PLANNING

NDOT's Planning Division consists of several sections, including Federal Programs, Performance Analysis, Research, Roadway Systems, Safety Engineering, Traffic Information, and Transportation Multimodal Planning. These sections are responsible for major corridor studies and development and plan adoption for urban freeway corridor improvements in Nevada, along with a large amount of data analysis. In addition, the Planning Division oversees NDOT's Transportation Alternatives Program, Nevada's State Bicycle and Pedestrian Program, the State Rail Plan, the Statewide Multimodal Plan, the department's research program, and the state's transit program.

The Planning Division plays a critical role in shaping the state's current and future transportation system, given the division's wide scope of responsibilities and relevance to TSMO. These responsibilities are undertaken in a fiscally constrained context that faces pressure from a growing population making increased demands on the transportation system. Budget constraints mean that capacity improvements cannot be the only way of maintaining or improving mobility.

Examples of NDOT TSMO strategies currently integrated into Planning Division activities include:

☐ **NDOT STRATEGIC PLAN (2020):** NDOT's Strategic Plan establishes the Department's strategic goals and strategic objectives. The strategic objectives describe how NDOT will make progress toward achieving the strategic goals. Some of the strategic goals that are most closely aligned to TSMO include:

- **Goal 1—Safety First: NDOT:** This goal encompasses reducing both workplace injuries and traffic-related injuries by increasing funding for safety in maintenance projects and explicitly considering safety in all planned future projects.
- **Goal 3—Efficiently operate and maintain the transportation system in Nevada:** This goal is focused on aligning NDOT's disparate transportation plans and processes to enable better transportation decisions. Key strategic objectives include the development of a performance-driven project prioritization system, planning for future mobility trends, balancing system preservation and expansion, and operating optimized asset management systems.
- **Goal 6—Consistent and effective data management:** Quality data are important for many of NDOT's core functions, including project prioritization, future planning, or performance measurement. These data include traffic volumes, vehicle characteristics, speed, travel time, and pedestrian and bicycle data. This goal ensures that NDOT is equipped to manage its data needs with appropriate state-wide policies, coordinating with local agencies' count programs, and planning for emerging technologies.

☐ **NV2X OFFICE OF INNOVATION:** Connected Vehicles (CV) use different forms of communication. The most common forms are: (1) V2V (vehicle-to-vehicle communication), (2) V2I (vehicle-to-infrastructure communication), and (3) V2X (vehicle-to-everything communication, which means that communication is enabled between vehicles, infrastructure, and even pedestrians). The NV2X (Nevada to everything) office is planning for and preparing a transportation system that is ready to take advantage of emerging CV technologies. NV2X's focus is on assisting with the development of a broad strategy for the implementation and integration of emerging transportation technologies.

- **BENEFIT-COST ANALYSIS:** This systematic process calculates and compares benefits and costs of a project to determine if it is a sound investment, and to enable comparisons among alternative projects. NDOT's Performance Analysis section is responsible for benefit-cost analyses, which typically have been required on projects that cost more than $25 million (Nevada Revised Statutes [NRS] 408.3195) and are considered as part of the statewide planning process. TSMO encourages the use of benefit-cost analysis on alternative projects that often do not meet statutory thresholds for evaluation but form the basis of improving mobility without expanding capacity. The benefit of including these non-traditional solutions is that the analysis can be used to support the inclusion of TSMO strategies in long-term planning efforts. This inclusion provides practitioners with more tools to solve transportation issues in the state.

  The Florida Department of Transportation's District 4 also has found benefit-cost analysis to be a useful tool. District staff conducted a benefit-cost analysis on an arterial management program that deployed systems along several corridors in Broward County. The project did not have any roadway expansion construction costs but included other expenses, such as licensing costs for an Advanced Traffic Management System, subscription costs to a mobility data provider, and costs for purchasing and maintenance of Intelligent Transportation Systems (ITS) devices. The benefits realized from the project included crash reductions, travel time savings, and energy savings. The resulting benefit-cost ratio was 17:1, incident duration was reduced by 30 percent, and this program is being used to advocate for similar projects in other areas of the state (Broward MPO, FDOT, 2017).

- **PERFORMANCE MEASUREMENT AND SYSTEM MONITORING:** Performance measures are indicators of how well the state's transportation system is functioning. The measures can be used to form a better understanding of the system's needs, evaluate deficiencies, weigh the effectiveness of mitigation strategies, and communicate more effectively with stakeholders. NDOT has developed a number of trackable performance measures that are linked to specific projects to ensure that all projects are aligned to the state's overall goals (NDOT, 2020). Development of decision support tools, such as performance dashboards and real-time analytics reporting tools, will further collaboration with stakeholders and help make informed decisions.

References

Broward MPO, FDOT. (2017). *Concept of Operations for I-95 Integrated Corridor Management Study*. FDOT.

NDOT. (2020). *One Nevada Transportation Plan*. Nevada Department of Transportation.

DESIGN

NDOT's Design Division resides within the Engineering Division and is responsible for guiding the development of construction projects from conception to the production of specifications, cost estimates, and construction plans. NDOT Design staff collaborate with other disciplines, such as transportation planners and operations staff, to develop designs and design manuals that consider operations in the entire design process, from conception to final design. This collaboration is a cornerstone TSMO strategy and, as the Federal Highway Administration (FHWA) points out, has the following benefits (FHWA, 2018):

- A safer and more operationally efficient facility design for all users (motorized and non-motorized), emergency responders, maintenance staff, and other operators
- Lower costs for future operational and intelligent transportation systems (ITS) deployments, as foundational ITS infrastructure can be included in highway designs during construction
- Less congestion and greater travel time reliability from the implementation of TSMO strategies

In practice, TSMO collaboration takes different forms during the project scoping, preliminary design, and final design phases of the design process. A couple of examples include:

- NDOT approaches TSMO integration into Design by using a TSMO Evaluation Tool. The tool is used to evaluate all projects within NDOT to identify opportunities for integrating TSMO solutions and addressing operational challenges. It uses NDOT's TSMO Strategic Goals as the basis of evaluation. The evaluation is conducted early in NDOT's project development/initiation process to identify and incorporate potential improvements aligned with the TSMO strategic goals into the project. At this stage, TSMO evaluation is initiated and completed by a Traffic Operations Division representative. This tool enables NDOT to maximize the integration of TSMO in the scoping phase of every project, ensuring TSMO and its recommended strategies are formally considered and evaluated. The TSMO Evaluation Tool has been deployed initially within the Traffic Operations Division, with the goal to deploy the tool to all other NDOT Divisions to ensure the successful integration of TSMO and TSMO strategies into all NDOT Divisions (NDOT, 2020).
- In 2018, NDOT restriped the Interstate 515/Interstate 215 (I-515/I-215) interchange for the southbound to westbound movement. This simple solution improved roadway efficiency delayed the need for major rehabilitation and reconstruction, increased safety, and improved mobility at a cost of approximately $800,000, which was substantially lower than the cost to rebuild the entire interchange.

FHWA highlights the following different ways in which various states have approached inclusion of TSMO considerations in the design process:

- The California DOT (Caltrans) recommends participation and input from various fields of expertise on each project development team during the planning, design, and construction phases. The traffic unit provides capacity studies and operational analyses and develops safety and delay indices.
- The Pennsylvania DOT has developed design checklists for numerous ITS elements for both standalone projects and as components of larger projects. The checklists address the design of closed-circuit televisions (CCTV), dynamic message signs, highway advisory radio, vehicle detectors, ramp meters, and travel time systems. They ensure that a thorough review of location, safety, power, communications, maintenance, usability, and other factors or requirements has been performed in the design of the ITS element.
- The Colorado DOT (CDOT) requires all projects to undergo a TSMO evaluation during the design scoping review phase of its projects. The three-part assessment (safety, operations, and ITS) ensures TSMO elements are considered early in the project lifecycle (e.g., managed lanes, service patrols, real-time traveler information, incident response teams, transportation management centers).

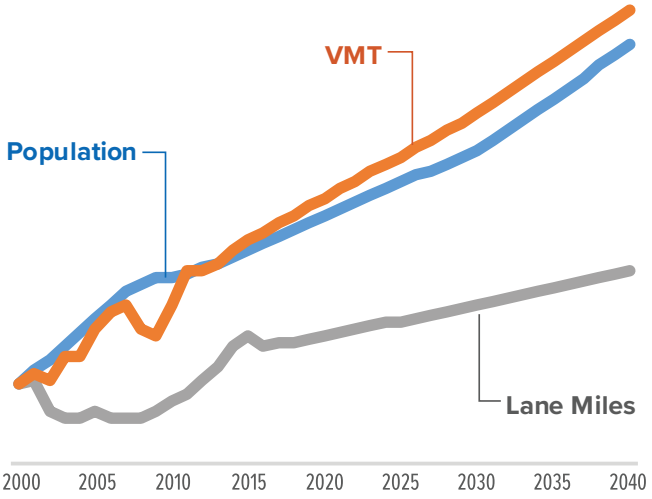
References

FHWA. (2018, January). *Enhancing Transportation: Connecting TSMO and Design.* Retrieved from https://ops.fhwa.dot.gov/publications/fhwahop18088/fhwahop18088.pdf

NDOT. (2020). *NDOT Statewide TSMO Program Plan*.

CONSTRUCTION

NDOT's Construction Division and District Construction Crews are responsible for construction and maintenance on more than 5,000 lane-miles of roadway that make up the state's transportation system. According to NDOT's *One Nevada Transportation Plan* (NDOT, 2020), the number of vehicle miles traveled (VMT) within the system will increase in coming years, as shown below.



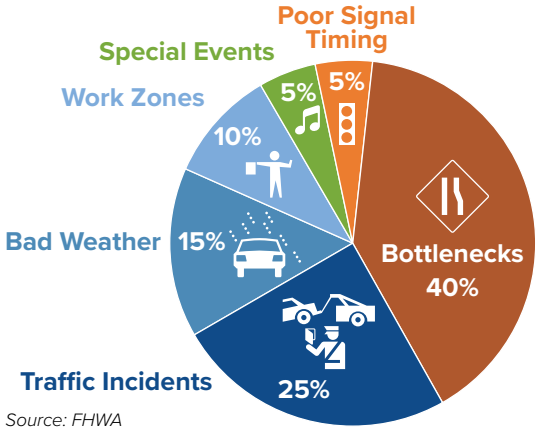
Source: One Nevada Transportation Plan, 2020

This increased demand on the system will necessitate more capacity improvement projects, rehabilitation projects, and maintenance. Limiting the impact of these construction-related activities will be of primary importance in maintaining the transportation system's reliability and safety. TSMO strategies can be deployed to provide safer and more-reliable travel during construction. The following sections present TSMO strategies under the three main categories of mobility, incident management, and work zone safety.

Mobility Strategies

Mobility refers to the ease with which people, goods, and services can move across the transportation system. NDOT has identified mobility for all transportation modes as one of the TSMO strategic goals to support safe, efficient, and accessible movement of people, goods, and services throughout the state.

As depicted below, the FHWA estimates that **10 percent of all congestion is caused by work zones and construction-related activities**, which has an impact on mobility (FHWA, 2007). TSMO strategies can be used to alleviate congestion through work zones and provide better mobility for travelers through improved system management and operations.



Source: FHWA

☐ **NDOT ACTIVE TRAFFIC MANAGEMENT SYSTEMS:** An example of a TSMO mobility strategy in Nevada is NDOT's implementation of Active Traffic Management Systems (ATMS) on Project Neon. Project Neon widened 3.7 miles of Interstate 15 (I-15) between Sahara Avenue and the "Spaghetti Bowl" interchange in downtown Las Vegas. This section of I-15 is the busiest stretch of highway in Nevada, with 300,000 vehicles using it daily (NDOT, 2016).

ATMS provides the ability to dynamically manage congestion based on prevailing traffic conditions. ATMS helps to manage traffic by:

- **Providing advance warning:** The system provides advance warning and guidance to motorists when incidents occur, which helps to prevent secondary crashes.
- **Monitoring traffic:** ATMS operators use CCTV cameras to identify and confirm incidents.
- **Collecting data:** ATMS detectors collect speed and volume data for each lane, allowing the system to identify congestion build-up, provide dynamic ramp metering, and provide speed harmonization to maintain traffic flow and reduce the risk of crashes.
- **Detecting queues:** Whenever queues form due to congestion or incidents, the ATMS system will detect the queue formation and alert drivers approaching the back-of-queue so that they can take appropriate measures to avoid secondary crashes.
- **Harmonizing speeds:** The system detects areas of congestion and automatically reduces speed limits along the freeway upstream of the congestion.

☐ **UTAH DOT INTEGRATED ITS STRATEGIES:** Another example of a TSMO strategy that can be used in the context of work zones is from the Utah DOT's implementation of work zone-specific ITS technology in combination with existing ITS devices to manage traffic during construction. The ITS devices provided important real-time information on travel times and travel routes and included improvements to traffic signals that were impacted by detours. The system was able to encourage diversion from work zone areas, with diversion rates of up to 50 percent. This diversion was important in reducing the intensity as well as the duration of congestion, thus providing safer work zones (Ullman & Jeremy Schroeder, 2014).

Incident Management Strategies

Incident management planning during major long-term construction projects is critical to maintain mobility and safety through the construction area.

☐ **NDOT TIM COALITION:** A TSMO strategy used by NDOT for incident management is the Nevada Traffic Incident Management (TIM) Coalition. This group coordinates and sustains an effective multi-agency, multi-disciplinary, and multi-jurisdictional TIM program that improves safety for first responders, incident victims, and users of the highway system while reducing traveler delay. The coalition is comprised of stakeholders representing law enforcement, tow operators, hazmat specialists, NDOT, paramedics, and emergency response personnel. Some strategies employed by the TIM Coalition include:

- Stationing law enforcement officers within work zones to encourage compliance with construction speed limits
- Implementing portable rumble strips within work zones to alert inattentive drivers to changing roadway conditions
- Ensuring coordination among stakeholders through regular construction updates at TIM Coalition meetings

Coalition Members Participating in TIM Training Involving a Realistic Crash Scenario

To facilitate coordinated response to incidents, the TIM Coalition provides training for various aspects of traffic incident management. As of 2019, 58 percent of first responders had received the same training. Additional training provided includes multi-disciplinary training for work zones, traffic control, and hazmat spills with hands-on demonstrations that are performed on realistic crash reconstructions.

The Southern Nevada TIM Coalition was the first coalition formed in 2008 and, based on its success, other coalitions have been formed, including the Northern Nevada TIM Coalition (2011) and various rural TIM Coalitions (2015). According to an NDOT case study (NDOT, 2019), this expansion was made possible by the benefits that TIM has had on the roadway system, including:

- 51-percent reduction in secondary crashes in the Las Vegas Valley
- 317-percent increase in effective TIM training of first responders throughout the state
- 298-percent increase in stakeholder participation in TIM Coalition meetings

As Nevada's TIM program continues to mature, developing performance measures would help the program monitor progress and better identify areas for improvement.

☐ **TENNESSEE DOT INCIDENT MANAGEMENT PLAN STAKEHOLDER REVISIONS:** The Tennessee Department of Transportation (TDOT) employed various TSMO strategies and planning concepts to deploy an incident management plan for the reconstruction of Interstate 440 (I-440), which serves as a bypass around downtown Nashville (TDOT, 2020). This project was to be the largest construction project in TDOT's history. TSMO planning concepts emphasize the need for greater coordination and collaboration between internal and external stakeholders. Even prior to awarding the contract, TDOT engaged stakeholders to identify changes to existing incident management plans and set up communication protocols to determine priority actions when incidents occurred. Examples of the different stakeholders that were engaged include:

- **State and Local Law Enforcement:** A work zone speed limit was set and accompanied by a concerted enforcement campaign.
- **Freight Management:** Wide and oversized trucks were prohibited from using the route under construction, so alerting these truck operators was crucial.
- **News Media:** The media was useful in disseminating information about closures and detours.

Crashes increased within the work zone as expected due to the construction conditions; however, clearance times for crashes were reduced, which in turn mitigated the intensity and duration of congestion. The disturbance to parallel routes also was minimized as a result (TDOT, 2020).

Work Zone Safety Strategies

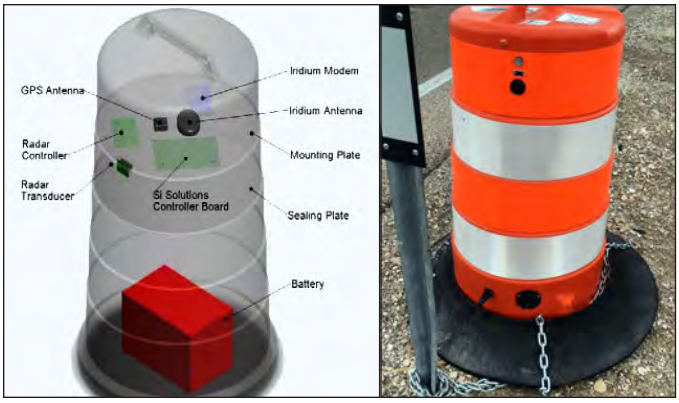
Reduced capacity through work zone areas often leads to formation of queues, which typically results in an increased risk of rear-end crashes. TSMO strategies can be used to mitigate this risk by providing continuous monitoring of roadway travel conditions, detecting queues, and providing timely notification of downstream queues to approaching traffic.

☐ **GUIDANCE:** In 2019, NDOT published the *Work Zone Safety and Mobility Implementation Guide*, whose purpose is to "... establish the fundamental principles, roles, responsibilities, and procedures for systematically addressing the safety and mobility impacts of work zones and developing strategies to help manage these impacts" (NDOT, 2019). The guide establishes state-wide processes and procedures, as well as project-level procedures, to address the impacts of work zones. Examples include:

- Training requirements for individuals engaged in the planning and design, construction and maintenance, permitting, or inspecting of work zones
- Procedures for the development and implementation of Transportation Management Plans (TMP), which lay out a set of coordinated transportation management strategies and describe how they will be used to manage the work zone impact

- Procedures for the development and implementation of work zone Incident Management Plans (IMPs), which address unplanned events or incidents for significant projects to ensure incident response operations within the work site are managed effectively; an IMP identifies priorities and procedures for detection and response to incidents with the goal of safeguarding the public and restoring traffic flow as quickly as possible
- Speeding countermeasures applicable in work zones.

SR 160 Smart Work Zone Components

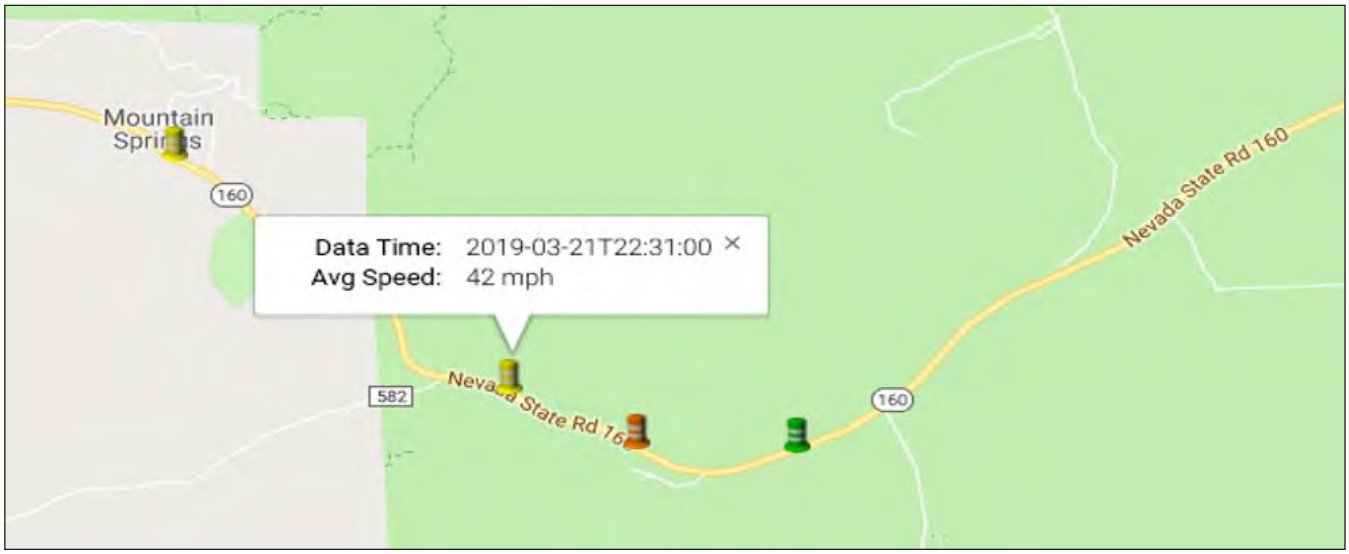


☐ **NDOT SMART WORK ZONE:** NDOT has implemented multiple Smart Work Zone projects within the state. An example is the deployment of devices on State Route (SR) 160 to address traffic disruptions cause by a widening project. As part of the project, NDOT deployed queue warning and dynamic travel time system components to provide road users with critical construction information in a timely manner. The components included:

- Devices that integrate with themselves
- Self-contained operating system
- Tools to review traveling speeds of traffic
- Pre-programmed messages, which update when speed thresholds are reached
- Solar battery charging system
- Portable components with easy setup
- Ability to view live traffic data
- Waze connected

Another example includes the deployment of Smart Work Zone on I-15, which is a key link to highly traveled corridors. The project implemented queue warning and dynamic travel time system components through the FHWA State Transportation Innovation Council (STIC) Incentive Program. Some of the components included:

SR 160 Smart Work Zone Early Reporting



- Devices that integrate with themselves
- Self-contained operating system
- Tools to review traveling speeds of traffic
- Pre-programmed messages, which update when speed thresholds are reached
- Stationary solar battery charging system and traffic sensors

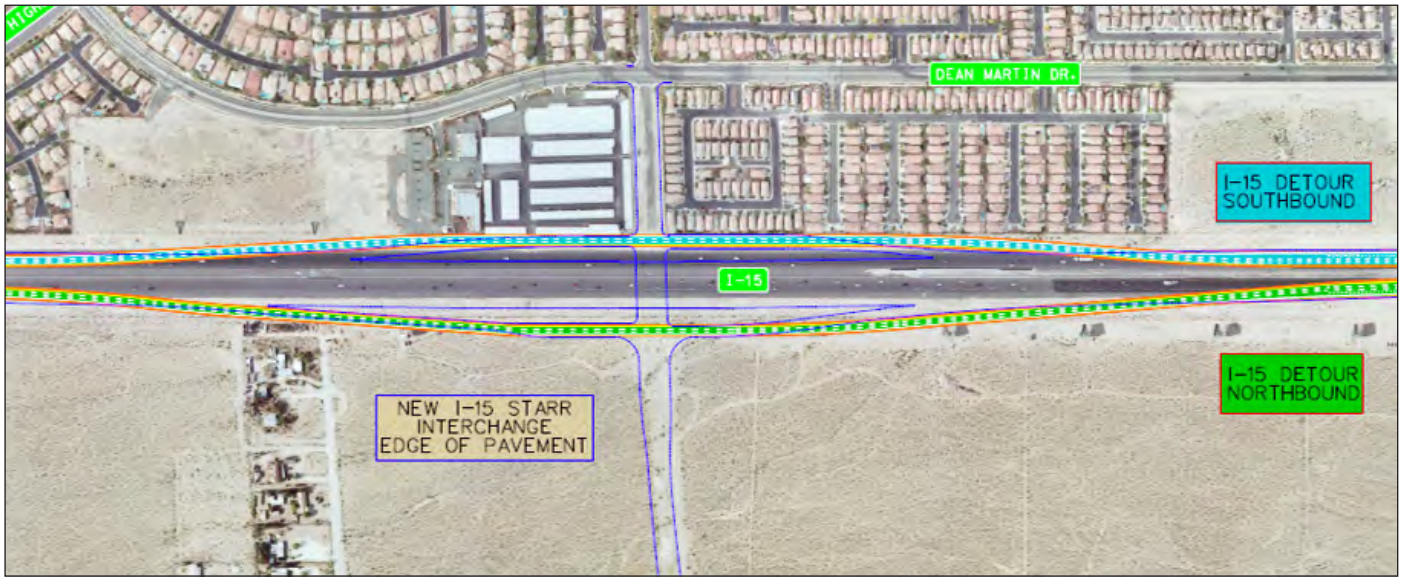
☐ **RTC SNV WORK ZONE SAFETY:** The Regional Transportation Commission (RTC) of Southern Nevada (SNV) was challenged with obtaining accurate information about construction zones in its jurisdiction. The construction zones are managed by different agencies and are constantly shifting based on project needs. Consequently, the impact to traffic is difficult to gauge accurately. Nexar's City Stream platform uses dashcams in private vehicles, taxis, and transportation network vehicles, such as Uber, to identify temporary traffic control devices. The footage allows Nexar to analyze the effect on traffic location, date, time, and number of traffic lanes affected, and it provides a video frame image of the detected activity. In addition, the system can report near-miss collisions or harsh braking situations—safety issues that previously were never recorded or monitored for causation trends and secondary effects (Roads and Bridges, 2020). RTC also uses iCone traffic control beacons that are installed on cones, drums, and other traffic control devices. Both the Nexar and iCone data are provided to the public through Waze. The provision of accurate roadway information from these platforms allows the public to make more-informed travel decisions.

☐ **ILLINOIS DOT MITIGATES FATAL WORK ZONE CRASHES:** The Illinois DOT (IDOT) implemented strategies to mitigate high-speed rear-end work zone crashes on the Interstate 70/Interstate 57 (I-70/I-57) interchange reconstruction project. The system was considered after several fatal rear-end crashes occurred in work zones on other freeway construction projects. The primary challenge was the formation of unpredictable queues that led to severe rear-end crashes. In addition, lengthy delays were experienced whenever these queues formed. The following requirements were deemed necessary for any proposed solution:

- Automatic detection of slow/queued traffic
- Provision of advance warning to traffic approaching the back of queued traffic
- The ability to encourage use of alternate routes by notifying motorists of prevailing delays

IDOT had tried previously to warn drivers of downstream queues via truck-mounted variable message signs (VMSs). This approach met with

I-15/Starr Interchange Early Reporting



difficulties in predicting where and when queues would form, and this made proper placement of the VMS signs challenging. IDOT also found it challenging to always have enough staff scheduled to deploy the VMS signs and monitor their locations relative to the back of the queue. Given these difficulties, IDOT decided to use work zone ITS and included "smart traffic monitoring system" as a bid item in its contract documents. The contractor selected the system, but IDOT was consulted during the selection process. The selected system included:

- A construction Traffic Management Center (TMC) with communication links to all the traffic management system components
- VMSs that were controllable from a remote TMC; the VMS displayed pre-determined messages based on traffic conditions, including advisory messages encouraging motorists to use alternate routes
- Traffic sensors for queue detection, also linked to the TMC
- Video cameras that could be controlled from the TMC
- A secured project website that project personnel could use to monitor conditions
- Portable trailers with additional radar traffic sensors and surveillance cameras

An assessment of the crash experience after the system was implemented noted a 14-percent decrease in queueing crashes and an 11-percent reduction in injury crashes despite a 52-percent increase in the number of days when lane closures were implemented on the project.

References

FHWA. (2007, April). *Public Roads*. Retrieved from Federal Highway Administration: https://www.fhwa.dot.gov/publications/publicroads/07mar/05.cfm

NDOT. (2016). Retrieved from NDOT Project Neon: http://ndotprojectneon.com/learn/overview/

NDOT. (2019, May). *Waycare Platform Deployment in Southern Nevada Traffic Management Center*. Retrieved from National Operations Center of Excellence: https://transportationops.org/case-studies/waycare-platform-deployment-southern-nevada-traffic-management-center

NDOT. (2020). *One Nevada Transportation Plan*. Nevada Department of Transportation.

Roads and Bridges. (2020, April). *Smart Work Zones Reduce Congestion & Improve Safety*. Retrieved from icone products: https://www.iconeproducts.com/news/smart-work-zones-reduce-congestion-amp-improve-safety

TDOT. (2020, July 6). *I-440 Active Congestion Management Leveraging*. Retrieved from National Operations Center of Excellence: https://www.transportationops.org/case-studies/i-440-active-congestion-management-leveraging-probe-data

Ullman, G., & Jeremy Schroeder, D. G. (2014). *Use of Technology and Data for Effective Work Zone Management: Work Zone ITS Implementation Guide*. Texas A&M Transportation Institute. FHWA. doi:FHWA-HOP-14-008

TRAFFIC SAFETY ENGINEERING

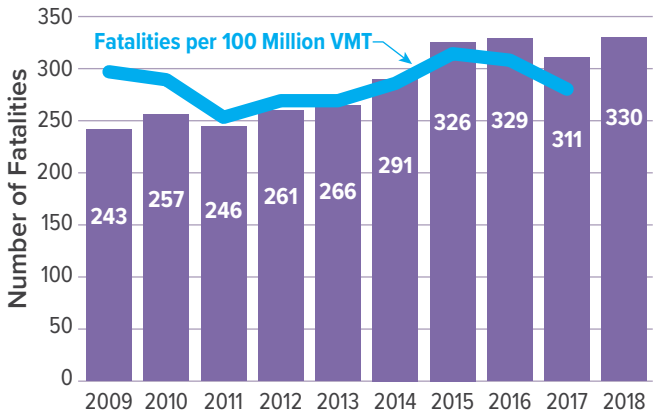
One of NDOT's key goals as defined in the *One Nevada Transportation Plan* is to "... enhance safety by building, maintaining, and operating the safest transportation system possible" (NDOT, 2020). NDOT's Traffic Safety Engineering Division is working collaboratively with stakeholders to improve safety for all modes of transportation.

Zero Fatalities

In 2011, NDOT adopted Zero Fatalities, which is an initiative that seeks to eliminate all traffic fatalities for all modes of travel by focusing on seatbelt use, impaired driving, pedestrian safety, and bicycle safety.

As shown below, the number of fatalities in Nevada has increased in the past decade. When the increase in VMT is considered, however, the crash rate per 100 million VMT has decreased slightly (Nevada Office of Traffic Safety, 2020).

Nevada Fatalities Trends



Source: Nevada Traffic Safety Crash Facts (Nevada Office of Traffic Safety, 2020)

TSMO strategies can be used to complement the investments NDOT has made already in transportation infrastructure to enhance safety on Nevada's transportation system in a cost-effective manner.

According to the *Nevada Traffic Safety Crash Facts* (June 2020) report, intersection crashes accounted for 31 percent of Nevada's total fatalities between 2014 and 2018. In rural or recreational settings, intersection and trail warning systems can provide road users with real-time warning of the presence of conflicting vehicles, pedestrians, or bicyclists approaching an intersection or crossing area. These warning systems improve awareness for road users and increase intersection safety.

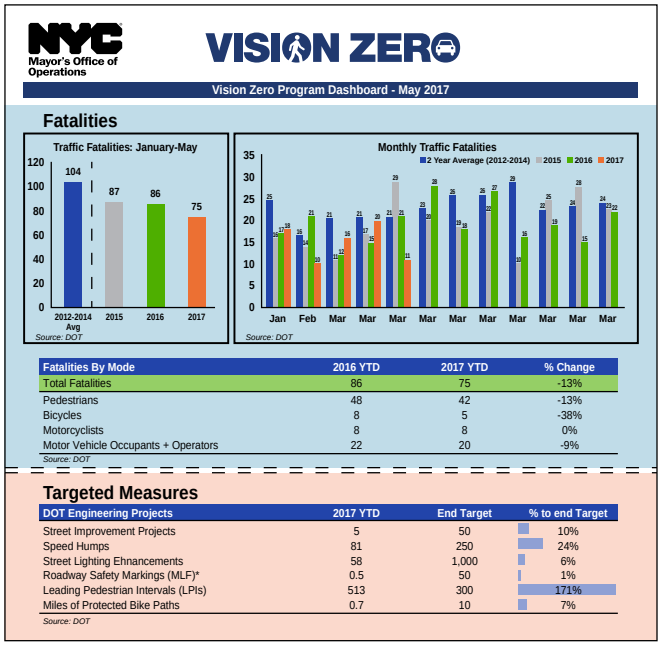
- **FHWA RESEARCH:** FHWA examined the crash reduction effectiveness of intersection conflict warning systems in Minnesota, North Carolina, and Missouri. An analysis of the crash data indicated a reduction in crashes of 27 percent at intersections of two two-lane roadways and a 17-percent reduction in crashes at intersections of two-lane and four-lane roadways.

- **NDOT VISION ZERO:** The State of Nevada has implemented Vision Zero as a commitment to achieving zero fatalities on Nevada's roadways. Through the Office of Traffic Safety (OTS), the state "... encourages the implementation of innovative traffic safety projects at the state and local level that improve motorist awareness, roadway environment, data collection systems, enforcement, and emergency responses aimed at reducing the number and severity of traffic crashes on public highways." This vision is aligned with the fundamentals of TSMO as it encourages data-driven analyses and cross-jurisdictional coordination. OTS administers various programs, such as the Joining Forces Program (multi-jurisdictional law

enforcement program targeting pedestrian safety, distracted driving, and seat belt use), Traffic Records, and Nevada Rider (motorcycle safety), that promote safety for all users of Nevada roads regardless of mode of travel.

☐ **NEW YORK VISION ZERO TASK FORCE:** One of TSMO's emphasis areas is to use data-driven approaches to address transportation challenges. One example of this approach was taken by New York City's Vision Zero Task Force. The Task Force is a collaborative effort between more than 10 agencies and stakeholders that meet on a bi-weekly basis. Meetings are used to discuss cross-agency ideas, review performance metrics, and monitor progress toward goals. Dashboards are used to evaluate program data and to monitor activities and timelines.

Internal Dashboard Used to Evaluate Program Data and Progress Toward Goals



Fatalities By Mode	2016 YTD	2017 YTD	% Change
Total Fatalities	86	75	-13%
Pedestrians	48	42	-13%
Bicycles	8	5	-38%
Motorcyclists	8	8	0%
Motor Vehicle Occupants + Operators	22	20	-9%

Source: DOT

Targeted Measures

DOT Engineering Projects	2017 YTD	End Target	% to end Target
Street Improvement Projects	5	50	10%
Speed Humps	81	250	24%
Street Lighting Ehnancements	58	1,000	6%
Roadway Safety Markings (MLF)*	0.5	50	1%
Leading Pedestrian Intervals (LPIs)	513	300	171%
Miles of Protected Bike Paths	0.7	10	7%

Source: DOT

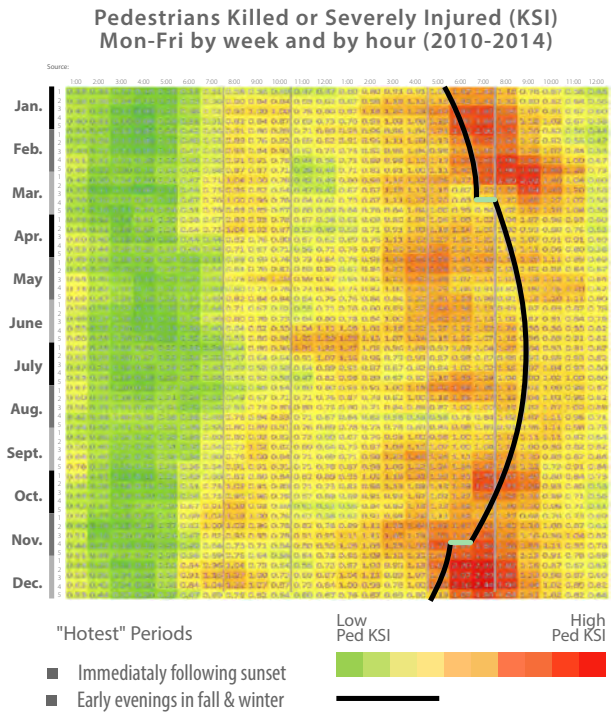
Monitoring program performance

Identifying progress towards goals

Source: Vision Zero Network

An example of how data monitoring has been used to identify problems, advocate for solutions, and inform decision making is when the Task Force identified a pattern of pedestrian crashes occurring in the late afternoon hours, as shown below. The Task Force launched a city-wide effort to mitigate these crashes by improving lighting at hotspot locations, engaging law enforcement to provide more nighttime patrols at the target locations, and by providing an educational outreach campaign. The City measured a 30-percent decrease in pedestrian fatalities for the time period that year (2016) compared to the same time during the previous three years (Vision Zero Network, 2017).

Data Evaluation Showing Pedestrian Crashes Occurred During the Late Afternoon



Source: Vision Zero Network

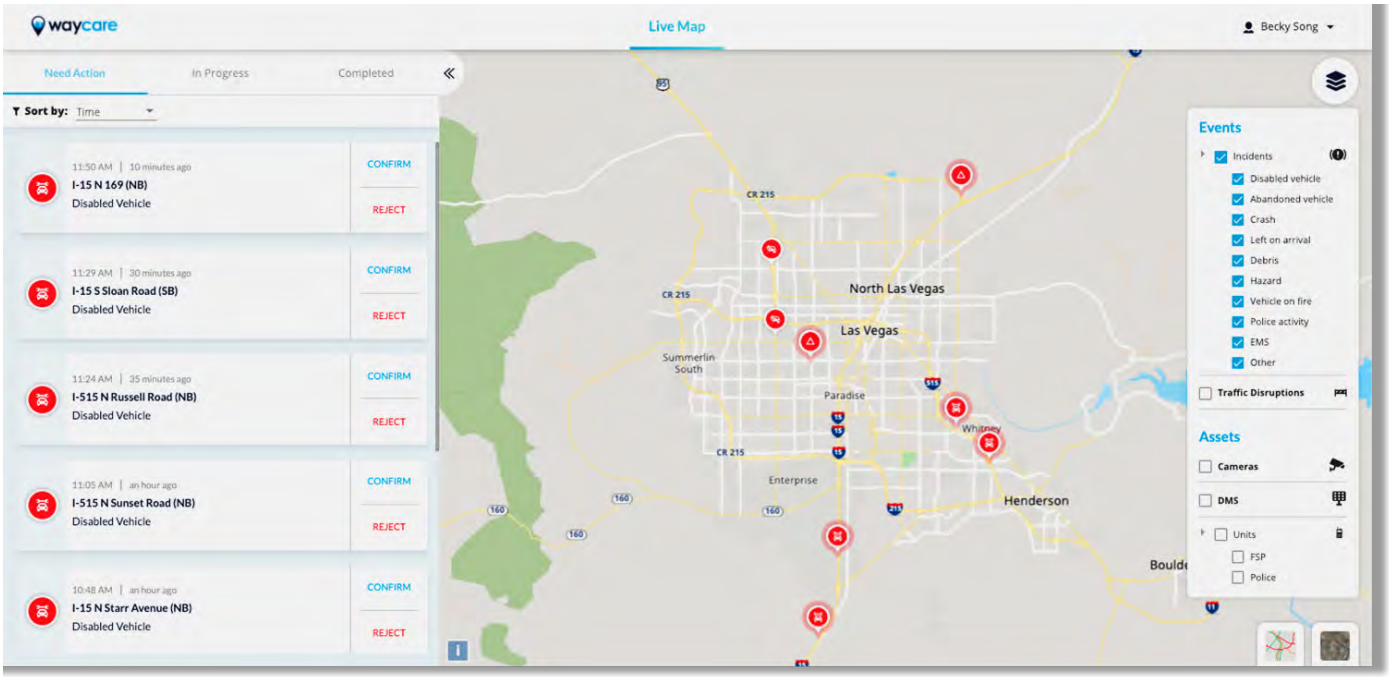
Incident Management

TSMO strategies, such as Incident Management, can be used as part of normal operations to support first responders in clearing crashes quickly. Quick clearance of crashes is beneficial in mitigating congestion by restoring lost capacity to the roadway and preventing the occurrence of secondary crashes. Incident Management also helps to facilitate coordination and resource sharing across jurisdictions whenever incidents occur.

- **NDOT FREEWAY SERVICE PATROL:** Traffic Operations describes the Freeway Service Patrol (FSP) program as follows: "The FSP operates in the Reno and Las Vegas areas to mitigate traffic congestion in the heavily traveled sections of our metropolitan freeways by providing quick and safe incident clearance. Statistics indicate that roadway incidents account for 25 percent of travel delay and that for every minute that a travel lane is blocked, the resulting congestion takes four minutes to dissipate and the probability of a secondary incident increases by 2.8 percent. The FSP program, as a guideline, aims to mitigate traffic incidents in under 15 minutes. These traffic incidents may include but are not limited to: crashes, disabled and abandoned vehicles, debris, lost or sick motorists, pedestrians, animals, scene safety, and other situations that disrupt traffic flow, such as fires and hazardous spills" (NDOT Traffic Operations, 2020). The FSP program measures several indicators to gauge the effectiveness of the program, including:
  - Time taken to complete mitigations, start to finish
  - Average roadway clearance time
  - Benefit-cost ratio
  - Total number of mitigations

In fiscal year 2020, the number of mitigations increased 15 percent despite the reduction in travel due to the COVID-19 travel restrictions. Even with this increase, more than 75 percent of the incidents were cleared in less than 15 minutes (7 percent in Las Vegas and 83 percent in Reno). The benefit-cost ratio of the program was estimated using the FHWA TIM Benefit-Cost Tool, which considers factors such as the number of mitigations, peak hour traffic weather conditions, and roadway geometry. The estimated benefit-cost ratio for the fiscal year 2020 was 24 in Las Vegas and 70 in Reno.

A Screenshot from the Incident Management Software Platform Showing a Live View of Active Incidents



☐ **NDOT INCIDENT MANAGEMENT SOFTWARE:** Another example of a TSMO strategy is implementation of shared incident management software in 2018 to improve incident identification, decrease response times, and foster better cross-agency collaboration.

Traditionally, Nevada Highway Patrol (NHP) officers were alerted to incidents only via 911 calls made to the agency dispatch center. Although this dispatch center is housed in the same facility as other critical first response service providers, including NDOT's FSP, Las Vegas ROADS (LVROADS), NHP, the Nevada Department of Public Safety (DPS-NHP dispatch), and RTC's Freeway and Arterial System of Transportation (FAST), these agencies did not have a common platform on which to share real-time information about traffic incidents. This lack of a common platform meant that a responding agency would not have the most recent information on an incident if the information was generated by a different agency. The common platform facilitates multi-agency sharing of information through the FAST TMC. Users can log into a web-based platform (Waycare, 2020) and view information such as:

- Precise locations of verified crashes
- Real-time location of FSP, NHP, and NDOT Maintenance personnel responding to incidents
- Pertinent incident information, i.e., vehicle types, lanes impacted, and injury status
- Real-time Geographical Information System (GIS)-based visual congestion queues
- CCTV camera feeds, if available, so that responders can make decisions prior to arriving on-scene
- A log of disabled and abandoned vehicles for LVROADS and NHP personnel

Use of this system has resulted in an average 12-minute reduction in incident response times, a reduction in secondary crashes, and seamless real-time sharing of information across multiple agencies (NDOT, 2019).

References

NDOT. (2019, May). *Waycare Platform Deployment in Southern Nevada Traffic Management Center*. Retrieved from National Operations Center of Excellence: https://transportationops.org/case-studies/waycare-platform-deployment-southern-nevada-traffic-management-center

NDOT. (2020). *One Nevada Transportation Plan*. Nevada Department of Transportation.

NDOT Traffic Operations. (2020). *FSP Facts and Figures*.

Nevada Office of Traffic Safety. (2020). *Nevada Traffic Safety Crash Facts*.

Vision Zero Network. (2017). *Vision Zero from the Inside-Out: A Case Study on Prioritizing Inter-Departmental Coordination and Accountability*. Retrieved from Vision Zero Network: https://visionzeronetwork.org/project/vision-zero-from-the-inside-out/

Waycare. (2020). Retrieved from Waycare: https://waycaretech.com/

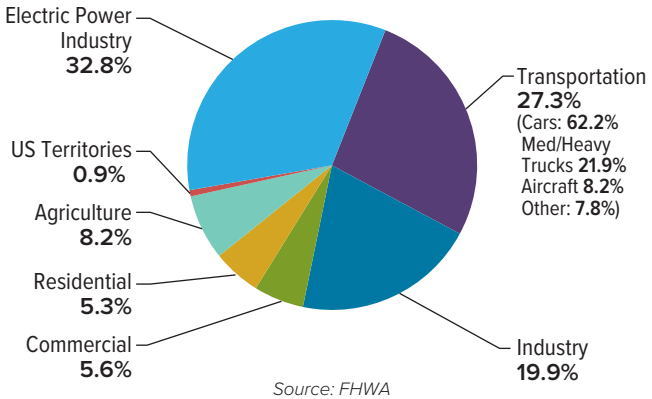
ENVIRONMENTAL INITIATIVES

NDOT's Environmental Division analyzes and monitors the environmental impact of transportation projects and considers strategies to mitigate those impacts. The Environmental Division's activities help to realize NDOT's adopted TSMO goal to foster sustainability. In adopting this goal, NDOT committed to developing a sustainable transportation system through balanced design, operations, and maintenance. In 2019, the state of Nevada passed into law Senate Bill 254, which required policy options to be developed to achieve reductions of greenhouse gas emissions of 28 percent and 45 percent by 2025 and 2030, respectively. As shown in the pie chart, the transportation sector contributes significantly to the overall amount of greenhouse emissions; consequently, reductions within the transportation sector will be a key part of achieving these goals.

TSMO can be useful in mitigating the transportation system's impact to the environment, as shown in the following examples:

- **NEVADA CARLIN TUNNELS ADAPTIVE LIGHTING:** As part of a larger project to improve Interstate 80 (I-80) through the Carlin Tunnels, NDOT sought to improve the lighting in the tunnels. The goals for the project were to lower energy consumption, have an effective control system, and meet applicable tunnel lighting standards. The new system uses an innovative white lighting system that monitors outside ambient conditions and adjusts the brightness of the tunnel lighting accordingly to improve safety and visibility while transitioning from outside lighting to tunnel lighting conditions. As shown in photo below, the white lighting provided by the new system enhances visibility.

Greenhouse Gas Emissions by Economic Sector in the U.S.



Source: FHWA

The New LED Lighting System (Left) vs the Old Lighting System (Right)

The new system improved overall energy consumption by a 37-percent decrease in the number of luminaires used for lighting the tunnel (Schreder, 2014). The table below is a comparison of lifecycle costs between the old system and the new LED lighting system.

Cost Comparison Between the Previous Lighting System and the New Lighting System

	Previous HPS Lighting System	New LED Lighting System
20-year lifecycle cost	$16,085,855	$7,050,511
Average annual energy cost	$387,673	$120,995
Average annual maintenance cost per luminaire	$2,567	$2,153
Benefit-cost ratio	—	1.3

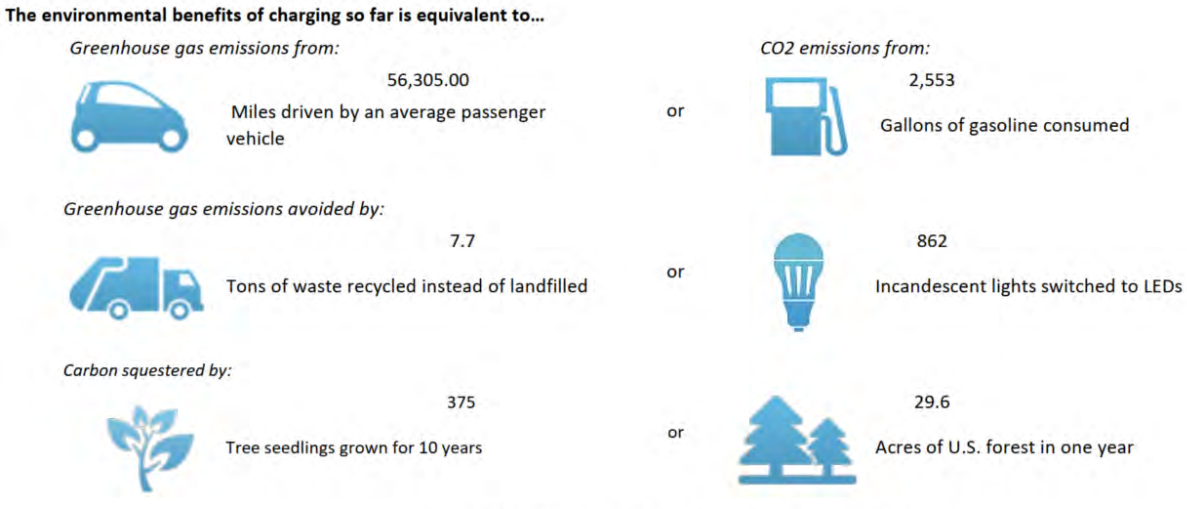
☐ **NEVADA ALTERNATIVE FUELS CORRIDOR:** The Fixing America's Surface Transportation (FAST) Act required the states to nominate and deploy fueling corridors along major national roadways that support plug-in electric vehicle charging and hydrogen, propane, and natural gas refueling with existing or planned infrastructure. In coordination with the Governor's Office of Energy, NDOT is developing Alternative Fuels Corridors (AFCs) with designated alternative fuels to establish a statewide network of alternative fueling and charging infrastructure along the National Highway System.

AFC Road Signs

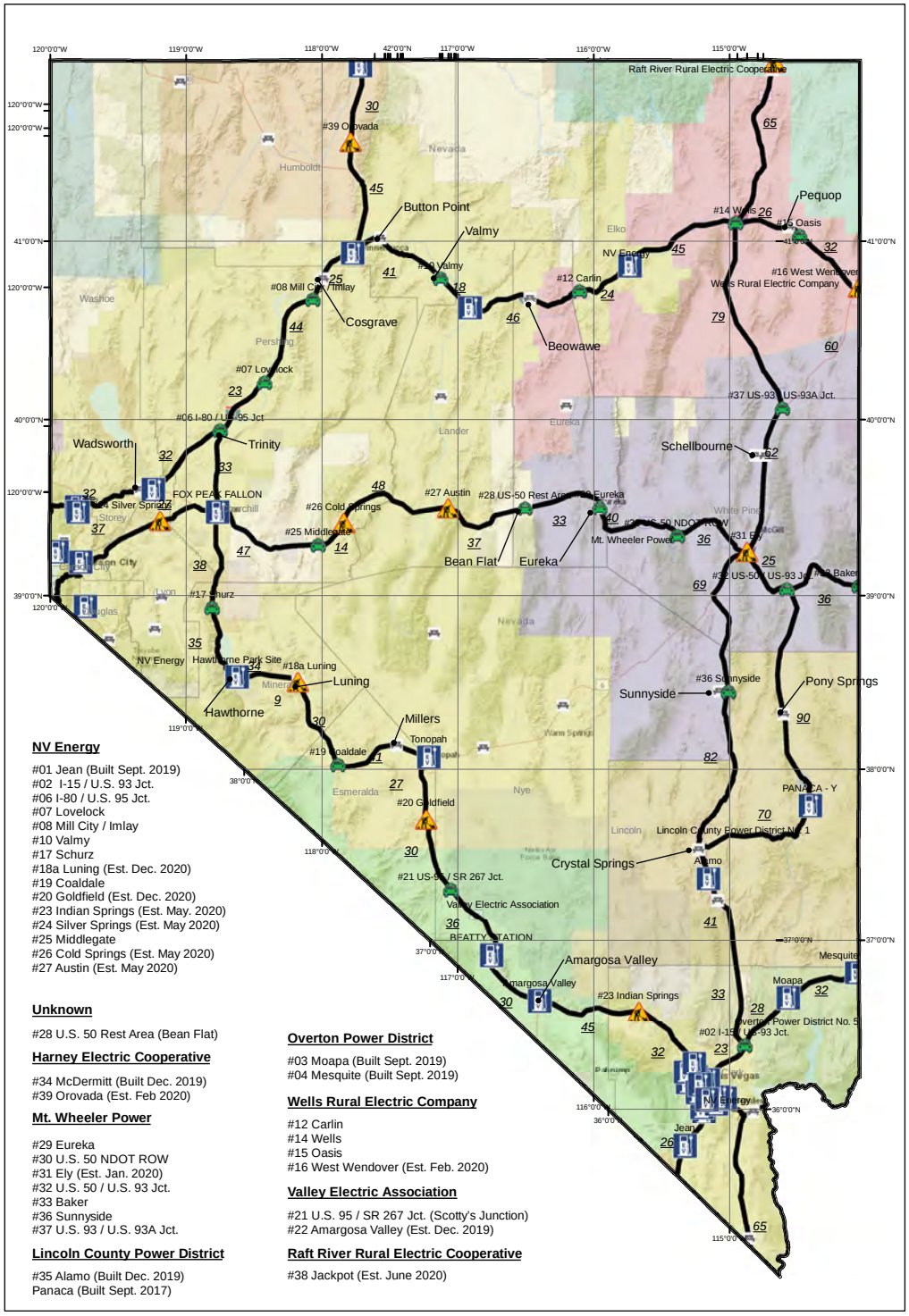
NDOT has currently deployed and completed AFCs along I-15 to the state line and along Interstate 580 (I-580) between Interstate 80 and U.S. Highway 50. NDOT is working with various developers to have electrical charging stations built, providing adequate opportunities to charging for electric vehicles.

TSMO strategies that improve mobility on a corridor by mitigating the intensity and duration of congestion also serve to reduce the amount of emissions released by traffic. This reduction in emissions comes as a result of a reduction in vehicle idling and stop-start driving conditions that are associated with the release of more emissions.

Environmental Benefits of Alternative Charging



Nevada Electric Highway



NV Energy

#01 Jean (Built Sept. 2019)
#02 I-15 / U.S. 93 Jct.
#06 I-80 / U.S. 95 Jct.
#07 Lovelock
#08 Mill City / Imlay
#10 Valmy
#17 Schurz
#18a Luning (Est. Dec. 2020)
#19 Coaldale
#20 Goldfield (Est. Dec. 2020)
#23 Indian Springs (Est. May. 2020)
#24 Silver Springs (Est. May 2020)
#25 Middlegate
#26 Cold Springs (Est. May 2020)
#27 Austin (Est. May 2020)

Unknown

#28 U.S. 50 Rest Area (Bean Flat)

Harney Electric Cooperative

#34 McDermitt (Built Dec. 2019)
#39 Orovada (Est. Feb 2020)

Mt. Wheeler Power

#29 Eureka
#30 U.S. 50 NDOT ROW
#31 Ely (Est. Jan. 2020)
#32 U.S. 50 / U.S. 93 Jct.
#33 Baker
#36 Sunnyside
#37 U.S. 93 / U.S. 93A Jct.

Lincoln County Power District

#35 Alamo (Built Dec. 2019)
Panaca (Built Sept. 2017)

Overton Power District

#03 Moapa (Built Sept. 2019)
#04 Mesquite (Built Sept. 2019)

Wells Rural Electric Company

#12 Carlin
#14 Wells
#15 Oasis
#16 West Wendover (Est. Feb. 2020)

Valley Electric Association

#21 U.S. 95 / SR 267 Jct. (Scotty's Junction)
#22 Amargosa Valley (Est. Dec. 2019)

Raft River Rural Electric Cooperative

#38 Jackpot (Est. June 2020)

Nevada Electric Highway

DC Fast Charging Station
GOE planned DC Fast Charging Station
NDOT Rest Area
DC Fast Charging Station In-Construction

0 50 100 200 Miles

Nevada Governor's Office of Energy

Updated 1/2020; v2.11

- **DRCOG Adaptive Traffic Signal:** Since 1989, the Denver Regional Council of Governments (DRCOG) has been working to reduce traffic congestion and improve air quality through its Traffic Operations Program. The program is a collaborative effort between DRCOG, CDOT, and local governments to coordinate traffic signals across jurisdictions in the region. In 2019, the program re-timed 92 signals, resulting in an annual reduction in daily travel time for motorists of 900,000 hours, a reduction in fuel consumption of 700,000 gallons, and a reduction in greenhouse gas emissions of 6,300 tons (Denver Regional Council of Governments, 2019).

TSMO strategies also can encourage the use of different transportation modes to reduce the impact of vehicular travel. This can be used as part of a larger corridor management strategy.

- **Dallas US 75 ICM:** An Integrated Corridor Management (ICM) system was implemented on U.S. Highway 75 in Dallas, Texas, to improve mobility on the corridor. The system supports multiple transportation modes by providing real-time information regarding the status of freeways, arterials, and transit facilities. This information is shared between operators of these facilities, the public, emergency responders, and local agencies. The project deployed ITS infrastructure, route diversion information systems, smart parking systems at transit stations, and advanced traveler information systems. Travelers can be diverted to different routes or to public transit when incidents occur. Travel time was reduced by 740,000 person-hours per year with an annual savings of one million gallons of fuel. These results were achieved with a benefit-cost ratio of approximately 20:1 (US DOT, 2017).

References

Denver Regional Council of Governments. (2019). *Traffic Operations Program*. Retrieved from Denver Regional Council of Governments: https://drcog.org/sites/default/files/traffic-operations-program-projects-2019.pdf

Schreder. (2014, July 17). *SCHRÉDER LIGHTS FIRST 100% LED HIGHWAY TUNNEL IN NORTH AMERICA*. Retrieved from lighting.eu: http://lighting.eu/article/464/schrder-lights-first-100-led-highway-tunnel-in-north-america

US DOT. (2017). *ITS Knowledge Resources*. Retrieved from US DOT: https://www.itsknowledgeresources.its.dot.gov/its/bcllupdate/pdf/BCLL_Freeway_ICM_2017_FINAL.pdf

HUMAN RESOURCES

The employment landscape in the transportation industry is undergoing profound changes as the industry itself is changing to embrace new technologies and methods of operation. The spread of ITS that uses the latest technologies has resulted in demand for a workforce that is skilled in maintaining and operating these systems. The ITS systems continue to evolve, placing more importance on having a workforce that is not only skilled, but continues to learn and adapt to changes in technology. Many TSMO solutions use ITS technologies. As such, the proper operation and maintenance of the ITS devices is critical to ensuring that the intended results are achieved.

Human Resources practitioners are responsible for hiring and staff retention policies that can be leveraged to meet the changing workforce demands of the transportation sector. The demands of TSMO-related jobs often exceed those of traditional roles, so position descriptions need to be updated to better align with the needs of TSMO. Recruitment strategies also may need to be revised to better target personnel with the appropriate skillsets. It is also important for the agency to support professional development for TSMO-related skills as part of work force management.

NDOT's Human Resources Division assists and supports the NDOT TSMO Program in the following areas (TSMO Workforce Guidebook, 2019):

- Providing recruitment specialists
- Determining when and where to recruit
- Performing screening and interview processes and procedures
- Determining incentives for TSMO positions
- Creating and delivering training and professional development for both new hires and current staff
- Developing work performance standards
- Providing feedback about development of the TSMO recruitment plan
- Developing and formalizing collaborative relationships between agency departments

Specific examples of Human Resources professionals working to enhance and integrate TSMO strategies include:

- **WORK PERFORMANCE STANDARDS:** In developing the NDOT Statewide TSMO Program Plan, the Traffic Operations Division identified specific action items to be undertaken to review and update Work Performance Standards (WPS). This step is necessary to ensure the TSMO skillset, knowledge, and responsibilities are integrated into current and future roles and positions. In addition, the Traffic Operations Division designed a phased approach to review and update the division's organizational structure for inclusion of new TSMO positions. Furthermore, as part of the Statewide TSMO Implementation Plan, the Traffic Operations Division is developing a TSMO Staffing and Workforce plan to assist with recruiting, training, and retaining TSMO staff.

- **OHIO DOT TSMO COORDINATOR:** The Ohio DOT (ODOT) developed its TSMO efforts through the addition of a TSMO Coordinator role in each of its DOT Districts. These coordinators' responsibilities were to support implementation and integration of TSMO practices. ODOT's TSMO plan was consulted to help define the specific duties that coordinators would fulfill, and then ODOT Human Resources helped to develop position descriptions. These position descriptions also were tailored to the specific needs of each District. Most of the coordinator positions were filled by internal candidates from the Operations Division that had the requisite understanding of TSMO. This organizational change has resulted in TSMO considerations being included early on in projects because the project managers now discuss all projects with their respective TSMO coordinators (NOCoE, 2020).

References

NDOT. (2020). *NDOT Statewide TSMO Program Plan*.

NOCoE. (2020, May 20). *Workforce Development with Ohio TSMO Coordinators*. Retrieved from National Operations Center of Excellence: https://www.transportationops.org/case-studies/workforce-development-ohio-tsmo-coordinators

MAINTENANCE AND ASSET MANAGEMENT

Asset management is the strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on engineering and economic analysis. It is based on quality information to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost. Within NDOT, the Maintenance and Asset Management Division plays a key role in establishing and implementing management processes that guide construction and maintenance activities.

- **NDOT TRANSPORTATION ASSET MANAGEMENT PLAN:** NDOT's 2019 Transportation Asset Management Plan (TAMP) details the development and implementation of a risk-based approach to asset management to maintain and improve the DOT's assets throughout their lifecycle. The TAMP summarizes the quantities and condition of certain assets (pavement, bridges, and ITS assets) and the agency's plans for managing these assets for the next 10 years (NDOT, 2020).

  NDOT is one of the few state DOTs that includes ITS assets and devices as part of its asset management plan, in addition to traditional assets, such as pavement and bridges. The traditional assets typically have performance measures used in asset management that are tied to field-measured conditions. For example, NDOT uses the National Bridge Inspection scale to rate the condition of bridges based on an inspector's assessment of a bridge's deck, superstructure, and substructure. For ITS assets and devices, NDOT is in the process of developing device-specific performance measures that are derived from the physical condition of each device. The manufacturer's recommended service life for each asset currently is used as a proxy measure of each asset's condition. Developing and implementing performance measures that better reflect the field condition of TSMO assets would help better inform long-term procurement and maintenance strategies.

  NDOT also has identified further enhancements for future consideration. These enhancements are recommended to also include TSMO assets and be a part of the TSMO planning process. The cornerstone of asset management, including TSMO assets, is to have a performance and outcome-based program. Performance targets must be set, against which the performance of measured asset conditions is assessed. These targets should align with the stated goals in NDOT's transportation plans. The targets will guide investment decisions to either achieve or maintain desired performance levels for asset conditions. NDOT is working toward this goal through the development of a TSMO Performance Management Program to advance its TSMO capabilities and improve how TSMO is integrated into the management and operations of the Nevada transportation system. The Traffic Operations Division has outlined several action items that support this objective and is further developing ITS asset management practices, including programmatic-level performance measures, that best support the TSMO Implementation Plan and the Moving Ahead for Progress in the 21st Century Act (MAP-21); align with NDOT's TAMP, maintenance management system, and Long-Range Plan; and meet the needs of all three NDOT Districts.

- **CALTRANS TAMP:** Caltrans includes TSMO assets in its TAMP and performs preventative maintenance checks on these assets annually. The assets then are given a performance measure rating of Good (operational) or Poor (non-operational or obsolete). These ratings are used to project future performance based on historical patterns and are used to assess the overall health of the system's assets, predict future needs, allocate funding, and schedule projects (Caltrans, 2018).

References

NDOT. (2020). *One Nevada Transportation Plan*. Nevada Department of Transportation.

Caltrans. (2018). *California Transportation Asset Management Plan*. Caltrans.

FREIGHT PLANNING

NDOT's Freight Program Division develops strategies, policies, and methodologies that work to improve the freight transportation system in Nevada. Businesses consider freight transportation access as part of their criteria in selecting where to invest and build. Nevada maintains a multimodal freight transportation system that provides services to residents, businesses, and tourists. The state's highway, air, and rail transportation systems all support freight operations that enable movement of goods and services across multiple supply chains. According to the *One Nevada Transportation Plan*, in 2015, more than $156 billion worth of goods were shipped into, out of, and within the state. International exports from Nevada accounted for more than $12 billion worth of products and 40,000 jobs as of 2016 (U.S. Census Bureau, 2018). Of all freight tonnage movements within the state, 77 percent rely on trucks, which in turn depend on a reliable highway system to traverse the more than 1.2 billion truck-miles traveled annually on NDOT facilities. Rail and air also are integral parts of the freight system, particularly in the mining and high-tech sectors.

According to *Nevada's State Freight Plan 2017*, the demand for freight services is expected to grow in the future due to several factors, namely:

- Nevada's growing population and the growth of populations in neighboring states—this will provide a larger market for goods and services flowing into and out of the state.
- Per capita disposable income is expected to grow, both in Nevada and nationally. This means that people have higher disposable income to purchase or sell goods and services.
- Nevada will continue to depend on imports from international markets, especially in Asia.
- The state's business-friendly climate will continue to attract businesses in manufacturing and technology sectors, which will increase the state's exports.

Another statewide goal adopted by Nevada is to "… improve daily highway system operations management to eliminate freight-associated motor vehicle fatalities." Initiatives introduced by NDOT to achieve the freight safety goal include:

- **CORRIDOR-SPECIFIC TRUCK PARKING PLANS:** In response to the need for safe and sufficient truck parking along major corridors, NDOT is developing the Nevada Truck Parking Implementation Plan, which is a plan for "expanding, improving, and integrating freight truck parking and truck parking communications systems in response to rising demand, changing hours of service requirements, and safety standards defined in Jason's Law. When implemented, these improvements will provide adequate and safe public truck parking where it is most needed, full-service private truck facilities, and real-time truck parking availability information" (Cambridge Systematics, Inc., 2018). For example, along I-15 and I-80, Truck Parking Availability Systems (TPAS) are being implemented to make finding truck parking spaces easier. TPAS are a type of ITS that can help by "… increasing the efficient use of existing capacity and more advanced analysis such as predictive analytics [to] help predict the future supply of truck parking, providing drivers and dispatchers with even more information. Sites can be outfitted with a number of different types of sensors to identify the number of spaces available in real-time, and transmit this information to signs, websites, or smartphone applications" (Cambridge Systematics, Inc., 2018).
- **THE NEVADA FREIGHT ADVISORY COMMITTEE:** This committee is made up of representatives from public agencies and private sector companies with the goal of maximizing coordination and collaboration. Together, the Committee discusses topics that impact freight transport in Nevada and provide NDOT with guidance.

- **I-15 DYNAMIC MOBILITY PROJECT:** The I-15 Dynamic Mobility Project will improve real-time communication and information exchanges among the four I-15 Alliance states (Nevada, Utah, California, and Arizona). An important goal of the project is to improve agency coordination when incidents, weather, and closures affect I-15. This coordination will ultimately translate into improved advanced warnings and consistent information provided to travelers along I-15 (I-15 Mobility Alliance, 2015). The project is funded under the Multistate Corridor Operations and Management (MCOM) Program. A key outcome of the project has been the development of a web-based platform that allows information sharing, facilitates TMC coordination, and acts as a decision support system. Since the I-15 Mobility Alliance was established, the group has developed a partnership with more than 90 public and private sector agencies; developed a comprehensive, multimodal master plan and subsequent update for the I-15 Corridor. Building on the success of the I-15 MCOM project, the I-80 MCOM project was launched to address the challenges faced on the I-80 corridor. While I-80 presents a different set of challenges, the approach and principles used on I-15 still apply, especially when it comes to coordinating and planning regionally—or even across state lines.

- **NEW JERSEY DOT TSWS:** Another example is the New Jersey DOT (NJDOT) Truck Safety Warning System (TSWS). NJDOT initiated TSWS at two interchanges based on an identified pattern of roll-over crashes. These crashes led to fatalities, property damage, delays, and hazardous material spills. The TSWS detects when a potential roll-over crash is likely to occur based on a truck's real-time speed, weight, and the roadway curvature and super-elevation. An automated warning message then is displayed to the truck driver via a variable message sign located before the truck enters the critical curve section. The system also can detect the occurrence of a roll-over crash, which then alerts operators at the Traffic Operations Center. So far, NJDOT reports that the number of trucks entering ramps at unsafe speeds has been reduced. This reduction has lowered the likelihood of roll-over crashes occurring at these ramps.

References

Cambridge Systematics, Inc. (2018). *Nevada Truck Parking Implementation Plan*.

I-15 Mobility Alliance. (2015). *Multi-State I-15 Dynamic Mobility Project*. Retrieved from https://i15alliance.org/projects/multistate-i-15-dynamic-mobility-project/#1578004216384-39e9fca0-1aa0