

## An Introduction



## We Are TSMO!

Transportation Systems Management and Operations (TSMO) is an integrated approach to optimize the performance of existing infrastructure by implementing multimodal, intermodal and often cross-jurisdictional systems, services and projects. This includes regional operations collaboration and coordination activities among transportation and public safety agencies. TSMO is not routine road maintenance, like resurfacing or guardrail replacement. TSMO strategies improve system efficiency, enhance public safety and security, reduce traffic delays of road users, and improve access to information for travelers. The emphasis of TSMO is an outcome-driven, performance-based system. It is critical that regional operations objectives can be measured because they have importance on a regional level. TSMO strategies include, but are not limited to traffic safety, traffic incident management, travel information services, roadway weather information, freeway management, connected vehicles and automated vehicles, traffic signal systems and coordination, work-zone management, managed lanes, emergency response and Homeland Security, freight management, active traffic management, and new technologies that are rapidly occurring.



# Director's Letter

Brent Cain, Division Director

What do operations, overhead message boards, signs and roadway striping, freeway pump stations, traffic safety and engineering, incident management, oversized load permits, highway lighting, connected and autonomous vehicles, traffic signals, pavement management, and emergency management, all have in common? TSMO! Transportation Systems Management and Operations (TSMO) is a relatively new ADOT division that was launched in October 2015. TSMO isn't just an Arizona movement. This is a national focus that many state DOTs are embracing and developing. Other states are looking at ADOT as a leader in this arena to re-create what we are doing. The division is also focusing on new technologies as a means to squeeze more capacity, efficiencies and safe operations out of our highway system. We've been working closely with the governor's office in successfully attracting industry to work and test technologies in Arizona, which has resulted in you seeing Uber, Google and other autonomous vehicles being tested here. We are also looking to pilot truck platooning across Arizona very soon and are also pioneering new technologies such as the Wrong Way Driver Pilot along Interstate 17 in Phoenix to save lives by detecting wrong-way drivers and informing the traveling public. The pilot has been successfully operationalized and has gained national attention. Nowhere else is this being done. TSMO is comprised of approximately 300 dedicated people that I'm very proud to be working with.

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## Mission

Integrated program to optimize the performance of existing infrastructure through implementation of systems, services, and projects to preserve capacity and improve reliability and safety of our transportation system.

## Vision

To operate our transportation system for safe, reliable, efficient, and cost effective means of transporting people, commerce, and data.



## Meet Brent

In regards to me, I grew up in Iowa, the heartland of the U.S. Out of high school in the early 1980s, I worked full time as a draftsman to pay my way through college while also taking night classes. While finishing my civil engineering degree at the University of Missouri-Rolla, I spent my summers working as a construction inspection intern at the Iowa DOT. I enjoy exploring Arizona and have hiked numerous areas throughout the state.

# THE TEAM



## Traffic Maintenance Group

The Traffic Maintenance Group's primary mission is to maintain roadway striping and signing on the State highway system. This group includes the Interstate Signing, Statewide Striping and the Sign Factory. These units perform many activities:

- Fabricating and installing interstate/highway signs
- Maintaining roadway striping and signing for the entire state highway system
- Providing technical support to the four Regional Traffic offices
- Providing statewide emergency response

## Statewide Striping

Statewide Striping is responsible for maintaining 16,628 long-line striping miles at high retro-reflectivity levels, ensuring that the pavement markings are visible to drivers at night to facilitate safe nighttime driving. The Statewide Striping Section uses waterborne paint to paint edge-line striping, skips, turn bays and islands. The legends and symbols are maintained by the regional strippers in the Operational Traffic and Safety Group.

## Interstate Signing

Interstate Signing maintains all signs on the state highway system and is responsible for maintaining all freeway signs, including the overhead and ground mounted signing, throughout the state. In addition, Interstate Signing also provides support and service to all nine districts, four regional offices, and construction operations when needed. Interstate Signing maintains over 60,000 signs on the interstate highway system.

## Sign Factory

The primary function of the Sign factory is to fabricate signs for highways and interstate. The Sign Factory's strategic partners are the regional signing teams, construction teams and the Interstate Signing Team. Additionally, the Sign Factory manufactures signage for state facilities and ADOT's yards.



## No Pass Zone

The authority for establishing no-passing zones (NPZ) is covered in Arizona Revised Statutes §§ 28-726 and 28-727, requiring that roadways meet the warrants for the no-passing zones.

The No-Passing Zone (NPZ) team's main objective is to ensure that all passing zones on Arizona state highways are set up per ADOT Traffic Engineering Guidelines and Processes and the MUTCD. This is done by reviewing and updating all changes that may occur in the roadways. NPZ changes come from many different causes. These changes include new junctions, new alignments, new buildings, overstriking or understriking; all of which may change the correct sight distance needed for safe passing. The team performs routine checks of the NPZ every two years.

The other objective of the team is to perform ball banking surveys or reviews for all statewide highways per the MUTCD. The department utilizes the ball bank results to determine if there is a need to install the horizontal alignment warning signs on the roadways per Section 321 of the ADOT Traffic Engineering Guidelines and Processes. The team performs the ball banking surveys or reviews per requests from construction project managers or districts. The NPZ team also provides recommendations on setting speed advisories on all curve signs on state highways by performing ball banking surveys.

## Traffic Management Group

The Traffic Management Group (TMG) accomplishes its mission by incorporating the following activities:



- Inform the public and authorities of crashes and other incidents as they happen
- Actively manage congestion and help reduce clearance times and the risk of secondary crashes
- Utilize existing Intelligent Transportation Systems (ITS) infrastructure; including CCTV cameras, dynamic messaging signs and many others, which provide the traveling public with information regarding travel times, incidents and crashes ahead, safety messages,

and other key information

- Test and deploy new ITS infrastructure, such as wrong-way driver detection equipment
- Coordinate with other traffic authorities within the state as well as the metropolitan areas regarding the Integrated Corridor Management (ICM) program. This program is an agreement between other governmental entities such as counties, cities and towns where



incident-related information about roadway closure is passed along to inform travelers. The ICM also provides better efficiencies and effectiveness of use regarding signal timing and detour or alternate routing during traffic-related incidents or other factors that contribute to congestion and queuing.

## Systems Maintenance Group

The mission of the Systems Maintenance Group is to serve the safety and mobility needs of the traveling public by keeping the system working.

The Systems Maintenance Group is composed of five sections and includes 41 positions responsible for maintenance of electrical/mechanical systems in the Central District and Intelligent Transportation Systems (ITS) statewide. The Group Administration includes four positions with the aim to provide leadership, communication and resources for frontline maintenance activities, where the work of "keeping the system working" is actually done.

The Traffic Signal and ITS Maintenance Unit includes 19 positions. This section is composed of three teams: Metro West, Metro East & Statewide.

The Metro teams are responsible for maintenance of roughly 200 traffic signals, 350 ramp meter/count stations, 300 Closed Circuit TVs (CCTV) cameras, 140 Dynamic Message Signs (DMS), -13 communication node buildings



and 425 miles of fiber-optic communications infrastructure in the Phoenix metro area. The Statewide team is responsible for maintenance of approximately 60 CCTV cameras, 40 DMS, and 18 Roadway Weather Information Systems across the state (outside the Phoenix metro area).

The Deck Park Tunnel Maintenance Unit maintains various electrical/mechanical devices that keep the critical life-safety subsystems working in the tunnel. These subsystems include ventilation, CO<sub>2</sub> monitoring, fire detection and suppression, emergency phones, fire hydrant water lines, and a back-up generator to keep these systems fully operational at all times. These subsystems are integrated by a tunnel monitor and control system. There are four vent rooms, a control room and a generator room that serve as the basic structures for the various subsystems. This unit also takes an active support role in ensuring the operability of the CCTV cameras and lighting within the tunnel.



The Urban Pump House Operations Unit maintains the electrical/mechanical systems for 72 pump stations that dewater the roadways and various basins across the Valley. There are anywhere from one to eight pumps in each station, with more than 250 pumps system wide.

The Roadway Lighting Maintenance Unit maintains approximately 18,000 fixtures as well as the accompanying supports and electrical distribution system. This unit is also responsible for maintenance of the more than 3,300 fixtures in the Deck Park Tunnel.

## Systems Management Group

The Systems Management Group serves to provide several support functions. The group prepares the yearly budget for Maintenance and Operations and allocates the appropriated budget to the districts. They participate in statewide meetings on maintenance and work closely with the districts to address their maintenance needs, setting high standards and rigorous quality assurance measures for statewide maintenance activities.

The goal of the Systems Management Group is to provide courteous, efficient and effective maintenance support services. This is done to increase the awareness of maintenance needs and accomplishments by making the maintenance program more visible to the management of the department, the legislature and the public. As part of this vision, they continually improve the measurements and accountability of all maintenance activities through modifications to the maintenance management system.

### Feature Inventory Systems

The Feature Inventory Systems (FIS) Section locates, collects and provides condition assessment of highway features, allowing our customers to efficiently manage their assets. Additionally, FIS locates highway features (assets) using Global Positioning System (GPS) and collects data using the FIS Data Collection Program (FISDC). They also provide accurate and detailed information on highway drainage features including condition assessment of selected features.

### Pavement Management Unit

The Pavement Management Unit is charged with implementing a Pavement Management System that optimizes selection of projects and investment in a cost-effective manner that keeps the state's paved roadway at acceptable levels and assists the department in meeting federal requirements. The Pavement Preservation Program, which includes the Statewide Rehabilitation Subprogram and Statewide Minor and Preventative Subprogram, is one of the major programs that constitute ADOT's Five-Year Transportation Facility Construction Program. The unit is an integral part of the process of developing the 5-Year Construction Program by identifying, prioritizing and recommending pavement preservation projects. The section is also intensively involved in the project development process by working with other functional groups and sections to ensure that projects are developed on schedule and within budget.

The Pavement Management Section runs ADOT's construction smoothness incentive/disincentive program, which includes testing the finished pavement for smoothness by one-tenth of a mile and calculating either incentives or disincentives for the contractors. The construction smoothness testing is conducted in an accurate, objective and timely manner. In addition, the section is also responsible for evaluating pavement structural and functional condition with annually surveyed data of cracks, potholes, flushing, IRI, faulting, rutting, falling weight deflectometer, deflections and friction. FWD deflections are major pavement structural design inputs for designing pavement rehabilitation projects.

The Pavement Management Section tests pavement friction, which is an important part of ADOT's overall strategy of enhancing highway safety. Other duties include participating in state and national research on pavement, preservation reviewing and voting on American Association of State Highway and Transportation Officials, TRB and ASTM ballots, proposals, standards and testing methods, and attending regional and national pavement preservation conferences.



### Maintenance Management Services

The Maintenance Management Services (MMS) Section works to create state-of-the-art maintenance management systems to effectively manage the maintenance budget and ensure the safe operations of the State Highway System. Their mission is to continuously improve resource management, cost control, planning, budget, and management of transportation systems by providing tools, data analysis, process improvements, and training for TSMO and the Intermodal Development Operations Division (IDO).

### Specific Focus Areas



Maintenance Management Systems:

- Supports 900 maintenance management system users across TSMO and IDO—including work history, planning, reporting and inventory
- Administers the statewide Level of Service inspections of more than 30 individual features for TSMO and IDO
- Administers the statewide maintenance budget and allocation for both TSMO and IDO, using a needs based budget formula
- Tracks and maintains routes, boundaries, Intergovernmental Agreements for roadway and TSMO maintenance activities

### Rest Areas P3 Management

The Arizona Rest Area Program consists of one concessionaire that is tasked to provide operations, maintenance and advertising at ADOT's 28 rest area sites. This contract (P3-13-01) was developed as a five-year partnership that would base the monthly payments on site inspections. Each of our sites are graded monthly on an inspection form and depending on the results, incentives or disincentives are possible. P3-13-01 also contains a sponsorship portion that allows possible revenue to be obtained to help offset maintenance costs. In the current contract, ADOT expects to receive a minimum of \$355,000 in sponsorship over the five-year period.





The ADOT rest areas are also in the process of being rehabilitated. The current schedule goes to 2024 and they rehab, on average, two rest areas per year. These rehabs consist of modernizing outdated facilities, addressing ADA compliance and upgrading the water treatment and wastewater distribution systems.

We are confident that our rest area program is sound, yet evolving and heading in the right direction thanks to our operations team and ADOT senior management. Our rest areas are staffed 16 hours a day, all year long and provide



Arizona travelers a safe and functional area to pull off the main line, stretch their legs, get a snack and see some of the best sites Arizona has to offer.

### Statewide Permits

Statewide Permits issues and provides regulatory enforcement and administrative guidance on a variety of highway related permits, including the following:

- Class C Permits: A Class “C” load is considered any vehicle/load that exceeds 14 feet wide, 16 feet high, 120 feet in length or 250,000 lbs. Class C permits personnel are responsible for reviewing, verifying

and processing permit requests for various types of exceptionally large overdimensional loads through Arizona. Class C permits must ensure that the route that the load will travel meets specified requirements to maintain the safety of the motoring public, maintain the integrity of the infrastructure and ensure that the load driver and the commodity being delivered get to where they’re going safely.

- Encroachment Permits: Administrative guidance for activities or construction of improvements within our right of way, such as parades, driveways, pipelines, power line crossings, cattle guards, special events and many other authorized uses. We also maintain the statewide historical permits files. Encroachment permits are issued through the appropriate district offices throughout the state.
- Film Permits: For motion pictures, documentaries and commercials that are filmed on or from the highway or right of way. Statewide Permits issues the permits and requests approval as necessary from the districts. Film permits are a form of encroachment permits.
- Outdoor Advertising Permits: for signs and billboards placed outside the right of way.

## Operational Traffic and Safety

The Operational Traffic and Safety Group combines a wide range of TSMO functions involved in traffic operations, access management, traffic maintenance, safety analysis and crash records.

### Regional Traffic Engineers

The regional traffic engineers (RTE) are located in the three major population centers of the State – Phoenix, Tucson and Flagstaff/Prescott. These engineers work directly with ADOT’s district engineers on all aspects of traffic operations, including, but not limited to, planning, construction and maintenance. Their localized experience and expertise allow them to act as TSMO’s liaisons with neighboring agencies and the public. The RTEs manage



### Regional Traffic Maintenance

Under the RTE office, TSMO’s maintenance units are the forces behind what the public sees on our roadways. Each of the regions have units specializing in either signing and striping or signals and lighting. These crews plan their work based on forecasted need and respond 24 hours a day to emergency needs due to weather and/or knock downs.

Field staff is responsible for assuring the condition of the following items are kept in acceptable condition:

- Pavement markings – lane striping, stop bars, crosswalks, legends and arrows and other miscellaneous pavement markings
- Roadway signing – regulatory signs, warning signs, directional and informational signs delineators
- Traffic signals – traditional signals, pedestrian signals and related detection and communication systems
- Roadway lighting – overhead luminaires and tunnel lighting

### Traffic Safety Section

The Traffic Safety Section is based in Phoenix and is composed of the Crash Records and Traffic Safety units. Together, the units support ADOT and other agencies statewide in crash data collection and evaluation. Staff within the unit are focused on collecting and analyzing crash data and using the results of these efforts to develop engineering, enforcement and educational solutions to traffic crash problems. The Section uses statistical techniques, design optimization software and predictive modeling to develop solutions into actionable projects. Traffic Safety also manages the Arizona portion of the Federal Highway Safety Improvement Program to prioritize and fund projects for construction.

The Traffic Safety Section has several primary duties:



engineering office staff and traffic maintenance crews in charge of pavement markings, signing, signals, and lighting.

Primary functions of the RTEs include:

- Review and approve Traffic Impact Analysis reports related to access points along the State’s roadways related to private development
- Prepare traffic studies to include speed limits, traffic signal needs, pedestrian crossing locations, turn lane configuration and sight distance
- Review, and approve, temporary traffic control plans supporting construction (ADOT or permit) and/or maintenance within ADOT rights of way
- Review infrastructure projects from the planning-level stage through construction plans
- Address constituent concerns related to signing, striping and traffic operations





- Crash form – develop and implement the standardized crash form, in partnership with the Governor’s Office of Highway Safety
- TRCC – support the goals of the Traffic Records Coordinating Council
- TRACS – develop and maintain the electronic crash submittal software platform
- Crash Analysis – evaluation of historical crash statistics to determine crash patterns and trends as well as possible solutions
- Safety Analyst Predictive Modeling Software – special software capable of evaluating roadway characteristics and crash histories to determine the best use of state funds
- Road Safety Assessment – evaluation of high crash locations throughout the state to develop possible engineering, enforcement or educational solutions to the crash problems
- Highway Safety Improvement Program – prioritization and administration of federal safety funding for project construction

## Systems Technology Group

The Systems Technology Group researches, plans, budgets, programs, develops, and implements innovative Intelligent Transportation System (ITS) technologies to enable the state’s transportation system to operate more efficiently and with improved reliability. The ITS Technology Team works to test and deploy various ITS components to ensure the system’s performance is continuously communicated to the Traffic Operations Center. This group is highly involved in assessing new technologies, performance metrics, and monitoring the status of ITS equipment in the field. The ITS Project Development Team offers ITS technology assistance to ADOT project managers and reviews ITS elements of project deliverables, including Systems Engineering Checklists, public interest findings and certification requests for proprietary ITS equipment. This team also maintains ADOT’s ITS Design Guidelines and ITS Specifications.

# Innovations and Initiatives

## Design work to begin on I-10 dust detection and warning system

On a stretch of Interstate 10 between Tucson and Phoenix, sensors placed along the highway set off an alert: Dust, whipped up by gusting wind, is creating dangerous driving conditions.

ADOT engineers have begun design work to turn that seemingly futuristic vision into reality along a 10-mile stretch of I-10 where dust storms often develop suddenly.

Installation of the state-of-the-art dust-detection system began near Eloy and Picacho Peak, and the system should be in operation by the Summer of 2019.

Sensors placed near the freeway will be able to detect dust as far as a mile or more away. That will give ADOT crews a chance to monitor conditions and alert the public about potentially hazardous situations.

“In addition to providing earlier warnings about blowing dust in an especially troublesome area, this innovative system will advance our understanding of whether similar systems can be effective in other locations around Arizona,” said Brent Cain, director of TSMO.

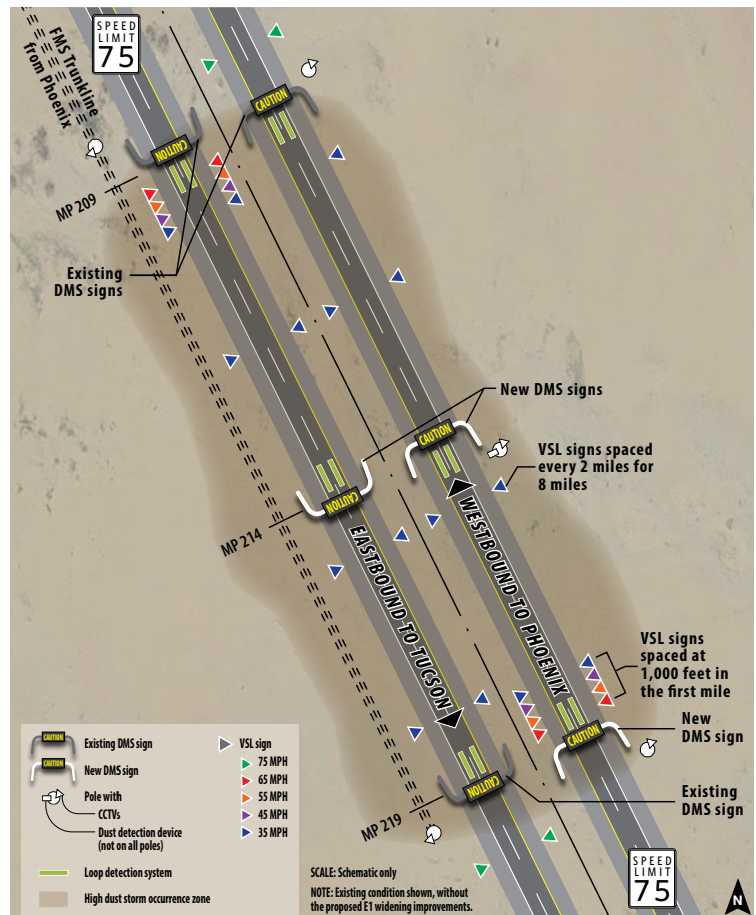
Once the system is in use and evaluated, similar warning systems could be used in other dust-prone areas, including I-10 in both western and southeastern Arizona, and I-40.

The system, estimated to cost \$12.8 million, will be funded in part by a \$54 million federal FASTLANE grant ADOT received for I-10 projects that also include widening and improving two of the three stretches between Phoenix and Tucson that aren't already three lanes in each direction. Widening those areas and improving interchanges at State Route 87 near Eloy and Jimmie Kerr Boulevard in Casa Grande are scheduled to be completed by winter 2019.

Along with the threat from monsoon storms in the summer and fall, soil conditions in this area are such that strong wind any time of year can suddenly produce localized dust that severely reduces visibility, a phenomenon known as a dust channel.



A key part of designing the system will be evaluating and selecting dust sensors. ADOT's emphasis will be on accuracy, reliability and durability.



## The Dust Detection System

### The dust detection zone planned will combine a number of existing technologies

Two types of radar detect blowing dust along the freeway and in the distance approaching I-10. Short-range detectors will be located every mile, as well as at half-mile increments in the center of the area. The long-range detector will be located at the north end of the area.

Variable speed limits will slow drivers. Speed limits, which are enforceable, will slow drivers from 75 mph to 35 mph, dropping 10 mph for each 1,000 feet to allow ADOT staff to lower the speed of traffic when dust is present and allow drivers time to safely reduce their speed.

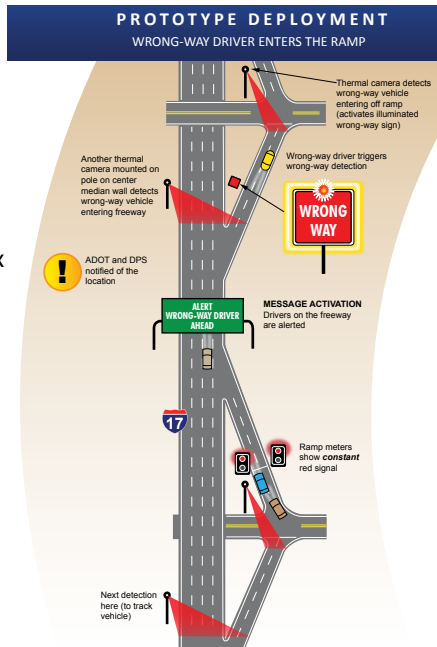
Closed-circuit freeway cameras on poles so ADOT traffic operators in Phoenix can view the situation in real time, while in-pavement sensors report the speed and flow of traffic.

ADOT's plan calls for overhead electronic message boards to relay information about conditions installed five miles apart in each direction.

# Project Background

## TSMO recognized for first-in-nation efforts to detect, intercept wrong-way drivers

It doesn't take long for a wrong-way driver to cause a lot of damage. ADOT's first-in-the-nation wrong-way driver detection system on Interstate 17 in Phoenix has been able to save precious minutes — and lives — by alerting law enforcement at the moment a vehicle enters the freeway traveling the wrong way. In 2018, ADOT's Transportation Systems Management and Operations Division (TSMO) was recognized for this detection system.



After a spike of wrong-way drivers caused injuries and fatalities on Arizona's highways, ADOT partnered with law enforcement to devise a system that would both deter wrong-way drivers and allow emergency responders to respond faster. At the time, however, responding to wrong-way drivers depended on other motorists calling 911 to tell law enforcement the location of the vehicle and its direction of travel.

"The challenge was really understanding where wrong-way drivers are getting on," said TSMO Director Brent Cain. "We were getting information on the identification of wrong-way drivers through 911, and it would take multiple calls to get it right. It was an extremely dynamic situation."

The answer: thermal cameras placed on exit ramps.

### Detecting, intercepting wrong-way vehicles

Along a 15-mile stretch of I-17 in Phoenix, thermal cameras are positioned to detect a wrong-way vehicle along exit ramps and frontage roads. When the cameras are triggered, wrong-way signs illuminate with flashing lights aimed at getting the attention of the wrong-way driver.

At the same time, the system immediately alerts ADOT and the Department of Public Safety (DPS) trooper, both located at the

Traffic Operations Center (TOC). With one click, law enforcement is alerted to the wrong-way vehicle, saving valuable response time. ADOT public information officers issue warnings on ADOT Alerts while TOC staff activate dynamic message signs advising other drivers to exit the freeway as soon as possible to avoid the wrong-way driver. Additional thermal cameras on the freeway assist state troopers in tracking the location of the wrong-way vehicle.

"DPS has been instrumental," Cain said. "When the system is activated, troopers at the TOC can alert other troopers to where wrong-way drivers are, and they can take action immediately."

Since its installation, the wrong-way vehicle detection system has recorded more than 30 vehicles traveling on I-17 exit ramps and frontage roads in the wrong direction, but most of those drivers were able to turn around or self-correct without entering the mainline freeway.

Often, wrong-way drivers on the freeway crash within only a few minutes. The new detection system has reduced the response time from minutes to seconds. Immediate notification from the detection system has proven critical in mitigating several wrong-way driver incidents.

In one incident, emergency responders were alerted four minutes prior to the first 911 call and were able to stop the vehicle six minutes after being alerted, avoiding possible casualties.



Thermal camera



Traffic Operations Center Monitor

### The future of detecting wrong-way vehicles

The pilot program has been recognized on both the state and national level for its success. The National Operations Center of Excellence recognized the detection system as the runner-up for the Best TSMO Project award in 2018. It was also awarded Best in Class at the 2018 Government Innovation Awards. The Phoenix chapter of WTS International also recognized the program with the 2018 Innovative Transportation Solutions Award.

A year's worth of data collected from the pilot program is now being analyzed to consider and develop engineering countermeasures to help deter wrong-way drivers from entering the freeway. Ideally, future solutions would be scalable and could be applied elsewhere on the state highway system.

"There's only so much we can do," Cain said. "A lot of these drivers are severely impaired. But using the data we've collected, we're evaluating other options that might prevent them from entering the freeway in the first place."

# PROJECTS IN MOTION

## Traffic Flow Sensors

The installation of new in-pavement sensors are part of the Freeway Management System and will monitor traffic flow on major freeways in the Phoenix region. Using electronic wires embedded in the pavement, the sensors have been used along many Valley freeways for years. These will replace less reliable acoustic detection that was mounted on poles along some freeways.

In addition to helping ADOT track and manage freeway conditions, these sensors provide the data used to estimate the travel times that drivers see on message boards above freeways. The data also helps ADOT and the Maricopa Association of Governments and the Regional Transportation-Planning Agency make decisions about future freeway improvements.

This project is one way ADOT is working toward the agency's continuous improvement goal of reducing congestion on freeways in metro Phoenix.



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