11. CONCLUSIONS AND RECOMMENDATIONS

11.1 CONCLUSIONS

Conclusions were drawn based on findings and focused on project objectives, which are repeated here:

1) Measure the performance and document the benefits of the deployed systems and ADOT's rural ITS program;
2) Identify and document current operating and maintenance (O&M) costs and issues;
3) Determine travelers' perceptions and reactions to rural ITS elements; and
4) Determine how well ADOT has adhered to the 1998 Statewide ITS Strategic Plan's vision.

Objective 1: Measure Performance and Document Benefits

This study identified universal and element-specific performance measures. Both types of measures are valuable means of evaluating ITS element performance.

One question addressed by the performance evaluation and documentation of benefits is, "Are any of ADOT's rural ITS elements underdeployed?"

Based on positive impacts on performance evaluation goal areas and in some cases, level of interest by non-user Districts, a number of ITS elements are good candidates for expanded deployment. Considering ADOT's ITS program as a whole:

- Existing ADOT plans to deploy more RWIS, remote cameras and VMS statewide are fitting as these systems have a strong positive impact.
- ADOT efforts to improve and promote 511 and az511.com (e.g., via static 511 signs) will broaden these important systems' user base.
- Based on benefits and level of interest expressed by non-user Districts, good candidates for expanded deployment are: shoulder-mounted VMS, highway advisory radio, emergency roadside callboxes and motorist assist patrols. Less popular but also providing benefits are speed detection/warning devices, license plate readers, and instrumented truck escape ramps.

Another question addressed by the performance evaluation is, "Are any of ADOT's deployed systems underperforming? If so, why?" This study concludes that many of ADOT's deployed systems are functioning quite well. It was found that ADOT is providing many services that contribute to safety, mobility and cost reduction, and that ADOT works steadily to improve system reliability and usefulness.

Six ITS elements were identified as underperforming in terms of potential versus actual benefits to rural Arizona. The following lists the ITS elements along with actions ADOT can take to improve performance:

- Road weather information systems – improve communications and sensor reliability;

- 511 - improve voice recognition and navigation;
- az511.com – improve content presentation/quality and provide low-graphics format for users with low-bandwidth (dial-up) Internet access;
- Highway advisory radio – improve quality (both in terms of transmission/reception and in terms of content);
- PrePass – improve compliance by CVOs; and
- Emergency roadside callboxes – reduce hang-ups and driver misunderstanding.

More detail about these suggested ADOT actions is provided in the recommendations section.

Objective 2: Identify and Document Operating and Maintenance Costs and Issues

The O&M costs tabulated earlier (see Tables 10, 17, 24 and 31) demonstrate that a substantial O&M funding commitment to deployed ITS elements is required. One District expressed that getting operations and maintenance arrangements set up and working smoothly is so critical that they are against further deployments in their District until that point in time. This is a reasonable concern since past failures to maintain equipment have led to numerous issues for ADOT.

The practice of requiring RTEOs to provide maintenance for VMS has drawbacks such as insufficient funding, training, parts inventory, and manpower. The Western RTEO has suggested that a statewide VMS maintenance team be put in place. Lacking that, the RTEOs need improved funding and training.

Some equipment vendors do not always provide the hoped-for level of support, or do so at a high price. ADOT's RWIS stations have been plagued with technical glitches and lack of vendor support to correct them. A recent contract will outsource RWIS maintenance; other ITS elements may also benefit from such alternative arrangements.

Objective 3: Determine Travelers' Perceptions and Reactions to Rural ITS Elements

Combining CVO and public survey results, Table 35 summarizes the percentage of respondents indicating awareness and frequent or rare usage of these elements.

Table 35: CVO and Public Respondents' Awareness and Usage of ITS Elements

ITS Element	Awareness	Usage	Difference
Variable Message Signs	82%	84%	+2%
az511.com	72%	61%	-11%
511 traveler information	67%	39%	-28%
Highway Advisory Radio	56%	33%	-23%

Respondents ranked information dissemination systems, both by level of awareness and by usage as: VMS, az511.com, 511 and HAR. An interesting pattern is seen in how many of the people that know about the ITS systems are using them. The figures are almost identical for VMS, while the usage drops off quite a bit for az511.com, 511 and

HAR. This seems to indicate a lower level of "customer satisfaction" for those systems than for VMS.

The same ranking holds almost perfectly in perceptions of these systems' contributions to safety, mobility and cost savings. Table 36 summarizes these survey results. The percentages provided are a sum of respondents who strongly or moderately agree that the ITS elements contribute to the goal area.

Table 36: ITS Element Contribution to Goal Areas – Public and CVO Perception

	Goal Area		
ITS Element	**Safety**	**Mobility**	**Cost Savings**
Variable Message Signs	69%	65%	50%
az511.com	59%	60%	45%
511 traveler information	37%	35%	39%
Highway Advisory Radio	29%	26%	45%

A large majority of CVO respondents were aware of PrePass (79%) and instrumented truck escape ramps (59%). A majority of CVO respondents strongly or moderately agree that PrePass and instrumented truck escape ramps contribute to safety (63%) and cost savings (strongly agree - 60%, moderately agree - 51%).

More than half (59%) of public respondents were aware of emergency roadside callboxes; less than a quarter (22%) were aware of the motorist assist patrol (MAP). However, a large majority agree that callboxes and MAPs contribute to safety (strongly - 61% and moderately - 57%). It should be noted that there is quite good awareness of these systems given their very limited deployment on highway segments with relatively low Annual Daily Traffic (ADT). In 2002, the ADT on I-19 in the vicinity of the emergency roadside callboxes was 28,348; on US 93 in the vicinity of the callboxes and MAPs it was 6,008.

Objective 4: Extent of ADOT Adherence to the 1998 Statewide ITS Strategic Plan's Vision

The ADOT vision statement for the statewide rural ITS planning program (which guided the 1998 Statewide ITS Strategic Plan) is: "To have new, innovative ITS technologies operational statewide, providing a safer and more efficient intermodal transportation system, meeting the short and long-term needs of visitors, local communities, commercial operators, and the traveling public" (3:1). Some key words in the vision statement and brief comments about how well ADOT has adhered to that vision follow:

Innovative: ADOT provides national leadership in 511 innovation, and the Kingman District, more than any other, has implemented innovative speed detection/warning devices, license plate readers, shoulder-mounted VMS, HAR, instrumented truck escape ramps, emergency roadside callboxes, and motorist assist patrols.

Operational statewide: ADOT has succeeded at deploying and keeping rural ITS elements operational across the state.

Safer/efficient: Rural ITS elements are perceived to contribute to safety and efficiency.
Short/long-term needs: The ITS plan accounts for short and long-term deployment horizons.
Visitors, local communities, commercial operators and the traveling public: ADOT has deployed ITS benefiting all of these user groups.

11.2 RECOMMENDATIONS

Recommendations were formulated based on findings and focused using the unmet needs priorities identified by the TAC.

A. Surveillance and Data Collection Systems

1. For RWIS, upgrade communications to digital cellular, satellite, or radio. Consider other data sources (NWS, airports, observers). Request NWS weather emergency notification. Provide bucket-truck-ready pullouts at pole-mount sites or use truss towers. Upgrade software to allow ad-hoc changes to standard data polling frequencies of the RWIS sensors and cameras.
2. Consider portable PAD/other non-intrusive technology for conducting counts.
3. Consider using speed detection/warning devices on curvy mountain roads and at transitions from higher to lower speed limits.
4. Consider license plate readers for travel time estimation on projects with long detours, high business impact, or high road user costs. Require backup system or assign penalty for downtime.

B. Information Fusion and Dissemination Systems

1. Upgrade HCRS program to allow verification of 511 audio and to interface with HAR.
2. For 511, expand marketing, improve VRAS and provide more user-friendly menu options.
3. For az511.com, offer data in low-bandwidth format and list HCRS events automatically.
4. Strive for data quality and completeness.
5. Customize traveler data via route registration and data dissemination to 511, website, e-mail and pagers (by private sector partners).
6. For VMS maintenance, consider improved RTEO funding and training or a specialized statewide team, and add catwalk extensions to VMS that currently require lane closures.
7. Consider HAR for construction project outreach, with broadcast quality, communications links, update frequency, and mode of operation (continuous broadcast versus broadcast only when a new message is available) as factors. Consider HAR applications at the Mexican border for delay and traveler information.

C. Traffic Control/Commercial Vehicle Electronic Clearance Systems

1. For portable traffic signals, consider hard-wiring power or having backup power supply. For one-lane section control, consider use of signals or flaggers, with costs,

visibility, high-profile vehicles, driver expectations and DPS support as factors. For temporary replacement of damaged permanent signals, consider use of portable or temporary signals, with estimated length of time and rental costs as factors.
2. For PrePass, train ports of entry on reporting of violations. Install mainline weigh-in-motion at all PrePass-equipped ports of entry.

D. Emergency Detection and Response Systems

1. For instrumented truck escape ramps, review images to identify high-risk trucks/companies to target in outreach efforts. Consider instrumenting additional ramps in Arizona, with ramp location, accident experience, traffic level, availability of communications, and level of roadway use by high-risk trucks/companies as factors.
2. In any expanded use of emergency roadside callboxes, consider accident experience, traffic levels, DPS coordination, ADA compliance, communications and system self-diagnostics.
3. Consider expanding use and coverage area of MAPs, with accident experience and traffic levels as factors. Consider making MAP operators state employees. Consult existing operators to help specify vehicle requirements, equipment lists and job requirements, and to train new operators.

E. General – Strategic Vision for ITS in Arizona

1. Review ADOT project prioritizing methods. Consider application of performance measures, and quantifying the benefits considered in this study in monetary terms.
2. Update Statewide ITS Strategic Plan; prioritize new construction and features; take technology changes, funding constraints, system goals, need priorities and usage experience into account.
3. Incorporate ITS concepts into driver education. Institute outreach program to introduce children to ITS concepts.
4. Create opportunities for Districts to share practical rural ITS ideas and experiences.

11.3 SUMMARY

In conclusion, this research project has met its goals and objectives. In this, the first unified effort to evaluate ADOT‘s deployed ITS statewide in Arizona:

- A comprehensive, practical, goal-based evaluation methodology was established to measure the performance and effectiveness of ADOT’s rural ITS program, using a combination of universal and element-specific performance measures.
- Rural ITS stakeholders and information resources were identified and contacted and a wealth of information pertinent to the evaluation and assessment of ADOT’s rural ITS program was obtained and organized.
- The information was analyzed, with particular emphasis on rural ITS innovations in the Kingman District.

- A gap analysis identifying and prioritizing unmet needs helped in the formulation of a preliminary action plan for addressing the unmet needs.
- Conclusions addressing the project objectives were identified.
  - The performance and benefits of rural ITS elements were identified, including identification of underdeployed and underperforming elements.
  - Operating and maintenance costs and issues were identified. Overall, rural ITS maintenance appears to be underfunded, and some creative alternative maintenance arrangements have been implemented.
  - Traveler perceptions and reactions to rural ITS elements were documented. Travelers are gaining more familiarity with rural ITS elements, even those that are deployed only locally, and generally feel that they contribute significantly to desirable outcomes such as safety, efficiency and cost savings.
  - It was found that ADOT has largely adhered to the 1998 Statewide ITS Strategic Plan's vision.
- Recommendations were formulated about future rural ITS deployment, performance measurement and promotion.

In summary, ADOT now has well-focused information in hand with which to make informed decisions about future expenditures for additional rural ITS deployments and enhancements. It is expected that implementation of this study's recommendations will help improve the quality of services ADOT provides to highway users, including traveler information, electronic clearance and emergency support.