resources for smart use of land and wise investment of resources. Life is more complex if transportation decisions need to consider how they will affect future land use and transportation efficiency.

5.3.2. Technical Assistance from the State DOT

A technical assistance and outreach program can be an effective way to increase the expertise of local governments and decision-makers. In some areas of the state, local and regional planning agencies are highly sophisticated and use state of the art techniques while other areas have fallen behind recent planning efforts and technologies.



The state can increase its involvement in land use issues by sponsoring conferences and training sessions. These programs are designed to make local government personnel more aware of good land use and transportation practices. For example, the state could sponsor local training sessions on access management for local government in order to convince local agencies of the need for better control of driveway entrances onto state highways. Typically, these training programs are run for one day and are held regionally to allow for attendance with a minimum of travel. Such programs may be offered by the state directly or by others with state sponsorship. The state DOT can be very effective as a catalyst for such programs if it actively encourages their development and promotion. Even if the

state feels that land use is entirely a local issue, training and conference programs can help local governments perform their jobs more effectively.

In addition, the state can develop guidebooks and technical assistance materials that are specifically directed to land use policies of local agencies. These materials can be used to help local government better understand best practices in planning and the interaction between transportation and land use. The materials can help create consistency in planning practice among local governments and be used to deliver information on emerging practices and techniques.[23]

5.4. Access Management

Access management is one of the most direct ways in which transportation agencies and local governments can deal with adverse effects of development on transportation system performance. Careful planning of access in newly developing areas and good policy for driveway spacing and design can avoid many problems of congestion and safety that would otherwise occur. Good traffic flow occurs if turning movements on and off arterial roads are minimized and concentrated at places where they can be done safely. The state should examine how it manages access on roads under its jurisdiction and also develop methods to encourage and assist local governments in their access management.

Access management is a way for the state DOT to protect its investments in transportation by preventing actions that deteriorate the function of the facility.[24] State transportation facilities would be managed in such a way as to maximize their long-term benefits and to provide the greatest return on investment. In such a case the state could adopt strategies that protect investments from losing their value through poor land use and access policies.

For example, the department might pursue access management aggressively to protect facilities from losing their ability to provide mobility because of excessive access points. Similarly the department could engage in extensive interchange area planning to assure that traffic entering and exiting a major highway is not subject to extensive conflicts from interchange area developments. In such a case the department would develop rules for areas near interchanges as to types of land uses, complementary activities, and sharing of off road facilities.

[23] Beimborn et al., "An Overview: Land Use and Economic Development in Statewide Transportation Planning", Report to the Federal Highway Administration, May 1999, Chapter 4.
[24] "Public Private Cooperation: Transportation Investment and Real Estate Development", Report to Wisconsin Department of Transportation by the Center for Urban Transportation Studies, University of Wisconsin-Milwaukee, June 1985.

5.5. Smart Growth

The most recent response to the problem of sprawl has been the adoption of 'smart growth' legislation.[25] This has occurred throughout the country and in places covering the political spectrum. Smart growth means different things to different places, but generally attempts to improve planning to avoid the adverse consequences of unplanned growth. These planning efforts are intended to continue to encourage growth, but with a better understanding of its long-term consequences. Smart growth legislation generally makes mandatory certain planning elements that were formerly optional for local government plans.

Smart growth conveys a new attitude towards planning that does not carry the stigma of imposing central control on land uses. A key feature of smart growth legislation is a strong reliance on local governments to make decisions. Ideally these are smart decisions that have a longer term view and weigh individual rights with the common good.

Smart growth legislation was first passed in more urbanized states on the east and west coasts with notable early efforts in Maryland and Oregon. Recently, states such as Tennessee and Wisconsin have adopted smart growth legislation. The Arizona legislature passed a series of laws to address smart growth, including the Arizona Preserve Initiative of 1996, the Growing Smarter Act of 1998, and the Growing Smarter Plus Act of 2000. These laws strengthen planning requirements at the local level and permit the use of tools such as purchase of development rights to protect critical lands. They also allow municipalities to set infrastructure service boundaries and indicate that municipalities may not annex an area unless they have a plan in place to provide the infrastructure within 10 years.[26]

The legislation is still new in the state and much of it remains to be implemented. Several communities have gone through plan ratification by voters and many others are in the process of developing plans that conform to the legislation. Time will tell if the legislation will make a difference in how Arizona grows and develops.

A critical question sometimes left out of smart growth legislation is what is the state required to do with smart growth. In some states, the legislation is silent about state agencies and programs, while in other places the state is required to conform to local plans. For example, the Maryland smart growth legislative package restricts most state infrastructure funding, economic development, housing and other program dollars to Priority Funding Areas[27] designated by local governments. Smart growth policy objectives are integrated into the transportation system through the planning process. This may mean that

---

[25] "Planning Communities for the 21st Century". A Report of the American Planning Association, December 1999.
[26] "Growth Management and Open Space Protection in Arizona: Current Tools and Progress". Issues in Brief, the Morrison Institute, Arizona state University, June 2001.
[27] Ibid., p. 6.

highway expansion does not take place outside of the priority funding areas if it will lead to sprawl elsewhere.

"The state DOT needs to decide how they will participate in local smart growth planning and how state projects complement the implementation of local plans."

It is obvious that transportation planning needs to be an integral part of smart growth at the local level. The state DOT needs to decide how they will participate in local smart growth planning and how state projects complement the implementation of local plans.

5.6. Land Use Programs

Smart growth provides a general framework for thinking about land use programs. Other practices can be used as individual measures to increase the tie between land use and transportation. These include improvement of connectivity between developments, consideration of transit corridor districts, and interchange area planning procedures. All provide common sense ways to avoid long term traffic congestion problems associated with growth. A rapidly growing state such as Arizona can use these steps to greatly reduce future problems.

5.6.1. Secondary Impact Analysis

The state might consider an extended environmental review of the land use impacts of transportation projects. For example, Wisconsin DOT developed a technical reference guidance document that its districts use to determine a project's potential to change land development patterns.[28] The document provides general information on land use planning, development regulation, and the relationship between transportation investments and land development patterns. The document provides a guide for evaluating land use impacts in the NEPA process.

The framework provides a means to assess impacts for potentially significant projects. Analysis of the indirect and cumulative effects on land development at the project level is different from local land use planning. Local land use planning merely studies and develops local goals and community vision, while project level analysis focuses on how the project alternatives affect local land use and land use plans. Local jurisdictions and consultants in the transportation planning process follow the guidelines provided in the reference guide.

5.6.2. Connectivity

An important topic for state and local governments is how they provide connectivity between adjacent developments and properties. Good practice includes providing multiple entrances and exists for residential and commercial

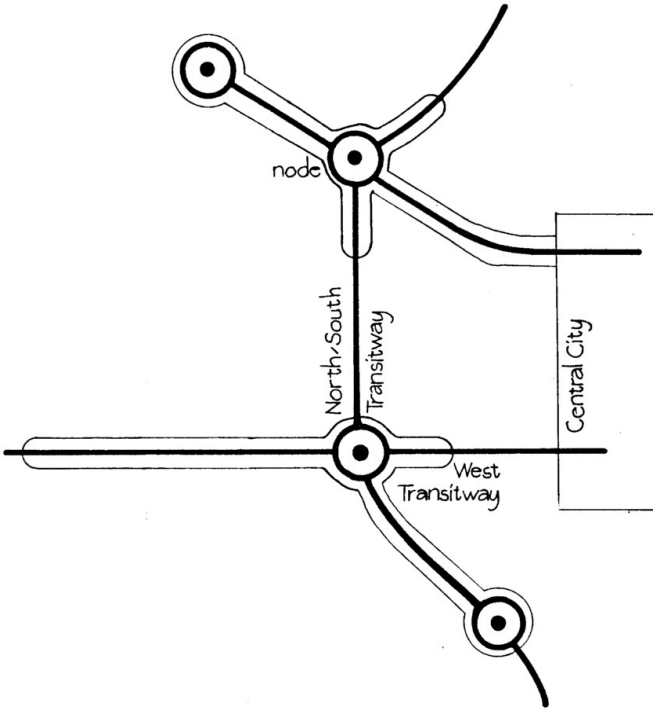
[28] "Indirect and Cumulative Effects Analysis for Project-Induced Land Development." Technical Reference Guidance Document, Wisconsin Department of Transportation. p. I-1.

developments to permit internal circulation and movement within neighborhoods without the need to use surrounding arterial roadways. This can reduce the need for excessive travel for short trips and lead to more efficient travel over the overall network. This implies limited use of cul du sacs and multiple ways in and out of each individual development. Guidelines for neighborhood connectivity could be developed as a tool for local government to use in the planning of growth areas and neighborhoods.

Improved connectivity within neighborhoods will also make it easier to walk or use bicycles for travel since those trips can be made without the need to travel along busy arterial highways. Access to transit service is also enhanced since walk paths to stops are direct and do not require circuitous travel.

5.6.3. Transit Corridor Districts

A transit corridor district is an area where transit service will be provided in the future and a place where land uses are arranged to facilitate transit services.[29] They include a mixture of land uses that relate well to transit and provide a street and pathway pattern that facilitates transit use, as well as bicycling and walking. Transit services would likely be bus-based with provisions to be upgraded to other technologies at a later date. To be effective they should be predesignated as part of a regional transportation planning effort. Early location and designation of the corridors is essential so that subsequent land use decisions can conform to the expected pattern of uses. They form the basis for the development of mixed use, pedestrian friendly places and provide a way for private developers to serve emerging residential and commercial markets.

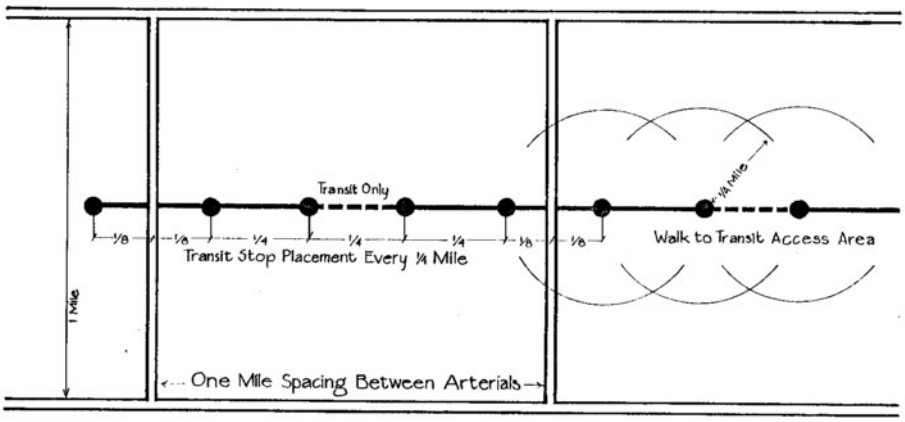


Ideally, transit corridor districts include the physical separation of transit service and primary auto-oriented travel. Transit corridors are located parallel to major arterials but within areas zoned for mixed use neighborhoods and transit-oriented land uses. Street patterns could be arranged to facilitate walking and transit stop access with a limited control of through auto movement along the transit corridor. Advance knowledge of where transit services will be provided will permit private sector developers to utilize property in an efficient way to take advantage

[29] For more information on this topic see "Guidelines for Transit Sensitive Land Use Design" Report to Federal Transit Administration by the Center for Urban Transportation Studies at the University of Wisconsin-Milwaukee, July 1991, also see TRB Record #xxx

of the alternative transportation choices. Arterial access management is an important complementary policy that can help to focus activity centers, such as commercial development, near transit stops. Transit corridor districts may have different zoning provisions that permit more flexibility by developers. They can create a win-win situation for private development and transportation agencies as both benefit through more logical linkages between land use and transportation.

Transit Corridor District Concept



Arizona may be particularly suited to this concept. Rapid growth, a well-developed grid system of arterial highways, and a diverse and aging population make it an ideal place to use the concept. Success depends upon coordination between regional planning agencies, local government, and the state DOT. The state should consider this concept as a way to increase choices in both land use and transportation services. The state must work with local planning agencies to explain the process and should consider the development of prototype designs and model code revisions.

5.6.4. Interchange Area Planning and Deployment Strategies

Highway interchange areas are prime sites for development. They attract commercial and employment activity and become the focus for substantial growth and development. If this growth is poorly planned, the interchange area becomes a place with excessive traffic conflicts and poor connection between properties and developments. The state should produce guidelines on issues of interconnection, access spacing, shared driveways, transit service location pedestrian movement, and internal circulation. These guidelines set the stage and ground rules for all that follows and help to avoid haphazard interchange area developments.

6. Conclusions

Land use changes are the result of many small decisions and occur incrementally over time. What may appear to be minor decisions at the time will accumulate to result in major changes in the landscape with unintended consequences. For all practical purposes, these changes are permanent and irreversible. Because of its fast growth, Arizona residents see an accelerated version of this process and even relatively new residents of Arizona can see dramatic changes in the landscape as they first saw it when they arrived in the state. Land use changes occur continuously as communities evolve and grow over time and do not stop at any point in the future.

By contrast, planning and land use policy efforts typically focus on a particular date or milestone in the future. They involve a significant effort for a short time and then are put to rest until updated some years later. These different perspectives make it difficult to implement meaningful change over time and to keep policies in place for the long run. Plans can be perishable commodities that are soon ignored or placed aside. To sustain a long term change in direction requires a change in attitudes and awareness by those who will work with them over the long run. Stable policies have to make sense to many constituencies to survive changes in administration that will occur over time.

Transportation and land use will become an increasingly important issue in Arizona. Rapid growth in the future and limited transportation resources means that the state DOT will have to take a more active role in land use decisions and policies. Furthermore smart growth initiatives will require the state DOT to consider how it interacts with local communities and other agencies. Critical questions the state needs to address are the following:

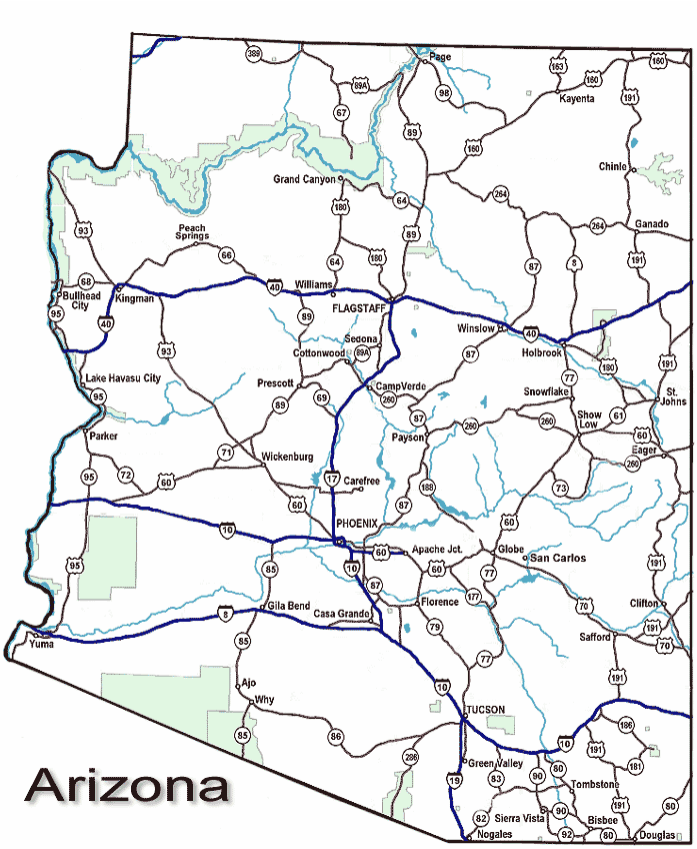
- How actively should the state participate in local land use and transportation planning decisions?
- What does the state do about projects that do not complement the implementation of local land use plans?
- How does the state DOT interact with other state, federal and tribal agencies on land use issues?
- How does the state increase its level of expertise in land use issues at the central office level as well as in the district offices?
- What level of technical assistance does the state provide to local governments in land use issues?
- How does the state balance private interests with public interests in land use and transportation decisions?
- What can the state do to increase the management of access on the state highway system?

- How does the state protect its investment in facilities to prevent their functional obsolesce?
- How can the state help in providing good connectivity between neighborhoods and developments?
- What can be done to provide a framework for transit oriented, compact development in growing areas of the state?
- How should the state manage the development of activities around the interchanges on the state highway system?

How Arizona deals with these questions during development of the long range transportation plan, as well as during subsequent implementation of the plan, will have an impact on many related concerns of importance to the State such as preservation of transportation system investments, economic vitality, resource conservation, and overall customer satisfaction with the functionality of the transportation system.

Security Considerations in Long-Range Transportation Planning

SECURITY CONSIDERATIONS IN LONG-RANGE TRANSPORTATION PLANNING: A WHITE PAPER FOR THE ARIZONA DEPARTMENT OF TRANSPORTATION



By
Steven E. Polzin, P.E. Ph.D.

for

Cambridge Systematics

under contract to the Arizona Department of Transportation

March 18, 2002

Table of Contents

List of Tables and Figures iii
Introduction 1
Transportation and Security 1
Security Risk 2
What Does Increased Security Risk Mean? 3
The Impacts of Security Concerns on Transportation 4
- Land Use 6
- Travel Behavior 7
  - Trip Generation 7
  - Trip Distribution 8
  - Mode Choice 8
  - Trip Assignment 10
- Transportation System Performance 11
- Investment Priorities 12

The Role of Security Risks in Long-Range Transportation Planning 14
Integrating Security Concerns into Long-Range Planning 15
General Observations on Security Planning 19
- The State of Knowledge and Uncertainty 20
- Defining Roles 20
- Priority Setting and Tradeoffs 21

Specific Security Issues in Arizona 22
- Critical Network Links and High Profile Targets 22
- Borders 24

Conclusions 24
References 25

List of Tables and Figures

Table 1 Scenarios Considered in the U.S. DOT Vulnerability Assessment 5
Table 2 Responsibilities of Transportation Agencies in Influencing Security Risks 16

Figure 1 Conceptual Model of Impacts of Security Risks on Transportation Planning 6
Figure 2 Annual Person Travel (Miles) 7
Figure 3 Phoenix Sky Harbor Airport Passenger Trends 8
Figure 4 Amtrak Ridership Trends 9
Figure 5 Draft Process of Long Range State Plan (transportation) 17
Figure 6 Arizona Commercial Vehicle Traffic 23

Introduction

This paper explores the implications of enhanced security concerns on state department of transportation long-range transportation planning activities. The Arizona Department of Transportation, (ADOT), in the process of updating its long-range plan, has recognized that security concerns will significantly influence how transportation facilities and services are provided. Hence, via this white paper, ADOT is exploring possible implications on long-range planning. The paper is an exploratory look at how security concerns may be integrated into long-range planning activities. Over the next several years, security considerations will most probably result in a multitude of changes in how transportation is planned, designed, implemented, and operated. Transportation goals, planning processes, databases, analytical tools, and organizational structures will change due to security concerns. This paper is intended to seed that discussion and facilitate that process of change.

Transportation and Security

A secure transportation system is critical to overall national security from terrorism. Groups or individuals motivated to terrorize or injure people or the economy may well have transportation facilities as a target or a tool. Most assuredly, they would have a transportation element in an overall plan. Thus, securing the transportation system is a critical consideration in overall security planning.

Terrorists may be motivated to disrupt the economy. Transportation infrastructure is critical to the functioning of the economy. Transportation activities comprise 12 percent of the gross domestic economy, and virtually all of the economy is contingent on a functioning transportation system. Disruption to critical links in the transportation system provides an opportunity to cause serious economic harm. Thus, transportation facilities may be targets of terrorists intending to harm the economy.

Terrorists may be motivated to cause personal injury to concentrations of people. Transportation facilities often provide anonymous gathering places for large numbers of individuals. Planes, trains, buses, terminal facilities, and pedestrian plazas have been terrorist targets. Thus, transportation facilities as gathering places for large groups of people may be targets of terrorists seeking to kill or injure significant numbers of individuals.

Terrorists may be motivated to strike at symbolic targets in an effort to harm a group or organization of people. High profile transportation facilities may be emotionally appealing targets for terrorism. The Golden Gate Bridge, the LA Airport, and other high profile transportation facilities have been mentioned as possible targets due to the fact that damaging these facilities would have impacts beyond the personal and economic consequences. Thus, high profile transportation facilities may be targets of terrorism.

Terrorists need to deliver the people, munitions, explosives, biological agents, or other destructive elements in their initiatives to terrorize. Transportation is explicitly an element of delivering terror. Be it airplanes, as in the case of September 11, 2001; trucks, as in the case of the Oklahoma federal building bombing and the 1993 World Trade Center bombing, or personal and freight vehicles that move the people and materials of terrorism around, transportation vehicles and facilities are critical elements in delivering terror.

Finally, as transportation is critical to the mobility of all people, including individuals who inflict terror and jeopardize security, transportation operating and regulatory agencies have opportunities and responsibilities to oversee various aspects of person movement and licensure. This includes involvement in securing borders, licensing vehicle operators, licensing vehicles, and enforcing various other laws regulating the safe use of vehicles and the transportation system.

Collectively, the transportation sector is intimately involved in the security of our society and, in many respects, will be a front-line area of focus in enhancing security. The future of transportation will be very much influenced by security considerations.

Transportation requires security because it:

- *Is a critical element of the economy*
- *Is a gathering place for groups of people*
- *Has symbolic and emotional importance*
- *Provides a delivery means for people and products of terrorism*
- *Includes institutions with licensing and enforcement responsibilities*

Security Risk

In its simplest terms, security risk might be expressed as a mathematical function. The security risk is a product of the probability of an incident attempt times the vulnerability of the target times the damage costs of a successful breach of security:

$$\textit{Security Risk} = \textit{Probability of Incident Attempt} \times \textit{Vulnerability} \times \textit{Damage}$$

Each of these terms suggests something about the nature of security risks to the transportation sector and the potential consequences of ongoing security concerns. Historically, domestic security concerns have been modest as a result of the fact that the probability of an incident was believed to be so dramatically small that the extent of vulnerability and the size of the potential damage had been relatively unimportant. However, in the post September 11th era, the probability of an incident attempt is far greater than previously appreciated by the vast majority of the public, thus resulting in the security risk being far greater than heretofore acknowledged. Additionally, the magnitude of the potential damage from an incident is now recognized as far higher than previously perceived. The extraordinary human and monetary consequence of the September 11th incident increased by orders of magnitude the perceived size of the possible damages from an incident of terrorism. Subsequent expert and media scenarios of increasingly sophisticated and dangerous tools of terrorism, including biological and chemical agents as well as the use of ever more powerful explosives strategically placed, has increased the commonly held perception of security risk being for virtually all public and private sector entities in the United States.

Although the above calculation could be applied to individual services and facilities, it can also be applied at the systems level where it would suggest that the security risk is now far greater, and, accordingly, should receive more attention and resources to aid in more fully diagnosing and taking other steps to reduce one or more of the factors -- probability of

incident attempt, vulnerability or damage. Both the freshness of the memories of September 11th and the empirical reality of this event on the cumulative calculation of security risk will result in heightened attention for a period of time, certainly several years, even in the absence of subsequent events. If significant subsequent terrorist events occur that involve transportation services or infrastructure, then the corresponding values in the above equation will continue to increase the measure of security risk and, most assuredly, the investment in enhancing the security of transportation.

What Does Increased Security Risk Mean?

Within days of the tragedy of the September 11th terrorist incidents, speculation began in the media among security and transportation experts and among the general public regarding the consequences of these incidents on America's mobility. The speculation has run the gamut, from predicting the end of skyscraper construction and the subsequent decline in urban densities, to anticipating or advocating new infrastructure investments such as high-speed rail as alternatives to air travel. In the months since the incident, there has been a flurry of responses including military personnel policing airports, organizations and businesses pulling sensitive information off web sites that could have aided terrorists in planning attacks, and the U.S. Department of Transportation establishing a process whereby all transportation employees will go through a screening and verification process. A multitude of other activities are in various phases of planning and implementation, and a significant effort is appropriately being invested in careful analysis and planning for subsequent steps in the overall plan to improve security. Old reports are being dusted off, new reports are being written, task forces are being formed, and training initiatives are being provided. Early action steps are already being identified and implemented while other actions will require considerable more evaluation before prudent actions can be determined.

The remainder of this paper explores how heightened security concerns will impact the planning, design, implementation and operation of transportation infrastructure and services and how these changes then might influence how long-range transportation planning is carried out -- specifically, how the Arizona Department of Transportation may be impacted and how the impacts of heightened security sensitivity may result in changes in how long-range planning is conducted. Evaluation criteria for project programming are likely to change and costs for various transportation investments may change as a result of different design standards that enable enhanced security. Intelligent Transportation System (ITS) investments may have security roles and incident response rolls that may change how we design and specify these systems. Mode choice behaviors may change influencing the overall demand for various travel options. The era of placing parking lots under elevated freeway sections may end, and the processes of issuing driver licenses and vehicle titles may change as security considerations influence the data collection and screening steps. The goal of this paper is not to identify or prescribe all the actions that will need to be taken, but rather to focus on how the changes that do occur will impact how one might go about doing long-range planning.

The response to terrorism is not restricted to the state departments of transportation. Security issues permeate all levels of government and all aspects of planning and delivery of services and infrastructure. The private sector also is significantly impacted. Security will impacts day-to-day operations, mid-term planning and programming and long-range planning activities.

The following section outlines some thoughts on how security concerns might influence transportation. The intention is to speculate on the full range of possible impacts and to

subsequently sort and classify them in a manner that enables one to systematically explore what this might mean in terms of transportation planning. Subsequent sections explore the implication on the long-range planning process.

The Impacts of Security Concerns on Transportation

The September 11th incident created a financial crisis for the airline industry; government involvement will inevitably change our perception of a mode that heretofore was generally regarded as user supported. Regardless of who pays, the long-term cost of air travel is likely to go up, due to greater security costs, higher risk costs, and perhaps fewer economies of scale. Time costs of air travel may also go up as security clearances slow boarding. And, somewhat unique to air travel, there may be an increase in those who have a mode-choice-altering fear of flying. How do these changes filter into our transportation planning activities? Should mode choice coefficients or the time and money cost estimates of various modes be altered for future planning studies? Has the steeply-sloped curve of growing air travel demand been permanently altered? Can technology and procedures ultimately provide needed security without significant time penalties? Does the willingness of the federal government to make a significant financial contribution to the airline industry render subsequent subsidies to Amtrak or high-speed rail more palatable?

After a decade of preaching multimodalism and modal integration, do we need to rethink those plans for remote airline check-in counters at downtown rail transit stations? Is the convenience of intermodal transfer offset by the security risk of larger concentrations of passengers and the complications of security screening to the highest prevailing standard of the associated modes? Are all modes of public travel inherently more attractive to terrorist attention and hence subject to higher security costs? Some have argued that investment in alternatives such as rail provides a necessary contingency -- do we now justify investments in these alternatives by highly valuing this contingency potential in our resource programming decisions?

Many have noted that transportation's importance to the economy was underscored by the terrorists' actions, and hence, the public may be more willing to increase the investment in our transportation system. Yet, security concerns will increase competition for funds in the near term and may significantly impact the cost of transportation infrastructure and services over time.

Will there be more subtle impacts in personal activity schedules and behaviors that will impact transportation? Some suggest that there is a renewed focus on the family and a tendency to stay closer to home. Others have speculated on a fear of traveling to high profile locations. Among the more subtle impacts, perhaps road rage will be lessened, as Americans draw closer together and become more considerate of others. Within an hour of the first terrorists' actions on September 11th, traveler behavior in response to security threats changed remarkably from passive to active roles in responding to security incidents.

Intelligent transportation system investments are now seen as an important tool in responding to terrorist incidents and their design is taking into consideration the possible role in disaster evacuation. Physical locations of transportation infrastructure are receiving more attention, with parking locations being scrutinized from the perspective of the opportunity parking provides for staging an attack on adjacent facilities. Table 1 outlines the types of security threats that have been contemplated as possibly impacting transportation facilities and

services. This same source cites a 1995 intentional derailing of a train in Arizona as an example of a security incident probably caused "by right-wing extremists or a former railroad employee."

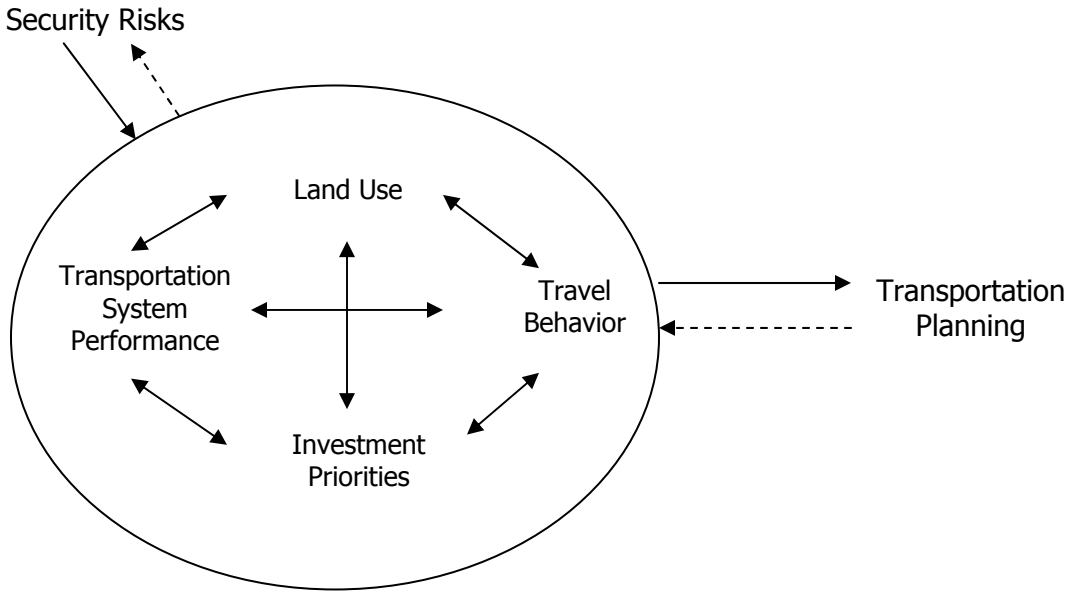
Table 1: Scenarios Considered in the U.S. DOT Vulnerability Assessment

Physical Attacks	
• Car bomb at bridge approach • Series of small explosives on highway bridge • Single small explosive on highway bridge • Single small explosive in highway tunnel • Car bomb in highway tunnel • Series of car bombs on adjacent bridges or tunnels • Bomb(s) detonated at pipeline compressor stations • Bomb detonated at pipeline storage facility • Bomb detonated on pipeline segment • Simultaneous attacks on ports • Terrorist bombing of waterfront pavilion • Container vessel fire at marine terminal • Ramming of railroad bridge by maritime vessel	• Attack on passenger vessel in port • Shooting in rail station • Vehicle bomb adjacent to rail station • Bombing of airport transit station • Bombing of underwater transit tunnel • Bus bombing • Deliberate blocking of highway-rail grade crossing • Terrorist bombing of rail tunnel • Bomb detonated on train in rail station • Vandalism of track structure and signal system • Terrorist bombing of rail bridge • Explosives attack on multiple rail bridges • Explosive in cargo of passenger aircraft
Biological Attacks	
• Biological release in multiple subway stations • Anthrax release from freight ship	• Anthrax release in transit station • Anthrax release on passenger train
Chemical Attacks	
• Sarin release in multiple subway stations	• Physical attack on railcar carrying toxics
Cyber and C3 Attacks	
• Cyber attack on highway traffic control system • Cyber attack on pipeline control system • Attack on port power/telecommunications	• Sabotage of train control system • Tampering with rail signals • Cyber attack on train control center

Source: National Research Council, *Improving Surface Transportation Security, A Research and Development Strategy*, Washington D.C: National Academy Press, 1999; originally in U.S. DOT, *Surface Transportation Vulnerability Assessment*, Final Report, Washington D.C. May, 1998.

It may be useful to explore the implications of security threats on transportation planning by reflecting on a simplistic model. Figure 1 outlines such a model, where security concerns influence land use, travel behavior, public investment priorities, and transportation system performance. In each category, impacts can be long or short range. These changes may create a need to change transportation planning activities. Changes in our planning subsequently feed back to influence these four factors and thus, the level of security risk may be impacted as changes influence the probability of an incident attempt, the vulnerability, or the damage.

Figure 1 Conceptual Model of Impacts of Security Risks on Transportation Planning



Each of the four factors is discussed below with examples of how they may change as a result of security risks.

Land Use -- Individuals have speculated on a variety of land use implications, ranging from an increase in employment dispersion and sprawl to a renewed focus on the importance of the city. Although signature high rises may not be a growth market, there is little reason to anticipate meaningful land use changes in the short term. The fixed nature of land use and capital intensive supporting infrastructure dampens any rapid land use changes even if there were strong pressures to make changes. According to participants in the recent Urban Land Institute's Global Mayors Forum, the September 11th terrorist attacks have sharpened the focus of municipal officials, both nationally and abroad, on the need to sustain urban revitalization efforts and enhance community livability. The participants concurred that although the possibility exists that the attacks could drive some people out of urban areas, the reaction of urban residents so far has resulted in an "overwhelming celebration" of cities. Other planners have postulated that the economic impacts will slow retirement-driven migration patterns as well as growth in tourism intensive economies. Subsequent reports from New York real estate analysts suggest that there will be some dispersion from Lower Manhattan to other locations in the near term. This appears to reflect a variety of factors including security concerns but other factors as well. There does seem to be some reinforcement of the concept of a given firm having multiple locations to enable it to have redundancy in case of disasters.

The complex set of factors that govern location choice will make it difficult to determine the significance of security risks in location decisions and subsequent land use patterns. Discerning security considerations from factors such as the ongoing shift to service and information industries and the influence of improved communications on location choice may favor dispersion of activities regardless of security concerns. If there were to be multiple

future terrorist incidents concentrated in highly urban areas or other specific locations, this could result in land use responses becoming more significant over time.

In Arizona one would not currently anticipate security concerns to induce changes in land use patterns that would influence long-range planning initiatives. Although one might speculate that heightened security concerns may reinforce demographic shifts to lower density smaller areas, there is currently no empirical basis for this expectation. There is no reason to expect that security concerns will impact migration to or from Arizona or the distribution of population within Arizona at this time.

Travel Behavior -- One can speculate on how security risks may impact each of the traditional four elements of travel behavior that transportation planners typically consider: trip generation, trip distribution, mode choice, and route assignment. As in the case of land use location choices, travel behavior is complex behavior influenced by a host of factors. The cumulative experiences and perceptions of travelers will influence travel behavior; thus, the perception of security risk as influenced by security incidents and perceptions of security levels for various travel options will influence individuals' travel decisions.

Travel Behavior:
- *Trip Generation*
- *Trip distribution*
- *Mode Choice*
- *Route Assignment*

Trip Generation -- After September 11th, trip making declined as people chose to forgo certain trips. This behavior was particularly apparent for long distance business and personal trips. There is speculation that a proportion of the general public will remain less willing to fly than they were prior to September 11th. Some may substitute auto or rail travel, but some others will simply forgo the activity. On the business side, there is likely to be some mode shift but also some occasion for other forms of communication to substitute for travel. The September 11th tragedy is likely to enhance the use of evolving telecommunications capabilities and result in some activities being carried out by phone and other electronic communications means. The information we have on changing trip generation is based on the single extraordinary September 11th event and is complicated by the economic consequences of that event and the underlying slowing of the economy. Certain travel demand may be postponed in time while other travel may be a net loss. The empirical data that is currently being gathered suggests that the travel industry is recovering from the consequence of September 11th. It is premature to predict how security risks will impact long-term long-distance trip generation directly. Indirectly, changes in travel costs and other factors as a result of security considerations could also impact trip generation levels. As shown in Figure 2, the share of total person travel that is classified as urban (less than 100 miles from home) is the vast majority of all travel nationwide, approximately 82 percent. Arguably, the fear of security risks has had very modest, if any, direct impacts on overall local trip making beyond the immediate physical area of an incident and the immediate aftermath of an incident. Only with sustained security incidents is it likely that local trip making rates would be measurably impacted.

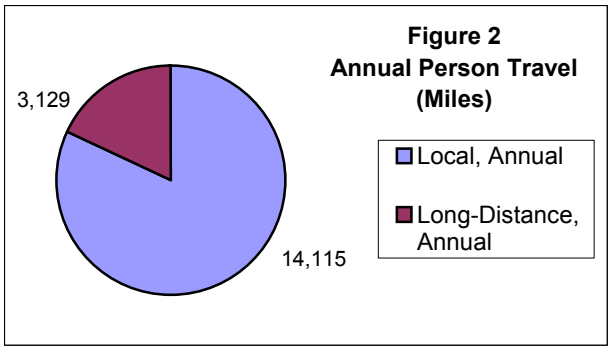
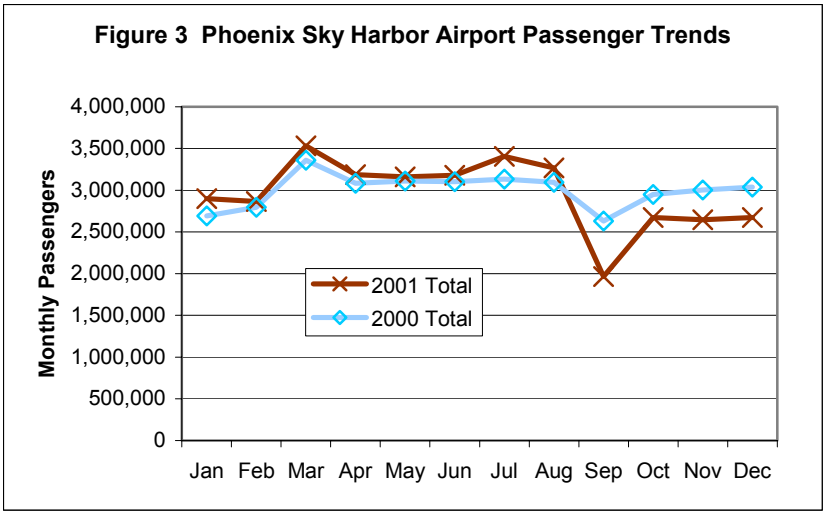


Figure 2
Annual Person Travel (Miles)

Figure 3 indicates travel activity at Phoenix Sky Harbor Airport. As this graphic indicates, air travel levels have recovered from the immediate post September 11th levels. The remaining discrepancy in travel levels from pre-September levels is most probably attributable to a number of factors from security related fears to economic conditions to declining air service frequency to longer travel times through airports as a result of security precautions.



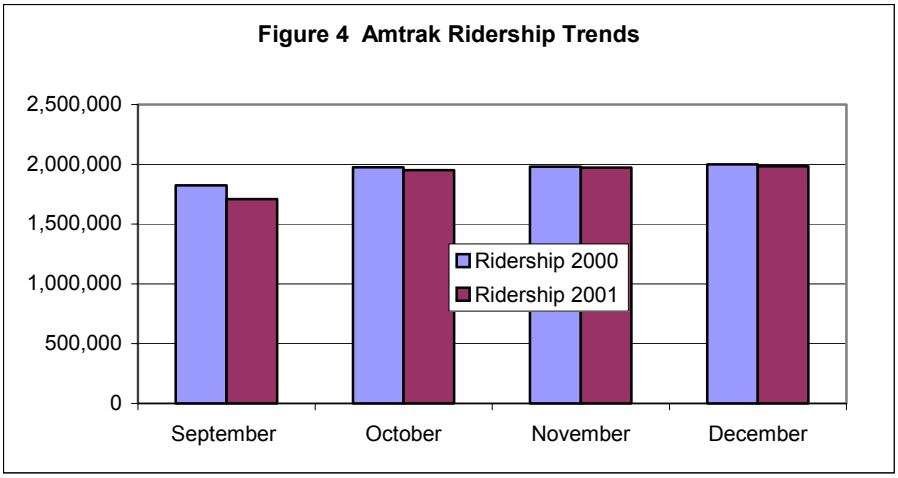
TRIP DISTRIBUTION -- Another possible significant change resulting from September 11th may be altered trip destinations. Individual travel location choices might be modestly altered. As people refocus their priorities, some may value time with family more highly and choose to minimize lengthy commutes to distant job sites. Conversely, others have argued that the push toward decentralized urban areas may result in greater sprawl, meaning longer commute trips for many. Independent of the effects of the slowing economy, work commitments and local urban travel activities are likely to remain unaffected. There may be situations where a high profile location and presumed attractive terrorist target may be avoided by some travelers. For example, following September 11th, there were warnings that the Golden Gate Bridge may be a target of terrorists. This type of attention may result in altered trip destinations with people substituting alternative destinations to avoid certain routes, or trip paths. Other travelers may be more reluctant to use various facilities that are perceived to be at risk or susceptible to significant damage if attacked. For example, some travelers may avoid tunnels and bridges. An example of changes in Trip Distribution includes dramatic falloff in retail sales at downtown Chicago buildings, such as the Sears Tower, when security measures made it more difficult to access interior businesses, such as restaurants and service outlets.

The largest prospect for change in trip distribution again involves those longer distance trips - specifically, trips that might involve air travel. In this regard, both personal and business trips are likely to be affected. Some individuals will choose vacation locations that do not require air travel, and other locations that are perceived as unsafe or prone to security bottlenecks, may be avoided. Travelers have long avoided international hot spots, and, if sustained terrorist activities result in concentrations of incidents in certain locations, then those locations are likely to be avoided. In a more general sense, travelers may seek to avoid crowded or high profile locations or events in fear that these could be targets for terrorists. At a national scale, Arizona does not have travel destinations that are likely to become compelling terrorist targets. Only with a sustained significantly higher frequency of incidents are travelers likely to meaningfully alter trip destinations as a result of the fear of terrorist incidents.

Mode Choice -- Mode choice changes as a result of security concerns are possible due to fears that arise from terrorist incidents or the prospects of them and as an indirect result of changes in the performance of modes due to security induced changes. The most obvious example is the impact on airline travel. Initially fears of flying altered long-distance trip-making mode choices for some people and, over time, change in the time or money cost of air travel may continue to impact air travel choice. To the extent that there is a fear that vehicles such as planes or buses could be hijacked and used in a terrorist incident or that mass mode vehicles or station locations are perceived as attractive targets with crowds of people, these modes may be avoided by some travelers. It would appear that public modes offer the opportunity for terrorists to both remain anonymous and to impact groups of people; thus, one might expect individual vehicles are less likely to be targets of terrorism. Currently there is no empirical or anecdotal evidence to indicate the extent to which mode choice behavior will be altered. There is no evidence to indicate the extent to which travelers removed in time and space would react to a terrorist incident. Would travelers in Phoenix be less likely to use the bus if there had been a bus bombing in New York three days ago, or three months ago, or three years ago? What if the incident were in Mesa or in Phoenix? At this point in time, planners do not know what types of incidents or frequency of incidents would be necessary to change travel behaviors that are reflected in long-range transportation modeling.

As shown in Figure 3, air travel has been disproportionally impacted by the September 11th attack -- however, one can only speculate with limited data regarding how much of this decline in air travel was accommodated by travel on other modes. Amtrak, as shown in Figure 4, was not as seriously impacted, but there is little evidence that much air travel shifted to intercity rail. Some speculate that there was a shift to auto travel. Again, mode choice changes appear to be more apparent for long distance trips. Local travel is predominantly auto travel, and the terrorist incident did nothing to discourage the individual auto mode choice.

Indirect impacts to mode choice are also likely as a result of security risks. Significant and highly visible changes to air travel security and perhaps less visible changes in security precautions for other modes of collective travel could result in mode choice differences. The most obvious impact will be the time and dollar cost of providing the security for travel by public carriers. Currently airport arrival time increases are variously perceived to be in the vicinity of an hour (more than previously required). Intercity bus and rail security also has increased, but service times are not perceived to have been impacted. Air travel security changes are continuing and are expected to evolve over the next several years as strategies and technologies are put in place. A $2.50 per flight segment passenger security surcharge has been introduced for heightened airport security.



Other estimates and strategies could result in a significantly higher per trip increase in the cost of delivering air travel. The magnitude of that cost and how it is passed on to travelers and non-travelers will impact the extent to which security costs influence mode choice for air travel. Time penalties for security enforcement also can influence mode choice as they may impact the comparative attractiveness of air travel versus alternatives. In many locations, an additional hour per air trip for check-in could be enough to encourage the traveler to choose an alternative such as driving or perhaps rail travel in corridors where it is available. The long distance nature of air travel to and from Arizona is such that few time-competitive alternatives to air travel exist; hence, the time costs of security are less likely to influence mode choice significantly.

Security incidents such as evacuations of terminals and cancellations of flights as a result of suspicious circumstances can, over time, result in poorer reliability of air travel and hence a greater reluctance of travelers to use it. However, air travel nationally carries approximately 100 times as many passenger miles as Amtrak; thus, the absence of competitive alternatives will dampen the impact of security concerns on air travel mode share.[1]

Beyond long-distance travel, security considerations may impact local travel as well. Factors that may affect more localized urban travel include changes in security procedures that affect public transit and parking facilities. In several areas of the country, parking facilities have been closed or security enhanced in order to restrict access. The fear that vehicles loaded with explosives could damage adjacent facilities or gatherings have resulted in changes in parking policy and locations in numerous areas. The 1993 World Trade Center bombing and the 1995 Oklahoma Federal Building bombing both involved trucks parked in locations that enabled their explosive contents to cause tremendous damage to the respective facilities.[2] To the extent that security concerns impede access by car or truck to various locations or result in search delays for entering vehicles, travel behavior could be impacted. Greater walk access from parking to the ultimate destination, higher-priced parking as accessible supplies dwindle, or other changes imposed as a result of security concerns could dampen the relative appeal of personal auto travel.

Finally, to the extent that subsequent terrorist activities create a fear of group travel, there is the prospect that public modes of group travel could be impacted. In Israel, repeated terrorist incidents on public buses have reportedly altered the willingness of some individuals to use public transportation. Although the prospects of such perceptions developing in the U.S. are not imminent at this time, they could impact mode choice.

Trip Assignment – Trip assignment refers to the actual decisions on the trip route once the location and mode have been determined. Security concerns may result in some changes in trip assignment behavior. Individuals may choose to avoid routes/facilities that they feel

---

[1] Bureau of Transportation Statistics, *Pocket Guide to Transportation*, Table 9, Page 13.

[2] 1993, Feb. 26, New York City: bomb exploded in basement garage of World Trade Center; killing six and injuring at least 1,040 others. Six Middle Eastern men were later convicted. They claimed to be retaliating against U.S. support for the Israeli government.

1995, April 19, Oklahoma City: car bomb exploded outside federal office building, collapsing walls and floors. 168 persons were killed. Over 220 buildings sustained damage. Timothy McVeigh and Terry Nichols later convicted in the antigovernment plot to avenge the Branch Davidian standoff in Waco, TX.

are higher security risks. Certain stations may be perceived as less secure due to crowds or other factors. Similarly some routes may be perceived as less safe if they traverse areas that may be perceived as more likely to have security risks. For years international travel has been impacted by security concerns where persons would avoid certain airports or locations in their travel due to security concerns. For example, large hub airports may be avoided in favor of secondary hubs or direct flights. Certain bridges or tunnels may be avoided as in the case of individuals choosing to avoid using the Golden Gate bridge.

Transportation System Performance -- Perhaps the most obvious area of impact to transportation emanating from security concerns is the prospect that the performance of the transportation system will be altered as a result of the responses to security risks. These changes in transportation system performance will then impact travel behavior. The nature of the changes in performance covers the range of performance attributes.

How Can Security Impact Transportation System Performance?

- *Cost to User*
- *Speed*
- *Accessibility*
- *Reliability*
- *Safety/Security*
- *Convenience*
- *Connectivity*

For example, near-term impacts of September 11th include the suspension of many airline services, long delays for airport security, security enhancements for rail travel, and minor changes in auto parking. Other changes, all intended to enhance security, may impact the transportation of various products. Of most interest to transportation planning efforts are the long-term impacts.

Security provisions will most probably result in higher user costs for some modes. Air travel costs are likely to increase as a result of airport security costs. The prospects that various modes will have to devote resources to security precautions may divert resources or in essence increase the cost of delivering services. Parking cost may increase if security initiatives and location constraints impact the available space for parking. Additional manpower will be required to provide the enhanced security, and the implementation of various technologies to inspect baggage and screen passengers will increase costs. To the extent that these costs are passed on to travelers, the comparative cost of air travel will increase and travel behavior may change. Other modes may also have higher costs as a result of security. This could include public modes and freight transport modes.

Travel speeds for various modes could also be impacted by security concerns. Specifically, security screening for public modes may impact the total trip time for those modes. In the case of air travel, there has been a significant increase in airport passenger servicing time in the near-term, and there is some prospect that some share of that extra time will be required even when the system fully adapts to new security standards. The high value of travel time for many air travelers will inevitably result in technology and staffing level adjustments to minimize the extra total trip time, however, that may be years in coming. Other travel time delays could be incurred for travel that involves structure parking with security, border crossings, and traveling to sensitive locations that have security restrictions.

Various modes could have changes in accessibility. For example, some parking facilities have closed sections in close proximity to buildings. Truck traffic has been restricted from certain locations and bridge, tunnel, and dam crossing travel may be eliminated or restricted. Access to and by sensitive facilities such as nuclear power plants may be more restricted, and no-fly

zones for such events as the Olympics and the Super Bowl are temporally impacting accessibility for some air travel. Modal reliability could also be impacted in situations where security incidents impact the on-time reliability of travel on various modes. Numerous incidents at airports have resulted in multi-hour shutdowns that have stopped air travel. Inspection delays for other modes may similarly impact travel time reliability. Over time, repeated occurrences will influence public perceptions about reliability and hence the attractiveness of the respective modes.

Safety and security is of concern to travelers, and, to the extent that the public perceives a change in relative security, they may change their travel behavior. This may include such actions as avoiding air travel, avoiding particular stations and terminals that are feared to be targets, avoiding routes with critical links that might be targets (bridges, tunnels etc.), and avoiding group travel. Convenience may be impacted in a number of ways. Enhanced security is certainly an inconvenience, as are luggage limitations and ticketing changes that, for example, require e-ticket receipts to access airport gate areas. Additional inconveniences may be caused by requirements for enhanced personal information sharing as a condition of receiving tickets for some modes. Parking location changes, restrictions on certain vehicles such as vans, and other changes may also inconvenience some travelers. Lack of vehicle access to certain locations or parking will inconvenience some travelers and licensure and vehicle registration requirements may become more burdensome. Security and convenience perceptions may alter some travel behaviors, particularly if they fall differentially across modes.

Finally, system connectivity could be impeded by security risk concerns. Over the past decade, a significant effort within the transportation planning community has focused on intermodalism for both personal and freight travel. The intention of intermodal connections is to enable easy transfer between modes and vehicles to facilitate the most convenient and cost effective use of various technologies for transport of people or freight to various locations. The focus of such planning has been to enable convenient unencumbered transfers. To the extent that security concerns require additional scrutiny of people or freight for various modes, then intermodal initiatives may be impeded by security concerns. For example, several states are considering high-speed rail networks that are being designed to have direct convenient access to airports. To the extent that direct connections require that all rail passenger undergo the same level of security review as airline passengers, then the concept of an integrated system requires the air travel security precautions to be applied to all rail travelers that would have access to the rail-air transfer station. Similarly, precautions for baggage handling would be required to meet the perhaps higher standards of airline baggage scrutiny. Airport security requirements could also impede the convenience envisioned with off-site airport baggage and passenger check in planned for some intermodal terminals. Similar issues could arise on the freight side where convenient intermodal transferring might require the security precautions of the most restrictive mode or product to be more broadly applied to insure security for intermodal connections.

Investment Priorities -- Speculation has centered on whether security risks will have an influence on public attitudes toward transportation investments. Some have suggested that the economic value of transportation is being recognized, and this will aid efforts to increase investment in transportation. Others anticipate a renewed interest in having transportation choices; specifically enhanced funding for rail modes. Still others worry that diversions of dollars to enhance security will detract from capacity improvements. The recent Bush administration proposal for the 2003 budget suggest at the aggregate level, overall national

priorities for enhanced security may put pressure on available transportation resources in the short term. Transportation investment priority changes could result from a number of considerations.

Transportation Resource Pressures Resulting from Security Concerns

- *Diversion of resources to security needs outside of transportation programs*
- *Diversion of funds to operating security enforcement/policing/planning/training*
- *Diversion of funds to capital investments in security (barriers, fencing, inspection, etc.)*
- *Use of funds to support network redundancy/connectivity*
- *Use of funds to support modal choice/redundancy*
- *Diversion of funds to design changes/enhancements to increase security*

Post September 11th, actions suggest a variety of possible investment needs as a result of increased sensitivity to security risks. These needs range from near-term initiatives to conduct strategic planning and assessments to supporting enhanced enforcement levels such as those found at airports, to longer-term needs to alter the physical characteristics of individual transportation investments and the system or network of investments. Changes could range from rerouting roadway alignments from sensitive sites to removing trash containers from rail station platforms. Enhancements to ITS technology as a tool to utilize in incident prevention and incident response have been contemplated, and simple design changes to enable additional vehicle inspection queues at border crossings or luggage and passenger scanning capacity at airports may be necessary. Revisiting the capability of our transportation network to handle special vehicles or military equipment in response to incidents or the exploration of modifications in our roadway network to more easily enable mass exodus from an urban area in response to a crisis are among the more complex and expensive strategies that might be pursued. Other major financial obligations could occur if decisions to change the connectivity or range of modal options in our transportation system were to move forward. Several interests, for example, have proposed major investments in high-speed rail in order to provide an alternative to dependency on air travel for longer distance trips. Additionally, certain travel behavior changes could result in different demands for transportation by various modes than are currently anticipated. This could result in changes in modal priorities, shifting geographic priorities, changes in project costs due to design or other security related changes, or other shifts in long-range transportation facility and service plans.

Having speculated on the possible repercussions of security risks to transportation and having attempted to organize those thoughts in something of a logical structure, the remainder of this paper focuses on more explicit consideration of how long range planning might change to accommodate explicit consideration of security risks.

The Role of Security Risks in Long-Range Transportation Planning

Prior to September 11th,state DOTs thought of security issues as being operational, not planning, issues. Principal responsibility usually rested with law enforcement agencies. State DOT involvement was mostly in a support role in development of emergency response plans. Security issues were not an issue in most state and MPO surface transportation planning processes. Transportation Improvement Programs (TIPs) at the state and MPO levels did not contain allocations for security related issues. Agencies are now faced with determining how security concerns should be integrated into how we plan, design, implement and operate transportation facilities and services. Is security simply another goal for our transportation system that can be integrated into our planning similarly to how we accommodate safety concerns today, or does addressing security require more radical changes including such actions as redefining organizational structures, modifying basic planning processes and developing or refining planning methods, models and tools?

The goal of long-range statewide transportation planning is generally to lay out a long-range vision of the transportation system and its role in the overall economy and quality of life, specifically identifying priorities and goals that will drive subsequent decisions on investments. The long-range plan also often lays out the processes by which these visions are turned into specific implementable projects. Exactly how the long-range transportation planning process might be altered in light of security risks is explored in the context of the security risk definition noted previously.

Table 2 outlines examples of how security risks might be interpreted in terms of the role of a transportation agency and the implications on transportation planning. As noted in the table, the role of transportation agencies in reducing the probability of an incident attempt is relatively modest. Prudent sensitive actions of the agency can reduce the prospects of internal and customer incidents motivated by actions of the agency. There is very limited history of these types of incidents and no basis for assuming significant changes in the future. Prudent administration and appropriate training of employees to deal with potential problems is the best action and this is an operational issue whose impact on long-range planning will be non-existent or at most a modest shift in resources to administration from capital or operating categories.

The second area where transportation agencies may influence the presence of individuals who may be motivated to carryout terrorist actions is in their role as a regulator. Prudent controls on the licensing of individuals and in selected other regulatory areas may also limit the prospect that individuals who may cause terrorist attacks are around or able to do so. This regulatory responsibility could preclude individuals from entering the country or from having the mobility afforded by vehicle licenses. Again, prudent administration and appropriate training of employees to deal with potential problems is the best action. The impact on long-range planning will be non-existent or at most a modest shift in resources to administration from capital or operating categories.

Transportation agencies can play a larger role in influencing the vulnerability of transportation facilities to attack. Strategies can include limiting the information that can help in planning a successful and damaging attack, reducing the prospect for an internal attack, limiting the geographic access to sensitive locations/facilities, or providing security to reduce the prospect that someone could do something harmful in sensitive locations. Only certain aspects of these strategies would have implications on long-range planning efforts.

There could be implications to facility location, facility design, and operations of facilities and services.

The final category of potential involvement of transportation agencies is in the area of reducing the damage associated with an incident. There are two major areas of damage reduction that merit consideration. The first is limiting the personal and physical damage of the incident by limiting the severity of the impact. This might, for instance, include structural design changes to limit the prospect of an explosion causing serious damage. Other responses could include physical and locational design considerations that minimize the amount and nature of incidents. The second general area of damage mitigation refers to minimizing the subsequent personal and economic impact by having evacuation and service restoration strategies in place that can limit losses and restore functioning. Among the most expensive strategies that are being considered as actions to respond to terrorism are actions to increase the redundancy of the transportation system. Alternative modes or network connectivity strategies are primarily a tactic for post-incident restoration of system functioning. These strategies may reduce the impacts from an incident, particularly the economic impacts, however they do not impact the probability of such incidents.

Integrating Security Concerns into Long-Range Planning

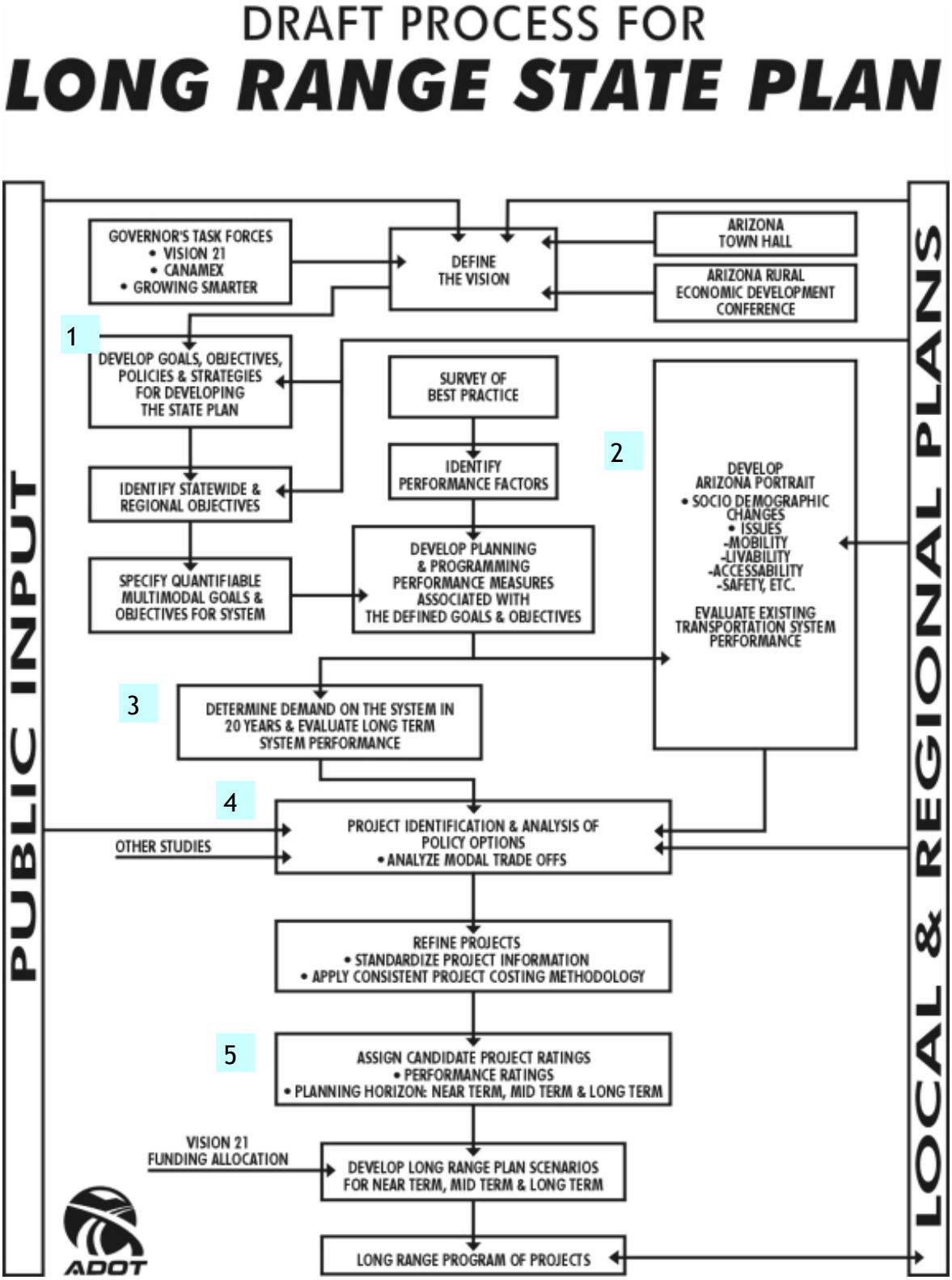
The discussions above address relationships among security risks and transportation agencies and transportation planning. They suggest how security concerns might be interjected into how transportation planning could be adapted to respond to security concerns but do not take the next step of specifically exploring how transportation planning professionals might go about changing what they do and how they do it in order to be more sensitive to security concerns. Are existing planning tools and models altered? Is the process amended to incorporate security? Is security another goal to add to the list along with subsequent objectives and performance measures? Can one simply screen all the jargon in plans and replace the term "safety" with "safety/security", or is there a distinct difference? Do security concerns merit changes in organizational charts, and how do the security responsibilities get spread across the federal, state, regional and local agencies involved in delivering transportation planning? Is security something that gets addressed in the public participation part of planning? How do the financial commitments to security initiatives get evaluated and how are tradeoffs made to reflect security concerns? And, is it premature to draw conclusions about how security impacts long-range planning?

Figure 5 outlines the long range planning process for ADOT. In review of this figure, one can consider how security issues might be reflected in the proposed overall process. For purposes of discussion, five specific boxes in the figure have been identified as representative of classic process steps in long range planning. Each of these is discussed in terms of how security issues might be accommodated.

Table 2 Responsibilities of Transportation Agencies in Influencing Security Risks

Security Risk Component	Possible Role of Transportation Agency	Implications for Transportation Planning
Probability of Incident Attempt Presence of individuals who have the motivation to plan and carryout acts of terrorism.	• Utilize regulatory and oversight capabilities to help identify/capture or exclude entry of possible terrorists (via licensing, border crossing enforcement, routine traffic enforcement, etc.). • Carry out responsibilities in a manner that will minimize the prospect that employees, or affected parties (land owners, contractors, system users etc.) will be motivated to seek revenge through terrorism.	• Enhance transportation agency capabilities in the areas of regulation and enforcement. • Enhance customer interface capabilities of transportation workforce.
Vulnerability Prospect that a transportation target could be successfully terrorized	• Limit the information availability that might influence the choice of transportation as a terrorist target. • Ensure the transportation workforce is screened and monitored to reduce likelihood of internal terrorism. • Limit the access to sensitive targets. • Secure critical elements in transportation system.	• Evaluate Knowledge sharing/dissemination strategies. • Upgrade employee and contractor screening and control capabilities. • Explore physical and operational controls on access to sensitive locations. • Reconsider alignment and service location criteria to include security concerns.
Damage The direct and indirect magnitude of the consequences in personal and economic terms	• Design systems and facilities so as to be resistant to attack. • Have incident response capability to minimize loss of life and restore functioning of transportation system. • Provide redundancies to enable system robustness after an incident.	• Evaluate/modify system and facility design standards. • Consider network robustness in project design and selection. • Support investments to enable rapid incident response.

Figure 5


DRAFT PROCESS FOR
LONG RANGE STATE PLAN
PUBLIC INPUT
LOCAL & REGIONAL PLANS
GOVERNOR'S TASK FORCES
• VISION 21
• CANAMEX
• GROWING SMARTER
DEFINE THE VISION
ARIZONA TOWN HALL
ARIZONA RURAL ECONOMIC DEVELOPMENT CONFERENCE
1
DEVELOP GOALS, OBJECTIVES, POLICIES & STRATEGIES FOR DEVELOPING THE STATE PLAN
SURVEY OF BEST PRACTICE
IDENTIFY PERFORMANCE FACTORS
2
IDENTIFY STATEWIDE & REGIONAL OBJECTIVES
DEVELOP ARIZONA PORTRAIT
• SOCIO DEMOGRAPHIC CHANGES
• ISSUES
-MOBILITY
-LIVABILITY
-ACCESSABILITY
-SAFETY, ETC.
EVALUATE EXISTING TRANSPORTATION SYSTEM PERFORMANCE
SPECIFY QUANTIFIABLE MULTIMODAL GOALS & OBJECTIVES FOR SYSTEM
DEVELOP PLANNING & PROGRAMMING PERFORMANCE MEASURES ASSOCIATED WITH THE DEFINED GOALS & OBJECTIVES
3
DETERMINE DEMAND ON THE SYSTEM IN 20 YEARS & EVALUATE LONG TERM SYSTEM PERFORMANCE
4
OTHER STUDIES
PROJECT IDENTIFICATION & ANALYSIS OF POLICY OPTIONS
• ANALYZE MODAL TRADE OFFS
REFINE PROJECTS
• STANDARDIZE PROJECT INFORMATION
• APPLY CONSISTENT PROJECT COSTING METHODOLOGY
5
ASSIGN CANDIDATE PROJECT RATINGS
• PERFORMANCE RATINGS
• PLANNING HORIZON: NEAR TERM, MID TERM & LONG TERM
VISION 21 FUNDING ALLOCATION
DEVELOP LONG RANGE PLAN SCENARIOS FOR NEAR TERM, MID TERM & LONG TERM
ADOT
LONG RANGE PROGRAM OF PROJECTS

Simplified Planning Process Steps

1. Goal Development
2. Conditions Assessment
3. Needs Assessment
4. Project Identification
5. Project Programming

1. Goal Development – Clearly the reemphasized interest in security merits incorporation as a goal of the transportation system. Security will be a prominent goal for all types of transportation planning and operations just as safety is the single most noted goal for transportation today. With the incorporation of the security goal will come the need to develop specific objectives, criteria and performance measures that reflect security concerns. It may be logical to structure these goals along the lines of the security risk calculation by focusing on minimizing each factor: incident attempts, vulnerability of system, and damage resistance of infrastructure and services. Various other approaches for defining security objectives and performance measures may also be logical in the context of the overall strategy for objective development.

2. Conditions Assessment - Just as planning benefits from a rich understanding of current conditions, so to it will be important to have a data base that can identify the current conditions as it relates to security. This might include enrichments to various databases that would specifically address relevant considerations such as vulnerability. Many of the system inventory data items may have traits appended that address security considerations. Items may include such things as share of facilities that are secured, proximity to sensitive sites, critical links or susceptible structures (tunnels, bridges, etc.). Information on volumes/units of hazardous materials by route may be compiled and the roles of various facilities in evacuation may be compiled. The status of employee and contractor security efforts may be itemized and initiatives to secure transportation information may be itemized. Other summaries of security relative to established security performance standards may also be itemized in the conditions assessment.

3. Needs Assessment - The needs assessment process determines how current trends and forecasts influence the performance of the transportation system for the design year of the plan. In this step of the process the planner would have to forecast future travel behavior and as such would need to incorporate evidence or forecasts of changes in travel behavior as a result of security concerns. If there were evidence of changes in trip generation, mode choice, trip distribution or trip assignment as a result of security concerns, these changes could result in different needs assessment findings than might otherwise be the case. These changes could be direct, for example fears of flying resulting in lower airline travel, or indirect, for example slower and more expensive air travel and thus greater use of alternatives. The needs assessment process requires forecasts of conditions twenty years in the future and hence it is difficult to extrapolate or deduce the impacts from security based on the relatively modest level of information available to date. Obviously, the magnitude of the impacts is very dependent on the prospect of future incidents and the pubic response. Even the consequence of security initiatives is difficult to determine at this point in time as technology and procedure changes will be refined and their consequences in terms of time and cost for various types of travel remain to be seen. Close monitoring of the

consequences of security initiatives is certainly appropriate in order to develop a database on changes in system performance and traveler response. This response is not limited to individual travelers. As or more important is its influence on freight and commercial traffic.

4. Project Identification - The project identification step is the essence of planning in that it uses the knowledge of needs and the knowledge of possible solutions to come up with specific proposed solutions to particular needs. This step involves the creative energies of planners in conceiving specific plans. The design and location of transportation solutions may be affected by security concerns. For example, alignments may be altered to avoid sensitive locations and aspects of the design may be modified to reduce the prospect of or damage from an incident. In the case of statewide planning the actual plan development may be occurring at the local or regional levels and are assembled into statewide plans at the state level. Other projects may be developed specifically to respond to security concerns. These may be initiatives to secure existing facilities, modify designs to minimize damage, or enhance incident response.

5. Project Selection - The final element in traditional planning is the selection of projects to be part of an overall program of actions. In this step, the projects that best respond to the collective goal set are chosen for implementation. The decision-makers will have to find ways to evaluate the relative merits of various project proposals in light of the set of goals. The importance of security in the context of other priorities such as safety and capacity will need to be determined. This resource programming activity forces tradeoffs and implicitly requires judgments or quantification of the value of security investments. At the state level, priorities can be dramatically influenced by federal mandates or requirements. Local public and political pressures may also influence project selections. In the case of security initiatives federal mandates may significantly influence decision-making. It remains to be seen how the general public rates security investments in the context of real tradeoffs between other projects or new revenues.

As the discussion above indicates, security concerns will influence how each of the five traditional steps in long-range planning is carried out. Similarly, security considerations will impact short- and mid-range planning, operations and maintenance activities, research agendas, and regulatory and administrative aspects of the operations of state departments of transportation. A significant share of the influence will be determined by federal guidance and input by enforcement agencies; the magnitude of the response to security concerns is only partially in the hands of state transportation officials.

General Observations on Security Planning

The response of transportation agencies to security concerns will encompass all aspects of agency operations from day to day operations and administration to midterm planning to long-range planning. Security assessments and enhancements for operating facilities will impact current operations the greatest. Beyond the near term the largest influence on long-range planning is likely to be the impact on resource availability. The available resources influence the long-range program of transportation investment and diversions of funds to

support near-term security initiatives may have a significant impact on long-range planning initiatives.

The State of Knowledge and Uncertainty

The memories of the incidents of September 11th are very fresh, yet the country has a very limited history of terrorism incidents that can form a meaningful knowledge base. This knowledge base is being supplemented with international experience and scenario development such as explored in Table 1. Nonetheless, there is far from a consensus on the various tactics and priorities for reducing security risks. Although it is important that energies be invested in understanding the security risks in our transportation systems and responding with prevention and response capabilities where evident, there are other aspects of security preparedness or prevention that have huge implications in terms of resource commitments that may not be prudent based on current knowledge levels. For example, some of the transportation initiatives being proposed are actions intended to provide a contingency transportation capability in response to a transportation terrorism attack. Network redundancy or alternative modes can help do that but these are very high cost options that do not reduce the prospects of an incident or minimize the probability of loss of life, only facilitate a return to normality after an incident. It may be premature to program these extremely expensive responses as other, not yet detailed or identified responses may be more effective and efficient. Terminology like "the war on terrorism" and the freshness of the memories of September 11th encourage a tendency to do everything possible to reduce security risks. Resource constraints, both financial and other, will quickly require a more selective strategy.

In the immediate aftermath of a tragedy there is also a temptation to do things that one is knowledgeable about or able to do. The transportation industry, with knowledge in areas such as disaster response and network design, is tempted to apply existing solutions to these new problems. Although these tools and tactics will have a place in a comprehensive response to terrorism, developing a rich understanding of the role of transportation in terrorism and careful and systematic evaluation of various responses is likely to offer the most rational long-term response. The emotions inherent in dealing with a subject of this type are understandable; however, just as the transportation community has developed measured and data based responses to transportation safety problems, so too is it necessary to develop the information and expertise base that will enable a response to terrorism in appropriate and effective ways. Clearly, this speaks to a need to invest in learning, research, and information collection at this point in time while simultaneously increasing security in areas where it is obviously necessary and possible.

Defining Roles

Perhaps the best parallel to security planning for transportation agencies is the experience in planning for emergency preparedness and incident management. Terrorists' threats and incidents are an example of an emergency of the type that transportation agencies in concert with law enforcement, the private sector, and other agencies have experienced. These types of initiatives require coordination across functional and jurisdictional lines and as such are

communications and process intensive activities. The agencies have very different cultures and perspectives and, thus, resource, turf and ego issues will inevitably evolve. Reiterating the critical shared mission and utilizing the lessons learned in prior collaboration intensive initiatives will be necessary. The diversity of involvement is well exemplified by looking at the diversity of ownership of transportation infrastructure. The roadway system has broad-based ownership and this is compounded by the private sector ownership of vehicles and terminal facilities.

Arizona Roadway Ownership
(Center Lane Miles, 2000)

Under Federal Control	11,926
Bureau of Indian Affairs/Tribal	7,725
US Forest Service	3,065
National Park Service	562
US Fish & Wildlife	557
Other Federal Agencies	17
Under State Control	6,611
Under Local Control	36,657
Counties (15)	19,158
Municipalities	17,499

Source: ADOT CY 2000 HPMS data submittal to FHWA.

September 11th reiterated the importance of coordination and communication among the many different operating agencies in a region and across the nation in response to an incident. Such coordination is needed to allow enforcement/security/safety responses to occur in an expeditious manner, while at the same time still permitting the transportation system to handle the possibly overwhelming public response to the incident. Although coordination and communication are critical to facilitate responses in a crisis mode, coordination and communication in planning for security is important to insure effective and efficient security risk investments. Security responses are also challenging some state officials who are being asked to make major short-term investment commitments that challenge TIP and NEPA approval processes. Cross-agency coordination and communications also will be necessary to insure rule modifications and expedited approvals where necessary.

Priority Setting and Tradeoffs

The security risk equation provides a helpful way to think about how security risk can be minimized. Transportation planners have opportunities to influence each of the factors that contribute to the overall security risk. Careful analysis of how each possible action might influence the overall security risk will be a helpful strategy in insuring that resources are

$$\textit{Security Risk} = \textit{Probability of Incident Attempt} \times \textit{Vulnerability} \times \textit{Damage}$$

directed in the most appropriate direction. Transportation agencies regularly make these types of rather complex and somewhat subjective tradeoffs for safety investments where options include near-term operating costs for enforcement, mid-term opportunities for education initiatives and maintenance activities, as well as longer-term investments in facility and vehicle design. Similar multifaceted tradeoffs will be required to prioritize security

resources both among competing security investments and between security goals and other transportation goals such as safety.

As immediate and near-term efforts focus on operational spending to reduce vulnerability, the most immediate planning challenge will be determining which, if any, significant longer-term capital investments to make to enhance security. Defining how various investments contribute to security such that their contribution can be evaluated and tradeoff decisions made will be the most challenging aspect of post September 11th planning. Expert judgment and multiagency collaboration will be required as agencies throughout the country work to develop experience in security investment evaluation.

Specific Security Issues in Arizona

Although many issues involving security are common across agencies and geography, each state and locality will also have unique conditions that will influence both the security risks that they face and the institutional context in which they do security planning and adapt transportation planning to incorporate security concerns. One element of uniqueness can be the nature of unique or specific threats that an area may face. Some of these items are addressed below.

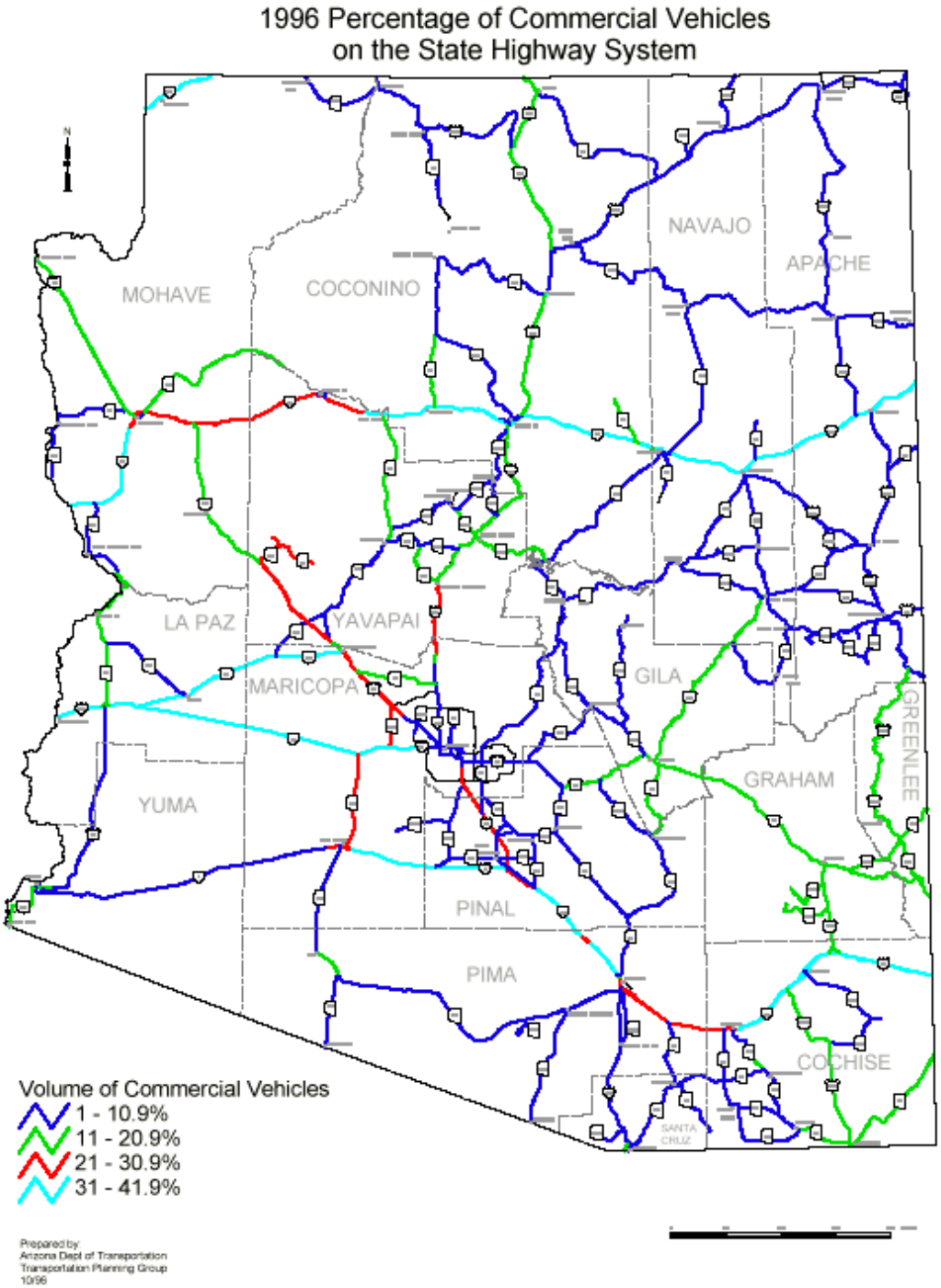
Critical Network Segments and High Profile Targets

One element of transportation security involves identifying areas that would be probable targets based on the prospect that an incident in that location could have a significant impact. Locations where the damage to people or property would be greatest may be high profile target locations that merit consideration for precautions or other initiatives to minimize the impacts of an incident. Several traits might be considered in identifying critical segments. Specific roadway links that are vulnerable or, if damaged, could cause expensive and prolonged disruptions in accessibility are examples of critical network segments. Bridges, tunnels or other critical links such as roadways over the Hoover Dam might be deemed critical links. The circuitry introduced if such a facility were out of service might be a consideration as might cost to repair or replace.

Other critical network segments might be defined based on the presence of alternative mode or path access to specific locations. For example, access to military facilities, nuclear facilities and other critical locations might increase the motivation for redundancy in access opportunities. The prospect of a federal nuclear waste material depository in neighboring Nevada may result in significant volumes of nuclear waste materials crossing through Arizona. This might be perceived as a possible terrorist target.

Finally, critical links might be defined based on the nature of the traffic flow and the opportunities this presents for terrorist opportunities. Routes with hazardous materials, routes with significant commercial traffic or military materials movements might be such routes. Figure 6 shows the shares of commercial traffic on Arizona roads. This might be one factor in evaluating security risks.

Figure 6 Arizona Commercial Vehicle Traffic



Borders

Arizona has an international border and as such is involved in border security. Borders present opportunities to monitor transportation activities and hence provide an opportunity to help insure that illegal materials of the type that might be used in a terrorist incident are precluded from entering the country. Similarly, persons crossing the border can be scrutinized to attempt to exclude illegal entry of persons that might be intent on causing harm.

Conclusions

Although it may be too early to begin changing our long-range infrastructure plans in response to security risks, it is apparent that there will be changes in spending priorities in the near term and most probably over a longer period of time. Over the next several years, security considerations will result in changes in how transportation is planned, designed, implemented and operated. Transportation goals, planning processes, databases, analytical tools, decision-making considerations, and organizational structures will change due to security concerns. Transportation will be on the front line in responding to security risks. The response to security concerns will cross jurisdictional and functional lines and be among the most complex and important challenges to transportation professionals.

It will be important for transportation planners to monitor closely changes in travel behavior and try to fully understand their underlying causes. This will help planners assess the potential for longer-term shifts in behavior as a result of security-induced changes. Similarly, planners should closely monitor the performance of our transportation systems with regard to time and cost factors as well as security, so as to be able to make informed extrapolations of how these system and service changes might be impacting travel behavior. It will be important to take steps to ensure that the September 11th tragedy does not slow our progress toward a true multimodal transportation system. Nor should these events serve to further polarize modal prejudices or be used as an emotional springboard to advocate investments whose merits should be scrutinized with clear thinking. Initiatives should be put in place to monitor how September 11th and subsequent security concerns actually change U.S. travel behavior and transportation needs.

As transportation planners have struggled to find adequate resources to fully fund capacity and safety goals, a major challenge of security concerns will be ensuring that the immediate emergency diversion of time and resources does not hinder the long-term capabilities of transportation planners to respond to transportation needs. Public recognition of the cost of providing enhanced security and public support for additional funding if transportation resources are diverted to security investments may be required to ensure that the price of security is not a rapid decline in the condition and performance of our existing transportation system.

In the meantime, transportation operating agencies will be busy providing near-term responses to security concerns. The transportation planning profession has a significant knowledge base and capability in various areas such as incident response, hazardous materials transportation, and disaster response and recovery that provide a strong springboard for providing enhanced security and incident response. Transportation planning has grown over the past several decades to encompass far more than providing cost-effective, safe transportation capacity. Transportation has embraced a broader goal set including social and

environmental factors. Thus, transportation planners are knowledgeable in integrating additional considerations into the goal set for planning transportation facilities and services. As experts in dealing with travel safety concerns, transportation professionals have an understanding of how complex tradeoffs between short- and long-term and capital and operating/enforcement decisions can be made. The new challenge will be applying the lessons learned in developing these capabilities to incorporating security considerations into the long-range planning process.

References

Badolato, Ed. "Cargo Security: High-Tech Protection, High-Tech Threats." *TR News* 211, November-December 2000. http://www.nas.edu/trb/publications/security/ebadolato.pdf (2002).

Bonner, Robert C. "Speech Before the Center for Strategic and International Studies (CSIS)." Washington, D.C. 17 January 2002. http://www.customs.ustreas.gov/about/speeches/speech0117-02.htm (2002).

Boyd, Annabelle, and Jim Caton. "Securing Intermodal Connections: meeting the Challenges of Rail Aviation Passenger Facilities." Salt Lake City, Utah, 12 September 2001. http://www.nas.edu/trb/publications/security/intermodal_facilities.pdf (2002).

Boyd, Annabelle, and John P. Sullivan. "Emergency Preparedness for Transit Terrorism." *TR News* 208, May-June 2000. http://www.nas.edu/trb/publications/trnews/transit_security.pdf (2002).

Flynn, Stephen E. "Transportation Security: Agenda for the 21st Century." *TR News* 211, November-December 2000. http://www.nas.edu/trb/publications/security/sflynn.pdf (2002).

"Global Intermodal Freight: State of readiness for the 21st Century: Report of a Conference; February 23-26, 2000; Long Beach, California." Transportation Research Board and National Research Council, 2001. http://www.nas.edu/trb/publications/security/cp25.pdf (2002).

Jenkins, Brian Michael. "Protecting Surface Transportation Systems and Patrons from Terrorist Activities Case Studies of Best Security Practices and a Chronology of Attacks." *IISTPS Report 97-4*, December 1997. http://transweb.sjsu.edu/publications/terrorism/Protect.htm (2002).

Jenkins, Brian Michael, and Larry N. Gersten. "Protecting Public Surface Transportation Against Terrorism and Serious Crime: Continuing Research on Best Security Practices." *MTI Report 01-07*, September 2001. http://transweb.sjsu.edu/publications/terrorism_final.htm (2002).

Mehan, Daniel J. "Information Systems Security: The Federal Aviation Administration's Layered Approach." *TR News* 211, November-December 2000. http://www.nas.edu/trb/publications/security/dmehan.pdf (2002).

Meyer, Michael D., "The Role of the Metropolitan Planning Organization (MPO) in Preparing for Security Incidents and Transportation System Response," Draft, January 2002.

Morgan, Daniel F., and H. Norman Abramson. "Improving Surface Transportation Security Through Research and Development." *TR News* 211, November-December 2000. http://www.nas.edu/trb/publications/security/dmorgan.pdf (2002).

National Research Council, *Improving Surface Transportation Security, A Research and Development Strategy*, Washington D.C: National Academy Press, 1999; originally in U.S. DOT, *Surface Transportation Vulnerability Assessment*, Final Report, Washington D.C. May, 1998.

O'Neil, Daniel J. "Statewide Critical Infrastructure Protection: New Mexico's Model." *TR News* 211, November-December 2000. http://www.nas.edu/trb/publications/security/doneil.pdf (2002).

Polzin, Steven E. "Transportation Planning After September 11th, 2001." *The Urban Transportation Monitor*, December 7, 2001.

Special thanks to Steven Lockwood, PB Consult, Michael Meyer, Georgia Tech, and Neil Pederson, Maryland DOT for reference materials.

Trends and Developments Shaping Transportation's Future

TRENDS AND DEVELOPMENTS SHAPING TRANSPORTATION'S FUTURE

Robert L. Olson
Research Director
Institute for Alternative Futures

INTRODUCTION

This white paper reports on trends and emerging developments that are relevant to transportation planning in Arizona. Many of the ideas presented here are future-oriented or are related to larger trends in technology and society, and so may not have previously come to the attention of the state's transportation planners.

Some of the trends and forecasts explored in this paper, such as future developments in intelligent transportation systems, are comparatively certain. It is possible to look at the research and testing underway today to see what is likely to be available tomorrow. Other topics, like the time frame in which global oil production will begin to decline, are inherently more uncertain and controversial. Still other topics, like the proliferation of Segways, a new kind of personal transportation device, are included as part of a deliberate look at "wildcards" – developments that may not be likely, but that would have very large consequences if they should occur. Exploring this whole range of emerging developments can help Arizona's transportation planners work with a broader understanding of the possibilities ahead. Your view of the future and its possibilities influences your actions today, and your actions today shape the future.

The paper explores trends and developments within six broad topic areas or themes:

- **New Ways of Thinking About the Future in Transportation Planning**
  - Understanding the larger context of decisions
  - Clarifying aspirations for the future and setting goals
- **Energy-Related Developments**
  - Rising oil and gasoline prices
  - High fuel efficiency IC vehicles and hybrids
  - Potential evolution toward a hydrogen economy
  - Implications for combined power-transportation infrastructure
  - Implications for auto usage, congestion and air quality
- **Converging Developments Affecting Urbanization Patterns**
  - Examples of unanticipated problems
  - Outlines of an emerging vision
- **Communication-Related Developments**
  - Computer power and network capacity
  - Communication substitutions for travel
  - Communication inducements for travel
  - Intelligent vehicles and transportation systems
- **Demographic and Societal Trends**
  - Population
  - Population and Water
  - Aging and Health
  - Boomer Retirement Lifestyle Preferences
  - Demands for Transparency
- **Wildcards**
  - Near-term oil price increases
  - Rapid rollout of the Segway
  - Near term water shortages limit development
  - A shift from SUVs to Hypercars

THEME 1: NEW WAYS OF THINKING ABOUT THE FUTURE IN TRANSPORTATION PLANNING

The most difficult public policy decisions are those that relate to strategic choices that have long-term impacts on society. Among all the strategic choices that a state like Arizona makes, capital budgeting decisions for transportation arguably have the most far-reaching impacts. They shape the direction and character of urban development and are literally "set in concrete," influencing the future for generations.

Transportation planning has often seemed more sophisticated than other areas of capital budgeting, with decision-making supported by computer-based demand projection models. Unfortunately, much of this apparent sophistication was illusory. A good case can be made that transportation planning was at its worst in decades past when planners were most confident of their quantitative methodologies. Now the problems they face are much more difficult, but the planning itself is improving thanks to less quantitative but more comprehensive ways of thinking about the future.

These more comprehensive ways of thinking about the future, being used in today's most sophisticated planning efforts in both corporations and government, involve: 1) striving to see the larger context of decisions, the driving forces of change, alternative possibilities, and the key uncertainties ahead, and 2) involving relevant stakeholders in clarifying their aspirations for the preferred future and setting goals for creating that future.[i] Both of these trends are already influencing transportation planning and are likely to affect it much more over the generation ahead.

Understanding the Larger Context of Decisions

Transportation planning has always projected trends into the future. What has been missing is not so much a long-range perspective as "peripheral vision" – a sustained effort to understand the larger context of what transportation decisions really affect.

This means, above all, striving to understand the connections between transportation choices and other concerns such as shaping land use and urban development patterns, reducing urban air pollution, avoiding unsustainable long-term costs of infrastructure maintenance, improving access to housing and jobs for lower income people and people living in poverty, minimizing the fragmentation of ecosystems and damage to environmentally sensitive areas, and maintaining or restoring the kind of human scale in the built environment that fosters a sense of local community. It also means looking at all forms of transportation, the intermodal connections between them, and other means of facilitating "access" such as mixed use development and pedestrian mobility.

The challenge is to keep working over time (not just the current planning cycle) to improve understanding of this larger context, to collaborate with people who have other kinds of expertise needed to build this understanding, and to be honest about uncertainties. Techniques like scenario development can be used to construct images of how this larger context could change over time and communicate them to the public and decision makers, highlighting rather than hiding the uncertainties and the alternative theories of how the future could unfold.[ii]

Clarifying Aspirations for the Preferred Future and Setting Goals

Rather than being reactive – responding only to immediate pressures, or extrapolating trends and developing plans to accommodate them – more

sophisticated planning efforts operate from the perspective that the future is something we proactively create. This does not mean that existing trends and circumstances can be ignored and that anything is possible. It does mean that the future is more open to shaping than we often assume, and that we tend to underestimate what is possible, especially over years or decades of effort.

A more proactive approach to planning implies that we need to clarify our aspirations for the preferred future, the kind of future we want to create. There is no way to do this in the transportation field except to open the debates and negotiations that were once held only among a small circle of transportation experts to environmental activists, community leaders, appointed members of metropolitan planning organizations, and the general public, who bring in all kinds of conflicting views. The ISTEA process has helped open transportation planning to these kinds of inputs, but much more needs to be done to foster real dialogue and meaningful collective learning that allows participants to reach greater agreement about the character of the long-term preferred future.

This approach involves a fundamental change from traditional planning. Instead of moving incrementally from the present into the future, it calls for understanding the broad context of change, clarifying aspirations, and then positing a “best feasible” preferred future and working backward toward the present to develop goals, strategies and actions for creating that future.

THEME 2: ENERGY-RELATED DEVELOPMENTS

Transportation is based on energy consuming technologies, primarily technologies that use oil. Cars and light trucks are oil’s main users and its dominant growth market. As a result, changes in the price and availability of oil could have major impacts on transportation. Conversely, improvements in transportation technology can improve energy productivity and reduce the effects

of fossil fuel combustion on human health and the environment. Important changes in oil prices and availability and in transportation technology are likely over the next two decades.

Rising Oil and Gasoline Prices

The price of gasoline was at or near all-time lows during the 1990s. But the surge in energy prices during 2000 and most of 2001 has drawn attention once again to the availability and security of energy resources and the prospects for both supplies and prices.

The most influential work on forecasting the availability of oil was done by petroleum geologist M. King Hubbert at the Shell research lab in Houston.[iii] In 1956, Hubbert calculated that U.S. oil production would follow a logistic curve, peaking in the early 1970s and then declining just as rapidly as it had grown. Most industry experts understandably rejected Hubbert's analysis, despite his highly respected status. It was news no one wanted to hear, and several forecasters had cried "wolf" before and been proved wrong. The controversy over Hubbert's analysis raged until 1970, when U.S. crude production peaked and began to fall, making the U.S. increasingly dependent on imports.

Beginning in 1995, several analysts began to apply Hubbert's methodology to world oil production, producing sobering estimates. The analysis that caused the greatest stir within the global oil industry was done by an organization known for its optimistic outlook, the influential, Paris-based International Energy Agency (IEA), and reported in the IEA's 1998 *World Energy Outlook*. The energy projections contained in previous editions of the World Energy Outlook had a time horizon of 2010. The 1998 edition extended the projection horizon from 2010 until 2020 and applied a Hubbert-type analysis using a generous United States Geological Service estimate of 2300 Bb for the world Ultimate. The analysis projected that non-OPEC conventional oil production will peak in the

early ‘00s and that total world production will peak during the period 2010-2020. This was a startling conclusion at the time and was published only after months of recalculation and internal debate.[iv]

Nearing the top of the so-called “global Hubbert’s peak” does not mean the world is running out of oil. But it does mean that prices will inevitably go up. This price rise is likely to begin during the 00s as non-OPEC production peaks and then declines, giving growing leverage over prices to nations in the Persian Gulf where two-thirds of the world’s petroleum reserves are located. Third World economic development will continue to drive the growth of demand. Once the global production peak is passed, both developed and developing nations will be bidding against each other for the dwindling oil supply, driving prices higher until substitutes are sufficiently developed to reduce oil demand.

High Fuel Efficiency IC Vehicles and Hybrids

Recent transportation projections for OECD regions conclude that, absent major price increases or policy actions, further strong increases in transportation energy demand and CO_2 emissions can be expected out to 2010. After 2010 a stabilization and then eventually a reduction in transportation energy demand is possible as more energy-efficient transportation technologies take an increasing market share.[v] Three transportation modes account for the vast majority of energy consumption: cars, trucks, and aviation. Modal shifts toward more energy-intensive modes for freight, including a projected tripling of air freight volume by 2020, mean that the largest opportunities for reducing oil consumption and CO_2 emissions are through technical improvements in cars and light trucks.

There is considerable room for improvement: new American cars average only 24 mpg, a 20-year low. In Europe, where gasoline prices are higher and smaller cars dominate the market, many models with conventional internal combustion engines get in the vicinity of 40 mpg. Volkswagen has recently begun selling

Europeans a 78-mpg, four-seat non-hybrid subcompact and plans an ultra-light two-seat city car for 2003 that will get 235 mpg (not a typo).

In the U.S., where small cars have a small market, fuel-electric hybrid technology will be the key to reducing oil consumption. The 48 mpg Toyota Prius, the 64-mpg Honda Insight, and the new Honda Civic hybrid are proving highly popular. Ford, Daimler-Chrysler, and General Motors all plan to begin selling Hybrid SUVs in 2003, and all three are already testing mid-sized family sedans in the range of 60 mpg to 80 mpg. Ford's chairman estimates that up to 20 percent of cars on the road by 2010 could be hybrid fuel-electric.

Potential Evolution Toward a Hydrogen Economy

The most important emerging development in road vehicle technology is the dramatic progress underway in the design and manufacturing of fuel cells. Fuel cells convert hydrogen into electricity by an electrochemical process that is highly efficient and totally nonpolluting. They can run on any hydrocarbon fuel, using a reformer to extract the hydrogen. Progress in fuel cell technology is occurring much faster than anticipated a few years ago because automobile manufacturers, under continuing pressure to lower emissions, and anticipating the coming global decline in oil production, have collectively poured over $2 billion into fuel cell research and development. It appears likely, therefore, that fuel-electric hybrids will be a transitional technology on the road to electric drive vehicles powered by fuel cells.

As per current plans, BMW, Daimler-Chrysler, Ford, GM, Toyota and Honda will all introduce fuel cell-powered cars by 2004-2005, but these initial vehicles will still be too expensive to be popular. Meanwhile, fuel cell growth is expected to occur much faster in the distributed power generation market. Every doubling of cumulative production volume is anticipated to make fuel cells 10 to 30 percent cheaper, so they are likely to gain substantial market share in buildings of all

kinds over the decade ahead. As production volume grows, falling prices will make widespread fuel cell use in vehicles affordable. Like other states, Arizona will need to consider steps it could take, such as fleet purchasing and partnerships with businesses, to help accelerate the shift to fuel cells. How fast this shift can occur is not yet fully clear. General Motors has announced the aim of having 10 percent of its new cars fuel cell powered by 2010.

Because of fuel cell progress, the concept of a "hydrogen economy" has recently caught the imagination of many industrial leaders. Top management at Royal Dutch Shell and BP say they are committed to bringing a hydrogen economy into existence. William Ford wants to preside over Ford's complete transition from internal combustion engines to electric drives powered by hydrogen fuel cells. The Bush administration has launched the Freedom Car initiative to support industry's development of fuel cell vehicles and increased the DOE budget for hydrogen and fuel cells. The November 2001 issue of Fortune magazine ran a feature article on "The Coming Hydrogen Economy" – a sure sign that the concept is entering the mainstream.

Not that a hydrogen economy is a sure thing. There are major questions and challenges ahead about the how best to produce hydrogen, how to make it available to consumers, and what pathways of infrastructure investment could take us to a hydrogen economy most quickly, safely and efficiently. Most hydrogen will initially be produced by steam reforming of natural gas, but there are many other options including extracting hydrogen from coal with carbon sequestration and thermal cracking or electrolysis to extract hydrogen from water using nuclear energy. The "holy grail" for many researchers in the field is a solar hydrogen economy based on biological hydrogen production, wind, photovoltaics, and other renewable sources. A major problem of solar electric technologies is their intermittency – they only produce power when the sun is shining. Conversion to hydrogen as a storage medium and energy carrier offers a solution.

Implications for Combined Power-Transportation Infrastructure

Some experts believe that the interaction between fuel cell-based power generation and vehicle markets could be the key to moving toward a hydrogen economy much more quickly than anyone thought possible a few years ago. Here is one example of how it might happen.

As production volume increases and costs come down, fuel cells will become more common in buildings of all kinds, including homes. At least a dozen North American companies are racing to create a new market for residential fuel cells that run on hydrogen extracted from natural gas. General Motors itself has announced plans to bring out a fuel cell power-generation product; Ballard in Canada, which has been heavily supported by Daimler-Chrysler, is working to bring out units for residential use; and Plug Power in Latham, NY has partnered with General Electric and will begin shipping the GE HomeGen 7000 in 2003. It might be possible, therefore, for some people to begin using hydrogen even before a hydrogen refueling infrastructure has been developed by "gassing up" their fuel cell cars at home, getting hydrogen from the natural gas reformers that feed their home fuel cells.

As national standards for connecting micropower technologies to the electric grid come into place, people could also begin to use their fuel cell cars as generators. Each new fuel cell-powered car will in effect be a ~20+kW_e power plant on wheels. The average American car is parked about 96 percent of the time, usually in habitual places. Imagine driving your car to work and leaving it in a parking structure where you plug it in to the electric grid–not to recharge, as battery powered electric cars require, but to serve as a generating asset. While you work, your car is part of the "virtual power plant" feeding electricity back into the grid, and you are being credited for this electricity production at the real-time price, which is highest in the daytime. While you go about your life, your car is busy repaying a significant part of its own purchase price or lease fee by selling

power to the grid. This arrangement would make fuel cell cars a great deal, causing sales to boom and creating the demand that can justify rapid construction of a major hydrogen infrastructure in which hydrogen is produced and delivered in many other ways.[vi]

Implications for Auto Usage, Congestion and Air Quality

The implications of these energy-related developments are difficult to assess. On the one hand, the prospect of rising prices means that over the generation ahead we may come within sight of inflection points in important transportation trends such as rising transportation energy consumption, constant growth in vehicle miles traveled, and the shift toward larger cars, SUVs, and light trucks. If the energy costs of transportation go high enough, they could put economic constraints on low-density development.

On the other hand, hybrid fuel-electric vehicles with high fuel efficiency might blunt the impact of gasoline price increases, allowing VMT to continue rising, and allowing Americans to maintain their love affair with big cars without incurring big costs. Fuel cell powered vehicles may allow us to maintain our high levels of auto use despite a drop in world oil production. Even if higher energy prices drive a shift to smaller "green cars," we may find ourselves suffering through worsening "green traffic jams." What actually happens will depend greatly on the timing of price changes and technology developments. The most disruptive impacts would occur if significant price increases occur before the end of the '00s, before hybrid vehicles have taken a significant market share.

One certainty is that the technical changes we can see coming today will make possible major improvements in air quality. The Toyota Prius hybrid cuts fuel consumption by nearly 50 percent from the similarly sized Corolla, but it cuts emissions by 90 percent. Fuel cells will cut emissions still further. Fuel cells running directly on hydrogen will have no emissions at all accept for water vapor.

By mid-century, one of the transportation-related complaints in Phoenix and Tucson may be that cars are increasing the humidity, worsening the temperature-humidity index.

THEME 3: CONVERGING DEVELOPMENTS AFFECTING URBANIZATION PATTERNS

Since World War II, our nation's urban development has been guided by a dominant vision of how metropolitan areas should grow. It is commonly described as suburbanization, low-density development, or urban sprawl. This urbanization pattern made an attractive way of life available for millions of people. It offered home ownership, modern schools, responsive local government, and an uncrowded environment of clean air and green lawns. It offered unprecedented mobility based on widespread automobile ownership and a rapidly expanding system of interstate highways and urban expressways. There is no question that this post-war development pattern contributed to an unprecedented surge of economic growth that brought the majority of our nation's population into the middle class. It literally became a part of the "American dream."

However, pursuing this development pattern over the past fifty years has given rise to **unanticipated problems**. At first they seemed to be manageable "side effects" of growth, but now they loom as serious threats to our nation's long-term well being. At the same time, **new visions** of how metropolitan areas should grow are emerging.

Examples of Unanticipated Problems

Infrastructure Maintenance Costs – Costs for maintaining the far-flung highway, water, and sewage infrastructure systems needed to support low-density

development are soaring in many parts of the country, making it increasingly difficult to finance new construction. This problem will continue to escalate as the infrastructures age. While infrastructure to support new development on urban fringes is becoming more expensive to build and maintain over the long run, we continue to leave underutilized infrastructure behind and build on the fringe because the short-term costs of doing so are low for both businesses and home buyers. Short-term incentive structures are leading us into a future where our children and grandchildren could face potentially crippling costs.

Congestion – Peak hour traffic congestion is worsening, especially in the suburbs, exacting an economic toll in lost time and worker productivity. Each year, Americans lose 2 billion hours to gridlock, and road jams are responsible for business losses of $40 billion. Longer commutes make it more difficult for people to get to where new jobs are, leading to higher labor costs. Congestion effects economic development by making areas less desirable for potential employees and customers.

Housing – Areas of low-density development provide little low- or even moderate-income housing. As a result, low-income people are often concentrated in the cheapest, most deteriorating housing within urban areas. Often they are without automobiles or adequate transit links to reach the areas where new jobs are being created. This concentration of poverty and isolation from jobs is a major contributor to unemployment, crime, school breakdown and other social problems.

Environment – A recent study within the U.S. Environmental Protection Agency highlighted the problem that current development patterns are fragmenting ecosystems into patches too small and isolated to maintain species diversity. Low-density development is also encroaching on environmentally sensitive areas, eliminating open space and causing a permanent loss of prime agricultural land. Travel in single occupancy vehicles is the greatest contributor to urban air

pollution and the single largest factor in the buildup of greenhouse gases in the atmosphere.

Security – High oil consumption, over half of which is used by automobiles, makes the U.S. vulnerable to cutoffs by foreign suppliers and makes oil imports the biggest item in our foreign trade deficit.

Community – Our society is going through a profound disintegration of local community life. One of the important developments weakening our sense of community is the loss of human scale in the physical environment as development is geared more toward automobiles, roads and parking than toward walkable communities where neighbors can meet and interact.

Outlines of an Emerging Vision

A new vision of how metropolitan areas should grow is emerging. Its outlines are visible in the heavy overlap between emerging movements of thought and policy such as *smart growth*, the *new urbanism*, *transit-oriented development*, *traditional neighborhood development, livable communities*, and *community sustainability*. Ideas being promoted by these movements are becoming increasingly influential, but it is not at all clear whether these ideas provide a workable alternative direction or whether they will become sufficiently accepted and influential to overturn public policies favoring the interests that benefit from current growth patterns.

These overlapping movements of thought all see the examples of unanticipated problems listed above not as separate, individual problems but rather as a "syndrome" of interconnected problems all generated simultaneously by our pursuit of low-density development. In this view, the only way to solve these interconnected problems is to invent new patterns of urban development superior to urban sprawl.

The general character of the new approach being proposed is a deliberate shift away from today's sprawl development pattern toward more compact, clustered, community-centered development patterns. Automobiles would still be the dominant means of transportation for a long period of time as this new development pattern evolved, and would always remain important, but eventually people would become less dependent on them. Expanded transit systems would connect centers of development with each other and with the older urban area. These centers of development would have many features of the traditional neighborhood designs that make older European cities and America's small towns so appealing. Many jobs and stores and a substantial amount of housing would be located within walking distance of transit stops. Neighborhoods would be designed to maximize the ease of pedestrian and bicycle movement. There would be wider choices of housing types, densities, and costs than in conventional suburbs, with affordable housing in relatively close proximity to lower- and middle-income jobs. Public plazas, squares, and greens would be designed to encourage the presence of people throughout the day and evening. Natural features like creeks and streams would be restored where feasible, with the most dramatic features highlighted in public settings. All development clusters would have well-defined centers with public buildings and distinctive architectural features to create a unique "sense of place." Each cluster of communities would have a defined edge such as a wildlife corridor or agricultural greenbelt permanently protected from development.[vii]

Not surprisingly, people with this kind of vision of the preferred future tend to share a harsh critique of much of transportation policy and planning, which they see as a principal driver of the urban sprawl that is the opposite of what they want.

Induced Traffic and Latent Demand – Their basic critique is that building more highways and widening roads to ease traffic congestion always acts to spur more development and induce more traffic. Increasing road capacity makes longer

commutes easier, so people are willing to live farther and farther from their places of work. But as growing numbers of people choose to live further out, the longer commutes grow as congested as the shorter commutes used to be and commuting times grow ever longer. Then additional lanes or highways are added to relieve congestion and the cycle of *induced traffic* repeats itself, with low-density development spreading over more and more of the landscape. If there is always more *latent demand* than can be met, then we will never be able to build our way out of traffic congestion, and the real constraint on driving is always going to be traffic. In this view, a fundamental reconsideration of transportation planning theory is called for that focuses on the broader question of "what do we want our urban areas to be like?" and is open to the radical notion of actually using congestion as a force for limiting automobile trips.[viii]

Automobile Subsidies – A related argument is that people have been willing to sit for longer and longer periods of time in bumper-to-bumper traffic largely because automobile use is to a significant extent what economists call a "free good," and demand always goes through the roof for free goods. Government subsidies for highways and parking alone have been estimated to amount to between 8 and 10 percent of the U.S. GNP. Local government services to motorists and truckers – traffic engineering, traffic control, police traffic patrolling, street repair, and maintenance – are also all free goods. Each year on U.S. roads, 6 million crashes occur; 41,000 people are killed and more than 3 million injured - this at the cost of $150 billion. "Softer" costs such as the health costs of urban air pollution could also be added. Everyone, not just drivers, pays these costs.[ix]

Urban Design – The fundamental question of "what do we want our urban areas to be like?" is the touchstone to which proponents of "smart growth," the "new urbanism" and related movements always return. They believe transportation planning has consistently led us in wrong directions. For example, the architects Andres Duany and Elizabeth Plater-Zybek argue that Norman Bel Geddes, the visionary behind the U.S. Interstate system, was right when he declared in 1939

that “Motorways must not be allowed to infringe upon the city.” Bel Geddes wanted the kind of highway development that has occurred more commonly in Western Europe, where roadside development is not permitted on highways passing through the countryside, and where highways providing access to urban areas must take on the low-speed geometries of avenues and boulevards. In the U.S., the exact opposite has become more common. Highways are typically lined with commercial strips and have often been routed through the centers of cities, splitting downtowns and cutting neighborhoods into pieces. Duany and Plater-Zyberk argue that nearly every aspect of urban design that supports a thriving pedestrian life, safer streets, a strong sense of community, aesthetic beauty, and easy access to nature has been shut out by a preoccupation with engineering criteria for achieving unimpeded flows of traffic.[x]

The emerging vision of a potentially superior pattern of urban development is certainly attractive in some respects, but many questions remain about its social, economic, and political desirability and feasibility. In any case, a change in this direction cannot be quick or easy. Today’s dominant vision of low-density development is deeply embedded in our mindsets, institutional arrangements, policies, regulations, and investments in existing infrastructure.

Nevertheless, if the unanticipated problems reviewed above continue to worsen, and if this emerging vision continues to be refined and to gain adherents, then over the coming generation transportation agencies will go through the greatest change since the post-war development of modern transportation planning.

THEME 4: COMMUNICATION-RELATED DEVELOPMENTS

Computer Power and Network Capacity

Computers and communications are increasingly central to the future of transportation. To use European terms, progress in "telematics" will influence transportation demand and "informatize" all transportation-related technologies. The rate of progress in telematics will therefore emerge as an important factor in transportation planning.

At the level of basic capabilities, progress in information technology is almost certain to continue for over a decade at rates far greater than people expect. Moore's Law, the observation of Intel co-founder Gordon Moore that the processing power of integrated circuit chips doubles roughly every 18 months, is expected to continue for at least a decade until the limits of the optical lithography used in manufacturing chips begin to be approached. Developments in molecular computing or quantum computing might keep Moore's Law going into the foreseeable future, but that is not yet a sure bet. What is sure, however, is that a doubling of processing power every 18 months will take us to barely imaginable levels of computing power within a decade. When chips were evolving from containing 10 transistors to 20 to 40 to 80, and so on, the impacts of doublings were modest. But the most advanced chip designs today contain nearly 10 million transistors. Before the limits of optical lithography are reached it should be possible to put over a billion transistors on a chip.

The rates at which information can be sent over a single strand of optical fiber have increased even faster than Moore's Law. The rate of progress toward both fixed and wireless high capacity broadband networks is limited far more by investment levels and uncertainties about future demand than by technology. It seems reasonable to say, therefore, that there is probably no telematics

application in transportation that will be blocked over the next 20 years by lack of computing or communication capacities.

Communication Substitutions for Travel

Facing frightening forecasts of worsening congestion, transportation planners are understandably interested in the possibility that telecommunication can substitute for travel. Areas where this kind of substitution seems feasible include:

- ✓ Telecommuting, using telecommunications to replace commuting between home and work
- ✓ Online shopping, banking, entertainment, and health services that allow consumers to obtain the services they desire without leaving home
- ✓ Distance learning and other interactive educational services that make formal learning possible from home or work
- ✓ Web portals for obtaining government services and carrying out routine activities like licensing and income tax filing
- ✓ Just-in-time manufacturing systems that avoid wasteful shipping and reduce dependence on large inventories
- ✓ Broadcasting of a wider variety of live events, combined with the spread of wide screen high resolution television, so that more people watch the events from home
- ✓ Dedicated telecommunications applications that expand traveler ridesharing or that save trips by consolidating freight loads

Substitutions such as these clearly have had some effect already and will have more effect in the future, but unfortunately there is no evidence to date that the effect is very significant.

Communication Inducements for Travel

The evidence of the last few decades suggests, to the contrary, that telecommunications and travel grow together, feeding on each other.[xi] Due to latent demand, other travelers quickly take any road space vacated by telecommuters and others utilizing communications instead of travel. At the same time, telecommunications appear to induce travel through a variety of casual routes:[xii]

- ✓ Telecommunication spurs productivity improvements and income growth, and people with more income tend to travel more
- ✓ Improvements in communication expand the number and geographic scope of the business and social relationships in which people engage
- ✓ Telecommunication supports the geographical decentralization of organizational functions and residential settlement, which tends to move trip origins and destinations further apart
- ✓ The use of wireless mobile phones, Palm Pilots, Blackberries and similar devices is reducing reluctance to travel by making travel time more productive
- ✓ Telecommunication is supporting population growth and economic activity in rural communities, causing growth in rural travel
- ✓ Telecommunication is enabling the rise of businesses that specialize in customized vehicle trips, from home pizza delivery and overnight package delivery to temporary employment services

The spread of higher bandwidth, more interactive communications will allow easier and more effective substitutions of communications for travel, but it will also increase all the inducements for travel listed above. As a result, there is no reason to anticipate that telecommunications will have any significant impact on reducing congestion over the generation ahead. However, if an oil crisis should occur, or if a significant rise in energy prices causes major increases in transportation costs, we might be surprised as a society by how much our rapidly evolving telecommunications systems can substitute for travel, when needed.

Intelligent Vehicles and Transportation Systems

At the same time that fuel-electric hybrids and fuel cell vehicles begin coming into the marketplace in large numbers later in this decade, a wide range of **intelligent vehicle technologies** will also be appearing. These two lines of development are likely to synergize, creating a public perception that a new era of high tech is emerging in transportation. Several of the expected developments are listed below. A few of these have already begun to appear as expensive options on Lexus, Mercedes-Benz, and Infiniti models.

- ✓ 42-volt power systems
- ✓ X-by-wire technology replacing all the hydraulic and mechanical systems in the vehicle with electronic sensors and motors
- ✓ Vehicle self-diagnostic systems that analyze the status of the vehicle and communicate results to the driver; more advanced systems will communicate status information to a control center when appropriate, which can analyze the data, predict malfunctions in real time, inform the driver, and schedule the service required
- ✓ Radar-based collision warning systems that gauge the speed and distance of oncoming traffic, alert drivers to danger, and induce braking in emergencies
- ✓ Emergency alert systems that alert the driver when a car drifts from its lane; more advanced systems will track driver's eyelid movements and sound an alarm if a driver is becoming too sleepy to drive safely
- ✓ Vision-enhancement screens on the windshield to reduce glare from the halo effect of approaching lights; more advanced systems will offer fighter-jet-style night-vision-equipped windshields
- ✓ Built-in mobile communications technology for wireless voice and data communication and serving as a basis for other telematic applications
- ✓ Global Positioning System (GPS) technology for navigation, vehicle location in the event of breakdowns or accidents, or locating a stolen vehicle

- ✓ Navigation technology based on GPS and detailed digital map databases
- ✓ Real time traffic congestion information as a value-added component to the digital mapping and navigation service
- ✓ Further into the future, "Intelligent Windshields" will display context-aware information and services, highlighting signs related to the driver's chosen route, highlighting obstacles ahead or pedestrians to watch for, and alerting drivers to points of interest. When parked, the windshield can serve as a kiosk presenting information about its surroundings or upcoming events, or as a movie/video display screen (possible by 2020)
- ✓ Still further in the future, vehicles may continuously talk to each other electronically to provide real-time, fully accurate traffic information
- ✓ This kind of inter-vehicle communication is likely to be the basis for automatic highway systems with computer controlled vehicles running in high-speed, close-spaced platoons – if this vision of the future is ever realized. The paradigm of centralized computer control of vehicles is likely to be replaced by a distributed paradigm that integrates fast computers and high performance networks through novel computer algorithms. This vision of the future may not materialize, however, due to the extraordinary demands it places on vehicle reliability and the potential for massive accident liability.

Most of these emerging capabilities will become available in the marketplace, but there is considerable uncertainty about what features will eventually become "standard" and what consumers will be willing to pay for. Higher accident rates among today's cell phone users highlights a potential problem of drivers being distracted by in-vehicle telematic systems. A growing area of "human factors" research is emerging to study this problem and find ways to avoid it.

Intelligent Transportation Systems (ITS) are a broader set of applications that include intelligent vehicle capabilities but also include a larger infrastructure of diverse technologies for information processing, communications, and control. ITS may become much more important than is currently appreciated, because it appears to be developing in the direction of a "super infrastructure." Existing infrastructures for information, security, banking, medical systems, and other areas are generally stand-alone systems that work independently of each other.

ITS systems are driving toward an integrating infrastructure that will allow these different functions to interact. A “super infrastructure” will make new integrated services possible and cut costs by eliminating duplicated functions, but it could also increase vulnerability.

To see how ITS may spur infrastructure integration, imagine an advanced truck passing through a highway ETC gate 25 years from now.

> *By wireless communication, the toll gate identifies the truck, identifies the bank the trucking firm uses, accesses the bank computer, and draws the toll fee from the appropriate bank account. The toll gate also reports the truck’s location to the company that is waiting for its contents to be delivered, estimating arrival time based on current and projected traffic conditions. It performs a security check to insure that the electronic seals on the truck’s cargo have not been broken. If the truck’s biomonitoring system indicates that the driver has become dangerously sleepy, the toll gate will shunt the driver to a temporary rest area.*

Many ITS applications are already coming into place. Applications likely to be adopted or become more widespread over the generation ahead include the following:

Advanced Traffic Management Systems (ATMS)

- ✓ Traffic signal coordination
- ✓ Freeway ramp meter signals for access management
- ✓ Changeable message signs to warn drivers of upcoming road closures, accidents, and other hazards
- ✓ Congestion detection systems evolving from closed circuit TV to GIS applications to intercommunicating vehicles as traffic probes
- ✓ Route diversion systems

Advanced Traveler Information Systems (ATIS)

- ✓ 511 systems that consolidate and expand phone access to travel information
- ✓ Traveler information via public kiosks, Internet web sites, radio broadcast, cable TV, etc.
- ✓ Dynamic message signs
- ✓ Smart call boxes
- ✓ In-vehicle navigation and information systems
- ✓ Weather information systems

Advanced Public Transportation Systems

- ✓ Electronic payment (VISA/MC/debt cards) of transit fares
- ✓ Automatic vehicle location (AVL) technology to track buses, provide up to the minute information on transit schedule and arrival times, reroute buses to avoid congestion, route paratransit flexibly and efficiently, and improve response time in case of accident
- ✓ Traveler information kiosks with real time information on transit schedules, arrival times, and intermodal connections

Advanced Rural Transportation Systems (ARTS)

- ✓ Hazardous weather warnings
- ✓ Animal warning systems
- ✓ Motorist emergency services including in vehicle Mayday devices
- ✓ Statewide software architectures that integrate operations and maintenance functions with information on road closings, weather, tourism and traffic

Commercial Vehicle Operation (CVO)

- ✓ Commercial vehicle applications of all intelligent vehicle systems
- ✓ Electronic credential checking
- ✓ Weigh-in-motion
- ✓ In vehicle self-inspection systems to assess cargo stability and security
- ✓ Smart inspections, such as performance-based brake testing devices
- ✓ E-seals and other electronic cargo security systems
- ✓ Smart gateways to automate vehicle, driver and cargo identification and clearance at port and terminal gates
- ✓ Smart truckways to optimize truck routing to reduce conflict with passenger traffic and manage truck travel through congested or high-risk areas
- ✓ Onboard office work via wireless Internet access, voice recognition, and other tools
- ✓ Virtual road signs to alert drivers to upcoming hazards, low-clearance bridges, curved ramps, steep downgrades, intersections with limited turning radii, etc.
- ✓ Load matching systems to optimize truck utilization, minimize empty haulbacks
- ✓ Intermodal hazmat management systems to track the flow of hazmat containers and cargo across modes, improve the routing of vehicles carrying hazardous materials, and facilitate rapid emergency response

THEME 5: DEMOGRAPHIC AND SOCIETAL TRENDS

Population

Population growth, population aging, and the growth of minorities are the most important demographic trends in Arizona that need to be considered in

transportation planning. Arizona's population grew by 40% between 1990 and 2000, reaching a total population of over 5 million. The state's population is projected to continue growing rapidly, reaching over 7 million by 2020, 10 million by 2040, and nearly 12 million by mid-century. However the possibility of worsening water scarcity may begin to slow growth during the latter part of this period (see below).

Despite its reputation as a retirement haven, Arizona's current population is actually slightly younger than the national average. But the most rapidly growing age cohort in Arizona is the 85 and over population, which grew by 82 percent over the past decade. The other, much larger, age cohort that grew most rapidly was people aged 45 to 54 (up 80 percent). That larger cohort will become the elderly population in 2020.

Arizona's other most distinctive demographic trait is the growth of minorities. Between 1990 and 2000, the state's Hispanic population increased by 57 percent to over 1 million, accounting for 22.7 percent of the total population. Arizona now has the sixth largest Hispanic population among all the states. American Indians are the state's second largest minority group, with a 1999 estimate of approximately 261,000. Arizona has the third largest number of American Indians among all 50 states, and since 1990 has led the nation in the numerical growth of its Native American population. Asians account for only a little over 2 percent of Arizona's population, but they are the fastest growing minority, up over 75 percent since 1990. Arizona's relatively small Black population grew by over 50 percent to about 175,000. Minorities now compose 36.2 percent of Arizona's total population. If current demographic trends continue, by mid-century Arizona could have a "minority majority."

Population and Water

Settlement patterns depend more than anything else on transportation patterns, but in Arizona and other parts of the West there is a possibility that water will become the ultimate determinant of development as urban areas outrun their water supplies. The limits of water availability are already being reached in smaller Arizona towns like Pine and Strawberry. Throughout rural parts of the state, where it is too costly to build more canals to bring in water from the Colorado River, more and more people are tapping into smaller and smaller supplies of groundwater. Wells are going deeper, and then going dry, forcing people to truck water in.

The state's biggest cities, Phoenix and Tucson, have abundant water supplies thanks to the 2.8 million acre feet of Colorado River water annually allocated to Arizona and transported via the Central Arizona Project. However continuing development is projected to fully tap the Central Arizona Project's water by 2030. Further growth would depend on expensive and speculative undertakings such as desalinizing seawater. After 2030, therefore, water scarcity may emerge as a significant constraint on growth.

Aging and Health

By 2030, more than one in five Arizonan's will be over 65. As the state's population lives longer and the proportion of the population over 65 grows, the number of people who will be limited by chronic conditions and disabilities will also grow. This will place increasing demands on state governments, especially on medical and social services, but also on transportation systems. Losing the independence and mobility that the automobile makes possible is one of the most heart-breaking stages of old age. Flexible and affordable transportation services that can come to people's homes and take them to their destinations will be in growing demand. Unlike younger people who need to travel quickly and on

schedule, older people can often tolerate slower service and more restricted service times. What matters most is simply that they retain the ability to travel.

One of the most important conclusions to emerge strongly from recent research on aging is that healthy lifestyles are more influential than genetic factors in helping older people avoid the physical deterioration traditionally associated with aging. People who maintain a proper weight, eat a healthy diet, remain physically active, do not use tobacco, and practice other healthy behaviors have half the rate of disability of those who do not practice healthy behaviors. Over the decades ahead, a growing proportion of the elderly population is likely to practice *healthy aging*, staying active and mobile longer than has been common in the past.

This healthy aging population will make growing demands for sidewalks and street arrangements that are safe for walking and bicycling. They will continue driving longer and can benefit from conscious efforts to improve the visibility of signage, road edges, and lane separations. "Intelligent vehicle" technologies such as emergency alert systems, collision warning systems, and vision-enhancing windshield screens can do much to help elderly people drive safely.

A simple change that can help avoid fatal collisions involving older drivers is to improve vision screening tests for driver's license renewal. Elderly deaths from car crashes are 12 percent higher in states that do not require vision screening tests, according to a study by Dr. Melvin Shipp, a professor at the University of Alabama's School of Optometry.[xiii] Dr. Shipp studied traffic fatality records from 1989 to 1991 in 48 states. Night vision declines steadily with age, and peripheral vision is reduced, affecting the ability to see other vehicles and pedestrians approaching from the side. State mandated vision tests prompt older drivers to visit their eye doctors to update the prescriptions on their corrective lenses prior to renewing their license. A thorough eye exam can identify the small number of

older drivers whose vision has reached a stage where they are likely to be a hazard to themselves and others.

Boomer Retirement Lifestyle Preferences

The individualistic, idealistic, demanding Baby Boom generation has continually transformed institutions and expectations as this large population group has moved through elementary school, college, birthing and parenthood, and midlife careers. Now the oldest Boomers are beginning to prepare for retirement, and it looks like they will remain true to form, transforming the life stage of retirement. Phyllis Moen, a professor of sociology at Cornell, is conducting the largest study to date of Boomer retirement lifestyle preferences.[xiv] The study's preliminary findings suggest that there is a fundamental shift in how Baby Boomers view retirement. Moen says that "Communities, workplaces and society will have to accommodate to aging Baby Boomers who will move into retirement healthier, better educated and more energetic than any previous generation and who don't want their father's retirement."

About one-third of the Boomers surveyed are planning to keep on working. Others are looking for ways to cut back significantly on work while still continuing, part-time, to do the work they like best. About a third are considering more formal education. Two-thirds consider traveling and volunteering as important. Many view retirement as a chance to do things more in keeping with their ideas and ideals than they were able to do in full time jobs. Moen concludes that, "Many workers of this generation do not view retirement as the end of work but rather as a change in work and lifestyle, a time to do what you like and consider important rather than what you have to do."

The healthy, educated, active Boomer retirees of the generation ahead seem likely to generate many more trips than the more relaxed retirees of the generation just passed. They are less likely to be satisfied living in Sun City-type

environments or suburbs distant from centers of activity. As driving becomes more difficult for many of them, they are likely to become strong advocates for improving transit services. The kind of neighborhoods advocated by proponents of the New Urbanism – traditional neighborhood designs centered on transit stations that connect out to the larger urban area – is likely to be one of the kinds of living arrangements most appealing to aging, empty nest Boomers.

Demands for Transparency

Transportation agencies, like other government operations and business activities, are likely to face growing pressures for greater *transparency* – for operating in an open and accountable manner and providing the public with information it can use to evaluate an organization's performance. Today's headlines are filled with stories that reflect this growing pressure, from Enron and Arthur Anderson to the FBI.

The growing demands for transparency are broad-ranging. The strongest demands are for information related to the bottom line – economic performance. The pressure for greater transparency comes primarily from the marketplace itself. Financial markets can only function well when investors have the information they need to make judgments about who will most productively make use of their capital. The more the economy is in flux due to rapid technological change, globalization and other forces, the more investors need good information. The greatest nightmare for investors is that corporations they are invested in may be hiding losses or covering up activities that if revealed could cause a major drop in stock value.

Demands for transparency are also increasing for the "new bottom lines" of environmental and social responsibility. Home Depot, the world's largest lumber company, recently committed itself to stop purchasing lumber from endangered forests. The decision was largely the result of an e-mail, Internet, and mass

media campaign that involved Internet coordination among hundreds of environmental organizations and grassroots groups around the world. In the late 1990s, when information circulated on the Internet showing that Nike produced some of its athletic shoes under unhealthy and exploitive working conditions, first CNN and then media outlets around the world picked up the story. The company quickly instituted sweeping reforms to protect its brand value from permanent damage.

As the pressure for external transparency grows, organizations will inevitably be pushed to be more transparent internally. Secrecy and distrust within bureaucracies sabotage efforts to motivate and empower employees and have them operate with a common purpose.

Transportation agencies influence the allocation of large amounts of money. They deal with a topic that really matters to citizens. Their decisions have major impacts not just on mobility but on the larger character of urban development. They have close relationships to political leaders and to private sector contractors. All of these conditions will make them increasingly vulnerable to criticism as pressures for greater transparency continue to build in our society. The best protection is to take the initiative internally to operate in an increasingly open and accountable manner.

THEME 6: WILDCARDS

“Wildcards” are developments that are not currently viewed as likely, but that would have very large consequences if they should occur. Several of the potential developments listed below are actually highly likely in the long run, but would be surprising if they occurred in the decade ahead.

Near Term Oil Price Increases

Two potential developments could lead to large energy price increases in the '00s, with highly disruptive effects on transportation. The first is a significant cutback of oil available from the Middle East as a result of war, coordinated efforts to use the "oil weapon" to influence U.S. policy toward Israel, terrorism, or other disruptions. The probability of such developments is impossible to estimate, but it is clearly not zero.

The second development is a sooner-than-expected peaking and decline of global crude production. Several recent analysis have estimated that the peak year for world oil production could be as soon as 2004 to 2008, after which oil availability would begin to decline and prices would rapidly rise. These analyses are controversial, but they have been published in major peer-reviewed sources such as *Nature, Science* and *Scientific American*.[xv] None of our political leaders have paid attention to these forecasts, so there has been no acceleration of the kind of actions that might mitigate the impacts.

A peaking of global production this early would be a truly disruptive wildcard. While energy efficiency and alternative energy sources could allow a smooth transition away from oil over the decades ahead, there is no way they could be brought into place fast enough to deal with a global production decline beginning in the '00s. The result would be rapidly raising oil prices with global economic disarray and particularly severe impacts on mobility and agriculture.

Rapid Rollout of the Segway

During 2001 the media gave a huge advertising boost to the thing called "It" being developed by Dean Kamen, a multimillionaire engineering legend with more than 150 patents. Amazon's Jeff Bezos and other high tech industry leaders invested in It and touted it as a more important development than the

personal computer or the Internet. As the time for revealing what It is grew near, some insiders got more specific and said it was the most revolutionary transportation invention since the automobile.

When It, now called the "Segway," was unveiled at the start of 2002, it turned out to be a two-wheeled personal transportation device about the size of a lawn mower, powered by a battery and stabilized by gyroscopes and 10 computers that keep it balanced. The rider stands on a platform over its single axel and holds on to handlebars that steer the device, leaning forward to accelerate up to 12.5 mph and leaning back to brake.

Segways are not on the market yet, but are being tested by the military, the Postal Service, the Atlanta police force, and General Electric – and winning enthusiastic fans. Most observers see the Segway as a high tech toy that will never have more than a small niche market. Kamen believes it's a wildcard that will happen, revolutionizing urban transportation.

Kamen has already spent nearly a million dollars lobbying legislatures, and 20 states have passed laws approving the use of Segways on public sidewalks. Nineteen other states are scheduled to consider the issue before the end of 2002. The Senate Committee on Environment and Public Works has approved on a voice vote a measure that allows the Segway to be used on all sidewalks and bike paths built with federal funds, as long as local authorities agree.

Segways would be most likely to become popular in states like Arizona where bad weather would seldom inhibit their use. They might be especially popular with aging baby boomers and retirees who could regain youthful mobility through the use of these "Human Transporters" (the other more formal name for the device). It is worthwhile considering what would happen if Segways catch on.

They weigh 69 to 95 pounds, depending on the model, and can carry up to 325 pounds (rider plus cargo). With that much mass, and traveling at 12 mph, some of the collisions that occur on sidewalks are sure to cause serious injuries. As more injuries occur, citizens and consumer groups will increasingly challenge the use of Segways on sidewalks, arguing that if bicycles, motor scooters, and rollerblades are not permitted on sidewalks in many cities, Segways should be banned as well. This might create unprecedented pressures for changes in urban design and transportation engineering toward more construction of bikeways and road lanes reserved for bicycles and Segways. In some areas, widespread Segway use might actually reduce traffic congestion.

Near Term Water Shortages Limit Development

Water issues are nothing new in Arizona, but there are a number of wildcard possibilities that could bring water limits on development into play earlier than expected. Water shortages in adjoining states might lead to renewed water conflicts that unhinge existing allocation agreements. The "death of the Gulf" might emerge as a major political and environmental issue as the lack of fresh water inflow and overfishing devastate the ecology of the Gulf of California. El Nino-driven drought and growing impacts of global warming might reduce water flows in the Colorado.

Developments like these may not be likely, but they are possible. In any case, it may not be too soon to think about what more "water-efficient settlement patterns" may need to be like, and to consider whether current transportation planning is encouraging or discouraging such patterns.

A Shift From SUVs to Hypercars

Americans love their big cars – over half of passenger car sales last year were for gas-guzzling SUVs, minivans, and light trucks. Barring dramatic gas price

increases, it seems highly unlikely that small economy cars will make a comeback. But there is a wildcard possibility that by the end of the decade the new rage will be big cars that get 70-100 miles per gallon. There is no doubt that vehicles like this are possible. They are a wildcard because a wide range of engineering improvements would need to be made by an industry not known for rapid innovation.

In 2000, Hypercar Incorporated, a firm spun off from the Rocky Mountain Institute in Colorado, designed a super-efficient cost-competitive, midsize-SUV concept car able to get the equivalent of 99 mpg. It can drive 330 miles on 7.5 pounds of compressed hydrogen. The car's body is made of ultralight carbon-fiber composite, which can absorb up to five times more crash energy per pound than steel. The body is mounted on a chassis platform that contains fuel cells, hydrogen tanks, the brake system, and a score of computers and auxiliary electronics. Electricity from the fuel cells drives electric motors mounted within all four wheels. Moving at 55 mph, the Hypercar uses no more power than a normal SUV needs just for its air conditioner.

GM's new AUTOnomy fuel cell-electric concept car draws on many of the ideas pioneered by Hypercar. A chassis platform GM's designers refer to as the "skateboard" is made of advanced composite material and houses all the drivetrain essentials and electronics. Bodies of various kinds, from 2-seater sports cars to SUVs, can be mated to the skateboard. The mating is both physical – with mechanical locks – and electronic, with the upper body connecting to the platform much like a laptop docks into a docking station. Like the Hypercar design, the AUTOnomy combines steering, acceleration and braking in a drive-by-wire system with a vertical handle that the driver grips.

AUTOnomy represents GM's vision of how automobiles will be designed and built in 2020, so it would be surprising – but not impossible – to see vehicles like

this on the road in the ‘00s. When they do appear, and reach a competitive price point, they are likely to be extremely popular.

CONCLUSION

There are four quite different lines of thinking that can be used to explore the policy implications the developments reviewed here may have for Arizona.

The first approach, which applies to comparatively likely developments, is to ask “***How do we need to respond?***” For example, it is virtually certain that Arizona’s population will continue to grow older and that older people will drive more than they did in the past. Appropriate responses include measures such as improving the visibility of signage, road edges and lane separations and mandating better vision screening tests for drivers’ license renewal.

A second approach, which applies to areas of greater uncertainty, is to ask “***What are the most ‘robust’ policies or actions that make sense across a variety of future conditions?***” For example, taking full advantage of emerging Advanced Traffic Management Systems and Advanced Public Transportation Systems will be essential if future traffic congestion is on the high side of the range of forecasts. But these actions make sense under almost any foreseeable conditions.

A third approach, which often applies in the areas of greatest controversy, is to ask “***Do we need to seriously question our basic assumptions about this issue?***” This is always difficult to do, impossible for some people who have been involved in a field for a long time. The critique of conventional transportation planning being put forward by smart growth advocates, the New Urbanism and others poses this question in a striking way. For Phoenix, in particular, it may be important to reexamine traditional assumptions and draw on ideas from the

emerging alternative vision of how metropolitan areas should grow and how transportation choices can steer growth into new patterns.

The fourth approach is to focus on the *preferred future* and ask "***What do we <u>want</u> the future to be like and how do we create it?***" And then act to drive change rather than adapt to it. The recent actions of the California legislature to require cuts in the tailpipe emissions of greenhouse gases by cars and light trucks is a dramatic example of this approach, where California is literally challenging the federal government for the lead in setting environmental and transportation policy in the United States. If the California action holds against court challenges, it will accelerate the shifts described here to hybrid fuel-electric and then fuel cell-electric vehicles.

Applying these four questions to the developments reviewed here, as well as other topics, is an excellent methodology for making transportation strategies more creative and responsive. This kind of thinking can be done individually, but often works best in interactive facilitated workshop settings.

Adopting new ways of thinking about the future can help take transportation planning to a higher level where decisions are made with an understanding of their larger context, a wider range of possible futures are examined, and transportation choices are made with greater attention to their role in shaping a desirable future.

---

[i] Institute for Alternative Futures, *Environmental Scanning Methods*, presentation to the seminar on Government Foresight at the Brookings Institution, May 2002.
[ii] Thomas W. Bonnett and Robert L. Olson, "How Scenarios Enrich Public Policy Decisions" in *Learning From the Future*, Liam Fahey and Robert M. Randall, eds. (New York: John Wiley & Sons, 2000), pp. 308-324.
[iii] Kenneth S. Deffeyes, *Hubbert's Peak* (Princeton, NJ: Princeton University Press), 2001.
[iv] International Energy Agency, *World Energy Outlook 1998* (Paris: IEA), 1998.
[v] Michael Landwehr and Celine Marie-Lilliu, *Transportation Projections in OECD Regions – Detailed Report* (Paris: IEA), May 2002.
[vi] Amory B. Lovins, *"A Strategy for the Hydrogen Transition,"* paper for the 10th Annual Meeting of the U.S. Hydrogen Association, Vienna, Virginia, (Snowmass, Colorado: Rocky Mountain Institute), April 1999.

[vii] Mobility for the 21st Century Task Force, *Mobility for the 21st Century: A Blueprint for the Future* (Washington: American Public Transit Association), 1996.
[viii] Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream,* Chapter 5, "The American Transportation Mess" (New York: North Point Press, 2000), pp. 88-93.
[ix] Stanley Hart and Alvin Spivak, *The Elephant in the Bedroom: Automobile Dependence and Denial; Impacts on the Economy and Environment* (Pasadena, Calif.: New Paradigm Books), 1993.
[x] Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, *Suburban Nation*, pp. 62-87.
[xi] John S. Niles, *Beyond Telecommuting: A New Paradigm for the Effect of Telecommunications on Travel* (Berkeley: DOE Lawrence Berkeley Laboratory, 1994).
[xii] *Ibid.*, p. 5.
[xiii] "Older Drivers, Seeing is Believing," news story reported at www.demko.com/m980302.htm
[xiv] Cornell University Newswise, "A Third of Baby Boomers Plan to Work Beyond Retirement" available online at www.newswise.com/articles/2001/10/BOOMWORK.CNS.html
[xv] C. B. Hatfield, "Oil Back on the Global Agenda," *Nature* 387:121 (1977); R. A. Kerr, "The Next Oil Crisis Looms Large—And Perhaps Close," *Science* 282:1128-31 (1998); C. A. Campbell and J. H. Laherrere, "The End of Cheap Oil," *Scientific American*, March 1998, 78-83.

MOVE AZ Long Range Transportation Plan

Appendix C. Public Partnering

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

MoveAZ Plan

Appendix C. Public Partnering

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

August 2004

Table of Contents

1.0 Introduction 1-1
1.1 MoveAZ and Public Partnering 1-1

2.0 Initial Partnering Events 2-1
2.1 Focus Group Summary 2-2
2.2 Regional Public Forums 2-10
2.3 Summary of Surveys 2-31
2.4 Combined Analysis 2-40

3.0 Intermediate Partnering Events 3-1
3.1 Focus Group Summary 3-1
3.2 Regional Solutions Forums 3-8
3.3 Summary of Surveys 3-17
3.4 Forum-Specific Concerns 3-24

4.0 Open Houses 4-1
4.1 Assessment of Open House Comments 4-2
4.2 Open House Reports 4-4

List of Tables

2.1 Attendance at Stakeholder Focus Groups 2-3

2.2 Regional Public Forum Attendance 2-11

2.3 Performance Factors and Long-Range Objectives for MoveAZ Access and Mobility Goal 2-17

2.4 Performance Factors and Long-Range Objectives for MoveAZ Safety Goal 2-18

2.5 Performance Factors and Long-Range Objectives for MoveAZ Environmental Sensitivity Goal 2-20

2.6 Performance Factors and Long-Range Objectives for MoveAZ Stewardship Goal 2-21

2.7 Performance Factors and Long-Range Objectives for MoveAZ Economic Vitality Goal 2-22

2.8 Performance Factor Validation by Regional Forum 2-23

2.9 Attendance and Survey Responses for MoveAZ Regional Public Forums 2-32

3.1 Attendance at Stakeholder Focus Groups 3-2

3.2 Importance of 10 Key Lessons to Native American Focus Group 3-3

3.3 Importance of 10 Key Lessons to Transit Focus Group 3-4

3.4 Importance of 10 Key Lessons to CVO/Economic Development/Aviation Focus Group 3-6

3.5 Regional Solutions Forums Attendance 3-9

3.6 Participant Responses to Key Findings by Forum 3-11

3.7 Primary Project Type by Location 3-14

3.8 Attendance and Survey Responses for MoveAZ Regional Public Forums 3-18

3.9 Survey Statements Regarding Additional Funding 3-19

List of Tables
(continued)

3.10 Survey Statements Regarding Reduced Funding 3-22

3.11 Project and Policy Strategy Recommendations by Forum..... 3-25

4.1 Open House Attendance 4-2

List of Figures

1.1 Connections Between Public Partnering and the MoveAZ Plan 1-2

2.1 Regional Public Forum Locations 2-10

2.2 Location of Participants' Best Transportation Experience by Mode 2-13

2.3 Distribution of Participant Concerns Across All Forums 2-25

2.4 Distribution of Participant Concerns About Transportation Options 2-27

2.5 Distribution of Participant Concerns About Stewardship 2-28

2.6 Distribution of Participants' Best Liked Aspects of the Transportation System 2-30

2.7 Responses to the Statement: "Overall, I Feel Safe Driving on the Highway System in this Region" 2-33

2.8 Responses to the Statement: "Rail and Vehicular Traffic Co-Exist in this Region and Do Not Pose a Major Safety Issue" 2-34

2.9 Percent of Respondents Agreeing to the Survey Statements Regarding Transit 2-35

2.10 Responses to the Statement: "Pedestrian and Bicycle Facilities Should Be Priorities on State Highways" 2-36

2.11 Responses to the Statement: "Rural Highways Are Well Connected to Major Transportation Systems" 2-37

2.12 Average Forum Responses to the Statement: "The Long-Range Plan Should Be Designed to Direct Growth to Appropriate Areas and Promote Smart Growth" 2-38

2.13 Responses to the Statement: "I Would Rather Have More Roads Than Have Part of the Budget Go to Landscaping and Aesthetics" 2-38

2.14 Responses to the Statement: "Truck and Freight Rail Movements Are a Major Environmental Issue in this Region" 2-39

List of Figures
(continued)

2.15 Responses to the Statement: "The Overall Maintenance of State Roadways in this Region Is Good" 2-40

2.16 Major Concerns by Forum Location 2-41

3.1 Regional Solutions Forums, Spring 2003 3-9

3.2 Assessment of Key Findings 3-10

3.3 Strategic Recommendations by Performance Factor 3-12

3.4 Projects Related to Performance Factors 3-13

3.5 Survey Responses to Additional Funding Questions 3-19

3.6 Average of Support for Four Transit Questions (Q1 to Q4) 3-20

3.7 Support for Highway Questions by Forum (Q5, Q7) 3-21

3.8 Survey Responses to Reduced Funding Questions 3-22

3.9 Acceptance to Changes in Mobility and Reliability 3-24

4.1 Open Houses, Spring 2004 4-1

4.2 Primary Subject of Comments Received at MoveAZ Open Houses 4-3

1.0 Introduction

1.0 Introduction

This report summarizes information gathered during the public partnering events held to support the Arizona Long-Range Transportation Plan (MoveAZ). This section introduces the MoveAZ public partnering process and describes its relationship to the MoveAZ plan. The following three sections review the information gathered during each of the three phases of public partnering and relate that information to the development of the draft and final MoveAZ plan.

1.1 MoveAZ and Public Partnering

The public partnering process is the second phase of a three-phase process to develop the MoveAZ plan. The three phases of the plan development were:

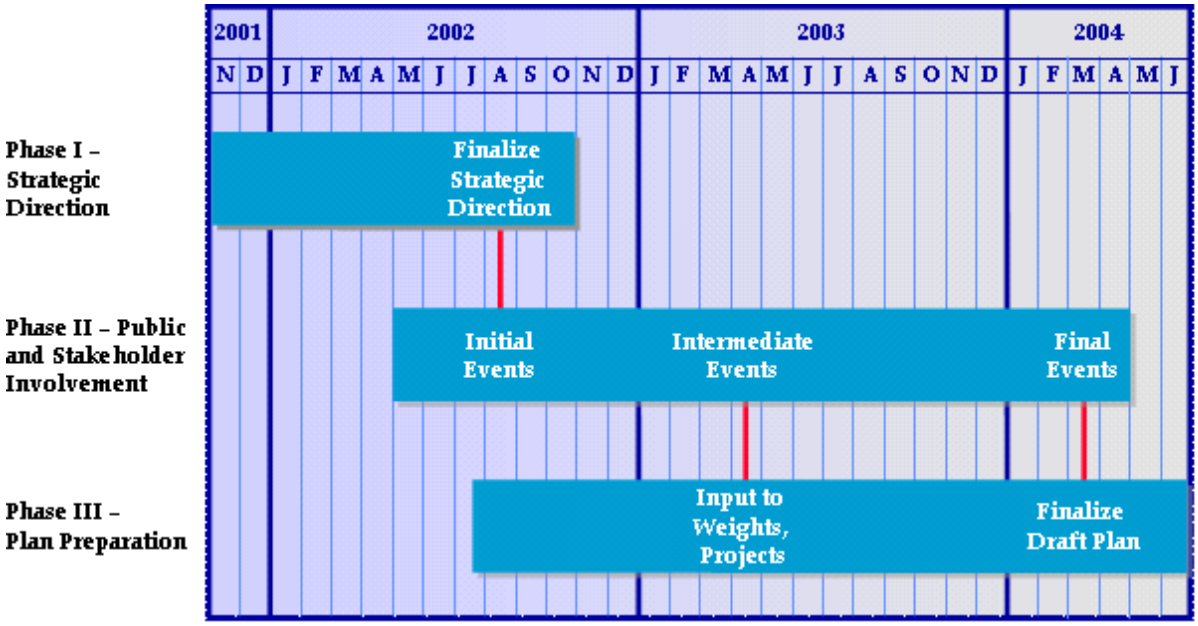
- **Phase I – Development of a Strategic Direction** identified a strategic direction for state transportation goals and objectives. This was accomplished through review and evaluation of existing documents, previous planning processes, Arizona-specific plans and processes, and similar experiences from other states. From these sources, recurrent themes and issues were identified and used to guide the development of the mission statement and strategic direction for transportation in Arizona.

- **Phase II – Public and Stakeholder Involvement** included a series of public partnering events designed to address key findings and decision points in Phase I and Phase III. The specific public partnering events and their relationship to work on Phases I and III are described below.

- **Phase III – Develop Long-Range Plan** involved technical analysis and production of the draft and final MoveAZ plan. This phase is concurrent with Phase II (public involvement), and both informed the public involvement process and developed the MoveAZ plan.

The public partnering process included three rounds of public events – initial, intermediate, and final – that relate to the completion of specific technical tasks (Figure 1.1).

Figure 1.1 Connections Between Public Partnering and the MoveAZ Plan



The *initial partnering phase* of the public partnering process provided opportunities for the public to confirm or refine the strategic direction and to help prioritize the long-range goals and objectives developed during Phase I. In addition, the initial partnering phase was implemented to develop an understanding of the transportation issues facing Arizona, and gather concerns and suggestions from stakeholders regarding the State's long-range transportation plan. Section 2.0 reviews the events of the initial partnering phase.

The *intermediate partnering phase* was used to evaluate the acceptability of policies and strategies developed in response to issues, concerns, and ideas expressed during the initial partnering phase and as a result of the analysis conducted for the plan. This intermediate phase provided additional public input and built a level of confidence to move forward in the development of the draft plan. Section 3.0 reviews the events of the intermediate partnering phase.

The *final partnering phase* of the public involvement process presented the draft plan to stakeholders and the public, solicited final comments on the draft plan, and encouraged involvement in the plan's implementation. Section 4.0 reviews the final partnering phase.

In addition to these three phases, the MoveAZ plan included ongoing communications through newsletters, a web site (www.MoveAZ.org), and a mailing list. The web site was regularly updated throughout the development of the plan and all documents produced for the plan are available online.

2.0 Initial Partnering Events

2.0 Initial Partnering Events

The *initial partnering phase* of public involvement was implemented to develop an understanding of the transportation issues facing the State and gather concerns and suggestions from Arizona citizens and stakeholders regarding the State's long-range transportation plan. The *initial partnering phase captured*:

1. Regional perspectives of the issues facing the State through regional public forums; and
2. Stakeholders' perspectives regarding the Arizona transportation system through stakeholder focus groups.

The outcome of the *initial partnering phase* was the identification of consistencies and discrepancies between public opinion and the goals and objectives determined during the development of the strategic direction (Phase I of the MoveAZ plan). The initial public partnering events also provided ADOT with an opportunity to interact with the public early in the planning process.

The stakeholder focus groups and regional public forums implemented in this initial phase helped shape the direction and priorities of the MoveAZ Plan. The material collected helped demonstrate that the long-range goals and objectives provide a thorough description of the major issues that Arizonans would like ADOT to address. The public input gathered here also suggested relative priorities of each of the long-range goals. The priorities of Arizonans, as demonstrated through this phase of public involvement, were reviewed by ADOT and the Arizona Transportation Board for incorporation into the planning process.

This section of the report presents a detailed review of the information collected from these initial events, including stakeholder focus groups and regional public forums. It summarizes the common themes and issues raised by participants, and provides an analysis of the connection between these key themes and the review of plans completed for the MoveAZ strategic direction.

2.1 Focus Group Summary

The Arizona Department of Transportation (ADOT) conducted Stakeholder Focus Groups to capture the particular interests of various users of the transportation system. In total, nine meetings were conducted with the following special interest groups:

- Aviation;
- Transit providers and users;
- Bike and pedestrian interests;
- Commercial vehicle operators, railroads, and distribution firms;
- Environmental concerns (state and national parks and forest service, air quality planners);
- Economic development interests (economic development organizations, industry associations, chambers of commerce);
- Health and human services providers;
- Native American communities; and
- Pipelines and utilities.

Each Stakeholder Focus Group included a presentation of the research and findings to date and a facilitated discussion of issues relevant to the stakeholders' perspective. Participants were encouraged to provide feedback and comments during the facilitated discussions.

The nine Stakeholder Focus Groups included between nine and 20 participants (Table 2.1), and were held in Phoenix in late September and early October 2002. This section summarizes the comments, concerns, and issues identified by participants in each focus group.

Table 2.1 Attendance at Stakeholder Focus Groups

Focus Group	Attendance
Aviation	11
Transit	20
Bike and pedestrian	13
Commercial vehicle operators	11
Environmental	9
Economic development	11
Health and human services	10
Native American	8
Utilities	10

Utilities

Ten individuals representing utility companies participated in the Utilities focus group on September 25, 2002. During the group discussion, participants raised the following key issues:

- **Coordination –** ADOT needs to improve its working relationship with utility companies, including coordinating utility input in long-range planning and creating consistent policies for shared use of facilities (e.g., bridges).

- **Permitting –** The permitting process needs to be streamlined and made consistent. Some corridors are in two districts (e.g., Grand Avenue) and the process or outcome can be totally different.

- **Right-of-way access –** Utility companies have numerous problems acquiring and accessing adequate right of way to accommodate their infrastructure. Residents generally prefer utility lines to run in the highway corridor, instead of neighborhoods; but all utility companies have had substantial difficulty working with ADOT on right-of-way issues.

- **Relocation compensation –** Relocation without compensation is a major concern. Many transportation projects include funding for utility relocation, but the utility companies claim that they never see this funding.

Participants would like to see more coordination between ADOT and the utility companies on utility location and right-of-way preservation. The utility companies want to work

with ADOT to find the most efficient and cost effective ways to install and maintain utility infrastructure. Early access to the planning process when ADOT is redesigning existing facilities or building new ones will enable them to make location decisions that save money.

Aviation Focus Group

Eleven individuals representing airports and air transportation users participated in the Aviation focus group on September 25, 2002. They had several ideas about how best to include air transportation issues in long-range transportation planning in Arizona. Some of the key suggestions from this focus group included:

- **The role of aviation in planning –** Focus group participants want ADOT to be more active in aviation planning, believing that ADOT's current role is primarily to match Federal grants. They wanted ADOT to look at aviation as part of the overall comprehensive state transportation network.

- **Economic opportunities –** Rapid growth in air freight has increased economic opportunities for Arizona. Participants argued that near saturation in the California air cargo market may create numerous opportunities for Arizona. To take advantage, participants would like ADOT to invest more in highway and rail connections to intermodal facilities, including airports that serve cargo operations. More generally, airports bring in over $1 billion per year in economic benefit, and participants felt that ADOT should work to make state agencies, the legislature, and the general public aware of these benefits.

- **Funding –** Participants complained that the aviation fund has been raided by the legislature. This funding comes from airport usage and was designed to help improve aviation statewide. ADOT could serve as an advocate for getting this funding back.

- **Cost of travel –** Participants noted the high cost of passenger service from smaller communities to Phoenix and other major airports, but did not suggest that these services be provided by the public sector.

- **Operations –** Growth has encroached or is encroaching on many of Arizona's airports, hampering their operations and creating major environmental issues. Consistent statewide development and buffering standards would protect these assets.

The aviation industry understands that ADOT has a limited role to play in aviation due to Federal Aviation Administration (FAA) regulations and other factors. The industry would like ADOT to advocate for their needs, including helping to protect the aviation fund. They would also like ADOT to actively pursue opportunities to enhance air freight by improving highway and rail connections to airports.

Economic Development Focus Group

Eleven individuals representing economic development associations and chambers of commerce participated in the Economic Development focus group on September 26, 2002. During the group discussion, participants raised the following key issues:

- **Connectivity –** Participants argued that many of Arizona's communities lack sufficient access to the state highway network. Poor north-south connections are a detriment to the economic development of towns that are long distances from major interstate highways (e.g., Lake Havasu City, Parker, Globe, Show Low).

- **Proactive planning –** Arizona must be proactive in identifying economic needs where transportation facilities can play an important role. ADOT needs to be flexible with funding in order to quickly respond to economic opportunities and projects. Economic development agencies would like the MoveAZ Plan to follow an aggressive approach to economic growth throughout the State.

- **Access to jobs –** Several participants indicated that the current transportation system did not allow efficient access to jobs. This is viewed as a possible deterrent to new businesses.

- **Safety –** Accidents cause economic hardship by blocking roadways for extended periods. The lack of redundancy in the State transportation system leads to major delays for shippers, as well as passengers.

- **Goods movement –** Increasing congestion in surrounding states provides Arizona with economic opportunities and potential problems. Congestion at California airports, for example, can increase the opportunities for freight air businesses in Arizona, but will also increase congestion on major highways and local roads. The CANAMEX transportation corridor could also bring substantial freight traffic to Arizona, increasing business opportunities, but worsening traffic.

Economic development agencies would like to have a stronger link between transportation planning and economic development. ADOT should plan transportation improvements that support an economic development vision for the State, rather than responding to development after it occurs.

Native American Focus Group

Eight individuals representing Native American tribes and interests participated in the Native American focus group on September 20, 2002. The issues identified during this focus group are described below.

- **Safety –** Participants raised a number of safety concerns, including at-grade railroad crossings; the mix of uses on roadways (e.g., logging trucks, tourists, and school buses); roadway conditions; livestock and wildlife; roadway amenities (lighting,

walkways, and bus pullouts); and environmental hazards (flooding, snow removal). Participants believed that tribal governments do not always share accident data with ADOT, understating the number of accidents on their lands.

- **Coordination –** Native American communities are very concerned about their relationship with other government agencies. Tribes have sovereign nation status, and the State of Arizona should recognize and support this through their policies and programs. Currently, tribes are not treated neither as a separate nation, nor do they have the same status as counties, councils of governments, or cities/towns. Most of their funding for transportation (and other needs) is only available through Bureau of Indian Affairs programs, and they believe that ADOT is not proactive in its attempts to secure that funding.

- **Hazardous materials –** The transportation of hazardous materials through tribal lands is a growing concern. Responsibility for dealing with accidents and hazardous spills on tribal lands is unclear.

- **Maintenance –** Participants raised concerns about the lack of snow plowing in winter months, mowing, and weed control. These maintenance activities often stop at the reservation boundary.

- **Economic development –** Several participants were concerned that the condition of roadways through tribal lands hinders economic development for many tribes. They perceive that state roads through their lands are lower quality than other state roads, making it difficult for them to attract businesses and tourists.

Participants would like ADOT and other state agencies to recognize that tribes have sovereign nation status and should be recognized as such in all policies and programs. A "government-to-government" protocol should be established in policy and carried out by all agencies, including ADOT.

Bicycle and Pedestrian Transportation Focus Group

Thirteen individuals representing bicycle and pedestrian users and advocacy groups participated in the Bicycle and Pedestrian focus group on September 25, 2002, and expressed the following concerns:

- **Multimodal plan –** Participants felt strongly that ADOT should develop a multimodal transportation plan that treats transit, bicycle, and pedestrian travel on an equal level with automobile travel. Historically, the majority of funding has gone for roadway improvements with bicycle and pedestrian projects as an afterthought. ADOT should also play an advocacy role in attracting funding for modal alternatives.

- **Connectivity –** Participants wanted ADOT to play a stronger role in ensuring that bicycle and pedestrian plans of various communities link and work together. State routes are often an important piece of the overall bicycle network, and the State needs

to ensure that they are able to be used by bicycles and pedestrians. State highways often times become a barrier to connectivity.

- **Coordination –** Participants would like ADOT to work more closely with local and regional agencies to coordinate bicycle and pedestrian planning. They were pleased that ADOT was updating its bicycle and pedestrian plan and would like this coordination to continue in the future.

- **Standards –** Participants argued that there should be state standards for sidewalks, bicycle lanes, rumble strips, and roadway shoulders. These standards would enable more consistent planning of facilities for bicycles and pedestrians.

Participants claimed that cities throughout Arizona are already attempting to create livable, walkable cities and multimodal local and regional systems. They would like ADOT to support these efforts by providing connections between local systems on state highways and providing funding transit and bicycle projects. ADOT should become the leader in creating a state multimodal transportation system. A true multimodal system would allow people transportation choices and a convenient way to get from one place to another. Alternative choices would reduce the burden on the automobile system, helping it to operate more effectively.

Transit Focus Group

Twenty individuals representing transit providers and users participated in the Transit focus group on October 7, 2002. Several transit issues were identified, including:

- **Multimodal –** Participants would like to see a shift in philosophy from purely highways to a multimodal system that offers transportation options. This includes providing direct additional funding for transit, as well as allowing more flexibility with existing (5310 and 5311) funding. Participants claimed that Arizona is one of only five states that does not directly fund transit.

- **Land use coordination –** Participants were especially concerned about the lack of coordinated land use and transportation planning in Arizona. Businesses currently are allowed to locate with few restrictions, creating a haphazard pattern of land uses that make it very difficult for transit to succeed.

- **Advocacy –** ADOT could play a much larger role in advocating and coordinating transit. Providing some funding, preserving right of way, and attempting to change Arizona's reliance on highways would benefit Arizona in the future.

- **Increase awareness –** Arizonans need to be made aware of the opportunities to use transit. Arizona has a growing population of seniors, disabled, poor, and young people with no alternative other than limited transit services. Making Arizonans aware of the benefits of transit will help the State long term.

Transit agencies and users would like there to be a closer link between transit service development and land use planning. ADOT should encourage this type of planning, including using performance indicators that promote this linkage. Participants also felt that transit can help stimulate economic development. However, the investment in transit may not provide a return until some time in the future, and this must be taken into consideration when measuring performance.

Health and Human Services Focus Group

Ten individuals representing health departments, senior concerns, public safety, and related interests participated in the Health and Human Services focus group on September 25, 2002. During the group discussion, participants raised the following key issues:

- **Incident management –** Mass evacuation and the transportation of medical supplies are concerns. Increased congestion in urban areas creates difficulties accessing accidents. Participants want roadways to be designed with adequate buffer zones or shoulders (even landscaped buffers) that emergency medical vehicles can use to reach an accident site.

- **Transportation options –** There is a growing need for demand-responsive transportation service to get people to medical appointments, shopping, and work, but little funding to support alternative transportation.

- **Safety hazards –** Several participants were concerned about the unintended consequences of roadway design. One major example is the "soft centers" on I-10 between Phoenix and Tucson that are claimed to contribute to numerous single vehicle rollovers.

- **Funding –** This is a critical problem facing all health and human service organizations. Agencies like the Department of Public Safety (DPS) have not been able to grow at the rate of population growth. The elimination of local transportation assistance funds (LTAF) has negatively impacted social service agencies.

Participants thought that ADOT could do more to ensure that alternate transportation services were available for disadvantaged populations. They also thought that access to jobs was a major problem for economically depressed areas.

Environmental Concerns Focus Group

Nine individuals representing state parks, national parks and forests, and air quality planners participated in the Environmental Concerns focus group on September 26, 2002. Participants of this group identified the following issues:

- **Access and tourism –** Providing access to recreational facilities, parks, and forests is critical for quality of life and tourism to the State. At the same time, access to sensitive natural areas raises substantial concerns and the need to mitigate impacts of

transportation. Context sensitive design and growth controls will help protect resources.

- **Balance environmental concerns –** Participants would like to see a balance between transportation needs and environmental concerns. Mobility should not always take the highest priority when designing roadways. Especially in sensitive areas, the State should design protections for wildlife and consider mitigations.

- **ADOT advocacy role –** Participants would like to see a stronger advocacy role for ADOT on environmental issues, including air quality planning.

- **Multimodal concerns –** ADOT should ensure that the MoveAZ Plan will provide multimodal solutions and encourage land use planning to shorten trips. This will improve air quality and reduce the impact of transportation on the environment.

Participants would like ADOT to promote planning that guides public policy. Planning should examine implications of roadway improvements, ensure effective mitigations, and examine the unintended consequences of roadway design.

Commercial Vehicle Operators Focus Group

Eleven individuals representing shipping companies, railroads, and other commercial vehicle operators participated in the Commercial Vehicle Operator focus group on October 8, 2002. This group identified several concerns, as described below.

- **Bypasses –** Many participants wanted to see designated truck bypass routes around urban areas (i.e., Phoenix and Tucson).

- **Safety –** Participants were concerned about conflicts between trucks and the general public. Growing population has led to greater demand for shipping, increasing conflicts between automobiles and trucks.

- **Economic growth –** In the past, Arizona has been a destination for products, but now is becoming a distribution center. Distribution centers are moving to Arizona from Southern California, and commerce is becoming more regionalized. This is good for the economy, but creates additional conflicts as freight traffic increases.

- **Infrastructure limitations –** Many shippers would like to rely more on railroads, but face bottlenecks and limitations on railroad capacity, in part because of the lack of connections between major rail lines in the Phoenix area. Participants would also like state facilities to provide better connections between various shipping modes (truck and rail)

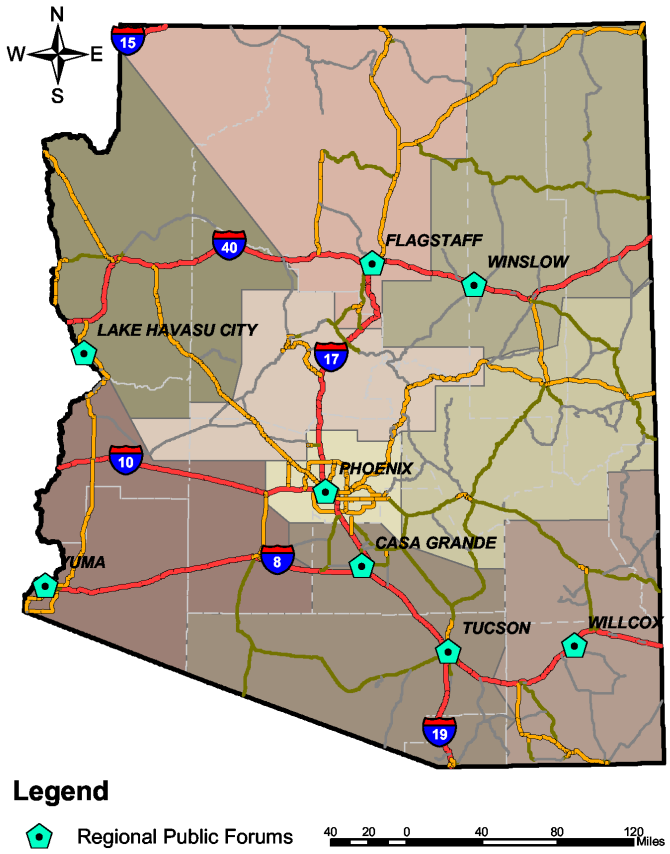
Commercial vehicle operations, including air and rail freight, are changing dramatically. The volume of products being shipped by trucks is increasing, and the railroads are operating near capacity. Participants thought that this increased the need for a safe transportation system that supports the movement of goods throughout the State. Safety issues

associated with trucking and railroads should be considered as part of the long-range plan for the State.

2.2 Regional Public Forums

ADOT conducted eight Regional Public Forums in selected areas throughout Arizona (Figure 2.1). The forums were used to introduce the MoveAZ Plan and elicit information to help confirm the mission statement, long-range goals, and objectives that were created as part of the MoveAZ strategic direction. Invitations were distributed to individual communities, governmental entities, business leaders, and under-served populations to ensure a broad representation of interests at each of the forums. These public forums provided an opportunity for citizens and their leaders to express opinions and provide suggestions for the long-range transportation plan.

Figure 2.1 Regional Public Forum Locations



As presented in Table 2.2, attendance at the forums ranged from 20 to 70 participants, with nearly 400 people participating across the State.

Table 2.2 Regional Public Forum Attendance

Forum	Attendees
Casa Grande	46
Flagstaff	67
Lake Havasu City	64
Phoenix	56
Tucson	71
Willcox	33
Winslow	20
Yuma	40
Total	**397**

Participants at each of the forums heard a short presentation about the direction and status of the MoveAZ Plan, and were then divided into groups of 15 to 20 individuals for in-depth discussions.

The bulk of each three-hour forum was spent in interactive sessions focusing on the following areas:

1. During introductions, participants described their best transportation experience anywhere in the world.

2. Participants were asked to describe quality of life in terms of the transportation system. These ideas were then related to the MoveAZ goals developed in as part of the strategic direction.

3. Finally, participants were asked to describe aspects of the current transportation system that work well and issues that need attention. At the end of this exercise, participants prioritized a list of things that work well and a list of concerns they had raised.

In addition to the interactive discussion, each participant received a survey with 15 questions covering a range of issues. The survey provided another opportunity for participants to describe their concerns about transportation in Arizona.

The discussions and surveys provided substantial meaningful input that can be compared to the Phase I strategic direction. Input from participants will be used to help refine the long-range goals and objectives. The remainder of this section presents the following:

- A review of the major issues raised through each of the three questions;
- Analysis of the survey responses; and
- An analysis of the relationship between the issues raised at the regional public forums and the MoveAZ goals and objectives developed for the Phase I strategic direction.

Description of Best Transportation Experiences

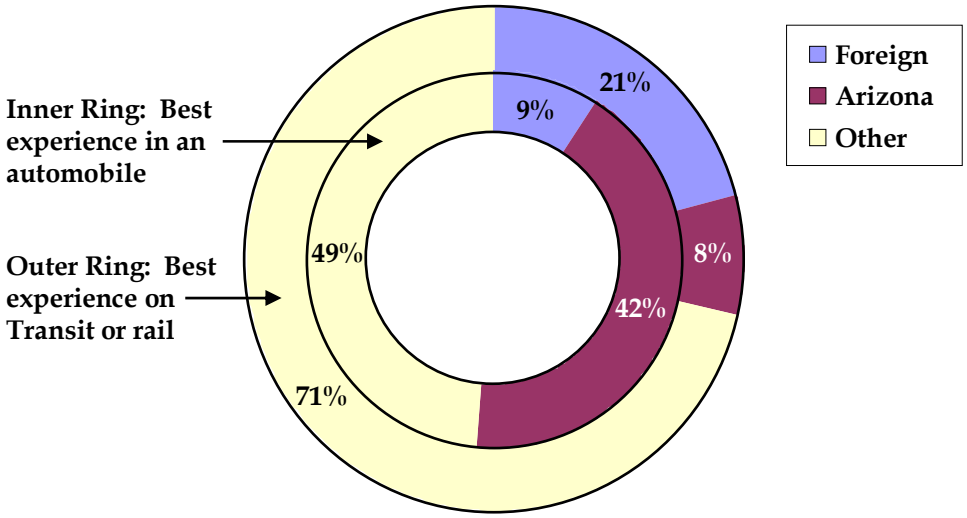
Each of the breakout discussions opened with introductions and a discussion of participants' best transportation experience. The intent of this question was to start participants' thinking about transportation issues.

Though this simple question only provides information about specific experiences, and is not suitable for in-depth analysis, some of the responses help set the stage for how Arizonans think about the transportation system.

Each of the participants chose a particular mode on which they had their best experiences. Across the eight forums, the majority of participants selected transit as the mode on which they had their best experience, closely followed by automobile experiences. A smaller number of participants selected an experience in the air or on a bicycle. Respondents in urbanized areas were most likely to select transit as the mode on which they had their best experience. In forums held in rural areas, a majority of respondents described automobile experiences as their best. Participants at the Yuma forum tended to select automobile experiences, though they also had the largest number of respondents to describe bicycle travel as their best experience. In Lake Havasu City, slightly more respondents described a transit experience than one by automobile.

Examining where participants said they had their best transportation experience in more detail, a clear pattern emerged (Figure 2.2). Participants who described a transit experience as their best tended to note experiences in other states or in foreign countries. Only eight percent of transit experiences were in Arizona. Participants describing automobile experiences were much more likely to describe an experience in Arizona (42 percent).

Figure 2.2 Location of Participants' Best Transportation Experience by Mode



Several participants noted particular aspects about their experience that made them select it as their best. For automobile travel, scenery and aesthetic issues were the most common qualifying statement made. Several respondents described the speed of travel, a lack of conflicts with truck traffic on certain roads, and general freedom of movement as contributing to quality of life. For transit and rail experiences, participants tended to describe particular systems that ran efficiently, were easy to use, and allowed for seamless transfers.

This question does not allow for detailed analysis, but many of the issues raised here – transportation choice, aesthetics on roadways, efficiency of connections between modes – were repeated throughout the regional forums. In particular, in both the discussion of quality of life and the ranking of concerns about the transportation system, participants raised concerns about transportation choices. The remainder of this section describes those responses in some detail. Section 2.4 presents a more complete synthesis of the major issues raised at each forum and the key lessons learned from the public involvement process.

Relating Quality of Life to Long-Range Goals

Participants in each breakout discussion were next asked to describe how transportation can help support and improve the quality of life in Arizona. These responses were then related to the five long-range goals developed for MoveAZ (access and mobility, stewardship,

safety, economic vitality, and environmental sensitivity).[1] The responses to this question provided information for three analyses.

- First, the responses indicate participants' general priorities for the transportation system. To the extent that they mentioned mobility concerns more frequently than safety concerns, for example, it is possible to interpret that to mean that mobility is a higher priority. However, participants were not asked to make tradeoffs between goals or consider the implications of how they described quality of life. As a result, these responses are considered only to be rough priorities for transportation. The final analysis of participant priorities will depend greatly on their rankings of major concerns.

- Second, the descriptions of quality of life were compared to the definitions of the MoveAZ goals generated during Phase I. This comparison provides some evidence that there is consistency between the long-range goals and the way participants describe quality of life.

- Lastly, a comparison of the quality of life statements to the long-range objectives generated during Phase I provides further indication that these objectives take Arizonans' transportation concerns into consideration.

Prioritizing Goals

Participants were allotted substantial time to describe how the transportation system supports quality of life, but were not specifically asked to make a structured tradeoff between different goals in this exercise. As a result, their descriptions of quality of life only provide some evidence about the transportation concerns they would like ADOT to address. The responses to this question suggest transportation issues that participants thought needed special attention, and not necessarily those that are already working well.

The following general statements summarize the participants' preferences that were described during this exercise:

- Improving access and mobility were the most often cited means to improve quality of life in every forum. Across the forums, roughly 40 percent of quality of life descriptions were categorized as access and mobility issues. In Yuma, over one-half of all quality of life descriptions fits this category.

- Safety was the next most frequently mentioned quality of life issue, closely followed by environmental sensitivity. Between 15 and 20 percent of quality of life descriptions were safety concerns, though this rose to one-quarter in Lake Havasu City and one-third in Winslow.

---

[1] A complete description of these five goals and the process of generating them can be found in the *MoveAZ Phase I Summary Report*. This report is available on the Internet at http://www.moveaz.org/Projects/Documents.html.

- Environmental sensitivity was especially important in urban areas, with roughly one-quarter of participants in both Phoenix and Tucson noting environmental issues. In Willcox and Yuma, by contrast, only five percent of quality of life descriptions were related to environmental issues. In all other areas, about one-sixth of the quality of life descriptions were related to environmental concerns.

- In general, stewardship and economic vitality were least often described as major quality of life issues by participants, with each receiving around one-tenth of quality of life descriptions across all the forums. Stewardship issues were slightly more important in Willcox and Yuma (around 15 percent). Economic vitality was fairly consistent across the forums, with only Tucson falling under 10 percent of quality of life descriptions.

Overall, the descriptions of quality of life suggest that access and mobility concerns may be the most important issue to forum participants. The quality of life question also provided useful data that correlated with the goals and objectives generated for MoveAZ. The long-range goals and objectives provided one direction for MoveAZ. Comparing the descriptions of quality of life to the MoveAZ goal and objective definitions revealed further support for the Phase I strategic direction.

MoveAZ Goals and Objectives Are Appropriate

The first finding from this analysis is that the MoveAZ goals selected in Phase 1 appear largely appropriate. Only a handful of the quality of life descriptions (roughly two percent) was categorized outside of the five long-range goals. Several of the descriptions that were categorized in this way have potential matches within the existing goals and objectives that may not have been apparent to forum participants. These issues included connectivity, land-use controls, reducing congestion, and improving travel times; all of which fit within one of the five long-range goals. The main issue raised that was outside the long-range goals was funding. Several participants suggested that providing additional funding for transportation would substantially improve their quality life. On the whole, however, the quality of life descriptions in each goal area suggests that ADOT has identified long-range goals that Arizonans support.

The remainder of this section describes the overlap between participants' descriptions and MoveAZ long-range goals and objectives. The objectives are grouped into 10 performance factors that are used to organize performance measurements and analysis.

Participants Descriptions of Access and Mobility

Access and mobility concerns were the most frequently raised quality of life issue at the regional forums. Many of the statements made were of a very general nature, discussing the need for improved access, reduced delay, and other general issues. Across the forums, participants raised the following four broad issues with some consistency:

1. Access to particular cities or to activities like employment and tourism;
2. Improved mobility and reduced congestion and delay;
3. Increased transportation options, such as transit; and
4. Increased efficiency and convenience of the transportation system as a whole.

Among these issues, transportation choice issues were the most frequently mentioned, with specific comments spread across a wide range of transportation modes, including transit, bicycles and pedestrians, high-occupancy vehicles (HOVs), rail, equestrian, air, and better modal integration. As might be expected, participants were most strongly in favor of transportation options in Phoenix, Tucson, and Flagstaff, but the differences among forums were small.

Participants were almost as likely to describe the need for an expanded highway system or a particular road for their area. These sentiments were especially strong at the Lake Havasu City and Winslow forums, but again there were no major deviations from these comments at any forum.

In addition to these broad-based issues, a number of responses dealt with specific access and mobility concerns. Some of the additional issues noted by participants included the following:

- Concerns about freight traffic and conflicts with trucks;
- The safety and environmental benefits of improved roadways;
- The need for access management on state highways (especially strong in Yuma);
- The benefits to mobility that result from regular maintenance and good construction management; and
- The potential of intelligent transportation system to provide enhanced mobility.

In the MoveAZ strategic direction, the access and mobility goal is broken into four factors and 15 long-range objectives (Table 2.3). The quality of life descriptions raised at the regional public forums correspond very closely to these objectives. Though they did not use the same language, participants mentioned every one of these objectives during at least one of the regional public forums and many were mentioned at several. A complete analysis of the overlap between specific issues and concerns identified during the forums and the MoveAZ long-range objectives is provided at the end of this section.

Table 2.3 Performance Factors and Long-Range Objectives for MoveAZ Access and Mobility Goal

Performance Factor	Long-Range Objectives
Mobility	• Maintain and enhance levels of circulation (e.g., reduced congestion) on highways, arterials, and major collectors. • Maintain and enhance the ability to move goods and services throughout the state and around urban areas with minimal delay. • Encourage the development of transit options, with a special emphasis for economically disadvantaged populations.
Reliability	• Improve the availability and quality of real-time information to increase the ease of use and attractiveness of both highways and public transportation. • Reduce delay caused by at-grade highway-railroad crossings. • Develop and implement an access management program to preserve the reliability of the state highway system.
Accessibility	• Encourage the development of effective public transportation, ride share, and related options (where appropriate and cost effective). • Support Title 6 ADA compliance for access by disadvantaged groups to all transportation services. • Integrate transit, bicycle, and pedestrian facilities into highway improvements (where feasible). • Maintain and enhance connections to major commercial, residential, and tourist destinations. • Maintain and expand border crossing facilities.
Connectivity	• Maintain and enhance intermodal passenger connections between air and surface transportation modes. • Maintain and enhance intermodal freight linkages for truck-rail, and truck-air transfers. • Continue necessary expansion and connection of Arizona's metropolitan highways and HOV lanes. • Ensure the connection of rural communities to the state highway network.

Participants Descriptions of Safety

Many of the forum participants suggested that safety was a key quality of life issue for the transportation system. Nearly one-quarter of the descriptions, however, did not describe a specific safety concern, only noting that they wanted to be safe on the transportation system. The remaining three-quarters of responses varied considerably in their description

of a safe transportation system. Some of the major issues noted by participants included the following:

- Identifying particular transportation modes that need to be safer, especially bicycling and walking;
- Improving the design of transportation facilities to reduce accidents, including signal timing, lighting, and general roadway design;
- Concerns about natural hazards, including snow removal and flooding;
- A need for quick and efficient response to traffic incidents;
- Reduction in the number of at-grade railroad crossings;
- The belief that congestion increases the number of accidents; and
- Improving enforcement and increasing penalties for bad driving.

These concerns relate to the MoveAZ goal of providing safe transportation for people and goods. Solutions to these issues are reflected in the long-range objectives of achieving a reduced rate of crashes, fatalities, and injuries; protection improvements in at-grade railroad crossings; and efficient access for emergency response and evacuation situations (Table 2.4).

Table 2.4 Performance Factors and Long-Range Objectives for MoveAZ Safety Goal

Long-Range Objectives Described by Participants	Long-Range Objectives Not Described by Participants
• Reduce the rate of crashes, fatalities, and injuries involving motor vehicles, bicycles, and pedestrians • Design new transportation facilities to minimize accidents • Improve the safety of commercial vehicles and public transportation vehicles and facilities • Upgrade at-grade railroad crossing protection • Increase ADOT's support and use of incident management on the state highway system • Improve safety and security for rural area travelers	• Coordinate with Federal, regional, local, and tribal officials to provide redundancy of access for emergency response and evacuation situations (e.g., bridge crossings, multiple access routes to airports, and other key transportation facilities, etc.) • Improve the safety at locations where different modes intersect

Participants' Descriptions of Environmental Sensitivity

Quality of life issues categorized as environmental sensitivity were raised with about the same frequency as safety issues. Participants raised several issues that dealt with the following environmental concerns:

- Nearly one-third of the environmental quality of life issues reflected a belief that ADOT should help protect the environment and reduce pollution. These concerns were especially strong at the Phoenix, Tucson, and Flagstaff forums.

- The second most frequently raised environmental concern related to the aesthetic quality of state roads, including landscaping, roadway design, general cleanliness of the roads, and related issues. Just over one-quarter of environmental quality of life issues raised dealt with these issues. Aesthetic issues also overlapped into other goal areas, including economic development, access and mobility, and stewardship. For example, participants described how aesthetically pleasing roads benefit the tourism industry.

- Several descriptions of quality of life reflected the environmental benefits of encouraging alternate modes or developing alternative motor vehicle fuels. Roughly 10 percent of the quality of life descriptions that were categorized as environmental issues reflected this sentiment.

- Participants noted the importance of protecting wildlife in about 10 percent of the environmental issues raised. These concerns were especially strong in Flagstaff, where they represented one-quarter of the environmental issues raised.

- A number of participants noted the negative impacts of noise on the environment.

These concerns correspond closely to the MoveAZ goals and objectives identified for environmental sensitivity (Table 2.5). The belief that ADOT should promote environmental protection and pollution reduction correlates to the MoveAZ objectives of 1) increasing energy conservation and the use of recycled materials and cost-effective alternate energy sources; and 2) minimizing the contribution of transportation investments to air, water, and noise pollution in all areas of the State. The objective of giving preference to use of native or indigenous species in transportation–related landscaping projects addresses participants' concerns regarding environmental landscaping and aesthetic issues.

Table 2.5 Performance Factors and Long-Range Objectives for MoveAZ Environmental Sensitivity Goal

Long-Range Objectives Described by Participants	Long-Range Objectives Not Described by Participants
Resource Conservation Performance Factor	
• Give preference to use of native or indigenous species in transportation-related landscaping projects • Encourage the development of smart growth policies in coordination with state, regional, local, and tribal planning processes • Increase energy conservation and the use of recycled materials and cost-effective alternate energy sources	
Environmental Protection Performance Factor	
• Minimize the contribution of transportation investments to air, water, and noise pollution in all areas of the State • Minimize the impact of transportation investments on natural habitats, animal travel corridors, historic sites, and endangered species	• Increase proactive coordination of transportation planning with Federal, state, and regional environmental agencies • Ensure that negative environmental impacts of transportation investments do not fall disproportionately on disadvantaged groups
Context Sensitive Solutions Performance Factor	
• Establish and meet design standards that maximize the visual harmony of and minimize the noise produced by transportation system investments	

Participants' Descriptions of Stewardship

Participants addressed stewardship issues relatively infrequently during the discussion of quality of life. Participants in Flagstaff raised these issues at a slightly greater rate than other forums, but the difference was small.

Across all the forums, maintenance was the most frequently raised stewardship issue. Maintenance included concerns about snow removal and litter control on highways, as well as concern that roads are well maintained (e.g., ensuring pavement quality). Each of these issues was described as supporting quality of life.

Another major stewardship issue raised during the discussion of quality of life dealt with coordinated planning. Participants at each of the forums raised the importance of

coordinating state transportation planning with state and local land use planning, as well as coordinated regional and state transportation planning.

The concerns of highway maintenance and coordinated planning are addressed in the MoveAZ Plan's goal of developing a balanced, cost-effective approach that combines preservation with necessary expansions and coordinates with local and regional transportation and land use planning (Table 2.6). The concerns will be addressed through achieving the objectives of preserving and maintaining existing transportation infrastructure and increasing efficient coordination of state transportation planning and programming processes with local and regional land use planning processes.

Table 2.6 Performance Factors and Long-Range Objectives for MoveAZ Stewardship Goal

Long-Range Objectives Described by Participants	Long-Range Objectives Not Described by Participants
Preservation Performance Factor	
• Preserve and maintain existing transportation infrastructure • Develop and implement an access management program to preserve the functionality of the state highway system • Increase efficient coordination of state transportation planning and programming processes with local and regional land use planning processes	• Coordinate planned transportation system expansions with future funding capabilities
Mobility Performance Factor	
• Increase and/or protect capacity of the existing transportation system through increased use of traffic operation and management strategies, including Intelligent Transportation Systems (ITS) methods	

Economic Vitality

Of the quality of life issues identified by the participants, relatively few could be directly related to the goal of economic vitality. The most frequently mentioned economic vitality issues identified were access issues and the availability of transportation options. Access issues included a general need for improved access to certain areas to attract businesses, and descriptions of particular roads that required improved access. Transportation options issues raised included investing in transit options, especially to enable disadvantaged populations to access employment; and improving air service to local communities.

These two basic concepts each described about one-quarter of the economic vitality quality of life issues.

Economic development was another important aspect of economic vitality raised by participants. Several participants described the economic value of goods movement for the economy of the State and regions as a key component of economic vitality. A number of participants mentioned the importance of encouraging transportation investments to benefit local economies. Overall, improving aesthetics was raised as an economic development issue nearly as frequently as providing access to jobs and other typical economic development concerns.

Finally, a number of participants suggested that the transportation system needed to be affordable and available to all users. This comment usually expressed a concern that existing patterns of transportation investment yield costs that are too high for some users. Affordability was also categorized as an issue of mobility and stewardship as well, reflecting an overlapping concern about the ability of Arizona residents to get between places quickly and efficiently.

Several quality of life issues identified by participants relate to the MoveAZ economic vitality objectives (Table 2.7). These issues are recognized in the plan and are addressed through the objectives of equitably distributing transportation to all areas of the State; encouraging the development of transit services that provide access to job centers; maintaining and expanding freight transportation and intermodal linkages; and maintaining and improving linkages between Arizona, other states, and Mexico. Each of these objectives was mentioned in at least one of the forums. A complete analysis of the overlap between the quality of life descriptions at each of the forums and the long-range objectives is in the following section.

Table 2.7 Performance Factors and Long-Range Objectives for MoveAZ Economic Vitality Goal

Performance Factor	Long-Range Objectives
Economic competitiveness	• Maintain and expand freight transportation and intermodal linkages • Increase coordination of transportation planning with the economic development activities of state, regional, and local governments • Distribute transportation to all areas of the State equitably.
Accessibility	• Maintain and improve truck linkages between Arizona, other states, and Mexico • Maintain and improve access to major tourist destinations • Encourage the development of transit services that provide access to job centers

Comparing Quality of Life Descriptions to Long-Range Objectives

Overall, participants at the regional public forums raised quality of life issues that were consistent with the long-range goals and objectives generated for MoveAZ. These goals and objectives were generated through an analysis of previous planning studies. Table 2.8 provides an overall analysis of the long-range objectives raised at each of the forums categorized by MoveAZ performance factor. Performance factors provide a means to group objective during analysis.

- Access and mobility were mentioned frequently at each of the forums. The related objectives under connectivity and accessibility were mentioned somewhat less frequently, but still were noted in many of the forums.
- Participants raised nearly every safety objective at each of the forums.
- Resource conservation and environmental protection objectives were well covered in most of the forums. Participants were primarily interested in aesthetics, however, which is categorized under context sensitive solutions.

Table 2.8 Performance Factor Validation by Regional Forum

Performance Factor	Casa Grande	Flagstaff	Lake Havasu City	Phoenix	Tucson	Willcox	Winslow	Yuma
Accessibility	●	●	●	●	●	●	●	●
Mobility	●	●	●	●	●	●	●	●
Reliability	○	●	●	○	○	○	○	●
Connectivity	○	●	●	●	●	○	●	●
Safety	●	●	●	●	●	●	●	●
Resource Conservation	○	●	○	○	●	○	○	○
Environmental Protection	●	●	●	●	●	○	○	○
Context Sensitive Solutions	●	●	●	●	●	○	●	●
Preservation	○	●	○	○	○	○	○	○
Economic Competitiveness	○	○	○	●	○	○	○	●

● Most or all long-range objectives raised at this forum.
○ Less than one-half of long-range objectives raised at this forum.

- Preservation and economic competitiveness issues were mentioned less frequently, as described above. Across all the forums, however, participants raised issues related to each of the objectives.

- Most importantly, across all forums, no long-range objective was left unmentioned.

Prioritizing Issues and Concerns

The final question asked of participants at the forums was intended to help identify and prioritize issues for MoveAZ. Participants were asked to describe: 1) aspects of the Arizona state transportation system that are working well, and 2) issues that need to be addressed. These statements were written down, and then ranked by each of the participants. Participants were allowed to select their top five most important concerns and top five aspects they liked.

This process provided a means to identify key issues without asking participants to rank specific MoveAZ goals or performance factors. The analysis included coding these very specific statements into the more general areas of concern represented by each of the MoveAZ goals and performance factors.

This section provides an analysis of the statements and rankings that described the issues that participants felt Arizona needed to work on. The analysis focuses on two key pieces of information that were coded from the comments made by participants: 1) the particular long-range goal, performance factor, or other general issue to which the comment relates; and 2) a more detailed coding of the key issues raised. The following section presents an analysis of the aspects of the transportation system that participants claimed worked well.

Responses to the question "what issues need to be addressed" were coded into the performance factor they most clearly resemble. A number of participants' issues did not neatly fit into one of the 10 factors. In these cases, the statements were coded as one of the following four additional concepts:

1. **Transportation options –** The need to invest in additional transportation modes;

2. **Funding –** The need for new funding or to redistribute funding more fairly;

3. **Planning and coordination –** Planning concerns included investing more in planning, conducting improved public involvement, and coordinating with other agencies (e.g., regional governments, land use planning); and

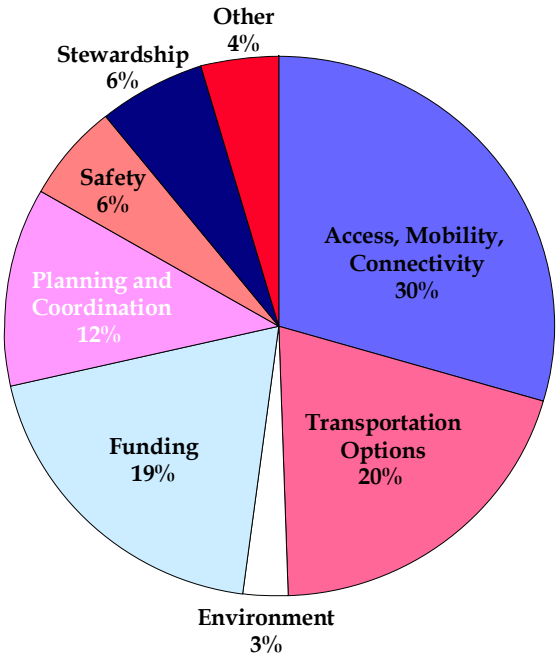
4. **ADOT organization –** Concerns about the structure of the ADOT organization, such as the districts, the transportation board, or the headquarters office.

Overall Concerns Across All Forums

Participants at the forums raised hundreds of separate concerns (Figure 2.3). Using the coding scheme outlined above, the following general statements about these concerns can be made:

- Mobility, access, and connectivity topped the list of issues raised across the forums, with just under one-third of all participants raising concerns about the ability to travel quickly and efficiently or access particular cities, recreational activities, employment, or other opportunities.
- Transportation options concerns were raised by one-fifth of the forum participants.
- Approximately one-fifth of forum participants ranked funding as a major concern, focusing primarily on the distribution of transportation funds around the State.
- Planning and coordination issues were the fourth most frequently raised concerns across the forums. These statements reflected concerns about the lack of coordinated transportation and land use planning.
- Concerns about the environment, safety, and stewardship of the system received some support, but substantially less than the previous four issues. Other issues, including economic vitality and ADOT organizational issues, received little support in the ranking process.

Figure 2.3 Distribution of Participant Concerns Across All Forums



The statements made in response to this question also provided detailed information that reflects how the forum participants would like the transportation system to operate. This section presents an analysis of some of this more detailed information for each major issue.

The following sections describe how participants ranked their concerns for each of a number of performance factors or general issue areas. The percentages listed reflect the relative importance of a given sub-issue within each of those general areas. They should not be interpreted as how individual issues were ranked out of all possible issues.

Access, Mobility, and Connectivity

Roughly three-quarters of participants' selections for these three issues dealt with mobility. These mobility issues were driven by suggestions of new roads, bypasses, road widening, passing lanes, and other similar projects.

Though many of the mobility issues focused on particular road projects, participants were also concerned about increasing truck traffic and its impact on mobility, safety, and other issues. Participants also raised issues related to access management, construction management, and inconsistent speed limits; though, overall, these received less support during the ranking.

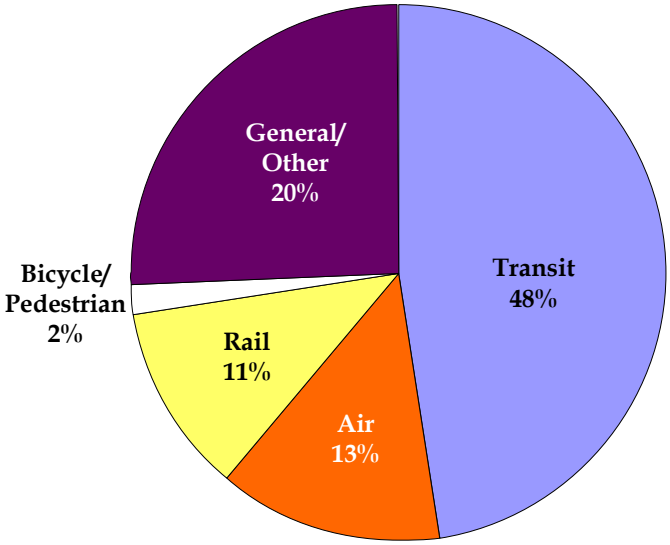
The issue of rural connectivity was raised at several of the forums, and received especially strong support in Lake Havasu City. Participants at this forum were concerned that the cities in the "Golden Triangle" are not well connected, increasing travel times, accidents, and business costs.

A number of other access and connectivity issues was raised at the forums, including new interchanges, further development of the HOV system, improved intermodal connectivity, and better connections to borders (both domestic and foreign). Among access and connectivity issues, these issues received fairly similar levels of support from forum participants.

Transportation Options

The second most frequently selected issue across all of the forums was the need to develop additional transportation options (Figure 2.4). Roughly one-half of these selections were calls for additional transit service, which were especially strong in Phoenix, Tucson, and Flagstaff. Participants at the Lake Havasu City forum also showed relatively strong support for improved transit options, ranking it nearly as high as the more urbanized areas.

Figure 2.4 Distribution of Participant Concerns About Transportation Options



Air and rail service improvements were the next most frequently raised transportation option issues. Forums held outside the Phoenix region were more concerned about the availability, cost, and frequency of air service; with these concerns especially strong in Winslow and Yuma. At the forums held in Willcox, Casa Grande, and Lake Havasu City, air service was also raised and received substantial support. Rail issues were raised most frequently in cities along the I-10 Phoenix to Tucson corridor, with Casa Grande and Tucson both supporting additional investment in rail. These issues received some support at the Lake Havasu City and Yuma forums as well.

Participants at the Phoenix and Tucson forums were especially strong in their support for a general increase in transportation options. Several participants made general comments about the need for additional choices that would increase the overall mobility of the population.

Funding

The two major funding issues raised at the forums were: 1) the need for additional funding to support the transportation system, and 2) a desire for a more equitable distribution of funding among Arizona's regions. Each of these points was raised in about 40 percent of the funding issues.

In addition, several statements at the forums suggesting specific sources of new funding received some support from participants. A number of participants in Phoenix, Tucson, and Flagstaff supported levying additional taxes or fees to fund transportation improvements. In Phoenix and Tucson, roughly 15 percent of the funding issues that received support from participants were related to new taxes or fees. In Flagstaff, nearly 10 percent of the funding issues were related to taxation.

Toll roads were raised as an option in several forums, especially in Lake Havasu City. This occurred both during the quality of life discussion and the listing of major concerns. When participants were asked to rank these issues, however, toll roads did not receive a lot of direct support.

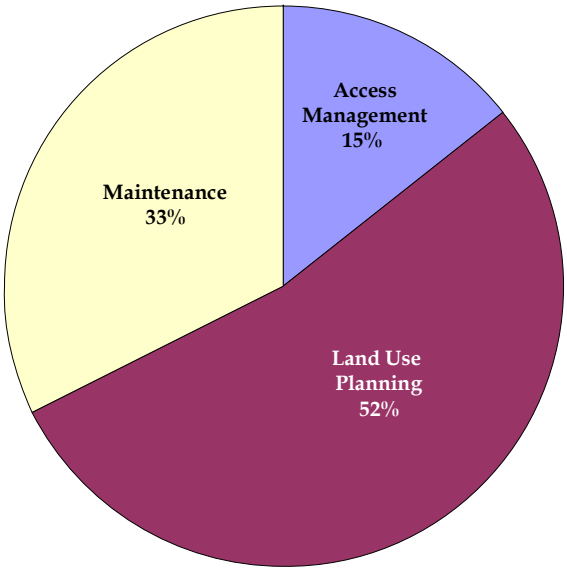
Participants at several of the regions supported additional funding for particular transportation modes. There was relatively strong support for transit funding in Tucson and Willcox, each of which received roughly 15 percent of the support for funding issues. In Casa Grande, nearly one-quarter of the support for funding specifically noted funding for air service.

Stewardship

Stewardship issues were not ranked highly at any of the forums (Figure 2.5). When they were selected by participants, three basic issues were raised: 1) coordinated land use and transportation planning; 2) access management; and 3) maintenance. Coordinated land use and transportation planning was the most frequently mentioned of the three; and was most frequently selected in Phoenix, Flagstaff, and Casa Grande.

Maintenance concerns were selected less frequently and were almost always directed towards concerns about litter, snow removal, and similar concerns; rather than pavement or bridge conditions. Access management was raised at several forums and was ranked highly at the Lake Havasu City forum, relative to other stewardship issues.

Figure 2.5 Distribution of Participant Concerns About Stewardship



Safety

Most of the comments raised about safety were very general in nature. Some of the specific safety-related concerns that were raised include the following:

- Increasing the availability of emergency phones in rural areas (especially in Lake Havasu City, Flagstaff, and Casa Grande);
- Special concerns about the safety of bicyclists and pedestrians (especially in Phoenix and Yuma);
- Concerns about natural and human hazards, including snow removal and conflicts with trucks and rail (especially in Tucson and Winslow); and
- A general concern for reducing the number of fatalities and accidents (especially in Flagstaff and Phoenix).

Environmental Concerns

Participants at the regional public forums usually ranked environmental concerns lower than others. Environmental issues were slightly stronger in Winslow, Flagstaff, and Phoenix than at other forums, but the differences were small.

When environmental issues were raised, they tended to concern the following four main issues:

1. The scenic and aesthetic quality of Arizona's roads was noted in most of the regional forums and received support in several of them;
2. The need to reduce air pollution received strong support at the Phoenix forum, relative to other environmental issues;
3. Concerns about protecting wildlife received support in Flagstaff, and Winslow to a lesser extent; and
4. The value of context sensitive design in building transportation facilities received support in Flagstaff.

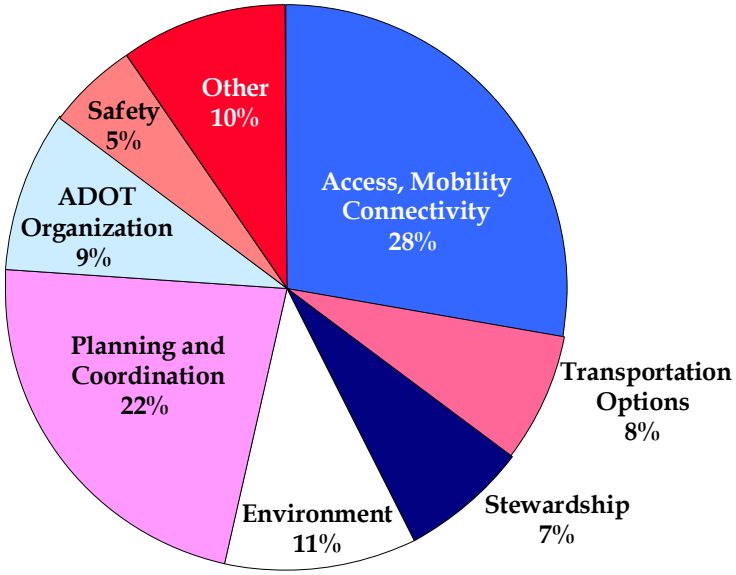
Prioritizing Aspects of the Transportation System That Work Well

The other part of the third question asked participants what aspects of the transportation system work well. As with the issues and concerns, participants listed a number of things that they liked about the transportation system, and were then asked to prioritize them. This section provides an analysis of the responses to this question.

Participants at most of the forums were somewhat more interested in describing concerns than things that worked well. On average, participants identified nearly twice as many

concerns as things that work well. The aspects of the transportation system that participants described as working well complimented the issues and concerns quite closely (Figure 2.6).

Figure 2.6 Distribution of Participants' Best Liked Aspects of the Transportation System



Again, mobility and access were among the key participant selections for what works well with the transportation system. These selections reflected support for the Phoenix loop system (which received support at several forums), bypasses in particular towns, passing lanes, highway widening projects, and other similar investments. Because forum participants were concerned about mobility on their roads, they were very supportive of mobility investments.

Similarly, participants who suggested that transportation options were something that worked well were referencing specific recent investments, such as new transit investments in Lake Havasu City, the bus system in Tucson, the possibility of new air service in Casa Grande, direct access to park-and-ride lots in Phoenix, and other similar issues. Again, transit and air transportation were the two most frequently noted transportation options, though several participants ranked bicycle and rail options.

Participants who felt that ADOT was a good steward of the roadway system identified roadway maintenance as something ADOT does well. The use of rubberized asphalt was also ranked highly in several forums, at least in part because of the reduction in noise.

Noise was raised as a purely environmental issue somewhat less frequently than scenic and aesthetic improvements. Participants in all of the forums noted this as the main

environmental issue that ADOT was doing a good job with, citing particular roads that they found to be especially high quality.

Participants ranked planning and organizational issues among the things that they felt ADOT has done the best job with. Forum participants tended to support several of ADOT's planning and organizational activities:

- The MoveAZ public involvement process received substantial support at a number of the forums. Participants were especially pleased that they were included at an early stage of plan development.
- ADOT also received support for recent attempts to coordinate with other regional and local governments, including recent outreach to Native American communities. In Winslow and Yuma, ADOT was commended for its general responsiveness to the region.
- Participants at several forums praised the makeup of the transportation board and the fact that they conduct their meetings all across the State. Support for the transportation board was especially strong in Willcox, Winslow, and Yuma.
- At roughly one-half of the forums, several participants indicated their support for the ADOT district system.

A wide variety of safety issues was raised that participants felt ADOT had been doing a good job on. These included construction zone management; incident management and on-road service; road treatments, such as rumble strips; and signage. None of these issues received much more support than any other.

2.3 Summary of Surveys

In addition to being led through the discussions summarized in previous section, participants filled out a simple survey that asked for their level of agreement with 15 statements relevant to the MoveAZ plan. Table 2.9 presents the total attendance at each forum and the number of usable responses received at each of these forums.

This section provides a brief overview of some key points raised in the surveys. The types of questions were grouped into five basic issues: 1) safety, 2) multimodal concerns, 3) system connectivity, 4) environmental issues, and 5) maintenance. Section 2.4 connects the analysis of the surveys to the material generated at the regional forums.

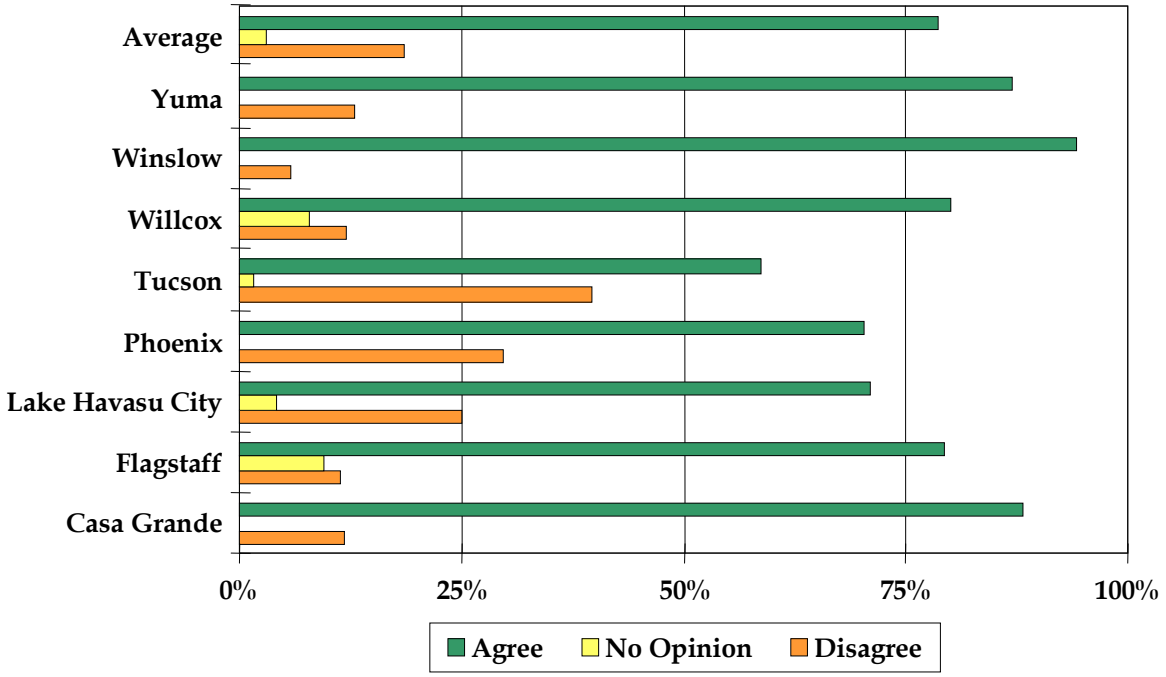
Table 2.9 Attendance and Survey Responses for MoveAZ Regional Public Forums

Forum	Attendees	Surveys
Casa Grande	46	42
Flagstaff	67	53
Lake Havasu City	64	48
Phoenix	56	37
Tucson	71	58
Willcox	33	25
Winslow	20	17
Yuma	40	31
Total	**397**	**311**

Safety

The survey included three safety-related questions, including overall perception of safety on the system, availability of information about weather and roadway conditions, and conflicts between automobiles and rail. Overall, respondents felt quite safe on the system, with an average of over 75 percent of respondents agreeing or strongly agreeing that they feel safe on the transportation system (Figure 2.7). Respondents from the two major urbanized areas of the State noted that they felt safe somewhat less often than those in rural areas, as did respondents from Lake Havasu City. Several participants at the Lake Havasu City forum raised safety concerns regarding State Route 95.

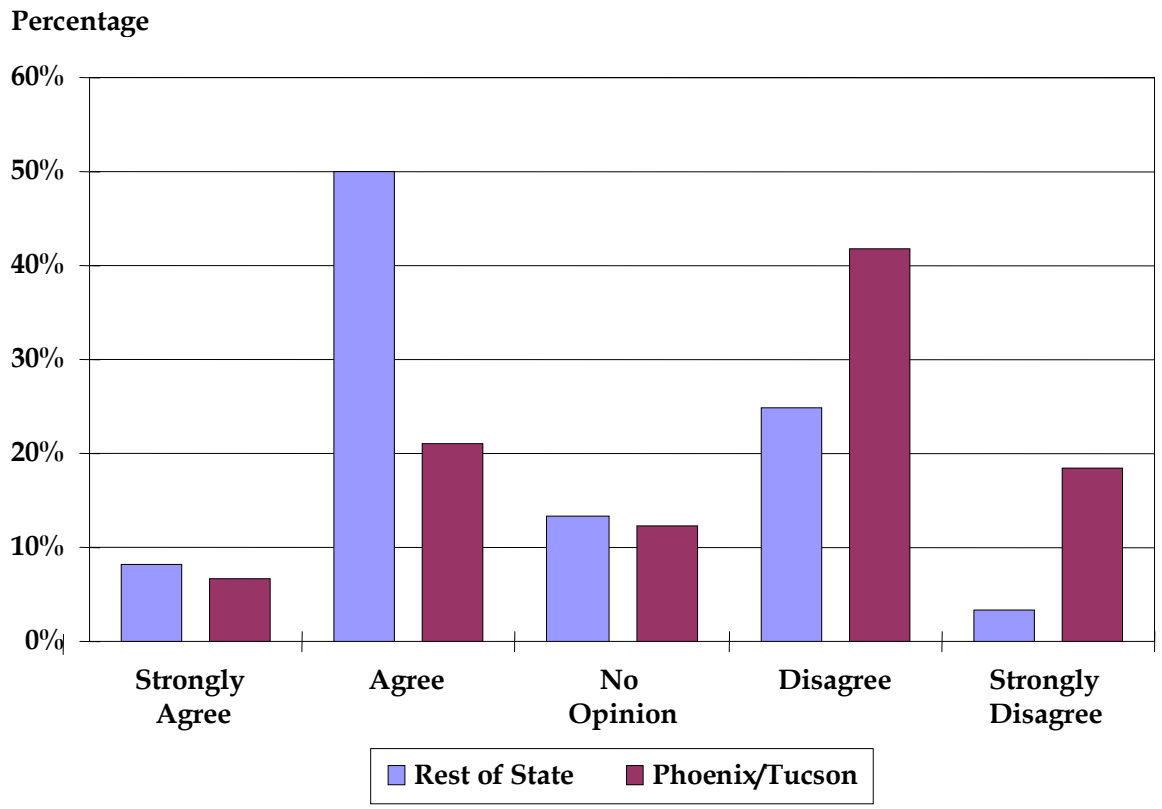
Figure 2.7 Responses to the Statement: "Overall, I Feel Safe Driving on the Highway System in this Region"



Everywhere, but Phoenix and Tucson, most respondents felt that rail-auto conflicts were not a major source of concern (Figure 2.8). In those two cities, the majority of respondents felt that rail-auto conflicts were a serious source of concern.

On average, over one-half of survey respondents felt that there is enough information available to travelers about weather and road conditions. Another 25 percent had no opinion. Respondents around the State had similar responses to this question.

Figure 2.8 Responses to the Statement: "Rail and Vehicular Traffic Co-Exist in this Region and Do Not Pose a Major Safety Issue"



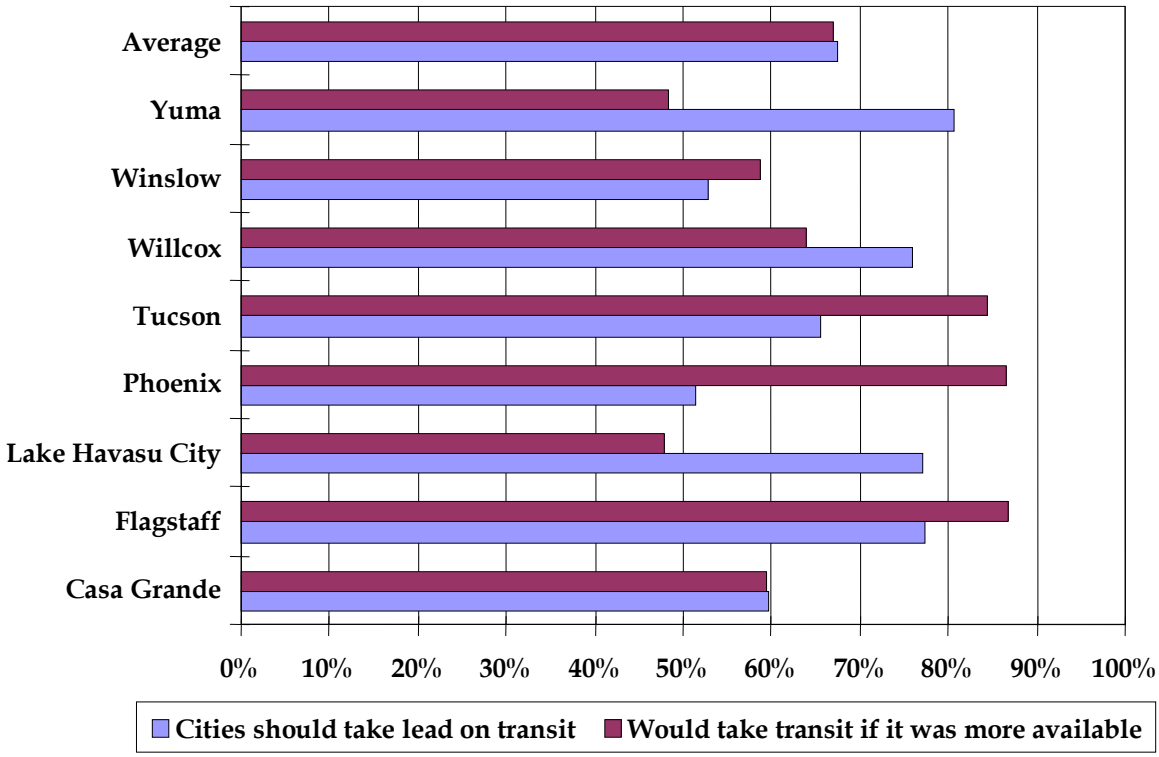
Multimodal Issues

Several questions queried respondents' interest regarding multimodal issues, including two transit-related questions, two air service questions, and a question regarding bicycle and pedestrian travel.

A substantial majority (over 65 percent) of respondents felt that cities should take the lead on planning and developing transit. Phoenix was somewhat of an exception, with 35 percent of respondents suggesting that another agency should play that role. Even in Phoenix, though, over 50 percent of respondents agreed that cities should lead transit operations and implementation.

A similar percentage of participants said they would take transit if it was more frequent and convenient. Figure 2.9 provides the percent of survey respondents who agreed with both of these statements. In Phoenix, Tucson, and Flagstaff, there was strong demand for transit services; but, across the State, most respondents suggested they would use transit if it was convenient.

Figure 2.9 Percent of Respondents Agreeing to the Survey Statements Regarding Transit



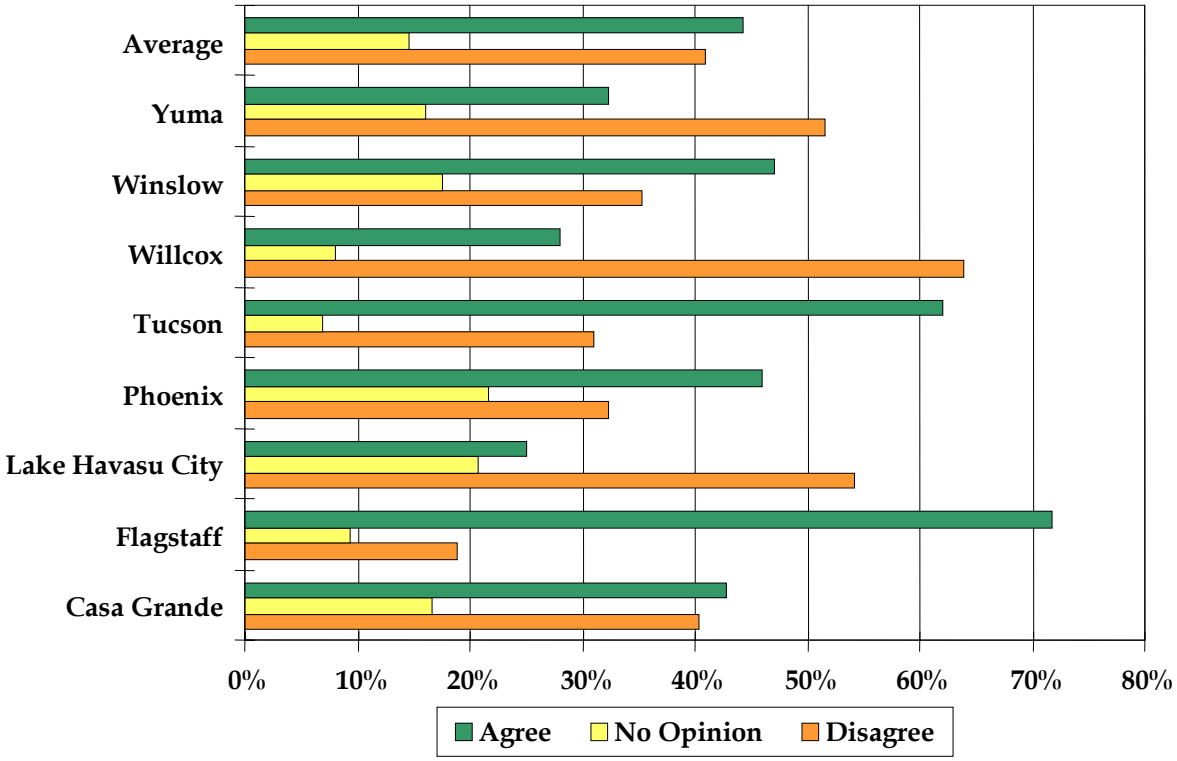
When questioned about air service, only about one-half of all attendees said they would chose to fly if it was more convenient. Over 80 percent of respondents statewide did think that the MoveAZ plan should address regional air service issues, however. Responses to the question, "should the long-range plan contain strategies to support airports in this region?" ranged from 70 to 100 percent in favor, depending on the forum.

Finally, respondents were split as to the priority of bicycle and pedestrian travel on the state highway. About one-half thought this should be a priority, but the responses varied greatly by location. In Flagstaff, over 70 percent of respondents thought these alternative modes should be considered, but in Lake Havasu City, Willcox, and Yuma, only 25 to 30 percent agreed with this statement (Figure 2.10).

Access and Mobility

Two questions dealt with issues that relate to the access and mobility goal area. The first asked if respondents felt that rural areas were well connected to the state transportation system. The second asked if ADOT should plan the transportation system to help improve economic opportunities.

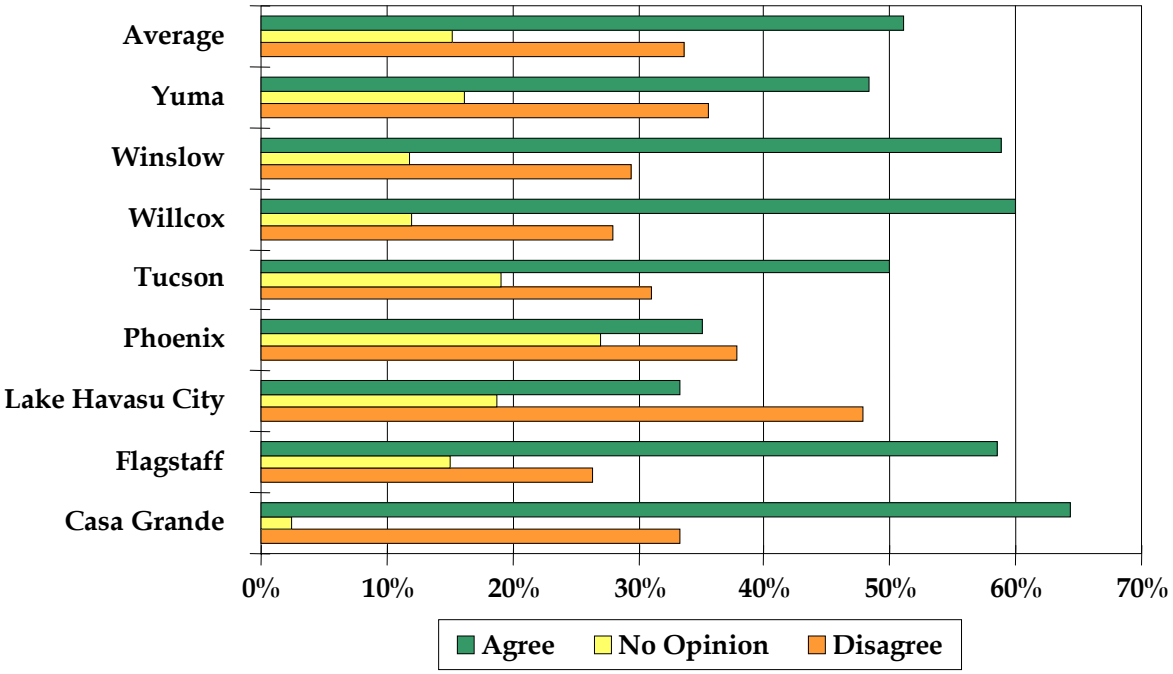
Figure 2.10 Responses to the Statement: "Pedestrian and Bicycle Facilities Should Be Priorities on State Highways"



On average, just over one-half of the respondents thought that rural areas were well connected to the state system (Figure 2.11). Responses ranged from a low of about one-third in Lake Havasu City and Phoenix, and a high of around 60 percent in Willcox, Winslow, and Casa Grande. In general, rural towns/cities that are fairly close to the major interstates thought they were better connected than those that were further away. Although only one-third of respondents in Phoenix thought that rural areas were well connected, over one-quarter registered no opinion. Only 37 percent thought that the areas were poorly connected.

Respondents were almost universal in the belief that ADOT should provide connections between the state highway system and economic opportunities. Between 70 and 80 percent of respondents at each of the forums agreed that economic development opportunities should be considered more in ADOT planning. Most of the remaining respondents had no opinion. Fewer than 10 percent suggested that the ADOT should do otherwise.

Figure 2.11 Responses to the Statement: "Rural Highways Are Well Connected to Major Transportation Systems"



Environmental Issues

Four survey questions dealt with a variety of environmental issues, including landscaping, natural habitats, and historic sites; the impact of trucks on the environment, and the role of the transportation system in shaping urban growth. In general, participants at the regional forums evoked an environmental perspective. Large majorities at each of the forums suggested that ADOT should actively use the MoveAZ plan to help direct and manage population growth (Figure 2.12).

Similarly, three out of four respondents said they would tolerate some inconvenience to protect habitats, historic sites, and endangered species, with very little variation among the locations. The lowest level of agreement came in Willcox, where 56 percent of the respondents suggested they would tolerate some inconvenience.

There was more variation in the responses to the other environmental questions. In four of the forums, a clear majority of respondents believed that ADOT should fund aesthetic improvements to roadways (Figure 2.13). In Lake Havasu, Casa Grande, and Willcox, however, a majority supported shifting any funding for aesthetics into building roads. In Yuma, respondents were nearly equally divided.

Figure 2.12 Average Forum Responses to the Statement: "The Long-Range Plan Should Be Designed to Direct Growth to Appropriate Areas and Promote Smart Growth"

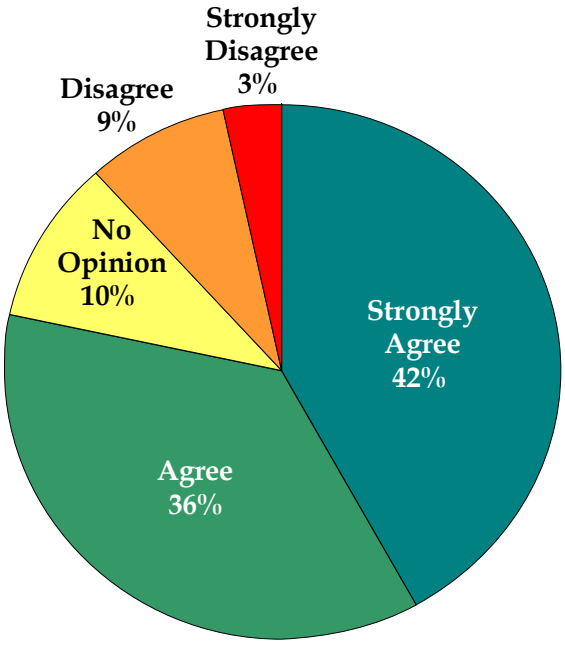
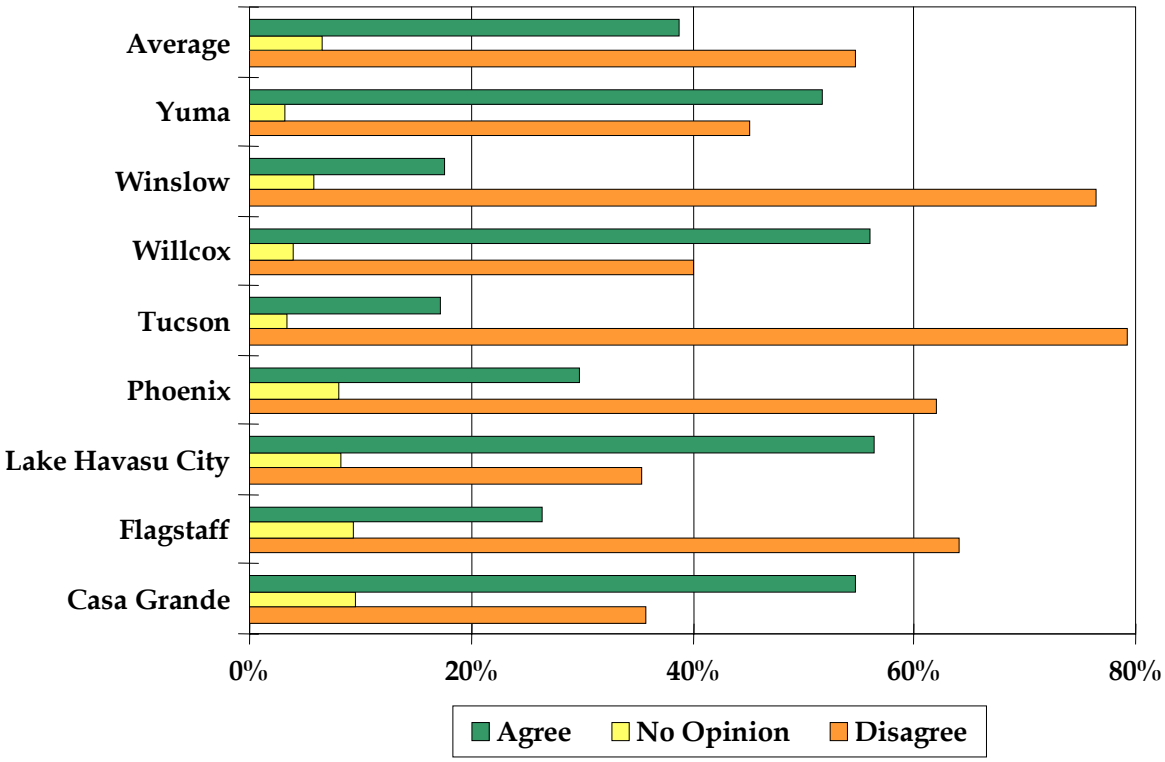
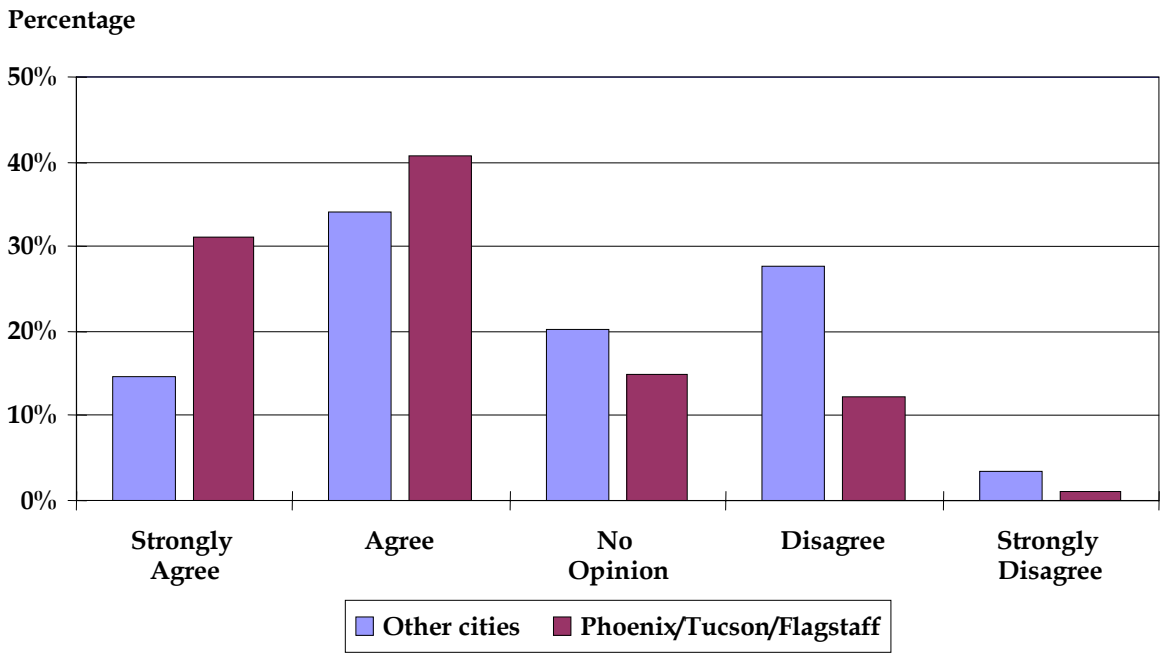


Figure 2.13 Responses to the Statement: "I Would Rather Have More Roads Than Have Part of the Budget Go to Landscaping and Aesthetics"



Finally, though respondents tended to believe that truck and freight rail movements caused environmental concerns, there was much stronger support for this idea in the more urbanized areas of Phoenix, Tucson, and Flagstaff (Figure 2.14).

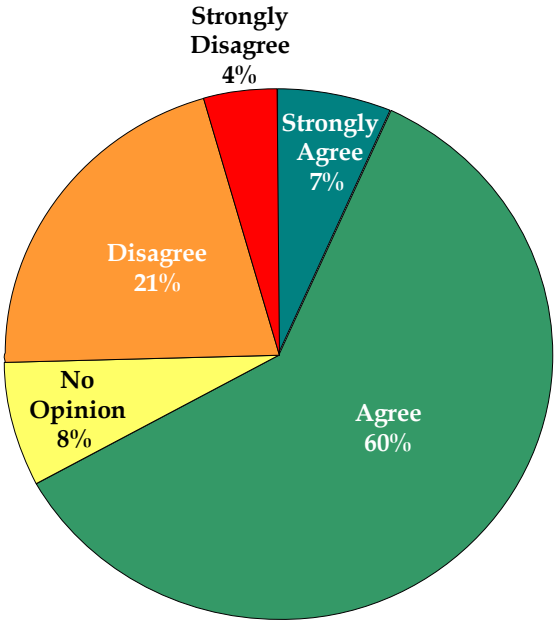
Figure 2.14 Responses to the Statement: "Truck and Freight Rail Movements Are a Major Environmental Issue in this Region"



Maintenance

One survey question dealt with maintenance issues on the state highway system. Specifically, respondents were asked if they felt that the overall maintenance of the state highway system was good (Figure 2.15). An average of 67 percent of the respondents at all the forums agreed that the overall maintenance on the state highway system was good. About 25 percent disagreed, while the remainder of the respondents had no opinion. During the forums, maintenance and preservation were also the least frequently raised issue when participants were discussing quality of life concerns. Verbal comments made by forum participants, as well as their response to the written survey questions, may reflect an expectation that ADOT will continue to maintain its roads at a high level.

Figure 2.15 Responses to the Statement: "The Overall Maintenance of State Roadways in this Region Is Good"



2.4 Combined Analysis

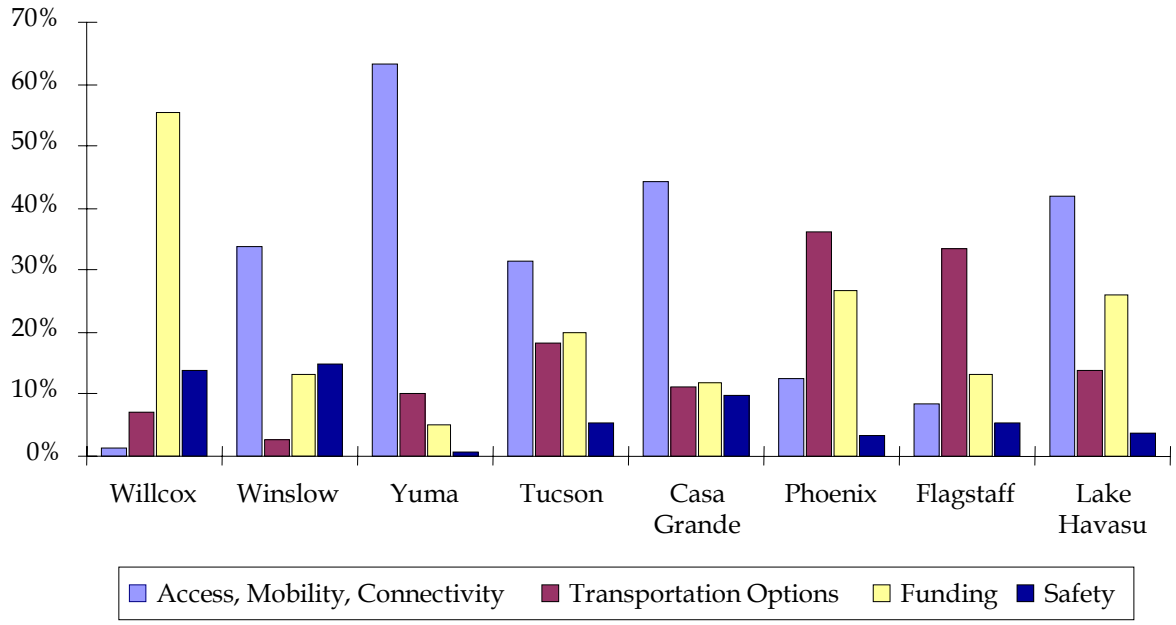
One of the purposes of the first phase of Public and Stakeholder Involvement is to provide direction for setting priorities for the MoveAZ goals and weights for the performance factors. The forums provided several methods to gather this information, including the facilitated discussion and the survey. Together, these items provide a good sense of the direction that the forum participants would like to see for MoveAZ.

This section presents a combined analysis of all these data items. First, it examines the responses to the regional public forum questions and surveys. Then, it provides an overall assessment of the MoveAZ goals and objectives based on all the data received.

Forum-Specific Concerns

Overall, though participants at the forums had many similar concerns, there were also substantial differences by forum. This section provides an analysis of the most important themes that were raised in each of the forums separately. Figure 2.16 shows the major concerns raised at each regional forum.

Figure 2.16 Major Concerns by Forum Location



Though access and mobility were the most frequently raised issue overall, some forums also raised other issues with similar frequency. In Phoenix and Flagstaff, transportation options were the largest concern; and in Willcox, funding was the dominant concern of participants. Funding issues were also raised above the average of the forums in Phoenix and Lake Havasu City. Safety issues were ranked as more serious concerns in Willcox, Winslow, and Casa Grande than in the other forums.

Lake Havasu City

Regional connectivity was the most strongly stated issue raised during the discussion of quality of life, the ranking of most serious concerns, and in the survey. Participants were concerned about the difficulty traveling between cities in the "Golden Triangle" of Kingman, Lake Havasu City, and Bullhead City. Several participants discussed the need for a new four-lane north/south corridor in western Arizona.

Three other issues were also raised at this forum:

1. Forum participants were concerned that western Arizona is not getting a fair share of state funding;

2. Survey responses from Lake Havasu City indicated that residents feel somewhat less safe on roads than most regions; and

3. Survey responses showed little support for bicycle and pedestrian improvements on state highways.

Casa Grande

Participants in Casa Grande thought the area well connected to the rest of the State. The main concern here was mobility, especially concerns about widening Interstate 10 between Phoenix and Tucson. In line with this, survey responses indicated a preference for spending transportation funds on new roads, and not on landscaping and aesthetics. Aesthetic issues were raised in the discussion of quality of life, but were not ranked highly during the prioritization of goals.

Participants in Casa Grande were especially in favor of improving air service to the region. This was clear in both the ranking of major concerns and in the survey, where nearly 90 percent of respondents thought that the MoveAZ Plan should contain strategies to support air service in the region.

Two other issues raised frequently during the ranking of goals were concerns about regional funding distribution and the need for coordinated planning for growth and development.

Phoenix

Phoenix forum participants were among the strongest supporters of transit options, as well as transportation choices in general. Phoenix participants were similarly supportive of HOV lanes and the park-and-ride system. Participants also raised concerns about funding that were related to providing funding for transportation choices. The survey supported these findings, with only one-half of respondents agreeing that cities should take the lead on public transit (the lowest of all eight forums). Though supportive of transit, Phoenix was somewhat less supportive of bicycle and pedestrian facilities on state highways.

Several environmental concerns were especially prevalent at the Phoenix forum. Participants ranked concerns about pollution more highly than in other forums. Similarly, survey responses indicated substantial concern about the environmental consequences of freight movements. Phoenix participants also showed some support for aesthetic improvements in both the quality of life question and the survey, but did not rank aesthetic concerns very highly as an issue they were concerned about or as something ADOT is currently doing well.

Willcox

Participants in Willcox were very concerned that their region was not getting its fair share of state funding. Along with this, there was surprisingly strong support for additional transit funding, in particular, for a rail connection from Willcox to Tucson and Phoenix.

Participants also had some concerns about safety, though these mainly reflected concerns about conflicts between agricultural and mining equipment and automobiles. When asked if, overall, they felt safe on the road, however, over 80 percent of survey respondents agreed. Similar concerns were not raised about conflicts between freight and

passenger traffic, with over 60 percent agreeing that these two types of traffic co-exist in the region.

Two other responses to the survey were of interest in Willcox. First, only a few of the respondents (28 percent) thought that bicycle and pedestrian facilities should be a priority on state routes. Second, a majority of participants in Willcox believed that rural areas are well connected to state transportation system.

Winslow

Participants at the Winslow forum ranked most of the issues they raised relatively equally. Distribution of transportation funding was ranked somewhat more highly, but this concern did not overwhelm other issues. As in other forums, mobility concerns were among the strongest, but concerns about safety and planning were also prevalent. In particular, several participants raised concerns about the extent of outreach to Native American communities in the region.

Several survey responses from Winslow provided the following additional information about priorities in northeastern Arizona:

- Respondents were most likely to indicate that they feel safe on the transportation system, with over 90 percent agreeing;
- A majority of respondents think that rural areas are well connected to the state transportation system; and
- Respondents in this area strongly prefer roads to aesthetic improvements, reflecting the relative importance of mobility in this area.

Flagstaff

Participants in Flagstaff provided strong support for transportation options, and transit in particular. Over three-quarters of survey respondents thought that cities should take the lead on building and operating transit systems, however. Survey respondents also supported providing improved bicycle and pedestrian facilities on the state highway system, with nearly three-quarters of respondents supporting these alternate modes.

Environmental and stewardship issues were raised somewhat more frequently than at other forums. The two key stewardship issues raised were access management concerns and land use planning issues. Flagstaff forum participants were especially concerned about state routes that pass through towns, and the need for coordinated planning on those roads.

On the environmental side, there was strong support for providing additional wildlife corridors and other protections for wildlife. Survey responses indicated substantial concern about the environmental consequences of freight movements, with over 60 percent

agreeing that these posed a problem for the region. Flagstaff participants were also among the most likely to support spending transportation funds on aesthetic improvements.

Flagstaff forum participants raised concerns about planning and the public involvement process more frequently than most other forums. This issue ranked among their top three concerns, with issues raised relating to the degree of coordination with regional transportation and land use planning, and concerns that public involvement materials would not be used to help shape the plan.

Tucson

Participants at the Tucson forum raised serious concerns about increasing truck traffic during the ranking of issues and concerns. This was also reflected in two freight-related survey questions. Less than 20 percent of survey respondents thought that freight and passenger traffic were co-existing in the region, and over 80 percent thought that truck traffic had substantial environmental consequences.

Forum participants also provided strong support for transit and transportation options, including a willingness to pay some additional taxes to raise funds. A majority of survey respondents did think that cities should take the lead on transit, but it was below the average across all forums. Similarly, a majority of Tucson participants tended to favor investing in bicycle and pedestrian facilities on state highways.

Of all the forums, survey respondents from Tucson were least likely to feel safe on the state transportation system. A small majority of Tucson respondents (58 percent) said they felt safe on the state transportation system, compared to 78 percent across all of the forums.

Tucson participants also raised concerns about the extent of coordination between ADOT and regional planning organizations.

Yuma

Mobility was the number one concern raised at the Yuma forum, and was raised more frequently there than at other forums. Many of the specific comments in both the quality of life and the ranking of concerns related to several specific road projects that participants thought would help the mobility of their area. As in Flagstaff, Yuma participants were particularly concerned about developing a four-lane north/south corridor in western Arizona. In a similar vein, less than one-half of survey responses from Yuma indicated that rural areas are well connected to the state transportation system.

Participants in Yuma provided somewhat less support for transportation options than at other forums. Major concerns about transportation options tended to revolve around the need for air service, with somewhat less support for transit or bicycle and pedestrian modes. Survey responses reflect this split. Over 80 percent of Yuma respondents agreed that that cities should take lead on transit, and only 30 percent thought that pedestrian and bicycle facilities should be a priority on state highways. Nearly 90 percent supported

developing strategies in the long-range plan to support regional airports, though this question received consistent support across all of the forums.

Maintenance concerns were raised with somewhat greater frequency during both the quality of life discussion and the ranking of issues and concerns than at other forums. In response to the survey, however, a majority of Yuma participants thought that the roads were well maintained.

Ten Directions from Phase I

The regional public forums and focus groups produced a large quantity of qualitative material for the MoveAZ Plan. The purpose of this report is to quantify and analyze this information to the greatest extent possible. The following 10 lessons provide a summary of the main points raised across the forums, surveys, and focus groups:

1. **Arizonans are particularly concerned about access and mobility.** Across all the forums, mobility ranked as the primary concern. This concern took numerous forms, including reducing travel time or congestion, building or improving particular roads to improve access to cities, reducing conflicts between automobiles and trucks, and many related actions to improve ease and efficiency of movement.

2. **Arizonans would like more transportation options, but are unsure of ADOT's role.** Transportation options were the second most frequently raised concern at the forums, but there was substantial variation from forum to forum. Many of the forums held in larger cities focused on the need for new transit options, while forums in smaller cities and rural areas tended to focus on air service. Responses for the surveys indicated that forum participants felt, overall, that local areas should take the lead on transit, though it is clear that they think ADOT should also play a role. Similarly, the aviation focus group specifically noted that they do not recommend or expect state-subsidized air service, but would like ADOT to advocate for their interests, as well as providing intermodal connectors to support air freight service.

3. **Arizonans think their roads are well preserved and maintained.** Participants raised some concerns about litter, snow removal, and related issues, but only rarely mentioned specific maintenance issues, such as pavement quality, bridges in disrepair, or related concerns. Over two-thirds of respondents to the survey thought that state roads are well maintained.

4. **Overall, Arizonans feel safe on their roads.** Though there are obvious concerns about particular locations and safety issues, most Arizonans felt safe on their roads. Safety was raised as an important goal of the transportation system, but most of these comments were very general. Participants at the forums and the focus groups (especially commercial vehicle operators and bicycle and pedestrian groups) raised concerns about increasing conflicts between automobiles and trucks or farm equipment. At the forums, participants also suggested that ADOT should improve incident management and reduce accidents, but these concerns did not receive much support when ranked

by participants. Similarly, when asked if they generally feel safe on the roads, over three-quarters of forum participants said that they did.

5. **Environmental issues were raised more frequently in some areas than in others.** Across the forums, environmental concerns were raised relatively less frequently than other issues. Phoenix participants raised air pollution and trucking issues, Tucson participants raised concerns about trucking, and Flagstaff participants raised wildlife concerns. Participants from several focus groups, including environment, transit, and bicycle and pedestrian groups, argued that investment in alternate modes could provide substantial benefits for the environment. The one environmental issue mentioned most frequently at the forums was the aesthetics of roadways. Participants in both the forums and focus group drew connections between aesthetic investments and economic development as well.

6. **Arizonans would like there to be a stronger connection between transportation and land use planning.** Land use planning concerns were raised at each of the forums and were especially prevalent in Phoenix, Flagstaff, and Casa Grande. Large majorities of survey respondents thought that transportation should be designed to direct growth to appropriate areas and promote smart growth. Similarly, land use issues were a frequent topic of discussion at several of the focus groups, especially the transit, bicycle, and pedestrian groups. These participants felt that transit investments will only be successful when transportation and land use planning are conducted to support one another.

7. **Arizona faces new economic development issues, especially regarding freight.** Goods movement was often raised at the forums as a safety concern, reflecting increasing conflicts between automobiles and trucks. Several participants, however, suggested that goods movement plays an important role in the future economy of Arizona that ADOT should support. This was reflected in comments made at several focus groups, including the commercial vehicle operator, aviation, and economic development groups. Participants in these three focus groups suggested that Arizona's economy is rapidly becoming more reliant on production and distribution activities, and could potentially become a major center for air and land freight shipment and distribution.

8. **Arizonans are concerned about the availability and distribution of funding.** Funding for transportation was one of the most frequently raised concerns at the forums and in some of the focus groups. Forum participants were generally concerned that their area was not receiving its fair share of funding; though, at a couple forums, ADOT was commended for the work it had done in that region. To a lesser extent, forum participants were also concerned about the overall availability of funding in Arizona, especially the level of funding the State receives from the Federal government.

9. **The strategic direction for MoveAZ captures the major concerns of Arizonans.** Overall, this analysis suggests that the long-range goals and objectives capture the major concerns facing Arizonans. Across all the forums, participants raised issues that related to each of the specific objectives identified for the MoveAZ strategic direction.

Each of the forums varied in its support of particular goals and objectives, but these goals and objectives appear to describe the transportation issues facing Arizona.

10. **Arizonans would like to continue to be consulted about transportation planning.** At several of the forums and focus groups, participants congratulated ADOT on talking with them about the long-range plan early in the process. They would like to continue to be involved in this planning process and future planning processes, and hope that their input will be reflected in the final plan.

3.0 Intermediate Partnering Events

3.0 Intermediate Partnering Events

The *intermediate partnering phase* of the public involvement process was implemented to develop an understanding of the types of solutions and strategies that Arizona's citizens and stakeholders would like to see included in the State's long-range transportation plan. The *intermediate partnering phase* captured:

1. Regional perspectives, using regional solutions forums, to assess the types of projects and policies that should be incorporated in the MoveAZ Plan; and

2. Stakeholders' perspectives regarding the Arizona transportation system through three additional stakeholder focus groups.

The outcome of the *intermediate partnering phase* was the identification of potential projects and policies that Arizonans envision for the State's future transportation system. This section of the report presents a detailed review of the information collected from the *intermediate partnering events*, including stakeholder focus groups and regional solutions forums.

State legislation (House Bill 2660) requires the development of weights be applied to performance factors to support development of the MoveAZ plan. Performance factors will capture the basic concepts (e.g., mobility, preservation, safety, etc.) that guide the evaluation of projects for inclusion in the long-range plan. Weights will be applied to each of the factors to capture the relative importance of particular factors. The suggestions raised at both the *initial* and *intermediate partnering phases* helped guide the development of these weights.

3.1 Focus Group Summary

During the *initial partnering phase*, ADOT conducted Stakeholder Focus Groups to capture the particular interests of various users of the transportation system. In total, nine meetings were conducted with various interest groups. Due to strong interest expressed by several groups in the *initial partnering phase*, ADOT conducted the following additional stakeholder focus groups during the *intermediate partnering phase:*

- Native American communities;
- Transit providers and users; and
- Commercial Vehicle Operators (CVO), Economic Development, and Aviation interests.

Each Stakeholder Focus Group included a presentation of the research and findings to date, review of information gathered during the *initial partnering phase*, and a facilitated discussion of issues relevant to the stakeholders' perspective. Participants were asked to rank the key lessons identified during the *initial partnering phase* by order of importance to their interests, and were encouraged to provide feedback and comments during the facilitated discussions. The purpose of the focus groups was to identify solutions, including specific projects and policies that addressed the needs and concerns identified in the *initial partnering phase*. These solutions and others identified by ADOT were presented at the regional solutions forums.

The three Stakeholder Focus Groups included between 11 and 70 participants (Table 3.1), and were held in April 2003.

Table 3.1 Attendance at Stakeholder Focus Groups

Focus Group	Attendance
Native American	11
Transit	70
CVO/Economic Development/Aviation	17

Source: Cambridge Systematics, Inc.; and PSA, 2003.

This section summarizes the comments, concerns, issues, and possible solutions identified by participants in each focus group.

Native American Focus Group

Eleven individuals representing Native American communities participated in the Native American Focus Group at the Pascua Yaqui Indian Reservation on April 16, 2003. Participants identified which of the 10 original key lessons were of highest importance to their interests, as shown in Table 3.2.

Table 3.2 Importance of 10 Key Lessons to Native American Focus Group

Key Lesson	Votes
Arizonans are concerned about the availability and distribution of funding	10
Arizonans are particularly concerned about access and mobility	9
Arizonans think their roads are well preserved and maintained	7
Arizonans would like a stronger connection between transportation and land use planning	7
Arizonans would like to continue to be consulted about transportation planning	5
Overall, Arizonans feel safe on their roads	4
Arizona faces new economic development issues, especially regarding freight	2
Environmental issues were raised more frequently in some areas than in others	1
Arizonans would like more transportation options, but are unsure of ADOT's role	0
The strategic direction for MoveAZ captures the major concerns of Arizonans	0

Source: Cambridge Systematics, Inc.; and PSA, 2003.

Overall, the Native American Focus Group was most concerned with coordination and funding. They would like to see ADOT proactively seek Federal (BIA) funding for Native American transportation systems, increase access for Native Americans to State funding sources and planning tools, and organize more community teams or task forces to increase coordination on transportation projects. The focus group also expressed great concern over access, mobility, and safety on Navajo Nation roads. During the group discussion, participants raised the following key issues:

- **Funding –** Tribal communities are concerned about the availability and distribution of funding. The current functional classification system makes it difficult for tribal projects to meet eligibility requirements for funding. Participants expressed that they would like ADOT to take a more active role in helping Native American communities gain access to State funding and transportation expertise.

- **Improved coordination –** The Focus Group participants noted that there needs to be better coordination and communication amongst tribal entities, ADOT, counties, and municipalities. This includes improved government-to-government policy and protocol and respecting tribal governments as pier entities to the State of Arizona.

- **Transportation planning –** Participants noted that all tribes need to be conducting long-range transportation planning, but do not have access to planning expertise. They also stated that ADOT needs to work with tribal communities to coordinate access with state highways and Navajo Nation roads.

- **Safety issues –** Participants noted that the fatality rate is three times higher than the rest of the State when traveling on reservation roads. Participants would like ADOT to help develop a system to get more tribal accident and traffic management data to the State.

The *intermediate partnering phase* differed from the *initial partnering phase*, in that, focus group participants were asked to recommend specific project and strategy solutions in which ADOT could address their concerns. Several types of projects were identified by the Native American Focus Group, including widening, alignment, and access improvements to freeways; expanding the use of ITS to identify tourism opportunities on tribal lands; and improving safety through such measures as expanding narrow shoulders, increasing signage, and adding rumble stripping.

Transit Focus Group

Approximately 70 individuals representing transit interests participated in the Transit Focus Group as part of the Arizona Transit Association Conference in Tucson on April 21, 2003. Table 3.3 illustrates the significance of the 10 key lessons to the Transit Focus Group.

Table 3.3 Importance of 10 Key Lessons to Transit Focus Group

Key Lesson	Votes
Arizonans are concerned about the availability and distribution of funding	59
Arizonans would like a stronger connection between transportation and land use planning	40
Arizonans would like more transportation options, but are unsure of ADOT's role	30
Arizonans are particularly concerned about access and mobility	27
Arizonans would like to continue to be consulted about transportation planning	21
Environmental issues were raised more frequently in some areas than in others	7
Arizona faces new economic development issues, especially regarding freight	2
The strategic direction for MoveAZ captures the major concerns of Arizonans	2
Arizonans think their roads are well preserved and maintained	1
Overall, Arizonans feel safe on their roads	0

Source: Cambridge Systematics, Inc.; and PSA, 2003.

The Transit Focus Group placed great emphasis on the need for additional transportation options. This group recommended that ADOT provide rural-to-urban area transit to support education, jobs, and medical and other services; explore opportunities for

implementing alternative modes, including intercity transit; and recognize that building more lanes to meet capacity demands is a never-ending process. The participants also expressed concern about mobility and accessibility. They, too, noted that ADOT needed to focus more on coordination with other agencies, specifically with the Legislature; and help advocate changes that could result in additional transit funding for the State. Some of the issues raised by the Transit Focus Group included:

- **Funding –** Arizona's rapid growth has put constraints on ADOT's ability to maintain transportation infrastructure and the ability to identify new or enhanced funding sources.

- **Improved rural access and service –** There is a great need for transit services from rural areas to urban centers, especially to meet the needs of the elderly. ADOT could help fund these investments.

- **ADOT's role in promoting transit statewide –** Participants supported a proportional distribution of funds to alternate transportation modes (i.e., light rail, buses, or bicycles would receive guaranteed funding). Participants suggested that there needs to be a separate division within ADOT dedicated to transit issues. Participants also encouraged ADOT to take the lead in promoting rail transit along the I-10 corridor between Phoenix and Tucson.

- **Cost benefit analysis –** ADOT should be a leader in transportation management by using benefit-cost analysis, encouraging travel using alternate modes, and considering qualitative and quantitative criteria that affect the State's economy. Participants suggested that ADOT needs to have broader criteria to evaluate and select projects, specifically through total cost analysis and the evaluation of air quality, land use, public health, energy consumption, and economic vitality impacts. If all of these factors were quantified, participants believed that multimodal solutions would be less costly.

The Transit Focus Group also was asked to consider specific solutions or recommendations that would benefit the State's transportation system. Several suggestions were made by the Transit Focus Group. The Group recommended that ADOT pursue, as a leader and an advocate, a multimodal approach to the State's transportation system; examine the economic impacts of transportation projects and broaden the performance-based criteria to also consider economic and social issues; and work with other organizations to be a partner in developing the State's transportation system.

CVO, Economic Development, and Aviation Focus Group

Seventeen individuals representing CVO, economic development groups, and aviation stakeholders participated in the CVO/Economic Development/ Aviation Focus Group in Tempe on April 22, 2003. This focus group, a combination of three stakeholder groups who participated in the *initial partnering phase*, identified their top priorities as described in Table 3.4.

Table 3.4 Importance of 10 Key Lessons to CVO/Economic Development/ Aviation Focus Group

Key Lesson	Votes
Arizonans are concerned about the availability and distribution of funding	25
Arizonans would like a stronger connection between transportation and land use planning	15
Arizona faces new economic development issues, especially regarding freight	14
Arizonans are particularly concerned about access and mobility	10
Arizonans would like to continue to be consulted about transportation planning	7
Arizonans would like more transportation options, but are unsure of ADOT's role	4
Arizonans think their roads are well preserved and maintained	0
Overall, Arizonans feel safe on their roads	0
Environmental issues were raised more frequently in some areas than in others	0
The strategic direction for MoveAZ captures the major concerns of Arizonans	0

Source: Cambridge Systematics, Inc.; and PSA, 2003.

Freight and economic development was the biggest concern for the CVO/Economic Development/Aviation Focus Group. Participants would like ADOT to consider the importance of freight transportation as it relates to economic development. Specifically they would like to see ADOT develop rail alternatives for goods passing through the State, explore opportunities for air freight, support development of underutilized outbound freight capacity, and develop roadway and transit connectors to airports and intermodal facilities. This focus group also expressed concerns about improving safety, the distribution of funding, mobility (bypass routes), and connecting land use and transportation planning. During the group discussion, participants discussed:

- **Funding –** Many concerns were expressed about the ability to fund transportation projects, given decreasing budgets. Participants stated that ADOT needs to help identify reliable funding sources, especially for cost-constrained projects, and ways for communities to share both costs and benefits of these projects. Participants encouraged ADOT to work more closely with the legislature to educate them about transportation needs in the State, or to work with organizations that can conduct lobbying activities.

- **ADOT's role –** Several participants indicated that ADOT needs to play an advocacy role in promoting a multimodal transportation system. Participants suggested that some of their organizations could work more closely with ADOT to support alternate modes. Participants suggested that ADOT should coordinate with the Department of Public Safety and Motor Vehicle departments to address safety and enforcement issues.

- **Underutilized transportation corridors for freight –** The amount of freight coming into the State is much higher than the amount going out of the State. ADOT needs to

focus on freight distribution in underutilized transportation corridors and modes, such as rail. These corridors represent potential assets for the State.

- **Access and mobility –** Participants raised several issues pertaining to traffic. They encouraged ADOT to start looking at ways to encourage off-peak traffic, particularly in urban areas. They also noted several projects that could be helpful, such as development of an additional freeway in the Southeast Valley, completing the San Tan Freeway, and adding a third lane to I-10 from Phoenix to Tucson. Participants suggested several bypass routes, but noted that ADOT needs a consistent policy regarding bypasses and their impact on economic development.

- **Aviation –** Many issues and concerns were raised regarding aviation in the State. Participants encouraged ADOT to consider the development of aviation for freight distribution. Concerns were raised regarding the industry's service to rural Arizona. Participants also noted strong concerns that the State's aviation fund is regularly used for other purposes, making it harder to meet the Federal match requirements. This focus group encouraged ADOT to advocate on behalf of aviation needs in the State.

Participants were asked to consider what types of solutions ADOT could provide to some of their concerns. The CVO/Economic Development/Aviation Focus Group primarily made design recommendations. Participants encouraged ADOT to consider topographic and other limitations for the movement of goods and people; an increased focus on engineering, education, and enforcement; the impacts of increased tourism on some state routes; creating the need for additional lanes and bridges; and safety improvements.

Summary of Project and Strategy Solutions

Across all three stakeholder focus groups held as part of the *intermediate partnering phase*, participants agreed that *funding* is the biggest issue facing the State's future transportation system. Stakeholders recommended that ADOT help local governments and tribal communities identify reliable funding sources. Participants advised ADOT to develop broad criteria for project evaluation and selection, including estimation of economic costs and benefits, social issues, and environmental concerns. Participants also noted concerns regarding using the State's aviation fund for non-aviation purposes, making it difficult to meet the Federal match requirements.

Participants also expressed concern about the connection between transportation and land use planning, citing the need for transportation options as an alternative to building lanes or roads. They encouraged ADOT to consider the movement of people through the State, not just automobiles. They also recommended creating connections between modes, such as between airports and railroads to the freeway system and between state highways and tribal roads.

The three stakeholder groups also identified concerns regarding access and mobility to the State's citizens and economy. Many participants suggested that ADOT should be a stronger proponent of a statewide multimodal transportation system. Some participants

supported a proportional distribution of funds to non-automobile modes of transportation (i.e., light rail, buses, or bicycles). The stakeholders advised that ADOT could help fund investments in transit services between rural and urban areas, and should consider ways of reducing congestion, such as by promoting non-peak travel in urban areas.

The transport of freight throughout Arizona was another key issue discussed by the focus groups. Participants noted that the amount of freight coming into the State is much higher than the amount leaving the State. Participants encouraged ADOT to focus on encouraging freight distribution on underutilized transportation corridors and modes, such as rail. Participants also encouraged ADOT to change the way it thinks about coordinating transportation modes to accommodate improved freight distribution and to take advantage of economic development opportunities.

3.2 Regional Solutions Forums

The goal of the *intermediate partnering phase* was for the public to discuss and suggest policies and strategies that would respond to the issues, concerns, and ideas expressed during the *initial partnering phase*. This intermediate phase provided additional stakeholder and public input and a review of initial findings to help guide the development of the draft plan. Nine regional solutions forums were held throughout the State (Figure 3.1), in addition to the stakeholder focus groups. Over 300 people attended the nine forums, ranging from 22 participants in Pinetop-Lakeside to 69 in Tucson (Table 3.5).

Each of the regional solutions forums consisted of the following activities:

- A presentation describing the current status of MoveAZ, the key issues learned during the *initial partnering phase*, and information about transportation system performance;
- An opportunity for participants to react to the key findings from the *initial partnering phase*; and
- A facilitated and open-ended discussion of potential strategies to address these key issues, including specific projects, programs, and policies. Participants were encouraged to recommend projects and programs that would potentially address the needs of their community, and suggest policy changes that would potentially benefit the State's transportation system.

Figure 3.1 Regional Solutions Forums, Spring 2003

Source: Cambridge Systematics, Inc. and PSA, Inc., 2003.

Table 3.5 Regional Solutions Forums Attendance

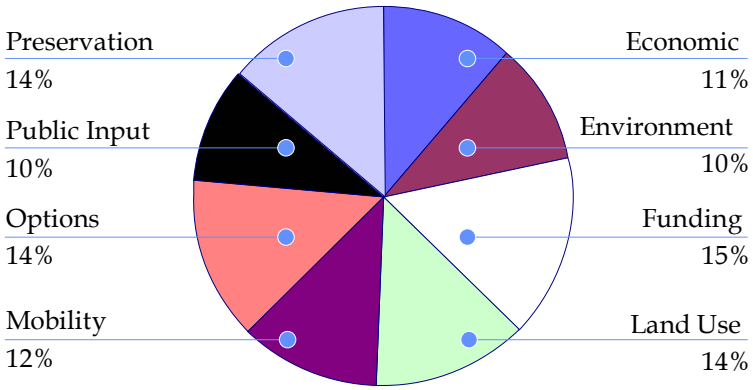
Location	Number of Participants
Flagstaff	24
Globe	27
Kingman	35
Phoenix	32
Pinetop-Lakeside	22
Prescott	35
Sierra Vista	35
Tucson	69
Yuma	38
Total	**317**

Source: Cambridge Systematics, Inc.; and PSA, Inc., 2003.

Assessment of Key Findings

The first activity of the facilitated discussions was a review and ranking of the key findings from the *initial partnering phase*. After examining all of the input from those previous events (forums and focus groups), ADOT identified several key findings focused on the issues and concerns expressed. During the facilitated discussions, participants were asked to review those findings and rank them based on the level of importance to their communities. The order of importance of those findings differed between locations, but, collectively, participants noted that the availability and distribution of funding were the most significant concerns regarding the State's future transportation system. They ranked the findings by the following order of importance (Figure 3.2):

Figure 3.2 Assessment of Key Findings



Source: Cambridge Systematics, Inc., 2003.

1. Concerns about the availability and distribution of **funding**,
2. Maintain **safety** on the roads,
3. Well **preserved and maintained roads**,
4. Create a stronger connection between transportation and **land use planning**,
5. Need more transportation **options**,
6. Transportation needs to address or enhance **economic development** opportunities,
7. Increased **access and mobility** are desired,
8. **Public input** is important to transportation planning, and
9. **Environmental** issues should be incorporated into transportation planning.

Averaging across all of the forums, no single key finding from the *initial partnering phase* was substantially under- or over-represented. Each of the key findings received between 10 and 14 percent of support from participants.

Examining responses to the key findings by location produced varied results (Table 3.6). Participants in Tucson and Phoenix noted that having transportation options was the most significant finding. Participants of the Yuma and Pinetop-Lakeside forums, however, noted that they were more concerned with well preserved and maintained roads.

Table 3.6 Participant Responses to Key Findings by Forum

	Flagstaff	Globe	Kingman	Phoenix	Pinetop-Lakeside	Prescott	Sierra Vista	Tucson	Yuma	Average
Freight	5%	14%	14%	10%	8%	6%	12%	6%	15%	10%
Environment	10%	4%	5%	16%	14%	13%	6%	12%	1%	9%
Funding	14%	11%	19%	7%	16%	10%	24%	9%	15%	13%
Land Use	16%	7%	7%	15%	13%	9%	8%	16%	13%	12%
Mobility	6%	21%	6%	13%	5%	7%	9%	14%	11%	10%
Options	15%	0%	10%	16%	3%	18%	4%	24%	5%	12%
Public Involvement	7%	13%	10%	8%	10%	8%	7%	6%	8%	8%
Preservation	14%	12%	16%	7%	17%	10%	13%	6%	18%	12%
Safety	13%	18%	12%	8%	16%	19%	17%	7%	15%	13%

Source: Cambridge Systematics, Inc., 2003.

Recommended Solutions

Participants of the regional solutions forums were asked to identify strategies that would potentially benefit the transportation system in their communities. These strategies considered specific project, program, and policy recommendations.

These recommendations will be used to support the development of performance factor weights as part of the MoveAZ evaluation process. The evaluation process will be used to examine the performance of specific transportation projects across the following factors:

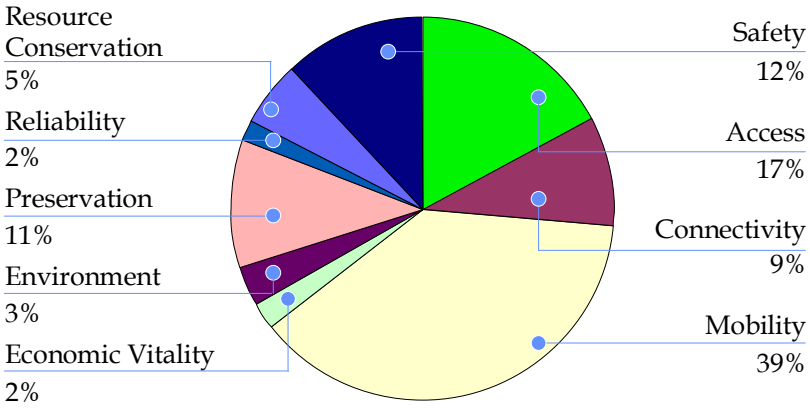
- Accessibility,
- Reliability,
- Connectivity,
- Mobility,

- Safety,
- Economic competitiveness,
- Preservation,
- Resource Conservation, and
- Environmental protection. [2]

Weights will be applied to each of the above factors to reflect their relative importance in guiding planning decisions in the MoveAZ plan.

To support this process, each suggested strategy was categorized by the most relevant performance factor. Across all of the forums, participants raised strategies related to mobility more frequently than all other performance factors (Figure 3.3). Nearly 40 percent of all participant votes were for mobility-related strategies. Several other performance factors – accessibility, preservation, connectivity, and safety – all received substantial votes at the forums, ranging from nine to 17 percent of all votes. The remaining performance factors – economic vitality, environmental sensitivity, resource conservation, and reliability – each received less than five percent of the total votes.

Figure 3.3 Strategic Recommendations by Performance Factor



Source: Cambridge Systematics, Inc., 2003

During the *initial partnering phase*, participants were asked to describe specific transportation issues and concerns. These issues also were categorized by performance factor (and other key issues outside of the performance factors, including ADOT organizational and management issues among others). There is a close link between the issues that related to

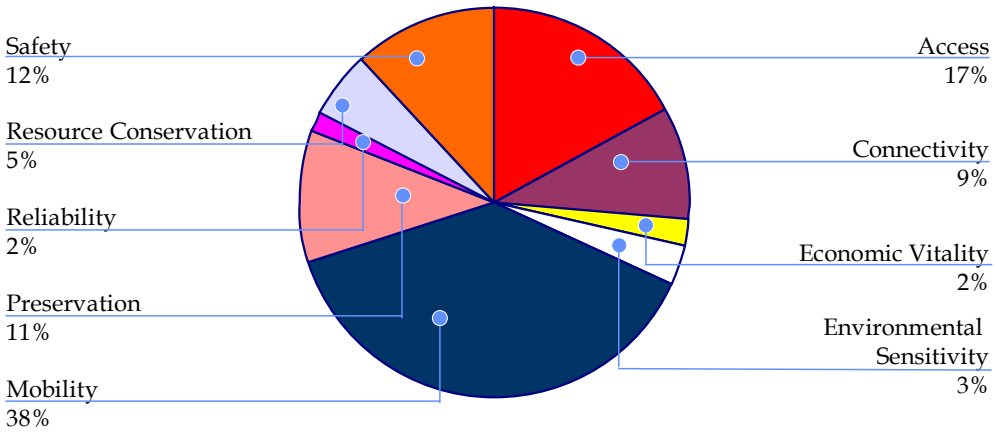
[2] Additional information about the development of performance factors can be found in the *MoveAZ Phase I Report*, available online at http://www.moveaz.org/.

performance factors from the initial round, and the strategies and solutions that were raised in the intermediate round. During the *initial partnering phase*, participants identified mobility, accessibility, and safety as their key concerns. In the intermediate partnering events described here, many of the suggested solutions also addressed those same issues (shown previously in Figure 3.2).

Project and Program Recommendations

Participants were asked to separately describe potential projects and programs and specific policies that would improve transportation in their communities. This section describes the types of projects that were recommended, as they relate to the performance factors (Figure 3.4) and other key issues.

Figure 3.4 Projects Related to Performance Factors



Source: Cambridge Systematics, Inc., 2003.

Collectively, participants recommended projects that promoted mobility, such as the expansion of existing roadway capacity or the development of transportation options to help move citizens and goods around the State. Participants also frequently suggested projects or programs that addressed accessibility, safety, preservation, and connectivity. Participants recommended projects related to economic development, environmental sensitivity, reliability, and resource conservation only infrequently.

The types of projects and programs recommended by each group often reflected local or regional transportation needs. This was revealed by the varying responses by group location (Table 3.7).

Table 3.7 Primary Project Type by Location

Location of Forum	Projects Related to Performance Factors	Percentage of Recommendations by Location
Flagstaff	Accessibility	28.56%
Globe	Mobility	57.50%
Kingman	Mobility	38.66%
Phoenix	Connectivity	32.22%
Pinetop-Lakeside	Resource conservation	42.22%
Prescott	Mobility	45.45%
Sierra Vista	Mobility	42.26%
Tucson	Mobility	64.60%
Yuma	Mobility	38.11%

Source: Cambridge Systematics, Inc., 2003.

Projects Related to Mobility

Participants of the forums held in Globe, Kingman, Prescott, Sierra Vista, Tucson, and Yuma suggested that the MoveAZ plan should, first and foremost, incorporate projects and programs that enhanced mobility. More than 64 percent of the recommendations made by participants in the Tucson forums noted projects related to mobility as the most significant type of project to the State. Participants in Pinetop-Lakeside, however, recommended the fewest number of projects related to mobility, supporting projects related to resource conservation. Many of the participants suggested that the State could benefit from the movement of goods and people by rail or other transit systems. Recommendations included adding lanes on highways to ease congestion, expanding the use of current modes of transportation, and designating new roads as part of the interstate system.

Projects Related to Accessibility

The majority of the projects recommended by participants in Flagstaff was related to accessibility. Also, participants in Kingman, Pinetop-Lakeside, and Yuma ranked projects related to accessibility as one of their top three recommendations. Approximately 35 percent of all project recommendations made in Kingman were related to accessibility. Participants were concerned with improvements to traffic interchanges and connections to the interstate system. Specific projects recommended included development of park-and-ride lots in border towns and bicycle lanes on state routes.

Projects Related to Safety

An average of 12 percent of the projects recommended by participants of all forums related to safety. Participants in the Prescott and Tucson forums identified safety projects as the second most important type of project that should be incorporated in the MoveAZ Plan. Participants of the Prescott forum recommended approximately 30 percent safety-related projects. Proposed projects related to safety included improved signage, grade separation at railroad crossings, improvements to rumble striping for bicycles, and additional education for users of all modes (car, bicycle, and truck were noted frequently).

Policy Recommendations

The regional solutions forums were also used to elicit the public's ideas and concerns regarding policies that affect Arizona's transportation system. This section describes the types of policies suggested by forum participants.

Participants suggested updated policies in three major areas: 1) funding, 2) transportation options, and 3) preservation.

Policies Related to Funding

More than 60 percent of the policy recommendations were related to funding. Participants showed great concern for how Arizona's transportation projects and programs will be funded during the next 20 years. Multiple comments were made regarding how current funding methods will not be adequate in the future. Participants encouraged ADOT to identify creative ways for funding transportation projects, examine the distribution of funding throughout the State, and support funding of various modes of transportation.

Many similar recommendations were reiterated across forums.

- To generate funding, participants recommended policies such as instituting toll roads and vehicle-related user fees (e.g., mileage-based user fees and fees for commercial vehicles). Of the funding recommendations made, over 10 percent supported increasing the State's gas tax.

- Several participants suggested that Highway User Revenue Funds (HURF) should only be allotted to capacity projects, and not be siphoned off for other agencies, such as the Department of Public Safety.

- Participants also suggested that HURF funds not be restricted to highways only (as they currently are), but also be available to fund alternate modes.

- A number of participants recommended that additional funding opportunities be available for Indian tribes.

These types of recommendations indicate that the participants are interested in working with ADOT to improve the development of the State's transportation system through their involvement in the implementation of the MoveAZ plan.

Policies Related to Preservation

Many participants noted that roads currently are well preserved and maintained, and that preservation and sustainability of current resources should be a major priority for the State's transportation system. Participants in Sierra Vista recommended the most of any one type of policy; over one-half of their policy recommendations was related to preservation. Some participants agreed that a certain amount of funding should be earmarked annually to maintain the current system. Participants throughout the State identified the need for more coordination between transportation and land use planning, and encouraged increased cooperation between the State and local governments as a way of meeting that need. The need for additional policies regarding the distribution of maintenance funds to rural and tribal communities also was noted.

Policies Related to Transportation Options

Many of the policy recommendations, as well as issues identified during the *initial partnering phase*, called for increased transportation options. Participants supported policy developments that would encourage increased mobility throughout Arizona for both people and goods. Participants in Prescott and throughout the other forums advised that ADOT needs to be the leader of and advocate for developing alternate modes of transportation, including developing a separate transit department within ADOT. Some of the specific recommendations included:

- Studying rail expansion as a viable transportation option for the State;
- Supporting additional bicycle and pedestrian services through increased regional funding for bicycle facilities and consideration of bicyclists and pedestrians in roadway design;
- Improving safety conditions for bicycle transportation (i.e., bicycle-friendly rumble),
- Protecting the Aviation Trust Fund from other uses; and
- Ensuring that rural airports are able to provide emergency response and evacuation services.

Many participants suggested that the key to creating a multimodal system that serves the entire State depends upon securing legislative support. Participants in the Phoenix forum, for example, strongly recommended that funding in urban areas should be reallocated towards transit development and could be handled on the legislative level, possibly through the development of a regional transit authority. Participants in rural areas recommended that Congressional changes be pursued to increase the percentage of funding

allocated to transportation funding and, specifically, the amount designated for rural transportation infrastructure.

Additional Policy Recommendations

Various policy recommendations were made that either did not fall under the categories of funding, transportation options, or preservation; or that were not broadly supported across all forums. These recommendations, however, may still be considered as viable solutions.

- Many policy recommendations referred to increased safety measures, such as increased coordination with the Office of Homeland Security for evacuation routes; and additional public education outreach.
- Some participants suggested improved coordination with Arizona Department of Game and Fish in the development of roadways to address wildlife issues.
- Several comments were made regarding the structure of ADOT and the state transportation board, usually supporting the current structure of the ADOT Board.
- Participants in several forums also mentioned the need for increased cooperation and communication between state organizations and communities.
- Participants encouraged ADOT to be the leader in facilitating communication with the State's council of governments (COGs), regional planning organizations, and Indian Tribes.

3.3 Summary of Surveys

In addition to participating in the facilitated discussions summarized in the previous section, regional solutions forum participants filled out a two-part survey that asked them to make choices among different types of programs and policies. Table 3.8 presents the total attendance and number of completed survey responses received at each forum.

The surveys used two questions to provide complementary perspectives on a set of general transportation system funding tradeoff issues. The first question asked survey respondents what their spending priorities would be if additional funds were available; and the second question asked what respondents might be willing to sacrifice (related to transportation levels of service) if funds were not available to meet all of Arizona's transportation needs. Participants were asked to think of themselves as members of the State Transportation Board, having to balance numerous requests from citizens and stakeholders, all with very important needs to address. The following section connects the analysis of the surveys to the material generated at the regional solutions forums.

Table 3.8 Attendance and Survey Responses for MoveAZ Regional Public Forums

Forum	Attendees	Surveys
Flagstaff	24	23
Globe	27	21
Kingman	35	32
Phoenix	32	30
Pinetop-Lakeside	22	19
Prescott	35	30
Sierra Vista	35	26
Tucson	69	47
Yuma	38	37
Total	**317**	**295**

Source: Cambridge Systematics, Inc.; and PSA, 2003.

Priorities for Additional Funding

The first set of questions asked, "If additional transportation funding were to be identified, please indicate how you would like to see this additional money spent by reacting to the following statements?" Respondents were provided with a list of 10 potential funding priorities (Table 3.9) and were asked to identify their level of support for each priority.

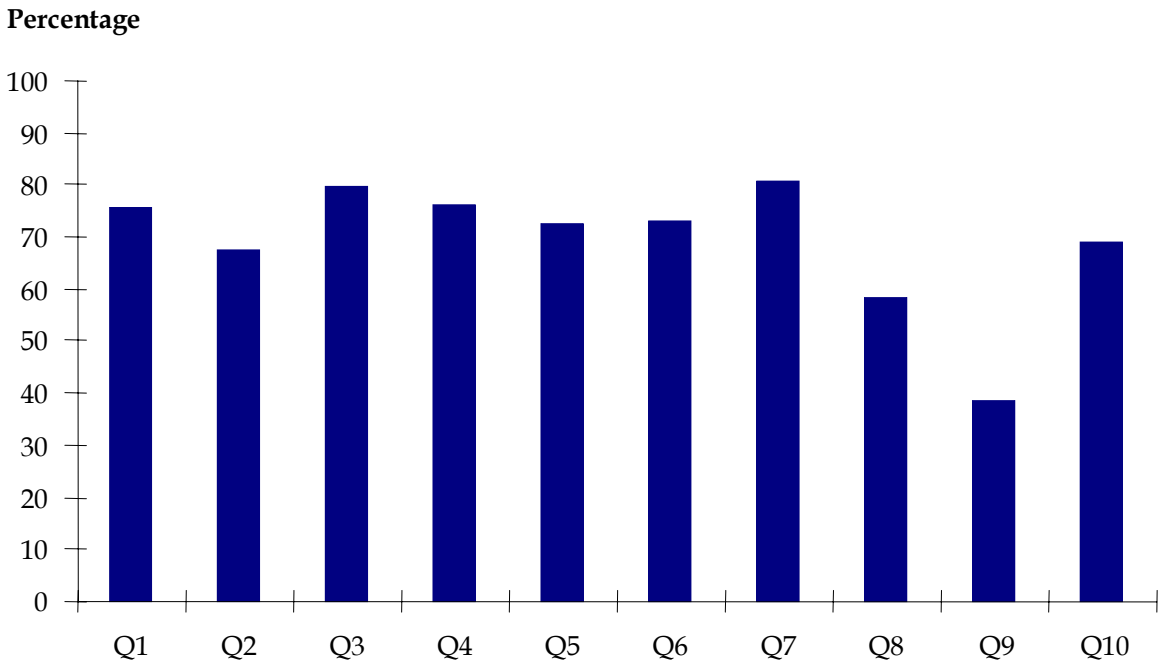
Most of the funding types received support across all of the forums (Figure 3.5). Only investments in highway beautification averaged less than 50 percent support across all of the forums. Support for HOV lanes (Q8) was less than 60 percent, averaged across all of the forums.

Table 3.9 Survey Statements Regarding Additional Funding

Q1	Commuter rail should be developed on existing rail lines, connecting suburbs to central employment areas
Q2	Light rail (urban train system) should be developed to serve urban areas
Q3	Expansion of bus system to serve urban and suburban areas
Q4	Develop intercity transit service connecting one city to another
Q5	Expand capacity of interstate highways (e.g., I-10, I-40)
Q6	Include bicycle and pedestrian facilities in future road development projects
Q7	Expand capacity of state highways (e.g., SR 95, U.S. 60)
Q8	Expand car pool/HOV lane system in metropolitan areas
Q9	Increase investment in highway beautification
Q10	Invest in key airport expansion and improvements

Source: Cambridge Systematics, Inc.; and PSA, 2003.

Figure 3.5 Survey Responses to Additional Funding Questions



Source: Cambridge Systematics, Inc.; and PSA, 2003.

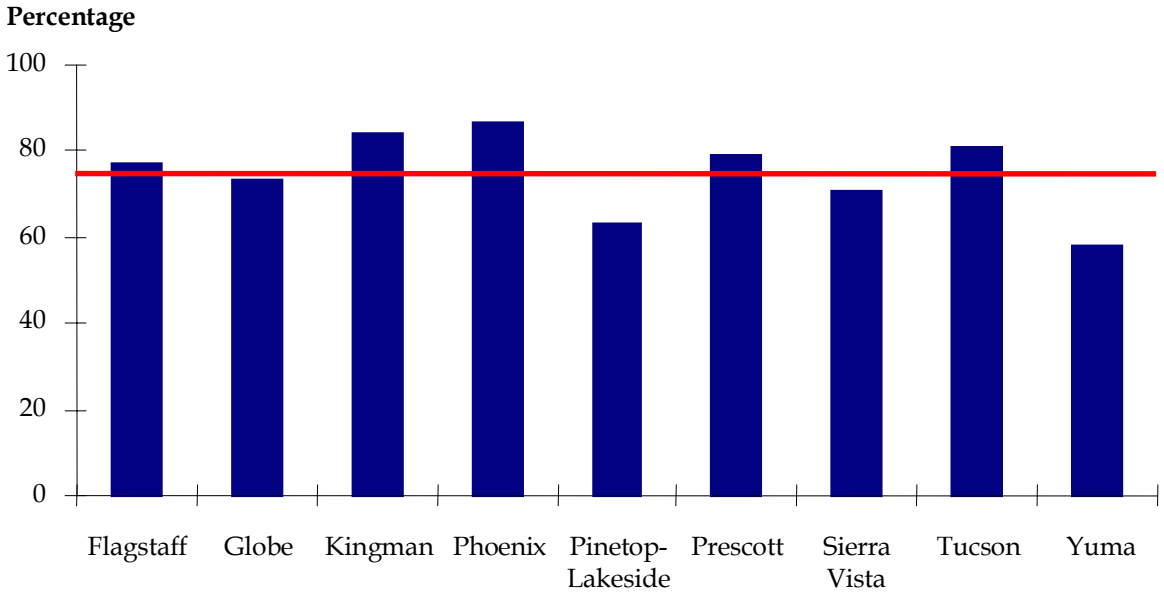
Transit and Commuter Rail Questions

Four questions considered support for transit and commuter rail programs (one for bus, one for rail transit, one for commuter rail, and one for intercity transit). On average, support for bus-based transit received the greatest support (80 percent) of these four, but each received support from an average of at least two-thirds of respondents across all of the forums.

In both Pinetop-Lakeside and Yuma, support for each of these questions was substantially lower than in the rest of the State (Figure 3.6). A majority of respondents in Yuma thought that light-rail transit (Q2) should not receive additional funds. On average, most transit questions received minimal support in Yuma, though for bus transit (Q3), nearly 70 percent of respondents were supportive. Respondents in Pinetop-Lakeside evinced slightly more support than those in Yuma, but still were 10 to 15 percent less likely to support transit than other respondents were.

Respondents from the Phoenix forum were more likely to support additional transit funding than any of the other groups (Figure 3.6), though Kingman, Tucson, and Flagstaff also provided above average support for transit.

Figure 3.6 Average of Support for Four Transit Questions (Q1 to Q4)



Source: Cambridge Systematics, Inc.; and PSA, 2003.

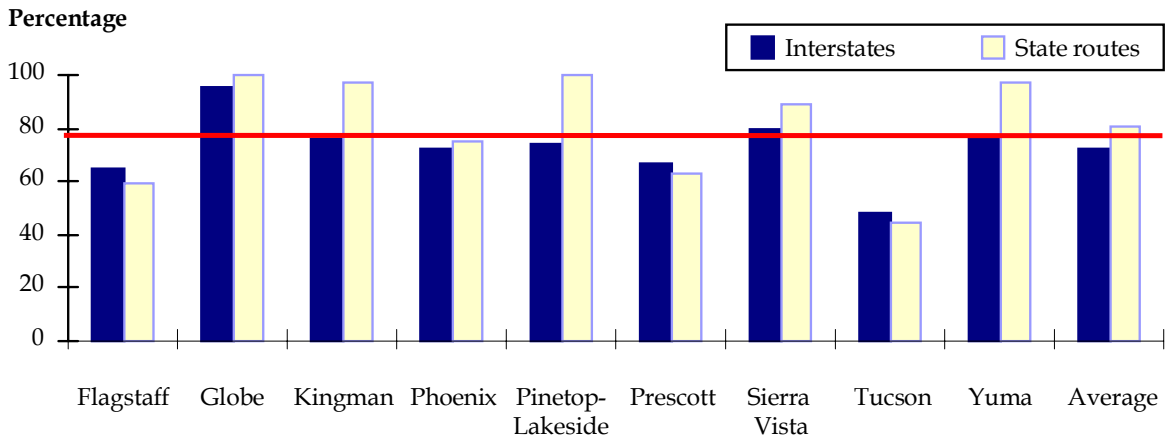
Highway-Related Questions

Two questions considered respondents support for highway-related projects – one focused on interstates (Q5) and the other focused on other State routes (Q7). The latter of

these two questions received the greatest total level of support (over 80 percent) across all of the forums (also shown in Figure 3.5).

Overall, both questions received support from the majority of participants at almost all of the forums (Figure 3.7). In Tucson, just under 50 percent of respondents supported these two questions. Support for the question regarding state routes was strongest in rural areas, with nearly 100 percent of respondents supporting this expenditure of funds at the Globe, Kingman, Pinetop-Lakeside, and Yuma forums. In Flagstaff, Phoenix, and Prescott, there was relatively less support for either of these two expenditures of funds, but still exceeded 50 percent.

Figure 3.7 Support for Highway Questions by Forum (Q5, Q7)



Source: Cambridge Systematics, Inc.

Priorities for Reduced Funding Levels

The second set of questions asked, "If we had to reduce funding from some transportation programs in order to maintain reasonable levels of service in other areas, where would you be most willing to accept a reduction in service or quality?" Participants were provided with a list of seven potential reduced funding options (Table 3.10), and were asked to identify their willingness to accept each possible scenario.

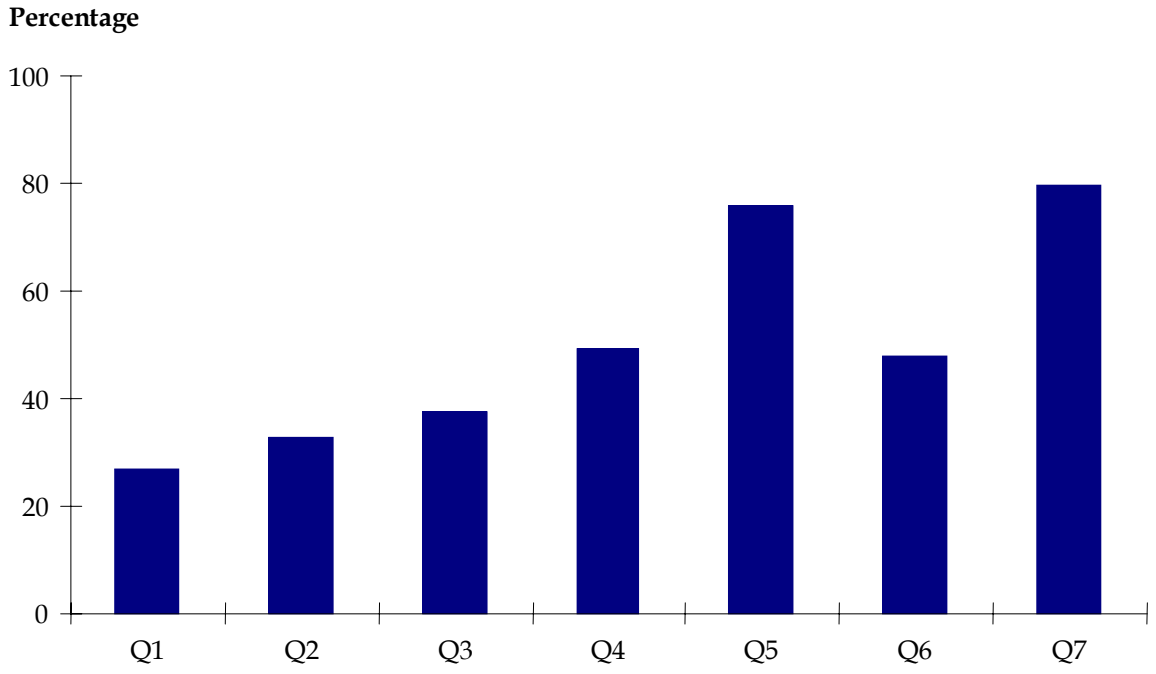
Table 3.10 Survey Statements Regarding Reduced Funding

Q1	Accept rougher roadways
Q2	Accept reduced rural and disabled transit service
Q3	Accept more congested roadways
Q4	Accept more unpredictable travel times and speeds
Q5	Accept less landscaping and aesthetics
Q6	Accept closure of some general aviation airports
Q7	I would be willing to pay more for transportation rather than reduce services (through toll roads, increased taxes or fees, etc.)

Source: Cambridge Systematics, Inc.; and PSA, 2003.

All of the possible scenarios of reduced funding strategies were supported across all forums (Figure 3.8). Respondents of the Pinetop-Lakeside forum gave the least amount of support for accepting rougher roadways (Q1). Respondents at the Tucson forum were the most supportive of paying for transportation services (Q7), with 91 percent strongly agreeing or agreeing with the strategy.

Figure 3.8 Survey Responses to Reduced Funding Questions



Source: Cambridge Systematics, Inc.

Acceptance of Increased Transportation User Fees

The majority of respondents across all forums (80 percent) strongly agreed or agreed that they would be willing to pay more for transportation rather than reduced services (Q7). Respondents at the Flagstaff, Kingman, Phoenix, Sierra Vista, and Tucson forums noted increased fees as their first choice for generating additional transportation funds. The least amount of support for increased fees was noted by respondents at the Prescott forum, although they still demonstrated 63 percent support for this option.

Acceptance of Less Landscaping and Aesthetics

Acceptance of less landscaping and aesthetics (Q5) was the second most supported strategy when faced with decreased transportation funding resources. An average of 76 percent of respondents across all forums supported this measure. Respondents at the Globe, Pinetop-Lakeside, Prescott, and Yuma forums chose it as their first option. The lowest percentage of support for this option was 60 percent in Phoenix, even though it was their second most acceptable strategy for dealing with decreased funding.

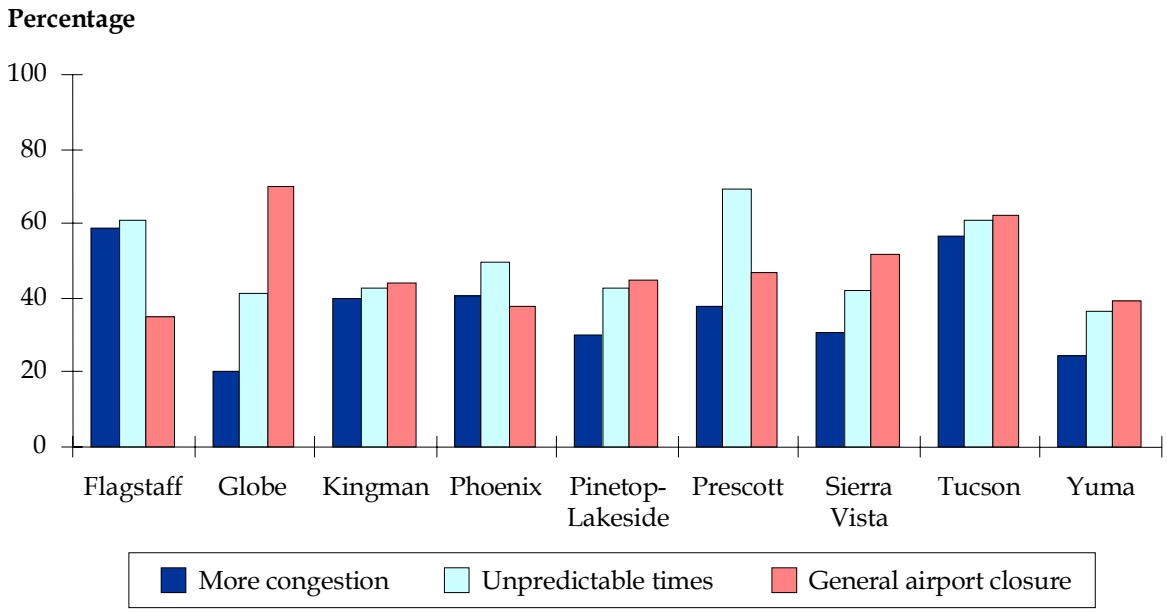
Acceptance of Changes to Mobility and Reliability

Three of the questions considered different aspects of mobility around the State – more congestion (Q3), more unpredictable travel times (Q4), and reduced service of general aviation airports (Q6). None of the respondents selected the decreased mobility options as their most acceptable strategy for dealing with decreased transportation funding (Figure 3.9).

Overall, less than 50 percent of the respondents were willing to accept more unpredictable travel times, though over 50 percent of respondents at the Flagstaff, Prescott, and Tucson forums found this strategy acceptable. Closure of some general aviation airports was also rejected overall, but three forums – Globe, Sierra Vista, and Tucson – all found this strategy acceptable.

Of the three mobility-related strategies, acceptance of increased congestion was the least popular, with only 38 percent of respondents supporting this alternative. Over 50 percent of respondents in Tucson and Flagstaff did support this alternative, but most of the respondents across the State thought reducing congestion should be a major priority.

Figure 3.9 Acceptance to Changes in Mobility and Reliability



Source: Cambridge Systematics, Inc., 2003.

Least Acceptable Strategies for Dealing with Decreased Funding

Survey respondents indicated that they were less likely to accept rougher roadways (Q1) or reduced rural and disabled transit service (Q2). On average, only 27 percent of all respondents were willing to accept rougher roadways (Q1), with the least amount of support for any option given by respondents in Pinetop-Lakeside of only five percent. Respondents at the Phoenix, Prescott, and Tucson forums noted reduced rural and disabled transit service (Q2) as the least acceptable strategy for insufficient transportation funding.

3.4 Forum-Specific Concerns

The purpose of the *intermediate partnering phase* of Public and Stakeholder Involvement is to help identify potential strategies and solutions to address the issues and concerns raised in the *initial partnering phase*. The forums utilized facilitated discussions and a survey to gather information that will help ADOT prioritize the MoveAZ performance factors that guide the long-range planning evaluation process. This section presents a summary of the combined analysis of the facilitated discussions and surveys, focused on the specific concerns raised at each of the forums.

Overall, though participants at the forums had many similar concerns, there were also substantial differences by forum (Table 3.11). This section provides an analysis of the most important themes that emerged for each of the forums.

Table 3.11 Project and Policy Strategy Recommendations by Forum

Factor	Flagstaff	Globe	Kingman	Phoenix	Pinetop-Lakeside	Prescott	Sierra Vista	Tucson	Yuma
Access	18%	4%	24%	21%	12%	8%	13%	4%	12%
Connectivity	0%	8%	9%	21%	6%	3%	0%	4%	16%
Economic Vitality	0%	4%	3%	4%	1%	0%	0%	6%	0%
Environment	12%	0%	7%	1%	0%	1%	7%	4%	4%
Mobility	26%	41%	33%	22%	3%	39%	39%	59%	27%
Preservation	24%	22%	16%	13%	25%	18%	21%	8%	11%
Reliability	5%	2%	3%	2%	1%	0%	0%	3%	18%
Resource Conservation	2%	4%	0%	0%	38%	0%	5%	2%	8%
Safety	13%	15%	5%	17%	14%	31%	14%	11%	5%

Source: Cambridge Systematics, Inc.; and PSA, Inc., 2003.

Flagstaff

Similar to most of the forums, strategies and projects that promoted access and mobility were most strongly supported through discussion and survey. At Flagstaff, however, this support was somewhat less strong than other areas (26 percent of project and policy recommendations, compared to 31 percent, on average). Preservation and accessibility issues were also very important in Flagstaff. Flagstaff participants encouraged development of rail and other transit options as a means of creating a multimodal transportation system. Policy recommendations most strongly supported preservation and resource conservation. Participants supported increasing taxes and user fees to address the needs for additional funding options. They also encouraged legislative changes that would reward responsible land use planning with transportation dollars.

Globe

Mobility emerged as the leading goal of projects recommended by participants in Globe. More than 40 percent of the project and policy recommendations were related to mobility, with concerns about widening existing roads or developing new roads at the top of the

list. Survey responses showed some support for transit options, but much less for state investment in increased bicycle and pedestrian facilities, expanded carpool/HOV lanes, or investments in highway beautification. Policy recommendations encouraged increased measures for preservation of and safety improvements to the State's transportation system. Participants of the Globe solutions forums gave the strongest support of any of the forums to policy changes related to safety. They also strongly supported the need to develop additional funding options, specifically through an increased gas tax. They showed the most acceptance for closure of some general aviation airports.

Kingman

Participants of the Kingman forums were strongly concerned with accessibility and connectivity issues facing the State. The majority of the projects they recommended or supported through the surveys would improve the ability of western Arizona to access the interstate and state highway system. Recommended projects included improving the SR 95 corridor from I-8 in the south to I-15 in the north, and interchanges along I-40. The majority of policy suggestions supported in the Kingman forums were related to preservation and connectivity. They indicated that they would strongly support increased fees for transportation in order to improve the State's system. Participants encouraged ADOT to study the effects of implementing toll roads in the State.

Phoenix

Accessibility, mobility, and connectivity were all major concerns for participants at the Phoenix forum. Phoenix participants showed the greatest support, more than 80 percent, for commuter rail, light rail, expansion of the bus service in urban and suburban areas, and intercity transit service connecting one city to another. They recommended improved connectivity of the regional HOV system. Participants strongly suggested that legislative measures should be in place to ensure proper land use planning and to examine transportation funding allocation. Increased transportation user fees and acceptance of decreased landscaping and aesthetics were supported in Phoenix. Their policy recommendations showed more support for economic development opportunities than in any other forum, though still below 10 percent.

Pinetop-Lakeside

Participants showed greatest support for projects and policies related to preservation and resource conservation. Participants recommended that ADOT revise highway standards and consult with local communities on highways that serve as main streets within towns. Participants also recommended that ADOT help provide transportation expertise to communities that currently do not have access to transportation planners. Pinetop-Lakeside participants were least likely to accept decreased quality of the roadways. In addition, participants encouraged ADOT to pursue expanding funding sources.

Prescott

Mobility, safety, and preservation were the most strongly supported project and policy recommendations made by participants in the Prescott forums. Project recommendations included creating increased capacity of roadways, developing new interchanges to support increased growth, and improving traffic enforcement and driver education. Participants indicated the most acceptance for unpredictable travel times, should transportation funding be reduced. They also showed strong support for development of new funding sources through transportation impact fees.

Sierra Vista

Participants in Sierra Vista supported projects that enhanced connectivity and policies that supported preservation of the State's current system. Bypasses, expanded capacity of highways, and transit connections for rural Arizonans were recommended. Policy recommendations were often related to funding. Participants suggested increasing the gas tax, additional distribution of funding to rural COGs, and a review of HURF distribution. They also supported paying more for transportation rather than accepting reduced services.

Tucson

Projects and policies that enhanced mobility were most strongly supported in the Tucson forums. More than 63 percent of the recommendations made by participants in the Tucson forums noted projects related to mobility as the most significant type of project to the State. Recommendations included developing rail system for transport of goods and people between Tucson and Phoenix, redesignating certain state routes to state highways, and increasing education of transportation options and travel conditions. Policy recommendations included additional support for an expanded rail system, restoring local government power to determine how transportation funds are distributed, and an index of the gas tax. Tucson participants also showed the greatest willingness to pay more for transportation rather than having reduced services.

Yuma

Participants of the Yuma forum most strongly supported projects that enhanced mobility, connectivity, and reliability. Participants were most strongly encouraging on the expansion of highway capacity, promoting the completion of the Area Service Highway, and recommending the planning of a regional loop system, in anticipation of high levels of projected population growth. The majority of the recommended policies supported resource conservation and the development of additional funding options. Recommendations included using technology to inform travelers of travel conditions, reinstating the

HURF dollars that are currently diverted to the DPS, and exploring the option of implementing vehicle user fees.

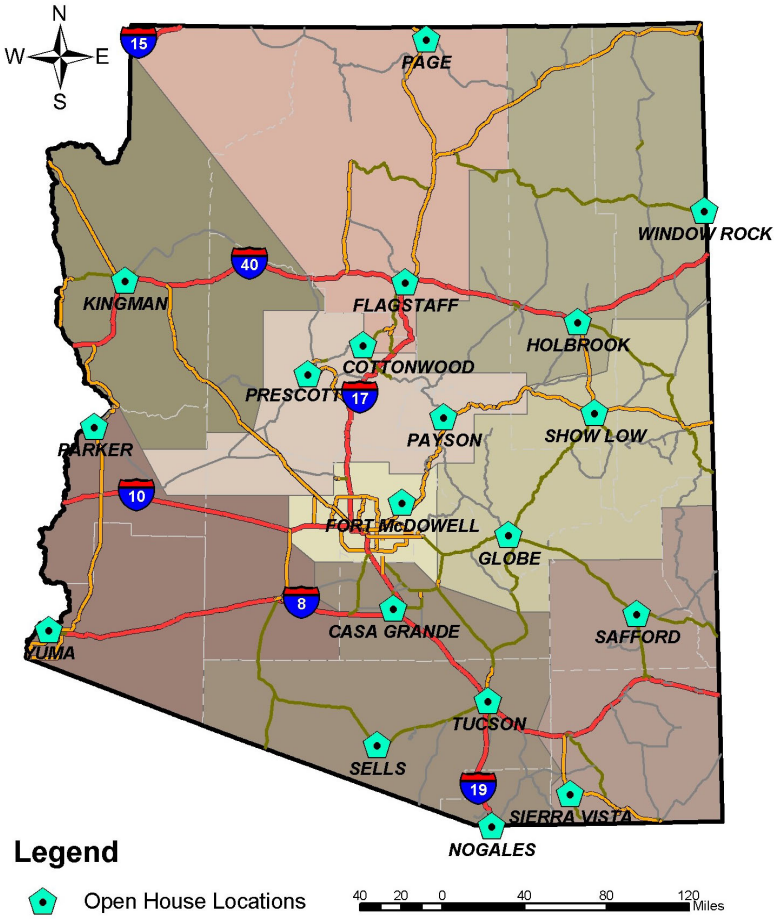
4.0 Open Houses

4.0 Open Houses

The goal of the *final partnering phase* was for the public to discuss and respond to the draft plan. This was accomplished through 20 open houses conducted all across the State. (Figure 4.1). Over 400 people attended the 20 open houses, ranging from 10 participants in Window Rock to 44 in Page (Table 4.1).

Unlike the regional forums in the initial and intermediate partnering phases, the open houses were relatively unstructured events. They were designed to allow participants to learn about the entire planning process, interact directly with ADOT representatives, and provide comments on either the process as a whole or specific information presented at the open houses.

Figure 4.1 Open Houses, Spring 2004



Source: Cambridge Systematics, Inc.; and PSA, Inc., 2004.

Table 4.1 Open House Attendance

Location	Number of Participants
Casa Grande	27
Cottonwood	22
Flagstaff	28
Fort McDowell	24
Globe	22
Holbrook	11
Kingman	41
Mesa (Transit Conference)	11
Nogales	15
Page	44
Parker	17
Payson	12
Prescott Valley	23
Safford	15
Sells	11
Show Low	15
Sierra Vista	32
Tucson	38
Window Rock	10
Yuma	21
Total	**439**

Source: Cambridge Systematics, Inc.; and PSA, Inc., 2004.

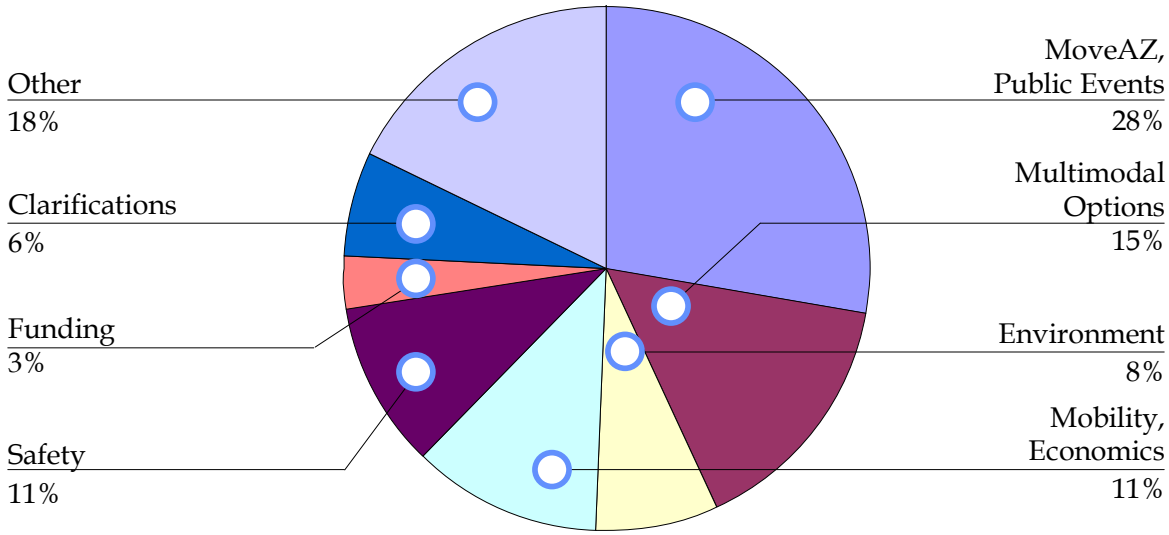
4.1 Assessment of Open House Comments

The purpose of the *final partnering phase* was to provide the public with an opportunity to comment on the draft plan. There were no facilitated discussions in this round, but plenty of opportunities to comment about any aspect of the MoveAZ plan or about the planning process in general.

ADOT received over 200 comments; over one-quarter of these comments was made in reference to either the MoveAZ planning process or public involvement process. A number of comments thanked ADOT for holding the open houses and other events in their communities. Several comments also noted the value of using a performance-based planning process in Arizona.

Many of the other comments received at the open houses reflected concerns raised during the initial and intermediate partnering events (Figure 4.2). These concerns include the need to pursue multimodal transportation options, such as improved transit and increased air service to rural areas of the State; the need to improve the safety of the state transportation system; and the importance of mobility to support the economic well being of the State and its residents.

Figure 4.2 Primary Subject of Comments Received at MoveAZ Open Houses



The initial and intermediate partnering phases were designed to elicit specific comments to help shape the strategic direction and guide the development of performance factor weights. In the *final partnering phase*, the objective was to provide an opportunity for residents of Arizona to view and react to the draft plan. The strong positive reaction to the open houses and the planning process generally suggests that the open houses provided this opportunity to Arizonans.

4.2 Open House Reports

This section identifies the specific comments received at each open house.

Casa Grande

- Any information on the prospect of the right of way of old SR 87 from the I-210 and Sacaton exit due south across the Gila River Indian Community into the saddle of the Sacaton Mountains? Thank you!
- Recently, my husband and I attended the MoveAZ event in Casa Grande on March 23. We are impressed with your posters and maps, but we need something done sooner. We need action! I have lived along I-10 between mile posts 211 and 236 all my life and seen too many traffic accidents, trucks/tractor trailers going too fast. Can there be a re-route?

Cottonwood

- I would like to see the multimodal aspect given more consideration, and provide citizens with real choices. Right now, fear of the roadways keeps people in their cars. We need bicycle facilities.
- I would like to see 10- to 12-foot boxes for hikers, wildlife, and horseback riding in the area and to connect towns and historical trails.
- The Sedona/Verde Valley area has some of the highest tourism visitation in the State. Why are our bicycle facilities medium or low? Tourism is suffering.
- Please address culverts for foot, wildlife, and horse traffic.
- Turn outs needed on SR 260, why not put in the first time?
- Please address 10- to 12-foot boxes for community trails, wildlife, bikes, horses, and historic trails.
- Regarding the utility concerns expressed in the focus groups, carry the communication that this process has started by working together in areas like Central Yavapai Municipal Planning Association to help each other plan infrastructure, as well as improve permitting process.
- This was not what I expected. I wanted to see the plans, not the process. I would like to see bike lanes, underpasses for wildlife, bikes, horses, and hiking access and bridges over riparian areas with consideration to the environment. Long-range plans are a wonderful idea. Remember that what is built will be there a long time.

Flagstaff

- The goals and mission are good. Objectives which tie to goals and objectives are needed. Without action it is just words, but a good start!
- Will there be bicycle/pedestrian and transit funding plans presented, as well as the highway plan?
- Access to tourist destinations is important, especially for air travel.
- There is no funding for other choices.
- Enforcement of transportation laws needs to be addressed, specifically auto and pedestrian interaction.
- What use is transportation if it is dangerous?
- Be sensitive to wildlife habitats and corridors.
- It is INCREDIBLE that the best overall transportation experience that most people indicated was for transit. WOW. Arizona needs more funding for transit!
- I noticed the same thing as above, and second the notion!!
- Other modes should not be segregated and should be funded and incorporated regularly.
- There is no public forum on your website – sad.
- ADOT should move to develop an outline of major concerns along Interstates 10, 17, 8, and 40 through the year 2050.
- The high ranking of transit indicated a desire for low stress travel. While cars are for convenience. I think high-speed connections between destinations with well developed local transit should be looked into.
- Figure 4.2(10) does not say much. Can you put more meat on it?
- Make sure pavement preservation is adequately funded.
- Heavy traffic is expected because too much emphasis is placed on automobile travel. Mass transit should get more attention. Sell it to the public!
- Shouldn't state land sales be subject to a transportation impact analysis prior to the State selling the land?
- ADOT needs some involvement in rail (maybe high speed) if it is to encourage the use of transit in urban hubs. This would allow time efficient location of park-and-ride

hubs around the State with destinations such as Phoenix, Tucson, Flagstaff, Kingman, and Yuma.

- All of the Flagstaff projects are roads. Why? Your goals and mission speak to "multi-modal," "transit," and transportation choices, but all of the project are for cars. Disappointing.
- If the second strongest transportation issue identified was "transportation options," why is NO INCREASD FUNDING recommended in this area?
- The policy and direction should be clearer in providing the Transportation Board latitude and discretion… The rating and use of this formula should not be interpreted as an edict that they must follow.
- More pedestrian, bicycle, and mass transit projects should be in focus. Cars are killing us and the environment and keeping us depended upon foreign fuel sources.
- Figure 5.2(14) please use common explanations. What does constrained scenario mean?
- Has consideration been given to tax tourists through airports taxes, car rentals, motor coaches, etc.? Less could go to stadiums, etc. Not everyone benefits from stadiums, but most do benefit from tourism dollars and our needs for getting around. The cities/counties building these structures should foot a larger portion of the bill. Seek more private funding

Fort McDowell

No comments were received at the Fort McDowell open house.

Globe

- Not enough alternative transportation focus – light rail and bicyclists.
- Need shoulders for bicyclists out of Globe. This is a major cross country route.
- There needs to be a Globe/Miami bypass study done.
- When will functional classifications be done?
- A Globe/Miami bypass study is critical to our planning.
- U.S. 70 needs to be four lanes to the New Mexico line. This is a Homeland Security issue.

- Project 12.02 does not have safety as a concern, yet it is second on the list.
- Cost of projects 12.32, 12.01, 12.43, 12.31, 12.04, 12.11, 12.61, 12.21, 12.06, 12.05, 12.51, and 12.45 are almost equal in projected cost to 12.02.
- Safety should be a concern here from Globe to Superior (project 12.02). Increasing population and more valley commuters make it more dangerous.
- Cross country cyclists use this as a primary route, yet there is no shoulder!
- I've witnessed five accidents this month at the intersection of U.S. 60 and South Street. Please check/study the feasibility of a stop light. Thank you!
- Thanks for coming to Globe. It is refreshing to see ADOT using performance measures to prioritize projects.
- On board 3.3 8, why is it frequency by category had three percent environment, but 10 percent on land use on the percentages of the partnering process? Does the former concern really reflect Arizona's values? The three percent drive too much of the process.
- The road to Payson, I like what you are doing.
- Very nice opportunity to see the results of the planning effort.
- ADOT seems to be reaching out to member of different communities, which is great. The information provided in Globe was very informative and clearly displayed. Great work!
- I want to see additional passing lanes on U.S. 60 between Superior and Miami and a bypass around Globe with four lanes to Lordsburg.
- In a tight funding environment, remember your Mission Statement says you will provide a variety of transportation options. Remember, bicyclist pay taxes too. Think safety!
- The planners were able to communicate their plans in laymen's terms. Positive feelings and I was urged to write my comments negative or positive.
- The highway between Miami and Superior needs to be four lanes. We have a very unsafe situation between Superior and Gonzales Pass as well.

Holbrook

- Very informative, well presented, public friendly.
- Very informative. Appreciate the outreach efforts – makes it easier for government folks to talk to the public when we are informed/involved in the process. Good luck in your efforts!
- Glad to see so much work being done over the next five years.
- Good job. Would like to see a little more early coordination with local agencies.
- Information covered seemed to be the tip of the iceberg. Ton of information still needs to be explained at the reservation level. Recommendation is to have information presented to the White Mountain Apache Tribe Tribal Transportation Committee. Thank you.
- Thanks for stopping in Holbrook – the information (both displayed and presented) was very helpful. We look forward to hearing and seeing more in the future.

Kingman

- How is the suitability for bicycles determined?
- Check SR 93 delay forecast for new bridge.
- Where is the I-40 to SR 68 extension? New road extending SR 95?
- Design and build project from Hoover Dam to connect to double highway on plan (five-year) to milepost 59? Rattlesnake Wash exchange or overpass?
- What is the status on the traffic interchange at Rattlesnake Wash east of Kingman three miles east of town? The town is cut in half by the railroad. We want access.
- I attended the other MoveAZ events, and it looks like you did what you said you would. Great job!
- Good job!! Great planning too!
- Would like more information on the prioritization of the connection of the new bridge over the Hoover Dam and Road to divided highway. Would love to know if the process could really be influenced by public. Also interested in current projects along SR 93 south and more about Burro Creek Bridge (milepost 153) and Wikieup Bypass (milepost 121-125).
- Thanks, this was very helpful. Keep up the good work.

- Very informational. Still needs lots of thought. Need an interchange on I-40 at Rattlesnake Wash and completion of the dam project.
- I am concerned regarding the acceptability of bicycle traffic on the various roadways.
- Good information.
- Need an extension of SR 95 to Bullhead City. Higher priority to recognize Mohave County.
- We appreciate your visit to Kingman.

Mesa (Transit Conference)

The Mesa community open houses were held as part of the Arizona Transit Association annual conference. No comments were received at the Mesa open house.

Nogales

- Public safety (law enforcement, fire, and emergency services) is an integral part of Access/Mobility and Safety, but not addressed.
- International border is a unique safety issue/Homeland Security.
- Emergency response community could/should have been a stakeholder discussion/ focus group.
- Does/will this translate to minimizing the impact of the transportation system on the hydraulics/hydrology of the washes, rivers, and arroyos aesthetics, and vice versa?
- With Arizona roads as unsafe as most public input indicates they feel – public safety sector should be an involved partner.
- Is there a special distribution associated with the Arizona public that think their roads are well preserved and maintained?
- Regional news outlets (especially in Tucson) seem to harp on how bad the roads are.
- Reduce (or eliminate) trucks on SR 82.
- Modify I-10 east of SR 83 to permit wide loads which now use 90/82/83.
- Restrict long-distance semi-trucks from SR 82.
- Tucson-Nogales rail passenger service would be a great benefit – how (again!) with current social-economic settings.

- The rail passenger service should connect to Phoenix to be economically viable.
- Tucson-Phoenix light-rail system.
- Where are the projects in Santa Cruz County?
- Wildlife corridors (see Santa Cruz County Comprehensive Plan) for SR 82 and I-19 (need underpasses with wildlife fencing).
- Natural gas pipeline easement along I-19 to Mexico may be required in 2007-2008.
- Don't ever pave Ruby Road west of Lake Pena Blanca.
- Add "Anza National Historic Trail Auto Route" signage along I-19 (also this has been a scenic road since the late 1960s). Add to state map and ADOT website.
- Can lit billboards be removed from scenic roads?
- When will I-19 be widened? I-19 Report states "after 2030 in Santa Cruz County."
- Projects should take into account current and ultimate build-out hydrology. Under-sizing structures should not continue. The savings does not outweigh future costs. Over-sizing would be useful for wildlife corridors as well.
- Keep SR 82 and SR 83 two lane roads.
- Well publicized meetings – poorly attended. Wonderful chance to ask all my questions. Thank you.
- Thank you for this presentation. We are interested in wildlife corridors throughout the I-19 Corridor.
- Maintaining 82-93 as scenic.
- Cut off lighting has to help the observatory.
- Thanks again – this format is quite useful.
- Very informative demonstration. However, there was no information on the proposed CANAMEX Highway.
- Great opportunity to talk to ADOT staff about future plans for the county.
- I think your visit to our community is great. It allowed us to communicate and see what ADOT is doing statewide and in the future allow us to get projects included in the state plan.
- We appreciate you coming to Santa Cruz County.

Page

- Need to provide alternate routes for rural areas (for potential emergency situations).
- Safety is not being met for bussing school children to and from home or school. Some of the roads for Navajo children are horrible and have been for over 30 years.
- The economic trends are only off reservation areas.
- Public services cannot be met or built due to the road conditions.
- Thank you for considering Coppermine Road N20 in the plan, we desperately need that road paved.
- The reason (i.e., condition of the road) is why we don't attend Chapter meetings. Thank you.
- These road improvements will be a great asset to Northern Arizona.
- This route is necessary for many traveling and it is totally unacceptable in the condition it is currently in.
- What gears (guides) the distribution of funding?
- Your maps only show Flagstaff and south. What happens to the true Northern Arizona? Especially in the rural areas.
- Unimproved roads need to be maintained. Not to be noisy.
- Is there a consideration for the safe transportation of youth in school programs? Bus miles on a road by school districts?
- Tuba City Regional Health Service currently selected a 75-acre site to build a hospital that benefits surrounding area to better service the school children, easy access to my/our elderly. Ambulance services should be available for the community that lives along the N-20.
- There can be an Indian Health Service Clinic right in the middle of Coppermine Chapter if there was a major highway through the area and other economic development benefits.
- How can ADOT work and fund other agencies (i.e., BLM, USBR, Navajo, and other Tribes) and a possible increase through grant funds.
- We believe U.S. 89 Utah border to 160-140 has a very large number of trucks. We also have a large recreational vehicle contingent traveling between Bryce Canon, Zion, and Grand Canyon National Parks.

- The passing lanes are critical.
- We would like to see/have traffic counters in this area. Need to prove measurability. Highway 98 needs to be upgraded and traffic counters.
- Why are most highways improved/developed south of Flagstaff mainly? Northern Arizona is once again left without much improvement. Does that mean Northern Arizona does not have any safety issues? This is wrong – Coppermine is only asking for a small percentage of the dollars to meet the needs of many!
- N20 really needs your consideration for health and safety reasons. Thanks for you consideration.
- N20 Road is important so we can attend Chapter meetings more often.
- N20 Road is important for us. We would like it paved and better for school and for traveling.
- N20 Road is important for us. We would like it better for traveling.
- Please pave our existing road N20.
- Greetings: It would be excellent if N20 was considered. N20 being paved will be a great asset due to travelers, PHSD bus route, and local resident daily travel would be smooth. Thank you.

Parker

- Professional and interesting displays. Personnel very friendly and helpful.
- We need a left-turn lane at Castle Rock Shores.
- Thank you!
- Appreciate chance for input. Great that ADOT is starting to plan in 10-, 15-, and 20-year horizons. This will allow ADOT to show needs for additional funding. Otherwise, public will think that all projects got into the five-year plan by magic.
- This is a very interesting project. I am interested in its outcome.
- Informative with people that back up with documentation.
- Thank you for all of the information. We're looking forward to the progress!
- We really appreciate you coming to Parker.

- Thank you for being responsive to our questions. We appreciate the progress you are trying to achieve.
- Very cordial staff, knowledgeable answers, informative presentation, hopefully my concerns will be addressed too. Thank you!
- Quit closing SR 95 in Parker for special events.
- I appreciate the presentation by ADOT. The Parker Area Historical Society is asking for assistance from ADOT in replacing the cement sidewalk along California Avenue (SR 95 in Parker) between 12th Street and Arizona Avenue – preserving the canopy.
- Thank you!

Payson

- What about the bypass road from SR 87 to SR 260? Need to study the economic impacts to the downtown area.
- There is intersection delay at the SR 87 and SR 260. It is worse on weekend on the northbound to eastbound lanes. Need a two-lane turn lane with improved signage.
- Need to include economic impacts on all projects: –Signage, –Access, –Tourism, –Scenery, –etc.
- Great job on SR 87 from Phoenix to Payson!
- Need for runaway truck ramps south on SR 87.
- Roadway reconstruction needed near Mount Ord on the southbound lanes.
- Funding for highways is necessary to facilitate the growth of this State. This is a cost of growth that is seriously under-funded.
- When you have refreshments you should have sugar free!

Prescott Valley

- We in the tri-cities area had four pieces to our road system puzzle. The first was the new Fain Road, second was the 89A connection to 89. Now we need (third) the other two pieces 89 to 69 to the airport and (fourth) from the airport to Chino Valley on 89. Thank you ADOT!

- Please include separate bike/pedestrian trails along roadways. We need alternatives to gas-guzzling transportation. We need safe travel lanes for healthy, non-polluting exercise. Thanks!

Safford

- You obviously put a lot of work into this plan. But why aren't there any projects planned for Duncan?
- Need more money. Gas tax, one-half-cent transportation sales tax, bonds.
- Great job!
- Thank you for coming to our valley. Very interesting.
- Thank you for your information. It is nice to know when and what you are doing for our community.

Sells

- I travel SR 86 to Tucson and Ajo and Route 15 to Casa Grande. The last 20 to 25 years the traffic has increased other than local community members.
- Highway 86 is a regular route for RVs with hitches, 4 x 4 trucks, and motorcycles.
- Highway 86 is a scenic route for vacationers, and leisurely drivers.
- More bicyclists are using SR 86 special interests traveling (e.g., Vision Quest and Wagon Train).
- Our roads need to be widened for the courtesy of others who want to use the roads and need to use these roads.
- Improve the roads, fencing, and include rest areas.

Show Low

- I would like to have seen more projects scheduled in the White Mountain area.
- Presentation well organized with knowledgeable staff.
- Very informative, thanks for coming.
- Appreciate your coming to Show Low.

- Informative, thanks for coming to Show Low.
- I do not believe that this MoveAZ plan is providing a "fair share" to the rural areas of Arizona.

Sierra Vista

- Maximize utilization of Arizona's natural resources; solar and wind.
- Utilization and conservation = sustainable development.
- When and where was public input sought for results shown – Tucson & Phoenix? Seem to show higher than representative numbers who use public transit.
- Add results from small area transportation plan.
- Safford in Graham County (district not city).
- What happened to I-10E of LaPaz County?
- Why not plan now to widen the excessive delay roads of 2005? And alternative rail from Tucson to Phoenix.
- Add small area transportation plans.
- No planned improvements along the U.S. 191 corridor from Douglas to the I-10 interstate.
- No improvements to sustain future truck traffic from Mexico (CD Obergon Highway).
- Good to be able to talk directly with transportation people.
- Informative – looks like ADOT is using sound scientific methods to determine future projects. P.S. Good cookies.
- Effective/performance-based management is necessary to stay on budget and on time.
- Very informative.
- Excellent set of visual displays and exhibits.
- Thanks for your time. Informative presentation and Ron Casper was very helpful.
- Great job. I learned a lot from the presentation.
- Good stuff – had hoped for handouts, but will download from the web site.

- A key improvement that only adds marginally to the cost of most highway improvement projects is the addition of bicycle lanes where none exists (e.g., Highway 92 has no shoulder virtually between Carr Canyon and Hereford Road). Also, don't lose existing bike lanes with widening projects. Such lanes promote tourism, healthy lifestyle, and improve property values.

Tucson

- 2.2(4) Environmental Sensitivity – be sure to include enough money for this very important issue!
- 2.3(5) Address freight in multimodal travel.
- 2.2(4) Streamline EA process to move congruently with planning element.
- 3.3(8) I encourage strongly the word "stewardship" – we need to be better stewards of our environment, as well as stewards of our infrastructure and mobility system. We can and need to do both.
- 3.3(8) While freight is an economic development issue, it is surely a transportation one too. Freight movements by truck and rail impact traffic and the environment, including land uses.
- If there was strong support for transportation options, were options considered?
- 3.3(8) Arizona roads are not all maintained/preserved. Rural areas are a concern.
- Be useful to see average cost for improvements (per mile/mile/bike lane).
- Need commuter train between Phoenix-Tucson.
- Only highway construction?!
- No comment cards submitted.

Window Rock

- Long-Range Transportation Plan should encourage and promote Tribal roads to retain MIA Roads to generate local economic spin-offs through real estate revenues within its rights of way.
- The plan should highly regard environmental/cultural/traditional sensitive areas within and adjacent to Tribal lands.
- No comments

- System performance – you have population and employment trends! What is the rate of agricultural/rural lands converting to urban/transportation use?
- Any ITS plans for SR 264 or U.S. 191?
- Truckers' short cut routes on SR 264 and U.S. 191. Control?
- Buses and truckers should pay the Navajo Nation when using tribal roads by tax as tribal buses do pay a fee whenever it leaves the Navajo Nation.
- Arizona needs to emphasize safety, especially for wildlife, avoidance of striking all wildlife by providing warning signs, caution signs, wildlife accessibility, and reducing speed limits.
- Need to build frontage roads to avoid turn-offs (right and left lane) onto busy, busy roads especially on Indian reservations.

Yuma

- You indicate a high suitability for bicycles on ASH Highway. NO bicycles on ASH.
- I strongly agree with the above comment.
- Bikes on ASH Highway are crazy.
- Bikes on high speed almost freeway type Truck Route is insane – it is an invitation, not a guarantee, of future bike/truck fatalities.
- The U.S. 95/16th Street overpass over I-8 is a critical chokepoint and funnel for all east-west traffic in the City of Yuma. That overpass desperately needs to be rebuilt and widened to at least six through lanes and double left-turn lanes. Possibly consider a six-lane overpass with a single-point urban interchange, especially with Yuma Palms Mall opening in November 2004.
- Interchange at I-8 and Avenue 15E is needed.
- Bike suitability – how about increasing availability of long-distance highway biking? Good to see the ASH Highway will have bike suitability.
- Thanks for coming to Yuma. Very informative.
- The concept of MoveAZ has provided a valuable format to develop directions, plans, and considerations of funding.
- More access to Phoenix. Alternate route such as through Florence for bypass around accidents. Important to get around accidents quickly.

MOVE AZ Long Range Transportation Plan

Appendix D. Performance Factors and Measures

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

February 2004

ADOT

MoveAZ Plan

Appendix D. Performance Factors and Measures

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

February 2004

Table of Contents

Introduction **1**

Performance Factor 1.0: Mobility and Economic Competitiveness **2**
Measure 1.1 – Percent of PMT by LOS 2
Measure 1.2 – Average Delay Per Trip 3

Performance Factor 2.0: Connectivity **3**
Measure 2.1 – Passing Ability 4
Measure 2.2 – Intercity Travel Time Connectivity 4

Performance Factor 3.0: Preservation **5**
Measure 3.1 – Reconstruction Need 5
Measure 3.2 – Pavement Condition 6
Measure 3.3 – VMT by Pavement Condition 6
Measure 3.4 – Bridge Condition 7
Measure 3.5 – Vehicle Trips by Bridge Condition 8

Performance Factor 4.0: Reliability **9**
Measure 4.1 – Additional Unexpected Delay 9

Performance Factor 5.0: Safety **9**
Measure 5.1 – Accidents Per 100 Million VMT by Functional Class 9
Measure 5.2 – Anticipated Change in Fatalities/Injuries 10

Performance Factor 6.0: Accessibility **11**
Measure 6.1 – Park-and-Ride Spaces 11
Measure 6.2 – Bus Turnouts 11
Measure 6.3 – Bike Suitability 12

Performance Factor 7.0: Resource Conservation **13**
Measure 7.1 – Total Mobile Source Emissions 13
Measure 7.2 – Percentage of Air Quality Improvement Projects Selected 14
Measure 7.3 – Noise Exposure 14
Measure 7.4 – Projects Listed in Regional Transportation Plans 15
Measure 7.5 – Fuel Consumption 15

List of Tables

1. Performance Measure Data, Tools, and Outputs 16

Introduction

This technical memorandum presents the performance measures selected by the Arizona Department of Transportation (ADOT) for use in the development of the MoveAZ plan. These measures were selected to identify and monitor performance and gauge the ability of proposed projects to satisfy ADOT's goals, which can be described by eight different performance factors:

1. Mobility;
2. Economic Competitiveness;
3. Connectivity;
4. Preservation;
5. Reliability;
6. Safety;
7. Accessibility; and
8. Resource Conservation.

The performance measures are organized according to the performance factors to which they apply (Mobility and Economic Competitiveness are grouped together, as performance measures for those factors apply to both). For each performance measure, a definition, a purpose, data sources, and a detailed example relevant to Arizona with calculations are presented.

In addition, this technical memorandum explains in general terms the scoring method for each measure to be used in assessing the system performance results of projects evaluated for the MoveAZ plan. During the analysis of existing conditions and future project evaluations, a more refined scoring method was developed for each performance measure (as documented in the Task 11, Project Evaluation Technical Memorandum). This scoring method considers specific statistical distributions among project scores for a specific measure, distribution of points among measures within a specific performance factor, and weighting of each performance factor.

Table 1, at the end of this technical memorandum, presents a summary of the supporting data, supporting tools, and expected output of each performance measure.

Performance Factor 1.0: Mobility and Economic Competitiveness

This factor uses two measures: 1) percent of person-miles traveled (PMT) by level of service (LOS) and 2) average delay per trip. The first gives a broad systemwide perspective of how much travel is occurring under congested (as well as free-flow) conditions. It provides a visual representation of system conditions by each functional class of roadway. The second measure describes how much extra travel time the average traveler spends to get to a given destination. It examines mobility from the user perspective, instead of the systemwide perspective.

Measure 1.1 – Percent of PMT by LOS

Definition: Percent of PMT occurring at different congestion levels, based on volume/capacity (v/c) ratio or LOS, and separated by functional classification. It can be calculated separately by rural or urban areas, as well as season. As the distribution becomes more skewed towards higher (better) LOS, conditions improve. For project comparison, an average v/c ratio weighted by PMT is reported; lower v/c is considered better. For each highway segment, the v/c was multiplied by the PMT. This product was summed for all segments in a district or across the entire state and divided by the total PMT in the district or state to generate a weighted v/c.

Purpose: This measure shows the percentage of passenger travel occurring under congested conditions. It can be calculated separately for rural or urban areas, or peak and off-peak tourist seasons, to ensure consistent and useful comparisons. Comparing this measure for different projects will show whether congested passenger travel increases or decreases, and by how much for each scenario. This measure can also show increases or decreases over time.

Data Sources: Data sources included geographic information system (GIS) layers, Highway Performance Monitoring System (HPMS), and regional agency data.

Example: The ADOT HPMS dataset provides mileage, average annual daily traffic (AADT), capacity, and v/c ratio for every link in the state highway system. Mileage and AADT are multiplied for every segment to find vehicle miles traveled (VMT), and VMT is in turn multiplied by the statewide average vehicle occupancy (and local vehicle occupancies for segments in the MAG and PAG regions) to generate PMT for every segment in the system. Segment PMT is summed across all rural and urban highways to find systemwide subtotal PMT for rural and urban segments. PMT is then summed across all highways in rural areas with an LOS of C or greater (defined by ADOT as a v/c ratio less than or equal to 0.70) and in urban areas with LOS D or better ($V/C \leq 0.80$). Dividing the latter by the former yields the percentage of PMT-rated LOS C (or D) or better systemwide in rural or urban areas, respectively.

Scoring: The project that causes the highest percent increase of PMT at or above LOS C (or D for urban areas) earns the maximum number of points for this measure. The lowest percent increase receives zero points. All other projects are scored proportionally within this scale.

Measure 1.2 – Average Delay Per Trip

Definition: Hours of extra travel time (defined as the total person-hours of travel less the total person-hours of travel at free-flow conditions) during a specified time period systemwide or in a particular ADOT district, divided by the average number of trips during that period. It can be calculated separately by season. As this measure decreases, conditions improve.

Purpose: This is a measure of congestion understandable by the general public. It can be used to compare alternative modal investments, and can be calculated separately for peak or off-peak tourist seasons. Comparing this measure by different project scenarios will show whether congestion increases or decreases. This measure can also show increases or decreases over time.

Data Sources: Supporting data included GIS layers, HPMS, and national trip and trip length data.

Example: The existing HPMS dataset – the "base case" – is input into the Highway Economic Requirements System (HERS), which subsequently calculates the systemwide delay in hours per 1,000 VMT. This gross number is divided by the number of average daily person trips, determined in Arizona through trip length data from the National Personal Transportation Survey (NPTS) and other national data, to arrive at the delay per trip. A modified HPMS dataset, which accounts for projects with changes in capacity, speed, functional class, and other design elements contained in HPMS fields, is then input into HERS to identify the change in delay.

Scoring: The project that decreases the average delay per trip the most receives the highest number of points for this measure; the project that decreases it the least receives zero points. All other projects are scored proportionally within this scale.

■ Performance Factor 2.0: Connectivity

The two connectivity measures consider the availability of efficient highway connections between Arizona cities and towns, particularly in more rural areas of the State. The first measure evaluates connectivity through the presence of passing ability along two-lane state highways; and the second evaluates the circuitousness and travel time of existing routes in selected high-priority corridors through the potential for decreasing the shortest travel time in those corridors.

Measure 2.1 – Passing Ability

Definition: This measure calculates a volume to service ratio for current two-lane facilities in Arizona. The service volume is calculated based on percent trucks, terrain, and the percent of lanes striped for passing. A decrease in the ratio is considered beneficial. This measure is based on the passing lanes methodology developed by ADOT in its Passing Lanes/Climbing Lanes report.

Purpose: This measures intercity connectivity by indicating a necessity for multi-lane highway segments, passing lanes, or climbing lanes. Projects that straighten curves, level terrain, or add passing lanes should all produce positive changes in this measure.

Data Sources: The data sources used to support this measure included GIS layers, HPMS, the ADOT Passing Lanes/Climbing Lanes report, and Highway Capacity Manual (HCM) methods.

Example: Only two-lane segments are evaluated for this process. The HPMS dataset provides data on the number of lanes on any highway segment, the percent of each segment that allows passing, percent trucks on the segment, and the v/c ratio. The percent passing ability is adjusted using thresholds established by ADOT for level, rolling, and mountainous terrain. A project that adjusts any of these parameters will change the passing ability.

Scoring: The project which provides the largest percent increase in passing ability within a district or the state as a whole receives the maximum amount of points for this measure. A project that widens a highway from two to four lanes will show a 100 percent improvement for that segment of the corridor. Projects that provide no increase in this measure receive zero points. All other projects are ranked proportionally within this scale.

Measure 2.2 – Intercity Travel Time Connectivity

Definition: Travel time savings as reported in one of the 1994 High-Priority Corridors, identified in the 1994 Long-Range Transportation Plan.

Purpose: To measure the potential for improvement in the shortest travel time between Arizona cities. This measure aids in comparing needs for decreased travel times in important corridors.

Data Sources: Data included GIS layers, HPMS, and the 1994 Long-Range Transportation Plan.

Example: ADOT GIS layers provide city locations, as well as state highways. Applicable city pairs are identified using these layers. The HPMS dataset provides data on the functional classification and speed of every highway segment. The GIS highway layer and HPMS layer are joined to establish the route length of the state highway routes in each corridor, and to identify the shortest travel time in each corridor using speed limits. The

GIS layers also determine the straight-line distance between the two cities in each corridor. The interstate speed limit (65 mph) is applied to find the straight-line theoretical travel times. The two travel times in each corridor are subtracted to find the difference between the theoretical fastest travel time and the actual shortest state highway travel time.

Scoring: This measure evaluates projects on a corridor level. The project which provides the largest percent decrease in the shortest travel time within a corridor receives the maximum amount of points for this measure. Projects which provide no decrease in this measure receive zero points. All other projects are ranked proportionally within this scale.

Performance Factor 3.0: Preservation

ADOT uses pavement and bridge management systems to determine future pavement and bridge conditions, and how to program resources for repairs and replacement. The preservation performance measures presented below are applied to projects and data output from these management systems. As pavement and bridge maintenance and construction are funded separately within ADOT, only the first measure – Reconstruction Need – is currently used for project selection. However, it is only a temporary measure that will be replaced by the other measures described in this section when ADOT's new pavement management system is operational.

Measure 3.1 – Reconstruction Need

Definition: Average number of years since last roadway reconstruction by roadway segment, as indicated by the ADOT Pavement Management System (PMS), weighted by average AADT. This measure considers old segments in need of total reconstruction, with an average year of last reconstruction before 1970.

Purpose: To evaluate projects that do not affect roadway capacity, but improve deteriorating roadways.

Data Sources: Supporting data included HPMS and ADOT PMS information.

Example: A hypothetical project under evaluation will reconstruct a 10-mile segment of I-40. According to the ADOT PMS, the last reconstruction of this segment was 1965 (averaged by mile) – 37 years ago relative to the current year (2002). The average AADT along this segment is 25,000 vehicles. 25,000 is divided by 1,000 and added to the age of the roadway, yielding a value of 62.

Scoring: The reconstruction project for a segment of roadway with the highest average value for this measure receives the maximum points. The reconstruction project for a

segment of roadway with the lowest value receives zero points. All other projects are scored proportionally within this scale.

Measure 3.2 – Pavement Condition

Definition: Percent of state highway lane miles by pavement condition, as rated in the ADOT Pavement Management System, reported by functional classification. This pavement serviceability rating (PSR) scale has five categories, ranging from "very poor" (0) to "excellent" (5). It can be calculated separately for rural and urban areas. As the distribution becomes more skewed towards higher pavement conditions ("moderate" to "excellent"), conditions improve. For project comparison, the average PSR will be reported: a higher number indicates an improvement.

Purpose: The percent of pavement by each rating provides information on the condition of ADOT state highway surfaces. Comparing this measure for different projects will show whether overall pavement conditions improve, and by how much for each project. This measure can also show changes in the percent of pavement in each condition over time. The overall systemwide PSR is reported for comparison to the recommended target of 3.27.

Data Sources: Data used to support this measure was obtained from the ADOT PMS.

Example: The ADOT PMS user defines a system goal, such as a maximum of 20 percent of roadways to be rated "bad," or a budget of $25 million. The PMS outputs recommended projects and the resulting PSR for every highway segment. For each functional classification, the miles per segment are multiplied by the PSR for that segment, the products are summed together, and they are divided by the total functional class mileage to find the average PSR.

Scoring: The project (or programming scenario) that causes the greatest percent increase in average PSR receives the maximum number of points for this measure. A project that results in a zero percent increase receives zero points. All other projects are scored proportionally within this scale.

Measure 3.3 – VMT by Pavement Condition

Definition: Percent of VMT on state highways by pavement condition, as rated in the ADOT Pavement Management System, reported by functional classification. This scale has five categories, ranging from "very poor" (0) to "excellent" (5). Can be calculated separately by rural or urban areas. As the distribution becomes more skewed towards higher pavement conditions ("fair" to "excellent"), conditions improve. For project comparison, the percentage of VMT on pavement rated "good" (PSR of 3.1) or better will be reported: a higher number indicates an improvement.

Purpose: The percent of VMT on pavement by each rating provides information on the condition of ADOT state highway surfaces, and what percentage of travelers is

experiencing each level of pavement. This measure is similar to Measure 3.1, but applies more weight to heavily traveled roadways. Comparing this measure for different projects will show whether overall pavement conditions improve, and by how much for each project. This measure can also show changes in the percent of pavement in each condition for the most heavily traveled roadways over time.

Data Sources: Data sources and tools used to support this measure included the ADOT PMS, HPMS, and HERS.

Example: Output from a PMS programming scenario (for example, a budget of $25 million) with suggested projects and refined PSR ratings is linked to the HPMS dataset. The corresponding VMT generated from HPMS for all highway segments now ranked "good" or better (3.1 or greater) are added together, the total systemwide VMT is calculated, and the two are divided to find the percent of VMT on pavement ranked "good" or better.

Scoring: The project (or programming scenario) that results in the largest percent increase of VMT on state highway lane-miles at or above "good" receives the maximum number of points for this measure. The project that results in the lowest percent system increase for this measure receives zero points. All other projects are scored proportionally within this scale.

Measure 3.4 – Bridge Condition

Definition: Number or percentage of deficient bridges on state routes, as rated in the ADOT Bridge Management System (BMS), separated by functional class of roadway. This is a seven-point rating for four different bridge components in accordance with National Bridge Inventory (NBI) reporting standards, with seven being excellent. It can be calculated separately by rural or urban areas. The percentage of deficient bridges is defined as the deck area of bridges with one or more deficient components (rated four or less) divided by the total deck area in the bridge inventory. A lower number indicates an improvement.

Purpose: The number of bridges rated at each sufficiency rating provides information on the condition of ADOT state bridge conditions. Comparing this measure for different projects will show whether overall bridge conditions improve, and by how much for each project. This measure can also show changes in the number of bridges in each condition over time.

Data Sources: Data supporting this measure were obtained from the ADOT BMS.

Example: The ADOT BMS outputs the rating of each of four components for every bridge on the state transportation system. It also contains data on the deck area of each bridge and the functional classification of roadway it connects. For each functional classification, the deck areas of all bridges with one component rated four or less are added together, the

total deck area of all bridges found, and the two are divided to find the percentage of deficient bridges on that functional class.

Scoring: The project (or programming scenario) that results in the largest decrease in deficient bridges receives the maximum number of points for this measure. The project that results in the lowest system value for this measure receives zero points. All other projects are scored proportionally within this scale.

Measure 3.5 – Vehicle Trips by Bridge Condition

Definition: This measure computes the annual number and percentage of vehicle trips on deficient bridges, as rated in the ADOT BMS. It considers a seven-point rating for four different bridge components in accordance with NBI reporting standards, with 7 being excellent. It can be calculated separately by rural or urban area. A deficient bridge is defined as a bridge with one or more deficient components (rated four or less). A lower number indicates an improvement.

Purpose: The percent of vehicle trips on bridges at each sufficiency rating provides information on the condition of all bridges on the state transportation system and the percentage of travelers experiencing each bridge condition level. This measure is similar to Measure 3.4, but applies more weight to heavily traveled roadways. Comparing this measure for different projects will show whether overall bridge conditions improve, and by how much for each project. This measure can also show changes in the percent of bridges for each condition level for the most heavily traveled roadways.

Data Sources: Data used to support this measure included ADOT BMS and HPMS.

Example: The ADOT BMS database of bridges (for the "base case") contains detailed information on the condition of each bridge and the traffic volumes using each bridge. The AADTs on bridges with one component rated four or below are added together, the total AADT is summed across all bridges, and the two are divided to identify the percentage of vehicle trips on deficient bridges.

Scoring: The project (or programming scenario) that results in the largest percent decrease of vehicle trips on deficient bridges on state highways receives the maximum number of points for this measure. The project that results in the lowest percent increase for this measure receives zero points. All other projects are scored proportionally within this scale.

Performance Factor 4.0: Reliability

Measure 4.1 – Additional Unexpected Delay

Definition: Incident-related non-recurring delay per VMT on the state highway system, based on methodology used in HERS. As this measure decreases, reliability improves.

Purpose: This measure provides a sense of how variable travel times are for an entire district or state, due to non-recurring incident delay. It can be used to compare modes, alternatives, and seasonal values for different project scenarios.

Data Sources: The data and tools used to support these measures included HPMS and HERS.

Example: The existing HPMS dataset – "base case" – is input into HERS, which subsequently calculates the systemwide incident-related delay in hours per 1,000 VMT. A modified HPMS dataset, which accounts for projects with changes in capacity, speed, functional classification, and other design elements contained in HPMS fields, is then input into HERS to compute the change in total incident-related delay.

Scoring: For this measure, it is necessary to know the base conditions for the year in which projects are being compared. In the list of projects being compared in Task 11, the project that results in the lowest non-recurring delay per VMT for the system receives the maximum number of points for this measure, and sets the maximum for the point scale. The value below, which will receive zero points for this measure, is determined through a statistical analysis procedure. All other projects are scored proportionally within this scale.

Performance Factor 5.0: Safety

The safety performance factor includes two performance measures: 1) accidents per million VMT by functional class, and 2) anticipated reduction in fatalities and injuries. The first is a normalized rate that accounts for more driving in future years: as VMT increases, the absolute number of accidents will likely increase, though the accident rate may stay the same or decrease. The second measure focuses on identifying specific locations that have a high absolute number of accidents.

Measure 5.1 – Accidents Per 100 Million VMT by Functional Class

Definition: Accidents on state highways, separated by accidents with fatalities or injuries, divided by 100 million VMT on those highways, distributed by functional classification. A decrease indicates an improvement in safety among that functional classification.

Purpose: This measures the number crashes by functional classification, divided by the traffic on a roadway. Indexing the number of accidents to 100 million VMT normalizes the effect of population and economic growth. Stratifying this measure by functional classification allows ADOT to evaluate information for different categories of roadway, and to consider geometric design, access, and speed limit issues and their effect on safety.

Data Sources: Data and tools used to support this measure included HPMS, GIS layers, ADOT accident database, and HERS.

Example: To establish the base conditions of accidents per million VMT by functional class, the ADOT accident database is used to determine the number of accidents on each roadway. The roadways are then cross-referenced with the Arizona Transportation Information System (ATIS) GIS state highway layers – which contain fields for both roadway names and functional classification – to determine the functional classification of each roadway in the accident database. Accidents are finally summed by each functional classification. Using total VMT by functional classification data, available from the HPMS dataset, each number of accidents is divided by the corresponding million VMT.

The existing HPMS dataset – the "base case" – is input into HERS, which subsequently calculates estimated accident rates per 100 million VMT, by functional classification. A modified HPMS dataset, which accounts for projects with changes in capacity, speed, functional classification, and other design elements contained in HPMS fields, is then input into HERS to see the new accident rates. Finally, the differences in rates between the two HERS runs are applied to the actual ADOT accident rates by functional classification.

Scoring: The project which decreases the overall accident rate by the largest percentage is assigned the full amount of points for this measure. The value below which will receive zero points for this measure is determined through a statistical analysis procedure. All other projects are scored proportionally within this scale.

Measure 5.2 – Anticipated Change in Fatalities/Injuries

Definition: This measure computes the anticipated percent change in fatalities and injuries from accidents. A lower percent change indicates an improvement in safety.

Purpose: This measure assesses at the actual number of fatalities and injuries reduced, not just the number of accidents reduced. It is useful for identifying significant accident reductions at high accident locations.

Data Sources: Data and tools used to support this measure included HPMS, GIS layers, and HERS.

Example: The existing HPMS dataset – the "base case" – is input into HERS, which calculates estimated annual systemwide fatality and injury rates per 100 million VMT. A modified HPMS dataset, which accounts for projects with changes in capacity, speed, functional classification, and other design elements contained in HPMS fields, is then input into HERS to see the change in accident rates. Finally, the differences in rates

between the two HERS runs are multiplied by the total systemwide VMT – available from the HPMS dataset and also output by HERS – to find the change in fatalities and injuries. The percent change is also calculated.

Scoring: The project with the greatest percent reduction in fatalities and injuries is assigned the full amount of points for this measure. The value below which will receive zero points for this measure is determined through a statistical analysis procedure. All other projects are scored proportionally within this scale.

Performance Factor 6.0: Accessibility

The following measures examine accessibility to non-auto travel modes, as well as high-occupancy vehicle (HOV) travel. These measures are used to assess the elements of HOV, bus, and bicycle transportation over which ADOT has direct jurisdiction and control.

Measure 6.1 – Park-and-Ride Spaces

Definition: This measure computes the number of park-and-ride spaces adjacent to state highways. An increase indicates an improvement in park-and-ride accessibility.

Purpose: This measure focuses on actions that can be taken directly by ADOT to improve access to the state transportation system by means other than construction of new roadways or reconstruction of existing roadways. These actions help to promote carpooling and, therefore, increase vehicle occupancy, decrease VMT, decrease total fuel consumption, and decrease system wide emissions.

Data Sources: ADOT information on existing park-and-ride spaces and GIS layers was used to support this measure.

Example: A proposed project along U.S. 60 near Power Road in Mesa will construct a park-and-ride lot with a total of 800 new spaces.

Scoring: A project that adds park-and-ride spaces receives the maximum number of points for this measure. Projects with zero added spaces receive zero points.

Measure 6.2 – Bus Turnouts

Definition: This measure computes the number of bus turnouts on state highways with transit or school bus service. An increase indicates an improvement in bus transit accessibility.

Purpose: This measures accessibility to public transportation for individuals near state highways were transit service already exists, as well as accessibility and safety for school

children. It focuses on actions that can be taken directly by ADOT to improve access to the state transportation system by means other than construction of new roadways or reconstruction of existing roadways.

Data Sources: ADOT information on existing bus turnouts and GIS layers were used to support this measure.

Example: Currently, no projects exist on the state transportation system which specifically mentions the construction of bus turnouts. As a result of the inclusion of this measure in the MoveAZ plan, projects that include bus turnouts (and that specifically mention their inclusion) will score favorably.

Scoring: In the list of projects being compared, those that add bus turnouts receive the maximum number of points for this measure. Projects with zero added turnouts receive zero points.

Measure 6.3 – Bike Suitability

Definition: Percent of state routes or state route miles that are more bike suitable, based on ADOT definitions of bike suitability in the recently completed Bicycle/Pedestrian Plan. Bike suitability is a function of percent trucks, v/c ratio, shoulders, and the speed limit. Urban interstates, freeways, and expressways are always considered "unsuitable." Current law also does not permit bicycles on Interstate 10 between Tucson and Phoenix, rendering this segment unsuitable. An increase indicates an improvement in bicycle accessibility. Measured systemwide.

Purpose: It focuses on actions that can be taken directly by ADOT to improve access to the transportation system by means other than construction of new roadways or reconstruction of existing roadways.

Data Sources: Data used to support this measure included GIS layers, HPMS, and the ADOT Bicycle/Pedestrian Plan.

Example: Based on the ADOT GIS layer of bicycle suitability, 28.7 percent of the state highway system are considered suitable, with 17.2 percent specifically more suitable. A hypothetical series of projects will repave U.S. 60 from I-10 in Guadalupe to Apache Junction and add significant shoulder width, moving it into the "more suitable" category. According to the project definition, this project improves 27 miles of U.S. 60. Adding 27 miles to the total "more suitable" highway miles, a recalculating yields 17.6 percent: a systemwide increase of 0.4 percent.

Scoring: In the list of projects being compared, the one which increases the systemwide bike suitability by the greatest percentage receives the maximum number of points for this measure. Projects that do not improve bicycle suitability receive zero points. All other projects are scored proportionally within this scale.

Performance Factor 7.0: Resource Conservation

The first measure evaluates mobile source emissions for transportation projects. This is a standard environmental measure that examines systemwide environmental performance, as well as the environmental impact in areas where air quality is already a critical concern. The second measure – percentage of air quality improvement projects selected – is a function of the first measure: any project that reduces mobile source emissions is considered an "air quality project." It serves as a screen to apply preference to projects that reduce emissions. The third measure evaluates highway noise exposure of residential areas. The fourth measure evaluates coordination between the MoveAZ plan and regional plans, ensuring that transportation (and, indirectly, land-use) decisions are consistent across different tiers of government. The final measure looks at conservation of fuel due to both changes in fleet fuel economy and direct changes in the transportation system made by ADOT.

Measure 7.1 – Total Mobile Source Emissions

Definition: This measure computes total tons of mobile source emissions. It can be calculated separately by rural or urban areas. A decrease in this measure indicates a positive change.

Purpose: This measure gauges the impact of transportation system usage on the environment by tracking the total Nitrogen Oxide and Volatile Organic Compound emissions related to transportation.

Data Sources: The data and tool used to support this measure included GIS layers, HCM, HERS, and MOBILE6 emission rate data.

Example: The MOBILE6 emissions calculation software is used to establish emission rates by emission type, vehicle (auto or truck), and speed. Using HCM equations by functional classification of roadway and v/c ratio data in HPMS, the average speed of every highway segment is calculated in mph. The speed on each segment is matched to the appropriate emissions total from the lookup table (hydrocarbon, carbon monoxide, and nitrous oxide). Finally, this emissions number on each segment is multiplied by the total VMT on that segment, and those products summed across the entire system to get total grams (reported in metric tons) of mobile source emissions.

Scoring: In the list of projects being compared, the one which results in the lowest total mobile source emissions for the system receives the maximum number of points for this measure. The value below which will receive zero points for this measure will be determined through a statistical analysis procedure. All other projects are scored proportionally within this scale.

Measure 7.2 – Percentage of Air Quality Improvement Projects Selected

Definition: This measure considers the annual percentage of transportation air quality improvement projects that are incorporated in the MoveAZ plan. An air quality improvement project is defined as any project which, when implemented, will result in an improvement from base conditions for Measure 7.1. A higher number indicates an improvement for this measure.

Purpose: This is a screening measure that is applied after the selection of projects to report the percentage of projects that have a positive impact on air quality. This measure is not used for individual project selection – Measure 7.1 fulfills that purpose for the Environmental Protection performance factor. This measure reports only one number, which can be compared to percentages of other years' project selection lists or to other packages of projects.

Data Sources: The results of Measure 7.1 and data from the GIS layers, HERS, and various ADOT project study reports were used to support this measure.

Example: The existing HPMS dataset – the "base case" – is used to calculate systemwide mobile source emissions as outlined in the example for Measure 7.1. A project that increases emissions is not an "air quality improvement project." Five modified HPMS datasets are created, each one accounting for a different potential project in the same designated package of projects. After each has its v/c ratios, average speeds, corresponding pollution rate, and total mobile source emissions recalculated as part of Measure 7.1, three result in total mobile source emissions that are less than the "base case," one results in a system increase, and one results in no change in emissions. Three of the five projects in this package, therefore, are "air quality improvement projects": this measure's value for the project package is 60 percent.

Scoring: A value of 100 percent receives the maximum number of points for this measure. A value of zero percent receives zero points. All other packages are scored proportionally within this scale.

Measure 7.3 – Noise Exposure

Definition: This measure computes the number of state highway miles with sound walls. An increase in this measure indicates a positive change.

Purpose: This measure is an indication of how much the disruption of the environment around existing or proposed transportation infrastructure can be mitigated. Transportation projects that build sound walls will have an effect on this measure.

Data Sources: Data such as GIS layers and the ADOT current sound wall location data were used to support this measure.

Example: A proposed freeway extension through a residential community in the Phoenix area also has a sound wall as part of the programmed project.

Scoring: A project that includes a sound wall receives the maximum number of points for this measure. Projects without sound walls receive zero points.

Measure 7.4 – Projects Listed in Regional Transportation Plans

Definition: Projects recommended for the MoveAZ plan that are also listed in regional transportation plans (RTPs). An increase in this measure indicates a positive change.

Purpose: This measures coordination between ADOT – through the MoveAZ plan – with regional and local entities, and encourages mutually beneficial policies. This measure can be used as an "all or nothing" screen, reported as a percentage to be compared between project packages, or reported as an overall total percentage to be compared over time.

Data Sources: Data sources included the RTPs conducted across the State and the proposed MoveAZ plan project list.

Example: A sample project being selected for the MoveAZ plan to add a new park-and-ride lot in Mesa is also included in the MAG RTP. A hypothetical project proposed by ADOT will add a bus turnout along U.S. 60 in Mesa. However, this project was not previously included in the MAG RTP. These projects are being grouped together for analysis as one project package. This project has a value of 50 percent, as one-half of the projects in this package are also listed in RTPs.

Scoring: This measure either is or is not fulfilled by each project: if the project is also in an RTP, then it receives the full points for this measure. If it is not, then it receives zero points.

Measure 7.5 – Fuel Consumption

Definition: This measure computes the number of gallons of fuel consumed. Calculations of future year values will be separated by changes due to variations in fleet fuel economy and changes due to modifications by ADOT. Can be calculated separately by urban or rural areas. A decrease in this measure indicates a positive change.

Purpose: This measures systemwide fuel consumption over time or for individual projects. Changes in fuel consumption due to variations in fleet fuel economy are calculated separately to ensure that this measure indicates changes in fuel consumption as a result of changes in the transportation system by ADOT (i.e., changes that reduce VMT).

Data Sources: Data included GIS layers, HCM methods, HPMS, and Intelligent Transportation System Deployment Analysis System (IDAS) fuel consumption rates.

Example: IDAS provides lookup tables for fuel consumption rates in gallons per mile. These tables are a function of speed, functional class, and vehicle type (auto or truck).

Using HCM equations by functional classification of roadway and v/c ratio data in HPMS, the average speed of every highway segment is calculated in mph. Based on the appropriate HCM equation and the given free-flow speed, the current average speed is calculated. HPMS indicates the percentage of total AADT that are trucks. IDAS assumes an even split between diesel and gasoline trucks, and that assumption is applied here. The resulting AADTs are multiplied by the length of the highway segment to find VMT. For the calculated average speed, the IDAS lookup table indicates fuel consumption rates per VMT for autos, gasoline trucks, and diesel trucks, respectively. Finally, each rate is multiplied by its corresponding VMT to yield gallons of fuel consumed per day.

Scoring: The project that results in the largest percent decrease in fuel consumption for the system receives the maximum number of points for this measure. The value below which will receive zero points for this measure is determined through a statistical analysis procedure. All other projects are scored proportionally within this scale.

Table 1. Performance Measure Data, Tools, and Outputs

Performance Measure	Supporting		Expected Outputs
	Data	Tools	
Percent of PMT by LOS	Volume, capacity, roadway miles, route coverage	GIS, HPMS, urban models	System, district, and project – Congestion by functional class
Average Delay per Trip	Volumes, travel speeds, trip lengths, route coverage	GIS, HPMS	System and district – Hours of congestion delay
Passing Ability	Terrain type, truck %s, two-lane roadway miles, % miles striped for passing, volumes	GIS, HPMS	System, district, and project – Percent change in deficient state highway miles
Intercity Connectivity	Speeds, route distances, route locations	GIS, HPMS	System, district, and project – Percent change in travel time
Reconstruction Need	Date of reconstruction, volumes	HPMS, PMS	Project – Average age, weighted by volume, of roadway to be reconstructed
Pavement Condition	Pavement serviceability ratings	PMS	System – Percent of highway miles by pavement condition rating and functional class
VMT by Pavement Condition	Volumes, pavement serviceability ratings	PMS, HPMS, HERS	System – Percent of VMT on highway by pavement condition rating and functional class
Bridge Condition	Bridge sufficiency ratings, bridge coverage	BMS, Pontis	System number of deficient bridges by functional class
Vehicle Trips by Bridge Condition	Volumes, bridge sufficiency ratings, bridge coverage	BMS, Pontis, HPMS	System – Annual and percentage of vehicle trips on deficient bridges by functional class

Table 1. Performance Measure Data, Tools, and Outputs (continued)

Performance Measure	Supporting		Expected Outputs
	Data	Tools	
Additional Unexpected Delay	Volumes, roadway mileage, ADOT incident data	HPMS, HERS	System – Travel time variability due to non-recurring incident delay by functional class
Accidents per 100 Million VMT by Functional Class	ADOT accident data, volumes, roadway mileage, route coverage	HPMS, GIS, HERS	System, district, and project – Change in accident rates by type and by functional class
Anticipated Change in Fatalities/ Injuries	ADOT accident data, volumes, roadway mileage, route coverage	HPMS, GIS, HERS	System, district, and project – Change in accidents by type and functional class
Park-and-Ride Spaces	Number of park and ride spaces, route coverage	GIS	System, district, and project – Park-and-ride spaces adjacent to highways
Bus Turnouts	Number of bus turnouts, route coverage	GIS	System, district, and project – Bus turnouts adjacent to highways
Bike Suitability	% trucks, volume, capacity, shoulder data, speeds	GIS, HPMS	System, district, project – Percent of bike suitable highways by functional class
Total Mobile Source Emissions	VMT and route coverage by functional class, emissions rates	GIS, HERS, MOBILE6	System – Total tons of emissions by functional class
Percentage of Air Quality Improvement Projects Selected	MoveAZ project list, RTPs, route coverage, output from emissions measures	GIS, HERS	System, district, and project – Number of air quality improvement projects
Noise Exposure	Sound wall locations	GIS	System and project – Sound walls added by proposed projects
Projects Listed in Regional Transportation Plans	MoveAZ project list, RTPs, route coverage	GIS	System and district – Number of state system projects identified by regional agencies
Fuel Consumption	Fleet size changes, VMT, speeds, route coverage, fuel consumption rates	GIS, IDAS	System and project – Changes in fuel consumption

Source: Cambridge Systematics, Inc., and Lima Associates, 2003.

MOVE AZ Long Range Transportation Plan

Appendix E. Demand and System Performance Analysis

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

MoveAZ Plan

Appendix E. Demand and System Performance Analysis

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

August 2004

Table of Contents

1.0 Introduction 1-1

2.0 System Demand 2-1
- 2.1 Data Sources 2-1
  - 2.1.1 Population and Employment Data 2-1
  - 2.1.2 Historical Traffic and Vehicle Miles of Travel Data 2-1
  - 2.1.3 Transit Utilization Data 2-2
  - 2.1.4 Aviation Utilization Data 2-3
  - 2.1.5 Bicycle and Pedestrian Utilization Data 2-3
  - 2.1.6 Freight Utilization Data 2-4
- 2.2 Travel Demand and Utilization Forecasting Methods and Results 2-4
  - 2.2.1 Population Forecasts 2-4
  - 2.2.2 Employment Forecasts 2-6
  - 2.2.3 State VMT Forecasts 2-8
  - 2.2.4 Urban System Travel Demand Analysis 2-16
  - 2.2.5 State Transportation System VMT and AADT Estimates 2-20
  - 2.2.6 Transit Utilization Forecasts 2-21
  - 2.2.7 Aviation Utilization Forecasts 2-26
  - 2.2.8 Bicycle and Pedestrian Utilization Forecasts 2-27
  - 2.2.9 Freight Utilization Forecasts 2-30

3.0 System Performance 3-1
- 3.1 Mobility and Economic Competitiveness System Performance 3-3
- 3.2 Connectivity System Performance 3-5
- 3.3 Preservation System Performance 3-7
- 3.4 Reliability System Performance 3-10
- 3.5 Safety System Performance 3-11
- 3.6 Accessibility System Performance 3-14
- 3.7 Resource Conservation System Performance 3-15

List of Tables

2.1 Population Estimates for Arizona Counties from 1980 to 2025 2-5

2.2 Employment Estimates for Arizona Counties from 1980 to 2025 2-7

2.3 Population Groups Used for State VMT Forecasting 2-8

2.4 Regression Equations for Population Groups and Functional Classification Types 2-10

2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025 12

2.6 Daily VMT Estimates by Arizona County for 2002, 2005, 2010, 2015, 2020, and 2025 2-15

2.7 Historical Estimates of State Population, Employment, and Daily VMT 2-16

2.8 Daily VMT Comparison for Urban Area Counties After Urban Area VMT Replacement 2-18

2.9 Estimated Daily Urban Bus Ridership for 2002 through 2025 2-22

2.10 Estimated Daily Rural Bus Ridership for 2002 through 2025 2-23

2.11 Intercity Bus Utilization Estimation Equations 2-24

2.12 Intercity Bus Boardings by County for 2002 and 2025 2-25

2.13 Estimated Daily Intercity Rail Boardings for 2002 through 2025 2-25

2.14 Estimated Daily Air Passenger Enplanements by County from 2002 through 2025 2-26

2.15 Estimated Daily General Aviation Operations by County from 2002 through 2025 2-27

2.16 Estimated Daily Bicycle Trips from 2002 through 2025 2-29

2.17 Estimated Daily Pedestrian Trips from 2002 through 2025 2-29

List of Tables
(continued)

2.18 Estimated Annual Tonnage of Air Freight for Sky Harbor and Tucson International Airports from 2002 through 2025 2-30

2.19 Estimated Annual Tonnage of Rail Freight from 2002 through 2025 2-31

2.20 Estimated Daily State Transportation System Truck VMT from 2002 through 2025 2-32

3.1 Measures Not Used in System Performance Analysis 3-2

3.2 Base System Performance of Percent of PMT by LOS 3-4

3.3 Average Delay Per Trip Base System Performance by ADOT District 3-5

3.4 Passing Ability Base Performance by District 3-6

3.5 Intercity Travel Time Base Performance by Corridor 3-7

3.6 Pavement Base System Conditions by District (2002) 3-8

3.7 VMT on "Good" or Better Pavement by District 3-9

3.8 Unexpected Delay by District (Hours Per 1,000 VMT) 3-11

3.9 Accidents Per 100 Million VMT by District 3-12

3.10 Anticipated Change in Injuries/Fatalities by District 3-13

3.11 Percent of State System Moderately/Highly Bike Suitable by District 3-15

3.12 Total Mobile Source Emissions Base System Performance by District (Metric Tons) 3-16

3.13 Daily Fuel Consumption Base System Performance by District in Gallons) 3-17

List of Figures

2.1 State Population Forecasts from 1980 to 2025 2-6

2.2 State Employment Forecasts from 1980 to 2025 2-7

2.3 Estimated Daily State VMT from 1980 to 2025 2-11

2.4 State Population, Employment, and Daily State VMT Growth Comparison from 2002 to 2025 2-11

2.5 Daily State VMT with Urban Area Replacement 2-17

2.6 MAG Regional Travel Model Versus the HPMS Network 2-18

2.7 Current (2002) Differences Before and After Urban Area VMT Replacement 2-19

2.8 Future (2025) Differences Before and After Urban Area VMT Replacement 2-19

3.1 MoveAZ Plan System Performance Evaluation Process 3-3

1.0 Introduction

1.0 Introduction

This technical memorandum presents the Task 9 – Demand and System Performance Analysis conducted for the Arizona Long-Range Transportation Plan (MoveAZ plan). The data used to generate base (2002) and future year (2025) travel demand and utilization of Arizona's multimodal transportation system are summarized and presented in Section 2.0. The analysis methods used to generate the demand estimates and the demand results by socioeconomic and modal category are also presented in Section 2.0. Section 3.0 presents base (2002) and future (2025) year system performance for the state transportation system, based on the performance measures computed in support of the MoveAZ plan. Detailed information about the performance measures are presented in the Task 10 MoveAZ Performance Measures Technical Memorandum.

2.0 System Demand

2.0 System Demand

2.1 Data Sources

This section identifies the data sources used to generate both base (2002) and future year (2025) travel demand and utilization of the Arizona transportation system. Data sources are presented by socioeconomic and modal category.

2.1.1 Population and Employment Data

Population Data

Historical population data from 1980 to 2002 for all counties in Arizona was obtained from the Arizona Department of Economic Security (DES). Population data from 2000 to 2002 was based on Census 2000 information. DES also provided approved population forecasts from 2000 to 2025, based on the 1990 Census and the 1995 Special Census. It should be noted that DES population forecasts using the 2000 Census were not available through December 2003. As an interim forecasting step due to the delay in receiving DES population forecasts, adjustments to the 2025 population forecasts, designed to reflect the 2000 Census projections, were prepared for integration with the MoveAZ plan as described below in Section 2.2.

Employment Data

The DES and Woods & Poole Employment datasets were the primary sources of employment information used to support the MoveAZ plan. DES provided employment information for all Arizona counties from 1994 to 2002. Employment information from 1980 to 2002 was obtained for Maricopa County, Pima County, and the entire State. The Woods & Poole employment data provided employment forecasts for each year from 2002 to 2010, as well as in five-year increments from 2010 to 2025.

2.1.2 Historical Traffic and Vehicle Miles of Travel Data

State System Traffic and Vehicle Miles of Travel Data

The Arizona Department of Transportation (ADOT) provided historical daily vehicle miles traveled (VMT) data for the primary Arizona highway system from 1980 to 2002. Daily VMT data for all counties was obtained for each year from 1992 to 2002. ADOT

provided its Highway Performance Monitoring System (HPMS) libraries and datasets from 1992 to 2002 to supplement the VMT analysis. Average Annual Daily Traffic (AADT) by roadway functional class is contained within each HPMS library.

Urban System Travel Demand Data

Several regional agencies provided urban area travel forecasting data to support the demand and utilization analysis for the MoveAZ plan. Agencies providing data included the Maricopa Association of Governments (MAG), the Pima Association of Governments (PAG), the Yuma Metropolitan Planning Organization (YMPO), and the Flagstaff Metropolitan Planning Organization (FMPO). Urban area information included base and travel demand forecasts, socioeconomic data, transportation network characteristics, and model area boundary coverages.

2.1.3 Transit Utilization Data

Urban Bus Data

Base and future year urban bus demand forecasts were obtained directly from MAG, PAG, and FMPO. Valley Metro in the MAG region provided ridership data for past years through 2001; PAG provided historical ridership data for 2000 and 2001, and a 2025 ridership forecast; and FMPO provided historical ridership data from recently prepared general plans. Valley Metro also provided expected bus service expansion information through 2025. Supplemental urban area population and employment data from 2000 to 2025, consistent with DES estimates, were obtained from each urban area.

Rural Bus Data

Arizona's 2002 base year rural bus estimates were based on historical rural transit operating data. Population and employment estimates corresponded to the 2002 calendar-year data from DES, Woods & Poole, and 2000 Census data. For the MoveAZ plan analysis, demand utilization forecasts for rural bus service did not include social service providers due to data availability.

Intercity Bus Data

Intercity bus travel utilization forecasts were prepared using data from the ADOT *Intercity Bus Analysis* report that included network and schedule information. Additional information was provided from individual transit operator web sites on network, schedule, and cost data; and current and forecasted population data from DES. Overhead trips that pass through Arizona without an origin or destination in the State were not included in the MoveAZ plan analysis.

Intercity Rail Data

Intercity rail utilization forecasts were prepared using annual station boarding data provided by ADOT. These 2000 data were scaled to 2002 and 2025 using population and employment estimates from DES.

2.1.4 Aviation Utilization Data

Air Passenger Data

Commercial aircraft operation forecasts were obtained from the Arizona State Aviation Needs Study 2000 (SANS 2000). The SANS data represented historical, current (2001), and future forecasts for every commercial airport in Arizona from 1995 through 2020. The SANS 2000 data were supplemented with the Federal Aviation Administration (FAA) revised systemwide forecasts prepared in March 2002 to account for the impact of the September 11th terrorist attacks. These data were obtained from the FAA Aerospace Forecasts Fiscal Year (FY) 2002-2013 (available at http://apo.faa.gov/pubs.asp?Lev2=1). Growth rates from 2020 to 2025 were based on overall growth factors derived from the FAA Long-Range Aerospace Forecasts: Fiscal Years 2015, 2020, and 2025 (available at the above web site). Current data for Phoenix Sky Harbor International Airport were taken directly from the airport's web site (available at http://phoenix.gov/AVIATION/info_stats/stats/index.html#P-5_0).

General Aviation Data

Annual operations at Arizona's general aviation airports were forecast through 2020 in SANS 2000. Those forecasts were adjusted for September 11th and extrapolated to 2025 using the same data and methods outlined in the "Air Passengers" section above.

2.1.5 Bicycle and Pedestrian Utilization Data

The primary source of data used in this analysis included the *Bicycle and Pedestrian Data: Sources, Gaps, and Needs*[1], the most comprehensive source of local bicycle and pedestrian usage provided in the U.S. Census Journey to Work files. These files included the modes of travel to work by individual counties in Arizona, as reported in the 1990 and 2000 Census. The most comprehensive source of national usage is the National Person Transportation Survey (NPTS). The DES forecasts of employment in each county were used to supplement the analysis. These sources provided the basis to estimate current and future bicycle and pedestrian usage in Arizona. For the MAG region, current year data

[1] Cambridge Systematics, *Bicycle and Pedestrian Data: Sources, Gaps, and Needs,* Bureau of Transportation Statistics, U.S. DOT, 2000.

were taken directly from the MAG Household Survey (available at http://www.mag.maricopa.gov/pdf/cms.resource/household-survey-final.pdf).

2.1.6 Freight Utilization Data

Air Freight Data

The two qualifying cargo airports in Arizona are the Phoenix International Airport (PHX) and the Tucson International Airport (TIA). Current year and forecasted total air cargo data were available for PHX from the City of Phoenix web site for 2001, 2005, 2010, and 2015. Current and historical air cargo data were provided by TIA. Estimates of nation-wide air cargo growth between through 2025 were provided by the FAA.

Rail Freight Data

The *1994 State Rail Plan Update* was the primary source for intercity freight rail utilization data. The *2000 State Rail Plan Update* also was used to provide 1998 Waybill data (by commodity) at the state level for interstate, through, and intrastate commodities, as well as total freight tonnage along every rail line segment in Arizona. The Freight Analysis Framework (FAF), prepared by the Federal Highway Administration (FHWA), was used to identify future forecasts of state-to-state commodity movements by rail through 2020. Woods & Poole data by employment sector and county were used to supplement this analysis. Each employment sector's level of consumption by commodity was generated from the Bureau of Economic analysis data.

Truck Vehicle Miles of Travel Data

Estimates of truck VMT for the base year were based on truck percentages contained within the HPMS dataset, which were applied to revised total VMT estimates described below in Section 3.0. Woods & Poole employment data were used to establish growth factors by county. The FAF data were used to estimate both the total amount of through truck tonnage for current and future years, as well as the relative split between through commodities and originating, terminating, and intrastate commodities.

2.2 Travel Demand and Utilization Forecasting Methods and Results

2.2.1 Population Forecasts

The DES population forecasts were the primary source of data used to forecast population by county and state in support of the MoveAZ plan. The approved population forecasts,

generated by DES for 2003 through 2025, were based on 1990 Census information. Through an analysis of the 1990 and 2000 Census data, it was determined that Arizona's DES population forecasts for 2000 and beyond were underestimated. To ensure consistency with the 2000 Census, DES adjusted the base year (2000 and 2002) population forecasts to be more consistent with current population estimates in Arizona.

However, DES did not adjust the population forecasts beyond 2003 at the time of this analysis. As a result, ADOT approved the implementation of a 2000 Census-based adjustment factor of the DES population forecasts from 2003 to 2025. The adjustment factor was computed by taking the percentage difference of the 1990 Census and the 2000 Census population estimates generated by DES. Adjustment factors were then applied to the DES population to generate for 2025 forecasts for use in the MoveAZ plan.

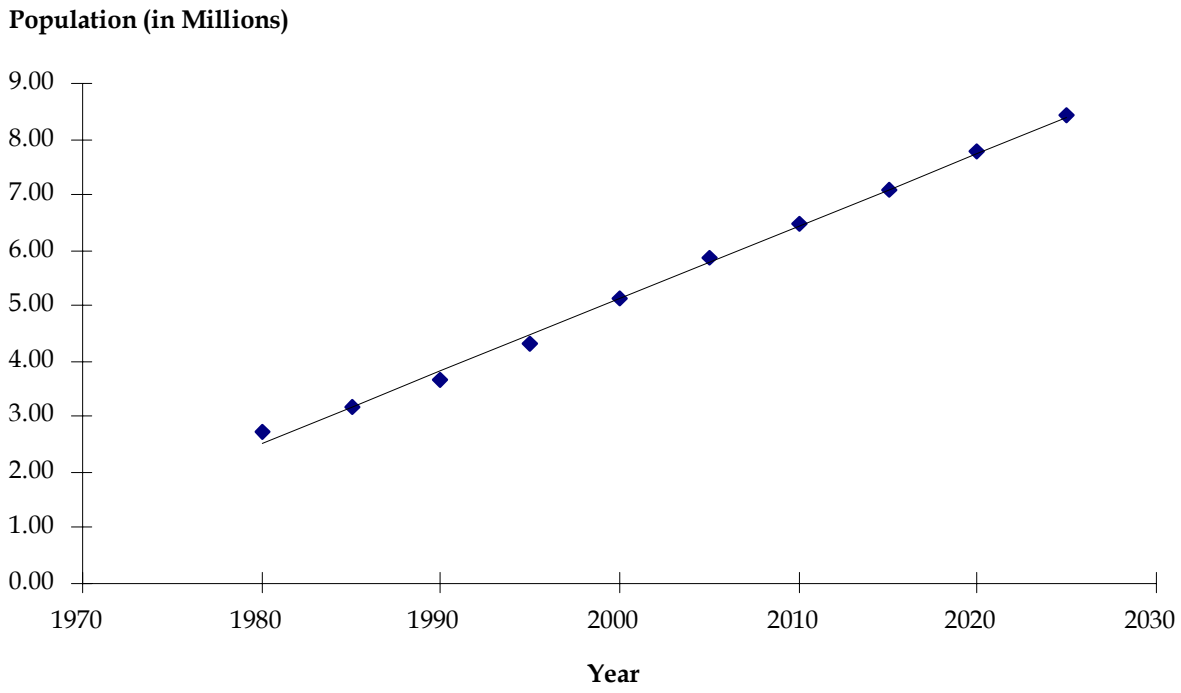
Population for Arizona was estimated at 5.47 million persons. Maricopa County alone accounts for 60 percent of the State's population in 2002. Forecasts for 2025 indicate that Arizona's population will reach 8.42 million persons, an increase of 54 percent. Table 2.1 shows the 2002 and 2025 population for all Arizona counties. Figure 2.1 shows the expected population growth for the Arizona.

Table 2.1 Population Estimates for Arizona Counties from 1980 to 2025

County	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Apache	52,108	53,465	61,600	63,750	69,423	72,705	77,142	81,700	86,323	90,868
Cochise	85,686	91,192	98,100	112,000	117,755	128,658	135,955	142,660	148,808	154,204
Coconino	75,008	84,431	96,900	110,750	116,320	132,533	144,024	155,168	165,518	175,500
Gila	37,080	37,319	40,300	44,525	51,335	54,927	58,074	61,276	64,620	67,810
Graham	22,862	24,574	26,700	30,050	33,489	36,423	40,185	43,586	46,812	49,939
Greenlee	11,406	9,052	8,000	8,525	8,547	8,775	9,066	9,366	9,694	10,007
La Paz	12,557	13,650	13,900	16,700	19,715	21,762	23,955	25,957	27,756	29,262
Maricopa	1,509,175	1,828,748	2,130,400	2,528,700	3,072,149	3,535,694	3,939,225	4,355,725	4,795,681	5,254,779
Mohave	55,865	70,769	95,400	125,150	155,032	181,551	205,791	228,641	250,244	269,887
Navajo	67,629	70,714	77,700	82,875	97,470	105,271	111,498	118,038	124,844	131,506
Pima	531,443	602,647	668,500	758,575	843,746	943,995	1,031,842	1,119,580	1,206,500	1,291,270
Pinal	90,918	103,230	116,800	139,000	179,727	205,652	226,307	245,004	262,017	276,966
Santa Cruz	20,459	23,534	29,900	34,275	38,381	42,212	46,310	50,626	55,187	59,888
Yavapai	68,145	82,642	108,500	130,300	167,517	195,501	220,381	244,374	268,003	290,180
Yuma	76,205	87,572	108,100	121,975	160,026	181,473	201,555	222,797	246,368	271,657
Total	**2,718,526**	**3,185,524**	**3,682,790**	**4,309,145**	**5,132,632**	**5,849,137**	**6,473,320**	**7,106,513**	**7,760,395**	**8,425,748**

Source: Lima and Associates, 2003.

Figure 2.1 State Population Forecasts from 1980 to 2025



Source: Lima and Associates, 2003.

2.2.2 Employment Forecasts

Historical employment data obtained from DES did not include information from 1980 to 1993 for counties other than Maricopa and Pima. Regression methods were used to generate county-level employment forecasts for these missing years. The resulting forecasts represented a critical input in the development of population- and employment-based VMT used to support the MoveAZ plan analysis. In this process, DES employment data (state totals) were used as the control total for each missing year (1980 to 1993).

To forecast employment data, primarily because DES does not forecast employment information for Arizona, a combination of historical DES estimates and forecasts of Woods & Poole employment were used. A comparison of the DES and Woods & Poole data revealed that historical employment growth rates from both sources followed a similar trend. The Woods & Poole employment growth rates were then calculated and applied to the DES historical data to derive employment forecasts from 2002 to 2025. As a check for reasonableness, linear regression was used to forecast employment with the DES historical data.

Arizona has an expected 2002 employment of 2.34 million. Maricopa County has 1.52 million employees, or approximately 65 percent of the State's current employment. Arizona's employment is expected to reach 3.68 million by 2025, a 57 percent increase.

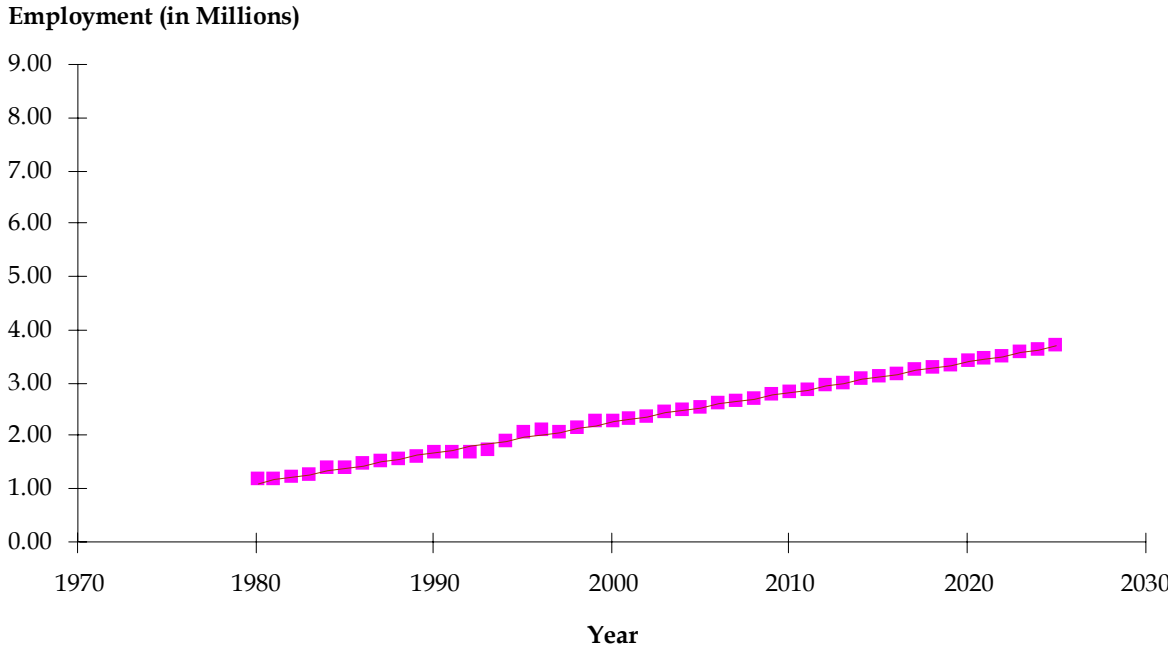
Table 2.2 shows the historical and future 2025 employment forecasts for all counties. Figure 2.2 shows the expected employment growth for Arizona.

Table 2.2 Employment Estimates for Arizona Counties from 1980 to 2025

County	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Apache	9,155	10,404	13,276	16,825	17,175	19,973	22,205	24,437	26,669	28,901
Cochise	22,803	25,258	31,300	39,525	37,525	43,458	47,639	51,820	56,001	60,182
Coconino	26,595	31,013	40,686	55,075	57,025	65,627	73,788	81,949	90,111	98,272
Gila	11,692	12,564	15,010	17,725	16,225	18,564	19,889	21,214	22,538	23,863
Graham	6,903	7,386	8,775	11,025	9,550	10,654	11,368	12,083	12,798	13,512
Greenlee	3,102	3,262	3,789	4,475	4,075	4,234	4,433	4,632	4,830	5,029
La Paz	2,949	3,431	4,489	5,825	6,375	7,191	8,076	8,961	9,846	10,731
Maricopa	709,500	867,600	1,073,500	1,302,400	1,463,600	1,640,894	1,834,635	2,028,377	2,222,119	2,415,860
Mohave	25,001	30,097	40,915	55,775	60,625	71,375	81,218	91,060	100,902	110,745
Navajo	15,226	17,185	21,759	27,550	27,675	32,084	35,550	39,015	42,480	45,946
Pima	240,584	273,900	319,121	371,300	373,700	410,712	444,870	479,028	513,187	547,345
Pinal	21,475	26,446	36,627	49,500	56,950	66,456	76,003	85,550	95,097	104,644
Santa Cruz	7,406	8,089	9,860	12,425	11,350	13,022	14,139	15,257	16,375	17,492
Yavapai	27,929	33,385	45,125	61,050	66,050	77,801	88,360	98,920	109,479	120,038
Yuma	26,681	29,980	37,770	49,000	47,900	54,939	60,728	66,517	72,306	78,095
Total	**1,157,001**	**1,380,000**	**1,702,002**	**2,079,475**	**2,255,800**	**2,536,984**	**2,822,901**	**3,108,820**	**3,394,738**	**3,680,655**

Source: Lima and Associates, 2003.

Figure 2.2 State Employment Forecasts from 1980 to 2025



Source: Lima and Associates, 2003.

2.2.3 State VMT Forecasts

State VMT were estimated to predict the level of expected utilization on Arizona's base and future highway system. Using the population and employment forecasts presented above, the process used to estimate state VMT is presented in this section. As described in Section 2.2.4, the state VMT presented in this section was supplemented with base and future year urban area travel demand forecasts from various regional agencies across the State. After estimating total daily state VMT, VMT specifically on the state transportation system was extracted and applied to state transportation system roadways to derive base and future AADT values for performance and project analysis, as described in Section 2.2.5.

Multiple linear regression equations were developed to estimate 2002 and 2025 state VMT by roadway functional classification and county as a function of population, employment, and the presence of interstate freeways. The resulting equations were categorized by population groups and functional classification types. The groupings included five categories of population groups by Arizona county, based on total population and travel characteristics as shown in Table 2.3. In support of this analysis, functional classification types used in the ADOT HPMS dataset were grouped into the following categories:

Table 2.3 Population Groups Used for State VMT Forecasting

	Population		
County	**Year 2002**	**Range**	**Group**
Greenlee	8,605	<30,000	A
La Paz	20,365	<30,000	A
Graham	34,070	30,000-75,000	B
Santa Cruz	39,840	30,000-75,000	B
Gila	53,015	30,000-75,000	B
Apache	70,105	30,000-75,000	B
Navajo	101,615	75,000-150,000	C
Cochise	124,040	75,000-150,000	C
Coconino	125,420	75,000-150,000	C
Mohave	166,465	150,000-250,000	D
Yuma	169,760	150,000-250,000	D
Yavapai	180,260	150,000-250,000	D
Pinal	192,395	150,000-250,000	D
Pima	890,545	>250,000	E
Maricopa	3,296,250	>250,000	E

Source: Lima and Associates, 2003.

- **Urban freeways –** all interstates and freeways in urban areas;
- **Rural freeways –** all interstates in rural areas; and
- **Non-freeways –** all other roadways in urban and rural areas.

County population and employment data were reclassified according to the population groups shown above in Table 2.3. Historical VMT from the HPMS-based functional classification types for each county were reclassified into the groups described earlier in this section. As part of this analysis, the following techniques were used to estimate missing historical VMT data by county and functional classification:

- **VMT data for all counties from 1980 to 1991 –** Regression was used to estimate VMT data for all counties from 1980 to 1991. Available statewide VMT was used as a control total in this process.

- **VMT data from 1980 to 2002 for all counties were not summarized by functional classification type –** ADOT's HPMS libraries from 1992 to 2002 were used to summarize VMT data for each county and functional classification type. For the remaining period of 1980 to 1991, regression techniques were used to estimate the missing data at the functional class level. Available total VMT by county from 1980 to 2002 was used as control totals.

Population, employment, and historical VMT datasets reflecting the population groups and functional classification groups described above were merged into a single dataset. Regression equations for each population group and functional classification type (scenario) were developed using the multiple linear regression analysis. Population and employment were used as the primary variables.

For some low population counties, the initial regression equations underestimated VMT. Since it was observed that these counties included rural interstate freeways, interstate mileage was used as an additional variable or sometimes replaced the employment variable. Regression equations were then developed for each population group and functional classification-type scenario.

The coefficient and determination (R^2) of the regression equation for each scenario was checked for reasonableness. Table 2.4 shows the regression equation data. In order to estimate 2025 state VMT for a given functional classification type for a county, county-level population and employment data were input into the appropriate regression equation. The same procedure was applied to derive VMT estimates for 2005, 2010, 2015, and 2020. A similar procedure was used to estimate 2002 VMT.

For 2002, daily state VMT for Arizona was estimated at 142 million and is expected to increase by 55 percent to 220 million by the year 2025. Figure 2.3 shows the expected state VMT for Arizona from 1980 to 2025. Figure 2.4 shows the projected increases in population, employment, and VMT for Arizona. Table 2.5 summarizes the daily VMT forecasts for all counties in Arizona by functional classification. Table 2.6 summarizes the total daily VMT for Arizona counties. Table 2.7 shows a comparison of the population, employment, and daily VMT for both historical and forecasted data.

Table 2.4 Regression Equations for Population Groups and Functional Classification Types

			Coefficient			
Functional Class	**R-Squared**	**Intercept**	**Population**	**Employment**	**Interstate Mileage**	**Interstate Volume**
Population Group A: <30,000						
Rural freeway	0.78	-141,702	44.15	86.29		
Urban freeway	0.00	0	–	–		
Rural and urban non-freeway	0.71	-178,501	39.33	30.77		
Population Group B: 30,000-75,000						
Rural freeway	0.86	-400,486	4.36	57.06		
Urban freeway	0.93	10,087	0.42	3.97		
Rural and urban non-freeway	0.75	-242,209	20.93	39.06		
Population Group C: 75,000-150,000						
Rural freeway	0.92	-974,784	12.57	26.70		
Urban freeway	0.88	-218,647	1.02	6.98	10,273.09	
Rural and urban non-freeway	0.87	635,186	4.52	48.19		
Population Group D: 150,000-250,000						
Rural freeway	0.67	-565,612	0.39	40.36		
Urban freeway	0.70	-424,166	1.02	5.92	27,180.36	
Rural and urban non-freeway	0.68	-125,060	4.38	56.90		
Population Group E: >250,000						
Rural freeway	0.84	-493,305	0.57	–	–	78.45
Urban freeway	0.93	-3,653,591	5.09	3.02		
Rural and urban non-freeway	0.99	3,027,873	1.67	26.00		

Source: Lima and Associates, 2003.

Figure 2.3 Estimated Daily State VMT from 1980 to 2025

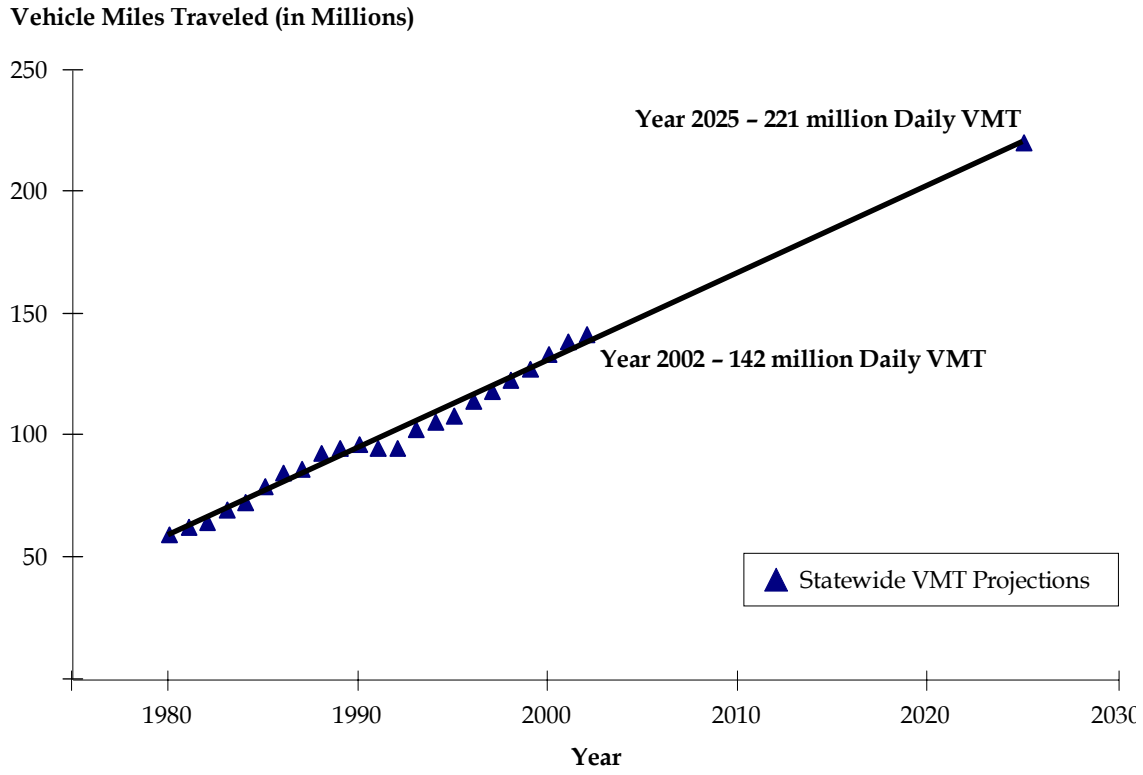
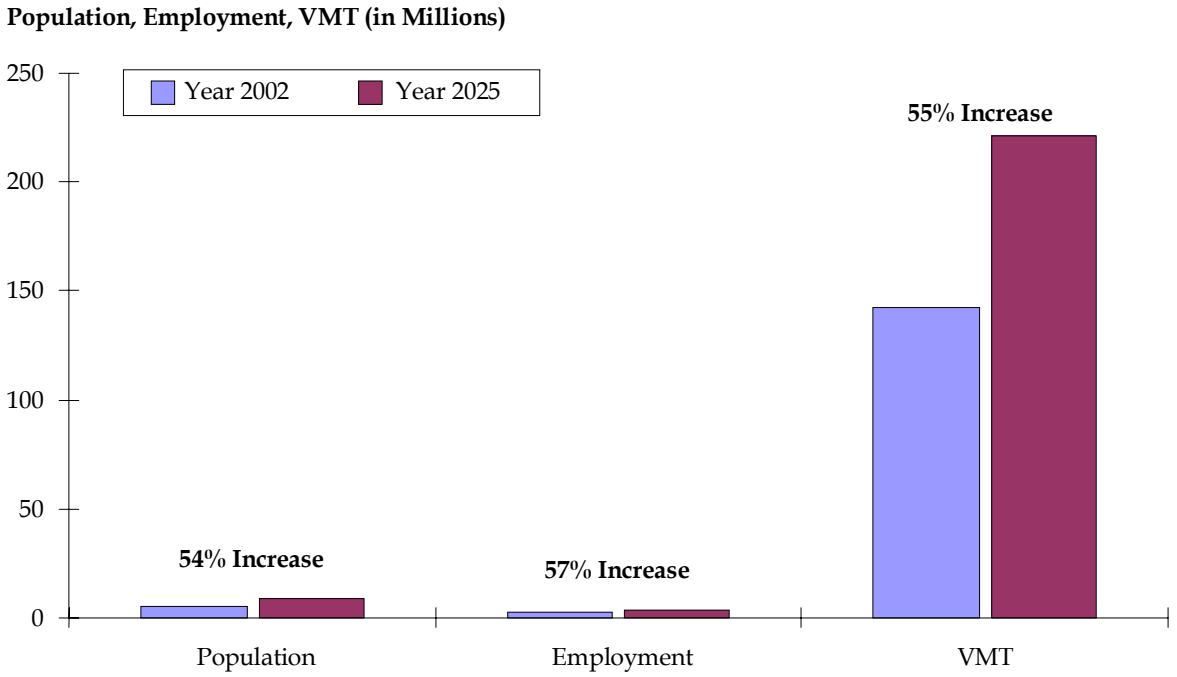


Figure 2.4 State Population, Employment, and Daily State VMT Growth Comparison from 2002 to 2025



Source: Cambridge Systematics, Inc. and Lima and Associates, 2003.

Table 2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025

County	Functional Class	VMT					
		2002	2005	2010	2015	2020	2025
Population Group A: <30,000							
Greenlee	Rural freeway	0	0	0	0	0	0
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	266,458	296,874	314,441	332,362	351,353	369,786
La Paz	Rural freeway	1,422,825	1,439,658	1,612,850	1,777,609	1,933,405	2,076,264
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	664,748	898,615	1,012,091	1,118,055	1,216,036	1,302,493
Population Group B: 30,000-75,000							
Apache	Rural freeway	1,173,180	1,056,155	1,202,858	1,350,089	1,497,603	1,644,777
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	1,611,888	2,059,854	2,239,916	2,422,511	2,606,466	2,788,788
Gila	Rural freeway	0	0	0	0	0	0
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	1,661,911	1,632,680	1,750,310	1,869,092	1,990,807	2,109,337
Graham	Rural freeway	0	0	0	0	0	0
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	747,807	936,372	1,043,010	1,142,130	1,237,586	1,330,932
Santa Cruz	Rural freeway	431,171	526,587	608,190	690,800	774,478	858,710
	Urban freeway	74,886	79,379	85,521	91,757	98,096	104,488
	Rural and urban non-freeway	453,594	1,150,047	1,279,459	1,413,474	1,552,617	1,694,652

Table 2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025 (continued)

County	Functional Class	VMT					
		2002	2005	2010	2015	2020	2025
Population Group C: 75,000-150,000							
Conchise	Rural freeway	1,994,143	1,802,842	2,006,200	2,202,116	2,391,030	2,570,491
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	2,474,297	3,310,229	3,544,647	3,776,392	4,005,622	4,231,456
Coconino	Rural freeway	2,574,366	2,443,445	2,805,787	3,163,767	3,511,793	3,855,166
	Urban freeway	626,521	538,277	617,169	685,436	763,176	850,809
	Rural and urban non-freeway	4,114,073	4,395,982	4,841,121	5,284,694	5,724,729	6,163,055
Navajo	Rural freeway	1,259,998	1,205,173	1,375,990	1,550,715	1,728,785	1,905,071
	Urban freeway	164,221	173,791	204,301	245,395	276,487	317,712
	Rural and urban non-freeway	2,865,583	2,656,551	2,851,684	3,048,182	3,245,881	3,442,978
Population Group D: 150,000-250,000							
Mohave	Rural freeway	2,260,953	2,385,455	2,792,114	3,198,192	3,603,786	4,008,659
	Urban freeway	218,591	373,735	483,900	565,465	672,940	778,426
	Rural and urban non-freeway	4,546,397	4,731,807	5,398,102	6,058,249	6,712,931	7,359,079
Pinal	Rural freeway	2,761,657	2,196,300	2,589,620	2,982,179	3,374,084	3,765,187
	Urban freeway	755,718	586,574	691,336	794,106	895,161	1,021,295
	Rural and urban non-freeway	4,580,516	4,557,550	5,191,292	5,816,451	6,434,231	7,042,964
Yavapai	Rural freeway	2,912,748	2,650,214	3,086,017	3,521,516	3,956,834	4,391,587
	Urban freeway	177,051	371,642	486,701	573,682	687,467	799,774
	Rural and urban non-freeway	5,022,490	5,158,580	5,868,420	6,574,430	7,278,787	7,976,781

Table 2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025 (continued)

County	Functional Class	VMT					
		2002	2005	2010	2015	2020	2025
Population Group D: 150,000-250,000 (continued)							
Yuma	Rural freeway	763,554	1,722,106	1,963,539	2,205,423	2,448,211	2,691,668
	Urban freeway	302,795	466,554	548,471	631,570	689,859	777,077
	Rural and urban non-freeway	2,536,966	3,796,273	4,213,676	4,636,164	5,068,859	5,509,084
Population Group E: >250,000							
Maricopa	Rural freeway	2,696,471	2,978,090	3,178,851	3,607,036	3,849,409	4,162,896
	Urban freeway	22,877,043	19,286,435	21,924,090	24,627,742	27,450,751	30,371,162
	Rural and urban non-freeway	47,157,521	51,595,650	57,306,831	63,039,671	68,811,637	74,615,506
Pima	Rural freeway	2,411,214	2,606,887	2,952,551	3,334,361	3,666,150	4,016,516
	Urban freeway	2,218,074	2,388,566	2,938,591	3,488,061	4,033,371	4,567,739
	Rural and urban non-freeway	13,328,002	15,282,723	16,317,506	17,352,107	18,385,370	19,415,020
Total		**142,109,431**	**149,737,652**	**167,327,153**	**185,170,981**	**202,925,788**	**220,887,385**

Source: Lima and Associates, 2003.

Table 2.6 Daily VMT Estimates by Arizona County for 2002, 2005, 2010, 2015, 2020, and 2025

County	VMT 2002	2005	2010	2015	2020	2025
Apache	2,785,068	3,116,010	3,442,775	3,772,600	4,104,069	4,433,565
Cochise	4,468,439	5,113,071	5,550,847	5,978,508	6,396,652	6,801,948
Coconino	7,314,959	7,377,704	8,264,078	9,133,897	9,999,699	10,869,030
Gila	1,661,911	1,632,680	1,750,310	1,869,092	1,990,807	2,109,337
Graham	747,807	936,372	1,043,010	1,142,130	1,237,586	1,330,932
Greenlee	266,458	296,874	314,441	332,362	351,353	369,786
La Paz	2,087,573	2,338,272	2,624,941	2,895,665	3,149,441	3,378,757
Maricopa	72,731,036	73,860,175	82,409,772	91,274,449	100,111,797	109,149,564
Mohave	7,025,941	7,490,997	8,674,117	9,821,906	10,989,657	12,146,163
Navajo	4,289,802	4,035,514	4,431,975	4,844,293	5,251,153	5,665,761
Pima	17,957,290	20,278,176	22,208,648	24,174,529	26,084,891	27,999,276
Pinal	8,097,891	7,340,424	8,472,247	9,592,736	10,703,475	11,829,445
Santa Cruz	959,651	1,756,013	1,973,170	2,196,032	2,425,191	2,657,850
Yavapai	8,112,289	8,180,435	9,441,138	10,669,628	11,923,088	13,168,142
Yuma	3,603,315	5,984,932	6,725,687	7,473,156	8,206,929	8,977,828
Total	**142,111,432**	**149,739,654**	**167,329,166**	**185,172,998**	**202,927,808**	**220,889,409**

Source: Lima and Associates, 2003.

Table 2.7 Historical Estimates of State Population, Employment, and Daily VMT

Year	Population	Employment	VMT	Year	Population	Employment	VMT
1980	2,716,546	1,157,001	60,112,100	1994	4,071,650	1,885,100	106,235,000
1981	2,810,108	1,194,000	62,795,106	1995	4,307,150	2,079,475	108,636,989
1982	2,889,860	1,205,001	64,832,130	1996	4,462,300	2,087,625	115,089,000
1983	2,968,924	1,261,000	70,031,066	1997	4,600,275	2,080,675	119,153,000
1984	3,067,134	1,370,000	73,171,061	1998	4,764,025	2,161,625	123,259,000
1985	3,183,539	1,380,000	79,592,973	1999	4,924,350	2,255,125	128,299,000
1986	3,308,261	1,462,999	85,321,908	2000	5,130,632	2,255,800	134,345,000
1987	3,437,103	1,511,000	86,927,945	2001	5,319,895	2,306,625	139,344,000
1988	3,535,183	1,556,000	93,569,866	2002	5,472,750	2,341,425	142,109,429
1989	3,622,184	1,617,000	95,384,897	2005	5,847,132	2,536,984	149,737,648
1990	3,680,800	1,702,002	97,139,000	2010	6,471,311	2,822,901	167,327,155
1991	3,767,070	1,674,001	95,691,000	2015	7,104,495	3,108,820	185,170,982
1992	3,858,805	1,676,999	95,760,000	2020	7,758,375	3,394,738	202,925,789
1993	3,958,875	1,717,000	103,095,988	2025	8,423,724	3,680,655	220,887,384

Source: Lima and Associates, 2003.

2.2.4 Urban System Travel Demand Analysis

The estimation process presented in Section 2.2.3 represents daily VMT for Arizona. In order to maintain as much consistency as possible with urban area travel demand and utilization, regional travel demand data from the MAG, PAG, FMPO, and YMPO regions were identified and used to supplement the state VMT estimates.

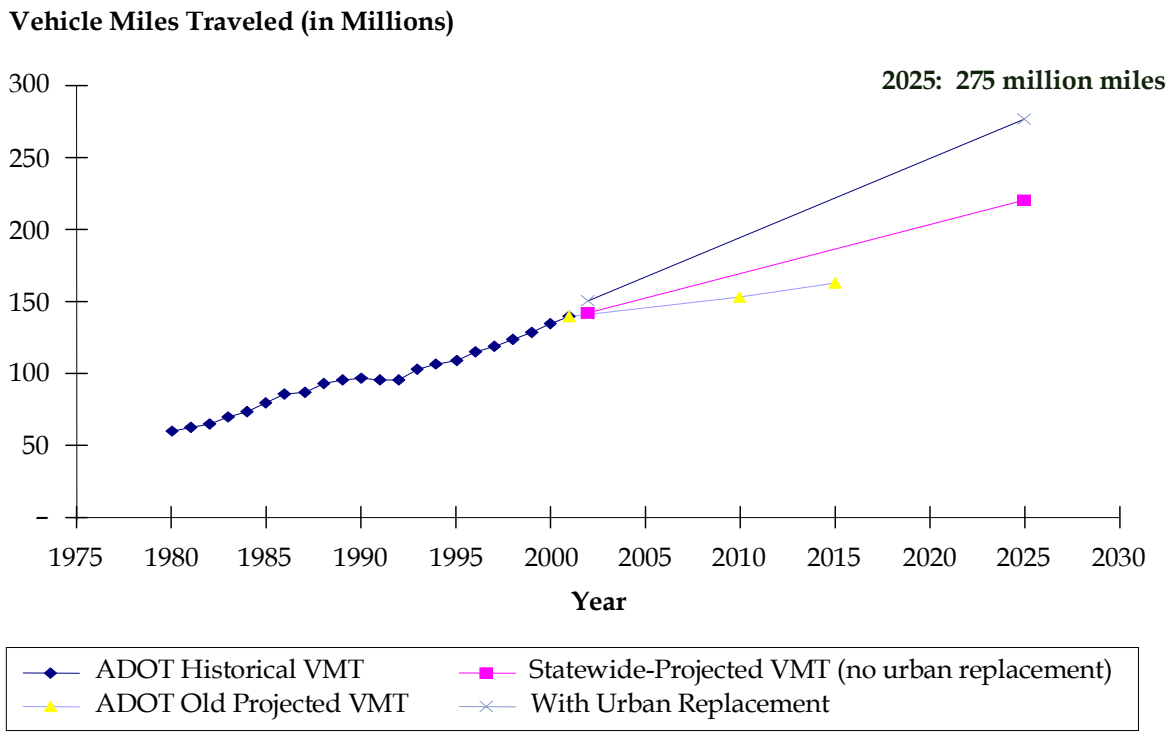
Using the regional travel demand model runs obtained from MAG, PAG, YMPO, and FMPO, VMT was calculated for the base and forecast years. For those modeling systems with base and forecast years other than 2002 and 2025, urban area VMT was adjusted using linear interpolation to match the analysis years specified for use in the MoveAZ plan.

Urban boundaries were spatially overlaid on ADOT's HPMS geographic information system (GIS) map to extract the VMT previously estimated for each of the four urban areas. This urban area VMT was then replaced with the urban area travel demand estimates using the geographic overlays. Seasonal adjustments also were developed and used to adjust the urban area VMT for consistency with the VMT estimates generated for the non-urban areas of the State.

With the urban area VMT replacement, Arizona's total VMT was estimated at 150 million for 2002. For 2025, the VMT was estimated at 276 million. Figure 2.5 shows the state VMT with urban area replacement. The differences in the number of roadways represented by the MAG regional travel model compared to the state system HPMS for the Phoenix region included:

- The MAG regional travel model network had 21 percent more miles of roadway detail than the state system HPMS in 2002 within the same area; and
- The MAG regional travel model used average weekday traffic; whereas, the state system HPMS used average annual daily traffic (AADT) to develop VMT.

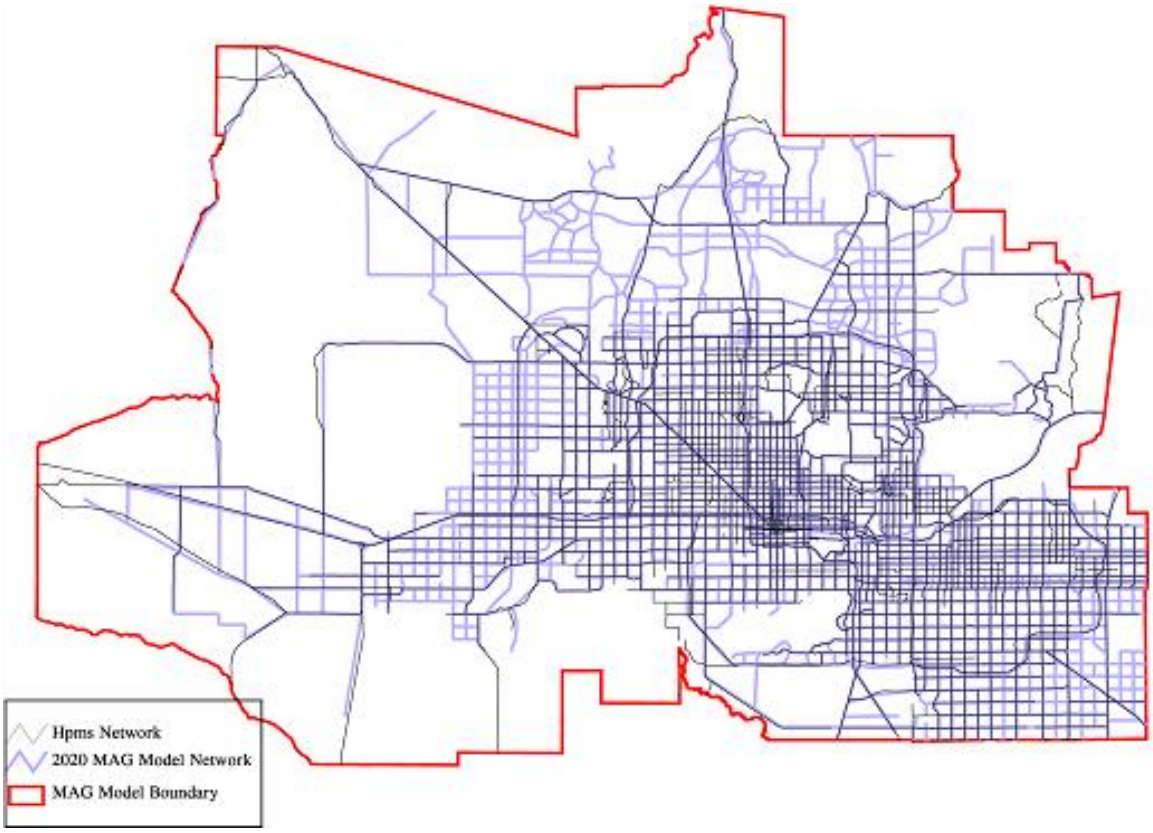
Figure 2.5 Daily State VMT with Urban Area Replacement



Source: Cambridge Systematics and Lima Associates, 2003

Figure 2.6 shows the differences in the MAG regional demand model and HPMS roadway coverages. Table 2.8 shows the comparison of VMT before and after urban area replacement for all selected urban counties, as well as the change in state VMT. Figures 2.7 and 2.8 show a comparison of VMT changes for counties with urban areas for 2002 and 2025, respectively.

Figure 2.6 MAG Regional Travel Model Versus the HPMS Network



Source: Lima and Associates, 2003.

Table 2.8 Daily VMT Comparison for Urban Area Counties After Urban Area VMT Replacement

	Without Urban Replacement		With Urban Replacement		Difference		Percent Difference	
County	**2002 VMT**	**2025 VMT**	**2002 VMT**	**2025 VMT**	**2002 VMT**	**2025 VMT**	**2002 VMT**	**2025 VMT**
Pima	17,957,290	27,999,276	19,709,057	33,183,260	1,751,767	5,183,984	10%	19%
Cononino	7,314,959	10,869,030	7,399,704	11,261,996	84,745	392,966	1%	4%
Yuma	3,603,315	8,977,828	4,549,120	9,074,556	945,805	96,727	26%	1%
Maricopa	72,731,036	109,149,564	78,216,663	158,747,274	5,485,628	49,597,710	8%	45%
Pinal	8,097,891	11,829,445	8,199,300	11,989,164	101,409	159,719	1%	1%
Statewide	**142,109,429**	**220,887,384**	**150,478,783**	**276,318,490**	**8,369,354**	**55,431,106**	**6%**	**25%**

Source: Lima and Associates, 2003.

Figure 2.7 Current (2002) Differences Before and After Urban Area VMT Replacement

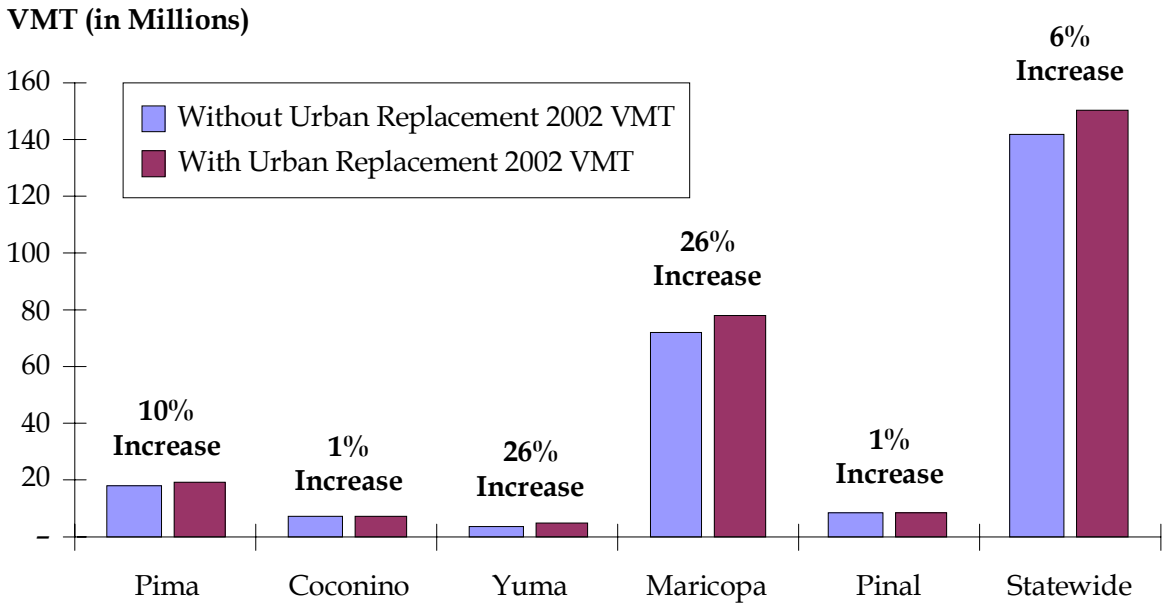
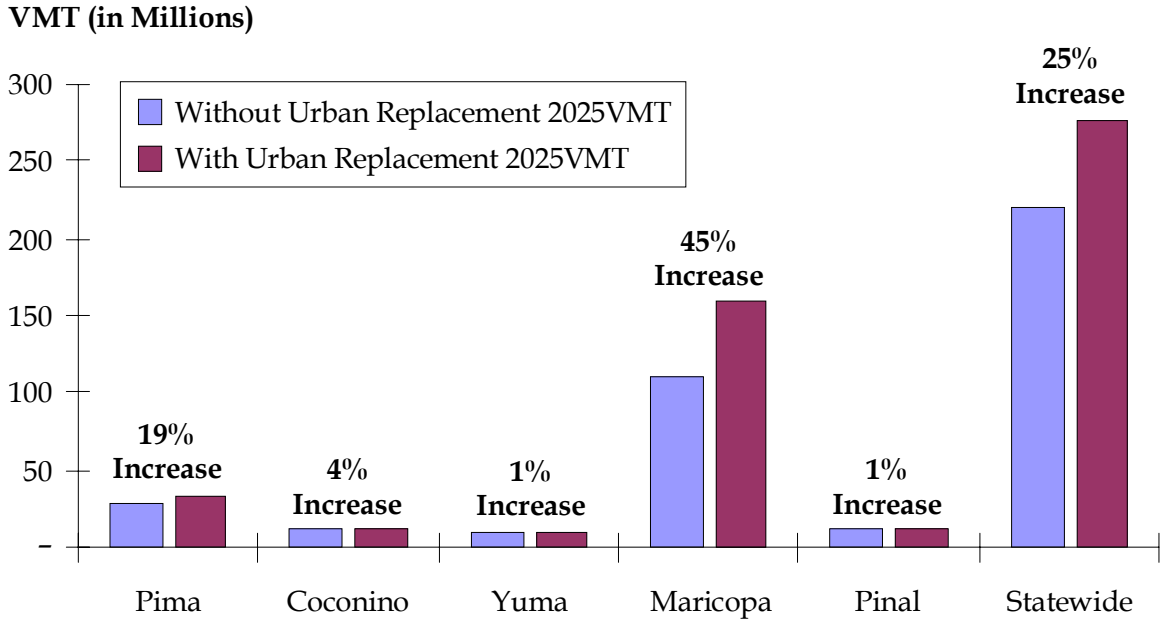


Figure 2.8 Future (2025) Differences Before and After Urban Area VMT Replacement



2.2.5 State Transportation System VMT and AADT Estimates

The process outlined above in Sections 2.2.3 and 2.2.4 was applied to estimate total state VMT by county and roadway functional classification. As the system performance and highway project evaluations in the MoveAZ plan apply to the state transportation system (those roadways controlled by ADOT) only, state transportation system VMT was then specifically extracted from the total state VMT. These estimates provided control totals that were mapped onto the HPMS network to generate segment-level estimates of VMT and AADT. The AADT estimates coded into the HPMS network were ultimately used as the basis for many of the base system performance calculations shown in Section 3.0 of this technical memorandum, as well as in the evaluation of specific future projects (explained in the Task 11 Project Evaluation Technical Memorandum).

The process for extracting state transportation system VMT from total state VMT and then mapping those estimates to the segment level required several steps:

1. First, for the four areas of the State that considered urban area travel demand models (MAG, PAG, YMPO, and FMPO), VMT estimates were used directly (as described in Section 2.2.4). AADT estimates and forecasts for state transportation system segments were coded directly from the urban area models onto the HPMS network.

2. For the rest of the State, the control totals for state transportation system roads were generated by estimating the percent of total VMT that occurs on the state system by county and functional classification. Some functional classifications, such as interstates, are entirely state controlled. The lower functional classifications (major and minor arterials and collectors) are controlled by both the state and local governments. For these functional classifications, the percentage of state control is based on the base year (2002) conditions.

3. The state VMT control totals were mapped proportionally to specific segments based on ADOT's estimates of segment-level VMT in the base year (2002) HPMS. VMT values in the existing HPMS were derived by multiplying the estimated AADT on a segment by the length of that segment. After mapping the VMT estimates to each segment, they were then converted back to AADT values by dividing by the length of each segment.

4. Segments were constrained to handle no more than 1.5 times their maximum daily capacity. The VMT from segments with a predicted VMT greater than this capacity constraint was redistributed to other state transportation system segments in the same county and functional classification with VMT below the capacity constraint.

5. Finally, segments at the edges of urban area model boundaries were investigated for discontinuities between the modeled data and the mapped HPMS results. In several cases, these were smoothed to better represent the conditions on the specific links. The data were smoothed from the last model observation down (or up) to the first AADT observation that was lower (or higher) than the final model observation.

Final state transportation system VMT estimates after the mapping process for the base and future years are shown in the Task 11 Project Evaluation Technical Memorandum.

2.2.6 Transit Utilization Forecasts

Urban Bus Forecasts

A "typical" demand elasticity for systemwide transit service expansion was adapted from Mayworm, Lago, and McEnroe (1980).[2] For example, an elasticity of +0.68 percent indicates that, for every one percent increase in service, there will be a corresponding 0.68 percent increase in ridership. This method provides a conservative growth estimate of urban bus forecasts for Arizona urban areas outside of the MAG, PAG, and FMPO regions. Urban bus utilization information obtained from transit operators in the MAG, PAG, and FMPO regions was used directly in this analysis. This method was used to support the transit utilization analysis for the MoveAZ plan and has been used in various other studies, including the update of the Georgia State Transportation Plan.

An initial estimation of 2002 and 2025 forecasts of annual transit ridership was prepared by scaling the historical ridership data for the MAG, PAG, and FMPO regions. A scaling factor was developed for 2025 by determining the average growth in population and employment from through 2025. This initial forecast assumed that transit service remained unchanged. There was a further implied assumption that growth occurred somewhat uniformly in each urban area, such that population and employment within the transit provider service areas would keep pace with overall regional growth (otherwise, the growth in transit trips would not keep pace with population and employment growth).

Initial forecasts for the MAG region were then adjusted to reflect planned service expansion. Based on Regional Transportation Plan (RTP) estimates for transit projects, the percent service expansion was multiplied by the estimated demand elasticity and the initial demand forecasts to arrive at a revised forecast. Planned service expansion for the PAG region was already included in the PAG RTP's ridership projections and used directly in this analysis. Table 2.9 shows the daily urban bus ridership estimates for 2002 and forecasts for 2005, 2010, 2015, 2020, and 2025 for the MAG, PAG, and FMPO regions.

[2] Mayworm, P. D., A. M. Lago, and J. M. McEnroe, *Patronage Impacts of Changes in Transit Fares and Services*, Urban Mass Transportation Administration, 1980.

Table 2.9 Estimated Daily Urban Bus Ridership for 2002 through 2025

County	2002	2005	2010	2015	2020	2025
MAG Region	118,465	133,950	160,298	189,172	220,870	255,378
PAG Region	43,629	47,592	54,197	60,803	67,408	74,013
FMPO Region	392	410	446	482	518	554
Total	**162,486**	**181,952**	**214,941**	**250,457**	**288,796**	**329,945**

Source: Cambridge Systematics, 2003.
Note: Transit ridership was not available for the YMPO region.

Rural Bus Forecasts

Annual rural transit demand in each county was calculated using the following equation from the *TCRP Report #3 – Workbook for Estimating Demand for Rural Passenger Transportation*:

$$\text{Annual demand} = RE\left(\frac{1}{1+k_e e^{-U_e}}\right) + RM\left(\frac{1}{1+k_m e^{-U_m}}\right) + RP\left(\frac{1}{1+k_p e^{-U_p}}\right)$$

Where:

R = 1,200;

E = Number of persons age 60 or over;

M = Number of mobility limited persons age 16 to 64;

P = Number persons age 64 or less in families with incomes below the poverty level (The definition of poverty level is that used for the 2000 U.S. Census.);

$k_e = e^{6.38}$;

$k_m = e^{6.41}$;

$k_p = e^{6.63}$;

$U_e = 0.000510 \times \frac{RVM}{Area}$;

$U_m = 0.000400 \times \frac{RVM}{Area}$; and

$U_p = 0.000490 \times \frac{RVM}{Area}$.

Key statistics required to implement this approach included population by age, mobility limitations, and income; annual revenue vehicle miles (RVM); and catchment area within the county. Future 2025 forecasts of demographics by age and income were available from Woods & Poole data, and were fit to match the DES population control totals by county. A scaling factor from average growth in population from DES was used to determine the number of mobility limited individuals in 2025. An increase in RVM was not assumed for 2025. Rural bus utilization estimates were combined at the county level and are presented in Table 2.10 for 2002 through 2025.

Table 2.10 Estimated Daily Rural Bus Ridership for 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	183	188	201	216	233	248
Cochise	278	297	327	360	396	428
Coconino	105	115	132	151	170	186
Gila	144	151	165	182	202	220
Graham	75	78	86	97	108	122
Greenlee	13	13	14	15	17	18
La Paz	58	63	72	82	93	102
Maricopa	393	432	499	581	679	789
Mohave	470	520	611	712	821	922
Navajo	247	262	288	318	352	381
Pima	787	849	966	1,103	1,257	1,404
Pinal	436	478	550	628	712	786
Santa Cruz	84	89	100	114	130	145
Yavapai	480	529	619	722	837	944
Yuma	366	393	441	502	576	661
Total	**4,119**	**4,457**	**5,071**	**5,783**	**6,583**	**7,356**

Source: Cambridge Systematics, 2003.

Intercity Bus Forecasts

The method for creating intercity bus demand estimates and forecasts was taken from the U.S. DOT's *Planning Techniques for Intercity Transportation Services Report*. Using data from 89 different intercity bus routes, this report established three different regression models based on route distance: 20 to 60 miles, 61 to 120 miles, and greater than 121 miles as shown in Table 2.11. Each equation was used to calculate passengers per month. Round trip frequency, population served (the sum of the populations of all communities along the route), and fare per mile converted to 1980 cents were required inputs into this analysis process. Routes significantly longer than 150 miles were segmented into smaller routes

to fit within these equations. Finally, estimates for each route were prepared separately for different transit operators.

Table 2.11 Intercity Bus Utilization Estimation Equations

One-Way Route Distance (Miles)	Equation
20-60	17.989 x (Round trip frequency)1.032 x (Population served/100)0.376 x (Fare per mile) – 0.645
61-120	6.871 x (Round trip frequency)1.093 x (Population served/100)0.409 x (Fare per mile) – 0.352
121+	1.510 x (Round trip frequency)0.415 x (Population served/100)0.726

Source: Planning Techniques for Intercity Transportation Services, U.S. DOT, July 1987.

These equations were used to estimate current intercity bus utilization, as well as to forecast 2025 utilization, using the population forecasts based on DES information. The 2025 forecasts should be considered annual "unconstrained" demand, and do not account for the potential lack of seat availability on intercity buses. The forecasts reflect the intercity bus network and schedule in Arizona as of 1993, as presented in the ADOT *Intercity Bus Analysis Report*, and updated based on current route and schedule information from the Internet. Therefore, the forecasts do not reflect the potential for route deletions, schedule modifications, new service, or travel time changes due to highway congestion. However, several sensitivity tests performed for various studies, including the Georgia State Transportation Plan Update, suggest that intercity bus demand is relatively insensitive to the time and cost changes on competing modes. Table 2.12 shows the daily intercity bus boardings by county from 2002 to 2025, which were estimated using the above methodology.

Intercity Rail Forecasts

Using annual station boarding data provided by ADOT, intercity passenger rail boardings were generated and summed to provide county-level demand estimates. Base year estimates for 2000 were scaled to 2002 and 2025 using population and employment estimates from DES. Table 2.13 shows the estimated daily intercity rail boardings for Arizona from 2002 through 2025.

Table 2.12 Intercity Bus Boardings by County for 2002 and 2025

County	2002	2025
Apache	0.04	0.05
Cochise	0.27	0.27
Coconino	31.46	37.85
Gila	0.58	0.66
Graham	0.85	1.06
Greenlee	0.05	0.05
La Paz	2.14	2.36
Maricopa	494.61	685.31
Mohave	16.59	23.68
Navajo	2.08	2.49
Pima	94.13	117.48
Pinal	6.19	8.11
Santa Cruz	1.08	1.30
Yavapai	9.21	11.55
Yuma	14.78	21.14

Source: Cambridge Systematics, 2003.

Table 2.13 Estimated Daily Intercity Rail Boardings for 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Maricopa	24	26	29	32	35	39
Mohave	9	10	11	13	14	15
Pima	73	78	85	92	99	105
Navajo	6	7	7	8	8	9
Cochise	5	6	6	7	7	8
Coconino	146	158	174	191	207	222
Yuma	7	8	9	10	10	11
Total	**270**	**293**	**321**	**353**	**380**	**409**

Source: Cambridge Systematics, 2003.

2.2.7 Aviation Utilization Forecasts

Air Passenger Forecasts

Using the September 11th adjusted commercial aircraft operation forecasts from the SANS 2000 report, daily air passenger enplanement forecasts were estimated for 2002, 2005, 2010, 2015, and 2020. Data for 2002 for Maricopa County were taken directly from Phoenix Sky Harbor International Airport. Growth rates from 2020 to 2025 were based on overall growth factors derived from the FAA Long-Range Aerospace Forecasts: FY 2015, 2020, and 2025. These growth factors were applied to the 2020 forecasts for all Arizona commercial airports. Table 2.14 shows the daily enplanements from 2002 through 2025 by county total, ensuring consistency with other modal demand estimates.

Table 2.14 Estimated Daily Air Passenger Enplanements by County from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Cochise	23	28	32	37	43	51
Coconino	876	1,050	1,211	1,396	1,609	1,916
Graham	0	6	7	9	10	12
Maricopa	48,256	53,548	61,722	71,144	82,004	97,647
Mohave	126	151	174	200	231	275
Navajo	5	12	14	16	18	22
Pima	4,660	5,586	6,439	7,422	8,555	10,186
Yavapai	20	24	28	32	37	44
Yuma	165	198	228	263	303	361
Total	**54,131**	**60,604**	**69,855**	**80,518**	**92,809**	**110,513**

Source: SANS 2000 Report and Cambridge Systematics, 2003.

General Aviation Forecasts

Annual operations at Arizona general aviation airports were forecast through 2020 in the SANS 2000 report. These forecasts were adjusted for September 11th and extrapolated to 2025 using the same growth methods outlined in the "Air Passengers" section above. Table 2.15 shows the general aviation daily operations by county total from 2002 through 2025.

Table 2.15 Estimated Daily General Aviation Operations by County from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	74	76	81	87	93	96
Cochise	310	317	330	343	357	366
Coconino	742	758	824	897	977	999
Gila	239	244	249	254	259	262
Graham	42	43	46	49	53	54
Greenlee	21	21	21	21	21	21
La Paz	39	40	43	46	48	49
Maricopa	5,212	5,322	6,182	7,043	7,903	8,089
Mohave	403	411	461	517	582	595
Navajo	220	224	236	249	262	267
Pima	1,217	1,243	1,399	1,478	1,557	1,581
Pinal	322	329	348	370	394	402
Santa Cruz	64	66	79	96	115	118
Yavapai	1,179	1,204	1,349	1,513	1,699	1,739
Yuma	109	111	120	131	142	145
Total	**10,193**	**10,409**	**11,768**	**13,094**	**14,462**	**14,783**

Source: SANS 2000 Report and Cambridge Systematics, 2003.

2.2.8 Bicycle and Pedestrian Utilization Forecasts

The NPTS indicates that, on average nationally and annually, nine percent of bicycle trips are commuting trips and that seven percent of walking trips are commuting trips. It was assumed for the MoveAZ plan analysis that this percentage will remain constant through 2025; and that, therefore, any increase in bicycle and pedestrian travel would be a function of increases in employment and population.

The method used to estimate bicycle and pedestrian demand for the MoveAZ plan was based on known state and national factors. It employed the market analysis method outlined in the *Guidebook on Methods to Estimate Non-Motorized Travel*.[3] That method produced estimates of the likely bicycle and pedestrian trip estimates based on local information and comparisons with other areas. As indicated in *Bicycle and Pedestrian Data: Sources, Gaps,*

[3] Cambridge Systematics, *Guidebook on Methods to Estimate Non-Motorized Travel: Overview of Methods*, Turner-Fairbanks Highway Research Center, FHWA, 1999.

and Needs[4], the most comprehensive source of local bicycle and pedestrian usage was provided in the U.S. Census Journey to Work dataset. These files included the modes of travel to work by individual counties in Arizona as reported in both the 1990 and 2000 Census. The most comprehensive source of national usage was the NPTS. These sources provided the basis to estimate current and future bicycle and pedestrian utilization in Arizona.

The Census Journey to Work data reported on the percentage of the workforce that uses bicycles or walks as their primary mode to work. This information was obtained for each county in Arizona. The percentages were applied to the 2000 DES employment to determine the existing bicycle and pedestrian usage for work trips. The NPTS indicated that, on average nationally, nine percent of bicycle trips were commuting trips and that seven percent of walking trips were commuting trips.

The forecasts of bicycle and pedestrian trips were calculated in the following manner:

- The forecast of employment in each county was available from DES;
- The county bicycle and pedestrian Journey to Work percentages were applied to the DES employment forecasts by county;
- The resulting number was multiplied by two to account for trips to and from work;
- This daily person work trip forecast was then multiplied by an average of 220 working days per year (accounting for holidays, vacations, sick, personal business, and other weekdays where no work trip are made) to determine the annual number of pedestrian and bicycle trips;
- The annual work-related bicycle trips were divided by nine percent to calculate the annual total bicycle trips; and
- The annual work-related pedestrian trips were divided by seven percent to calculate the annual total walking trips.

Base data for bicycle and pedestrian utilization in Maricopa County were taken directly from the MAG Household Survey. Utilization was then forecasted using the same procedure outlined above. Tables 2.16 and 2.17 show the resulting forecasts of daily bicycle and pedestrian utilization by county from 2002 through 2025.

[4] Cambridge Systematics, *Bicycle and Pedestrian Data: Sources, Gaps and Needs,* Bureau of Transportation Statistics, U.S. DOT, 2000.

Table 2.16 Estimated Daily Bicycle Trips from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	377	438	487	536	585	634
Cochise	3,991	4,623	5,067	5,512	5,957	6,401
Coconino	11,534	13,274	14,924	16,575	18,226	19,876
Gila	771	882	945	1,007	1,070	1,133
Graham	395	441	470	500	530	559
Greenlee	26	27	29	30	31	32
La Paz	729	822	924	1,025	1,126	1,227
Maricopa	156,948	168,094	187,941	207,788	227,635	247,482
Mohave	3,618	4,260	4,848	5,435	6,022	6,610
Navajo	288	334	370	406	443	479
Pima	72,656	79,852	86,493	93,134	99,775	106,416
Pinal	3,664	4,276	4,890	5,504	6,119	6,733
Santa Cruz	305	349	379	409	439	469
Yavapai	4,497	5,297	6,016	6,734	7,453	8,172
Yuma	6,715	7,701	8,513	9,324	10,136	10,947
Total	**266,514**	**290,670**	**322,295**	**353,921**	**385,547**	**417,172**

Note: Trips represent all purposes, but primarily recreational trip making.
Source: Cambridge Systematics, 2003.

Table 2.17 Estimated Daily Pedestrian Trips from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	26,431	30,737	34,172	37,607	41,042	44,477
Cochise	35,580	41,206	45,170	49,134	53,099	57,063
Coconino	82,392	94,821	106,612	118,404	130,196	141,988
Gila	9,906	11,335	12,144	12,953	13,761	14,570
Graham	6,399	7,139	7,617	8,097	8,576	9,054
Greenlee	1,370	1,423	1,490	1,557	1,623	1,690
La Paz	7,626	8,602	9,661	10,719	11,778	12,836
Maricopa	1,125,445	1,205,367	1,347,685	1,490,004	1,632,323	1,774,641
Mohave	26,669	31,398	35,727	40,057	44,386	48,716
Navajo	9,161	10,621	11,768	12,915	14,062	15,209
Pima	164,007	180,250	195,241	210,232	225,224	240,215
Pinal	26,673	31,125	35,596	40,067	44,539	49,010
Santa Cruz	8,209	9,418	10,226	11,034	11,843	12,651
Yavapai	39,717	46,783	53,132	59,482	65,831	72,181
Yuma	34,261	39,296	43,437	47,578	51,718	55,859
Total	**1,603,846**	**1,749,519**	**1,949,678**	**2,149,839**	**2,350,001**	**2,550,160**

Note: Trips represent all purposes, but primarily recreational trip making.
Source: Cambridge Systematics, 2003.

2.2.9 Freight Utilization Forecasts

Air Freight Forecasts

Current (2001) and forecasted total air cargo data were available for PHX from the City of Phoenix web site for 2001, 2005, 2010, and 2015. Current and historical air cargo data were provided by TIA. The FAA estimates of nationwide air cargo growth between through 2025 were applied to the TIA data to identify expected 2025 air cargo projections. These forecasts were applied to the PHX 2015 forecasts to estimate PHX 2025 air freight forecasts. Table 2.18 shows the estimated tons of annual air freight from 2002 through 2025 for Sky Harbor and TIA.

Table 2.18 Estimated Annual Tonnage of Air Freight for Sky Harbor and Tucson International Airports from 2002 through 2025

City/Airport	2002	2005	2010	2015	2020	2025
Phoenix Sky Harbor	421,791	750,000	1,025,000	1,500,000	1,920,000	2,400,000
Tucson International	33,686	40,297	53,595	69,138	88,496	110,620
Total	**457,479**	**792,302**	**1,080,605**	**1,571,153**	**2,010,516**	**2,512,645**

Source: PHX, TIA, and Cambridge Systematics, 2003.

Rail Freight Forecasts

The *1994 State Rail Plan Update* showed a 57 percent growth in annual average freight hauled by rail in Arizona from 1993 to 2015 (including both intrastate and overhead traffic). The *2000 State Rail Plan Update* provided 1998 Waybill data (by commodity) at the state level for interstate, through, and intrastate commodities, as well as total freight tonnage along every rail line segment in Arizona. The FAF projected state-to-state commodity movements by rail through 2020.

The growth rates for each commodity to and from Arizona were applied to the Waybill data to estimate 2025 rail freight tonnages for each freight movement category:

- Interstate shipments originating in Arizona;
- Interstate shipments terminating in Arizona;
- Interstate shipments passing through Arizona; and
- Intrastate shipments.

The total statewide projections were disaggregated to county levels using Woods & Poole sector employment data (fitted to the DES-based employment totals) and DES population

data. Manufacturing sectors were assumed to drive the growth in shipments outbound from Arizona; and, therefore, manufacturing employment was used to split interstate shipments originating in Arizona to the county level.

Growth in population and employment in all sectors by county and each sector's level of consumption by commodity (based on Bureau of Economic Analysis data) were used to split interstate shipments terminating in Arizona to the county level. Intrastate trips, with both an origin and destination county within Arizona, were allocated using the same procedures used for interstate trips.

Interstate trips were allocated using the Burlington-Northern Santa Fe (BNSF) or Union Pacific (UP) rail lines that pass through Arizona and through each county along those lines. Interstate commodities were split between the two lines based on total rail tonnage by line given in the *2000 State Rail Plan Update*.

Interstate and intrastate traffic often pass through other Arizona counties in route to final destinations. This county-level additional "through tonnage" was allocated to each county based on the likelihood that rail traffic must pass through it to get to another county. This likelihood was established based on the county's geographic position in the State, the number of rail lines passing through it, and the relative traffic on those lines. Table 2.19 shows the estimated annual tons of rail freight from 2002 through 2025.

Table 2.19 Estimated Annual Tonnage of Rail Freight from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	59,775	71,559	83,337	94,886	106,435	117,985
Cochise	28,517	33,826	39,109	44,267	49,426	54,585
Coconino	60,362	72,212	84,055	95,678	107,301	118,924
Gila	454	507	526	556	589	626
Graham	426	481	503	528	555	585
Greenlee	954	1,120	1,289	1,493	1,688	1,874
La Paz	97	113	128	142	156	170
Maricopa	45,524	52,579	59,918	67,077	74,262	81,474
Mohave	60,379	72,284	84,165	95,811	107,458	119,103
Navajo	60,357	72,248	84,125	95,792	107,453	119,105
Pima	33,001	38,826	44,579	50,214	55,835	61,445
Pinal	30,520	36,194	41,844	47,453	53,068	58,694
Santa Cruz	107	130	144	159	174	189
Yavapai	61,104	73,083	85,037	96,785	108,526	120,258
Yuma	28,949	34,334	39,682	44,895	50,107	55,317
Total	**470,526**	**559,496**	**648,441**	**735,736**	**823,033**	**910,334**

Note: Represented by annual tons (1,000).
Source: ADOT and Cambridge Systematics, 2003.

Truck VMT

Estimates of truck VMT for the base year were based on truck percentages contained in the HPMS dataset, which were applied to state transportation system (with urban demand replacement) VMT estimates. Growth in manufacturing sectors was assumed to drive growth in truck traffic, so Woods & Poole employment data, adjusted for changes in productivity, were used to establish growth factors by county. Truck VMT totals were then calculated by county and disaggregated to the state system roadways using the same relative split as provided in the base year HPMS.

Some additional growth due to truck traffic passing through Arizona was not captured by employment changes within the State. The FAF data was used to estimate both the total amount of through truck tonnage for current and future years, as well as the relative split between through commodities and originating, terminating, and intrastate commodities. Using these data, additional growth rates were established to apply to total truck VMT established by county. However, since through traffic travels primarily on interstates and other freeways, these additional rates were applied only to those functional classifications in the HPMS dataset. Table 2.20 shows the estimated daily state transportation system truck VMT from 2002 through 2025.

Table 2.20 Estimated Daily State Transportation System Truck VMT from 2002 through 2025

	2002	2025
Total VMT (State System)	77,879,575	142,551,447
Truck VMT (State System)	14,518,766	33,376,876
Truck Percentage of Total VMT	19%	23%

Source: Cambridge Systematics, 2003.

3.0 System Performance

3.0 System Performance

This section presents the base (2002) and future (2025) year system performance for the state transportation system. System performance was computed for the factors and measures identified in the Task 10 Performance Factors and Measures Technical Memorandum to establish the future 2025 "basecase" conditions on the state transportation system prior to the evaluation and analysis of specific 20-year improvement projects for testing in the MoveAZ performance-based planning process. The process for developing the performance measures, a detailed description and example calculation of each measure, and the link between measures, factors, and goals also are presented in the Task 10 Performance Factors and Measures Technical Memorandum. This section presents the system performance results by the following factors:

- Mobility and economic competitiveness;
- Connectivity;
- Preservation;
- Reliability;
- Safety;
- Accessibility; and
- Resource conservation.

Mobility and economic competitiveness were combined because the supporting performance measures for each factor apply to both. The future state transportation network used in the system performance analysis considered existing (2002), plus financially committed projects (specified by ADOT) to be constructed by 2025. System performance results presented in this section consider daily conditions, unless otherwise indicated. As shown in Table 3.1, several performance measures were not applied to identify base and future system performance. Reasons for not using these measures for system performance analysis included unavailable data; some measures were relevant to compare (rather than to measure) project performance; and other measures were oriented to programming (bridge, safety, etc.), rather than the project analysis conducted for the MoveAZ Plan.

Table 3.1 Measures Not Used in System Performance Analysis

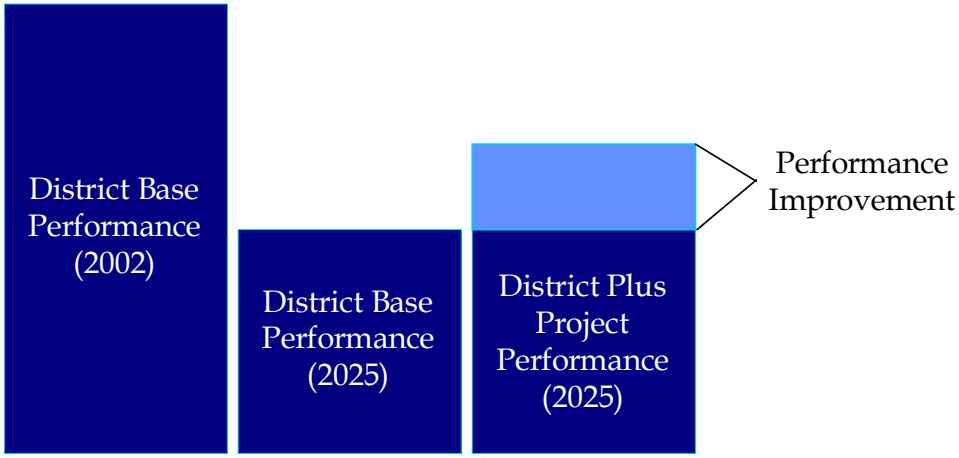
Performance Measure	No System Performance Calculations		Reasons for not including these measures in systems analysis
	2002	2025	
Reconstruction Need	X	X	Relevant only for project comparison (interim measure)
Pavement Condition		X	Separate programming area
VMT by Pavement Condition		X	Separate programming area
Bridge Condition	X	X	Separate programming area
Vehicle Trips by Bridge Condition	X	X	Separate programming area
Park and Ride Spaces	X	X	Data unavailable
Bus Turnouts	X	X	Data unavailable
Percentage of Air Quality Improvement Projects Selected	X	X	Relevant only for project comparison
Noise Exposure	X	X	Data unavailable
Projects Listed in RTPs	X	X	Relevant only for project comparison

Source: Cambridge Systematics, Inc., 2004.

The base and future year system performance results will be used as a benchmark for evaluating the performance benefits of each project considered for analysis in the MoveAZ plan (as presented in the Task 11 Project Evaluation Technical Memorandum). The effect of each project on future year system performance was measured individually, reported by each measure and factor at both district and state levels. The analysis considered identifying the projects that best met the goal of bringing future year system performance as close as possible back to base levels of performance (Figure 3.1). For each performance factor, a project under analysis was measured favorably based on the degree (relative to other projects) to which the future year performance improved in the direction of the base year performance.

For each section below, a definition of each performance factor and measure are provided and the computations and results of each performance measure are summarized in Figure 3.1.

Figure 3.1 MoveAZ Plan System Performance Evaluation Process



Source: Cambridge Systematics, Inc. 2004.

3.1 Mobility and Economic Competitiveness System Performance

Mobility considers the efficient movement of people and goods. Economic competitiveness includes measures that examine the effects of transportation on the economic vitality of a region and state. However, performance measures that examine economic competitiveness do so by measuring the efficient movement of people and goods within a region, and, therefore, the mobility and economic competitiveness factors were combined.

These factors use two measures: 1) percent of person-miles traveled (PMT) by level of service (LOS), and 2) average delay per trip. The first measure provides a broad systemwide perspective of how much travel is occurring under congested (as well as free-flow) conditions. It provides a visual representation of system conditions by each functional classification of roadway. The second measure considers how much extra travel time the average traveler has to spend to get to a destination. It examines mobility from the user perspective, instead of the systemwide perspective.

Percent of PMT by LOS

This measure was defined as the percent of PMT occurring at different congestion levels by roadway type based on volume/capacity (v/c) ratio or LOS. It was calculated separately by rural or urban area. For project comparison, the percentage of PMT occurring at LOS D or better (A to d) in urban areas and LOS C or better (A to c) in rural areas was reported. Table 3.2 shows the system performance results of this measure by ADOT district for 2002 and 2025.

Table 3.2 Base System Performance of Percent of PMT by LOS

District	% PMT at LOS A to C Rural, LOS A to D Urban	
	2002	2025
Flagstaff	97	54
Globe	84	79
Holbrook	100	82
Kingman	98	59
Phoenix	64	20
Prescott	73	40
Safford	93	68
Tucson	68	38
Yuma	100	39
State Total	**77**	**38**

Source: Cambridge Systematics, October 2003.

In this analysis, uncongested or good travel conditions for both 2002 and 2025 were considered between levels of service A to C in rural areas and A to D in urban areas. Transportation conditions were considered worse if levels of services for rural and urban areas degraded to D to F and E to F, respectively.

In 2002, 77 percent of the person-miles traveled on the state transportation system occurred in uncongested conditions. Travel conditions are expected to worsen by 2025, with only 38 percent of person-miles traveled occurring in uncongested conditions. The Flagstaff, Kingman, Phoenix, and Yuma districts will experience the largest degradation, with uncongested travel in both rural and urban areas decreasing by 40 percent or more. Congestion is also expected to worsen in the Prescott, Safford, and Tucson districts, with uncongested person travel decreasing by 25 percent or more. Person travel will deteriorate slightly by 2025 in the Globe (five percent) and Holbrook (18 percent) districts. Arizonans are expected to travel in congested conditions on the state transportation system at a rate five times greater in 2025 than in 2002.

Average Delay Per Trip

This measure is defined as the hours of extra travel time during a specified time period systemwide or in a particular ADOT district, divided by the average number of trips during that period. It considers the total person-hours of travel less the total person-hours of travel at free-flow conditions. As this measure decreases, conditions improve. The system performance results of this analysis are shown in Table 3.3.

Table 3.3 Average Delay Per Trip Base System Performance by ADOT District

District	Average Delay Per Trip (Minutes) 2002	2025
Flagstaff	0.94	1.67
Globe	0.74	1.57
Holbrook	0.25	0.45
Kingman	0.59	2.66
Phoenix	1.94	9.27
Prescott	0.72	2.49
Safford	0.46	1.14
Tucson	0.62	3.27
Yuma	0.91	2.82
State Total	**1.29**	**6.97**

Source: Cambridge Systematics, October 2003.

The average traveler on the state transportation system in 2025 will experience nearly six times the delay as travelers currently experience in 2002 (from an average of about one to seven minutes per trip). While the Phoenix district contributes significantly to the overall increase in delay on the state transportation system, other urban and rural districts also are expected to show significant increases in average delay over the next 20 years. For example, the Yuma, Prescott, and Kingman districts will experience increases of average delay of about two additional minutes similar to those expected in Tucson. This equates to an increase in delay of three to five times for travelers in these districts.

3.2 Connectivity System Performance

Connectivity considers the availability of efficient highway connections between Arizona cities, particularly in more rural areas of the State. The first measure evaluates connectivity through the absence of passing or climbing lanes along two-lane state highways in selected corridors; and the second evaluates the circuitousness and travel time of existing routes in selected corridors through the potential for decreasing the shortest travel time in those corridors.

Passing Ability in Major Two-Lane Corridors

This measure uses the passing lanes methodology developed by ADOT in its *Passing Lanes/Climbing Lanes Report*. This method uses v/c ratios, percent trucks, and percent of roadways striped for passing to develop a ratio of the volume on a two-lane roadway to the LOS B service volume on that roadway. Base and future year district-level results for this measure are shown in Table 3.4. A decrease in the ratio is considered beneficial.

Table 3.4 Passing Ability Base Performance by District

District	2002	2025
Flagstaff	1.01	1.51
Globe	1.23	1.51
Holbrook	0.59	0.74
Kingman	1.06	1.25
Phoenix	0.39	1.11
Prescott	1.26	1.81
Safford	0.63	0.88
Tucson	0.64	1.35
Yuma	0.38	0.87
State Total	**0.82**	**1.23**

Source: Cambridge Systematics, October 2003.

The 2002 value of 0.82 indicates that overall two-lane state transportation system roadways are currently operating at good levels of service, without serious need for additional passing lane segments. However, the 2025 analysis predicts that most districts across the State will be approaching at or above a value of 1.0 (state transportation system average of 1.23), an indicator that LOS is deteriorating across the State due to a lack of passing ability. While all districts across Arizona will experience decreases in motorist passing ability, rural areas show significant degradations in districts such as Prescott, Globe, and Flagstaff.

Some districts currently have a higher value for this measure (greater than 1.0), despite a relatively low average for the State. The Prescott, Globe, and Flagstaff districts, for example, have a passing ability ratio greater than 1.0 in 2002 already, so that even small increases in volumes and truck percentages cause significant degradations in this measure. In other districts, such as Yuma, Tucson, and Phoenix, the state transportation system currently operates at good levels of service in two-lane segments. However, these districts experience the highest percent increase by 2025 for this measure at over 110 percent for each.

Intercity Travel Time Connectivity

This measure considers the travel time savings in each of ADOT's high-priority corridors, identified in the 1994 Long-Range Transportation Plan. A decrease in this measure indicates an improvement. Corridor-level travel time results for this measure are shown in Table 3.5.

Many of the high-priority corridors across Arizona show moderate increases in travel time between 2002 and 2025, including an average increase of 32 percent. However, the Phoenix to Hoover Dam, Phoenix to Lukeville, Phoenix to Mogollon Rim, and Prescott to Cordes Junction corridors all show substantial increases in travel time by 2025: an indication that traffic volumes in these corridors will be at or exceeding roadway capacities. The Phoenix to Hoover Dam corridor, for example, is expected to experience worse conditions with an 82 percent increase in travel time, and the Prescott to Cordes Junction corridor increases in travel time by 68 percent.

Table 3.5 Intercity Travel Time Base Performance by Corridor

Corridor	2002	2025
Douglas – Benson	2.21	2.57
Phoenix – Hoover Dam (Nevada State Line)	4.81	7.97
Flagstaff – Page (Utah State Line)	2.45	2.46
Phoenix – Globe	1.05	1.08
Phoenix – Lukeville	2.52	4.60
Phoenix – Mogollon Rim (Show Low)	3.24	4.81
Prescott – Cordes Junction	0.80	1.34
Yuma – Bullhead City	3.80	4.01
Tucson – Holbrook	4.55	4.76

Source: Cambridge Systematics, October 2003.

3.3 Preservation System Performance

ADOT uses pavement and bridge management systems to determine future pavement and bridge conditions, and how to program resources for repairs and replacement. The preservation performance measures are applied to project scenarios and data output from these management systems. However, currently only the first measure – Reconstruction Need – is used for assessing performance in the MoveAZ plan. It is an interim measure

until ADOT's new pavement management system is operational and integrated with the performance-based planning system.

Reconstruction Need

Reconstruction need is defined as the average number of years since last roadway reconstruction by roadway segment, as indicated by the ADOT Pavement Management System, weighted by average AADT. This measure considers old segments in need of total reconstruction, with an average year of last reconstruction before 1970.

Base and future year performance for this measure was not relevant at an aggregate district level, but was relevant at the project level. Therefore, this measure was used to support the project evaluation performance conducted in Task 11 (refer to the Task 11 Project Evaluation Technical Memorandum). Segments with a higher value for this measure are considered in greater need of reconstruction, and so reconstruction-specific projects along such segments receive higher scores.

Pavement Condition

This measure examines the percent of state highway lane miles by pavement condition, as rated in the ADOT Pavement Management System, reported by functional classification. This pavement serviceability rating (PSR) scale has five categories, ranging from "very poor" (0) to "excellent" (5). As the distribution becomes more skewed towards higher pavement conditions ("moderate" to "excellent"), conditions improve. For project comparison, both the average PSR and percent of miles at "good" or better were reported: a higher number indicates an improvement. Table 3.6 shows 2002 system pavement conditions by district (2025 pavement conditions were not analyzed).

Table 3.6 Pavement Base System Conditions by District (2002)

District	% "Good" or Better	Average PSR
Flagstaff	84	3.57
Globe	73	3.38
Holbrook	76	3.42
Kingman	96	3.96
Phoenix	93	3.64
Prescott	91	3.75
Safford	67	3.45
Tucson	84	3.62
Yuma	84	3.84
State Total	**82**	**3.59**

Source: Cambridge Systematics, October 2003.

Current pavement conditions on the state transportation system highways exceed the national averages for all functional classifications. All ADOT districts have an average PSR above 3.0, and almost all districts have over 70 percent of state transportation system highways at "good" or better conditions – Kingman, Phoenix, and Prescott are above 90 percent. Overall, the state transportation system has an average PSR of 3.59 with 82 percent of the highways at "good" or better conditions.

VMT by Pavement Condition

This measure considers the percent of VMT on state highways by pavement condition, as rated in the ADOT Pavement Management System. This scale (the same as shown above for pavement condition) has five categories, ranging from "very poor" (0) to "excellent" (5). As the distribution becomes more skewed towards higher pavement conditions ("fair" to "excellent"), conditions improve. For project comparison, the percentage of VMT on pavement rated "good" (PSR of 3.1) or better was reported: a higher number indicates an improvement. Table 3.7 shows the percent VMT on pavement rated "good" or better by district (2025 conditions were not analyzed).

Table 3.7 VMT on "Good" or Better Pavement by District

District	2002 % VMT on Pavement Rated "Good" or Better
Flagstaff	89
Globe	87
Holbrook	89
Kingman	99
Phoenix	90
Prescott	95
Safford	87
Tucson	95
Yuma	93
State Total	**91**

Source: Cambridge Systematics, October 2003.

Similar to the pavement condition performance measure presented previously, state transportation system roadways by all functional classifications across Arizona score above average in this measure. In 2002, drivers are able to experience "good" or better pavement conditions on state transportation system highways 91 percent of the time, on average. Drivers on the state transportation system in the Kingman, Prescott, Tucson, and

Yuma districts experience "good" or better pavement conditions the most frequently, relative to other districts. However, no district falls below 87 percent for this measure.

Bridge Condition

This performance measure considers the number or percentage of deficient bridges on state routes, as rated in the ADOT Bridge Management System. It considers a seven-point rating for four different bridge components in accordance with National Bridge Inventory (NBI) reporting standards, with seven being excellent. The percentage of deficient bridges is defined as the deck area of bridges with one or more deficient components (rated four or less), divided by the total deck area in the bridge inventory. A lower number indicates an improvement.

Performance, funding, and priority programming for bridges in the MoveAZ plan were analyzed separately as part of the ADOT Bridge Management System. Therefore, base year and future year performance for this measure was not computed and presented.

Vehicle Trips by Bridge Condition

This measure records the annual number and percentage of vehicle trips on deficient bridges, as rated in the ADOT Bridge Management System. It considers a seven-point rating for four different bridge components in accordance with NBI reporting standards, with seven being excellent. A deficient bridge is defined as a bridge with one or more deficient components (rated four or less). A lower number indicates an improvement.

As with the bridge condition measure above, performance, funding, and priority programming for bridges in the MoveAZ plan were analyzed separately as part of the ADOT Bridge Management System. Therefore, base year and future year performance for this measure was not computed and presented.

3.4 Reliability System Performance

Additional Unexpected Delay

Unexpected delay is defined as incident-related non-recurring delay per VMT on the state highway system, based on methodology documented in the Highway Economic Requirement System (HERS). As this measure decreases, reliability improves. Table 3.8 reports the unexpected delay in hours per 1,000 VMT for the base and future system conditions.

Table 3.8 Unexpected Delay by District (Hours Per 1,000 VMT)

District	2002	2025
Flagstaff	0.62	0.53
Globe	0.06	0.06
Holbrook	0.04	0.20
Kingman	0.07	2.15
Phoenix	2.01	6.07
Prescott	0.20	1.25
Safford	0.07	0.22
Tucson	0.46	2.55
Yuma	0.12	2.57
State Total	**0.81**	**3.19**

Source: Cambridge Systematics, October 2003.

Unexpected delay on the state transportation system, driven largely by future increases in accident rates, is expected to increase by almost four times from 2002 to 2025, from less than one hour per 1,000 VMT to over three hours per 1,000 VMT. That equates to almost 450,000 hours of unexpected daily delay experienced on the state transportation system in 2025.

The Globe district is not expected to increase and the Flagstaff district is expected to experience a slight decrease in this measure in the future, but all other Arizona districts are expected to increase significantly from 2002 to 2025. The Yuma (about 15 minutes to over two hours) and Kingman (about 10 minutes to over two hours) districts are expected to have the most significant percent increase in unexpected delay. Tucson, Prescott, and Holbrook all increase by five times or more in unexpected delay. Although the Phoenix district is anticipated to increase only threefold by 2025, it currently has the highest rate of unexpected delay in 2002 and 2025 (about two hours and about six hours per 1,000 VMT, respectively).

3.5 Safety System Performance

This factor included two performance measures: 1) accidents per million VMT by functional class, and 2) anticipated reduction in fatalities and injuries. The first measure accounts for more driving in future years: as VMT increases, the absolute number of accidents will likely increase, though the accident rate may stay the same or decrease. The second measure focuses on specific locations that have high absolute numbers of accidents.

Accidents Per 100 Million VMT

This measure is defined as accidents on state highways, separated by accidents with fatalities or injuries, divided by 100 million VMT on those highways. Accident rates are a function of roadway functional classification, roadway design, speed, and volume. A decrease indicates an improvement in safety. Table 3.9 shows accidents per 100 million VMT for the base and future conditions by district.

Table 3.9 Accidents Per 100 Million VMT by District

	2002			2025		
District	**Accident**	**Injury**	**Fatality**	**Accident**	**Injury**	**Fatality**
Flagstaff	165.0	44.5	1.9	172.9	46.8	2.1
Globe	151.6	54.6	3.2	148.1	60.7	3.5
Holbrook	56.0	20.0	2.4	59.3	19.4	2.4
Kingman	132.4	45.9	2.3	149.5	51.7	2.3
Phoenix	761.6	287.3	3.5	776.9	292.7	3.6
Prescott	154.3	51.7	2.2	171.0	58.3	2.33
Safford	132.9	43.5	2.3	137.0	47.0	2.44
Tucson	472.5	184.2	3.1	469.2	183.2	3.2
Yuma	132.6	55.1	3.0	106.2	46.1	3.3
State Total	**421.0**	**157.1**	**2.9**	**415.7**	**155.8**	**3.1**

Source: Cambridge Systematics, October 2003.

Accident and injury rates are expected to decrease slightly between 2002 and 2025, due to decreases in average speeds on the state transportation system. Some individual districts' accident and injury rates increase, while others decrease. However, every district's fatality rate is expected to stay the same or increase slightly by 2025. The Kingman and Prescott districts experience the largest growth in accident and injury rates on the state transportation system: over 10 percent for both. The Yuma district is expected to have the largest decrease in both accident and injury rates at almost 20 percent, though the fatality rate is still expected to increase by 10 percent.

Though overall rates for all accident types are relatively low in the Holbrook district, about three in every 100 accidents on the state transportation system there involve a fatality in both 2002 and 2025: the highest of any Arizona district. Both the Tucson and Phoenix districts have the lowest number of fatalities as a percent of total accidents, with less than one fatality-related accident per 200 accidents on the state transportation system in both 2002 and 2025. In the Yuma district, nearly 30 of every 100 accidents involve an injury, the highest number of injuries as a percent of total accidents for both 2002 and 2025. In the Flagstaff district, however, only 21 of every 100 accidents involve an injury.

Anticipated Change in Injuries/Fatalities

This measure reports the anticipated difference in injuries and fatalities resulting from accidents. Table 3.10 shows the expected change of annual injuries and fatalities between the 2002 and 2025 system performance. A negative change indicates an improvement in safety.

Table 3.10 Anticipated Change in Injuries/Fatalities by District

	Injuries		Fatalities	
District	**2002-2025**	**Percent Change**	**2002-2025**	**Percent Change**
Flagstaff	911	94	40	95
Globe	404	83	23	81
Holbrook	230	80	30	89
Kingman	1,039	139	41	108
Phoenix	26,367	107	330	110
Prescott	1,262	138	48	121
Safford	617	103	31	99
Tucson	7,400	109	134	118
Yuma	1,894	228	150	333
State Total	**40,124**	**111**	**827**	**123**

Source: Cambridge Systematics, October 2003.

All values are expected to increase from 2002 to 2025 due to the increase in VMT, though injury and fatality rates may stay the same or even decrease. The Yuma and Prescott districts' annual injuries and fatalities increase the most, while the Phoenix district will experience the largest absolute increase of both types of accidents. The magnitude of the percent increase by 2025 of both accident types is between 80 percent (Holbrook) and 228 percent (Yuma) for injury accidents and between 81 percent (Globe) and 333 percent (Yuma district) for fatalities. Injuries and fatalities on the state transportation system in most districts are expected to increase by over 100 percent.

With the highest VMT in the State, the Phoenix and Tucson districts also have the highest numbers of annual injuries and fatalities for 2002 and 2025 on the state transportation system. Currently, the Flagstaff district has the third highest number of annual injuries (almost 1,000) in 2002, but will be surpassed by the Yuma district by 2025 as a result of the district's enormous percent increase in injuries (due in large part to the Yuma district's projected growth in VMT). The Globe district has the fewest number of fatalities and the Holbrook district has the fewest injuries, both now and in the future.

3.6 Accessibility System Performance

This factor examines accessibility to non-auto travel modes, as well as to high-occupancy vehicle (HOV) modes of travel. The measures defined below assess the HOV, bus, and bicycle transportation systems over which ADOT has direct control.

Park-and-Ride Spaces

This measure is defined as the number of park-and-ride spaces adjacent to state highways. An increase indicates an improvement in park and ride accessibility and directly contributes to HOV travel. In 2001, the MAG region reported 1,119 park-and-ride spaces between three publicly owned or leased park-and-ride lots. Current data for the total number of park-and-ride spaces across the State were not available for this analysis. Future year performance was relevant at the project level (refer to the Task 11 Project Evaluation Technical Memorandum).

Bus Turnouts

This measure reports the number of bus turnouts on state highways with transit or school bus service. An increase indicates an improvement in bus transit accessibility. Current data for the total number of statewide bus turnouts were not available at this time. Future year performance was relevant at the project level (refer to the Task 11 Project Evaluation Technical Memorandum).

Bike Suitability

Bike suitability considers the percent of state route miles that have high, medium, or low bike suitability, based on ADOT's Bicycle and Pedestrian Plan definitions. This measure is a function of bike lane presence; physical characteristics of the roadway (e.g., shoulder size); and traffic volume. For project comparison purposes, this measure was reported as an average bike suitability value. Table 3.11 shows the 2002 and 2025 system performance as the percent of the state system expected to be both moderately and highly bike suitable. An increase in the percent of highly suitable state route miles or in the average bike suitability value indicates an improvement in bicycle accessibility.

Due to the projected increases in traffic volumes on the state transportation system, the percent of the system that is moderately bike suitable or above is anticipated to decrease from 79 percent (56 percent moderately, plus 23 percent highly suitable) to 62 percent (48 percent moderately, plus 14 percent highly suitable). The Kingman and Tucson districts' moderate plus high bike suitability percentages decrease the most: by 31 and 20 percent, respectively. Some districts (Globe, Phoenix, and Prescott) experience an increase in the percent of moderately bike suitable state transportation system miles as conditions worsen on currently highly bike suitable highway segments, and they decrease in suitability.

Table 3.11 Percent of State System Moderately/Highly Bike Suitable by District

District	2002		2025	
	Percentage of State System Moderately Bike Suitable	Percentage of State System Highly Bike Suitable	Percentage of State System Moderately Bike Suitable	Percentage of State System Highly Bike Suitable
Flagstaff	59%	24%	48%	14%
Globe	50%	30%	52%	21%
Holbrook	63%	22%	49%	15%
Kingman	71%	10%	45%	5%
Phoenix	58%	19%	61%	12%
Prescott	49%	21%	50%	15%
Safford	56%	35%	56%	23%
Tucson	52%	9%	37%	4%
Yuma	49%	28%	41%	16%
State Total	**56%**	**23%**	**48%**	**14%**

Source: Cambridge Systematics, October 2003.

The Safford district has the highest percentage of bike suitable routes in the State for both 2002 and 2025 at 91 and 79 percent, respectively. In the Tucson district, bike suitability on the state transportation system is at the lowest among the districts: 61 percent in 2002 and 41 percent in 2025.

3.7 Resource Conservation System Performance

The first resource conservation measure evaluates total mobile source emissions for transportation projects. This is a standard environmental measure that examines systemwide environmental performance. The second measure – percentage of air quality improvement projects selected – is a function of the first measure: any project that reduces mobile source emissions was considered an "air quality project." The second measure served as a screen to give preference to projects designed to reduce emissions. The third measure evaluates the reduction of highway noise exposure of residential areas through the presence of sound walls. The fourth measure examines coordination between the MoveAZ plan and local or regional plans, ensuring that transportation (and, indirectly, land-use) decisions were consistent across different tiers of government. The final measure was applied to consider the conservation of fuel due to both changes in fleet fuel economy and direct changes in the state transportation system.

Total Mobile Source Emissions

This measure is defined as the total tons of mobile source emissions, based on MOBILE6 emission rates. Emissions are a function of VMT, type of vehicle, speed, and the natural environment. A decrease in this measure indicates a positive change. Table 3.12 shows the 2002 and 2025 system performance total mobile source emission results.

Table 3.12 Total Mobile Source Emissions Base System Performance by District (Metric Tons)

District	2002	2025
Flagstaff	83	91
Globe	25	34
Holbrook	55	68
Kingman	60	73
Phoenix	251	560
Prescott	60	99
Safford	50	55
Tucson	131	181
Yuma	56	128
State Total	**771**	**1,288**

Source: Cambridge Systematics, October 2003.

Emissions due to travel on the state transportation system in Arizona are estimated to increase by 67 percent between 2002 and 2025. The ADOT districts that experience the largest percent increase include Phoenix and Yuma with increases of 123 and 129 percent, respectively. By 2025, the remaining districts all show increases of total mobile source emission tons ranging from 10 to 65 percent, with Prescott showing the highest increase within the range.

The Phoenix and Tucson districts account for about one-half of all mobile source emissions on the state transportation system in Arizona, both currently and in 2025. The Yuma district, though it has only a relatively moderate amount of mobile source emissions (56 tons) in 2002 relative to other districts, has the third highest emissions (128 tons) of all Arizona districts in 2025 due to its high projected increase in VMT.

Percentage of Air Quality Improvement Projects Selected

The annual percentage of transportation air quality improvement projects selected in the MoveAZ plan was reported. An air quality improvement project is defined as any project

which, when implemented, will result in an improvement of the total mobile source emissions measure. A higher number indicates an improvement. This measure was computed for the project analysis conducted in Task 11 and not computed for the system performance analysis.

Noise Exposure

This measure reports the number of sound walls on state highways. An increase indicates an improvement (reduction) in noise exposure. Current data for the total number of state transportation system sound walls were not available to support this analysis. Future year performance was conducted for the Task 11 project evaluations.

Projects Listed in Regional Transportation Plans

This measure reports projects that are selected for evaluation in MoveAZ plan and also listed in RTPs. An increase in this measure indicates a positive change. This measure was used in the Task 11 project evaluations.

Fuel Consumption

This measure is defined as daily gallons of fuel consumed, and is a function of auto and truck fuel consumption rates, roadway functional class, and speed. A decrease in this measure indicates a positive change. Table 3.13 shows 2002 and 2025 fuel consumption by district.

Table 3.13 Daily Fuel Consumption Base System Performance by District (in Gallons)

District	2002	2025
Flagstaff	436,235	846,999
Globe	155,092	242,377
Holbrook	276,347	617,528
Kingman	309,992	767,568
Phoenix	1,555,214	5,090,310
Prescott	327,844	765,393
Safford	259,819	555,306
Tucson	695,671	1,697,151
Yuma	288,042	1,305,129
State Total	**4,304,257**	**11,887,762**

Source: Cambridge Systematics, October 2003.

Fuel consumption due to travel on the state transportation system is projected to increase by 176 percent (from over 4 million to about 12 million gallons of gasoline consumed daily) from 2002 to 2025. Though the VMT on the state transportation system increases at only one-half that rate between 2002 and 2025, measures such as "Percent PMT by LOS" and "Average Delay per Trip" indicate that congestion, delay, and travel times are increasing substantially. This has a direct effect on the reduction of speed on the system, causing vehicles to consume more fuel per mile traveled in 2025 than they did in 2002.

The gallons of fuel consumed in almost all districts, except for Globe and Flagstaff, are expected to more than double. In the Yuma district, the daily fuel consumption is expected to increase by 353 percent: a greater increase than in any other district. This is due to the projected high increase in VMT in the Yuma district.

Changes to automobile technology and gas prices can have a major impact on fuel consumption. Increasing gas prices have a tendency to reduce automobile trips. New electric/gas hybrids now being sold in the U.S. also can substantially reduce fuel consumption. These vehicles can travel two or three times farther on a gallon of gas than conventional automobiles. Though these vehicles have currently captured only a small share of the automobile market, increasing fuel prices and competitive pricing could increase their share in the future. As these vehicles become more prevalent, both fuel consumption and emissions will decrease overall.

MOVE AZ Long Range Transportation Plan

Appendix F. Project Evaluation Process

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

MoveAZ Plan

Appendix F. Project Evaluation Process

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

August 2004

Table of Contents

1.0 Introduction **1-1**

2.0 Funding **2-1**
2.1 Funding Scenarios 2-1
2.2 Funding Regions 2-2
2.3 Sub-Program and Project Funding 2-3

3.0 Data **3-1**
3.1 Highway Performance Monitoring System (HPMS) 3-1
3.2 Crashes 3-2
3.3 Highway Utilization and Demand 3-2
3.4 Proposed Project Descriptions 3-2

4.0 Project Evaluation Process **4-1**
4.1 Calculating Project Performance 4-1
4.2 Performance Measure Thresholds 4-3
4.3 Affected Traffic Volume 4-4
4.4 Measure Normalizing 4-6
4.5 Factor Scoring 4-6

5.0 Weights **5-1**
5.1 Weighting Methodology 5-1
5.2 Sources for Weights 5-2
5.3 MoveAZ Descriptive Weights 5-3
5.4 MoveAZ Numeric Weights 5-8

6.0 Project Bundles **6-1**

7.0 Performance Analysis Results **7-1**
7.1 MoveAZ Performance Analysis in the Rest of the State 7-1
7.2 Maricopa County 7-12

List of Tables

2.1 Available Funding for MoveAZ by Scenario 2-2

2.2 Funding for Sub-Programs by Region 2-4

2.3 Total Funding for Major Projects and Sub-Programs by Region, 2010 to 2025 (2004 $ Millions) 2-4

3.1 Typical Unit Cost by Project Type for MoveAZ Plan Performance Evaluation 3-5

4.1 MoveAZ Performance Measures 4-2

4.2 MoveAZ Performance Measure Thresholds 4-5

4.3 Performance Factor Scoring Methodology 4-7

5.1 Performance Factors Weights 5-8

6.1 MoveAZ District Codes 6-1

6.2 Flagstaff District Projects 6-2

6.3 Globe District Projects 6-5

6.4 Holbrook District Projects 6-8

6.5 Kingman District Projects 6-12

6.6 Prescott District Projects 6-14

6.7 Safford District Projects 6-15

6.8 Tucson District Projects 6-17

6.9 Yuma District Projects 6-19

7.1 MoveAZ Plan Projects – Constrained Scenario 7-2

7.2 Total Funding for Major Projects and Sub-Programs by Region, 2010 to 2025 (Additional Revenue Scenario) 7-5

7.3 MoveAZ Plan Projects – Additional Revenue Scenario 7-6

7.4 MoveAZ Plan Projects (Unconstrained) 7-8

7.5 MoveAZ Plan Projects – Constrained Scenario 7-12

List of Figures

3.1 MoveAZ Plan Project "Bundling" Decision Guidelines 3-4

3.2 ADOT Engineering Districts 3-6

4.2 Performance Measure Threshold Example 4-4

5.1 Sources of MoveAZ Factor Weights 5-3

5.2 Performance Factors Raised During Immediate Partnering Events 5-4

5.3 Existing Pavement Quality in Arizona and the U.S. 5-5

7.1 Map of Constrained Scenario Projects 7-4

7.2 Map of Additional Revenue Projects 7-7

1.0 Introduction

1.0 Introduction

This technical memorandum describes the process used to evaluate major transportation projects in support the Arizona Long-Range Transportation Plan (MoveAZ plan). This technical memorandum is the third in a series of report that describe the technical evaluations conducted as part of the MoveAZ plan. The *Task 10, Performance Measures Technical Memorandum* describes the performance measures that are the basis for the analysis described here. The *Task 9, Demand and System Performance Technical Memorandum* provides estimates of system use for all transportation modes and an evaluation of current and future performance for the entire State and each of the State's engineering districts.

The following sections are presented in this memorandum:

1. **Funding –** An overview of the institutional environment that determines the funding available for major projects;

2. **Data –** A review of the data sources used to support the evaluation process;

3. **Project Evaluation Process –** A description of the application of performance measures used to evaluate projects and system performance; and

4. **Weights –** A description of the system of weights used by MoveAZ.

2.0 Funding

2.0 Funding

The MoveAZ performance evaluation process began with an examination of the total funding available to construct major projects on the state transportation system. Identifying available funding sets the ultimate constraint on the transportation projects identified by the MoveAZ plan. This section describes the process used to estimate funding available for major projects over the course of the plan from 2010 through 2025. The evaluation process will be implemented to represent the 2010 transportation system, because the Arizona Department of Transportation (ADOT) has made commitments to specific projects through 2009 as part of its *Five-Year Transportation Facilities Construction Program* (referred to as the five-year program).

The five-year program is a list of transportation projects for which ADOT has identified funding. This program is generated through the coordinated efforts of several ADOT divisions and adopted by the Arizona Transportation Board each year. The program will begin to include MoveAZ plan generated projects and analysis in the 2006 to 2010 program cycle.

The process for estimating the available funding for projects involved the following steps:

- **Funding scenarios –** Estimation of three funding scenarios used to guide the MoveAZ plan;
- **Funding regions –** Funding is divided among three major regions of the State, in accordance with existing ADOT policy; and
- **Sub-program and project funding –** Funding levels are estimated for sub-programs and major projects in the three major regions of the State, in accordance with existing ADOT programming practice.

2.1 Funding Scenarios

The MoveAZ plan used three investment scenarios based upon estimates of state and Federal funds available to Arizona, as estimated by ADOT's financial section. The three scenarios were:

1. **Constrained –** A projection of currently available funding sources through 2025.
2. **Reasonably increased revenues –** An increase above the constrained scenario based on a reasonable increase in revenues that could be derived from Federal and/or state

sources. This incremental revenue could come from a Federal or statewide motor fuel tax, other user fees, increased Federal spending from the pending transportation reauthorization legislation, or other sources.

3. **Unconstrained –** No financial constraints, including all projects that address specific needs on the state highway transportation system, as identified in previous planning processes.

The constrained scenario represents funding that will likely be available to the State for future programming by 2025. The reasonably increased revenues scenario provides a means to describe the additional performance gains that could be derived from a modest increase in transportation funding. Table 2.1 provides the estimate of total funding available in each of these two scenarios.

Table 2.1 Available Funding for MoveAZ by Scenario

Scenario	Funding ($M)
Constrained	8,975
Reasonably Increased Revenues	10,958
Potential Funding Increase	***1,983***

Source: ADOT, 2004.

Estimates of total funding, as well as project specific costs, were estimated in constant 2004 dollars. This allows ADOT to consistently compare total funding and project funding at any point in time.

2.2 Funding Regions

MoveAZ was designed to work within ADOT's existing institutional framework. The Arizona Transportation Board has ultimate authority to determine a program of funding and MoveAZ follows current Board policy by dividing funding and conducting performance analysis independently for three major regions of the State. Through the recommendation of the Resource Allocation Advisory Committee (RAAC), the Board allocates construction funding into three major regions:

1. Maricopa County;
2. Pima County; and
3. The 13 Other Counties.

Maricopa County receives a total of 37 percent of state funding, Pima receives 13 percent, and 50 percent is provided to the 13 Other Counties. These amounts include major projects and sub-program budgets. MoveAZ uses this existing funding allocation to determine the level of funding for each region through 2025. The project analysis method described below in Section 4.0 evaluates all projects together, but projects are included in the MoveAZ plan separately for each region, in accordance with the available funding for that region.

Projects in the MAG region were identified through the MAG regional transportation plan (RTP). The MAG RTP was adopted by the State Transportation Board in November 2003. As a result, these projects were not analyzed using the methods described below. The methods were only applied to projects in Pima County and the 13 Other Counties.

2.3 Sub-Program and Project Funding

The final step for identifying funding available for projects will be to estimate the allocation between sub-program and major project funding. ADOT funds many transportation improvements through sub-programs that address key functional areas, such as pavement and bridge maintenance, safety, district-identified minor projects, and others. These sub-programs are funded as a whole, with the relevant projects identified by individual sub-program managers and analyzed using sub-program-specific tools and performance measures. For example, the ADOT pavement management system identifies roadway segments that require repaving and estimates the cost to maintain a particular pavement condition standard.

The Arizona Transportation Board sets levels of funding for each of ADOT's sub-programs. In recent years, these funding levels have been fairly stable. For the purpose of the MoveAZ plan, the total funding available for sub-programs is assumed to be constant each year and consistent with established funding levels. Because the MoveAZ plan estimate of total funding available is in constant dollars, using a constant dollar estimate of sub-programs accounts for inflation.

Because MoveAZ uses the RAAC determined allocation of total funding, it was necessary to estimate the allocation between sub-program and major project funding for each of the three regions of the State (Maricopa, Pima, and the 13 Other Counties). Though the specific projects funded by a given sub-program and the level of funding for a particular region will vary from year to year, over several years the distribution of funding across the State will follow the pattern established by the RAAC. Table 2.2 provides a historical estimate of the yearly funding provided to sub-programs for each of the three major regions.

The total funding available for major projects for each region from 2010 to 2025 was derived by estimating total funding, allocating it among the three major regions using the RAAC distribution described above, and subtracting out total sub-program funding in

each region over the same period. The total major project funding identified using this process is provided in Table 2.3.

Table 2.2 Funding for Sub-Programs by Region

Counties	Yearly Funding (2004 $M)
Maricopa	30.5
Pima	18.5
The 13 Other Counties	171.0
Total	**220.0**

Source: ADOT, 2004.

Table 2.3 Total Funding for Major Projects and Sub-Programs by Region, 2010 to 2025 (2004 $ Millions)

Counties	Funding for Major Projects	Funding for Sub-Programs	Total
Maricopa	2,832.7	488.0	3,320.7
Pima	870.7	296.0	1,166.7
The 13 Other Counties	1,751.7	2,736.0	4,487.7
Total	**5,455.1**	**3,520.0**	**8,975.1**

Source: ADOT, 2004.

3.0 Data

3.0 Data

The MoveAZ plan evaluation process integrates data on transportation use, system condition, and other factors to analyze the system performance impacts of proposed transportation projects in Arizona. To support the analysis, the following data sources were used:

- Highway Performance Monitoring System (HPMS);
- Crashes;
- Highway demand and utilization; and
- Proposed project descriptions.

3.1 Highway Performance Monitoring System (HPMS)

The primary data used to support the performance evaluation process was the ADOT 2001 HPMS submittal. HPMS data represent information on roadway structure, performance, and conditions for public roads, and the state transportation system. The data include basic information for all public roads and a set of information for a smaller sample of roads, including traffic volumes, pavement conditions, roadway geometrics, and roadway use.

Each state is required to submit HPMS data to the Federal Highway Administration (FHWA) each year. This submittal is comprised of 98 data items, some of which are required for the universe of public roads, and others that are required only for some functional classes (e.g., the National Highway System) or for "sample" segments. The use of sample segments allows the FHWA to capture more detailed information on a smaller number of segments and to use that data to predict conditions across the nation or for individual states.

ADOT is one of several states that develops a "full sample" HPMS for state-owned roads. This means that ADOT has a complete set of HPMS variables (all 98 data items) for all state-controlled roadway segments. This full sample enabled the MoveAZ plan to evaluate projects across the state transportation system.

For the MoveAZ plan, two versions of the HPMS database were created. The first version was the 2001 HPMS submittal. This submittal represents the most current data about Arizona's transportation system used for the Plan analysis. The second version of the HPMS data used for MoveAZ was an updated version of the 2001 submittal, including

projects built or programmed since the 2001 submittal. These additional projects were identified from the 2004-2008 Five-Year Transportation Facilities Construction Program. This later data is referred to as the HPMS Existing Plus Committed file.

HPMS data records were thoroughly checked for missing and inconsistent data. This process involved a link-by-link examination of the data items and comparison to other data, where available, focused on the variables most relevant to the evaluation process. Two additional data sources were used to supplement the HPMS: 1) ADOT crash data and 2) highway utilization and demand data generated for MoveAZ. These data items are summarized in later sections.

3.2 Crashes

ADOT collects data on all crashes – property damage only (PDO), injuries, and fatalities – that occur on the Arizona transportation system. These crashes were identified by the road or street they occurred on and the nearest intersection or interchange. The MoveAZ evaluation method predicts crash rates using the Highway Economic Requirements System (HERS) for both the base (2002) and future (2025) conditions (see the *Task 10, Performance Measures Technical Memorandum* for more information). These predicted rates were calibrated to observed crash data to produce a more accurate estimate of expected changes in crash rates.

3.3 Highway Utilization and Demand

The process for estimating travel demand is described in the *Task 9, Demand and System Performance Analysis Technical Memorandum*. This process estimated travel demand and utilization for base (2002) and future (2025) years for all transportation modes. For roadway travel, MoveAZ included estimates of total vehicle miles traveled (VMT) by county and roadway functional class. These estimates were mapped onto the HPMS network to generate segment-level estimates of VMT and annual average daily traffic (AADT) for 2002 and 2025.

3.4 Proposed Project Descriptions

MoveAZ includes a process to identify proposed projects for the performance analysis. This process included reviewing available study and plan documents to identify potential projects, bundling projects into corridor-level projects for analysis, validating costs of

these projects, and reviewing and refining the project bundles and elements with the ADOT district engineers and their staff.

Project Identification

The 1994 ADOT long-range transportation plan identified 33 high-priority corridors for further evaluation. Since that time, ADOT has conducted at least one profile of each of these major corridors. These profiles were prepared to analyze the transportation deficiencies and needs of a particular corridor and identify projects that could alleviate deficiencies. ADOT also conducted small area transportation studies that focus on a smaller region and the region's short- and long-term transportation needs. These two types of studies provided a list of projects for MoveAZ plan evaluations.

Another source of projects was the Vision 21 plan, developed by the Governor's office. This plan included a major effort to identify all transportation needs in the State. The Vision 21 effort identified transportation needs from ADOT's corridor profiles and small area transportation studies, as well as regional and local transportation plans and studies. The resulting database of projects was merged with the projects described above to generate a list of proposed projects for consideration and evaluation in the MoveAZ plan.

Finally, projects in Maricopa County were identified and analyzed by the Maricopa Association of Governments (MAG) Regional Transportation Plan (RTP). The performance analysis process described below was applied only to projects in the remainder of the State. The State Transportation Board adopted in the MAG RTP in November 2003. The MAG RTP was used to identify the specific projects to be funded in Maricopa County over the course of MoveAZ.

Project Bundling

Given the geographic scope and 20-year time period covered by the MoveAZ plan, only transportation projects of substantial size can be analyzed by the performance evaluation method. The projects identified in corridor profiles and other studies, however, included both large and small projects of a variety of types. To ensure that the evaluation process accurately measured the performance impacts of these projects, smaller projects were bundled together with appropriate large and small projects and only these larger bundles were analyzed.

ADOT adopted a set of decision guidelines to bundle projects for evaluation (Figure 3.1). These guidelines were general rules of thumb intended to allow ADOT the flexibility to design bundles appropriate to the circumstances of a particular region or project type. These decision guidelines were applied to the project list to develop bundles. These bundles were then reviewed by ADOT planning staff and district engineers, as described below. The resulting project bundles are provided in Section 6.0 at the end of this report.

Cost Validation

In addition to bundling projects for evaluation, cost estimates for individual projects (that when combined form a bundle) were checked for validity and consistency. Because corridor profiles and other studies were conducted over several years using numerous sources of financial data, there were inconsistencies in the cost estimates. A two part process was used to develop consistent cost estimates. First, unit costs were estimated for types of projects from ADOT's corridor profiles. Project types included highway widening, interchange construction, bridge replacement, and others. Second, these "typical" unit cost estimates were compared to the original cost estimates in meetings with each of the ADOT district engineers to determine the appropriate cost for a particular project. The meetings with the district engineers are described below.

Figure 3.1 MoveAZ Plan Project "Bundling" Decision Guidelines

1. Small cost items within a widening project that are not part of a sub-program will be grouped with the widening.
2. Bridge and pavement preservation projects will be analyzed using management systems and not as capital projects.
    a. Exception: If a bridge must be replaced due to a road widening or other project, then it will be included in the project bundles.
3. Short widening segments will be grouped together in a corridor if they are nearly adjacent (less than two miles apart).
4. Interchanges and bridge replacement projects will be grouped with widening (or other projects) whenever they overlap or are very close (within two miles).
    a. Exception: If a corridor study specifies the interchanges or bridges to be altered as part of the widening project, only those interchanges or bridges within the project area will be included.
5. Projects on different roadways that are tightly aligned and have been planned together (according to existing sources) will be grouped as a single project. (Example: Widening projects in downtown Yuma on I-8, B-8, and SR 280.)
6. A group of similar projects that are more than two miles apart may be grouped together if they have been planned to address a single problem. (Example: Climbing lanes that are one to three miles apart.)
7. Total combined project costs will be kept within a reasonable range of about $50 million. This serves as a guide only, not a rule. For example, if three widenings in a corridor come to $40 million each, these will be kept separately, rather than combining them into a single $120 million project.

Source: Cambridge Systematics, Inc., and ADOT, 2003.

The typical unit cost by project type is shown in Table 3.1. Outliers – projects that were noticeably outside of the range of costs of other similar projects – were excluded from this analysis. Because many of the projects are from older studies, the typical unit cost calculation puts more weight on more recent estimates.

Table 3.1 Typical Unit Cost by Project Type for MoveAZ Plan Performance Evaluation

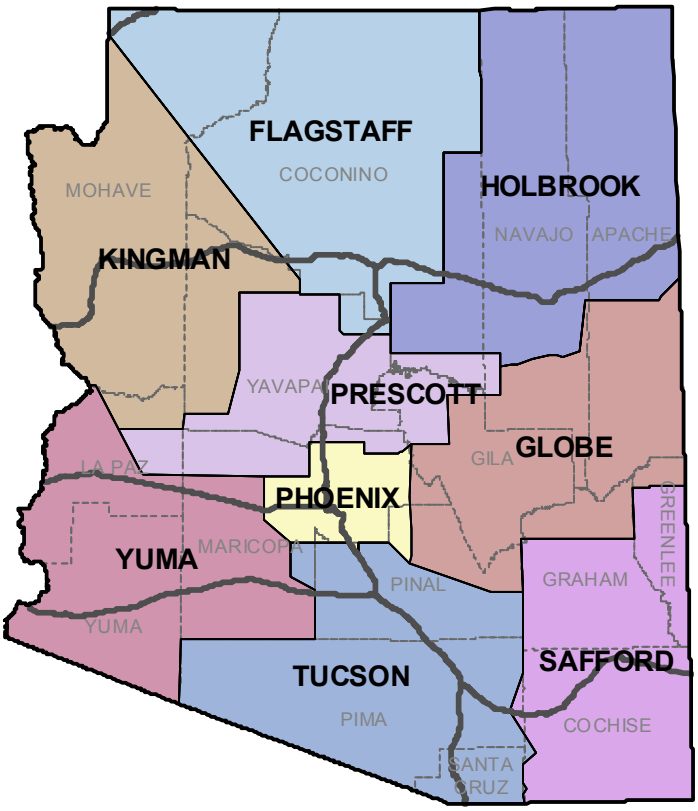
	Unit Cost Per Project ($1,000)			
Project Type	**Typical**	**Average**	**Minimum**	**Maximum**
Bridge reconstruction (per bridge)	650	640	150	1,640
Replace bridge (per bridge)	2,000	1,892	1,000	4,200
Port of entry improvements (per POE)	1,500	1,235	300	3,000
Rest area, construct (per rest area)	4,000	3,217	500	6,000
Noise barriers & landscaping (per mile)	1,000	1,000	1,000	1,000
Construct roadway, general (per mile)	3,500	3,232	1,000	9,673
Reconstruct roadway (per mile)	4,000	3,181	410	9,673
Climbing lanes, construct (per mile)	500	587	29	3,200
Passing lanes, construct (per mile)	750	575	45	1,730
Widen roadway/add lane each direction (per mile)	3,000	2,141	258	10,031
Improve curves, horizontal and vertical (per mile)	750	562	500	1,429
Shoulders, improvement, paved to AASHTO standards (per mile)	500	467	18	700
Variable message sign (per VMS)	250	252	52	520
Traffic interchanges, construct (per interchange)	10,000	722	1,000	22,500
Reconstruct interchange (per interchange)	15,000	10,507	1,910	71,850

Source: Cambridge Systematics estimates from ADOT corridor profiles, 2004.

District Engineer Review

The final piece of the MoveAZ project identification and bundling process included meetings with each of ADOT's 10 district engineers. Each of these districts is unique to a particular region of the State, except for Phoenix, which has separate districts for maintenance and engineering (Figure 3.2).

Figure 3.2 ADOT Engineering Districts



Nine meetings were scheduled and held (including a combined Phoenix maintenance and engineering meeting) to provide an opportunity for the ADOT district engineers and staff to engage with the MoveAZ process and to provide the most current information about the projects and programs in their district. The chief engineer and selected staff from each district reviewed all aspects of the project identification process. The review focused on several issues, including:

- Projects that were already completed or superseded by new projects;
- Projects missing from a particular district;
- Verification of project start and end mile points on the transportation system;

- Cost estimates of each project; and
- The appropriateness and accuracy of the project bundles.

At the conclusion of each of these meetings, a final project list was developed for MoveAZ performance evaluations and sent to each of the ADOT district engineers for further review. These final project lists are available in Section 6.0.

4.0 Project Evaluation Process

4.0 Project Evaluation Process

The core of the MoveAZ plan evaluation process is an analysis of the system performance impacts of major transportation projects on the state transportation system. Having identified the funding available to support major projects over the course of the plan and the data necessary to support this process, this section presents the methodology used to perform these project evaluations. The overall goal of this process is to produce a set of scores on seven performance factors that were identified in the MoveAZ strategic direction. The project evaluation process included five basic components:

- **Calculating project performance –** The method for calculating the observed impact of a project on system performance;
- **Performance measure thresholds –** Minimum or maximum thresholds used to establish the need for a particular project;
- **Affected traffic volume –** A second accounting for the need for a particular project, estimated for most measures by the total volume of the affected roadway segments;
- **Measure normalizing –** The method used to normalize raw scores developed from the first three components onto a 10-point scale; and
- **Factor scoring –** The method used to develop scores for each factor on a 10-point scale from the performance measures relevant to each factor.

The following sub-sections describe the performance measures used, the method for deriving the components of the project system performance score, and the method used to normalize performance measures to a common scale and generate scores for each of the factors.

4.1 Calculating Project Performance

The evaluation process is based on 13 performance measures selected to support the MoveAZ plan (Table 4.1). These performance measures were selected through the MoveAZ planning process in conjunction with the ADOT steering committee, the MoveAZ Working Group, and a technical input team that provided advice on measure selection. Detailed descriptions of each of these 13 measures are provided in the *Task 10, MoveAZ Performance Measures Technical Memorandum*.

Table 4.1 MoveAZ Performance Measures

Performance Factor	Performance Measures
Mobility and Economic Competitiveness	• Improvement in vehicle-to-capacity (V/C) ratio (weighted average by person miles traveled (PMT)) • Reduction in hours of delay
Connectivity	• Ability to pass in major two-lane corridors • Travel time improvement on ADOT high-priority corridors
Safety	• Improvement in crash rate (crashes per 100 million VMT) • Reduction in injuries
Reliability	• Reduction in hours of incident-related delay
Accessibility	• Improvement in bike suitability (from bicycle/pedestrian plan) • Added bus turnouts
Resource Conservation	• Reduction in mobile source emissions • Reduction in fuel consumption • Added sound walls • Project consistency with local plans

Source: Cambridge Systematics, 2004.

The 13 measures identified above can be grouped into three basic types:

- Formula-based measures used an ADOT-defined algorithm and any of several data sources to calculate an expected change in performance for a given project "bundle."
- Several performance measures were calculated using the Highway Economic Requirements System (HERS).
- A small number of measures received only a single point if a project "bundle" had a particular attribute. These measures included the bus turnout, noise walls, and regional plan consistency measures.

For the purposes of the MoveAZ plan, most of the performance measures fall into the first two categories. These measures were first calculated at the district level to determine the "district base performance." These base performance values were calculated using the 2025 estimates of travel volumes for the entire HPMS network in the district. As described in the previous section, these values were calculated assuming that all currently programmed projects (through 2008) would be built.

After calculating the district base performance, the HPMS links of a single project "bundle" were updated to reflect the changes proposed by a single project. Then, the performance for the relevant district was recalculated with this new project "bundle" included. This was referred to as the "district plus project performance." The improvement from the district base performance to the district plus project performance showed the performance gains that resulted from a particular project "bundle". This process was repeated for each of the project "bundles" in each district to calculate the system performance of each.

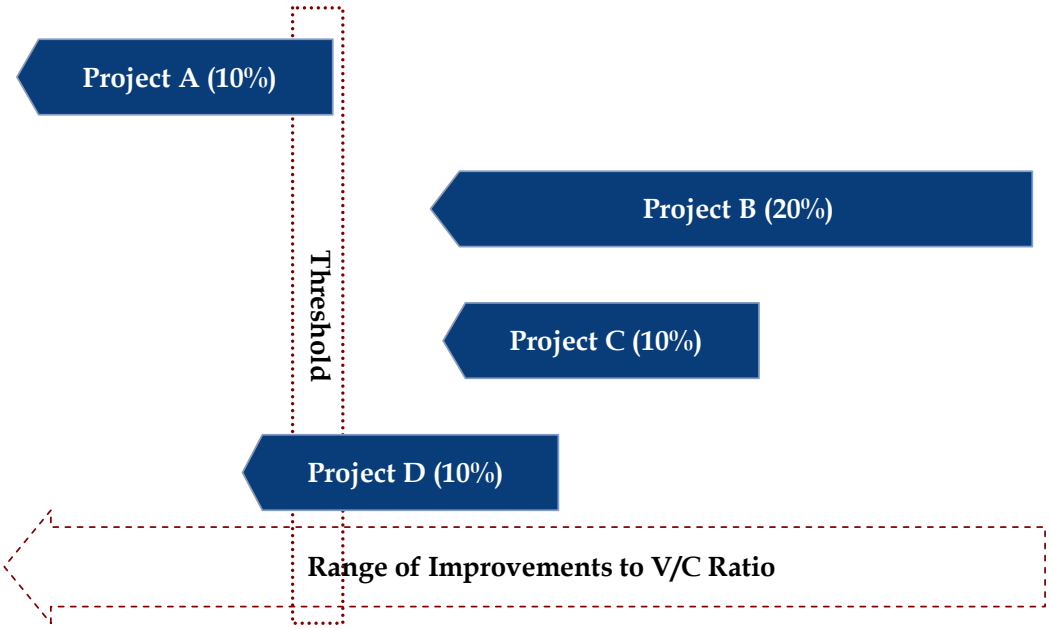
Several measures could not be calculated using this method, because they had no natural baseline to be measured against. These included measures of bus turnouts, noise barriers, and consistency with regional transportation plans. These were simple binary measures that were either included or covered by a project "bundle" or not. The performance improvement for these measures was, therefore, a simple binary calculation.

4.2 Performance Measure Thresholds

The performance measures described above provided a raw assessment of the *estimated improvement* that a given project "bundle" would produce. In addition to the performance improvement, the MoveAZ plan evaluation process also accounted for the *need* of a particular project, using two methods. The first of these methods included the application of upper and lower bounds on the particular performance measures. These threshold values ensured that the roadway segments improved by a particular project "bundle" had an actual need. Projects on highway segments above or below a particular threshold were unlikely to show a need for the particular improvement.

For example, one measure of mobility was vehicle congestion, estimated using the volume-to-capacity (V/C) ratio. ADOT had identified level of service (LOS) standards using the V/C ratio by area type. These included LOS C (V/C = 0.71 or lower) for rural highway segments and LOS D (V/C = 0.80 or lower) for urban highway segments. For the MoveAZ plan evaluation process, project "bundles" that reduced the V/C ratio below the relevant urban or rural threshold received a score for only that portion of the improvement down to the threshold. Figure 4.1 represents this concept graphically. Project A, which improved segments already below the threshold, would score no improvement. Project D would score a reduced improvement, because it crossed the thresholds. Projects B and C improved segments, but not quite to the level of the threshold, and the entire performance improvement was calculated in the performance measure score (20 percent for Project B and 10 percent for Project C).

Figure 4.1 Performance Measure Threshold Example



Source: Cambridge Systematics, 2004.

Thresholds were used for several of the performance measures to help ensure that the evaluation process captured the need for a given project, in addition to the performance improvement. Not all of the performance measures used thresholds. Some have no natural upper or lower bound. For example, *reduction in injury crashes* was measured without a threshold, because each additional crash eliminated was as beneficial as the previous. Table 4.2 presents the thresholds used for each measure.

4.3 Affected Traffic Volume

A second method was used to help account for the need of a particular project "bundle." For several of the measures, the MoveAZ plan evaluation process also accounted for volume of traffic using the segments of roadway affected by the project (project "bundle" AADT). The performance improvement was multiplied by the project "bundle" AADT to generate the performance score.

There were several exceptions to this process. The delay and incident delay measures, which were calculated as hours of delay saved (delay rate multiplied by VMT), were not multiplied by the project AADT. Similarly, the measure of number of injuries reduced by

Table 4.2 MoveAZ Performance Measure Thresholds

Performance Measure	Threshold
Mobility and Economic Competitiveness Factor	
Improvement in V/C	Uses existing ADOT standards: 0.71 for rural highway segments and 0.8 for urban highway segments. A segment that is already below the given threshold scores zero points; segments that are improved below the threshold value will receive the portion of their improvement to the threshold.
Reduction in hours of delay	The threshold is the total delay for a given district in 2002. If a project reduces delay in a given district below the 2002 level, it receives that portion of the improvement down to the 2002 level.
Connectivity Factor	
Ability to pass in major two-lane corridors	The threshold for this measure is set to one, the point at which AADT is equal to passing-lane weighted service volume. Improvements that reduce the ratio below one are scored only to this threshold.
Travel time improvement on ADOT high-priority corridors	The threshold is the 2002 travel time in the affected corridor. If a project reduces the travel time to below the 2002 level, it only receives that portion of the improvement to the 2002 level.
Safety Factor	
Improvement in Crash Rate Reduction in Injuries	No thresholds used.
Reliability Factor	
Reduction in hours of incident-related delay	The threshold is the total incident delay for a given district in 2002. If a project reduces incident delay in a given district below the 2002 level, it only receives that portion of the improvement to the 2002 level.
Accessibility Factor	
Improvement in bike suitability Added bus turnouts	No threshold used.
Resource Conservation Factor	
Reduction in mobile source emissions	The distribution of emissions rates is U-shaped, with peaks at low and high speeds. Projects score on this measure only if they reduce emissions.
Reduction in fuel consumption	The distribution of fuel consumption rates is U-shaped, with peaks at low and high speeds. Projects score on this measure only if they reduce fuel consumption.
Added sound walls Project consistency with local plans	No threshold used.

Source: Cambridge Systematics, 2004.

a project was already calculated using the project "bundle" AADT. The three binary measures – bus turnouts, noise barriers, and regional plan consistency – also did not use the project "bundle" AADT. Finally, the bicycle condition score (BCS) measure used the existing BCS on the affected segments as a measure of need, rather than the project "bundle" AADT. Projects with a low BCS prior to building would receive a higher score than projects with a higher BCS. Using the 2002 BCS for this measure retained the multi-modal nature of the measure.

4.4 Measure Normalizing

To develop consistency in the measures, raw scores on each measure were converted into a normalized score between zero and 10 points. A zero indicated that a given project did nothing to improve a particular measure. The remaining points were assigned to projects relative to the scores of all projects analyzed for MoveAZ.

The scores produced as described above were normalized on a 10-point scale based on their position in the distribution of all project "bundles" on that score. This process is referred to as the percent rank. A project with a score that was better than X percent of all projects on a given measure received a normalized score of X/10. For example, a project "bundle" that performed better than 80 percent of all other project 'bundles" scored eight points; a project that performed better than half of other projects scored five points; and a project that performed better than only 10 percent of other projects scored a single point. Project "bundles" that provide no performance improvement scored zero points.

This method was applied to reduce the influence of outliers on the scoring scheme. If one or two projects performed much better on a given measure than all other projects, they would not skew the scale. For example, if the third best project scored better than 92 percent of all projects, it received 9.2 points, even if the performance score for the top two projects were substantially larger (i.e., double or greater) than the third best project.

4.5 Factor Scoring

Project "bundles" received a final score on each performance factor as a function of their score on one or more performance measures. Similar to the measures, each of the performance factors was also scored on a 10 point scale. The reliability factor had only one measure, so the factor score was the same as the measure score. For all other factors, multiple measures contributed to the factor score. For most factors, the final score was the average of the measures making up that score, with some exceptions. Table 4.3 describes the procedure for combining each set of measures into a single factor score.

Table 4.3 Performance Factor Scoring Methodology

Performance Factor	Measure Methodology
Mobility and Economic Competitiveness	Average of the two measures
Connectivity	Average of the two measures
Safety	Average of the two measures
Reliability	Single measure
Accessibility	Score of bike suitability measure, plus a single point for any added bus turnouts; maximum of 10 points
Resource conservation	Average of emissions and fuel consumption measures, plus a point each for a project with sound walls or a project that is consistent with local plans; maximum of 10 points

Source: Cambridge Systematics, 2004.

5.0 Weights

5.0 Weights

The final step in the MoveAZ plan evaluation process was the application of performance factor weights to each of the factor scores to generate a total score for each project "bundle." Weights provided a means to formalize the priorities of the long-range goals and performance factors of the MoveAZ plan. The legislation directing ADOT to develop a long-range plan (House Bill 2660) also required a system of weights to be applied to the performance factors.

A system of weights for each of the seven performance factors (as shown previously in Table 4.1) used in project analysis was developed through public and stakeholder involvement for the plan in coordination with existing ADOT policies and technical concerns. This section describes the process used to develop weights and is divided into the following four subsections:

1. **Weighting methodology –** The overall method used to develop weights;
2. **Sources for weights –** The data used to support the weights;
3. **MoveAZ descriptive weights –** A qualitative description of the weight appropriate to each factor; and
4. **MoveAZ numeric weights –** The translation of the descriptive weights into specific numerical weights for analysis.

5.1 Weighting Methodology

A three-step process was used to develop performance factor weights:

- First, performance factors were identified using the process described above;
- Second, each factor received one of three descriptive weights that represented the relative priority assigned to that factor; and
- Finally, each of the descriptive weights was assigned specific quantitative values that were then applied to the factor scores resulting from the evaluation process.

Three descriptive weights were selected to describe the relative priorities of the factors:

1. **Enhance** was used for factors with the highest priority for ADOT. These were factors that ADOT should focus on to improve system performance, possibly at the expense of other factors.

2. **Sustain** was used for factors for which ADOT should try to maintain current performance levels.

3. **Neutral** was used for all other factors. These factors represented issues that are important, but somewhat less so than other factors.

All of the factors selected to be part of the strategic direction are important for project evaluation. The purpose of the strategic direction was to develop long-range goals and performance factors that captured the issues and concerns that ADOT should address over the next 20 years. Though some of these factors are more important than others, the weights were designed to provide relatively small adjustments to the final factor scores.

During the evaluation process, the descriptive weight categories (above) will be translated into numerical weights. The final weights were subject to extensive sensitivity testing in the MoveAZ planning process.

5.2 Sources for Weights

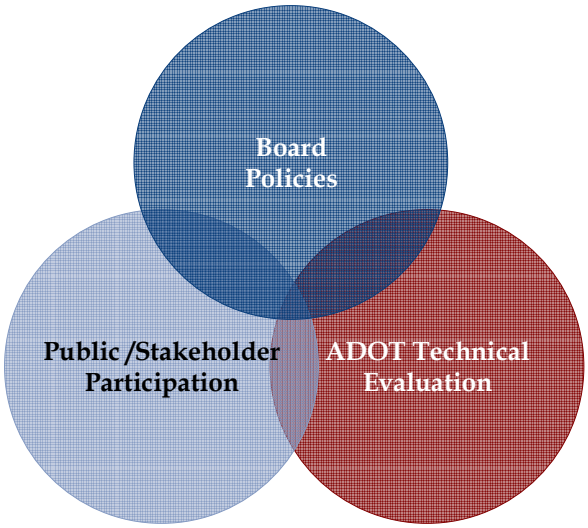
The following major sources were used to develop the performance factor weights (Figure 5.1):

- **Currently adopted board policies –** The Arizona Transportation Board policy document describes the current vision and commitments that the Board makes for transportation in Arizona. It also outlines a set of policies to help meet these commitments.

- **Public input conducted as part of the MoveAZ planning process –** MoveAZ includes three phases of public and stakeholder involvement, two of which occurred prior to finalizing the evaluation process. Through focus groups and regional forums, members of the public were able to help shape the MoveAZ strategic direction. MoveAZ included an analysis of comments made at all of these public events (Initial and Intermediate Partnering Phase Reports), as well as through previous planning processes (MoveAZ Phase I Final Report). Details of this analysis can be found in the corresponding reports for each set of events.

- **Consistency with departmental goals –** The MoveAZ Continuity Team is an internal ADOT committee consisting of representatives of ADOT's major divisions. This group provided guidance on the selection of weights to ensure that the weights fit with existing departmental goals.

Figure 5.1 Sources of MoveAZ Factor Weights



Source: Cambridge Systematics, 2004.

5.3 MoveAZ Descriptive Weights

This section describes the recommended weighting scheme for use in the MoveAZ plan evaluation process. Each of the following subsections describes the basis for assigning a particular descriptive weight to each performance factors. Overall, each of the performance factors received support at all of the regional public forums and in the Arizona Transportation Board policy statement. During the intermediate partnering phase of the MoveAZ plan, participants were asked to select the most important key findings from the initial phase. Across all of the forums, each of the key findings received nearly the same level of support (within two percentage points of the average). The following explanations, then, capture the relatively small differences among the factors that the weights are intended to reveal.

Mobility and Economic Competitiveness – Enhance

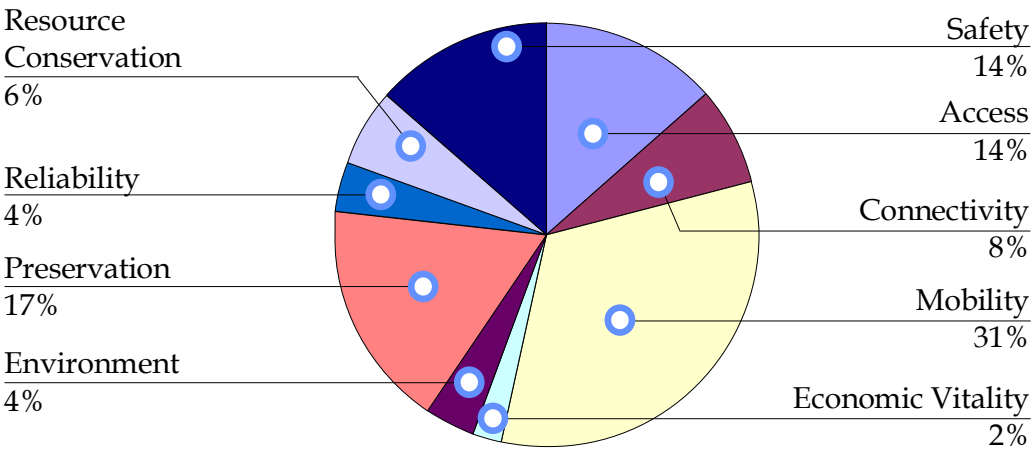
Mobility is one of the primary goals of both ADOT and the traveling public. Through consultation with ADOT staff and in public partnering events, mobility consistently rose as one of the top concerns.

Participants at the regional public forums raised concerns and strategies related to mobility more frequently than all other performance factors during both the initial and

intermediate partnering events. During the initial partnering events, over 40 percent of all participant-ranked responses relating to mobility concerns.

During the intermediate partnering events, the most frequently raised solutions also dealt with mobility issues (Figure 5.2). Participants of the forums held in Globe, Kingman, Prescott, Sierra Vista, Tucson, and Yuma suggested that the MoveAZ Plan should, first and foremost, incorporate projects and programs that enhanced mobility. More than 64 percent of the recommendations made by participants in the Tucson forums noted projects related to mobility as the most significant type of project to the State.

Figure 5.2 Performance Factors Raised During Immediate Partnering Events



Source: Cambridge Systematics, 2004.

Evidence from the review of previous plans also indicated that mobility is a high priority. Nearly all of the plans reviewed discussed mobility in one way or another. Furthermore, economic development issues (which are captured by the same measures as mobility) were also raised frequently in the review of plans. ADOT's small area transportation plans and plans for Indian reservations were particularly interested in the economic impacts of transportation investments.

Accessibility – Sustain

Providing access to the transportation system for multiple users is an important goal for ADOT. This goal received relatively strong support during the public partnering events. It was also consistent with ADOT policy to develop a multimodal transportation system that provides opportunities for all Arizonans to use the transportation system.

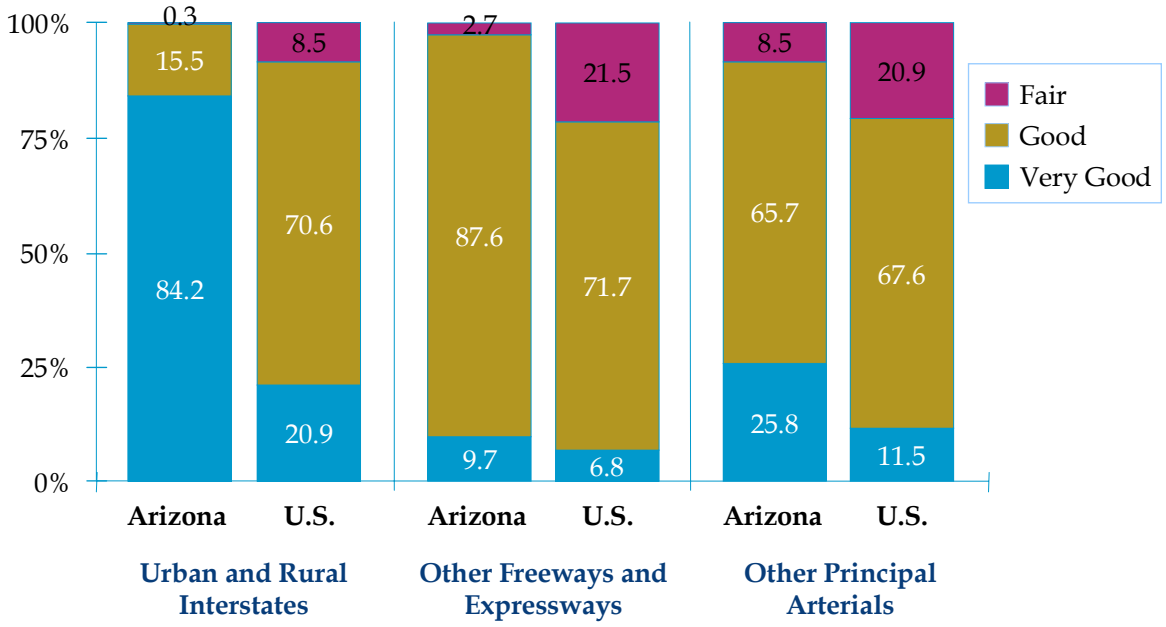
Improving access to the transportation system was strongly encouraged by forum participants. Accessibility concerns and strategies were often raised in conjunction with mobility concerns. Strategies related to accessibility were the third most strongly supported of all strategies raised during the intermediate partnering events. Participants in Flagstaff, Kingman, Pinetop-Lakeside, and Yuma ranked accessibility-related projects strongest of each of the forums, but participants at all forums supported accessibility.

During the initial partnering events, accessibility was second only to mobility in participants' rankings of transportation concerns. The first round of focus groups also provided strong support for accessibility. Participants in the bicycle/pedestrian, human services, economic development, aviation, and Native American communities focus groups all stressed the importance of access to the state transportation system. Several of these groups focused on access to particular modes of travel (aviation and bicycle/pedestrian), while the others were concerned about access to services or jobs, especially for disadvantaged groups.

Preservation – Sustain

Arizona has a history of investing in the maintenance of the transportation system. For example, the condition of pavement in Arizona is substantially better than for the U.S. as a whole (Figure 5.3). This commitment to preservation was supported by participants at public partnering events. Because the quality of maintenance is already quite high, this factor receives a sustain, instead of an enhance.

Figure 5.3 Existing Pavement Quality in Arizona and the U.S.



Source: ADOT, 2004.

Throughout the public and stakeholder involvement process, participants noted satisfaction with the State's current efforts for preservation. During the initial partnering events, participants rarely raised preservation issues as a transportation system concern. According to the survey from the initial phase, over two-thirds of participants thought that the roads were well maintained in Arizona.

In the intermediate partnering phase of MoveAZ, participants voiced concern that building of additional infrastructure should not compromise the high quality of the State's existing transportation network. ADOT was commended for the superior quality of its roadways and was encouraged to maintain this quality. Preservation-related strategies were raised nearly as frequently as accessibility strategies. Though the strong support in the intermediate partnering phase might suggest an "enhance" weight for preservation, the perception that the roadways are already high quality gives preservation a "sustain" weight.

Safety – Enhance

Safety is one of the key goals of for ADOT, Arizonans, and the Federal government. ADOT is committed to reducing crashes and developing a safer transportation system. In public partnering sessions, safety was consistently raised as an issue. Recent concerns at the Federal level have focused attention on the need for improved safety on the transportation system. For these reasons, safety received an enhance rating.

In the public partnering sessions, strategies related to safety were supported across the State. Public involvement participants encouraged ADOT to maintain their existing efforts regarding safety of the transportation system. Strategies related to safety were the fourth most supported type of recommendation, with just under 14 percent of participants across the regional solutions forums supporting these strategies. Transportation safety is a focus of many communities throughout the country, and proved to be of great importance to Arizonans.

During the initial partnering phase, over 75 percent of survey respondents indicated that they feel safe driving on the roads in Arizona. Though they varied by region, well over 50 percent of respondents in every region claimed to feel safe on the roads. At certain forums, safety was identified as a major concern, but this varied considerably by location. In Phoenix and Tucson, survey respondents identified rail-truck conflicts as a source of safety concerns, though other areas did no support this contention.

Resource Conservation – Neutral

Like all of the factors identified for MoveAZ, resource conservation is an important goal for ADOT. Compared to some of the issues raised by other factors, however, resource conservation is somewhat less important. Providing for travel mobility and improving the safety of the transportation system form the core of ADOT policy. Similarly, public

partnering sessions were less likely to point to resource conservation issues. For these reasons, the resource conservation factor receives a neutral rating.

Resource conservation and environmental sensitivity were often raised during the public partnering sessions, but they did not receive the same level of support as other factors across all of the forums. Participants were able to both raise and vote on particular concerns and strategies in the two phases of public involvement. Environmental and resource conservation issues were raised at each of the forums, but only received strong support at select forums. In the initial partnering phase, participants at the Phoenix, Tucson, and Flagstaff forums voted for environmental concerns at a much higher rate than other forums. The intermediate partnering phase events show a similar pattern, with participants of forum in Pinetop-Lakeside also providing strong support for projects related to resource conservation.

Reliability – Neutral

Reliability taps the public's desire for predictability of travel. As a growing state with a rapidly growing transportation system, reliability concerns are somewhat less important than overall mobility. As the Arizona transportation system matures, however, reliability concerns will likely grow. For the MoveAZ plan, reliability received a neutral rating.

Strategies related to reliability received the least public support of all of the factors. Participants did raise concerns about the ability to reliably navigate the roadway system, especially after a serious crash. However, only two percent of participants' votes in the intermediate partnering phase were for reliability issues. Arizonans indicated that they supported maintaining a reliable system, but not necessarily at the cost of pursuing other strategies. When asked on the intermediate partnering phase survey if they would be willing to accept more unpredictable travel times, respondents were split on their decision. Of the questions that asked participants to describe how they would deal with reduced funding, less reliable travel times received more support than most other responses. Only reducing funding to landscaping and aesthetics received more support overall than less predictable travel times.

Connectivity – Neutral

Connectivity is a goal supported by ADOT and at public partnering sessions. Again, however, it received overall less support than other related issues. Connectivity is closely related to other issues, such as mobility and accessibility. But where these issues received substantial public support, the support for connectivity was much more varied.

Strategies related to connectivity often emerged in conjunction with other strategies. For example, as participants discussed the desire to have mobility throughout the State, they sometimes also noted the need to connect various regions. Participants at several forums were especially supportive of connectivity issues. In the initial partnering phase, connectivity was the primary concern of participants at the Lake Havasu City forum. During the

intermediate partnering phase, connectivity was supported most strongly at the Kingman, Yuma, and Phoenix area forums.

During the initial partnering phase, survey respondents were asked if they thought that rural areas were well connected to major transportation systems. Responses to this question varied from a low of 33 percent agreeing in Lake Havasu to nearly 65 percent agreeing in Casa Grande. On average, roughly one-half of all survey respondents thought that rural areas are well connected to the major transportation systems.

Connectivity received relatively less support across all of the forums, compared to other performance factors. Similar to the environmental and resource conservation factors, connectivity received very strong support in some areas and much more tepid support in others. This strategy, therefore, was weighted as neutral, because it is important, but not more so than other strategies.

5.4 MoveAZ Numeric Weights

The final set of weights developed for the MoveAZ performance factors was based on consultations with the ADOT advisory bodies and detailed sensitivity analyses. The objective of using weights in the evaluation process was to provide additional support to projects that perform well on higher-priority factors, such as safety and mobility. However, ADOT recognized that each of performance factors is important for the transportation system. Weights were not intended to cause a radical redistribution of performance to projects. As a result, the weights shown in Table 5.1 provide a moderate boost to project "bundles" that improve mobility, safety, accessibility, and preservation.

Table 5.1 Performance Factors Weights

Performance Factor	Weight
Mobility	1.4
Reliability	1.0
Connectivity	1.0
Accessibility	1.2
Safety	1.4
Preservation	1.2
Resource Conservation	1.0

Source: Cambridge Systematics, 2004.

6.0 Project Bundles

6.0 Project Bundles

The bundles that resulted from the project bundling process (described in Section 4.0) are provided here. These projects constitute the master list of projects that were evaluated in the performance analysis process, provided by district. The projects are organized by bundle – shown in bold – with the elements of each project following the overall bundle. Each project includes the county, roadway, mileposts, a short description, and costs of the project. The bundle description combines the specific descriptions of the individual project elements.

Each bundle is given a code that represents the district and a unique two-digit project number in the format *XX.YY*. The district codes are given in Table 6.1. For example, 11.21 would be project 21 of the Flagstaff district (Table 6.2). Project elements use the bundle code plus a unique two-digit number for the project element in the format: *XX.YY.ZZ*. For example, 14.11.01 would be the first project element of the 11th bundle in the Kingman district.

Table 6.1 MoveAZ District Codes

Code	District
11	Flagstaff
12	Globe
13	Holbrook
14	Kingman
15	Phoenix
16	Prescott
17	Safford
18	Tucson
19	Yuma

Tables 6.2 through 6.9 present the project bundles by district that were evaluated in the MoveAZ performance analysis process, including the individual project elements that comprise each bundle. Because projects in Maricopa County were not analyzed using the MoveAZ performance analysis process, they are not shown here. Section 7.0 provides those projects, as well as the performance results for the rest of the State.

Table 6.2 Flagstaff District Projects

Project	Road	BMP	EMP	County	Description	Cost
11.01	**I-17**	**298.98**	**322.72**	**Coconino, Yavapai**	**Climbing lanes, realign highway**	**$110,250,000**
11.01.01	I-17	298.98	322.72	Coconino, Yavapai	Climbing lanes, animal control	$68,250,000
11.01.02	I-17	306.30	0.00	Yavapai	Reconstruct TI	$15,000,000
11.01.03	I-17	317.02	0.00	Coconino	Realign hwy/rebuild bridge	$6,000,000
11.01.04	I-17	321.98	0.00	Coconino	Realign hwy/rebuild bridge	$6,000,000
11.01.05	I-17	322.72	0.00	Coconino	Reconstruct TI	$15,000,000
11.02	**I-17**	**333.85**	**340.05**	**Coconino**	**Widen to 6 lanes**	**$35,150,000**
11.02.01	I-17	333.85	340.05	Coconino	Widen to 6 lanes	$20,150,000
11.02.02	I-17	337.39	0.00	Coconino	Reconstruct TI	$15,000,000
11.11	**I-40**	**155.00**	**165.00**	**Coconino**	**Reconstruct highway**	**$14,000,000**
11.11.01	I-40	155.00	157.00	Coconino	Reconstruct highway	$8,000,000
11.11.02	I-40	159.00	165.00	Coconino	Safety project (wild game)	$6,000,000
11.12	**I-40**	**167.00**	**196.00**	**Coconino**	**Climbing lane, safety**	**$84,420,000**
11.12.01	I-40	167.00	186.00	Coconino	Safety project (inclement weather/ nighttime)	$19,000,000
11.12.02	I-40	189.00	193.00	Coconino	Safety project (inclement weather)	$4,000,000
11.12.03	I-40	194.40	195.40	Coconino	Climbing lane WB	$1,500,000
11.12.04	I-40	171.65	0.00	Coconino	Reconstruct Pittman TI (widening)	$15,000,000
11.12.05	I-40	185.11	0.00	Coconino	Reconstruct Transwestern TI (widening)	$15,000,000
11.12.06	I-40	191.67	0.00	Coconino	Reconstruct W. Flagstaff TI (widening)	$15,000,000
11.12.07	I-40	195.42	0.00	Coconino	Widen 2 bridges	$4,000,000
11.12.08	I-40	180.00	185.00	Coconino	Rest area kiosk & CC TV (WB & EB)	$250,000
11.12.09	I-40	190.00	0.00	Coconino	Variable message sign (EB)	$250,000
11.12.10	I-40	195.00	195.42	Coconino	Need noise barriers	$420,000
11.12.11	I-40	196.00	0.00	Coconino	Construct Lone Tree Road interchange	$10,000,000
11.13	**I-40**	**195.42**	**205.00**	**Coconino**	**Widen to 6 lanes**	**$41,180,500**
11.13.01	I-40	198.00	199.00	Coconino	Safety project	$1,000,000
11.13.02	I-40	195.42	200.00	Coconino	District preference CC TV (WB)	$45,500
11.13.03	I-40	200.00	0.00	Coconino	Variable message sign (WB)	$260,000
11.13.04	I-40	195.42	201.00	Coconino	Reconstruct and widen to 6 lanes	$29,295,000
11.13.05	I-40	201.00	202.00	Coconino	Safety project	$1,000,000
11.13.06	I-40	195.42	205.00	Coconino	Need noise barriers	$9,580,000
11.16	**I-40**	**226.00**	**233.88**	**Coconino**	**Climbing lane, reconstruct highway**	**$25,000,000**
11.16.01	I-40	229.00	230.00	Coconino	Safety project (curve)	$2,000,000
11.16.02	I-40	226.00	230.00	Coconino	Reconstruct and add WB climbing lane	$8,000,000
11.16.03	I-40	233.88	0.00	Coconino	Reconstruct meteor crater TI	$15,000,000

Table 6.2 Flagstaff District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
11.21	**U.S. 89**	**442.00**	**482.00**	**Coconino**	**Widen to 4-lane divided**	**$130,284,000***
11.21.01	U.S. 89	442.00	442.61	Coconino	Widen to 5-lane undivided section	
11.21.02	U.S. 89	443.21	455.97	Coconino	Widen to 4 lanes divided (84' median)	
11.21.03	U.S. 89	456.61	458.05	Coconino	Widen to 4 lanes (10' shoulders) with raised median, and curb & gutter	
11.21.04	U.S. 89	458.39	463.95	Coconino	Widen to 4 lanes divided	
11.21.05	U.S. 89	466.00	467.11	Coconino	Widen to 4 lanes (10' shoulders) with raised median, and curb & gutter	
11.21.06	U.S. 89	467.60	482.00	Coconino	Widen to 4 lanes divided (84' median)	
11.21.07	U.S. 89	465.20	0.00	Coconino	New TI	
11.21.08	U.S. 89	466.80	0.00	Coconino	New TI	
11.21.09	U.S. 89	480.80	0.00	Coconino	New TI	
11.22	**U.S. 89**	**498.00**	**504.00**	**Coconino**	**Passing lanes**	**$1,500,000**
11.22.01	U.S. 89	498.00	504.00	Coconino	Construct passing lanes	$1,500,000
11.23	**U.S. 89**	**531.00**	**556.99**	**Coconino**	**Widen to 4 lanes, passing lanes**	**$17,570,000**
11.23.01	U.S. 89	531.00	556.99	Coconino	Widen NB shoulder	$11,000,000
11.23.02	U.S. 89	534.00	536.00	Coconino	Build NB & SB passing lanes	$1,500,000
11.23.03	U.S. 89	549.54	551.23	Coconino	Construct 4-lane section	$5,070,000
11.24	**U.S. 89A**	**579.30**	**613.00**	**Coconino**	**Widen to 4 lanes**	**$13,708,000**
11.24.01	U.S. 89A	612.00	613.00	Coconino	Provide bus turnaround	$108,000
11.24.02	U.S. 89A	610.20	613.00	Coconino	Widen to 4 lanes	$9,100,000
11.24.03	U.S. 89A	579.30	609.00	Coconino	Construct passing lanes/pullouts	$4,500,000
11.24.04	U.S. 89A	N/A	N/A	Coconino	Install bike lanes	
11.31	**U.S. 160**	**336.50**	**343.50**	**Coconino**	**Passing/climbing lanes**	**$1,500,000**
11.31.01	U.S. 160	336.50	341.50	Coconino	Passing/climbing lanes	$750,000
11.31.02	U.S. 160	338.50	343.50	Coconino	Passing/climbing lanes	$750,000
11.32	**U.S. 160**	**321.00**	**323.00**	**Coconino**	**Widen to 5-lane cross section**	**$26,500,000**
11.32.01	U.S. 160	321.00	323.00	Coconino	Widen to 5-lane cross section	$6,500,000
11.32.02	U.S. 160	313.00	314.00	Coconino	Add paved shoulders to AASHTO standards	$500,000
11.32.03	U.S. 160	315.00	321.00	Coconino	Widen to 5-lane cross section	$19,500,000

Table 6.2 Flagstaff District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
11.41	**SR 64**	**185.70**	**235.00**	**Coconino**	**Widen to 4 lanes, passing/climbing lanes**	**$47,400,000**
11.41.01	SR 64	185.70	213.00	Coconino	Add paved shoulders to AASHTO standards	$13,650,000
11.41.02	SR 64	214.00	233.50	Coconino	Add paved shoulders to AASHTO standards	$9,750,000
11.41.03	SR 64	192.00	197.00	Coconino	Passing/climbing Lanes	$750,000
11.41.04	SR 64	194.00	199.00	Coconino	Passing/climbing Lanes	$750,000
11.41.05	SR 64	213.50	218.50	Coconino	Passing/climbing lanes	$750,000
11.41.06	SR 64	215.50	220.50	Coconino	Passing/climbing lanes	$750,000
11.41.07	SR 64	213.00	214.00	Coconino	Widen to 5-lane cross-section	$2,500,000
11.41.08	SR 64	214.00	224.00	Coconino	Add passing lanes at selected locations	$1,500,000
11.41.09	SR 64	224.00	227.00	Coconino	Add passing lanes at selected locations	$1,500,000
11.41.10	SR 64	227.00	231.50	Coconino	Add northbound passing lanes at selected locations	$1,500,000
11.41.11	SR 64	231.50	235.00	Coconino	Widen to 4 lanes plus turn lanes	$14,000,000
11.51	**SR 264**	**322.00**	**340.20**	**Coconino**	**Widen to 5 lanes, add shoulders, climbing lanes**	**$18,060,000**
11.51.01	SR 264	322.00	322.90	Coconino	Widen to 5-lane cross section with shoulders	$2,250,000
11.51.02	SR 264	322.90	340.20	Coconino	Add paved shoulders to AASHTO guidelines	$12,110,000
11.51.03	SR 264	324.50	329.00	Coconino	Climbing lane – EB	$2,250,000
11.51.04	SR 264	333.00	333.00	Coconino	Drainage upgrade	$650,000
11.51.05	SR 264	332.70	333.30	Coconino	Climbing lane – EB	$300,000
11.51.06	SR 264	322.00	333.30	Coconino	Add bus pullout	$500,000

*Estimates of individual project elements are not available separately for this bundle.
Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.3 Globe District Projects

Project	Road	BMP	EMP	County	Description	Cost
12.01	**U.S. 60**	**212.80**	**226.80**	**Pinal**	**Widen to 5 lanes**	**$50,648,000**
12.01.01	U.S. 60	222.30	224.70	Pinal	Construct new EB & WB bypass north of the arboretum	$16,608,000
12.01.02	U.S. 60	224.70	226.80	Pinal	Improve the existing 3-lane to a 5-lane section with portions curbed	$8,990,000
12.01.03	U.S. 60	212.80	0.00	Pinal	Queen Valley TI	$10,000,000
12.01.04	U.S. 60	224.50	226.80	Pinal	Provide pedestrian facilities separate from highway	$50,000
12.01.05	U.S. 60	226.00	0.00	Pinal	Construct new TI @ SR 177	$15,000,000
12.03	**U.S. 60**	**260.00**	**273.00**	**Gila**	**Passing/climbing lanes**	**$2,250,000**
12.03.01	U.S. 60	260.00	265.00	Gila	Passing/climbing lanes	$750,000
12.03.02	U.S. 60	265.00	270.00	Gila	Passing/climbing lanes	$750,000
12.03.03	U.S. 60	268.00	273.00	Gila	Passing/climbing lanes	$750,000
12.04	**U.S. 60**	**336.40**	**402.00**	**Apache, Navajo**	**Widen to 5-lanes, add paved shoulders**	**$49,179,250**
12.04.01	U.S. 60	391.00	392.00	Apache	Add paved shoulders to AASHTO standards	$500,000
12.04.02	U.S. 60	391.00	392.00	Apache	Add paved shoulders to AASHTO standards	$500,000
12.04.03	U.S. 60	394.50	395.50	Apache	Add paved shoulders to AASHTO standards	$500,000
12.04.04	U.S. 60	398.00	399.00	Apache	Add paved shoulders to AASHTO standards	$500,000
12.04.05	U.S. 60	342.50	402.00	Apache, Navajo	Install delineators along shoulder, entire corridor	$29,250
12.04.06	U.S. 60	389.00	391.00	Apache	Pavement rehabilitation	$900,000
12.04.07	U.S. 60	342.50	344.00	Navajo	Construct 4-lane roadway section	$5,250,000
12.04.08	U.S. 60	344.00	352.00	Navajo	Add paved shoulders to AASHTO standards	$4,000,000
12.04.09	U.S. 60	352.00	384.00	Apache	Add paved shoulders to AASHTO standards	$16,000,000
12.04.10	U.S. 60	367.00	389.00	Apache	Pavement rehabilitation	$9,900,000
12.04.11	U.S. 60	336.40	339.70	Navajo	Widen to 5-lanes	$11,100,000
12.05	**U.S. 60**	**241.00**	**242.50**	**Gila**	**Passing lanes**	**$6,945,000**
12.05.01	U.S. 60	241.00	242.50	Gila	Passing lanes, Top of the World	$6,945,000

Table 6.3 Globe District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
12.06	**U.S. 60**	**252.00**	**337.00**	**Gila, Navajo**	**Climbing lanes, passing lanes**	**$28,250,000**
12.06.01	U.S. 60	252.00	254.00	Gila	Climbing lanes	$1,000,000
12.06.02	U.S. 60	260.00	269.00	Gila	Climbing lanes	$4,500,000
12.06.03	U.S. 60	269.00	272.00	Gila	Climbing lanes	$1,500,000
12.06.04	U.S. 60	276.00	281.00	Gila	Climbing lanes	$2,500,000
12.06.05	U.S. 60	281.00	288.00	Gila	Passing lanes	$1,500,000
12.06.06	U.S. 60	288.00	298.00	Gila	Climbing lanes	$5,000,000
12.06.07	U.S. 60	299.00	301.00	Gila	Climbing lanes	$1,000,000
12.06.08	U.S. 60	301.00	312.00	Gila	Passing lanes	$2,250,000
12.06.09	U.S. 60	312.00	322.00	Gila	Climbing lanes	$5,000,000
12.06.10	U.S. 60	323.00	326.00	Navajo	Climbing lanes	$1,500,000
12.06.11	U.S. 60	330.00	334.00	Navajo	Climbing lanes	$2,000,000
12.06.12	U.S. 60	336.00	337.00	Navajo	Climbing lanes	$500,000
12.11	**U.S. 70**	**253.60**	**287.40**	**Graham, Gila**	**Widen to 5-lane cross-section**	**$66,301,000**
12.11.01	U.S. 70	261.00	N/A	Gila	Lengthen passing lane by approx 0.5 mile	$935,000
12.11.02	U.S. 70	253.60	254.10	Gila	Widen from 2-lane to 5-lane urban	$45,376,000
12.11.03	U.S. 70	254.10	262.00	Gila	Widen to 4-lane divided	**
12.11.04	U.S. 70	256.00	257.00	Gila	Widen railroad crossing bridge to 5 lanes	$5,000,000
12.11.05	U.S. 70	271.10	279.40	Graham	Widen shoulders to meet design standards	$4,150,000
12.11.06	U.S. 70	279.40	287.40	Graham	Widen shoulders to meet design standards	$4,000,000
12.11.07	U.S. 70	255.60	287.40	Graham, Gila	Repair and maintain fencing	$2,290,000
12.11.08	U.S. 70	255.60	271.10	Gila	Widen shoulders to meet design standards	$4,550,000
12.21	**SR 73**	**310.38**	**335.21**	**Gila**	**Shoulders**	**$13,108,100**
12.21.01	SR 73	310.38	319.84	Gila	Widen shoulders	$3,108,100
12.21.02	SR 73	319.84	326.08	Gila	Widen shoulders	$4,800,000
12.21.03	SR 73	326.08	335.21	Gila	Widen shoulders	$5,200,000
12.31	**SR 77**	**153.00**	**171.00**	**Gila**	**Climbing lanes**	**$10,500,000**
12.31.01	SR 77	153.00	156.00	Gila	Climbing lanes	$1,500,000
12.31.02	SR 77	157.00	159.00	Gila	Climbing lanes	$1,000,000
12.31.03	SR 77	163.00	168.00	Gila	Climbing lanes	$2,500,000
12.31.04	SR 77	156.00	159.00	Gila	Shoulder improvements	$1,500,000
12.31.05	SR 77	161.00	162.00	Gila	Shoulder improvements	$500,000
12.31.06	SR 77	164.00	171.00	Gila	Shoulder improvements	$3,500,000

Table 6.3 Globe District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
12.32	**SR 77**	**342.00**	**359.00**	**Navajo, Gila**	**Climbing lanes, 5-lane roadway section**	**$28,250,000**
12.32.01	SR 77	342.00	357.00	Navajo	Climbing lanes	$7,500,000
12.32.02	SR 77	357.00	359.00	Navajo	Construct 5-lane roadway section	$7,000,000
12.32.03	SR 77	290.60	0.00	Gila	Runaway truck ramp	$500,000
12.32.04	SR 77	293.20	0.00	Gila	Runaway truck ramp	$500,000
12.32.05	SR 77	295.30	0.00	Gila	Runaway truck ramp	$500,000
12.32.06	SR 77	320.00	323.00	Navajo	Realignment/structure	$12,000,000
12.32.07	SR 77	321.00	0.00	Navajo	Bridge rehabilitation	$250,000
12.33	**SR 77**	**342.00**	**358.00**	**Navajo**	**Widen to 4 lanes**	**$50,750,000**
12.33.01	SR 77	342.00	358.00	Navajo	Widen to 4 lanes	$48,000,000
12.33.02	SR 77				Rural ITS – Salt River Canyon	$2,000,000
12.33.03	SR 77				Rural ITS – Salt Show Low to Globe	$750,000
12.42	**SR 260**	**317.16**	**335.00**	**Navajo**	**Passing lanes**	**$3,000,000**
12.42.01	SR 260	317.16	317.90	Navajo	Passing/climbing lane (EB) & 5' shoulders	$1,000,000
12.42.02	SR 260	319.23	320.45	Navajo	Passing/climbing lane (EB) & 5' shoulders	$1,000,000
12.42.03	SR 260	330.75	332.00	Navajo	Passing/climbing lane (EB) & 5' shoulders	$1,000,000
12.43	**SR 260**	**331.00**	**338.00**	**Navajo**	**Widen to 5-lane cross section**	**$11,518,900**
12.43.01	SR 260	331.00	338.00	Navajo	Extend 5-lane roadway	$11,518,900
12.51	**SR 277**	**331.40**	**336.40**	**Navajo**	**Widen to 5-lane cross-section**	**$26,000,000**
12.51.01	SR 277	334.90	336.40	Navajo	Widen to 5 lanes	$10,700,000
12.51.02	SR 277	333.40	334.90	Navajo	Widen to 5 lanes	$8,700,000
12.51.03	SR 277	331.40	333.40	Navajo	Widen to 5 lanes	$6,600,000
12.61	**SR 79**	**132.48**	**150.25**	**Pinal**	**Widen to 4 lanes**	**$60,000,000**
12.61.01	SR 79	132.48	150.25	Pinal	Widen to 4 lanes	$60,000,000

*Roadway uses new alignment, actual mileposts to be determined.
**Costs included in Item 12.11.02.
Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.4 Holbrook District Projects

Project	Road	BMP	EMP	County	Description	Cost
13.03	**I-40**	**282.00**	**289.00**	**Navajo**	**Widen to 6 lanes, noise barriers**	**$19,050,000**
13.03.01	I-40	285.00	290.00	Navajo	District Preference CC TV (WB) and RWIS	$750,000
13.03.02	I-40	285.00	290.00	Navajo	VMS at district preference (WB/EB)	$500,000
13.03.03	I-40	286.60	289.00	Navajo	Design, reconstruct and widen existing road	$9,600,000
13.03.04	I-40	285.00	286.60	Navajo	Design, reconstruct and widen existing road	$2,200,000
13.03.05	I-40	282.00	288.00	Navajo	Construct noise barriers	$6,000,000
13.04	**I-40**	**292.82**	**311.60**	**Navajo, Apache**	**Reconstruct roadway**	**$75,185,000**
13.04.01	I-40	304.00	0.00	Navajo	Proposed RWIS (WB/EB)	$65,000
13.04.02	I-40	292.82	311.60	Navajo, Apache	Reconstruct roadway	$75,120,000
13.05	**I-40**	**311.60**	**339.52**	**Apache**	**Reconstruct roadway**	**$127,180,000**
13.05.01	I-40	311.60	339.52	Apache	Reconstruct roadway	$111,680,000
13.05.02	I-40	326.00	0.00	Apache	Reconstruct TI (Navajo)	$15,000,000
13.05.03	I-40	330.00	0.00	Apache	Variable message sign (WB/EB)	$500,000
13.06	**I-40**	**339.00**	**360.00**	**Apache**	**Reconstruct roadway**	**$112,785,500**
13.06.01	I-40	342.00	0.00	Apache	Variable message sign (WB)	$260,000
13.06.02	I-40	350.00	355.00	Apache	District preference CC TV (WB)	$45,500
13.06.03	I-40	339.52	360.00	Apache	Reconstruct roadway	$81,920,000
13.06.04	I-40	339.00	0.00	Apache	Variable message sign (EB)	$260,000
13.06.05	I-40	345.00	350.00	Apache	RWIS (EB/WB)	$300,000
13.06.06	I-40	357.50	0.00	Apache	Reconstruct Lupton TI	$15,000,000
13.06.07	I-40	359.00	0.00	Apache	Reconstruct Window Rock TI	$15,000,000
13.07	**I-40**	**230.00**	**233.88**	**Coconino**	**Widen to 6 lanes and climbing lane**	**$51,620,000**
13.07.02	I-40	230.43	0.00	Coconino	Reconstruct Two Guns TI (Widening)	$15,000,000
13.07.03	I-40	233.88	0.00	Coconino	Reconstruct Meteor Crater TI (Widening)	$15,000,000
13.07.04	I-40	230.00	233.88	Coconino	Reconstruct and widen to 6 lanes	$20,370,000
13.07.05	U.S. 95	233.70	0.00	Coconino	Meteor Crater TI UP (WB)	$1,250,000
13.11	**U.S. 160**	**361.00**	**384.00**	**Navajo**	**Passing lanes**	**$7,200,000**
13.11.01	U.S. 160	361.00	371.00	Navajo	Add passing lanes at selected locations	$4,800,000
13.11.02	U.S. 160	381.00	384.00	Navajo	Add passing lanes at selected locations	$2,400,000
13.21	**U.S. 191**	**344.00**	**365.00**	**Apache**	**Rebuild roadway**	**$52,030,000**
13.21.01	U.S. 191	352.18	365.00	Apache	Rebuild roadway and improve drainage and isolated intersection improvements	$51,280,000
13.21.02	U.S. 191	354.00	355.00	Apache	Passing/climbing lanes	$750,000
13.22	**U.S. 191**	**370.00**	**379.00**	**Apache**	**Rebuild roadway**	**$24,000,000**
13.22.01	U.S. 191	370.00	371.00	Apache	Rebuild roadway	$4,000,000
13.22.02	U.S. 191	374.00	379.00	Apache	Rebuild roadway	$20,000,000

Table 6.4 Holbrook District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
13.23	**U.S. 191**	**379.00**	**412.00**	**Apache**	**Passing lanes, reconstruct roadway**	**$133,000,000**
13.23.01	U.S. 191	390.00	0.00	Apache	Passing lanes	$1,000,000
13.23.02	U.S. 191	379.00	412.00	Apache	Rebuild roadway	$132,000,000
13.24	**U.S. 191**	**420.50**	**446.50**	**Apache**	**Shoulders, reconstruct roadway, widen to 4 lanes**	**$62,000,000**
13.24.01	U.S. 191	420.50	427.00	Apache	Rebuild roadway and improve drainage	$26,000,000
13.24.02	U.S. 191	427.00	441.00	Apache	Add paved shoulders to AASHTO standards	$14,000,000
13.24.03	U.S. 191	441.00	446.50	Apache	Rebuild roadway and widen to 4 lanes	$22,000,000
13.25	**U.S. 191**	**446.50**	**510.50**	**Apache**	**Widen to 5-lane cross section**	**$93,500,000**
13.25.01	U.S. 191	449.00	461.00	Apache	Widen to 4-lane divided	$39,000,000
13.25.02	U.S. 191	462.00	510.00	Apache	Add paved shoulders to AASHTO standards	$48,000,000
13.25.03	U.S. 191	446.50	448.50	Apache	Widen to 5-lane cross section	$6,500,000
13.32	**SR 264**	**340.20**	**388.00**	**Navajo, Coconino**	**Shoulders, curves, turn lanes**	**$51,002,500**
13.32.01	SR 264	340.20	366.80	Coconino, Navajo	Add paved shoulders to AASHTO guidelines	$18,620,000
13.32.02	SR 264	340.50	340.50	Coconino	Drainage upgrade	$650,000
13.32.03	SR 264	344.10	344.10	Coconino	Widen intersection for turn lanes	$500,000
13.32.04	SR 264	350.00	350.00	Coconino	Improve curve to AASHTO guidelines	$500,000
13.32.05	SR 264	362.50	362.50	Navajo	Improve curve to AASHTO guidelines	$500,000
13.32.06	SR 264	366.90	366.90	Navajo	Widen intersection for turn lanes	$500,000
13.32.07	SR 264	366.80	368.00	Navajo	Widen to 3-lane cross section	$1,560,000
13.32.08	SR 264	368.00	388.00	Navajo	Add paved shoulders to AASHTO guidelines	$14,000,000
13.32.09	SR 264	368.50	372.70	Navajo	Climbing lane – WB	$2,100,000
13.32.10	SR 264	371.60	371.60	Navajo	Improve curve to AASHTO guidelines	$500,000
13.32.11	SR 264	372.10	372.10	Navajo	Improve curve to AASHTO guidelines	$500,000
13.32.12	SR 264	Howell Mesa		Navajo	Install Road Weather Information System	$50,000
13.32.13	SR 264	340.20	372.70	Navajo	Add bus pullout	$812,500
13.32.14	SR 264	374.20	374.20	Navajo	Drainage upgrade	$650,000
13.32.15	SR 264	375.60	375.60	Navajo	Widen intersection for turn lanes	$500,000
13.32.16	SR 264	376.40	376.40	Navajo	Improve curve to AASHTO guidelines	$500,000
13.32.17	SR 264	377.30	379.00	Navajo	Climbing lane – EB	$850,000
13.32.18	SR 264	378.10	382.6	Navajo	Improve curves to AASHTO guidelines (9 locations)	$500,000
13.32.21	SR 264	378.80	379.80	Navajo	Widen to 3-lane cross section	$1,300,000
13.32.22	SR 264	381.20	381.20	Navajo	Widen intersection for turn lanes	$500,000
13.32.23	SR 264	381.20	383.60	Navajo	Climbing lane – WB	$1,200,000
13.32.30	SR 264	374.20	382.60	Navajo	Add bus pullout	$210,000

Table 6.4 Holbrook District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
13.34	**SR 264**	**386.20**	**411.50**	**Navajo**	**Widen to 5-lane cross section with shoulders**	**$31,872,500**
13.34.01	SR 264	386.20	386.20	Navajo	Widen intersection for turn lanes	$500,000
13.34.02	SR 264	388.00	393.00	Navajo	Widen to 5-lane cross section with shoulders	$12,500,000
13.34.03	SR 264	388.90	388.90	Navajo	Realign intersection	$500,000
13.34.04	SR 264	393.00	396.00	Navajo	Add paved shoulders to AASHTO guidelines	$2,100,000
13.34.05	SR 264	393.20	393.20	Navajo	Widen intersection for turn lanes	$500,000
13.34.06	SR 264	395.90	395.90	Navajo	Widen intersection for turn lanes	$500,000
13.34.07	SR 264	396.00	401.75	Navajo	Add paved shoulders to AASHTO guidelines	$4,025,000
13.34.08	SR 264	396.90	396.90	Navajo	Widen intersection	$250,000
13.34.09	SR 264	401.75	403.30	Navajo	Widen to 3-lane cross section	$2,015,000
13.34.10	SR 264	403.20	411.20	Navajo	Add paved shoulders to AASHTO guidelines	$5,600,000
13.34.11	SR 264	406.50	408.50	Navajo	Climbing lane – WB	$1,000,000
13.34.12	SR 264	407.90	407.90	Navajo	Widen intersection for turn lanes	$500,000
13.34.13	SR 264	409.00	411.50	Navajo	Climbing lane – EB	$1,250,000
13.34.14	SR 264	386.20	411.50	Navajo	Add bus pullout	$632,500
13.35	**SR 264**	**411.20**	**439.40**	**Apache, Navajo**	**Climbing lanes, shoulders**	**$27,060,000**
13.35.01	SR 264	411.20	425.90	Navajo, Apache	Add paved shoulders to AASHTO guidelines	$10,290,000
13.35.02	SR 264	411.20	411.20	Navajo	Widen intersection for turn lanes	$500,000
13.35.03	SR 264	418.40	418.40	Navajo	Improve curve to AASHTO guidelines	$500,000
13.35.04	SR 264	419.30	420.00	Apache	Climbing lane – EB	$350,000
13.35.05	SR 264	425.00	425.00	Apache	Drainage upgrade	$650,000
13.35.06	SR 264	425.90	426.70	Apache	Widen to 3-lane cross section	$1,040,000
13.35.07	SR 264	426.70	441.00	Apache	Add paved shoulders to AASHTO guidelines	$10,010,000
13.35.08	SR 264	428.00	428.10	Apache	Drainage upgrade	$65,000
13.35.09	SR 264	429.50	430.50	Apache	Climbing lane – EB	$500,000
13.35.10	SR 264	430.50	430.50	Apache	Improve curve to AASHTO guidelines	$500,000
13.35.11	SR 264	430.50	430.50	Apache	Drainage upgrade	$650,000
13.35.12	SR 264	437.10	437.90	Apache	Climbing lane – EB	$400,000
13.35.13	SR 264	438.20	438.70	Apache	Climbing lane – WB	$250,000
13.35.14	SR 264	439.40	439.40	Apache	Drainage upgrade	$650,000
13.35.15	SR 264	411.20	439.40	Apache, Navajo	Add bus pullout	$705,000

Table 6.4 Holbrook District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
13.36	**SR 264**	**441.00**	**446.89**	**Apache**	**Widen to 4-lane divided**	**$15,572,250**
13.36.01	SR 264	441.00	441.00	Apache	Widen intersection for turn lanes	$500,000
13.36.02	SR 264	441.00	441.80	Apache	Widen to 5-lane cross section with curb/gutter/sidewalk	$2,000,000
13.36.03	SR 264	441.80	444.70	Apache	Widen to 4-lane divided cross section	$7,250,000
13.36.04	SR 264	444.23	444.23	Apache	Bridge rehabilitation	$200,000
13.36.05	SR 264	444.70	446.20	Apache	Widen to 5-lane cross section with shoulders	$3,750,000
13.36.06	SR 264	446.20	446.89	Apache	Widen to 5-lane cross section with curb/gutter/sidewalk	$1,725,000
13.36.07	SR 264	441.00	446.89	Apache	Add bus pullout	$147,250
13.37	**SR 264**	**446.89**	**473.60**	**Apache**	**Widen to 4-lane divided**	**$52,054,750**
13.37.01	SR 264	446.89	447.60	Apache	Widen to 5-lane cross section with curb/gutter/sidewalk	$1,775,000
13.37.02	SR 264	447.60	448.60	Apache	Widen to 5-lane cross section with shoulders	$2,500,000
13.37.03	SR 264	448.00	448.00	Apache	Drainage upgrade	$650,000
13.37.04	SR 264	448.60	466.00	Apache	Widen to 4-lane divided cross section	$43,500,000
13.37.05	SR 264	451.30	451.30	Apache	Bridge replacement	$2,000,000
13.37.06	SR 264	452.10	452.10	Apache	Widen intersection for turn lanes	$500,000
13.37.07	SR 264	473.60	473.60	Apache	PCCP intersection	$462,000
13.37.08	SR 264	446.89	473.60	Apache	Add bus pullout	$667,750
13.41	**SR 77**	**362.00**	**387.00**	**Navajo**	**Climbing lanes**	**$13,500,000**
13.41.01	SR 77	362.00	387.00	Navajo	Climbing lanes	$12,500,000
13.41.02	SR 77	366.50	0.00	Navajo	Bridge rehabilitation	$250,000
13.41.03	SR 77	368.10	0.00	Navajo	Bridge rehabilitation	$250,000
13.41.04	SR 77	370.80	0.00	Navajo	Bridge rehabilitation	$250,000
13.41.05	SR 77	379.30	0.00	Navajo	Bridge rehabilitation	$250,000

Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.5 Kingman District Projects

Project	Road	BMP	EMP	County	Description	Cost
14.01	**I-40**	**37.00**	**44.31**	**Mohave**	**Reconstruct and widen to 6 lanes**	**$62,895,000**
14.01.01	I-40	37.03	0.00	Mohave	Reconstruct Griffith TI (widening)	$15,000,000
14.01.02	I-40	44.31	0.00	Mohave	Reconstruct McConnico TI	$15,000,000
14.01.03	I-40	37.00	44.31	Mohave	Reconstruct and widen to 6 lanes	$32,895,000
14.02	**I-40**	**44.31**	**55.00**	**Mohave**	**Widen to 6 lanes**	**$142,355,000**
14.02.01	I-40	51.68	0.00	Mohave	Reconstruct Stockton Hill TI (widening)	$15,000,000
14.02.02	I-40	53.08	0.00	Mohave	Reconstruct E. Kingman TI (widening)	$15,000,000
14.02.03	I-40	45.00	0.00	Mohave	Variable message sign (EB)	$250,000
14.02.04	I-40	44.31	55.00	Mohave	Reconstruct and widen to 6 lanes	$48,105,000
14.02.05	I-40	49.00	53.00	Mohave	Need noise barriers	$4,000,000
14.02.06	I-40	48.85	0.00	Mohave	Improve West Kingman TI to full directional	$60,000,000
14.03	**I-40**	**55.00**	**71.93**	**Mohave**	**Widen to 6 lanes**	**$107,185,000**
14.03.01	I-40	71.00	71.93	Mohave	Safety project	$1,000,000
14.03.02	I-40	59.65	0.00	Mohave	Reconstruct D W Ranch Rd TI	$15,000,000
14.03.03	I-40	66.47	0.00	Mohave	Reconstruct Blake Ranch Rd TI	$15,000,000
14.03.04	I-40	55.00	71.93	Mohave	Reconstruct and widen to 6 lanes	$76,185,000
14.04	**I-40**	**71.93**	**89.50**	**Mohave**	**Reconstruct highway, climbing lanes**	**$34,030,000**
14.04.01	I-40	81.50	82.20	Mohave	Climbing lane (WB)	$350,000
14.04.02	I-40	83.70	84.00	Mohave	Climbing lane (WB)	$150,000
14.04.03	I-40	87.00	89.50	Mohave	Construct climbing lane (EB)	$1,250,000
14.04.04	I-40	71.93	79.00	Mohave	Reconstruct highway	$28,280,000
14.04.05	I-40	84.00	85.00	Mohave	Reconstruct highway	$4,000,000
14.05	**I-40**	**91.70**	**120.00**	**Yavapai**	**Widen to 6 lanes**	**$111,390,000**
14.05.01	I-40	91.70	94.00	Yavapai	Reconstruct and widen to 6 lanes	$10,350,000
14.05.02	I-40	103.58	110.50	Yavapai	Reconstruct highway	$27,680,000
14.05.03	I-40	115.00	120.00	Yavapai	Variable message sign (EB)	$250,000
14.05.04	I-40	96.02	0.00	Yavapai	Reconstruct Cross Mountain TI	$15,000,000
14.05.05	I-40	103.58	0.00	Yavapai	Reconstruct Jolly Rd TI (due to road widening)	$15,000,000
14.05.06	I-40	94.00	103.58	Yavapai	Reconstruct and widen to 6 lanes	$43,110,000
14.06	**I-40**	**123.40**	**144.94**	**Yavapai**	**Reconstruct highway**	**$86,160,000**
14.06.01	I-40	123.40	144.94	Yavapai	Reconstruct highway	$86,160,000
14.11	**U.S. 93**	**2.50**	**17.00**	**Mohave**	**Widen to 4 lanes**	**$47,125,000**
14.11.01	U.S. 93	2.50	17.00	Mohave	Widen to 4 lanes (near Hoover Dam)	$47,125,000

Table 6.5 Kingman District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
14.12	**U.S. 93**	**92.50**	**121.30**	**Mohave**	**Widen to 4 lanes**	**$250,217,000**
14.12.01	U.S. 93	92.50	95.10	Mohave	Widen to 4 lanes (design, construct, ROW)	$10,515,000
14.12.02	U.S. 93	104.10	106.00	Mohave	Widen to 4 lanes (design, construct, ROW)	$5,491,000
14.12.03	U.S. 93	101.80	104.10	Mohave	New 4-lane alignment (design, construct, ROW)	$21,805,000
14.12.04	U.S. 93	108.90	113.00	Mohave	Widen to 4 lanes (design, construct, ROW)	$13,602,000
14.12.05	U.S. 93	113.00	116.30	Mohave	Widen to 4 lanes (design, construct, ROW)	$12,903,000
14.12.06	U.S. 93	116.30	119.70	Mohave	New 4-lane alignment (design, construct, ROW)	$23,475,000
14.12.07	U.S. 93	106.00	108.90	Mohave	New 4-lane alignment (design, construct, ROW)	$22,183,000
14.12.08	I-40				Cedar Hills interchange	$16,012,000
14.12.09	U.S. 93	91.20			New U.S. 93/I-40 interchange	$16,591,000
14.12.10	U.S. 93	121.30	125.20	Mohave	Wickieup bypass + new 4-lane alignment	$45,654,000
14.12.11	U.S. 93	92.50	98.20	Mohave	Reconstruct existing segment	$17,045,000
14.12.12	U.S. 93	98.20	101.80	Mohave	Reconstruct existing segment	$12,147,000
14.12.13	U.S. 93	119.70	121.30	Mohave	Reconstruct existing segment	$6,420,000
14.12.14	U.S. 93	104.10	106.00	Mohave	Reconstruct existing segment	$4,358,000
14.12.15	U.S. 93	108.90	113.00	Mohave	Reconstruct existing segment	$11,489,000
14.12.16	U.S. 93	113.00	116.30	Mohave	Reconstruct existing segment	$10,527,000
14.13	**U.S. 93**	**161.71**	**182.90**	**Yavapai**	**Widen to 4 lanes**	**$84,760,000**
14.13.01	U.S. 93	161.71	182.90	Yavapai	Widen to 4 lanes	$84,760,000
14.21	**SR 95**	**163.50**	**172.30**	**Mohave**	**Passing lanes**	**$1,750,000**
14.21.01	SR 95	148.00	153.00	Mohave	New signs on SR 95	$250,000
14.21.02	SR 95	163.50	168.50	Mohave	Passing/climbing lanes	$750,000
14.21.03	SR 95	167.30	172.30	Mohave	Passing/climbing lanes	$750,000
14.22*	**SR 95**	**175.00**	**202.00**	**Mohave**	**Widen to 4 lanes**	**$42,000,000**
14.22.01	SR 95	175.00	177.00	Mohave	Widen to 4 lanes	$6,000,000
14.22.02	SR 95	191.00	202.00	Mohave	Widen to 4 lanes	$36,000,000

* ADOT is currently developing an Access Management Study for this roadway that will update potential projects.

Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.6 Prescott District Projects

Project	Road	BMP	EMP	County	Description	Cost
16.02	**I-17**	**244.00**	**262.65**	**Yavapai**	**Widen to 6 lanes**	**$60,612,500***
16.02.01	I-17	244.00	262.65	Yavapai	Widen, rural ITS other	
16.02.02	I-17	244.44	252.52	Yavapai	New lanes, rockfall containment, other	
16.03	**I-17**	**278.00**	**286.00**	**Yavapai**	**Widen to 8 lanes**	**$80,250,000**
16.03.01	I-17	278.00	286.00	Yavapai	Widen to 8 lanes	$80,250,000
16.04	**I-17**	**286.00**	**298.98**	**Yavapai**	**Widen to 6 lanes**	**$81,930,000**
16.04.01	I-17	286.00	298.98	Yavapai	Widen	$81,930,000
16.21	**SR 69**	**281.00**	**296.00**	**Yavapai**	**Widen to 6 lanes**	**$48,750,000**
16.21.01	SR 69	281.00	296.00	Yavapai	Widen to 6 lanes	$48,750,000
16.41	**SR 89**	**314.02**	**330.18**	**Yavapai**	**Widen to 4 lanes, 5 lanes**	**$44,000,000**
16.41.01	SR 89	314.02	316.07	Yavapai	Widen to 4 lanes	$8,000,000
16.41.02	SR 89	320.04	325.00	Yavapai	Widen to 4 lanes	$18,000,000
16.41.03	SR 89	325.00	330.18	Yavapai	Widen to 5-lane cross-section	$18,000,000
16.42	**SR 89A**	**320.96**	**329.90**	**Yavapai**	**Widen to 4 lanes**	**$29,055,000**
16.43.01	SR 89A	320.96	329.90	Yavapai	Widen to 4 lanes	$29,055,000
16.51	**SR 260**	**208.60**	**228.00**	**Yavapai**	**Widen to 4 lanes**	**$122,199,800**
16.51.01	SR 260	208.60	212.90	Yavapai	Widen to 4 lanes divided	$26,510,600
16.51.02	SR 260	212.90	218.40	Yavapai	Reconstruct roadway	$26,590,700
16.51.03	SR 260	218.40	222.00	Yavapai	Construct 4-lane divided	$9,369,500
16.51.04	SR 260	222.00	228.00	Yavapai	Reconstruct to 4-lane divided highway	$59,729,000
16.52	**SR 260**	**256.00**	**282.00**	**Gila**	**Widen to 4 lanes**	**$15,412,000**
16.52.01	SR 260	256.00	260.00	Gila	Widen from 2 lanes to 4 lanes	$15,412,000
16.53	**SR 260**	**282.00**	**302.00**	**Coconino, Navajo**	**Widen to 4 lanes**	**$104,000,000**
16.53.01	SR 260	282.00	288.00	Coconino	Reconstruct 2 lanes to 4 lanes	$24,000,000
16.53.02	SR 260	288.00	293.00	Coconino, Navajo	Widen	$20,000,000
16.53.03	SR 260	293.00	302.00	Navajo	Reconstruct 4 lanes	$36,000,000
16.53.04	SR 260	295.00	301.00	Navajo	New WB lanes	$24,000,000

*Estimates of individual project elements are not available separately for this bundle.
Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.7 Safford District Projects

Project	Road	BMP	EMP	County	Description	Cost
17.01	**I-10**	**288.78**	**303.00**	**Pima, Cochise**	**Widen to 6 lanes**	**$46,215,000**
17.01.01	I-10	288.78	303.00	Pima, Cochise	Widen to 6 lanes	$46,215,000
17.02	**I-10**	**310.00**	**325.00**	**Cochise**	**Climbing lanes**	**$21,000,000**
17.02.01	I-10	310.00	311.00	Cochise	Climbing lanes (EB)	$3,000,000
17.02.02	I-10	316.00	319.00	Cochise	Climbing lanes (EB)	$9,000,000
17.02.03	I-10	322.00	325.00	Cochise	Climbing lanes (WB)	$9,000,000
17.11	**U.S. 70**	**287.40**	**329.80**	**Graham**	**Shoulders, headwalls**	**$11,264,000**
17.11.01	U.S. 70	287.40	300.10	Graham	Repair and maintain fencing	$914,000
17.11.02	U.S. 70	287.40	300.10	Graham	Repair shoulders to meet design standards	$6,350,000
17.11.03	U.S. 70	300.10	329.80	Graham	Move headwalls back to a safe distance from road	$4,000,000
17.12	**U.S. 70**	**335.30**	**349.50**	**Graham**	**Widen to 4 lanes divided**	**$19,000,000**
17.12.01	U.S. 70	340.00	346.20	Graham	Widen to 5 lanes, new bridge on San Simon River	$12,000,000
17.12.02	U.S. 70	346.20	349.50	Graham	Widen to 4 lanes divided	$7,000,000
17.21	**U.S. 191**	**87.40**	**104.50**	**Graham**	**Shoulders**	**$8,650,000**
17.21.01	U.S. 191	87.40	92.70	Graham	Widen SB shoulder (NB traffic will use new roadway programmed for 2003)	$2,650,000
17.21.02	U.S. 191	92.50	97.80	Graham	Widen shoulders as recommended in U.S. 191 Master Plan Study (1997)	$2,650,000
17.21.03	U.S. 191	97.80	100.70	Graham	Widen SB shoulder (NB traffic will use new roadway programmed for 2003)	$1,450,000
17.21.04	U.S. 191	100.70	104.50	Graham	Widen shoulders to meet design standards	$1,900,000
17.22	**U.S. 191**	**111.00**	**121.00**	**Graham**	**Widen to 5-lane cross section**	**$34,162,000**
17.22.01	U.S. 191	111.00	118.20	Graham	Widen from 2-lane to 5-lane urban section	$24,309,000
17.22.02	U.S. 191	118.20	121.00	Graham	Realign/reconstruct to remove S-curve & provide uniform 5-lane section	$9,853,000
17.23	**U.S. 191**	**130.80**	**144.10**	**Graham**	**Climbing lanes**	**$22,202,000**
17.23.01	U.S. 191	139.00	144.10	Graham	Construct a 1.5 to 2-mile NB climbing lane, to complement climbing lanes	$5,402,000
17.23.02	U.S. 191	335.30	340.10	Graham	Construct bypass to a) U.S. 191 S of Safford or b) E end of SR 366	$16,800,000
17.24	**U.S. 191**	**154.50**	**165.50**	**Greenlee**	**Shoulders**	**$24,500,000**
17.24.01	U.S. 191	154.50	154.50	Greenlee	Raise Cold Creek bridge 12-20 feet and lower intersection 3 feet	$5,000,000
17.24.02	U.S. 95	154.80	157.00	Greenlee	Widen shoulder to meet design standards	$5,500,000
17.24.03	U.S. 191	156.90	162.50	Greenlee	Widen shoulder to meet design standards	$14,000,000

Table 6.7 Safford District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
17.25	**U.S. 191**	**23.46**	**27.00**	**Cochise**	**Roadway reconstruction, widen to 4 lanes**	**$14,160,000**
17.25.01	U.S. 191	23.46	27.00	Cochise	Roadway reconstruction, widen to 4 lanes	$14,160,000
17.26	**U.S. 191**	**45.69**	**65.00**	**Cochise**	**Roadway reconstruction**	**$77,240,000**
17.26.02	U.S. 191	45.69	55.70	Cochise	Roadway reconstruction, drainage improve	$40,040,000
17.26.03	U.S. 191	55.70	65.00	Cochise	Roadway reconstruction, drainage improve, roadway realignment, bridge replacement	$37,200,000
17.31	**SR 80**	**294.66**	**299.78**	**Cochise**	**Widen to 5-lane cross section**	**$37,640,000**
17.31.01	SR 80	294.66	299.78	Cochise	Widen to 5-lane cross section	$16,640,000
17.31.02	SR 80	294.00	0.00	Cochise	Traffic interchange	$10,000,000
17.31.03	B 10	S 80/ B10 TI	I10/ B10 TI	Cochise	Widen to 5 lanes	$5,000,000
17.31.04	SR 80	299.00	302.00	Cochise	Widen to 3-lane cross section	$6,000,000
17.41	**S 90**	**322.53**	**336.40**	**Cochise**	**Widen to 4 lanes, 5-lane cross-section**	**$45,077,500**
17.41.01	S 90	322.53	328.00	Cochise	Widen to 5-lane cross-section	$17,777,500
17.41.02	S 90	328.00	336.40	Cochise	Widen to 4 lanes	$27,300,000
17.51	**SR 92, 90**	**321.21**	**325.22**	**Cochise**	**Widen to 6 lanes divided**	**$14,140,000***
17.51.01	SR 90	320.65	321.52	Cochise	Widen to 6 lanes divided	
17.51.02	SR 92	321.21	325.22	Cochise	Widen to 6 lanes divided	
17.52	**SR 92**	**352.00**	**354.86**	**Cochise**	**Widen to 4 lanes, 5 lanes**	**$6,023,000***
17.52.01	SR 92	351.56	352.47	Cochise	Widen 2 to 5 lanes symmetrically with curb and gutter	
17.52.02	SR 92	352.87	354.57	Cochise	Reconstruct existing 2-lane roadway to 5-lane asymmetrically with curb and gutter	
17.52.03	SR 92	354.57	354.86	Cochise	Widen 2 to 4 lanes asymmetrically with curb, gutter and sidewalk	
17.52.04	SR 92	354.86	0.00	Cochise	Widen to 5 lanes	
17.53	**SR 92, 90**	**321.21**	**321.84**	**Cochise**	**Widen to 6 lanes divided**	**$4,240,000***
17.53.01	SR 90	321.24	321.52	Cochise	Widen to 6 lanes divided	
17.53.02	SR 92	321.21	321.84	Cochise	Widen to 6 lanes divided	
17.61	**SR 266**	**104.60**	**123.80**	**Graham**	**Shoulders**	**$4,795,000**
17.61.01	SR 266	104.60	123.80	Graham	Widen shoulders to meet design standards	$4,795,000
17.71	**SR 366**	**136.70**	**143.20**	**Graham**	**Reconstruct, pave road**	**$15,418,000**
17.71.01	SR 366	136.70	143.20	Graham	Reconstruct as paved roadway with no shoulders & improved drainage	$15,418,000

*Estimates of individual project elements are not available separately for this bundle.
Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.8 Tucson District Projects

Project	Road	BMP	EMP	County	Description	Cost
18.01	**I-10**	**175.80**	**226.00**	**Pinal**	**Widen to 6 lanes**	**$163,150,000**
18.01.01	I-10	175.80	226.00	Pinal	Widen to 6 lanes	$163,150,000
18.02	**I-10**	**240.40**	**252.40**	**Pima**	**Widen to 8 lanes**	**$159,639,908**
18.02.01	I-10	240.40	252.40	Pima	Widen to 8 lanes (roadway, earthwork)	$61,807,378
18.02.02	I-10	240.40	252.40	Pima	Replace roadway and railroad structures, retaining walls	$40,623,140
18.02.03	I-10	240.40	252.40	Pima	Repair/replace drainage	$40,389,724
18.02.04	I-10	240.40	252.40	Pima	Signing, lighting, signals	$3,032,500
18.02.05	I-10	240.40	252.40	Pima	Right-of-way	$3,772,961
18.02.06	I-10	240.40	252.40	Pima	Landscaping	$10,014,205
18.03	**I-10**	**275.49**	**288.78**	**Pima**	**Widen to 6 lanes**	**$36,782,500**
18.03.01	I-10	275.49	279.40	Pima	Widen to 6 lanes	$12,707,500
18.03.02	I-10	281.68	288.78	Pima	Widen to 6 lanes	$23,075,000
18.03.03	I-10	289.20	0.00	Pima	Structure	$1,000,000
18.04	**I-10**	**262.52**	**275.98**	**Pima**	**Widen to 6 lanes**	**$43,745,000**
18.04.01	I-10	262.52	275.98	Pima	Widen to 6 lanes	$43,745,000
18.13	**I-19***	**63.58**	**91.10**	**Pima**	**Widen to 4 lanes, 6 lanes**	**$300,220,000****
18.13.01	I-19*	63.58	75.43	Pima	Widen to 4 lanes & auxiliary lanes in each direction	
18.13.02	I-19*	75.43	91.10	Pima	Reconstruct or widen to 3 lanes & auxiliary lanes in each direction	
18.13.03	I-19*			Pima	Reconstruct 7 TIs (Ajo Way, Irvington, San Xavier, Papago, Sahuarita, Duval Mine, Esperanza)	
18.13.04	I-19*			Pima	2 TI improvements (Continental, Canoa)	
18.13.05	I-19*			Pima	2 New TI s (Drexel, Los Reales)	
18.13.06	I-19*			Pima	Frontage Roads	
18.13.08	I-19*			Pima	Right-of-way acquisition	
18.13.09	I-19*			Pima	Drainage improvements	
18.13.09	I-19*			Pima	Noise walls	
18.22	**SR 77**	**92.00**	**95.22**	**Pinal**	**Climbing and passing lanes**	**$1,286,500**
18.22.01	SR 77	91.28	91.87	Pinal	Passing lanes and shoulder improvement (8')	$471,440
18.22.02	SR 77	94.20	95.22	Pinal	Passing lanes and shoulder improvement (8')	$815,060
18.31	**SR 85**	**32.54**	**80.69**	**Pima**	**Widen roadway to standards**	**$86,670,000**
18.31.01	SR 85	32.54	80.69	Pima	Widen roadway (standards), safety	$86,670,000
18.41	**SR 86**	**52.90**	**113.90**	**Pima**	**Reconstruct roadway to 38-foot cross-section**	**$78,800,000**
18.41.01	SR 86	52.90	92.30	Pima	Reconstruct roadway to 38-foot cross-section	$78,800,000

Table 6.8 Tucson District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
18.42	**SR 86**	**92.30**	**141.40**	**Pima**	**Reconstruct roadway to 40' cross-section**	**$61,900,000**
18.42.03	SR 86	128.50	132.80	Pima	4.3 miles offset widening	$6,600,000
18.42.04	SR 86	124.50	128.50	Pima	4 miles offset widening	$5,800,000
18.42.05	SR 86	120.20	124.50	Pima	4.3 miles Offset widening, widen bridge at MP 122.1	$6,600,000
18.42.06	SR 86	116.10	120.20	Pima	2.65 miles symmetrical widening, 1.45 miles offset widening	$5,600,000
18.42.07	SR 86	109.30	113.10	Pima	1.78 miles new roadway, 2.02 miles symmetrical widening, new drainage structures	$6,700,000
18.42.08	SR 86	106.10	109.30	Pima	2.43 miles new roadway, 0.77 miles symmetrical widening, 1.63 miles detour, new drainages structures	$6,500,000
18.42.09	SR 86	103.10	106.10	Pima	1.63 miles new roadway, 1.37 miles widening, 0.91 miles detour, new drainage structures	$6,000,000
18.42.10	SR 86	100.83	103.10	Pima	0.99 miles new roadway, 1.28 miles symmetrical widening, new drainage structures	$4,800,000
18.42.11	SR 86	98.30	100.14	Pima	1.23 miles new roadway, 0.61 miles symmetrical widening, new drainage structures	$3,700,000
18.42.12	SR 86	94.30	97.90	Pima	0.83 miles new roadway, 2.77 miles symmetrical widening, new drainage structure	$5,600,000
18.42.13	SR 86	92.30	94.30	Pima	0.76 miles new roadway, 0.24 miles symmetrical widening, new drainage structure	$4,000,000
18.43	**SR 86**	**150.10**	**171.90**	**Pima**	**Widen to 6 lanes, 4 lanes**	**$22,700,000**
18.43.01	SR 86	169.90	171.90	Pima	Widen from 4 to 6 lanes	$6,500,000
18.43.02	SR 86	150.10	159.50	Pima	Widen to 4-lane divided	$16,200,000
18.51	**SR 87**	**134.76**	**141.18**	**Pinal**	**Widen to 4 lanes**	**$38,000,000**
18.51.01	SR 87	134.76	141.18	Pinal	Widen to 4 lanes	$28,000,000
18.51.01	SR 87			Pinal	New TI	$10,000,000
18.61	**SR 287**	**134.75**	**142.76**	**Pinal**	**Widen to 4 lanes, replace railroad bridge**	**$56,000,000**
18.61.01	SR 287	134.75	142.76	Pinal	Widen to 4 lanes, replace railroad bridge	$36,000,000
18.61.01	SR 287			Pinal	2 new TIs	$20,000,000

* Listed projects are in kilometer posts, not mileposts. I-19 is the only U.S. Interstate marked in kilometer posts.

**Estimates of individual project elements are not available separately for this bundle.

Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

Table 6.9 Yuma District Projects

Project	Road	BMP	EMP	County	Description	Cost
19.01	**I-8**	**2.23**	**12.21**	**Yuma**	**Widen to 6 lanes**	**$55,020,000**
19.01.01	I-8	2.23	12.21	Yuma	Widen	$39,920,000
19.01.02	I-8	9.40	0.00	Yuma	Interchange reconstruction	$15,000,000
19.01.03	I-8	7.63	0.00	Yuma	Interchange improvements	$10,000
19.01.04	I-8	7.67	0.00	Yuma	Bridge reconstruction	$45,000
19.01.05	I-8	7.67	0.00	Yuma	Bridge reconstruction	$45,000
19.02	**I-8**	**17.00**	**20.40**	**Yuma**	**Shoulders/geometry/sight distance**	**$1,950,000**
19.02.01	I-8	17.00	20.40	Yuma	Shoulders/geometry/sight distance	$1,700,000
19.02.02	I-8	18.88	0.00	Yuma	Truck warning system	$250,000
19.21	**U.S. 95**	**26.00**	**31.80**	**Yuma**	**Widen to 6 lanes**	**$18,850,000**
19.21.01	U.S. 95	26.00	31.80	Yuma	Widen to 6 lanes	$18,850,000
19.22	**U.S. 95**	**26.00**	**31.80**	**Yuma**	**Add 2-way left-turn lane**	**$1,500,000**
19.22.01	U.S. 95	26.00	31.80	Yuma	Add 2-way left-turn lane	$1,500,000
19.23	**U.S. 95**	**31.80**	**70.00**	**Yuma, La Paz**	**Widen to 4 lanes**	**$116,600,000**
19.23.02	U.S. 95	31.80	47.00	Yuma	Widen to 4 lanes	$45,600,000
19.23.03	U.S. 95	47.00	70.00	Yuma	Widen to 4 lanes	$69,000,000
19.23.04	U.S. 95	38.00	0.00	Yuma	Replace bridge	$2,000,000
19.24	**U.S. 95**	**44.50**	**99.00**	**Yuma, La Paz**	**Passing/climbing lanes**	**$9,000,000**
19.24.01	U.S. 95	44.50	49.50	Yuma	Passing/climbing lanes (2 miles)	$1,500,000
19.24.03	U.S. 95	67.50	72.50	La Paz	Passing/climbing lanes (2 miles)	$1,500,000
19.24.05	U.S. 95	77.00	82.00	La Paz	Passing/climbing lanes (2 miles)	$1,500,000
19.24.07	U.S. 95	82.00	87.00	La Paz	Passing/climbing lanes (2 miles)	$1,500,000
19.24.09	U.S. 95	89.00	94.00	La Paz, Yuma	Passing/climbing lanes (2 miles)	$1,500,000
19.24.11	U.S. 95	94.00	99.00	La Paz	Passing/climbing lanes (2 miles)	$1,500,000
19.31	**SR 72**	**13.00**	**49.90**	**La Paz**	**Shoulders, horizontal and vertical curves**	**$59,240,000**
19.31.01	SR 72	13.11	49.91	La Paz	Construct shoulders	$18,400,000
19.31.02	SR 72	49.90	0.00	La Paz	Intersection improvement	$400,000
19.31.03	SR 72	19.00	32.50	La Paz	Improve vertical curves	$10,125,000
19.31.04	SR 72	19.00	32.50	La Paz	Improve horizontal curves	$10,125,000
19.31.05	SR 72	36.00	47.00	La Paz	Improve vertical curves	$8,250,000
19.31.06	SR 72	36.00	47.00	La Paz	Improve horizontal curves	$8,250,000
19.31.07	SR 72	13.00	49.90	La Paz	Bike lane/shoulder	$3,690,000
19.51	**SR 95**	**131.00**	**147.70**	**La Paz**	**Widen to 6 lanes, passing lanes**	**$6,575,000**
19.51.01	SR 95	143.10	144.20	La Paz	Widen to 6 lanes	$3,575,000
19.51.02	SR 95-134 NB	131.00	142.00	La Paz	Passing/climbing lanes	$2,250,000
19.51.03	SR 95-134 SB	133.00	138.00	La Paz	Passing/climbing lanes	$750,000

Table 6.9 Yuma District Projects (continued)

Project	Road	BMP	EMP	County	Description	Cost
19.52	**SR 95**	**147.70**	**161.71**	**La Paz**	**Add center turn lane**	**$31,650,000**
19.52.01	SR 95	147.70	161.71	La Paz	Add center turn lane	$31,400,000
19.52.02	SR 95	148.00	153.00	La Paz	New signs on SR 95	$250,000
19.53	**SR 95**	**110.00**	**131.00**	**La Paz**	**Widen roadway to 40' cross section**	**$10,500,000**
19.53.01	SR 95	N/A	N/A	La Paz	Drainage	
19.53.02	SR 95	110.00	131.00	La Paz	Widen roadway to 40' cross section	$10,500,000
19.61	**SR 195**				**Controlled access facility, 3 interchanges**	**$30,000,000**
19.61.01	SR 195				Avenue E TI	$10,000,000
19.61.02	SR 195				Avenue B TI	$10,000,000
19.61.03	SR 195				County 14th Street TI	$10,000,000

Source: ADOT and Vision 21, reviewed by ADOT District Engineers.

7.0 Performance Analysis Results

7.0 Performance Analysis Results

This section shows the results of the performance analysis process. Because MoveAZ did not include an analysis of projects in Maricopa County, the results are presented separately for the rest of the State and Maricopa County. Maricopa County projects were analyzed as part of the Maricopa Association of Governments (MAG) regional transportation plan and are, therefore, not presented with the full set of results.

7.1 MoveAZ Performance Analysis in the Rest of the State

MoveAZ project bundles were evaluated on the seven performance factors described in Chapter 4. Projects were evaluated separately for Pima County and the 13 Other Counties to be consistent with the separate funding streams identified for each region. The results of each of these analyses are organized here by the three funding scenarios described above. Projects from the MAG RTP are shown in the next section.

Constrained Revenue Scenario

The constrained revenue scenario presents projects that performed the best in the analysis process. Table 7.1 presents the projects in this scenario for the two regions. These projects were analyzed using MoveAZ performance measures and factors. The locations of the constrained scenario projects are shown in Figure 7.1.

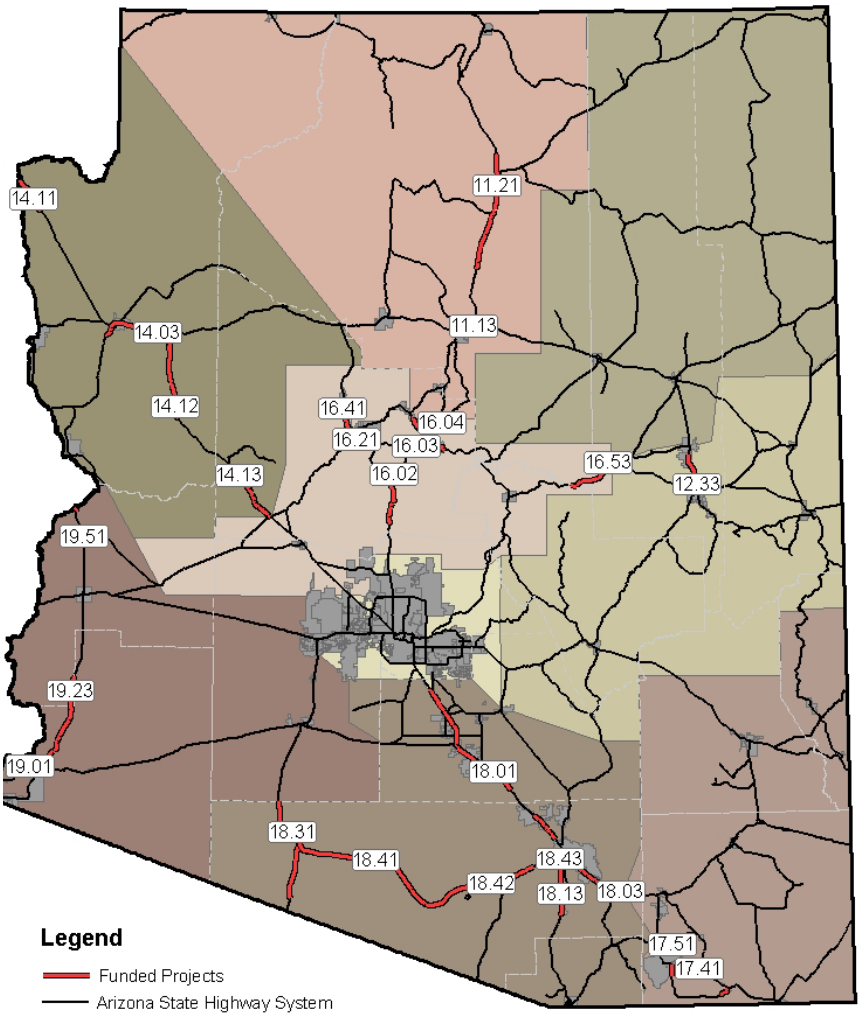
Table 7.1 MoveAZ Plan Projects – Constrained Scenario

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars (in Millions)
Projects in the 13 Other Counties													
16.21	SR 69	281	296	Widen to 6 lanes	9.3	8.1	8.0	0.0	9.6	5.0	0.0	47	49
14.02	I-40	44	45	Widen to 6 lanes, reconstruct or improve 3 interchanges, noise barriers	9.7	9.6	8.6	0.0	1.0	0.0	4.9	42	142
14.11	U.S. 93	2	17	Widen to 4 lanes	5.9	0.0	6.1	0.0	4.0	9.9	4.5	36	47
17.51	SR 92, SR 90	321	325	Widen to 6 lanes, raised median	7.7	1.9	9.6	0.0	8.1	1.4	0.4	36	14
14.12	U.S. 93	92	121	Reconstruct as a 4-lane divided roadway, new interchanges	2.8	0.0	7.1	2.8	0.0	6.8	9.8	36	250
19.23	U.S. 95	31	70	Widen to 4 lanes, replace bridge	3.7	0.0	7.8	0.0	0.0	7.7	8.9	35	117
14.13	U.S. 93	161	182	Reconstruct as a 4-lane divided roadway	5.1	0.0	6.7	0.0	0.0	7.9	6.9	33	85
14.03	I-40	55	71	Widen to 6 lanes, reconstruct two interchanges	7.8	6.3	0.0	10.0	0.0	0.0	1.9	32	107
16.51	SR 260	208	228	Widen to 4 lanes, raised median (14 miles), reconstruct (6 miles)	7.3	0.0	7.4	0.0	0.0	4.2	5.2	31	122
16.41	SR 89	314	330	Widen to 4 lanes, some segments with turn lanes	6.0	0.0	8.7	0.0	1.9	3.6	4.0	31	44
17.52	SR 92	352	354	Widen to 4 lanes, some segments with turn lanes	6.6	0.0	9.9	0.0	7.2	0.0	0.2	30	6
11.13	I-40	195	205	Reconstruct roadway, widen some segments to 6 lane, noise barriers	7.5	4.4	1.7	9.4	1.0	0.0	0.0	30	41
16.04	I-17	286	298	Widen to 6 lanes	9.3	8.5	4.7	0.0	0.0	0.0	0.0	28	82
18.01	I-10	175	226	Widen to 6 lanes	9.7	9.3	3.5	0.0	0.0	0.0	0.0	28	163
16.03	I-17	278	286	Widen to 8 lanes	9.0	7.8	4.1	0.0	0.0	0.0	0.0	26	80
17.41	SR 90	322	336	Widen to 4 lanes, some segments with turn lanes	5.8	0.0	2.3	0.0	0.0	9.0	4.6	26	45

Table 7.1 MoveAZ Plan Projects – Constrained Scenario (continued)

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars (in Millions)
Projects in the 13 Other Counties (continued)													
12.33	SR 77	342	358	Widen to 4 lanes, implement Rural ITS system	1.6	0.0	7.0	0.0	1.7	7.4	3.8	26	51
19.51	SR 95	131	147	Construct passing lane segments, widen a one-mile segment to 6 lanes	2.8	0.0	7.6	0.0	0.4	5.6	3.9	25	7
16.53	SR 260	282	302	Reconstruct roadway, widen a 5-mile segment to 4 lanes	1.2	0.0	3.9	1.1	0.0	6.3	8.6	25	104
16.02	I-17	244	262	Widen to 6 lanes, implement ITS system	8.6	6.7	0.0	0.0	0.0	0.0	2.7	22	61
11.21	U.S. 89	442	482	Widen to 4 lanes, raised median, 3 new interchanges, some segments with turn lanes	1.2	0.0	4.5	0.0	0.0	5.3	6.7	21	130
19.01	I-8	2	12	Widen to 6 lanes, reconstruct interchanges and bridges	8.0	5.6	2.9	0.0	0.0	0.0	0.0	21	55
Projects in Pima County													
18.02	I-10	240	252	Widen to 8 lanes, construct 3 new interchanges	10.0	10.0	2.9	0.0	9.4	0.0	0.0	38	159
18.04	I-10	262	275	Widen to 6 lanes	9.0	8.9	1.5	0.0	0.0	0.0	0.0	24	43
18.43	SR 86	150	171	Widen to 4 lanes (10 miles) and 6 lanes (11 miles)	6.0	3.7	0.9	0.0	5.7	2.2	0.1	21	22
18.13	I-19	63	91	Widen to 6 lanes (16 miles) and add auxiliary lanes (12 miles)	8.6	7.4	0.0	0.0	0.0	0.0	0.0	19	300
18.03	I-10	275	288	Widen to 6 lanes, reconstruct bridge	8.3	7.0	0.0	0.0	0.0	0.0	0.0	19	36
17.01	I-10	288	303	Widen to 6 lanes	8.4	5.2	0.0	0.0	0.0	0.0	0.7	18	23
18.42	SR 86	92	141	Reconstruct roadway to standards	0.0	0.0	0.0	4.4	0.0	0.0	9.3	16	61
18.41	SR 86	52	92	Reconstruct roadway to standards	0.0	0.0	0.0	3.3	0.0	0.0	8.8	15	122
18.31	SR 85	32	80	Reconstruct roadway to standards	0.0	0.0	0.0	0.0	0.0	0.0	9.9	12	86

Figure 7.1 Map of Constrained Scenario Projects



Additionally Expected Revenues

The second scenario examines the additional projects that might be built if ADOT were to identify new state or Federal funding sources. This scenario was estimated at roughly $2 billion in additional funding. This funding was split between major projects and sub-programs, as described in Section 2.3. Table 7.2 shows the additional funding that would be available to each region in this scenario.

The additional projects funded in this scenario are shown in Table 7.3. The locations of the constrained scenario projects are shown in Figure 7.2.

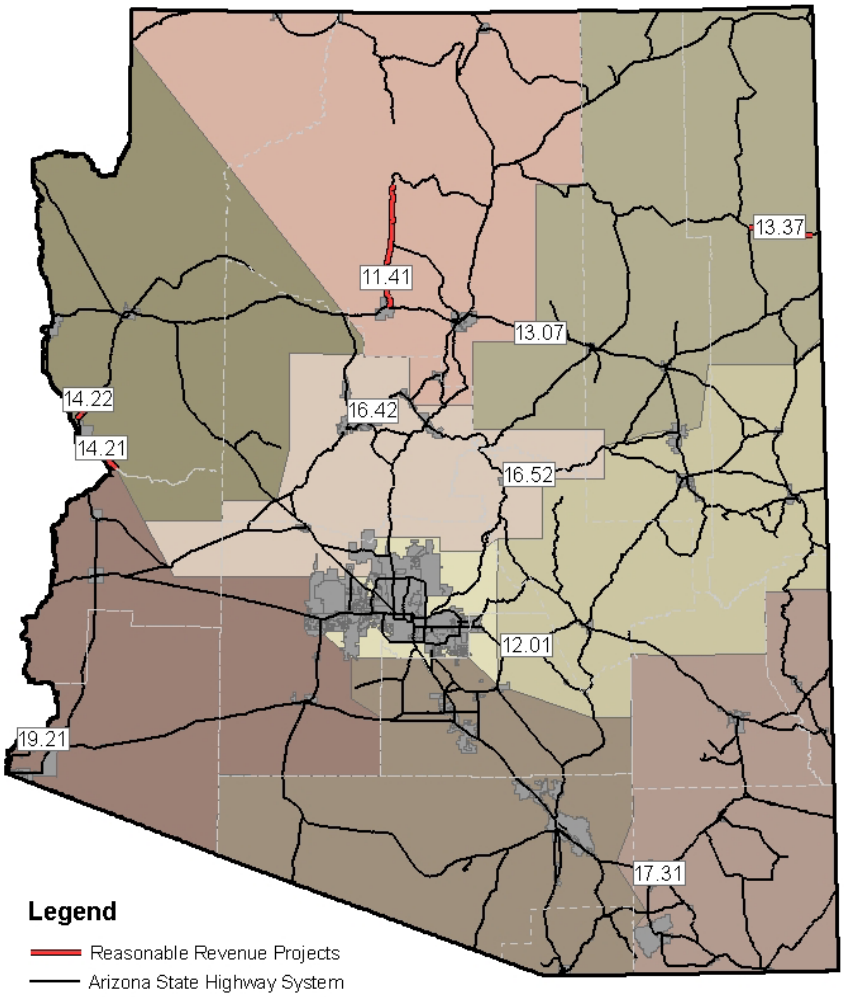
Table 7.2 Total Funding for Major Projects and Sub-Programs by Region, 2010 to 2025 (Additional Revenue Scenario)

County	Funding for Major Projects ($M)	Funding for Sub-Programs ($M)	Total ($M)
Maricopa	626	108	734
Pima	192	65	258
The 13 Other Counties	387	605	992

Table 7.3 MoveAZ Plan Projects – Additional Revenue Scenario

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars in Millions)
Projects in the 13 Other Counties													
16.42	SR 89A	320	329	Widen to 4 lanes	3.7	0.0	6.3	0.0	0.0	0.0	5.1	20	29
13.07	I-40	230	233	Reconstruct, widen to 6 lanes, reconstruct 3 interchanges	3.7	2.2	0.0	8.9	0.0	0.0	1.3	20	52
13.37	SR 264	446	473	Widen to 4 lanes, raised median, some segments with turn lanes, replace bridge, construct bus turnout	2.3	0.0	0.0	0.0	0.0	4.0	10.0	19	52
16.52	SR 260	256	282	Widen to 4 lanes	1.0	0.0	0.0	0.0	0.0	6.8	8.2	18	15
17.01	I-10	288	303	Widen to 6 lanes	8.4	5.2	0.0	0.0	0.0	0.0	0.7	18	23
12.01	U.S. 60	212	226	Widen to 5 lanes (2 miles), construct new bypass (2 miles), construct 2 interchanges	3.1	0.0	0.0	0.0	0.0	8.7	3.6	17	51
17.31	SR 80	294	299	Add turning lanes, widen some segment s to 4 lanes, reconstruct SR 80/I-10 interchange	5.1	0.0	0.0	0.0	0.0	7.6	1.8	17	38
14.22	SR 95	175	202	Widen to 4 lanes at selected locations (14 miles total)	1.8	0.0	2.0	0.0	0.0	5.1	5.0	16	42
19.21	U.S. 95	26	31	Widen to 6 lanes	2.5	0.0	6.2	0.0	0.0	1.0	2.6	16	19
11.41	SR 64	185	235	Add paved shoulders, widen some segments to 4 lanes (5 miles) and add turn lanes (1 mile), construct several passing lanes	2.7	0.0	0.0	0.0	0.0	2.9	7.0	15	47
14.21	SR 95	163	172	Construct passing/climbing lanes, new signage	1.2	0.0	0.0	0.0	0.0	6.0	5.6	14	2

Figure 7.2 Map of Additional Revenue Projects



Unconstrained Scenario

The MoveAZ performance analysis process is based on an assessment of a large number of projects intended to address transportation needs across the State. Because funding is limited, not all of these projects can realistically be constructed in the timeframe of a long-range plan. The unconstrained scenario is designed to identify projects that did not perform, as well as other major projects, but was identified through previous needs assessments conducted by ADOT. Table 7.4 presents the projects in the unconstrained scenario.

Table 7.4 MoveAZ Plan Projects (Unconstrained)

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars in Millions)
Projects in the 13 Other Counties													
19.31	SR 72	13	49	Add paved shoulders, improve vertical/ horizontal curves on some segments	0.0	0.0	1.4	0.0	0.0	0.0	10.0	14	59
13.35	SR 264	411	439	Construct climbing lane segments, add passing lanes (1 mile), improve intersection, construct bus turnout	0.4	0.0	0.0	0.0	0.0	0.9	10.0	13	27
11.02	I-17	333	340	Widen to 6 lanes, reconstruct interchange	4.8	4.1	1.8	0.0	0.0	0.0	0.0	13	35
11.24	U.S. 89A	579	613	Construct passing lane segments, widen some segments to 4 lanes (3 miles), construct bus turnout	0.0	0.0	0.0	0.0	0.0	1.2	10.0	13	14
17.22	U.S. 191	111	121	Widen to 5 lanes	1.4	0.0	2.7	2.2	0.0	1.8	2.4	13	34
18.51	SR 87	134	141	Widen to 4 lanes, reconstruct interchange	1.0	0.0	0.0	0.0	2.6	1.6	6.0	13	38
13.24	U.S. 191	420	446	Reconstruct roadway, add shoulders (14 miles), and widen some segments to 4 lanes (5.5 miles)	0.2	0.0	1.5	0.0	0.0	0.5	8.1	13	62
13.41	SR 77	362	387	Construct climbing lanes, rehabilitate 4 bridges	0.5	0.0	0.0	0.0	0.0	4.3	6.2	12	14
19.53	SR 95	110	131	Reconstruct roadway to standards	0.0	0.0	1.4	0.0	0.0	0.0	8.3	12	11
13.03	I-40	282	289	Widen some segments to 6 lanes, construct noise barriers	4.9	3.0	0.0	0.0	1.0	0.0	0.8	12	19
19.61	SR 195			Construct 3 interchanges to make SR 195 a controlled access facility	3.2	0.0	3.9	0.0	0.0	0.0	1.5	12	30
13.36	SR 264	441	446	Widen to 4 lanes, raised median (3 miles), turn lanes (3 miles), construct bus turnout	1.3	0.0	0.0	0.0	0.0	2.1	6.7	12	16
13.25	U.S. 191	446	510	Add paved shoulders, widen some segments to 4 lanes (14 miles) with turn lanes in several locations (2 miles)	0.5	0.0	0.0	0.0	0.0	0.0	9.4	12	94
12.04	U.S. 60	336	402	Add paved shoulders, widen some segments to 4 lanes, with some turning lanes	0.4	0.0	0.0	0.0	0.0	0.7	8.7	12	49

Table 7.4 MoveAZ Plan Projects (Unconstrained) (continued)

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars in Millions)
Projects in the 13 Other Counties (continued)													
14.04	I-40	71	89	Reconstruct roadway (8 miles), add climbing lanes on some segments	5.8	3.3	0.0	0.0	0.0	0.0	0.0	11	34
12.31	SR 77	153	171	Improve shoulders and construct climbing lane segments	0.0	0.0	0.0	0.0	0.0	2.2	7.6	11	11
13.32	SR 264	340	388	Add paved shoulders, construct climbing lanes (6 miles), turn lanes (2 miles), improve curves at 14 locations, and 4 intersections	0.0	0.0	0.0	0.0	0.0	0.0	9.5	11	51
11.01	I-17	298	322	Construct climbing lanes on some segments, reconstruct interchanges and bridges	3.8	5.9	0.0	0.0	0.0	0.0	0.0	11	110
12.43	SR 260	331	338	Widen to 5-lane cross-section	0.9	0.0	1.1	0.0	0.0	4.7	3.1	11	12
13.34	SR 264	386	411	Add paved shoulders, construct climbing lane segments, widen some segments to 4 lanes (5 miles), add turning lanes (6.5 miles), construct bus turnout	0.2	0.0	0.0	0.0	0.0	0.4	8.7	11	32
11.23	U.S. 89	531	556	Improve shoulders, construct passing lane segments (2 miles) and 4 lane segments (2 miles)	0.9	0.0	0.1	0.0	0.0	2.6	5.8	11	18
14.05	I-40	91	120	Reconstruct roadway, widen some segments to 6 lanes (18 miles), reconstruct two interchanges	4.7	2.6	0.0	0.0	0.0	0.0	1.4	11	111
17.23	U.S. 191	130	144	Construct climbing lane segments, construct bypass (5 miles)	2.2	0.0	0.0	0.0	0.0	3.1	3.7	11	22
13.04	I-40	292	311	Reconstruct roadway	0.0	0.0	0.0	8.3	0.0	0.0	0.0	10	75
17.12	U.S. 70	335	349	Widen to 4 lanes, raised median, some segments with turn lanes	2.5	0.0	0.0	0.0	0.0	2.8	2.9	10	19
13.21	U.S. 191	344	365	Reconstruct roadway, add passing lane	0.0	0.0	0.0	1.7	0.0	0.0	6.5	10	52
11.32	U.S. 160	321	323	Widen to 5 lanes, add paved shoulders (1 mile)	1.0	0.0	0.0	0.0	0.0	1.1	6.1	10	27
12.61	SR 79	132	150	Widen to 4 lanes	0.5	0.4	0.4	0.0	0.0	2.3	4.8	10	60

Table 7.4 MoveAZ Plan Projects (Unconstrained) (continued)

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars in Millions)
Projects in the 13 Other Counties (continued)													
12.11	U.S. 70	253	287	Add shoulders, widen some segments to 4 lanes with occasional turning lanes, lengthen passing lane (0.5 miles)	0.0	0.0	2.5	0.0	0.0	0.9	4.2	9	66
11.51	SR 264	322	340	Add paved shoulders, widen some segments to 5 lanes (1 mile), construct climbing lane segments and bus turnout	0.0	0.0	0.0	0.0	0.0	0.0	7.8	9	18
13.05	I-40	311	339	Reconstruct roadway and one interchange	0.0	0.0	0.0	7.8	0.0	0.0	0.0	9	127
13.23	U.S. 191	379	412	Reconstruct roadway, add passing lane (1 mile)	0.1	0.0	0.0	0.0	0.0	0.0	7.1	9	133
13.06	I-40	339	360	Reconstruct roadway, reconstruct 2 interchanges	0.0	0.0	0.0	7.2	0.0	0.0	0.0	9	113
18.22	SR 77	92	95	Construct climbing/passing lanes at selected locations	1.4	0.0	0.0	0.0	0.0	6.6	0.0	9	1
11.31	U.S. 160	336	343	Construct passing and climbing lanes	0.7	0.0	0.0	0.0	0.0	1.0	5.5	8	2
17.24	U.S. 191	154	165	Widen shoulders, raise bridge	0.0	0.0	3.3	0.0	0.0	0.0	3.2	8	25
17.25	U.S. 191	23	27	Reconstruct roadway, widen to 4 lanes	0.0	0.0	0.0	5.6	0.0	0.1	1.1	8	14
11.11	I-40	155	165	Reconstruct segments (2 miles)	0.0	0.0	0.0	6.7	0.0	0.0	0.0	8	14
17.61	SR 266	104	123	Widen shoulders	0.0	0.0	0.0	0.0	0.0	0.0	6.4	8	5
12.21	SR 73	310	335	Widen shoulders	0.0	0.0	0.0	0.0	0.0	0.0	6.3	8	13
14.01	I-40	37	44	Reconstruct and widen to 6 lanes, reconstruct two interchanges	0.0	1.5	0.0	5.0	0.0	0.0	0.0	7	63
14.06	I-40	123	144	Reconstruct roadway	0.0	0.0	0.0	6.1	0.0	0.0	0.0	7	86
13.11	U.S. 160	361	384	Add passing lanes at selected locations	0.3	0.0	0.0	0.0	0.0	1.5	4.3	7	7
18.61	SR 287	134	142	Widen to 4 lanes, construct 2 new interchanges	0.3	0.0	0.0	0.0	0.0	2.4	3.3	7	56
12.06	U.S. 60	252	337	Construct selected passing and climbing lane segments	0.0	0.0	0.0	0.0	0.0	3.0	3.0	7	28
11.22	U.S. 89	498	504	Construct passing lanes	0.8	0.0	0.0	0.0	0.0	2.6	2.1	6	2

Table 7.4 MoveAZ Plan Projects (Unconstrained) (continued)

Project	Road	BMP	EMP	Description	Mobility	Reliability	Safety	Preservation	Resource Conservation	Connectivity	Accessibility	Weighted Score	Cost (Dollars in Millions)
Projects in the 13 Other Counties (continued)													
13.22	U.S. 191	370	379	Reconstruct roadway	0.0	0.0	0.0	0.6	0.0	0.0	3.5	5	24
17.26	U.S. 191	45	65	Reconstruct roadway	0.0	0.0	0.0	3.9	0.0	0.0	0.0	5	77
12.03	U.S. 60	260	273	Construct selected passing and climbing lane segments	0.0	0.0	0.0	0.0	0.0	1.6	1.2	3	2
12.51	SR 277	331	336	Widen to 5 lanes	0.0	0.0	0.0	0.0	0.0	0.0	2.3	3	26
11.16	I-40	226	233	Reconstruct roadway, add some climbing lane segments, reconstruct traffic interchange	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2	25
17.02	I-10	310	325	Construct selected climbing lane segments	1.6	0.0	0.0	0.0	0.0	0.0	0.0	2	21
17.11	U.S. 70	287	329	Repair shoulder segments, move headwalls	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2	11
19.02	I-8	17	20	Add paved shoulders	0.0	0.0	1.4	0.0	0.0	0.0	0.0	2	2
19.52	SR 95	147	161	Add turn lane, new signage	0.0	0.0	1.4	0.0	0.0	0.0	0.0	2	32
12.42	SR 260	317	335	Construct selected passing/climbing lane segments, add paved shoulders	0.0	0.0	0.0	0.0	0.0	0.3	1.0	1	3
17.21	U.S. 191	87	104	Widen shoulders	0.0	0.0	0.5	0.0	0.0	0.0	0.0	1	9
11.12	I-40	167	196	Construct climbing lane (1 mile), reconstruct 4 interchanges, widen 2 bridges, construct noise barriers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	84
17.71	SR 366	136	143	Reconstruct as a paved roadway	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	15

7.2 Maricopa County

In Maricopa County, the Maricopa Association of Governments (MAG) Regional Transportation Plan (RTP) was adopted by the State Transportation Board as the state plan for this area. As described previously, 37 percent of total state and Federal funding programmed by ADOT will be available to the MAG region. Table 7.5 identifies the projects that would be funded from both ADOT and local sources.

Table 7.5 MoveAZ Plan Projects – Constrained Scenario

Project	Road	BMP	EMP	Description	Score	Cost ($M)
Projects in Maricopa County						
15.01	I-10	113	125	Widen to 6 lanes, new interchange	–	$115
15.02	I-10	125	134	Widen to 8 lanes with HOV, 2 new interchanges	–	$178
15.03	I-10	134	143	Widen to 10 lanes	–	$79
15.04	I-10	147	156	Collector/distributor roadway system	–	$500
15.05	I-10	156	168	Widen to 8 lanes, extend HOV, new interchange	–	$113
15.03	I-10R			Construct new 2 and 6-lane road (I-10 Reliever)	–	$805
15.11	I-17	194	201	Add HOV lanes in each direction	–	$77
15.12	I-17	202	209	Widen to 12 lanes (some 14 lane segments)	–	$1,000
15.13	I-17	209	224	Widen to 10 lanes, extend HOV, new interchanges		$268
15.14	I-17	224	229	Widen to 8 lanes with HOV		$72
15.15	I-17	229	232	Widen to 6 lanes		$26
15.21	SR 101	2	23	Widen to 10 lanes with HOV, 2 new interchanges	–	$334
15.22	SR 101	23	51	Widen to 10 lanes with HOV, new interchange		$387
15.23	SR 101	51	61	Widen to 10 lanes with HOV		$104
15.31	SR 202	0	21	Widen to 10 lanes with HOV, some segments Eastbound lanes only	–	$258
15.32	SR 202	54	76	Construct new 6 lane freeway	–	$1,067
15.41	SR 303	0	36	Construct new 6 lane freeway	–	$1,420
15.51	SR 51	10	16	Widen to 10 lanes	–	$51
15.61	SR 85	117	154	Widen to 4 lane divided highway	–	$90
15.71	U.S. 60	139	163	Widen to 6 lanes with grade separation	–	$250
15.72	U.S. 60	171	194	Widen to 8, 10, and 12 lanes, extend HOV	–	$147
15.81	WG FWY			Construct 6 lane Williams Gateway freeway	–	$325

MOVE AZ Long Range Transportation Plan

Appendix G. Goods Movement in Arizona

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

MoveAZ Plan

Appendix G. Goods Movement in Arizona

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, California 94607

August 2004

Table of Contents

1.0 Introduction 1-1

2.0 Goods Movement and the Domestic Economy 2-1
2.1 Relationship of Goods Movement with State Economy 2-1
2.2 Production of Goods for Domestic Market 2-2
2.2.1 Transportation Expenditure by Industry 2-3
2.2.2 Goods Movement within the Electronic Industry 2-6
2.2.3 Goods Movement in Other High-Value Industries 2-6
2.2.4 High-Tonnage Commodities 2-7
2.2.5 Summary of Goods Produced for Domestic Market 2-13
2.3 Consumption of Goods from Domestic Market 2-13
2.3.1 Inbound Electronics Goods Movement 2-13
2.3.2 Inbound Goods Movement of Coal 2-14
2.3.3 Inbound Goods Movement of Farm Products 2-15
2.3.4 Inbound Goods Movement of Food Products 2-15
2.3.5 Inbound Goods Movement of Chemicals Products 2-17
2.3.6 Inbound Goods Movement of Secondary Flows 2-18
2.3.7 Value of Inbound Goods 2-18
2.4 Directionality of Goods Movement 2-19
2.5 Goods Movement at the Metropolitan Level 2-20
2.6 Through Trips 2-23
2.7 Forecast of Goods Movement 2-25
2.7.1 Forecast by Trip Type 2-25
2.7.2 Forecast by Commodity Type 2-26

3.0 Goods Movement and the International Economy 3-1
3.1 Exports 3-1
3.1.1 Goods Movement at the Arizona-Mexico Border 3-3
3.2 Imports 3-5
3.3 Highway Flows at the Arizona-Mexico Border 3-7
3.3.1 Arizona-Mexico Border Crossing Points 3-7
3.3.2 Economic Activity from Maquiladoras 3-7
3.3.3 Through Trips from International Goods Movement 3-9

4.0 Logistics Trends 4-1
4.1 National Trends 4-1
4.1.1 Shift toward Customer-Based Requirements 4-1
4.1.2 Declining Logistics Costs Relative to GDP 4-2
4.1.3 Inventory Reductions and JIT 4-3
4.1.4 Cycle Time Reduction 4-4

Table of Contents
(continued)

4.1.5 Outsourcing of Logistics Services 4-5
4.1.6 Globalization 4-5
4.1.7 Postponement 4-5
4.2 Arizona Business Trends 4-6
4.3 Goods Movement to Support Arizona's Growing Population 4-7
4.4 Supply Chain Description for Construction and Food 4-8
4.4.1 Construction 4-8
4.4.2 Food 4-11

5.0 Freight Infrastructure and Traffic Flows 5-1
5.1 Highway Infrastructure and Flows 5-1
5.1.1 Highway International Ports of Entry 5-6
5.2 Railroad/Intermodal Infrastructure 5-6
5.2.1 Rail Infrastructure Between Arizona and Mexico 5-12
5.2.2 Intermodal Facilities 5-12
5.3 Air Infrastructure 5-14
5.4 Metropolitan Freight Infrastructure 5-16
5.5 Key Freight Indicators 5-17

6.0 Institutional Environment for Goods Movement 6-1
6.1 Truck Size and Weight Restrictions 6-1
6.2 Truck Routes 6-3
6.3 Truck Hours of Service 6-4
6.4 Border Crossing Regulations 6-5
6.4.1 Trade Act of 2002 6-5
6.4.2 Customs-Trade Partnership Against Terrorism 6-8
6.4.3 Free and Secure Trade Implementation on U.S.-Mexico Border 6-9
6.4.4 Bioterrrorism Act of 2002 6-9
6.5 Air Quality 6-10
6.5.1 Federal Regulations 6-10
6.5.2 Emissions in Arizona 6-11

7.0 Critical Freight Transportation Findings 7-1

List of Tables

2.1 Economic Output and Employment by Sector for Arizona in 1997 2-2

2.2 Value of Shipments by Commodity and Tonnage for Arizona in 1997 2-3

2.3 Value Spent on Transportation by Commodity Originating in Arizona in 1997 (in Million Dollars) 2-4

2.4 Mode Split for Electronic Goods Shipped in Arizona in 1997 2-6

2.5 Mode Split for Top 10 Commodities by Value Originating in Arizona in 1997 2-7

2.6 Tonnage by Value of Goods Movements for Top 10 Commodities Originating in Arizona in 1997 2-8

2.7 High-Tonnage Commodities Produced in Arizona in 1998 2-9

2.8 Destination of Primary Metal Products Produced in Arizona in 1998 2-10

2.9 Destination States for Farm Products Originating in Arizona in 1998 2-11

2.10 Destination States for Food Products Originating in Arizona in 1998 2-11

2.11 Outbound Destination States for Secondary Flows Originating in Arizona in 1998 2-12

2.12 Inbound Electrical Machinery Shipments into Arizona by State in 1998 2-14

2.13 Inbound Shipments into Arizona for the Top 10 Commodities in 1998 2-15

2.14 Inbound Shipments to Arizona of Farm Products by Other States in 1998 2-16

2.15 Inbound Shipments of Food Products to Arizona by Other States in 1998 2-17

2.16 Inbound Shipments of Chemicals to Arizona by Other States in 1998 2-18

2.17 Inbound Shipments of Secondary Flows to Arizona by Other States in 1998 2-19

2.18 Value of Arizona's Inbound Shipments by State of Origin in 1997 2-19

List of Tables
(continued)

2.19 Tons Shipped Into and Out of Arizona in 1998 2-20

2.20 Truck Movements in the Maricopa County by Type of Carrier in 2001 2-22

2.21 Rail Movements in Maricopa County by Type in 2001 2-22

2.22 Estimated Tons Shipped by Trip Type in 1998 2-24

2.23 Estimated Ton-Miles by Trip Type in 1998 2-24

2.24 Forecast of Tons Shipped by Trip Type in 1998 and 2020 2-25

2.25 Forecast by Mode and Trip Type by Annual Tons in 2020 2-26

2.26 Forecast Growth Rates Between 1998 and 2020 by Mode and Trip Type 2-26

2.27 Forecast of Tons by Commodity for Internal Trips in 1998 and 2020 2-27

2.28 Forecast of Tons by Commodity for Outbound Trips in 1998 and 2020 2-28

2.29 Forecast of Tons by Commodity for Inbound Trips in 1998 and 2020 2-29

3.1 Destinations for Arizona's Exports in 2002 3-1

3.2 Arizona Exports by Commodity in 2002 3-2

3.3 U.S.-Mexico Surface Exports Through Arizona, 2002 3-3

3.4 Commodity Distribution by Highway of Export Tons Originating in Arizona, 1998 and 2020 3-4

3.5 U.S.-Mexico Surface Imports Through Arizona, 2002 3-6

3.6 Commodity Distribution for Imports into Arizona (Highway Only), 1998 and 2020 (Tons) 3-6

3.7 Inputs for Maquiladoras, 1993 to 1997 (in Millions of Dollars) 3-8

3.8 Factors Influencing Sonoran Location Decision 3-10

3.9 Barriers to Future Success of the Maquiladoras 3-10

3.10 Imports, Exports, and Selected International Through Flows in 1998 3-11

List of Tables
(continued)

5.1 Highest Truck Volume Locations in Arizona by Milepost, 2002 5-3

5.2 Highest Truck Volume Locations by Interstate, 2002 5-3

5.3 Highest Truck Volume Locations by County, 2002 5-4

5.4 Truck, Passenger Car, and Bus Volumes at Arizona-Mexico Border, 1999 5-10

5.5 Rail Incidents by County, 2003 5-12

5.6 Cargo and Passenger Volumes at Arizona Airports for 2000 5-16

5.7 Volume-to-Capacity Ratio at Highest Truck Volume Locations by County, 2002 5-18

5.8 Truck Volumes at Locations with Highest Volume-to-Capacity Ratios by Interstate 5-18

5.9 Logistics Quotient for Selected Metropolitan Areas Across the U.S. and Arizona 5-20

6.1 Arizona Road Restriction Report, 2004 6-3

6.2 Summary of Requirements for Advance Electronic Cargo Information 6-6

6.3 Arizona Nonattainment Areas by County and Pollutant, 2004 6-12

List of Figures

2.1 Total Freight Flows Into, Out of, and Within the Maricopa County by Mode in 2001 (by Total Tons) 2-21

4.1 Historical Spend on Transportation and Inventory from 1981 to 2001 4-3

4.2 Historical Spend on Inventory as a Percent of GDP from 1981 to 2001 4-3

5.1 Major Roads in Arizona by Functional Class 5-2

5.2 Average Daily Truck Traffic on Arizona Highways in 2002 5-5

5.3 Truck Volumes and Motor Vehicle Crashes on Arizona Highways, 2002 5-7

5.4 Truck Volumes and Congestion on Arizona Highways, 2002 5-8

5.5 Arizona International Ports of Entry 5-9

5.6 Arizona Railroad Lines and Passenger Stations 5-11

5.7 Intermodal Facilities in Arizona 5-13

5.8 Locations of Arizona's Public Use Airports 5-15

5.9 Phoenix Region Freight Infrastructure 5-17

6.1 EPA Standards for New Trucks and Buses 6-11

1.0 Introduction

1.0 Introduction

This technical memorandum presents a summary of current goods movement and freight transportation needs and issues facing Arizona. This material was prepared to compliment the high-level assessment of freight activity that was presented in the Phase I: Strategic Directions Report of the Arizona Long-Range Transportation Plan (MoveAZ Plan). It provides a more detailed assessment of critical freight transportation issues and their relationship to transportation policy and infrastructure. The analysis was structured to examine industry and trade trends that influence freight transportation needs, and to examine the condition and performance of the state transportation system to meet freight needs.

The outcome of this analysis will provide ADOT with several broad themes that could guide future freight planning in Arizona. Other outcomes include:

- Identify the significant industries in Arizona that are most critically dependent on freight transportation;
- Examine how trends in these critical industries are likely to impact future demand on the state transportation system;
- Identify how future system performance might impact these critical industries;
- Understand freight transportation demand levels in the State and by mode;
- Develop a set of key indicators that describe the impact of freight traffic on the general performance of the state transportation system; and
- Identify the institutional environment (e.g., regulatory, policy, financial, etc.) that governs and directs transportation-dependent industries in Arizona.

Available data sources and information were used to support this analysis. Information from various economic development agencies in the State was collected to identify the industries contributing to the economic growth and health of Arizona. Available freight and commodity flow movement data sources, such as the Freight Analysis Framework (FAF) and Commodity Flow Survey (CFS) were used to supplement the information obtained from local agencies. In addition, information used to develop various elements of the MoveAZ Plan, such as the *Task 9 Demand and System Performance Technical Memorandum*, was used to prepare the material in this memorandum.

Sections 2.0 and 3.0 present overviews of goods movement with both the domestic and international economies, as well as into and out of Arizona. Section 4.0 summarizes logistics trends in the State, while Section 5.0 summarizes freight infrastructure and freight

demand flows by mode (trucks, rail, and air). Section 6.0 presents a brief overview of the institutional environment impacting goods movement in Arizona, and Section 7.0 presents the key findings of this analysis.

2.0 Goods Movement and the Domestic Economy

2.0 Goods Movement and the Domestic Economy

2.1 Relationship of Goods Movement with State Economy

Goods movement is a critical part of the Arizona and national economy, both in terms of output and employment. Based on the most recent (1997) U.S. Economic Census, the percentage of output in the goods-related sectors of the economy was nearly three-fourths of the output of the entire economy in Arizona (Table 2.1). The largest goods-related sectors are wholesale trade, retail trade, and manufacturing. These three sectors combined account for over 60 percent of the State's economy in 1997. The goods-related sector accounts for 42 percent of the total employment in the State. This is a lower percentage than the contribution to economic output of the goods-related sector, which indicates that the goods-related sectors are more productive than the service sector.

Relative to the entire U.S., Arizona has a higher percentage of its economic output in the goods-related sectors, but a slightly lower percentage of its employment in goods-related sectors. Retail trade and construction are particularly higher in Arizona, compared to the U.S. These factors are consistent with Arizona's demography of being a growing state with goods being moved to support personal consumption.

Employment in the goods-related sector in Arizona is more lucrative than the service sector. The average salary of the goods-related sector is 14 percent higher than the average salary in the service sector. Of particular note are the wholesale trade, manufacturing, and mining jobs, which pay over $10,000 more per year than the average job in the service sector. Nationally, average goods-related sector salaries are slightly lower than service sector salaries.

Table 2.1 Economic Output and Employment by Sector for Arizona in 1997

Sector	Sales ($1,000)	Percent of Total – AZ	Percent of Total – U.S.	Employees – AZ	Percent of Total – AZ	Percent of Total – U.S.	Salary Per Employee – AZ
Wholesale trade	45,899,068	21.3%	22.8%	80,155	4.9%	5.7%	34,295
Retail trade	43,960,933	20.4%	13.8%	232,050	14.1%	13.8%	18,202
Manufacturing	43,030,348	20.0%	21.6%	193,616	11.8%	16.7%	34,881
Construction	19,115,244	8.9%	4.8%	131,871	8.0%	5.6%	27,460
Transportation & warehousing	4,086,230	1.9%	1.8%	45,233	2.8%	2.9%	24,479
Mining	3,068,897	1.4%	1.0%	12,889	0.8%	0.5%	39,569
All goods-related sectors	159,160,720	73.9%	65.8%	695,814	42.4%	45.2%	27,256
All services	56,120,983	26.1%	34.2%	945,281	57.6%	54.8%	24,000
All sectors	215,281,703	100.0%	100.0%	1,641,095	100.0%	100.0%	25,380

Source: U.S. Bureau of the Census, U.S. Economic Census, 1997.

2.2 Production of Goods for Domestic Market

The Bureau of Transportation Statistics (BTS) estimates the goods moved throughout the U.S. based on shipper surveys in its Commodity Flow Survey (CFS). This data allows for goods movement estimates to be created by commodity and origin-destination pairs for all goods by value and by tonnage. Table 2.2 shows the distribution of goods movement originating in Arizona by commodity, including shipments with destinations in Arizona, based on the most recent (1997) CFS data. The electronics industry is observed to be the dominant shipment type in terms of value for goods shipped in the State. The movement of goods in the electronics industry constitutes nearly one-third of the value of all the goods shipped, and it is over five times larger than the movement of the next largest commodity, base metals. The five next largest commodities constitute only 20 percent of the total in terms of value.

Table 2.2 Value of Shipments by Commodity and Tonnage for Arizona in 1997

Commodity	Value ($ mil)	Value %
Electronic and other electrical equipment and components and office equipment	27,628	32.0%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	5.5%
Miscellaneous manufactured products	4,373	5.1%
Motorized and other vehicles (including parts)	4,297	5.0%
Transportation equipment, n.e.c.	4,147	4.8%
Other prepared foodstuffs and fats and oils	3,997	4.6%
Machinery	3,810	4.4%
Chemical products and preparations, n.e.c.	2,798	3.2%
Precision instruments and apparatus	2,490	2.9%
Mixed freight	2,244	2.6%
Metallic ores and concentrates	2,075	2.4%
Other 30 commodities	23,653	27.5%
All commodities	86,256	100.0%

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.2.1 Transportation Expenditure by Industry

The industries shipping the commodities shown in Table 2.2 consider a mix of in-house and outsourced transportation to deliver goods to their final destination in Arizona. Data from the National Transportation Satellite Account (NTSA), shown in Table 2.3, were used to develop estimates of the total amount spent on transportation for each commodity, and to identify the split between insourced and outsourced shipments. This table assumes that transportation spending for specific industries in Arizona mirrors that for the rest of the nation. The electronics industry in Arizona is estimated to spend the highest amount among all industries on transportation with $418 million. This indicates that improvements in the transportation system are likely to have the largest economic impact on the electronics industry. The percentage spent on transportation for the electronics industry is estimated to be 1.5 percent. This is one of the lowest percentages spent on transportation for any industry. Therefore, even though this industry will benefit from transportation improvements, it is not likely that the electronics industry in Arizona will gain a competitive advantage over other states due to transportation improvements.

Table 2.3 Value Spent on Transportation by Commodity Originating in Arizona in 1997 *(in Million Dollars)*

Commodity	Total Value of Shipments	Transportation Spent		Spent on Transportation	
		Outsourced	Insourced	Total	Percent
Electronic and other electrical equipment and components and office equipment	27,628	358.5	59.8	418.3	1.5%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	214.9	33.4	248.2	5.2%
Miscellaneous manufactured products	4,373	67.9	32.7	100.6	2.3%
Motorized and other vehicles (including parts)	4,297	99.7	40.7	140.4	3.3%
Transportation equipment, n.e.c.	4,147	62.2	19.2	81.4	2.0%
Other prepared foodstuffs and fats and oils	3,997	109.3	38.7	148.0	3.7%
Machinery	3,810	58.5	20.1	78.6	2.1%
Chemical products and preparations, n.e.c.	2,798	80.9	6.1	87.0	3.1%
Precision instruments and apparatus	2,490	25.4	3.8	29.2	1.2%
Mixed freight	2,244	57.9	20.9	78.8	3.6%
Metallic ores and concentrates	2,075	36.0	47.8	83.9	4.0%
Gasoline and aviation turbine fuel	1,945	70.5	8.4	78.9	4.1%
Furniture, mattresses and mattress supports, lamps, lighting fittings	1,870	42.2	47.8	90.0	4.8%
Articles of base metal	1,832	36.5	9.4	45.9	2.5%
Plastics and rubber	1,789	68.4	13.9	82.3	4.6%
Pharmaceutical products	1,682	48.6	3.7	52.3	3.1%
Textiles, leather, and articles of textiles or leather	1,657	35.9	10.0	45.9	2.8%
Alcoholic beverages	1,403	38.4	13.6	51.9	3.7%
Printed products	1,365	28.5	7.6	36.1	2.6%
Nonmetallic mineral products	1,256	81.0	19.6	100.5	8.0%
Milled grain products and preparations, and bakery products	1,062	29.0	10.3	39.3	3.7%
Wood products	971	21.9	24.8	46.7	4.8%

Table 2.3 Value Spent on Transportation by Commodity Originating in Arizona in 1997 *(in Million Dollars)* **(continued)**

Commodity	Total Value of Shipments	Transportation Spent		Spent on Transportation	
		Outsourced	Insourced	Total	Percent
Meat, fish, seafood, and their preparations	836	22.9	8.1	30.9	3.7%
Basic chemicals	673	19.4	1.5	20.9	3.1%
Pulp, newsprint, paper, and paperboard	583	12.2	3.2	15.4	2.6%
Fuel oils	578	20.9	2.5	23.4	4.1%
Animal feed and products of animal origin, n.e.c.	530	14.5	5.1	19.6	3.7%
Paper or paperboard articles	521	24.6	1.8	26.4	5.1%
Commodity unknown	283	7.3	2.6	9.9	3.6%
Coal	282	4.9	6.5	11.4	4.0%
Coal and petroleum products, n.e.c.	209	7.6	0.9	8.5	4.1%
Fertilizers	85	2.5	0.2	2.6	3.1%
Tobacco products	84	0.9	0.1	0.9	1.1%
Waste and scrap	75	2.2	0.2	2.3	3.1%
Natural sands	45	0.8	1.0	1.8	4.0%
Nonmetallic minerals n.e.c.	10	0.2	0.2	0.4	4.0%
Monumental or building stone	4	0.1	0.1	0.2	4.0%
Nonclassifiable	2,023	52.2	18.9	71.0	3.6%
All commodities	86,256	1,864.8	545.2	2,410.0	2.6%

Source: Bureau of Transportation Statistics, Commodity Flow Survey and National Transportation Satellite Account data, 1997

Commodities that are relatively high in value and that are estimated to require a relatively high percentage spent for shipments include base metals and food products. These commodities have the highest potential for price reductions and competitive advantage from improvements in the transportation system. For example, a 20 percent reduction in transportation costs for base metals would reduce the overall operating costs by one percent to produce these commodities. In low margin industries, such as mining and agriculture, these small percentage reductions can result in increased market share for Arizona businesses.

2.2.2 Goods Movement within the Electronic Industry

Table 2.4 shows the modal usage for goods movement in the electronics industry, compared to goods in other industries in Arizona. Over one-half of the goods moved in the electronics industry are shipped by parcel, United States Postal Service, or other courier. For other industries, this mode represents only 10 percent of the shipments by value. Most goods in other industries rely on the truck mode for their shipments. The truck mode carries 74 percent of the goods in other industries by value, compared to just 20 percent for the electronics industry.

Table 2.4 Mode Split for Electronic Goods Shipped in Arizona in 1997

Mode	Electronics Industry ($ Billion)	Percent of Total	Other Industries ($)	Percent of Total
Parcel, U.S. Postal Service, or courier	14.0	51%	6.1	10.4%
Air	7.5	27%	3.8	6.5%
Truck	5.6	20%	43.6	74.4%
Rail	(Not reported)	< 1%	3.5	6.0%
Other	(Not reported)	< 2%	1.6	2.7%
Total	**27.6**	**100%**	**58.6**	**100.0%**

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.2.3 Goods Movement in Other High-Value Industries

After electronics, the next five largest commodities in terms of value moved in Arizona are base metals, miscellaneous manufactured products, motorized vehicles, other transportation equipment, and prepared foodstuffs. Table 2.5 shows the value of these goods and the mode split for each commodity. Each of the modes is important for at least one of these high-value industries. The rail mode carries over $1 billion worth of base metal originating in Arizona. The air mode carries a large percentage of the transportation equipment (likely related to parts) and precision instruments, in addition to being critical for the electronics industry. The courier mode is also important for these three industries. In addition, miscellaneous manufactured products are also reliant on couriers for a large percentage of their shipments. The truck mode is important for all of the modes. Excluding the precision instruments, the truck mode carries over $1 billion worth of goods for each of the other top 10 commodities.

Table 2.5 Mode Split for Top 10 Commodities by Value Originating in Arizona in 1997

All Commodities	Value ($ mil)	Percent of Total	Truck	Rail	Water	Air (Includes Truck & Air)	Parcel, U.S. Postal Service, or Courier	Multiple or Unknown
Electronic and other electrical equipment and components and office equipment	27,628	32%	20%	0%	0%	27%	51%	2%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	38%	60%	35%	0%	0%	0%	5%
Miscellaneous manufactured products	4,373	43%	51%	0%	0%	0%	23%	26%
Motorized and other vehicles (including parts)	4,297	48%	90%	0%	0%	0%	3%	7%
Transportation equipment, n.e.c.	4,147	52%	45%	0%	0%	29%	25%	1%
Other prepared foodstuffs and fats and oils	3,997	57%	100%	0%	0%	0%	0%	0%
Machinery	3,810	61%	79%	0%	0%	0%	8%	13%
Chemical products and preparations, n.e.c.	2,798	65%	96%	0%	0%	0%	3%	1%
Precision instruments and apparatus	2,490	68%	26%	0%	0%	38%	33%	3%
Mixed freight	2,244	70%	99%	0%	0%	0%	0%	1%
Other commodities	25,728	100%	77%	7%	0%	0%	9%	7%
All Commodities	86,256		57%	4%	0%	13%	23%	3%

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.2.4 High-Tonnage Commodities

The high-value commodities produced in the State of Arizona are markedly different than the commodities that dominate in terms of tonnage. Table 2.6 shows the tonnages moved for the top 10 commodities in terms of value. As mentioned earlier, this includes goods originating within the State, including goods with destinations in Arizona. Some of the data are not reported in the CFS to protect the confidentiality of companies in a particular industry.

Table 2.6 Tonnage by Value of Goods Movements for Top 10 Commodities Originating in Arizona in 1997

Commodity	Value ($ mil)	Value %	Tons (000)	Tons %
Electronic and other electrical equipment and components and office equipment	27,628	32.0%	359	0.3%
Base metal in primary or semi-finished forms and in finished basic shapes	4,744	5.5%	3,090	2.5%
Miscellaneous manufactured products	4,373	5.1%	580	0.5%
Motorized and other vehicles (including parts)	4,297	5.0%	n/a	n/a
Transportation equipment, n.e.c.	4,147	4.8%	32	0.0%
Other prepared foodstuffs and fats and oils	3,997	4.6%	6,439	5.3%
Machinery	3,810	4.4%	381	0.3%
Chemical products and preparations, n.e.c.	2,798	3.2%	n/a	n/a
Precision instruments and apparatus	2,490	2.9%	27	0.0%
Mixed freight	2,244	2.6%	1,084	0.9%
Top 10 commodities	60,528	70.2%	11,992	9.9%
Other 32 commodities	25,728	29.8%	109,655	90.1%
All commodities	86,256	100.0%	121,647	100.0%

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

The 10 commodities shown in Table 2.6 represent 70 percent of the total goods shipped in dollar terms, but less than 10 percent of the goods in terms of tonnage. Only three of these 10 commodities (base metal, prepared foodstuffs, and metallic ores) are over one percent of the total tonnage moved in the State.

The Federal Highway Administration (FHWA) has created the Freight Analysis Framework (FAF) database that provides goods movement data by commodity and origin-destination pair at the state level for tonnage only. Since the FAF database was collected using a different methodology compared to the BTS CFS, the two databases are not entirely consistent with one another. The FAF database also reports commodities using a different classification scheme than the CFS. Nevertheless, the FAF data are particularly useful for determining the origin-destination combination for commodities at the state level.

The top 10 commodities, in terms of tonnage moved in Arizona, are shown in Table 2.7. The data are based on the FAF database. The top four commodities represent 72 percent of the total tonnage produced in the State. Of the remaining six largest commodities in terms of tonnage, four are consistent with the top 10 dollar value of goods moved. These four commodities are primary metal products (which corresponds to base metals in the CFS data), food products (which corresponds to prepared foodstuffs in the CFS data),

chemicals or allied products (which corresponds to chemical products and preparations), and metallic ores.

Table 2.7 High-Tonnage Commodities Produced in Arizona in 1998

Standard Transportation Commodity Classification (STCC)	Internal	Outbound	All Goods Produced in State (Internal+Outbound)	Percent of Total
Clay, concrete, glass or stone products	21,901,237	1,417,614	23,318,851	19%
Petroleum or coal products	21,114,081	2,054,777	23,168,858	19%
Nonmetallic minerals	22,975,832	69,408	23,045,240	19%
Secondary flows	15,485,681	2,279,523	17,765,204	15%
Food products	2,776,080	3,924,191	6,700,271	6%
Farm products	3,822,873	2,610,167	6,433,040	5%
Lumber or wood products	1,296,378	2,567,525	3,863,903	3%
Metallic ores	2,400,116	855,156	3,255,272	3%
Chemicals or allied products	773,644	2,261,795	3,035,439	2%
Primary metal products	235,011	2,661,832	2,896,844	2%
Other 20+ commodities	3,074,613	4,932,071	8,006,683	7%
All commodities	95,855,546	25,634,059	121,489,605	100%

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Goods movement of nonmetallic mineral products and clay, concrete, glass, or stone products. Nonmetallic mineral products and clay, concrete, glass or stone products are common materials for several types of construction, including residences, commercial buildings, and roads. In large part, these activities are centered on urban areas. These products are generally mined from quarries and require little or no manufacturing (or processing) after removal from the ground. Therefore, it is beneficial to maximize utilization of the quarries that are closest to the locations of construction. These construction locations tend to be in the urban areas. In Arizona, over 99 percent of the nonmetallic minerals produced in the State remain within Arizona, while 94 percent of the clay, concrete, glass, and stone products generated in the State remain in Arizona. Due to the dominance of short-distance trips, nearly all of these goods are shipped via truck.

Goods movement of petroleum or coal products. The shipments within this commodity are dominated by truck movements from distribution centers to gasoline stations. Most of the gasoline is brought into the State via pipeline to distribution centers. Trucks are then used to deliver the gasoline to their final destination for consumption. Therefore, the vast majority of the truck portion of this goods movement remains within Arizona.

Goods movement of metallic ores and primary metals. Metallic ores are mined in several locations, primarily in the northern portion of Arizona. As shown previously in Table 2.7, the majority of the metallic ores are shipped to destinations within the State. However, Table 2.8 shows that 92 percent of the primary metal products are shipped outside of Arizona. These data indicate that metallic ores are being shipped to processing facilities inside the State, and then transformed into primary metal products for shipping outside of the State. Three states (Texas, Illinois, and California) are responsible for over 60 percent of the total shipments of primary metal products. Trucks are the largest mode for moving these outbound shipments, but rail is also quite high at around 40 percent of the mode share for Texas, Illinois, and California.

Table 2.8 Destination of Primary Metal Products Produced in Arizona in 1998

			Truck-Rail Mode Split		
State	**Tons Shipped**	**Percent of Total**	**Truck Percent**	**Rail Percent**	**All Modes**
Texas	767,774	26.5%	61%	39%	100%
Illinois	560,342	19.3%	60%	40%	100%
California	507,548	17.5%	78%	22%	100%
Arizona	235,011	8.1%	95%	5%	100%
Connecticut	139,849	4.8%	59%	41%	100%
Indiana	98,548	3.4%	72%	28%	100%
Mississippi	94,950	3.3%	74%	26%	100%
Michigan	94,158	3.3%	100%	0%	100%
Other States	398,663	13.8%			
Total	**2,896,843**	**100.0%**			

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Goods movement of farm products and prepared foodstuffs. Farm products represent goods shipped directly from farms, while food products are the result of farm products that are processed at manufacturing facilities. These represent the largest commodities produced in Arizona that have a relatively even balance between goods that are shipped internally and goods that are shipped outbound to other states. As shown in Table 2.9, the out-of-state recipients of farm products are distributed across a wide number of states across the U.S. California and Texas are the largest recipients of these goods, but they account for only 34 percent of the total outbound shipments for farm products produced in Arizona. As shown in Table 2.10, outbound food products are much more concentrated in the southwestern portion of the U.S. Nevada, California, Utah, and New Mexico represent 85 percent of the outbound food product shipments. Due to the perishable nature of

these products, over 90 percent of farm and food products are transported by truck in Arizona, even for the longer-distance movements.

Table 2.9 Destination States for Farm Products Originating in Arizona in 1998

Destination State	Tons	Percent of Total
Arizona	3,808,037	59.3%
California	664,797	10.4%
Texas	231,453	3.6%
Illinois	193,002	3.0%
Georgia	105,141	1.6%
Florida	101,991	1.6%
Pennsylvania	98,959	1.5%
Michigan	96,796	1.5%
New York	89,210	1.4%
Other	1,028,818	16.1%
All states	**6,418,204**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.10 Destination States for Food Products Originating in Arizona in 1998

Destination State	Tons	Percent of Total
Arizona	2,776,080	41.4%
Nevada	1,541,624	23.0%
California	1,071,788	16.0%
Utah	387,453	5.8%
New Mexico	180,729	2.7%
Texas	151,335	2.3%
Illinois	150,908	2.2%
Tennessee	108,081	1.6%
Colorado	107,654	1.6%
Other	224,619	3.4%
Total	**6,700,271**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Goods movement of secondary flows. In the FAF data, a separate commodity classification was created for secondary flows. Secondary flows represent freight flows that originate in warehouses and distribution centers. These goods originate from locations that are used for storing and sorting, but not for further manufacturing. These goods may be destined for other warehouses and distribution centers, but more likely they are destined for the final consumer. The specific goods within the secondary flow commodity include any of the other commodities in the traditional STCC system, such as electronics, food products, or lumber products. It should be noted that for all commodity-specific outputs that are prepared using FAF data, the commodity detail within the secondary flows are not reported.

Because warehouses and distribution centers are often located near final consumption locations, most of the secondary flows tend to be transported by truck and remain within their state of origin. Table 2.11 shows that in Arizona, 87 percent of the secondary flows remain in the State and all of these goods are transported by truck. The vast majority of outbound flows is destined for California, Nevada, and New Mexico, indicating that Arizona serves as a regional distribution center for some freight ultimately destined to other southwestern and western states. The secondary flows to Texas are minimal, which indicates that Texas is outside the reach of Arizona's distribution activity.

Table 2.11 Outbound Destination States for Secondary Flows Originating in Arizona in 1998

Destination State	Tons	Percent of Total
California	967,726	42.5%
Nevada	598,317	26.2%
New Mexico	242,449	10.6%
Utah	196,424	8.6%
Colorado	46,770	2.1%
Illinois	22,317	1.0%
Idaho	22,275	1.0%
Texas	19,915	0.9%
Other	163,330	7.1%
Total	**2,279,523**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework. 1998.

2.2.5 Summary of Goods Produced for Domestic Market

The electronics industry is by far the most important goods-related industry in Arizona in terms of value of goods shipped and, therefore, the most important commodity to the overall state economy. The highest tonnage goods produced in Arizona are low value commodities, such as stone, nonmetallic minerals, and petroleum products. The vast majority of these high-tonnage goods produced in Arizona remains within the State, and is consumed by industries supporting the growing population of Arizona. Of the goods shipped outside of Arizona, most are destined for other states in the west and southwest, primarily California and Texas. This interstate trade demonstrates Arizona's economic tie to nearby states.

2.3 Consumption of Goods from Domestic Market

The previous section identified the primary commodities produced in Arizona, both in terms of dollars and tonnage of output. These commodity movements were used to make inferences about the major industries in Arizona related to both economic relevance and the relative impact on freight transportation infrastructure. However, the major industries not only produce goods, but also consume goods. The consumption of these goods can be tracked by examining both inbound (shipped into Arizona from other states) and internal (within Arizona) flows. In addition to consumption by industries, there is a significant amount of consumption of goods by the local population.

This section describes the major goods shipped into the State and describes their importance to the overall economy. The CFS was used in the previous section to determine the value of shipments by commodity. However, the CFS does not include value by commodities for inbound shipments. Therefore, the analysis used to support this analysis considers the use of FAF data to characterize freight flows. The FAF data are reported in tonnages, rather than value. As mentioned previously, available data and tools were used to support this analysis. The use of other data sources, such as IMPLAN (input output economic modeling software) and Reebie TRANSEARCH data (proprietary freight data source), can be used to understand the value of goods shipped. In addition, IMPLAN also can be used to determine the types of goods and services that are purchased by industries for a region.

2.3.1 Inbound Electronics Goods Movement

As described in Section 2.2, the electronics industry is the largest goods-related industry in Arizona. The electronics industry uses a significant amount of electrical machinery as input into its manufacturing process. Therefore, tracking the inbound shipments of this commodity will reveal the level of dependence on transportation system links with other states for the electronics industry. Over 400,000 tons of electrical machinery are shipped

into Arizona – roughly equivalent to the 407,000 tons that are shipped out of the State, and much larger than the 55,000 tons that remain within Arizona. The inbound shipments of electrical machinery are a key aspect of the electronics industry in Arizona. As shown in Table 2.12, nearly one-half of the inbound shipments of electrical machinery comes from California and Texas. This is likely due to the large amount of high-tech activity in these states.

Table 2.12 Inbound Electrical Machinery Shipments into Arizona by State in 1998

State of Origin	Total Tons	Percent of Total
California	116,293	28.3%
Texas	71,343	17.4%
Tennessee	30,214	7.4%
Illinois	23,326	5.7%
Oregon	18,113	4.4%
Indiana	16,383	4.0%
Wisconsin	16,136	3.9%
Other	118,507	28.9%
Total	**410,315**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

The other key inbound commodities are identified in Table 2.13. The top 10 commodities represent over 85 percent of all the inbound flows by tons into Arizona.

2.3.2 Inbound Goods Movement of Coal

Coal is the largest commodity shipped into the State constituting over 10 million of the 48 million total inbound tons. Approximately, 95 percent of the coal that is shipped into Arizona come by rail from New Mexico. Coal is used as a fuel source for power plants throughout the State.

Table 2.13 Inbound Shipments into Arizona for the Top 10 Commodities in 1998

Commodity	Tons	Percent of Total
Coal	10,653,757	22.2%
Farm Products	8,703,175	18.2%
Food and kindred products	4,728,434	9.9%
Chemicals or allied products	3,853,898	8.0%
Petroleum or coal products	2,829,623	5.9%
Lumber or wood products, excluding furniture	2,509,980	5.2%
Clay, concrete, glass, or stone products	2,336,786	4.9%
Primary metal products	2,223,921	4.6%
Transportation equipment	1,783,988	3.7%
Secondary moves	1,755,437	3.7%
Other 20 commodities	6,565,697	13.7%
Total	**47,944,696**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.3.3 Inbound Goods Movement of Farm Products

There are approximately 8.7 million tons of farm products shipped into Arizona. This is slightly larger than the 6.4 million that are shipped out of and around the State, making Arizona a net importer of farm products. Farm products are primarily shipped into Arizona from states in the Midwest and the Plains, as shown in Table 2.14. Each of the top six states for farm product origins is in the Plains and Midwest, and these six constitute 64 percent of the total inbound shipments of agriculture to Arizona. California, with its enormous agricultural industry, ships a relatively small amount of farm products into Arizona. Roughly 91 percent of the inbound shipments of this commodity are transported by truck, with the remainder by rail. This mode-split holds true for the longer-distance shipments due to the perishable nature of farm products.

2.3.4 Inbound Goods Movement of Food Products

As shown in Table 2.15, roughly 4.7 million tons of food products are shipped into Arizona, compared to the 2.8 million tons shipped out of and 1.1 million tons shipped within the State. Arizona is a net importer of food products. California is the primary shipper of food products into Arizona; it is responsible for over one-third of the total

inbound shipments of this commodity. The other major shipper states include the Plains and Midwest states; and Texas, Utah, and New Mexico. Based on the FHWA FAF database, the rail share of food products is 20 percent, compared to 10 percent of farm products; the remaining 80 percent are carried by trucks. The higher rail share for food products is due to the decreased perishability of food products.

Table 2.14 Inbound Shipments to Arizona of Farm Products by Other States in 1998

Originating State	Tons	Percent of Total
Iowa	1,203,460	13.8%
Nebraska	1,178,039	13.5%
Minnesota	1,005,651	11.6%
Kansas	802,674	9.2%
South Dakota	706,278	8.1%
Colorado	697,819	8.0%
Utah	432,671	5.0%
North Dakota	337,135	3.9%
Texas	310,720	3.6%
Idaho	297,005	3.4%
California	291,826	3.4%
Wisconsin	269,924	3.1%
New Mexico	260,497	3.0%
Montana	208,507	2.4%
Illinois	155,631	1.8%
Other	545,338	6.2%
Total	**8,703,175**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.15 Inbound Shipments of Food Products to Arizona by Other States in 1998

Origin State	Tons	Percent of Total
California	1,565,198	33.1%
Iowa	424,394	9.0%
Texas	349,317	7.4%
Idaho	246,873	5.2%
Colorado	236,670	5.0%
Missouri	198,948	4.2%
Kansas	176,056	3.7%
Minnesota	165,033	3.5%
Utah	152,387	3.2%
Illinois	146,364	3.1%
Arkansas	138,105	2.9%
New Mexico	107,875	2.3%
Indiana	98,214	2.1%
Nebraska	79,717	1.7%
Other	643,283	13.6%
Total	**4,728,434**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.3.5 Inbound Goods Movement of Chemicals Products

Over 3.8 million tons of chemicals are shipped into Arizona annually, as shown in Table 2.16. Five states account for nearly two-thirds of the total shipments. These five states include the petroleum rich States of Texas and Louisiana, along with Arizona's neighboring States of California and New Mexico.

Table 2.16 Inbound Shipments of Chemicals to Arizona by Other States in 1998

Origin State	Tons	Percent of Total
Texas	1,033,067	26.8%
New Mexico	513,136	13.3%
California	408,142	10.6%
Louisiana	353,832	9.2%
Oklahoma	221,059	5.7%
Other	1,324,662	34.4%
Total	**3,853,898**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.3.6 Inbound Goods Movement of Secondary Flows

Secondary flows are movements of any type of goods from warehouses and distribution centers. These can be contrasted with primary flows which are generated at manufacturing facilities, mining sites, or farms. A large number of companies operate warehouses and distribution centers in the Los Angeles metropolitan region, and the operating range of the facilities can often stretch throughout the entire southwest region of the U.S. This explains the high percentage of inbound flows of secondary moves from California to Arizona. California is the origin state for 44 percent of the inbound shipments of secondary flows for Arizona, as shown in Table 2.17. Other nearby states, such as New Mexico, Nevada, and Utah, also have relatively high levels of shipments into Arizona.

2.3.7 Value of Inbound Goods

The 1997 CFS provides value data for inbound shipments to Arizona for all states. Table 2.18 shows that California is the largest out-of-state shipper of goods to Arizona. The value of goods shipped from California is greater than the next four greatest states combined. This indicates that the transportation infrastructure between Arizona and California is the most important interstate infrastructure in terms of Arizona's overall economy.

Table 2.17 Inbound Shipments of Secondary Flows to Arizona by Other States in 1998

Origin State	Tons	Percent of Total
California	765,923	43.6%
New Mexico	225,854	12.9%
Indiana	174,124	9.9%
Nevada	113,633	6.5%
Utah	106,339	6.1%
Texas	52,879	3.0%
Other	316,685	18.0%
Total	**1,755,437**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.18 Value of Arizona's Inbound Shipments by State of Origin in 1997

State of Origin	Value ($000)	Percent of Total
Arizona	32,386	33.6%
California	20,425	21.2%
Texas	4,387	4.6%
Illinois	2,321	2.4%
New York	2,285	2.4%
Michigan	2,118	2.2%
Other 44 states	32,440	33.6%
Total	**96,362**	**100.0%**

Source: Bureau of Transportation Statistics, Commodity Flow Survey, 1997.

2.4 Directionality of Goods Movement

Arizona is a net importer of goods. Table 2.19 shows that the tons shipped into the State are nearly twice that of the tons shipped out of State. This indicates that Arizona's domestic goods movement is more focused on end consumption by the growing

population. Over one-half of Arizona's total tonnage is shipped internally within the State. The vast majority of these shipments was by truck. This underscores the importance of the state transportation system for goods movement.

Table 2.19 Tons Shipped Into and Out of Arizona in 1998

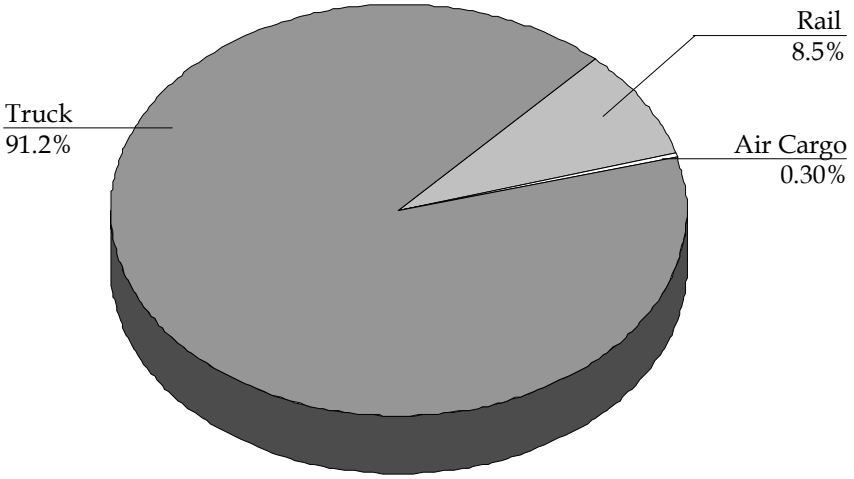
Trip Type	Tons	Percent of total
Internal	95,855,546	56.6%
Outbound	25,634,059	15.1%
Inbound	47,944,696	28.3%
Total	**169,434,301**	**100.0%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.5 Goods Movement at the Metropolitan Level

In the recently completed Maricopa Association of Governments (MAG) Regional Transportation Plan (prepared in 2003) for the Phoenix metropolitan area, MAG compiled a substantial amount of data on goods movement. These data show that Maricopa County (representative of the MAG region) goods movement is tied to regions outside of the County. In 2001, only eight percent of the tonnage moved in the County were considered internal movements. In addition, 49 percent of the goods moved were shipped from outside to inside the County. Forty-three percent of the goods originated in the County, but were destined for regions outside of the County. These freight movements were dominated by the truck mode. Figure 2.1 shows that, for Maricopa County, 91.2 percent of all movements were performed by truck, 8.5 percent by rail, and the remaining 0.3 percent by air. Truck movements accounted for 86.4 percent of all inbound freight. Also, 97.8 percent of all goods that were sent out of the region were shipped using trucks. Many of these goods were likely headed to adjacent counties. According to the 1997 Commodity Flow Survey, in the greater Phoenix metropolitan region, 63 million tons of goods had both an origin and a destination in the Phoenix metropolitan region. This is roughly one-third of the combined internal, inbound, and outbound tons for the State (see Table 2.19).

Figure 2.1 Total Freight Flows Into, Out of, and Within the Maricopa County by Mode in 2001 (by Total Tons)



Source: Reebie Associates and Maricopa Association of Governments, 2001.

Approximately, 86 percent of all goods coming into the County in 2001 came from the western region of the United States. The major trading area for incoming goods into the County consisted of the remaining 14 counties within Arizona. Approximately 57 percent of all incoming freight were generated from areas within the State. When assessing trade areas throughout the U.S. in 2001, the primary trade area for Maricopa County for all incoming and outgoing freight was the State of Arizona.

Table 2.20 shows the type of truck carrier utilized to ship freight in the MAG region. In 2001, the majority (51.8 percent) of all outbound truck freight was shipped to other destinations by private truck; whereas, 47.1 percent of all truck freight consisted of for-hire Truckload (TL) movements, and only 1.1 percent consisted of for-hire Less Than Truckload (LTL) movements. Reported LTL movements, as displayed by Table 2.20, consist of individual loads that are less than 10,000 pounds.

The current Union Pacific (UP) railroad lines located in the Phoenix metropolitan area include a northern track network that extend from the southern UP main line, which is located in southern Maricopa County. The southern UP line travels east and west throughout the region and the State, and serves as a viable east-west transcontinental connection between southern California, the City of Chicago, the ports of the Gulf Coast, markets in the eastern U.S., and a number of states and cities throughout the south. The northern UP branch extends from its origin in central Pinal County, and enters into the Phoenix metropolitan area from the southeast valley. The northern UP line travels west into downtown Phoenix and terminates near the Palo Verde nuclear facility in the west valley. All northbound and southbound freight to Phoenix travels along the existing UP lines originating near Picacho Junction, which is located near the City of Eloy in central Pinal County.

Table 2.20 Truck Movements in the Maricopa County by Type of Carrier in 2001

Type of Movement	Total Tons	Percent
Outbound truck freight		
For-Hire Truckload (TL)	22,348,463	47.1
For-Hire Less Than Truckload (LTL)	524,236	1.1
Private truck	24,620,516	51.8
Total	**47,493,215**	**100.0**
Inbound truck freight		
For-Hire Truckload (TL)	23,975,594	51.3
For-Hire Less Than Truckload (LTL)	1,270,448	2.7
Private truck	21,482,233	46.0
Total	**46,728,275**	**100.0**

Source: Reebie Associates and Maricopa Association of Governments, 2001.

In 2001, 88.2 percent (7.1 million tons) of rail cargo was inbound, and 11.8 percent (954,067) were outbound from the Phoenix metropolitan area. When assessing the types of movements that occur in the rail industry, most goods are either categorized as transported by carload or intermodal rail. Unlike other areas of the U.S. where intermodal rail freight can be transferred by truck, pipeline, air, or water, within Maricopa County, the only connecting mode with intermodal rail freight is by truck. Table 2.21 shows the distribution of rail freight by type of transport – carload or intermodal. The majority of both inbound and outbound rail freight is made via carload.

Table 2.21 Rail Movements in Maricopa County by Type in 2001

Type of Movement	Total Tons	Percent
Outbound rail freight		
Carload	606,301	63.6
Intermodal	347,766	36.4
Total	**954,067**	**100.0**
Inbound rail freight		
Carload	6,261,089	88.0
Intermodal	856,247	12.0
Total	**7,117,336**	**100.0**

Source: Reebie Associates and Maricopa Association of Governments, 2001.

As shown previously in Figure 2.1, about 0.3 percent of all cargo movement within the Maricopa County is moved by air. In absolute numbers, these translate into a total of 342,674 tons of inbound and outbound air cargo moving in and out of Maricopa County in 2001. Of this amount, 72.1 percent (247,172 tons) were inbound, and 27.9 percent (95,502 tons) were outbound from the region.

2.6 Through Trips

Through trips constitute a significant portion of the truck traffic on Arizona's state transportation system. The volume of trucks can be inferred by using various information from the FAF data. Through visual observation of the national highway network, the vast majority of trucks passing through Arizona without stopping has a trip end in California. The other trip end considers states to the east of Arizona, including primarily New Mexico, Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Alabama, Tennessee, North Carolina, South Carolina, Georgia, and Florida.

These origin-destination combinations represent a minimum threshold of through trucks. There are other combinations, such as Oregon-New Mexico and California-Virginia in which some, but not all, of the trucks likely use Arizona's transportation system. Trucks from southern California to states north and east of Arizona (such as Utah and Illinois) are likely to use I-15, which cuts through the northwest corner of the State.

Rail-through trips cannot be estimated using the FAF data due to the unpredictable nature of routing for some origin-destination movements. For example, a percentage of the California-Florida rail flows likely travels through Chicago, rather than using a linear east-west route. Therefore, the estimates of through trips presented in this section are likely an underestimate of actual flows, and should be considered to be a minimum level of actual rail-through trips.

The total truck tons for the origin-destination pairs from California with other states to the east of Arizona are 40.6 million tons. As shown in Table 2.22, when the tonnage of these through trucks are added to the other directional flows (of all modes), the through trucks represent nearly one-fifth of the total tons of goods moved in Arizona. Through truck tons are comparable with the inbound tonnage of goods for all modes, and it is nearly 60 percent higher than the outbound tonnage of goods from all modes.

Through trucks travel longer distances on Arizona's transportation system than other trip types, an estimate of ton-miles was performed to better compare each trip type. A rough estimate of the average distance that a through truck travels on Arizona roads is 400 miles. This is based on the 360 miles of highway between the California and New Mexico borders on the I-8 and I-10 corridor, the 500 miles of highway between the California and New Mexico borders on I-40, and the 385 miles of highway between the California and New Mexico borders on I-10. Using a rough estimate of 400 miles, through truck ton-miles is estimated at over 16 billion ton-miles. According to the 1997 CFS, the average

distance of an internal trip in Arizona is 127 miles. The average trip for an inbound or outbound truck trip is considered one-half of the average through trip distance (200 miles) based on the east-west orientation of Phoenix and Tucson, and the large volumes of trade to states both west and east of Arizona. Using these values, the ton-miles of each trip type were estimated and shown in Table 2.23. With these rough estimates, the ton-miles of the through trucks are greater than the ton-miles of each of the other three trip types, and these represent 38 percent of the total ton-miles for Arizona.

Table 2.22 Estimated Tons Shipped by Trip Type in 1998

Trip Type	Tons	Percent of Total
Internal	95,855,546	46%
Outbound	25,634,059	12%
Inbound	47,944,696	23%
Through	40,566,117	19%
Total	**210,000,418**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998; and Cambridge Systematics, 2004.

Table 2.23 Estimated Ton-Miles by Trip Type in 1998

Trip Type	Tons	Rough Estimate of Average Length of Trip in AZ	Rough Estimate of Ton-Miles	Percent of Total
Internal	95,855,546	127	12,173,654,342	28%
Outbound	25,634,059	200	5,126,811,800	12%
Inbound	47,944,696	200	9,588,939,200	22%
Through	40,566,117	400	16,226,446,800	38%
Total	**210,000,418**		**43,115,852,142**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998; and Cambridge Systematics, 2004.

The through flows shown in Tables 2.22 and 2.23 are likely underestimated, because the rail mode is not included. In addition, there are some highway origin-destination pairs which use Arizona's transportation system that were not included in this through trip estimate.

2.7 Forecast of Goods Movement

2.7.1 Forecast by Trip Type

The FHWA FAF data provide forecasts for 2010 and 2020 by commodity and origin-destination pair. Overall, the tonnage shipped into, out of, and within Arizona is forecast to increase by 87 percent between 1998 and 2020. By comparison, auto vehicle miles traveled (VMT) in Arizona is forecast to increase by 83 percent between 2002 and 2025. Outbound commodity flows show the largest increase of all the trip types, but internal trips will continue to dominate the directional flow of goods for Arizona. Table 2.24 shows that the internal trips are estimated to represent 60 percent of the total tonnage in Arizona by 2020.

Table 2.24 Forecast of Tons Shipped by Trip Type in 1998 and 2020

Trip Type	Tons (1998)	Tons (2020)	Percent Growth (1998-2020)
Internal	95,855,546	213,171,075	122%
Outbound	25,634,059	59,792,719	133%
Inbound	47,944,696	84,021,716	75%
Total	**169,434,301**	**356,985,510**	**111%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

The high percentage of internal trips will continue to fuel Arizona's reliance on the state transportation system to move goods. Tables 2.25 and 2.26 show that the air mode was forecasted to increase by 237 percent between 1998 and 2020. This is the highest growth percentage of all of the modes. The share of tonnage captured by the rail industry will increase at the slowest rate (59 percent) of each of the modes. The decrease in the share of goods using rail contributes to the increase in truck usage in the State. Any shifts of goods from truck to rail would potentially relieve congestion and other state transportation system impacts. Since outbound flows are increasing at the fastest rate, these trips are the most likely to consider potential shifts from truck to rail.

Because the aviation forecasts identified in this section are based on the FAF, they are not consistent with the aviation forecasts generated as part of the *Task 9 Demand and System Performance Technical Memorandum*. To avoid confusion of data sources, only the FAF numbers are presented in this section.

Table 2.25 Forecast by Mode and Trip Type by Annual Tons in 2020

Trip Type	Transportation Mode				Percent of Grand Total
	Highway	Rail	Air	Total	
Internal	210,329,783	2,817,439	23,853	**213,171,075**	**60%**
Outbound	51,229,104	8,065,830	497,785	**59,792,719**	**17%**
Inbound	53,108,361	30,074,157	839,198	**84,021,716**	**23%**
Total	**314,667,248**	**40,957,426**	**1,360,836**	**356,985,510**	**100%**
Percent of Grand Total	**88%**	**11%**	**< 1%**	**100%**	

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.26 Forecast Growth Rates Between 1998 and 2020 by Mode and Trip Type

Trip Type	Mode			Total
	Highway	Rail	Air	
Internal	55%	38%	75%	**122%**
Outbound	145%	77%	267%	**133%**
Inbound	88%	54%	221%	**75%**
Total	**120%**	**59%**	**237%**	**111%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

2.7.2 Forecast by Commodity Type

Four commodities represent 85 percent of the internal tons of goods moved in Arizona, including:

1. Nonmetallic materials;
2. Clay, concrete, glass or stone products; and
3. Petroleum or coal products; and
4. Secondary flows.

These commodities are growing slightly faster than Arizona's overall internal tonnage. However, two of these commodities (clay, concrete, glass, or stone products; and

secondary flows) are forecast to nearly triple between 1998 and 2020. The growth in these commodities is a result of the goods shipped to support the growing population in the State. Clay, concrete, glass, or stone products are important for commercial and industrial construction; and secondary flows consider movements from distribution centers and warehouses, which are ultimately destined for final consumption by the general population.

Secondary flows are also forecast to triple for outbound flows, making it the fastest growing outbound commodity for Arizona. As shown in Table 2.27, secondary flows are forecast to be the second largest outbound commodity by 2020, increasing from fifth largest in 1998. Arizona's position as a regional distribution center is going to be a significant driver in the increase of freight flows for the State. The vast majority of these flows is destined for California and Nevada. Specifically, the Los Angeles and Las Vegas metropolitan areas will be the most likely recipients of goods from distribution centers and warehouses in Arizona. The outbound flows of food products and primary metal products are forecasted to grow at moderate rates between 1998 and 2020, as shown in Table 2.28. These industries are likely to decrease in importance for Arizona relative to transportation and distribution.

Table 2.27 Forecast of Tons by Commodity for Internal Trips in 1998 and 2020

	1998		2020		Percent Growth (1998-2020)
Commodity Description	**Tons**	**Percent of Total**	**Tons**	**Percent of Total**	
Nonmetallic minerals	22,975,832	24.0%	36,796,782	17.3%	60.2%
Clay, concrete, glass or stone products	21,901,237	22.8%	61,071,455	28.6%	178.8%
Petroleum or coal products	21,114,081	22.0%	40,034,346	18.8%	89.6%
Secondary flows	15,485,681	16.2%	47,850,354	22.4%	209.0%
Other commodities	14,378,715	15.0%	27,418,138	12.9%	90.69%
Total	**95,855,546**	**100.0%**	**213,171,075**	**100.0%**	**122.4%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Table 2.28 Forecast of Tons by Commodity for Outbound Trips in 1998 and 2020

Commodity Description	1998 Tons	1998 Percent of Total	2020 Tons	2020 Percent of Total	Percent Growth (1998-2020)
Food and kindred products	3,924,191	15.3%	9,736,661	**16.3%**	**148.1%**
Primary metal products	2,661,832	10.4%	4,053,823	**6.8%**	**52.3%**
Farm products	2,610,167	10.2%	2,841,202	**4.8%**	**8.9%**
Lumber or wood products, excluding furniture	2,567,525	10.0%	5,863,216	**9.8%**	**128.4%**
Secondary moves	2,279,523	8.9%	7,387,288	**12.4%**	**224.1%**
Chemicals or allied products	2,261,795	8.8%	5,682,176	**9.5%**	**151.2%**
Petroleum or coal products	2,054,777	8.0%	5,688,847	**9.5%**	**176.9%**
Other commodities	7,274,249	28.4%	18,539,507	**31.0%**	**154.9%**
Total	**25,634,059**	**100.0%**	**59,792,719**	**100.0%**	**133.3%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998

Overall, inbound tons are forecasted to increase by 75 percent. However, inbound flows of the top two commodities (coal and farm products) are forecasted to grow at much slower rates. Table 2.29 shows that food products and chemical products are forecasted to more than double between 1998 and 2020. The slow growth of coal imports is indicative of shifts in the reliance on coal as a fuel source. The slow growth of this commodity also contributes to the slower growth rate of rail to move goods by 2020. Approximately 95 percent of the coal shipped into the State were brought in by rail from New Mexico.

These data also indicate a shift in the agricultural industry, in that farm products are increasing at a very slow rate, while food products are increasing at a much faster rate. This pattern was also evident for outbound and internal flows. By 2020, agricultural products are more likely to be processed on-site or nearby to the farms where they are produced. After processing, the food products are more likely to be shipped across state borders for final consumption.

Table 2.29 Forecast of Tons by Commodity for Inbound Trips in 1998 and 2020

Commodity	1998		2020		Percent Growth (1998-2020)
	Tons	Percent of Total	Tons	Percent of Total	
Coal	10,653,757	22.2%	13,407,311	**16.0%**	**25.8%**
Farm products	8,703,175	18.2%	10,279,106	**12.2%**	**18.1%**
Food and kindred products	4,728,434	9.9%	10,960,225	**13.0%**	**131.8%**
Chemicals or allied products	3,853,898	8.0%	7,787,390	**9.3%**	**102.1%**
Other commodities	20,005,432	41.7%	41,587,684	**49.5%**	**107.9%**
Total	**47,944,696**	**100.0%**	**84,021,716**	**100.0%**	**75.2%**

Source: Federal Highway Administration, Freight Analysis Framework, 1998.

Shipments of the electronics industry will be among the fastest growing industries in terms of tons. As shown previously in this section (see Table 2.2), the electronics industry represented 32 percent of all shipments in the State by value. In terms of tons, the electronics industry is forecasted to grow by 271 percent between 1998 and 2020, compared to 87 percent for all Arizona goods. Therefore, the disproportionately higher increase in the electronics industry will result in this industry further increasing its share of the total value of all shipments for the State. Use of parcel services will continue to be the most important mode for the electronics industry. However, air and truck will be critical as well. Because the electronics industry will be an increasing part of the goods-related economy in Arizona, the needs of the electronics industry should be considered an important element of transportation planning conducted by ADOT and regional agencies across the State.

3.0 Goods Movement and the International Economy

3.0 Goods Movement and the International Economy

3.1 Exports

In 2002, $11.9 billion of exports were shipped out of Arizona (Table 3.1). This is a significant percentage relative to the total $86 billion of domestic goods that were shipped originating in Arizona in 1997. Mexico is the largest single export country for Arizona. Mexico received $3.0 billion of goods from Arizona in 2002, 26 percent of the total exports from Arizona in terms of value. However, the shipments to Asian countries exceeded the value of shipments to Mexico. The top nine export destination countries in Asia received $3.9 billon of goods from Arizona, while Mexico received $3.0 billion. Malaysia received $1.2 billion of goods, or 40 percent of the total for Mexico.

Table 3.1 Destinations for Arizona's Exports in 2002

Region	Exports (Millions of Dollars)	Percent of Total
Asia (top 9 countries only)	3,868.7	33%
Mexico	3,044.2	26%
Europe (top 4 countries only)	2,140.9	18%
Canada	1,167.3	10%
Total (top 15 countries)	10,221.1	86%
Other	1,649.9	14%
Arizona Total	**11,871.0**	**100%**

Source: U.S. Census Bureau, Foreign Trade Division, 2002.

Canada is the third largest recipient of Arizona exports, receiving $1.1 billion of goods in 2002. However, Arizona's exports to Europe were nearly double its exports to Canada. The large value of exports to Asia and Europe was due primarily to the size of these economies relative to the economies of Mexico and Canada. Therefore, in terms of value, the amount of exports was a function of both proximity to the state of origin and the size of the economy of the trade partner. The large value of exports to Asia and Canada underscores the importance of air cargo for the health of the Arizona economy.

Companies that have suppliers or customers overseas rely heavily on the parcel and bulk air cargo modes for shipments.

The Foreign Trade Division of the U.S. Census Bureau reports export data on the top 25 commodities at the six-digit level, defined by the Harmonized System Commodity Code (HSCC). These top 25 commodities represented 60 percent of the total exports for Arizona in 2002. Table 3.2 shows the groupings of 25 commodities into their respective two-digit HSCC categories. At the two-digit level, three of the commodities account for over one-half of the exports for the State, including:

- Electrical machinery and equipment;
- Aircraft, spacecraft, and parts; and
- Machinery, not electrical.

As shown in Table 3.2, Arizona's largest export commodity is electrical machinery and equipment, which accounts for over one-third of the total exports. This underscores the importance of the electronics industry for Arizona.

Table 3.2 Arizona Exports by Commodity in 2002

HS Code	Description	Exports ($ Millions)	Percent of Total
85	Electrical Machinery and Equipment	4,110.5	**35%**
88	Aircraft, Spacecraft and Parts	1,323.8	**11%**
84	Machinery, not Electrical	890.4	**8%**
90	Precision Parts and Accessories	239.1	**2%**
39	Plastic Products	216.9	**2%**
93	Arms and Ammunition	125.6	**1%**
52	Cotton and Fabrics	111.6	**1%**
48	Paper Products	85.0	**1%**
83	Articles of Base Metal	66.4	**1%**
Other	Other	4,701.7	**40%**
Total		**11,871.0**	**100%**

Source: U.S. Census Bureau, Foreign Trade Division, 2002.

3.1.1 Goods Movement at the Arizona-Mexico Border

Mexico is the largest single destination country for Arizona exports. The vast majority of the trade between Arizona and Mexico is transported by truck and rail. The U.S. Department of Transportation (DOT) records data on transborder surface trade at each of the border states in the U.S. Table 3.3 shows the distribution of the commodities that are exported to Mexico across the Arizona border. (Note that this table includes goods that are produced outside of the State, but are exported via Arizona.) Goods from the electronics industry represent over one-third of the transborder shipments through Arizona. Table 3.3 mirrors the export statistics shown in Table 3.1 for Arizona and shows similar values of the electronics industry for domestic shipments. Plastics, machinery, and paper products are the next three largest export commodities; combined, these commodities represent 28 percent of the total exports.

Ninety-five percent of the goods by value exported from Arizona to Mexico move by truck. However, 80 percent of the lower value goods (denoted by "other" in Table 3.3) are transported using trucks. This is consistent with overall modal usage of truck and rail. Low-value goods tend to use rail more often than high-value goods.

Table 3.3 U.S.-Mexico Surface Exports Through Arizona, 2002

Commodity Description	Export Value – All Modes ($ millions)	Percent of Total Exports	Export Value – Trucks Only ($ millions)	Percent of Commodity Hauled by Truck
Electrical machinery and equipment and parts	1,029.2	36%	1,013.7	98%
Plastics and articles	393.6	14%	391.5	99%
Machinery (non-electrical) and parts	255.0	9%	249.2	98%
Paper products	138.3	5%	129.5	94%
Precision instruments and apparatus	94.0	3%	93.7	100%
Articles of base metal	88.5	3%	87.1	98%
Aluminum and products	64.8	2%	64.7	100%
Articles of iron or steel	57.8	2%	57.0	99%
Copper and articles	53.0	2%	48.8	92%
Motorized vehicles (excluding railway vehicles)	46.8	2%	46.1	99%
Meat and edible meat offal	43.9	2%	42.8	97%
Other	566.3	20%	457.4	81%
Total	**2,831.2**	**100%**	**2,681.5**	**95%**

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Surface Freight Data, 2002.

The Federal Highway Administration's (FHWA) Freight Analysis Framework (FAF) database reports tonnage of goods moved by mode. The vast majority of international flows is destined for Mexico, and the vast majority of all exports to Mexico uses the highway. The FAF database can be used to examine the commodity distribution between Arizona and Mexico in terms of tonnage, and it can be used to examine growth rates for each commodity between Arizona and Mexico.

Several low-value commodities are the largest goods exported from Arizona to Mexico in terms of tonnage. Farm products, petroleum or coal products, and stone products constitute nearly one-half of the total export tons. In contrast, the commodities with the highest values represent relatively few of the tonnage exports. As shown in Table 3.4, electronic goods, plastics, and machinery represent 59 percent of the total exports by value, but only 12 percent by tonnage.

Table 3.4 Commodity Distribution by Highway of Export Tons Originating in Arizona, 1998 and 2020

STCC	Highway 1998 (Tons)	Percent of Total	Highway 2020 (Tons)	Growth (1998-2020)
Farm products	521,000	28%	1,206,100	131%
Petroleum or coal products	244,700	13%	844,200	245%
Clay, concrete, glass or stone products	167,100	9%	454,300	172%
Primary metal products	156,100	8%	380,500	144%
Food products	150,800	8%	335,500	122%
Rubber and plastic products	106,600	6%	250,900	135%
Pulp and paper products	106,000	6%	272,900	158%
Chemicals or allied products	80,600	4%	250,000	210%
Machinery, not electrical	74,700	4%	445,700	497%
Fabricated metal products	63,900	3%	167,200	162%
Transportation equipment	35,700	2%	159,000	346%
Electrical machinery, equipment or supplies	33,100	2%	251,400	660%
Nonmetallic minerals	27,100	1%	50,600	87%
Other	109,300	6%	327,900	200%
Total	**1,876,600**	**100%**	**5,396,100**	**188%**

Source: Federal Highway Administration, Freight Analysis Framework Database, 1998.

Several of the highest value goods are also the fastest growing export commodities in Arizona. For example, exports of electronics by highway are projected to grow from 33,000 tons in 1998 to 251,000 tons in 2020. This is a 660 percent increase overall, and a

9.7 percent annual increase. If the value of electronics goods grows in proportion to the projected tonnage growth, electronics exports will grow from $1.0 billion in 2002 to $5.4 billion in 2020. Arizona's other fast-growing commodities are also high-value goods. Between 1998 and 2020, machinery and transportation equipment are forecast to grow 497 percent and 346 percent, respectively.

3.2 Imports

As shown in Table 3.5, the commodities Arizona imports from Mexico are very different from the commodities it exports. Food and farm-related products represent 35 percent of total imports in terms of value. Nogales, the main port of entry from Mexico to Arizona, is the largest port of entry for winter vegetables in the United States. By comparison, the highest food or farm-related export to Mexico in terms of value was meat products, which represented just two percent of the total.

High-value commodities are also evident in imports, but in smaller proportions. Electronics is the second largest import category in terms of value, with 22 percent of the total import value. Machinery is the third largest, at 14 percent. Some high-value goods are manufactured in Maquiladoras in the Sonora region at the Arizona-Mexico border. The Maquiladoras are described in more detail in Section 3.3.2.

The FHWA FAF data can also be used to determine the distribution of the commodities imported from Mexico to Arizona. Farm and food products, for example, represent a higher total of the tonnage compared to the value: 60 percent of the imported goods by tonnage, compared to 35 percent in terms of value. Conversely, the electronics industry and machinery each represents six percent of the imports by tonnage, while they constitute 35 percent of the imports from Mexico in terms of value.

As shown in Table 3.6, Arizona's trade (of farm products in particular) with Mexico will grow much more quickly than Arizona's domestic trade. Between 1998 and 2020, imports carried by truck are projected to grow more than 300 percent, while exports carried by truck are projected to grow by 188 percent. Over the same period, domestic goods carried by truck are expected to grow by 120 percent. Electronics goods and machinery are projected to be the two fastest growing import commodities for Arizona (see Table 3.6). All of the top eight imported commodities are projected to at least double in tonnage from 1998 and 2020.

Table 3.5 U.S.-Mexico Surface Imports Through Arizona, 2002

Commodity Description	Import Value ($ millions)	Percent of Total
Edible vegetables	797.6	23%
Electrical machinery and equipment and parts	781.7	22%
Machinery (non-electrical)	457.7	13%
Edible fruit and nuts	199.0	6%
Copper and articles	197.9	6%
Fish and other marine products	137.1	4%
Textile articles	132.3	4%
Special classification provisions	118.0	3%
Precision instruments and apparatus	92.7	3%
Live animals	80.5	2%
Articles of apparel and clothing accessories	70.3	2%
Articles of base metal	58.7	2%
Aluminum and articles	51.2	1%
Zinc and articles	28.0	1%
Motorized vehicles (excluding railway vehicles) and parts	27.2	1%
Plastics and articles	23.1	1%
Other	223.4	6%
Total	**3,476.4**	**100%**

Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Transborder Surface Freight Data, 2002.

Table 3.6 Commodity Distribution for Imports into Arizona (Highway Only), 1998 and 2020 (Tons)

Commodity	Highway 1998	Percent of Total	Highway 2020	Growth (1998-2020)
Farm products	1,369,600	55%	5,539,000	304%
Electronics	161,400	6%	1,109,500	587%
Machinery	148,000	6%	797,800	439%
Food Products	130,600	5%	667,500	411%
Primary metals	103,400	4%	365,200	253%
Stone products	101,800	4%	459,200	351%
Transportation equipment	97,900	4%	442,800	352%
Miscellaneous products of manufacturing	94,60	4%	327,100	246%
Rubber or miscellaneous plastic products	401,000	2%	144,000	251%
Other	245,300	10%	1,106,200	351%
Total	**2,493,700**	**100%**	**10,958,200**	**339%**

Source: Federal Highway Administration, Freight Analysis Framework Database, 1998.

3.3 Highway Flows at the Arizona-Mexico Border

3.3.1 Arizona-Mexico Border Crossing Points

The primary port of entry from Mexico to Arizona is through Nogales. The Nogales Port of Entry consists of the following crossings:

- Nogales I and II, located in the downtown area of Nogales near the terminus of I-19; and
- Nogales III, located on SR 189, approximately 1.5 miles west of Nogales I and II.

Nogales I has pedestrian, passenger vehicle, and rail access between Mexico and the U.S. Nogales II is a pedestrian crossing only, and is located immediately east of Nogales I. Nogales III serves commercial and passenger vehicles. Nogales III is reached via SR 189 (Mariposa Road), which interchanges with I-19 approximately 3.1 miles north of the border crossing. Mariposa Road is a two-lane facility from Nogales III to I-19. For commercial trips, Nogales III is open from Monday through Friday between 9:00 a.m. to 8:00 p.m., and Saturday from 9:00 a.m. to 6:00 p.m.

In 1996, the state DOTs for Arizona, Nevada, Utah, Idaho, and Montana, along with the Mexican province of Sonora and the Canadian province of Alberta, sponsored the CANAMEX Corridor Study to evaluate the needs for the highway system that connects Mexico to Canada through each of these states. In Arizona, the CANAMEX Corridor would operate on I-19, I-10, and U.S. 93, utilizing the new Hoover Dam Bridge. In Maricopa County, a bypass of the Phoenix-Mesa metropolitan region is planned that would route trucks on I-8, SR 85, and a yet-to-be built connector from the SR 85 and I-10 junction to U.S. 93.

According to this study, commercial daily truck traffic at the Nogales Port of Entry varied from 400 to 1,200 vehicles per day in 1999, with the heaviest traffic occurring during the winter months. A total of 14.4 million passengers and pedestrians; 255,000 commercial trucks; and 34,500 rail cars crossed the border from Mexico in 1999. The CANAMEX Corridor Study also estimated that international flows constitute 83 percent of the truck volume on I-19 between Nogales and Tucson, equating to roughly 2.7 million annual tons of international truck movement.

3.3.2 Economic Activity from Maquiladoras

A significant amount of the trade at the Arizona-Mexico border is related to the Maquiladora activity in the Sonora region of Mexico. The term Maquiladora refers to a manufacturing or processing firm that operates in Mexico to assemble component parts temporarily imported from other countries, and subsequently to export the completed product to the home country for final processing and sale. Maquiladora inputs are

divided into two categories: 1) primary materials (components and parts), and 2) packaging materials. As shown in Table 3.7, in 1997, total primary materials inputs for all of Mexico from all home countries were $34.5 billion, and total packaging material was worth more than $1.5 billion. The vast majority of the inputs was imported. The industry mix of the Maquiladoras is similar to the industry mix in Arizona. The electronics industry represents just over one-third of the destination for inputs of Maquiladoras. Other heavy manufacturing industries, such as transportation equipment and machinery, are also major industries for the Maquiladoras.

Table 3.7 Inputs for Maquiladoras, 1993 to 1997
(in Millions of Dollars)

Industry	Total Inputs 1993	Total Inputs 1997	% Change (1993-1997)	Imported Inputs 1997	Percent of Inputs That Are Imported
Electronics	5,751	13,720	139%	13,528	99%
Transportation equipment	5,516	7,779	41%	7,726	99%
Machinery and equipment	2,204	5,234	138%	5,172	99%
Apparel	1,029	3,231	214%	2,687	83%
Other manufacturing	1,350	3,121	131%	3,046	98%
Wood and metal furniture	932	1,132	21%	1,066	94%
Services	302	809	168%	767	95%
Tools	176	422	140%	414	98%
Chemical products	256	378	48%	354	93%
Toys and sporting goods	145	240	66%	227	95%
Leather and footwear	115	200	74%	198	99%
Food items	144	125	-13%	71	56%
Total	**17,920**	**36,392**	**103%**	**35,256**	**97%**

Source: *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, Arizona-Mexico Commission, 1999.

A study of the Maquiladora industry, titled *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, was produced for the Arizona-Mexico Commission in 1999. According to the study, at the end of the 1990s, the Sonoran Maquiladora industry included 326 factories, 36 industrial parks, and a workforce of 95,000. The study estimated that 24,000 direct jobs and 22,000 indirect and induced jobs were generated in Arizona from different industry sectors for exporting goods to Mexico.

In 1997, according to the Border Trade Institute, roughly 85 percent of all exported goods leaving the United States through Arizona border points of entry were destined for Sonora. Since $2.9 billion of goods were exported through Nogales that year, at least

$2.4 billion worth of goods traveled from the U.S. to Sonora through Arizona. The vast majority of these exports are goods that were produced in Arizona.

The Arizona-Mexico Commission report also included the results of a survey of 48 Maquiladoras in the Arizona-Sonora region. The survey included a question regarding the factors influencing the decision to locate a subsidiary in the Sonora region. Table 3.8 shows the results of this survey item with each potential benefit rated on a five-point scale, with 1 being "not important" and 5 being "very important." Of the 12 benefits considered, low labor costs ranked as the number one reason to locate a subsidiary in Sonora, with two-thirds of the respondents rating this factor "very important." The availability of a skilled workforce, low transportation costs, and the availability of cross-border transportation carriers ranked second, third, and fourth, respectively. Each of these three factors was considered "very important" by about one-third of the respondents. These responses suggest that the efficient operation of the state transportation system is crucial to the success of the Arizona-Sonora Maquiladora economic relationship. Conversely, the availability of third-party logistics firms was seen as not an important factor in this location decision. About 79 percent of the respondents felt that this was either "not important" or "somewhat important" in their decision.

Overall, as shown in Table 3.9, the survey respondents identified few barriers to the future success of the Maquiladoras. In particular, transportation infrastructure was not seen as a significant barrier to success for the Maquiladoras in the region. About 40 percent of the respondents felt that this was not an important factor at all, and only nine percent felt that it was very important. Border-crossing delays were seen as slightly more important by 63 percent of all respondents, indicating that this factor is between somewhat important to very important.

3.3.3 Through Trips from International Goods Movement

In terms of tonnage, through trips of international goods using the Arizona transportation system are much larger than through trips of domestic goods. As shown in Table 3.10, over six million tons of international goods travel between California and Texas alone. This is more than the sum of the total exports to Mexico from Arizona and the total imports from Mexico to Arizona, and is an underestimate of the through flows because several other international goods travel through Arizona. North-south through trips, in particular, are not captured in the California-Texas movement. Many of these goods likely utilize the El Paso border point of entry and travel between El Paso and the population centers in California. It is preferable for goods developed in central and eastern Mexico to use a Texas border crossing location, because the transportation infrastructure in the southwestern U.S. is in better condition than the transportation infrastructure in Mexico.

Table 3.8 Factors Influencing Sonoran Location Decision

Benefit	Not Important	Between Not Important and Somewhat Important	Somewhat Important	Between Somewhat and Very Important	Very Important	Mean
Low labor costs	2%	2%	9%	20%	67%	4.47
Availability of skilled workforce	0%	6%	34%	23%	36%	3.83
Low transportation costs	**2%**	**2%**	**46%**	**15%**	**35%**	**3.78**
Availability of cross-border transportation carriers	**4%**	**8%**	**30%**	**23%**	**34%**	**3.74**
Inexpensive land and/or rental costs	7%	11%	47%	18%	18%	3.29
Ease of technology transfer	11%	7%	36%	32%	14%	3.30
North American Free Trade Agreement (NAFTA) provisions	28%	5%	23%	12%	33%	3.16
Concentrated presence of other Maquiladoras	18%	7%	35%	22%	18%	3.15
Close proximity to U.S. consumer markets	20%	11%	30%	15%	24%	3.13
Close proximity of parent company	33%	6%	17%	15%	28%	3.00
Close proximity of suppliers	22%	17%	33%	15%	13%	2.80
Availability of third-party logistics firms	35%	14%	30%	12%	9%	2.47

Source: *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, Arizona-Mexico Commission, 1999.

Table 3.9 Barriers to Future Success of the Maquiladoras

Benefit	Not Important	Between Not Important and Somewhat Important	Somewhat Important	Between Somewhat and Very Important	Very Important	Mean
Availability of skilled workforce	8%	13%	35%	27%	17%	3.30
Foreign competition	13%	21%	30%	19%	17%	3.10
Border-crossing delays	**19%**	**19%**	**26%**	**26%**	**11%**	**2.90**
Government regulations	26%	19%	32%	19%	4%	2.60
U.S. competition	40%	23%	28%	13%	6%	2.40
Transportation infrastructure	**40%**	**13%**	**34%**	**4%**	**9%**	**2.30**
Mexican competition	53%	11%	26%	2%	9%	2.00
Availability of financing	63%	15%	9%	7%	7%	1.80

Source: *The Maquiladora Industry in the Arizona-Sonora Region: Impacts and Trends*, Arizona-Mexico Commission, 1999.

Table 3.10 Imports, Exports, and Selected International Through Flows in 1998

Shipment Type	Tons	Percent of Total
Exports (originating in Arizona)	1,876,577	18%
Imports (destined for Arizona)	2,493,687	24%
International through flows (CA-TX only)	6,102,462	58%
Total	**10,472,726**	**100%**

Source: Federal Highway Administration, Freight Analysis Framework Database, 1998.

The CANAMEX Corridor Study described high volumes of international trucks that use Arizona's highways. This study estimated that roughly 2.7 million truck tons of international goods use I-19 between Nogales and Tucson, as described in Section 3.3.1. This compares to roughly 7.5 million truck tons of international goods estimated on I-10 between Tucson and Phoenix. At a minimum, 4.8 million of the 7.5 million truck tons are likely from east-west traffic, rather than the north-south traffic that emanates from Nogales. The east-west traffic likely use border crossing points to the east and west of Nogales, but the only other major border crossing points are outside of the State. Therefore, these out-of-state border crossing points are responsible for trucks that ultimately use Arizona highways.

4.0 Logistics Trends

4.0 Logistics Trends

Worldwide logistics trends have created an intensely competitive global environment in which shippers, receivers, carriers, and intermediaries participate. From the myriad shifts taking place in the logistics field, several major national trends were identified, and the implications of these trends on goods movement in Arizona are described in the following section.

4.1 National Trends

This section describes seven national trends that will continue to influence the nature of goods movement in Arizona. The seven trends are:

1. Shift toward customer-based requirements;
2. Declining logistics costs relative to Gross Domestic Product (GDP);
3. Inventory reductions and Just in Time (JIT) trends;
4. Cycle time reduction;
5. Outsourcing of logistics services;
6. Globalization; and
7. Postponement and transloading.

4.1.1 Shift toward Customer-Based Requirements

A large part of the trends toward logistics functions being customer-centric is a result of deregulation. Deregulation in the U.S. has allowed companies to change their business models to be more responsive to customers through transportation, communications, utility, and financial functions. At the same time, deregulation has dramatically increased competition and forced carriers to become more responsive or lose business.

Customers for logistics services (e.g., warehouses, truck, etc.) have a very wide range of requirements and varying levels of sophistication. Several logistics options have developed in recent years to meet different customer needs. For example, in highly competitive markets with slim profit margins (e.g., retail supermarkets), participants are under intense pressure to minimize logistics costs, while maintaining competitive service levels. For goods in which profit margins are higher, but competition is still stiff (e.g., retail

computers), logistics performance is crucial, but costs are of lesser concern. For goods in which time-to-market is critical (e.g., high-fashion apparel), speed becomes foremost. For products with low values (e.g., sand and gravel), predictable delivery is more important than speed. In this case, logistics costs are driven down, but reliability must be maintained. For products that have severe implications for service failure (e.g., "shut down" loads of parts for assembly lines), no logistics cost will be spared to deliver on time.

At the margin and overall, the market is requiring improved reliability (better), shorter order cycle times (faster), and lower unit logistics costs (cheaper). Firms are willing to have less visibility of the actual conduct of the operation, and may even want to reduce management involvement in day-to-day logistics. The market recognizes that choosing among options and managing carriers are both getting more complex than can be managed in-house, and is looking to carriers and logistics management companies for outsourced support.

In practical terms, "better, faster, cheaper" translates into a set of stringent customer demands for high-quality service. To provide "better" freight transportation systems, carriers and intermediaries alike must offer national or even global reach, e-commerce capabilities, high reliability, and strong customer service. In addition, transportation systems must be reliable to the point where travel times are predictable for logistics service providers. Multiple supply chains will be needed to support different customers' characteristics.

To provide "faster" transportation, carriers must invest in new equipment, new terminals, and new operating systems. To provide "cheaper" transportation, carriers must continuously reduce expenses and compete strenuously for new business, while intermediaries attempt to exploit the cost-saving potential of shipment consolidation and increased bargaining leverage with customers and carriers.

4.1.2 Declining Logistics Costs Relative to GDP

The level of expenditures for logistics services in 2002, as reported by the Cass/ProLogis *State of Logistics Report,* was $957 billion (as revised). This was down from $1 trillion in 2001, the highest level of dollars ever reported for logistics costs; the first time over $1 trillion. As a percentage of the national GDP, logistics costs have been declining for many years, with 2002 being a new all time low of only 9.5 percent of GDP as shown in Figure 4.1. Recently, better management of inventories has been where the gains have been most substantial. As a percentage of GDP, inventories have been declining significantly as shown in Figure 4.2. However, not all sectors of industry have been contributing to the decline. In a study of selected sectors, the food industry (broadly defined to include processing, distribution, and retail) showed no gains over recent years.

Figure 4.1 Historical Spend on Transportation and Inventory from 1981 to 2001

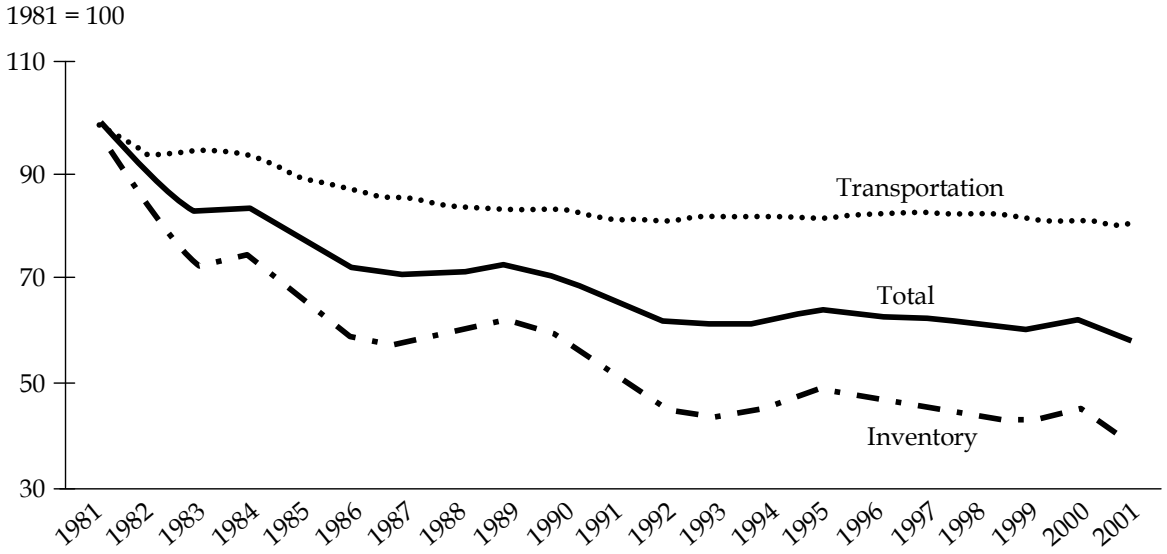
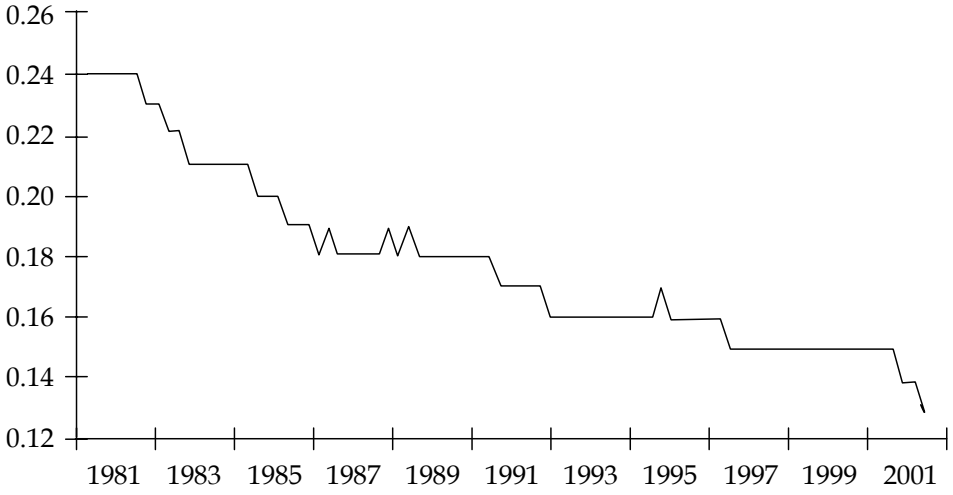


Figure 4.2 Historical Spend on Inventory as a Percent of GDP from 1981 to 2001



Source: U.S. Department of Commerce.

4.1.3 Inventory Reductions and JIT

The dollar value of inventory as a percentage of national GDP has been declining since the early 1980s. Reductions in finished goods and in-process inventory have been accomplished by precise engineering of transport modes and instant data availability. With rare

exception, stock-outs have been avoided often by moving small amounts of product via expedited services (at a transportation cost premium) to in-fill the expected shortfall. Use of such contingencies is information intensive. As a result, there has been a proliferation of computer software designed and installed to accomplish the necessary status reporting and remedial actions.

All of this augurs for smaller shipments (less than 75 to 100 pounds); moving shorter distances (in local metropolitan areas); via the fastest mode (express, dedicated truck); via the most reliable mode (one truck with its driver); with total visibility of location; timing and product at the Stock Keeping Unit level; monitoring product condition, such as temperature and level of security risk; and a proliferation of small trucks on the metropolitan roads. In turn, it augurs well for a service that can provide faster transit and greater reliability than the over-the-highway option.

JIT refers to a drastic case of inventory reduction, where inbound shipments are timed to arrive just when they are needed and on-site inventory is minimized. JIT practices have received widespread attention in the industry and popular press, but true JIT operations are relatively rare as they require intensive management and leave production vulnerable to minor outages. Tightly managed inbound logistics and low inventories, whether truly JIT or not, have important implications for truck movement in urban areas. In particular, JIT-like scheduling effectively transfers a portion of the inbound inventory to the streets. In order for a trucker to make a tight delivery appointment with near 100 percent certainty, the driver will arrive early and wait in the near vicinity of the destination. Often drivers will actually arrive in the area the night before to make sure of meeting morning appointments. Thus, a substantial portion of the inventory will be waiting in loaded trucks on nearby streets, in truck stops, or in legal or illegal off-street parking. Truckers cannot risk morning rush hour traffic, and so will typically either spend the night parked nearby or make an early morning trip from a regional truck stop.

4.1.4 Cycle Time Reduction

"Better, faster, cheaper" has come to summarize the logistics demands of major purchasers. From the carrier perspective, "faster" means reduced cycle time – in this case, the time required from product manufacturing to retail delivery. Generally speaking, faster is better, since reduced cycle time translates into lower costs of keeping inventory, faster returns on production costs, and increased responsiveness to market shifts. For all carriers and intermediaries, there has been and will be continual pressure to complete the delivery or freight handling faster, with less tolerance of delay or uncertainty. In order for the entire supply chain to yield faster cycle times, each link must be highly reliable. Ironically, one common method of achieving reliable, on-time delivery is to create "slack" in the trucker's schedule. For example, to meet narrow, early morning import delivery "windows" at locations, drayage firms must often pull import loads from marine terminals the day before and store them in a secure lot overnight.

4.1.5 Outsourcing of Logistics Services

In terms of logistics, outsourcing refers to the practice of having selected goods and/or services that were previously produced within an organization supplied from an outside company. The objective is to harness the expertise and synergy of external supply chain partners to achieve success, while sticking internally to the firm's core competencies.

Outsourcing trucking services is an increasingly common practice. In general, private trucking operations have been on the decline as fleets are sold or turned over to contract operators. Shippers and receivers are more likely to rely on a select group of "core carriers," rather than expand or maintain their own truck fleet. A collateral development is the shift of responsibility for timely pickup and delivery. Formerly, receivers of goods might have been expected to stage or store incoming loaded trailers or containers on their own property until they were ready to unload them. Now, the outside trucking firms are expected to deliver loaded trailers and containers just when desired, and to manage the storage functions off-site. This trend contributes to the demand for off-street truck parking in urban areas.

4.1.6 Globalization

Globalization describes the increasing tendency of U.S. and foreign firms to obtain inputs and sell their products worldwide, searching the globe for the best opportunities. From the perspective of inbound and outbound logistics, this trend implies increasing complexity, as domestic distribution centers draw goods from multiple foreign sources using multiple modes and carriers. Globalization has also contributed to the growth in trade, as more domestic producers are exporting their output and obtaining inputs from abroad, rather than from domestic sources. Supply lines are getting longer, and longer supply chains tend to build in buffers to cope with uneven arrival times and other fluctuations in the flow of goods. This trend towards globalization has meant that goods movement is more reliant on transportation in general, and that the reliance is spread across to all of the modes.

4.1.7 Postponement

Postponement means making decisions later in the supply to take advantage of more current information enabling increased responsiveness to market shifts. Major importers are now pursuing postponement strategies by waiting longer to decide on a mix of merchandise types and volumes for each distribution center; they can use more recent demand information and reduce subsequent rework. This trend has led some importers to shift the point in the supply chain where the final make-up of a shipment is determined.

4.2 Arizona Business Trends

Over the past few decades, Arizona has become a haven for companies looking to expand or relocate. This has been particularly true for companies with operations in California or other west coast states where labor and benefit costs are higher than in Arizona. In particular, Arizona has built an infrastructure to attract high-tech companies with focus on specific niche markets. The governors of Arizona and Sonora announced the formation of four bi-national industry clusters:

1. Manufacturing;
2. Agribusiness;
3. Health services; and
4. Tourism.

Both the manufacturing and agribusiness industry clusters are heavily reliant on freight transportation as part of their operations.

There has also been a successful recruitment enacted by the Phoenix and Tucson metropolitan areas. The Phoenix metropolitan area is home to major operations for several large goods movement-related companies, including:

- Intel;
- STMicroelectronics;
- Motorola;
- Sumitomo Sitix;
- Honeywell;
- PetsMart;
- On Semiconductor; and
- Phelps Dodge Corporation.

Phoenix features extensive telecommunications infrastructure offering companies vital bandwidth, indicating that Phoenix is likely to continue to attract high-tech companies in the future. These high-tech corporations generally produce and consume high-value, low-weight products. Therefore, the companies are likely to rely heavily on parcel delivery and air cargo in the Phoenix metropolitan area. Secondarily, having reliable truck access to the air cargo facilities in the region would be a key transportation concern for these companies.

Tucson has utilized a focused cluster approach in attracting businesses to its metropolitan region. One of its primary focus clusters is in optics technology. Optics technology is used in fiber optic telecommunications, missile guidance systems, data storage, and

medical imaging. Aerospace is also one of Tucson's largest industry clusters, anchored by companies, such as:

- Raytheon;
- Honeywell;
- Bombardier;
- Texas Instruments;
- Sargent Controls; and
- Evergreen Air Center.

Aerospace manufacturing, which has long been the staple of Tucson's economy, represents defense and space-related manufacturing, research and development, industrial high-tech fields, assembly, distribution, and warehousing. With these companies as a base, it is likely that Tucson will also continue to attract high-tech companies in the future.

4.3 Goods Movement to Support Arizona's Growing Population

As shown previously in Table 2.7, a significant percent of the tonnage shipped in Arizona support consumption by the local population. Two of the largest economic activities that support local consumption are the construction and food industries. Clay, concrete, glass, or stone products, along with nonmetallic minerals, are major inputs for the statewide construction industry. Farm products and food products are also shipped in response to local population consumption. In addition, much of the secondary flows are also food and farm products. Combined, these two industries represent nearly one-half of the total goods shipped in and around the State. Consumption of these commodities and the transportation of these commodities will continue to increase significantly as Arizona's population continues to grow.

The implications of this continued demand for population-centered freight transportation is that there will be proportionately more trucks, specially more small- and medium-duty trucks, more trucks during the working hours, and more truck distribution of consumer goods brought to the urban areas of the State by rail and truck. As that occurs, the last leg of the overall supply chain from the distribution center to either the retailer or the consumer will be pressured to perform to tighter standards. Such pressure will proportionately increase the number of truck trips on the highways and the proportion of those trips conducted by local, smaller trucks, typically two-axle, light-heavy duty trucks.

Because the cost of land is more expensive in the urban areas relative to the suburban and rural areas in Arizona, many distribution centers and some local light manufacturing goods will continue to locate further from the population centers that they are actually

serving. As that occurs, the final leg of the distribution of consumer goods will be longer in miles than previously. This means that there will be a confluence of three trends: 1) smaller shipments, 2) in smaller trucks, and 3) with truck trips being longer in miles. All three result in a greater demand for highway capacity, because no alternative mode is cost or service competitive.

4.4 Supply Chain Description for Construction and Food

This section provides details on the supply chains of the construction and food industries. These industries are both large in terms of tonnage, and are directly related to the growing population of Arizona.

4.4.1 Construction

Construction is logistics intensive. It can be viewed as occurring in three separate components:

1. Getting the manpower and equipment to the job site;
2. Getting the materials used as input to the facility to the site; and
3. Getting the fixtures and furniture into the facility to make it ready for use.

Independent of the type of structure being erected, all three components exist to a degree.

The first component can include anything from bulldozers to forms for concrete pours, from cranes to forklifts to elevators. In addition, all of these items must be removed from the job site during continuing construction, but after the use of the item is completed. This necessary step is a major added complexity as it is rare that it is either physically possible or commercially viable to simply hold the item on the site until after the project is completed. Virtually all of these support equipment and supplies are scheduled into and out of the site by truck; sometimes very large trucks, including overweight and over dimension trucks and nighttime hours of arrival and departure, particularly in city centers.

The second component is getting the materials that will go into the structure onto the site. This includes positioning the materials at the point of usage. While there can be many steps in the activity chain for any one component, the final steps are the arrival (in variably by truck) and the site, unloading, queuing into sequence, and moving to place of usage. These materials become part of the finished project as opposed to those in the first component that have to be removed from the project.

The third component sometimes is overlooked. It is the arrival and installation of everything that makes the new facility operate. Examples range from utilities to furniture, to

forklifts, to paint and signs, to whatever is permanently installed in – as opposed to built into – the facility. This includes moving in the articles that the tenant/user needs to conduct its business, be it files and computers, or racks and lighting, or traffic signals and signage, or personal effects. Often, this is the most complex logistically, because typically it is not done by the contractor, but by the landlord or facility manager, whose manager is not experienced in such activities. Some managers often outsource management of this to a contractor (of a different type, such as a moving and storage company). But, even then, the arrival of the various suppliers can be fraught with complications. While this is outside of the realm of the construction industry, it is integral to the ultimate customer's operation and satisfaction with the contractor hired to build the facility.

Other factors can significantly affect the construction of the structure and have a ripple effect on the logistics practices necessary for continuous and efficient erection of the structure. Examples of such factors are:

- **Site configuration –** A Greenfield is much easier to manage than a new multi-story office building on a lot surrounded by existing structures that must be protected.

- **Congestion and traffic conditions –** Access to an open and already improved housing development is much easier to manage than adding a lane to a bridge on a freeway.

- **Proximity of personnel and supplies –** An ability to find and access a nearby subcontractor, skilled labor, and support supplies is easier in a metropolitan area than on top of a mountain deep in a wilderness.

- **Pre-prepared components –** Assembly of custom sub-assemblies is much easier than assembly of individual pieces.

- **Transportation scheduling –** Arrival of needed parts at the pre-designated time minimizes confusion; the need to store parts at the construction site; loss and damage; inventory management; and emergency shipments of critically needed tools, parts, sub-assemblies, etc.

- **A long supply chain –** Depending on the structure, input materials can come from great distances, through multiple manufacturing and distribution intermediaries, from multiple subcontractors, through multiple intermediate handlings and shipments, and from a huge array of potential vendors (or only one vendor in the case of very specialized items).

- **The need to get the part (or support material) to the point of usage –** Almost invariably, this involved a human being transporting the piece to the point of usage, whether it be the carpenter lugging in his tools or the crane operator lifting the concrete bucket to the point of discharge.

All of these factors are involved in all three components of erecting a facility. Also, all of these factors utilize trucking to a great degree. Rare are the construction sites that are on rail or on water. Instead, usually, there is a truck trip from the source of the materials to the staging point ahead of the point of usage. So, while lumber, as an example, may be

sourced from a nearby lumberyard that obtained it via rail car or water barge, the last leg is by a truck, often trucks of multiple sizes and configurations, to bring the lumber to the point of usage. Like lumber, any of the other items that go into the final facility, be they steel beams, asphalt, fill materials, landscaping, or light fixtures, are relatively easy to isolate and understand one at a time. It is the task of sourcing each from multiple origins and manufacturers/distributors, and then sequencing them onto the building site that is the major logistical effort. To the casual observer, this may appear relatively easy, particularly when only one item is being analyzed. However, the big picture is a huge jigsaw puzzle made even more difficult by adding the fourth dimension of timing.

In addition, the use of sub-assemblies is gaining acceptance with certain types of construction. Instead of the prior practice of bringing all the pipes and fixtures to the construction site individually, now pre-assembled sets of piping attached to fixtures are more prevalent. This is due to the economic and quality assurance of having a specialized and controlled assembly line, rather than the individual assembly on the site by a carpenter, electrician, etc. Also, for many tasks, specialized contractors are employed, such as roofers, drywall, framing, etc. These practices result in many more trips to the job site by many more people and trucks than occurs with a full-time, permanent crew staffing the job. All of these practices result in specialized, medium-sized trucks making trips to and from the job site, in addition to the pickup trucks that transport the workers to and from the site.

An additional aspect of the building/road/facility construction cluster is that all of the equipment and materials used to build the facility have to be moved to and from the site and stored when they are not in use. Often, this involves additional movements to perform maintenance on or rehabilitate the items. These items move via highway trips on trucks to intermediate and final storage locations and to/from repair stations. Often, when requisitioned for a new project, they move to a nearby staging area preparatory to being sequenced into the actual construction site.

Another critical aspect is the fact that the facility being constructed is a one-time event, but the companies, suppliers, and labor are a continuing resource. While contractors, their subcontractors, and suppliers continue in business indefinitely, each construction site has its own peculiar geography and is used, in essence, only once. Hence, contractors and their subcontractors and suppliers are somewhat amorphous and ubiquitous. It is true, however, that in some ways they do coagulate. Most of the materials used to construct a facility is relatively low value and cannot tolerate high costs of transportation. Hence, suppliers tend to be located on rail and water and received product in bulk form. Contractors need yards and storage facilities. These tend to be in very low-cost locations; sometimes, they are out in the open exposed to the elements. Hence, they will be in older parts of town in otherwise abandoned lots and warehouses.

4.4.2 Food

Food processing can be disaggregated into four components:

1. Transporting farm products from the field to processing plants;
2. Processing activities at the plant;
3. Support transportation and storage; and
4. Distribution.

Each component is described in this section.

Field to processing plant. All food products originate with a harvest from the field where the item is grown or raised. Due to the ripening process, this time interval is very short and the effort is dominated by the pressure to get the raw crop gathered and moved to the first level of processing (or to retail as a fresh product). Virtually all the logistics activity is trucking of bins, tubs, or in bulk a short distance from the field to a nearby processing plant. Most agricultural products are harvested during the summer and early fall months. However, Arizona is one of the largest producers of winter crops, so the shipping patterns in the State are slightly less cyclical than other states.

Commercial trucking companies specializing in agricultural products that follow the harvest of various crops in order to maximize utilization of their trucks and drivers do much of the trucking. The trucker does not provide most of the trailing equipment, because the farmer and/or the processor need to use the trailers to hold and stage product for processing. Due to the rush to get as much done as possible in the field during daylight hours, Federal and state hours of service regulations for trucking have specific provisions allowing truck drivers engaged in agricultural hauling to be on-duty for periods of time longer than normal commercial trucking. This can result in unsafe practices, such as poorly illuminated trailers traveling after dark on rural roads and an individual driver engaging in questionable driving practices due to fatigue.

A special case of "field" to processing plant is meat. Inventory can be carried "on the hoof" for a period of time, but once the animal is slaughtered, time is critical. However, the animal is often moved live to the point of slaughter as opposed to fruit and vegetables that have to be "slaughtered" at the point they are grown.

Activities at the processing plant. This is the first point of inventory, and it is a delicate balance. On the one hand, the plant can operate at only a fixed capacity, but the crop or meat can arrive in surges. On the other hand, the plant cannot operate in excess of 24/7 when there is demand. In fact, often, it cannot operate even a second or a third shift for lack of qualified personnel. Further, the plant is idle for most of the year; thus, to have it fully operational without breakdowns for a short, intense period of processing is very taxing. The result is that fresh product can sit in the sun getting too ripe for use if the processing plant lags too far behind demand.

Once the product is initially processed, the constraint is holding capacity (i.e., vats, tanks, or other materials handling devices used at the processing plant). This, too, is a delicate balance between time and the ultimate best and highest use for the semi-processed meat, liquid, fruit, or vegetables. Ultimately, the in-process goods have to be contained or they become waste. Again, like the initial processing, the canning, bottling, and packing are constrained by plant capacity. Lacking sufficient capacity will result in product loss, but contrary-wise having insufficient demand for the processing will have adverse economic effects.

Support transportation and storage. The cyclicality of agribusiness often manifests itself in the logistics practices of the companies as practices are compromised and compete with each other. An example is the practice of making and storing of cans or bottles prior to filling them. Empty containers have to be manufactured (and stored) well in advance of usage. However, that can be extremely expensive in terms of finding and contracting for warehousing space that gets one turn per year on its inventory. Hence, some processors try to own such storage relying on historical costs to be competitive, while others tend to rent such storage resulting in space rental costs that are so high as to make uneconomic the underlying business of selling the food. This phenomenon is even more exaggerated when applied to the storage of finished or semi-finished food awaiting sale. It is even more exaggerated when the final product requires refrigeration, such as meats and frozen processed foods, due to the higher costs of refrigerated warehousing.

Another example is the need to move the semi-finished and finished product from the point of production to and from storage. Invariably, this is trucking; although some use of rail boxcar service has been used as a devise to create temporary "storage in-transit" on the railroad. There is a material cost in such handling that is forced due to space considerations and awaiting ultimate sale. As a result, some processors have engaged in private trucking and private leasing of railcars. These have been attempts to better manage the total cost of logistics and production equation. Very frequently, such as with the transport of frozen packaged meats, the company has been lured into ancillary businesses in the attempt to utilize the assets. This has proven difficult for most as it is too far removed from the core business.

Distribution. At this point, the logistics activities become dramatically more complex and competitive. Food processors sometimes sell goods at their production site; sometimes, they sell goods at the customers' site. Sometimes, they try to operate their own sales and distribution organization. All of these are intense, both in terms of marketing and logistics. The skills required for value-added distribution and food processing are very different and not often housed at the same company. There are some exceptionally successful food retail chains, often at the expense of the producer and/or the distributor. This is because there is a real battle as to extract the value out of the supply chain. This plays out in the terms of the sale, the terms of the transaction, and the details of the logistics that get the goods from processing plant to the supermarket shelf. Logistics and terms are the essence of this business, and there are as many ways of doing this portion of the business as free enterprise can generate. The core difficulty is that farmers controlling cooperative food packers are not likely to be successful competing in food distribution. Similarly, food

distribution firms have generally not been successful integrating backwards into food processing and farming.

5.0 Freight Infrastructure and Traffic Flows

5.0 Freight Infrastructure and Traffic Flows

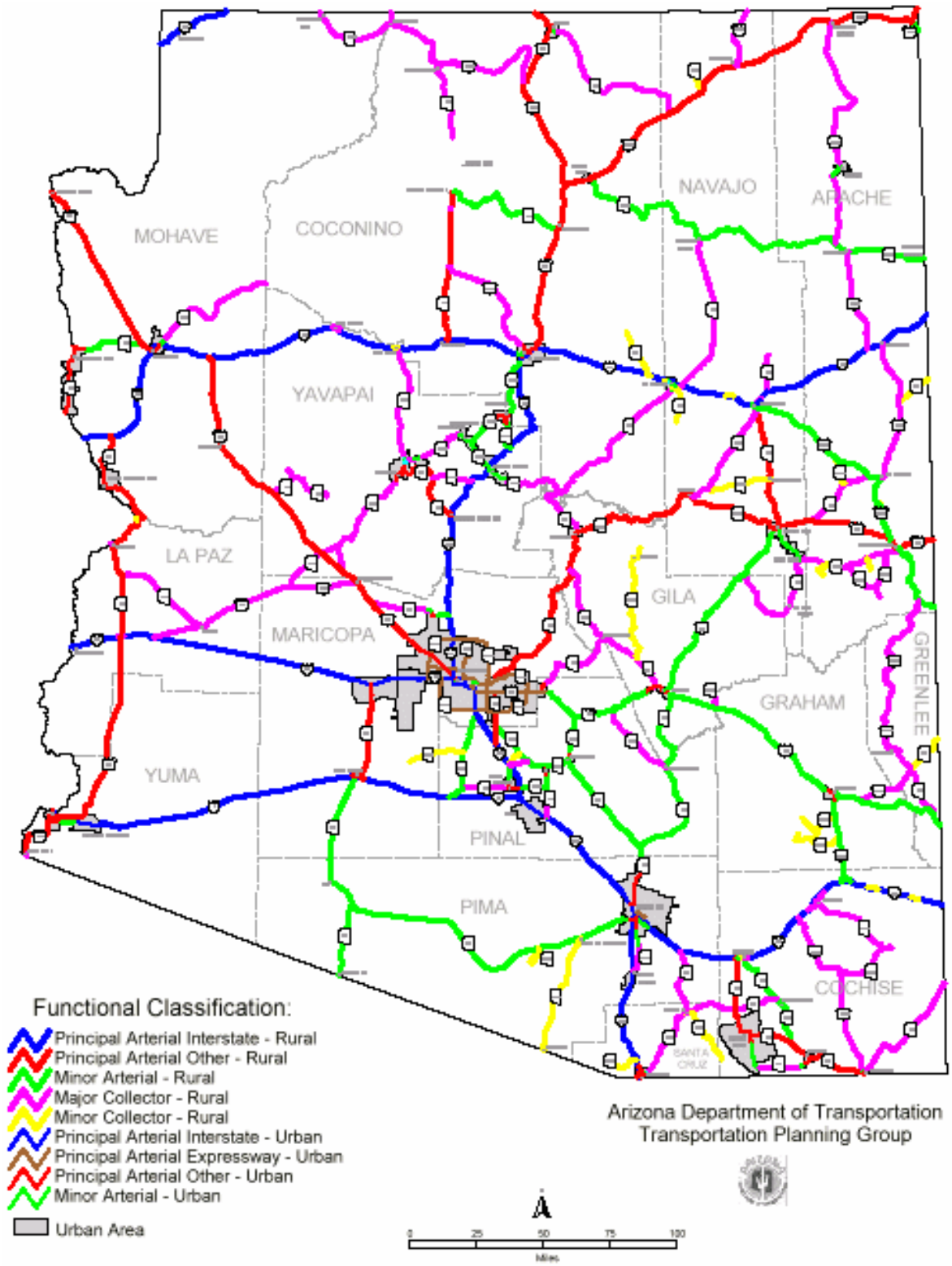
5.1 Highway Infrastructure and Flows

There are over 58,000 miles of roads in Arizona, of which two percent are interstate highways, three percent are U.S. routes, and nearly six percent are state routes. Figure 5.1 shows this extensive network by functional class. Arizona's roads are generally well-maintained; pavement ratings of "good" or "excellent" have been assigned to 79 percent of the roads owned by the Arizona Department of Transportation (ADOT), 99 percent of the interstate system, 86 percent of other freeways, and 80 percent of principal arterials.

Large trucks account for about 12 percent of the vehicle-miles traveled (VMT) in Arizona. As part of the Highway Performance Monitoring System (HPMS), ADOT counts truck at thousands of locations throughout the State. The highest truck volumes are found on the interstate system, particularly along a 100-mile stretch of Interstate 10, as shown in Table 5.1. At the 158.3 milepost on I-10 in Maricopa County, an average of 54,000 trucks passes during a typical weekday. After I-10, the next highest truck volumes are found at certain mileposts on I-40 (18,000 trucks per day); I-17 (17,000 trucks per day); and I-15 (14,000 trucks per day). The highest truck volume locations by interstate are shown in Table 5.2. The highest truck volume locations by county are shown in Table 5.3. Maricopa and Pima head the list, with an average of 54,000 trucks at the 158.3 milepost on I-10 in Maricopa County and 43,000 trucks at the 250.6 milepost on I-10 in Pima County per weekday. The location with the highest percentage of truck traffic is milepost 2.0 on I-15 in Mohave County; here, on an average weekday, 14,000 of the 22,000 vehicles recorded – 61 percent – are large trucks.

HPMS data were used to map truck volumes on Arizona's highways, as shown in Figure 5.2. The proportional thickness lines indicate that I-10 carries the largest number of trucks, although truck traffic is significant on other state highways, both urban and rural.

Figure 5.1 Major Roads in Arizona by Functional Class



Source: Arizona Department of Transportation, Transportation Division, 2001.

Table 5.1 Highest Truck Volume Locations in Arizona by Milepost, 2002

County	Inter-state	Milepost	AADT	Total Number of Trucks	Number of Single Unit Trucks	% Single Unit Trucks	Number of Combination Trucks	% Comb. Trucks
Maricopa	I-10	**158.3**	154,800	**54,200**	18,400	12%	35,800	23%
Pima	I-10	**250.6**	112,600	**42,900**	14,600	13%	28,300	25%
Pima	I-10	**251.0**	112,600	**42,900**	14,600	13%	28,300	25%
Pima	I-10	**251.4**	112,600	**42,900**	14,600	13%	28,300	25%
Maricopa	I-10	**159.3**	119,300	**41,800**	14,200	12%	27,600	23%
Maricopa	I-10	**159.5**	119,300	**41,800**	14,200	12%	27,600	23%
Maricopa	I-10	**159.8**	119,300	**41,800**	14,200	12%	27,600	23%
Pima	I-10	**253.0**	102,400	**39,000**	13,300	13%	25,700	25%
Pima	I-10	**254.3**	102,400	**39,000**	13,300	13%	25,700	25%
Pima	I-10	**251.7**	101,600	**38,700**	13,200	13%	25,500	25%

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 5.2 Highest Truck Volume Locations by Interstate, 2002

County	Inter-state	Milepost	AADT	Total Number of Trucks	Number of Single Unit Trucks	% Single Unit Trucks	Number of Combination Trucks	% Comb. Trucks
Maricopa	**I-10**	158.3	154,800	**54,200**	18,400	12%	35,800	23%
Coconino	**I-40**	197.9	41,600	**17,900**	6,100	15%	11,800	28%
Maricopa	**I-17**	212.0	216,500	**17,300**	5,800	3%	11,500	5%
Mohave	**I-15**	2.0	22,200	**13,500**	2,600	12%	10,900	49%
Pima	**I-19**	99.93*	75,100	**6,800**	2,300	3%	4,400	6%
Pinal	**I-8**	174.5	9,900	**3,900**	800	8%	3,200	32%

* I-19 is signed in kilometers. The value given above is a kilometerpost.

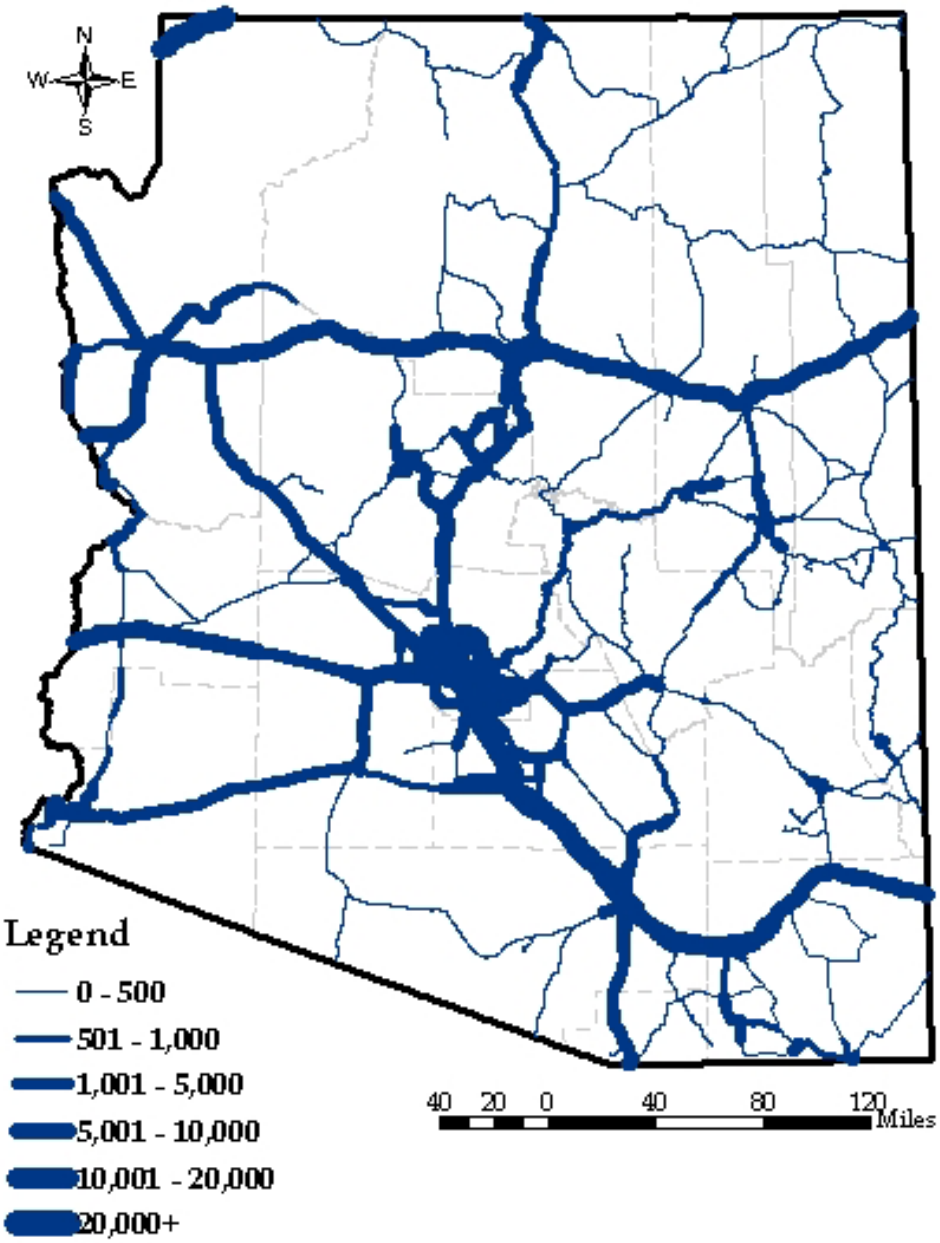
Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 5.3 Highest Truck Volume Locations by County, 2002

County	Interstate	Milepost	AADT	Total Number of Trucks	Number of Single Unit Trucks	% Single Unit Trucks	Number of Combination Trucks	% Comb. Trucks
Maricopa	I-10	158.3	154,800	**54,200**	18,400	12%	35,800	23%
Pima	I-10	250.6	112,600	**42,900**	14,600	13%	28,300	25%
Coconino	I-40	197.9	41,600	**17,900**	6,100	15%	11,800	28%
Pinal	I-10	176.4	45,800	**15,900**	3,000	7%	12,900	28%
Mohave	I-15	2.0	22,200	**13,500**	2,600	12%	10,900	49%
Cochise	I-10	297.8	37,900	**12,000**	2,300	6%	9,700	26%
Navajo	I-40	251.7	24,200	**10,400**	3,500	15%	6,900	28%
Apache	I-40	319.6	26,600	**9,900**	1,900	7%	8,000	30%
Lapaz	I-10	45.4	22,300	**9,800**	1,900	8%	8,000	36%
Yavapai	I-17	47.6	35,300	**6,700**	1,300	4%	5,400	15%
Yuma	I-8	8.9	26,200	**3,900**	1,300	5%	2,600	10%
Santa Cruz	I-19	5.3	29,700	**3,300**	600	2%	2,600	9%

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Figure 5.2 Average Daily Truck Traffic on Arizona Highways in 2002



Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Delays, caused either by unexpected events such as motor vehicle crashes or by recurring events such as rush hour congestion, can seriously disrupt the movement of freight by truck. Off-peak crashes have a disproportionately larger effect on trucks than crashes that occur at other times of day, because trucks make up a higher percentage of vehicles traveling off peak. Figure 5.3 shows the spatial relationship between truck volumes and motor vehicle crashes. Crashes occur more frequently in urbanized areas, while truck volumes are spread more evenly throughout the State. Figure 5.4 shows the spatial relationship between truck volumes and congestion. The figure indicates that trucks are most likely to suffer serious delays in Phoenix and Tucson, where congestion is greatest.

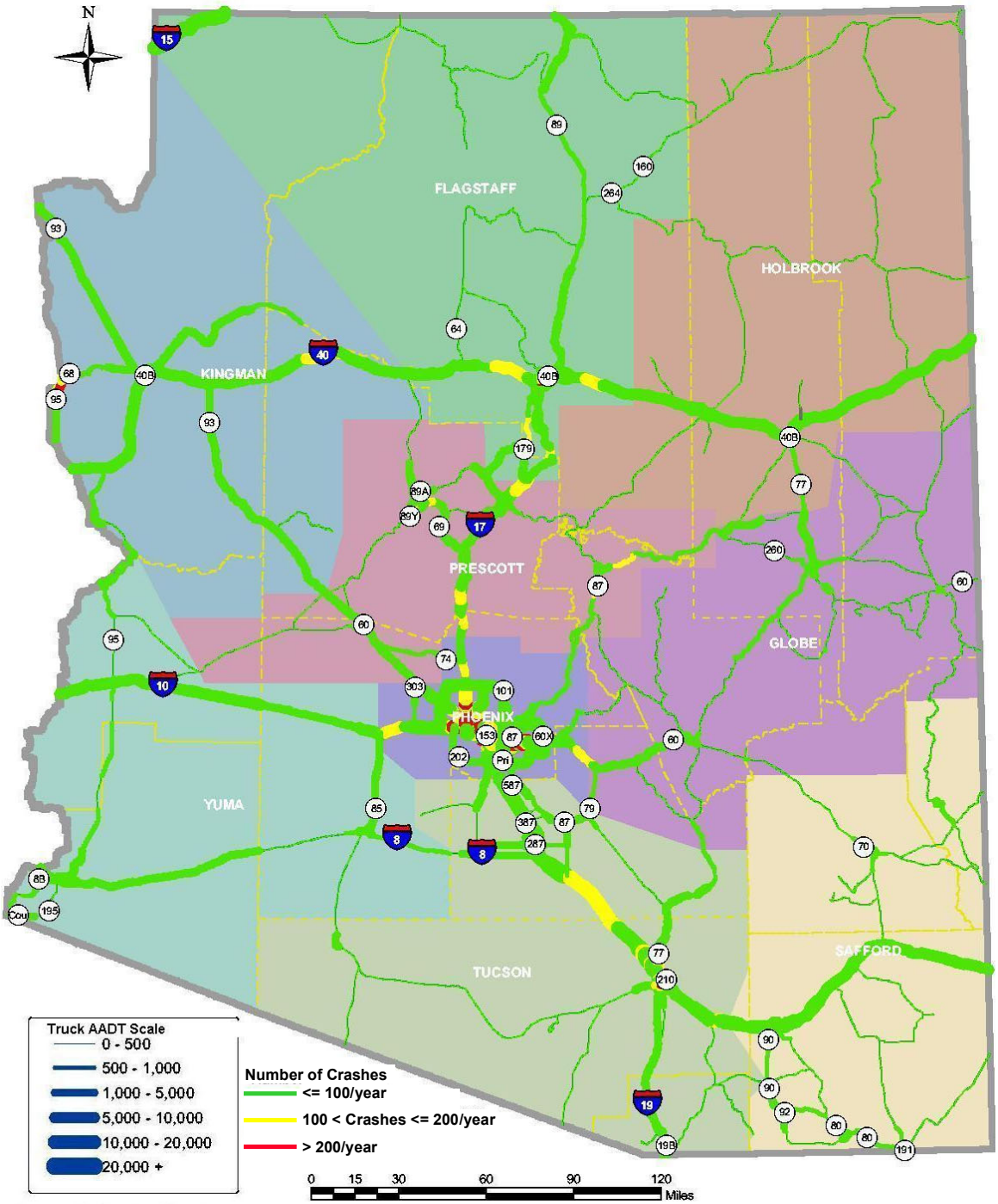
5.1.1 Highway International Ports of Entry

As shown in Figure 5.5, there are six ports of entry between Arizona and Mexico: Douglas, Naco, Nogales, Sasabe, Lukeville, and San Luis. The Port of Nogales enjoys the most convenient highway access, with Interstate Highway 19 and State Highway 82 on the Arizona side and a divided Mexican Federal Highway 15 on the Sonora side. San Luis is served by U.S. Highway 95 in Arizona and Mexican Federal Highway 2 in Sonora. Douglas is served by U.S. Highway 191, State Highway 80, and Mexican Federal Highway 2. The remaining border crossings are served only by undivided state highways. Table 5.4 shows that 348,000 trucks carrying 242,000 loaded containers of freight crossed the U.S.-Mexican border into Arizona in 1999, 74 percent of them passing through Nogales. This volume of trucks marks a 50 percent increase over Arizona-Mexico traffic reported in 1991 and 1992.

5.2 Railroad/Intermodal Infrastructure

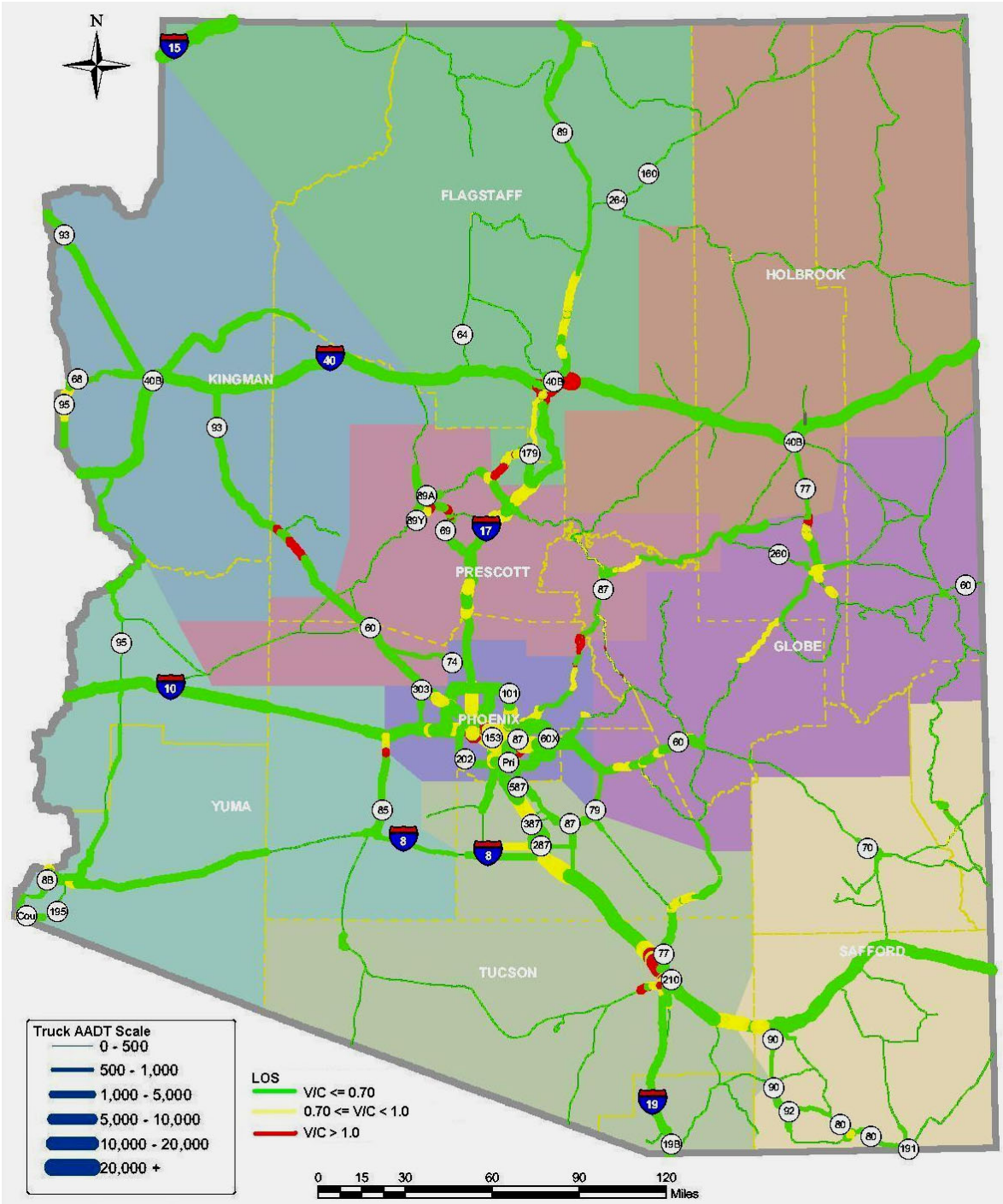
Arizona's rail network consists of 2,700 miles of track, including mainline, spurs, and yards. Of these, 1,900 actual route-miles are owned and/or operated by the railroads: 39 percent by Union Pacific (UP), 31 percent by Burlington Northern Santa Fe (BNSF), and most of remaining 30 percent by various local switching and terminal railways. A very small amount of track is operated by the U.S. Government or by private railroads for recreational purposes. All current Arizona rail lines are shown in Figure 5.6. According to the Federal Railroad Administration, there are 1,600 grade crossings in Arizona, 900 of which are public and 700 of which are private. In 2000, Arizona freight railroads employed 2,500 Arizona residents and carried 103 million tons of cargo in 4.2 million carloads.

Figure 5.3 Truck Volumes and Motor Vehicle Crashes on Arizona Highways, 2002



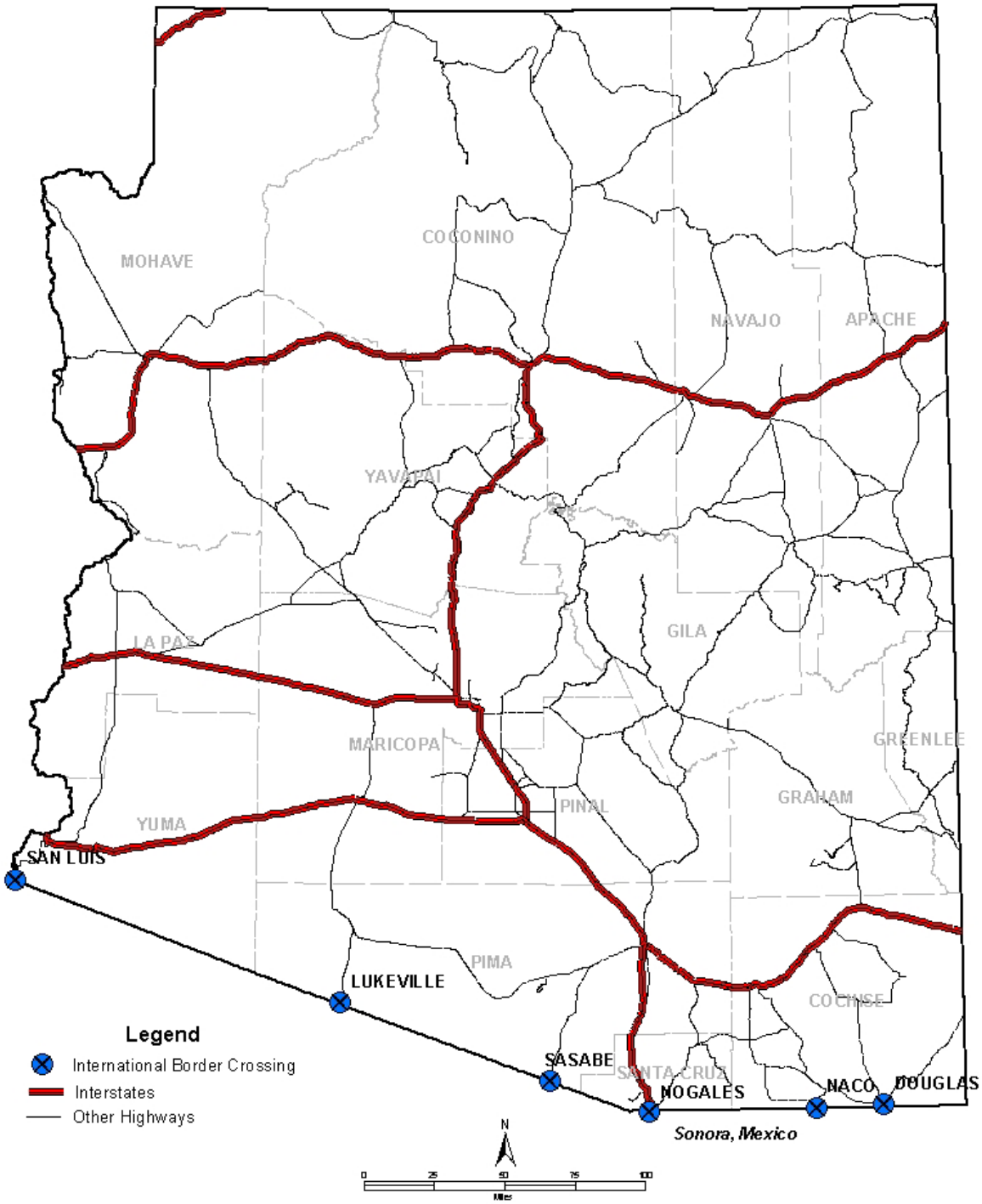
Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002; and ADOT Transportation Planning Division, 2002.

Figure 5.4 Truck Volumes and Congestion on Arizona Highways, 2002



Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Figure 5.5 Arizona International Ports of Entry



Source: Arizona Department of Transportation Planning Division, 2002.

Table 5.4 Truck, Passenger Car, and Bus Volumes at Arizona-Mexico Border, 1999

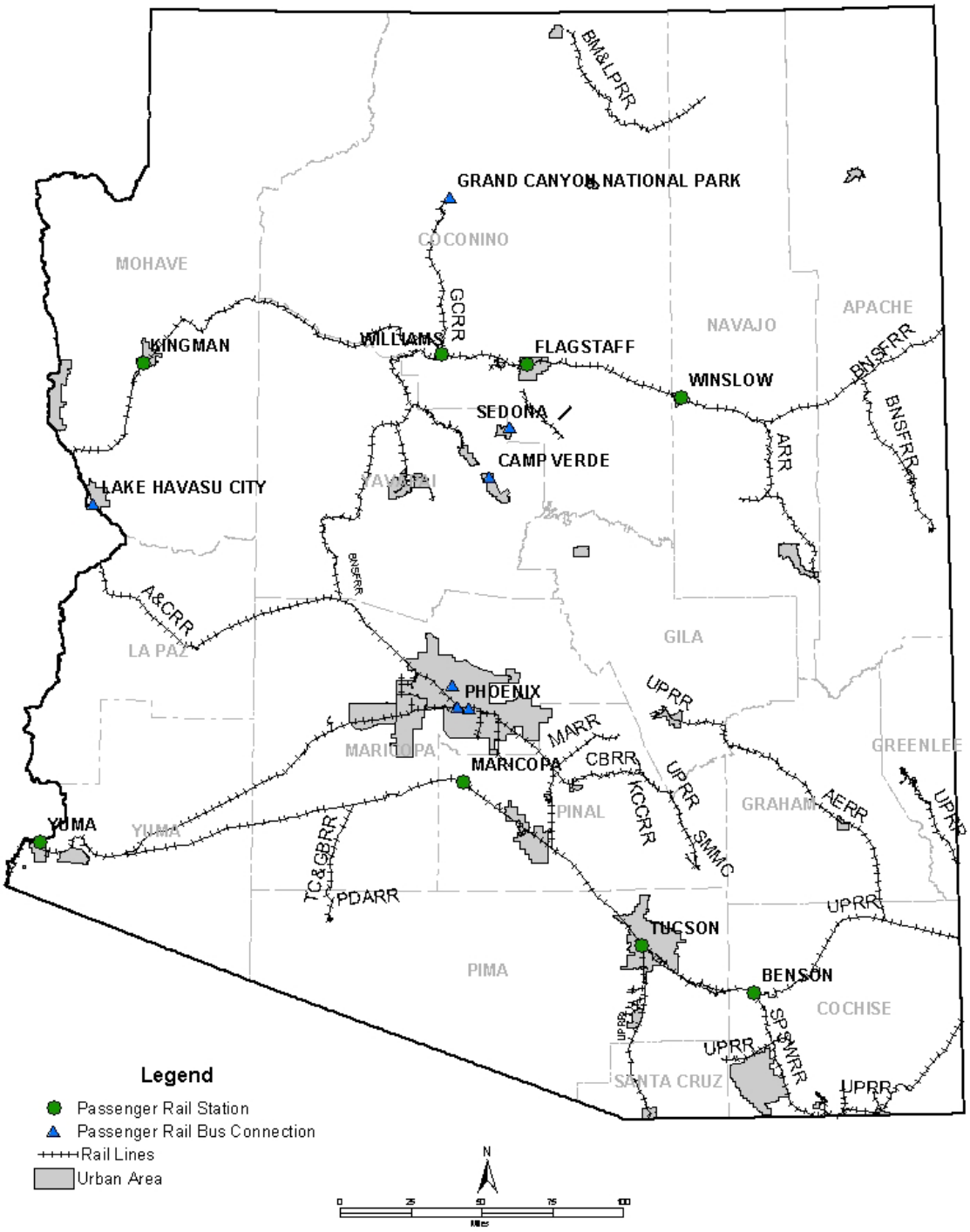
Port of Entry	Trucks	Percent of State Total	Loaded Freight Containers	Percent	Personal Vehicles Entering AZ	Percent	Buses Entering AZ
Nogales	256,426	74%	200,358	85%	4,186,962	42%	5,814
San Luis	44,829	13%	13,744	6%	2,687,387	27%	59
Douglas	32,568	9%	14,745	6%	2,150,092	22%	N/A
Naco	7,766	2%	5,886	2%	326,640	3%	N/A
Lukeville	4,291	1%	451	<1%	501,345	5%	495
Sasabe	2,442	1%	891	<1%	34,942	<1%	N/A
Total	**348,322**	**100%**	**236,075**	**100%**	**9,887,368**	**100%**	**10,018**

Source: Bureau of Transportation Statistics. Bus data not available at all border crossings.

Freight and intercity passenger rail service share the same track in Arizona. Amtrak operates three east-west through trains in states: the Southwest Chief, which provides daily service between Chicago and Los Angeles; the Sunset Limited, which provides service three times per week between Orlando and Los Angeles; and the Texas Eagle, which provides service three times per week between Chicago and Los Angeles. In Arizona, the Southwest Chief stops in Winslow, Flagstaff, Williams, and Kingman. The Sunset Limited and Texas Eagle stop in Benson, Tucson, Maricopa, and Yuma. In addition, the Grand Canyon Railway and Resort operates one round trip per day between Williams and Grand Canyon National Park. The Grand Canyon Railway serves the Amtrak station in Williams, but its schedule is not coordinated with that of Amtrak. Arizona rail lines and station locations are shown in Figure 5.6.

The Federal Railroad Administration recorded a total of 24 freight rail-related incidents in Arizona in 2003, resulting in one death, six injuries, and $4.2 million in track and equipment damage. Half of these incidents occurred in Maricopa County. Twenty-one were caused by or resulted in the derailment of a freight car or locomotive. Table 5.5 presents freight rail incident data by county, excluding rail crashes involving motor vehicles, which are reported in the FHWA crash statistics.

Figure 5.6 Arizona Railroad Lines and Passenger Stations



Source: Arizona Department of Transportation, Transportation Planning Division, 2002.

Table 5.5 Rail Incidents by County, 2003

County	Incidents	Deaths	Injuries	Reportable Damage
Cochise	2	0	0	$180,000
Coconino	2	0	0	$189,000
Gila	2	0	2	$174,000
Maricopa	12	1	4	$3,512,000
Mohave	1	0	0	$52,000
Navajo	1	0	0	$21,000
Pima	3	0	0	$37,000
Yavapai	1	0	0	$30,000

Source: Federal Railroad Administration, 2004. Excludes crashes involving motor vehicles.

5.2.1 Rail Infrastructure Between Arizona and Mexico

Important segments of Arizona's rail network serve international freight traffic between Arizona and Mexico. UP's Nogales Branch, which runs between Tucson and Nogales, parallel to I-19, connects with Grupo Ferroviaria Mexicana (GFM) at the Arizona-Mexico border. GFM operates a north-south line linking Nogales with Hermosillo, and ultimately Mexico City. As of 1998, UP handled almost 5 million gross ton-miles per mile (MGTM/M) on the line. Its shipments through Nogales include double-stack containers of auto parts bound for the Ford/Mazda assembly plant in Hermosillo, and assembled automobiles from Hermosillo bound for the U.S.

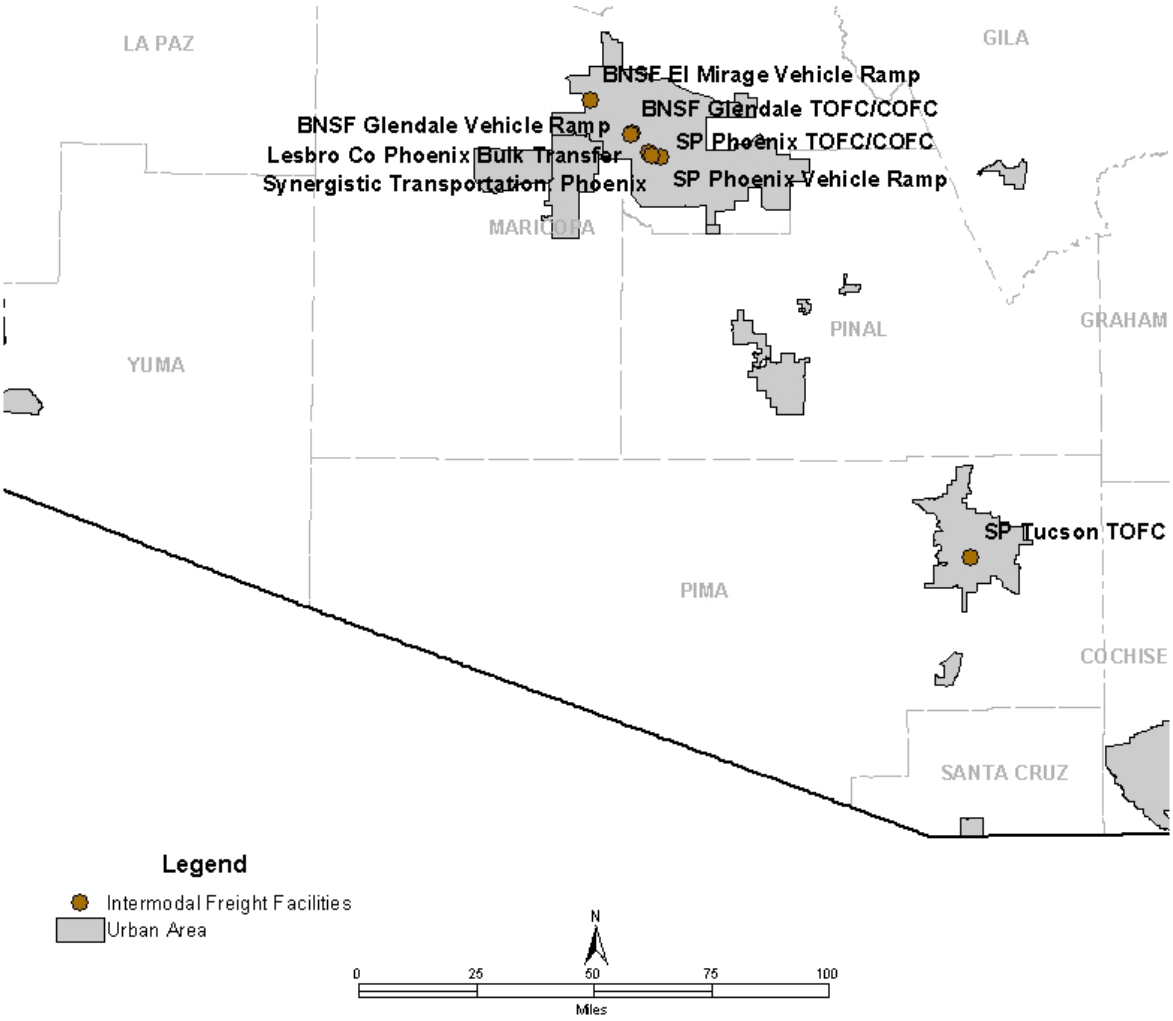
The Nogales rail border crossing is located in the City's central business district. With the volume of freight moving through Nogales projected to increase as a result of the North American Free Trade Agreement, the former Southern Pacific Transportation Company (which operated the line until its 1996 merger into the UP system) and the City of Nogales proposed moving the existing rail line outside the downtown. At present, however, there are no specific plans to act on this suggestion.

5.2.2 Intermodal Facilities

Freight intermodal facilities provide transfer points between different freight modes. There are 10 major highway-rail freight intermodal facilities in Arizona, two serving the Arizona and California Railway (ARZC), three serving Union Pacific, and five serving BNSF. Three of these facilities are container cargo facilities, three are automobile transfer points (two of which allow transfer from only rail to highway), three transfer chemicals

and chemical products, and one transfers liquid edibles. As shown in Figure 5.7, seven of the 10 facilities are located in the Phoenix metropolitan area, two are located in Parker, and one is located in Tucson.

Figure 5.7 Intermodal Facilities in Arizona



Source: Arizona Department of Transportation, Transportation Planning Division.

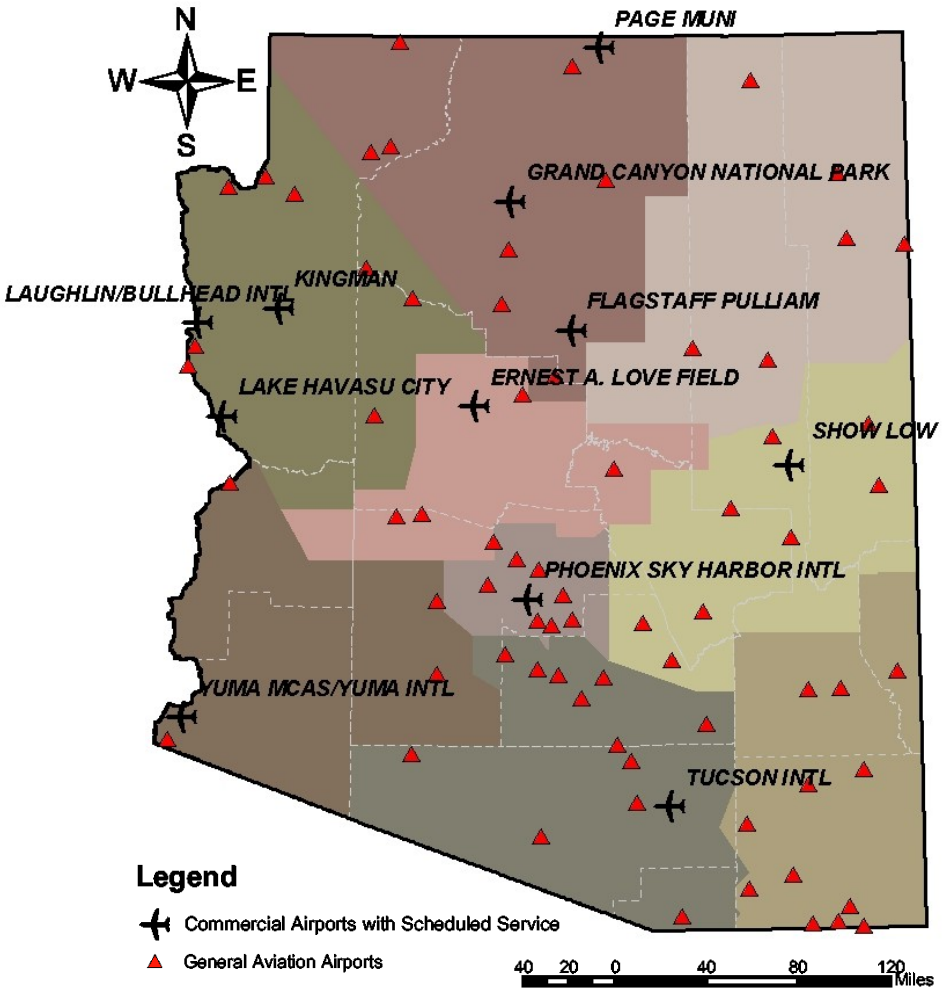
5.3 Air Infrastructure

A total of 83 airports in Arizona are classified as "public use"; that is, they may be used by the public without prior permission and without restriction within the physical capabilities of the facility. Another 236 airports are "private use," and accommodate airplanes, gliders, helicopters, and other forms of aviation. Of the 83 public-use airports, 65 are publicly owned, one is owned by the U.S. Army, one is owned by the U.S. Navy, and the remainder are privately owned. Eleven are certified to handle scheduled air carrier service; although just two, Phoenix Sky Harbor International Airport and Tucson International Airport, are the primary facilities used to transport air cargo in Arizona. The locations of Arizona's major public-use airports are shown in Figure 5.8. The year 2000 cargo and passenger enplanements for the major airports in the State are shown in Table 5.6.

Sky Harbor International is the largest airport in the Phoenix/Mesa metropolitan area that maintains active schedules for inbound and outbound air freight. Sky Harbor's air cargo facilities on the west side of the airport provide non-integrated and integrated air cargo services. Cargo Buildings A, B, and C contain a total of 198,000 square feet of space, and collectively have a total of 103 air cargo bays. Measured in tons, over 85 percent of all air cargo in Arizona move through Sky Harbor.

Air cargo operations at Williams Gateway include specialized services and unscheduled charter flights. To meet the growing demands of the east valley of metropolitan Phoenix and to relive pressure at Sky Harbor, cargo service improvements are planned at Williams Gateway. These include dedicated air cargo facilities at the east and west sides of the airport and a runway extension to accommodate air cargo aircraft. Currently, an $11 million cargo ramp is under construction and land adjacent to the ramp is being leased for new cargo-related buildings.

Figure 5.8 Locations of Arizona's Public Use Airports



Source: Arizona Transportation Planning Division, 2002.

Table 5.6 Cargo and Passenger Volumes at Arizona Airports for 2000

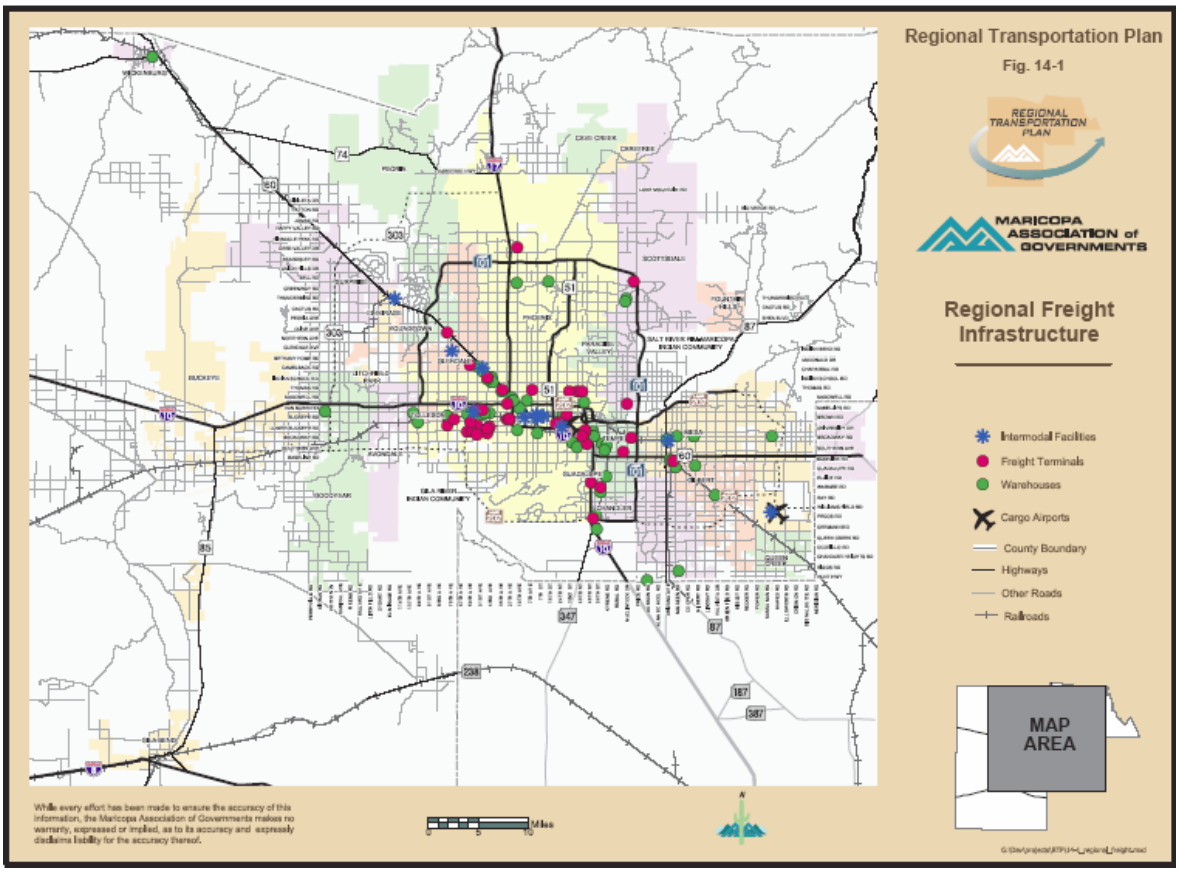
Airport	City	Cargo Gross Landed Weight (Tons)	Enplanements (Passengers)
Phoenix Sky Harbor Intl	Phoenix	374,164	17,616,143
Tucson Intl	Tucson	34,158	1,816,412
Grand Canyon National Park	Grand Canyon	–	411,416
Yuma MCAS/Yuma Intl	Yuma	–	50,337
Laughlin/Bullhead Intl	Bullhead City	–	75,020
Flagstaff Pulliam	Flagstaff	–	33,371
Page Muni	Page	–	2,131
Lake Havasu City	Lake Havasu City	–	8,569
RRA Sierra Vista Muni-Libby AAF	Fort Huachuca SIE	–	6,073
Ernest A. Love Field	Prescott	–	4,682
Show Low Muni	Show Low	–	2,857
Kingman	Kingman	–	1,656
Total		**408,322**	**20,028,667**

Source: Arizona Department of Transportation, Tucson International Airport, and Maricopa Association of Governments.

5.4 Metropolitan Freight Infrastructure

The Maricopa Association of Governments has worked extensively to document the freight infrastructure in the Phoenix metropolitan area, including freight terminals and warehouses. Figure 5.9 shows the key elements of this infrastructure. The figure shows that the majority of the freight-related facilities are located along the I-10 corridor, with another concentration of facilities along State Highway 60 northwest and east of downtown.

Figure 5.9 Phoenix Region Freight Infrastructure



Source: Maricopa Association of Governments Regional Transportation Plan (2003).

5.5 Key Freight Indicators

Several indicators can be used to measure the level of performance of Arizona's roads. One indicator particularly relevant to freight is the spatial relationship between truck volumes and congestion, shown previously in Figure 5.4. This relationship is determined first by calculating the volume-to-capacity ratio, which is the number of vehicles passing a certain point on a roadway over a given period divided by the capacity of that roadway over the same period. The volume-to-capacity ratio is typically measured during critical peak hours. Table 5.7 shows the volume-to-capacity ratio at the highest truck volume locations by county. The higher the ratio, the more congested the roadway. Table 5.8 shows the truck volumes at the most congested locations in the State.

Table 5.7 Volume-to-Capacity Ratio at Highest Truck Volume Locations by County, 2002

County	Interstate	Milepost	AADT	Total Number of Trucks	V/C Ratio
Maricopa	I-10	158.3	154,800	**54,200**	**0.89**
Pima	I-10	250.6	112,600	**42,900**	**1.00**
Coconino	I-40	197.9	41,600	**17,900**	**1.00**
Pinal	I-10	176.4	45,800	**15,900**	**0.80**
Mohave	I-15	2.0	22,200	**13,500**	**0.40**
Cochise	I-10	297.8	37,900	**12,000**	**0.71**
Navajo	I-40	251.7	24,200	**10,400**	**0.45**
Apache	I-40	319.6	26,600	**9,900**	**0.46**
Lapaz	I-10	45.4	22,300	**9,800**	**0.35**
Yavapai	I-17	47.6	35,300	**6,700**	**0.80**
Yuma	I-8	8.9	26,200	**3,900**	**0.55**
Santa Cruz	I-19	5.3	29,700	**3,300**	**0.56**

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

Table 5.8 Truck Volumes at Locations with Highest Volume-to-Capacity Ratios by Interstate

County	Interstate	Milepost	AADT	V/C Ratio	Total Number of Trucks
Pima	I-10	257.8	148,700	**1.15**	**17,800**
Coconino	I-40	198.4	72,500	**1.50**	**31,200**
Coconino	I-17	337.4	97,300	**1.48**	**18,500**
Mohave	I-15	23.7	22,300	**0.46**	**13,600**
Pima	I-19	101.5	64,000	**0.94**	**5,800**
Yuma	I-8	2.2	60,400	**0.91**	**7,200**

Source: Arizona Department of Transportation, Highway Performance Monitoring System, 2002.

A combination of private logistics firms and freight logistics publications jointly has created a numerical ranking called a "logistics quotient" for 328 metropolitan areas around the country. As shown in Table 5.9, the rating system helps companies weigh the advantages and disadvantages of locating logistics facilities in various metropolitan areas. The rating system measures the performance of each metropolitan area based on a diverse range of freight-related characteristics, including road infrastructure, workforce, taxes, and fees. The methodology used to calculate each of the ratings is proprietary, and, therefore, should be used very generally to estimate how the private sector views different aspects of the freight transportation system. However, the rating system does allow for a general comparison of cities in Arizona with cities across the country.

The Flagstaff, Tucson, and Yuma areas rated fairly low overall on the scale, largely due to perceived deficiencies in the workforce. However, those areas' road infrastructure, in terms of road conditions and interstate highways, rated quite high. The freight railroad system and the lack of access to waterborne commerce are also seen as deficiencies in Arizona's freight transportation system.

Several other freight indicators require data collection and/or analysis beyond the scope of this work. These include:

- Average travel time between key freight activity centers (measure of recurrent congestion);
- Reliable travel time between key freight activity centers (e.g., 90 percent probability travel time);
- Peak-hour spreading of automobile activity;
- Mean and variance of speeds on key truck routes;
- Truck-involved crashes;
- Truck-rail split for select commodities (e.g., farm products); and
- Mean and variance of process time at border-crossing locations.

Collecting data on these freight performance indicators would allow for a comprehensive understanding of the various aspects of the freight transportation system in Arizona. Over time, this data could be used to determine which aspects of the freight transportation system are improving and which are not.

Table 5.9 Logistics Quotient for Selected Metropolitan Areas Across the U.S. and Arizona

2003 LQ Final Rank	Metropolitan Area	T&D Industry Metro Rank	Workforce Labor Metro Rank	Road Infra-structure Metro Rank	Road D/C/S Metro Rank	Road Condition State Rank	Interstate Highways Metro Rank	Taxes & Fees State Rank	Rail Road State Rank	Waterborne Commerce Metro Rank	Air Cargo Metro Rank
1	Savannah, GA	41	13	163	204	6	55	13	13	25	128
2	Nashville, TN	5	2	90	141	65	36	58	181	43	59
3	Atlanta, GA	9	9	299	130	6	13	13	13	197	1
4	Cleveland-Lorain-Elyria, OH	35	98	169	176	71	7	142	65	29	17
5	Toledo, OH	60	51	146	185	71	16	142	65	31	43
30	Los Angeles-Long Beach, CA	52	84	197	58	329	13	329	6	3	15
58	El Paso, TX	18	106	307	127	155	125	84	45	197	62
84	Sioux Falls, SD	79	94	209	19	232	55	142	303	197	51
85	**Phoenix-Mesa, AZ**	**107**	**154**	**247**	**18**	**52**	**85**	**219**	**264**	**197**	**40**
86	Riverside-San Bernardino, CA	67	164	151	24	329	55	329	6	197	69
96	Salt Lake City-Ogden, UT	216	101	254	80	135	24	206	200	197	8
109	Las Vegas, NV-AZ	171	102	272	34	26	125	280	196	197	49
110	Denver, CO	208	149	238	133	161	16	200	148	197	2
119	Albuquerque, NM	252	45	285	117	194	85	77	213	197	25
168	Alexandria, LA	113	138	95	284	290	160	45	84	197	241
169	**Flagstaff, AZ-UT**	**305**	**245**	**42**	**11**	**94**	**85**	**213**	**232**	**197**	**224**
170	Hamilton-Middletown, OH	136	48	276	265	71	160	142	65	197	289
171	**Tucson, AZ**	**181**	**274**	**250**	**59**	**52**	**85**	**219**	**264**	**197**	**68**
172	Newburgh, NY-PA	230	65	9	271	261	85	310	65	197	158
272	Dutchess County, NY	314	266	10	118	252	160	323	77	197	247
273	Las Cruces, NM	291	232	155	215	194	85	77	213	197	307
274	**Yuma, AZ**	**301**	**296**	**245**	**42**	**52**	**160**	**219**	**264**	**197**	**196**
275	Pocatello, ID	326	236	165	82	148	85	271	297	197	167
276	Fort Pierce-Port St. Lucie, FL	261	259	22	287	19	160	290	213	197	270

Source: Expansion Management + Logistics Today Magazines, Penton Media, Inc., 2003.

6.0 Institutional Environment for Goods Movement

6.0 Institutional Environment for Goods Movement

Goods movement in Arizona is subject to a number of Federal and state regulations. This section describes the primary institutions and legislative acts that regulate goods movement activity in the State.

6.1 Truck Size and Weight Restrictions

Several Federal and state regulations pertain to trucks because they operate on public roadways and share facility use with passenger cars. The size and weight of trucks have been regulated on Federal roads since the Federal-Aid Highway Act of 1956. Federal truck weight law applies to the interstate system, while Federal vehicle size law applies to the National Network, which includes the interstate system and several other roads as well. Current Federal truck size and weight (TS&W) law establishes the following limits:

- 20,000 pounds for single axles on the interstate;
- 34,000 pounds for tandem axles on the interstate;
- Application of a bridge formula for other axle groups up to the maximum of 80,000 pounds gross vehicle weight on the interstate;
- 102 inches for vehicle width on the National Network;
- 48-foot minimum for semi-trailers in a semi-trailer combination on the National Network; and
- 28-foot minimum for trailers in a twin-trailer combination on the National Network.

Federal law regulates trucks by specifying basic TS&W standards and exempting certain situations from those standards by recognizing state grandfather rights and special permits. In 1991, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) froze the maximum weight of longer combination vehicles and limited them to routes that were specified by the states. Long combination vehicles (LCVs) were defined as any combination of a truck tractor and two or more trailers or semi-trailers which operate on the National System of Interstate and Defense Highways with a gross vehicle rating greater

than 80,000 pounds. ISTEA also froze the length of trailers and semi-trailers, specifically cargo and carrying units.

Arizona has standard TS&W limits. The highest allowable gross vehicle weight rating is 80,000 pounds; single axles are limited to 20,000 pounds; and tandem axles are limited to 34,000 pounds. Arizona limits the length of semi-trailers to 57 feet on the interstate system, making the State one of 10 that allows semi-trailers over 53 feet in length. Truck weight limits are measured at truck weigh stations that are primarily located near the State's borders. Truck size limits can be enforced throughout the interstate system, but are most rigorously checked at the truck weigh stations. Vehicles found to be in violation of the TS&W limits are issued citations that include a fine.

ADOT is one of 34 states that issues overweight/oversize permits for some loads. These permits are issued to qualified applicants for specific loads with exact dimensions and exact weights. Class A oversize/overweight permits are issued for vehicle and load combinations that are within specific size and weight limits, in which the load cannot be otherwise separated into smaller loads. The Class A permit can be issued for either a single trip or 30 days. Class A permits are issued only for travel on the state routes. Permits for use for other routes are procured from the proper local authority, usually the county roads department. The following eligibility criteria must be met before issuing a Class A permit:

- Non-reducible (the load can not be separated into smaller loads);
- Specifically described load;
- The width of the vehicle and/or load is 14 feet or less;
- The height of the vehicle and/or load is 16 feet or less;
- The length of the vehicle and/or load is 120 feet or less;
- The combined weight of the vehicle and/or vehicle combination is 250,000 pounds or less;
- If the load projects from the side of the vehicle and the load is greater than or equal to 12 inches deep, the projection does not exceed three feet on either side;
- If the load projects from the side of the vehicle and the load is less than 12 inches deep, the projection does not exceed two feet on either side;
- Permit may not be used to routinely transport legal loads on over width trailers; and
- Vehicle must be currently registered for 80,000 pounds to be allowed to purchase an overweight permit.

6.2 Truck Routes

ADOT's web site maintains a list of road restrictions that is updated daily. Some road restrictions are only applicable to trucks and other large vehicles. Table 6.1 shows the *Road Restriction Report* as of January 20, 2004. Several jurisdictions in Arizona also have permanent lists of roads that are restricted from heavy truck use, and other recommended routes for trucks traveling between select origin-destination pairs.

Table 6.1 Arizona Road Restriction Report, 2004

	Width Restriction	Description
Tangerine Road	11' 0" wide	Restriction on Tangerine Road, Tucson
I-8	12' 0" wide	Eastbound milepost 36.0 east of Wellton through January 31, 2004
I-10	12' 0" wide	E/W bound milepost 2 – 12 detour route, exit 19 to B-10 to SR 95 to Indian Rt 1 to Poston Mohave Road to exit @ I-10 through April 30, 2004
I-15	10' 0" wide	N/S bound milepost 14 – 16, detour: Cedar City, UT to Las Vegas, NV/56 to 319 to 93 to I-15 through January 31, 2004
I-19	12' 0" wide	N/S bound milepost 61 – 64 (Tucson), effective through June 30, 2004
U.S. 60	11' 0" wide	E/W bound milepost 151 – 153 (Grand Avenue between 67th Avenue and 83rd Avenue), effective through July 12, 2004
SR 79	12' 0" wide	N/S bound milepost 100.9 – 106.4 North of SR 77 (escort vehicle required), through January 30, 2004
SR 95	10' 0" wide	N/S bound milepost 176 – 191 Lake Havasu Area, through March 31, 2004
SR 264	10' 0" wide	E/W bound milepost 381 – 382 second Mesa area, through February 28, 2004
SR 67	Closed for winter	N/S bound milepost 579.4 – 610.26 @ Grand Canyon, through May 14, 2004
SR 261	Closed for winter	N/S bound milepost 383 – 401.6 North of SR 273, through May 3, 2004
SR 273	Closed for winter	N/S bound milepost 383 – 396.9, through May 3, 2004
SR 366	Closed for winter	E/W bound milepost 136 – 136.3, effective through April 15, 2004
SR 473	Closed for winter	N/S bound milepost 0 @ SR 260 milepost 9 (Hawley Lake Road), through May 3, 2004

Source: Arizona Department of Transportation, 2004.

6.3 Truck Hours of Service

The amount of hours that a truck driver can drive consecutively is regulated by the U.S. DOT's Federal Motor Carrier Safety Administration (FMCSA). These new rules, effective as of January 4, 2004, are the first substantial change the FMCSA has made to the truck driver hours-of-service rules (HOS) since 1939. This rule governs drivers transporting freight in interstate commerce in a property-carrying commercial vehicle with a gross vehicle weight rating of 10,001 pounds or more, and operating vehicles transporting hazardous materials in quantities requiring vehicle placards.

The new rules allow drivers to drive 11 hours after 10 consecutive hours off duty. Also, drivers may not drive beyond the 14th hour after coming on duty, following 10 hours off duty. Similar to existing rules, drivers may not drive after being on duty for 60 hours in a seven-consecutive-day period or 70 hours in an eight-consecutive-day period. This on-duty cycle may be restarted whenever a driver takes at least 34 consecutive hours off duty. The current rule allows 10 hours of driving within a 15-hour on-duty period after eight hours of off-duty time. Also, drivers may not drive after their 15th hour on duty in a workday or after 60 hours on duty in seven consecutive days or 70 hours on duty in eight consecutive days.

Short-haul truck drivers – those drivers who routinely return to their place of dispatch after each duty tour, and then are released from duty – may have an increased on-duty period of 16 hours once during any seven-consecutive-day period. The 16-hour exception takes into consideration legitimate business needs without jeopardizing safety. FMCSA estimates that without the extra two on-duty hours, the industry would be required to hire at least 48,000 new drivers, actually reducing crash-reduction benefits.

The intention of the rule change is to improve highway safety and help reduce the number of truck crashes and related fatalities and injuries by addressing commercial motor vehicle (CMV) driver fatigue. The FMCSA estimates the new rule will save up to 75 lives and prevent as many as 1,326 fatigue-related crashes annually. There were an estimated 4,902 truck-related fatalities in traffic crashes in 2002. The impact on motor carrier operations is that more truck drivers will be needed by companies that perform long-haul trucking operations. This will increase the cost of transporting goods long distance. In addition, more stops will be made by trucks on long-haul routes. Since Arizona has a large amount of through truck traffic that includes several long-haul trips, it is likely that there will be more stops in the State of Arizona by these trucks that perform through trips.

Vehicles used in oil-field operations, groundwater well-drilling operations, utility service, and transporting construction materials and equipment retain the 24-hour restart provision provided by the National Highway System Designation Act. Agricultural operations will retain their current statutory exemption from driving time requirements when occurring within a 100-air-mile radius of a farm or distribution point during planting and harvesting seasons.

6.4 Border Crossing Regulations

Goods crossing the nation's borders have been subject to several regulations for many years. The regulations have intensified in the last few years due to increased concerns about terrorism. Arizona operates 20 fixed ports of entry throughout the State, in addition to the main commercial permits office. Six of the ports are international border ports. Each of the border crossing locations operates a port of entry program, which mission is to ensure that all commercial vehicles operating on Arizona highways have proper credentials and are in safe operating condition, while providing efficient, fair, and friendly treatment to all of the customers and citizens of Arizona. Arizona ports of entry monitor and screen all commercial traffic entering the State of Arizona for registration, motor tax, size and weight restrictions, commercial driver's license requirements, insurance requirements, and motor carrier equipment safety requirements.

6.4.1 Trade Act of 2002

Section 343 of the Trade Act of 2002 includes a requirement that electronic cargo information on international goods be passed from the carrier to Customs prior to the goods arriving at the border-crossing location. The advance notification depends on the mode of transportation. Table 6.2 shows the advance time needed and the data system requirements by mode. This Trade Act will have a particular impact on Arizona goods movement.

Arizona-Mexico trucking is handled through a network of U.S.-based trucking firms that transport the goods between their final U.S. location and the U.S. side of the border. The actual border crossing truck activity is generally performed by specialty trucking firms that are primarily based in Mexico and operate on slim margins with limited technology. Therefore, a significant upgrade of equipment is likely needed by these firms to comply with the advance notification rule. In addition, a large portion of the agricultural goods that cross the Arizona-Mexico border are currently handled using last minute orders by shippers to carriers. This reduces the window of opportunity of carriers to notify Customs regarding the type of goods and the estimated time of arrival to the Customs location. This new rule is likely to create significant logistical obstacles for imported goods, and eventually increase the price of transporting these goods.

Table 6.2 Summary of Requirements for Advance Electronic Cargo Information

Mode	In/ Out	Data System	Transmittal Timeframes		Responsible Parties	Length of Transition Period After Publication of Final Rule
			NPRM	Final Rule		
Air & Courier	In	Air AMS	a. 4 hrs, or b. "Wheels up" from certain nearby areas prior to arrival in U.S.	Same as NPRM	a. Air carriers b. Importer or its broker c. Freight forwarder d. Express consignment facility e. Other air carriers	90 days. However, CBP could delay the implementation at a given port until the necessary training has been provided to CBP personnel at that port. Also, CBP could delay the effective date if any essential programming changes to the approved data interchange system were not in place.
	Out	AES	2 hrs prior to departure from U.S.	Same as NPRM	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.
Rail	In	Rail AMS	2 hrs prior to arrival in U.S.	Same as NPRM	Rail carrier	90 days after rail AMS is operational at port.
	Out	AES	4 hrs prior to attachment of engine before going foreign	2 hrs prior to arrival at the border	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.

Table 6.2 Summary of Requirements for Advance Electronic Cargo Information (continued)

Mode	In/ Out	Data System	Transmittal Timeframes		Responsible Parties	Length of Transition Period After Publication of Final Rule
			NPRM	Final Rule		
Vessel	In	Vessel AMS	24 hrs prior to lading at foreign port	Same as NPRM	a. Vessel carriers b. NVOCCs	Parties to be automated on vessel AMS within 90 days at all ports where their vessels arrive.
	Out	AES	24 hrs prior to departure	24 hrs prior to departure from U.S. port where cargo is laden	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.
Truck	In	FAST, PAPS, BRASS, or CAFES	a. FAST: 30 mins b. Non-FAST: 1 hr prior to arrival in U.S.	Same as NPRM	a. Truck carriers b. Importer c. Customs broker	90 days from the date CBP has officially notified affected carriers by *Federal Register* publication that an approved data interchange is in place and fully operational.
	Out	AES	1 hr prior to border crossing	Same as NPRM	Exporter	Current AES exporter reporting requirements will be employed on an interim basis until the AES Commodity Redesign Project is developed pursuant to Census regulations due to be issued in 2004.

Source: http://www.azfuel.com/mvd/commercialenforcement/document/RoadRestrictionReport.pdf.

6.4.2 Customs-Trade Partnership Against Terrorism

Customs-Trade Partnership Against Terrorism (C-TPAT) is a government-industry partnership program designed to increase security at the nation's borders. Industry participation is on a voluntary basis. After completing a comprehensive survey of the cargo security aspects of their supply chain from foreign point of origin through delivery to U.S. consignee, companies sign an Agreement to Voluntarily Participate (AVP), complete a Supply Chain Security Questionnaire, and submit these to Customs. Before the required application and questionnaire can be completed, a comprehensive evaluation of security procedures, training, and recordkeeping must be undertaken by the company to ensure that the protocols are in line with Customs C-TPAT standards.

Currently, C-TPAT is open to importers, transportation providers, and brokers. Customs plans to expand C-TPAT's scope to include other vendors and exporters in the future. Customs hopes to create a community of C-TPAT-approved companies. Customs has provided a matrix of standards and will continue to develop the methodology over time in reaction to various situations that occur. Customs has published minimum requirements that must be met by companies seeking C-TPAT certification. C-TPAT is open to all importers. However, there is no guarantee of admission. Importers that are considered to be high risk may be declined admission to the C-TPAT program.

The importer is required to ensure that all suppliers of materials, services, and transportation, both internally and externally, are fully compliant with C-TPAT guidelines. These outside service providers include brokers, carriers, freight forwarders, and other partners.

Customs has proposed some concrete benefits to companies that participate in this program. Included in these are the following:

- Reduced Customs inspections;
- Reduced border delays;
- Entitlement to a Customs account manager; and
- Eligibility for account-based processes.

Shippers that do not participate in the C-TPAT program are likely to experience increased inspections, increased border waiting time, exclusion from the next generation of Customs partnership programs, and potentially negative publicity from failure to act with due diligence in the event of a catastrophic event associated with the supply chain. The C-TPAT program is one of continuous improvement. If there are shortfalls, companies will design action plans, with the assistance of their Customs account managers that reflect their C-TPAT commitments. Companies will be able track their progress in fulfilling the required security improvements.

6.4.3 Free and Secure Trade Implementation on U.S.-Mexico Border

The Free and Secure Trade (FAST) program is a trade program that has recently been extended to the U.S.-Mexico border from its previous operations exclusively at the U.S. – Canada border. The FAST program is a direct outgrowth of the Smart Border Accords entered into between the U.S. and Canada and the U.S. and Mexico in the wake of the terrorist attacks of September 11, 2001. The FAST program uses common risk-management principles, supply chain security, industry partnerships, and advanced technology to improve the efficiency of screening and clearing commercial traffic at ports of entry along the U.S.-Canada and U.S.-Mexico borders.

The FAST program aims to ensure – and expedite – the legitimate flow of goods and people across the United States' northern and southern borders, thereby, enhancing security, while also facilitating trade. Participants qualify by enhancing the security of their manufacturing plants, warehouses, and shipping systems under the auspices of the U.S. C-TPAT. FAST processing on the U.S.-Mexico border also requires the foreign manufacturer to use high-security seals properly placed in the approved manner when crossing the border.

The first dedicated FAST lanes on the U.S.-Mexico border opened on December 4, 2003, in El Paso, Texas. FAST lanes will be opened at additional ports of entry on the U.S.-Mexico border within the next few months, according to the Department of Homeland Security. The government of Mexico has committed to designate special FAST access lanes from Mexico where the local highway infrastructure allows. As of November 25, 2003, CBP received 1,153 driver applications. CBP has issued FAST identification cards to 974 of these commercial truck drivers at the El Paso FAST Driver Enrollment Center. Nearly 3,000 trucks have been processed through the FAST lanes in El Paso since October 27, 2003.

6.4.4 Bioterrrorism Act of 2002

The Bioterrorism Act of 2002 was enacted to improve the ability of the U.S. to prevent, prepare for, and respond to bioterrorism and other public health emergencies. This Act included three main components, including:

1. To increase the national preparedness for bioterrorism and other public health emergencies;

2. To enhance the controls on dangerous biological agents and toxins; and

3. To protect the safety and security of the food and drug supply.

This Act also sets forth a specific set of rules that require the U.S. Food and Drug Administration (FDA) to be given advance notification of the shipments of imported food.

One of the specific regulations developed as a result of this act is the requirement for registration of all food facilities serving the U.S. market. This includes a requirement that domestic and foreign facilities that manufacture, process, pack, or hold food for human or animal consumption in the United States must register with FDA by December 12, 2003. As mentioned earlier, Arizona has a large agricultural industry and imports a significant amount of agricultural products from Mexico. Therefore, this registration process and the special notification requirements are likely to lead to an increase in prices for these goods.

6.5 Air Quality

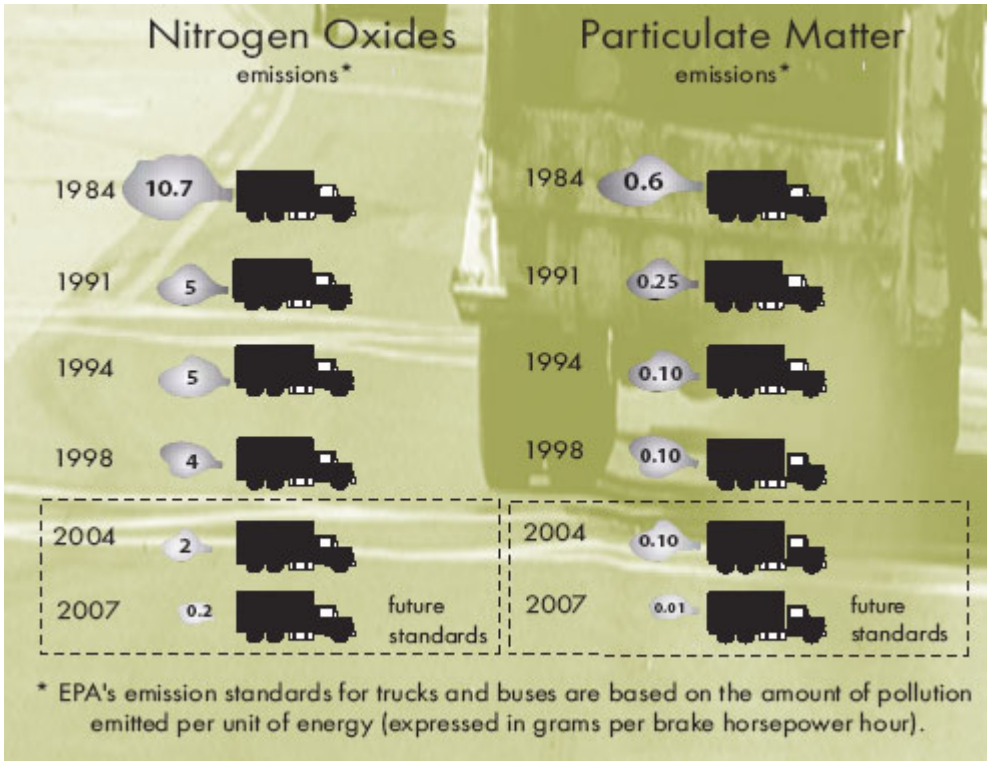
6.5.1 Federal Regulations

Emissions of goods-carrying vehicles (including diesel engines and locomotives) contribute to the overall emissions inventory. There have been several steps at the national and local level to reduce the emissions from these vehicles as part of larger air quality goals. The U.S. Environmental Protection Agency (EPA) sets emissions limits for these vehicles by limiting the amount of emissions of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2).

At the agency level, the emission limits for the diesel engines used in most heavy-duty trucks are being reduced. However, because heavy-duty trucks have a longer life cycle than passenger cars, many engines in the existing fleet will be in operation for another 25 to 30 years. The old and new regulations for NO_2 and PM emissions are shown in Figure 6.1. The new regulations have increased the cost of diesel engines; therefore, many motor carriers are delaying the purchase of new trucks as long as possible, partially through retrofitting the engines of older vehicles. As a direct impact to this policy, there will be a larger proportion of older trucks on the road in the near future. Other programs being run by the EPA to control heavy-duty emissions include the retrofitting of existing diesel vehicles with pollution controls, implementation of emissions testing programs for diesel vehicles, creation and implementation of anti-idling programs, and the promotion of cleaner fuels like ultra-low sulfur diesel and compressed natural gas.

In addition, by 2006, diesel fuel will be required to contain 97 percent less sulfur than in 2003. This ultra-low sulfur diesel fuel, in combination with advanced pollution control technology, will mean that, in 2007, new trucks and buses rolling off the production lines will be up to 95 percent cleaner than today's models.

Figure 6.1 EPA Standards for New Trucks and Buses



Source: U.S. Environmental Protection Agency.

6.5.2 Emissions in Arizona

Pollutant levels are measured in each metropolitan area and compared to the National Ambient Air Quality Standards. Regions that are found to have emissions levels that do not meet EPA standards are found to be in nonattainment. The regions in Arizona which are in nonattainment as of July 20, 2000 are shown in Table 6.3.

As part of an effort to reduce and regulate diesel emissions, all 1967 and newer diesel-powered vehicles registered within the emissions control areas of Phoenix and Tucson are required to be emissions tested annually. The only exception is for apportioned vehicles, which are commercial vehicles that are licensed in multiple states. Diesel vehicles pulling trailers will not be accommodated at the inspection stations.

Heavy-duty diesel vehicles (vehicles with gross vehicle weight rating above 8,500 pounds) in Maricopa County are tested using the Society of Automotive Engineers J1667 test protocol, commonly referred to as the "snap-acceleration test." Diesel-powered vehicles may be tested at any of the vehicle emissions inspection stations in Maricopa County. In Pima County, heavy-duty diesel vehicles with 26,000 pounds gross vehicle weight or greater or any truck with tandem drive axles must be tested at a particular location within the County.

Table 6.3 Arizona Nonattainment Areas by County and Pollutant, 2004

	Pollutant				
County	**CO**	**PM_{10}**	**SO_2**	**Ozone (1 Hour)**	**Ozone (8 Hours)**
Cochise		Moderate	Primary		
Gila		Moderate	Primary		
Greenlee			Primary		
Maricopa	Serious	Serious		Serious	Non-attainment
Mohave					
Pima	Maintenance	Moderate			
Pinal		Serious	Primary		Non-attainment
Santa Cruz		Moderate			
Yuma		Moderate			

Source: Environmental Protection Agency, May 2004. Nonattainment areas generally include only parts of counties.

7.0 Critical Freight Transportation Findings

7.0 Critical Freight Transportation Findings

There are four critical freight transportation findings from this study that can be used to develop broad themes to guide future freight and goods movement planning in Arizona. These include:

1. Goods movement is a critical part of Arizona's economy.

Approximately 74 percent of the economic output and 42 percent of the employment in Arizona are in transportation-dependent industries. In terms of dollars of output, the electronics industry represents 32 percent of all of the goods-producing industries in the State, by far the largest of any industry. Electronics is also the fastest growing of the transportation-dependent industries, so its dominant share of Arizona's economic output will increase in the future. The electronics industry relies heavily on the air and truck modes for transporting its goods. Therefore, transportation planners should consider the preservation of highway access for air cargo to the State's cargo airports as a priority.

2. Future capacity of the State's transportation system should match the logistics trends of Arizona's primary industries.

Of the 122 million tons of goods output in Arizona, the top four commodities (nonmetallic mineral products, coal, metallic ores and concentrates, and natural sands) represent 41 percent of total movements. These commodities are primarily used in light and heavy construction to support Arizona's growing population. The industries that produce these commodities rely on a mix of truck and rail to move their goods. The truck and rail industry infrastructure must ensure that it has the capacity to match the logistics trends of these industries. Over one-third of the total tonnage moved in Arizona has both an origin and a destination in the Phoenix metropolitan area, so Phoenix's intraregional highway infrastructure is a critical component of the State's goods movement infrastructure.

3. Through truck movements constitute a significant portion of Arizona's total goods movement activity and further confirm the need for continued multi-state freight planning.

There are over 40 million tons of domestic through truck trips using Arizona's transportation system. These movements equate to roughly 16 billion annual ton-miles from through truck traffic in the State. This is 40 percent of the total ton-miles for the non-through trips (internal trips, internal-external trips, and external-internal trips) of all modes. An additional six million tons of through truck flows are goods that are imported or exported through the El Paso border crossing and connecting with California. This

high percentage of through truck trips underscores the need for Arizona to partner with neighboring states in multi-state planning efforts that will improve goods movement for the region.

4. Exports and international trade will account for a significant portion of Arizona's growing, future economy.

In 2002, Arizona exported $11.9 billion of goods to other countries, approximately 12 percent of the total goods output for the State. International trade is also the fastest growing segment of the Arizona economy. Mexico is Arizona's largest international trade partner with $3.0 billion of exported goods, and the Maquiladoras constitute a large fraction of this trade. High-value goods, such as electrical and other machinery, constitute the largest portion of the Mexico-Arizona trade by value. Agricultural products are the largest portion of these goods by tonnage. I-19 between Nogales and Tucson is the portion of the Arizona transportation system that is most heavily affected by international flows, with 70 percent of the truck volume on the interstate being generated by international moves. International shippers along the Arizona-Mexico border have also cited an efficient transportation system as important for the continued growth of international trade.