Congestion Management Process 2023

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Abstract

This document, Congestion Management Process (CMP), provides a transportation planning tool for managing traffic congestion impacting Southern Nevadans. It is continually edited and updated over time to respond to changes in travel demand, policy, technology, and data availability.

The CMP is published by the Regional Transportation Commission of Southern Nevada (RTC) which serves as the Metropolitan Planning Organization (MPO) responsible for regional transportation planning in the Las Vegas Metropolitan Planning Area.

The CMP emphasizes the feasibility of cost efficient strategies such as Travel Demand Management (TDM) and Transportation Systems Management (TSM). TDM focuses on user behavior modification strategies to reduce single-occupancy vehicles (SOV) and shift travel away from peak periods. TSM involves effective management of existing infrastructure through intersection improvements, signalization changes, and freeway optimization.

The report begins with an examination of the causes of traffic congestion and the underlying objectives of the CMP. Road network performance is reported using federally required metrics such as regional travel time reliability and peak hour excessive delay. Congestion management performance measures of bus on-time performance and incident clearance time are also included.

In addition to performance reporting, the report defines the study network and describes methods of data collection. The use of travel time reliability metrics allow for analysis which varies from the traditional approach of projecting future traffic volumes and determining its ratio to current roadway capacity. Travel time reliability metrics have been leveraged to track the history of traffic congestion on Southern Nevada's road network. This history is easily accessed via the report's companion web map application which provide a ready reference for where and when congestion has occurred over time.

The report also contains detailed findings of Southern Nevada's most severely congested road segments and most impactful bottleneck locations. The many congestion management strategies implemented by the RTC and partnering agencies are accounted for and organized into four prioritized categories. All the aforementioned resources provide a starting point from which to evaluate the effectiveness of implemented congestion management strategies. The success of the CMP depends upon it being fully integrated into the regional transportation planning process.

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This report has a companion web application.

This resource can be accessed at the following URL:

https://arcg.is/1K5b1S

Introduction to Congestion Management

Congestion management is the application of strategies to improve transportation system performance and reliability by reducing the adverse impacts of congestion on the movement of people and goods.

Traffic congestion occurs when there are too many vehicles at the same place at the same time. Traffic congestion results in slower speeds, longer travel times, increased fuel consumption, and air pollution. In this sense, congestion deals with two dimensions: the where (a location such as an intersection or roadway segment) and the when (time and date). As a major metropolitan area and global tourist destination, Southern Nevada roads experience congestion. Understanding where and when the congestion is occurring is prerequisite for managing it efficiently.

The Four Dimensions of Congestion

Congestion can be conceptualized as having four primary dimensions.

1. **Extent**: The number of system users or components (e.g. vehicles, pedestrians, transit routes, and lane miles) affected by congestion. The extent may also be described as the proportion of system network components (roads, bus lines, etc.) that exceed a defined performance measure target.
2. **Duration**: The amount of time the congested conditions persist before returning to an uncongested state.
3. **Intensity**: The relative severity of congestion that affects travel.
4. **Variability**: The changes in congestion that occur on different days or at different times of day. When congestion is highly variable due to non-recurring conditions, such as a roadway with a high number of traffic accidents causing delays, this has an impact on the utility of the system.

The Primary Sources of Congestion

There are a variety of circumstances which cause congestion to form. Figure 1 is a finding of a 2021 national study completed by the University of Maryland CATT Lab on the causes of congestion during calendar year 2019 on the national highway system (NHS). The study, entitled "Transportation

Disruption and Disaster Statistics", provides an estimated annual total of vehicle hours of delay and share of each causes' contribution to that total. The annual user delay cost estimate assumes a 90% passenger and 10% commercial traffic volume split and the most recent hourly operation costs provided by Texas Transportation Institute.

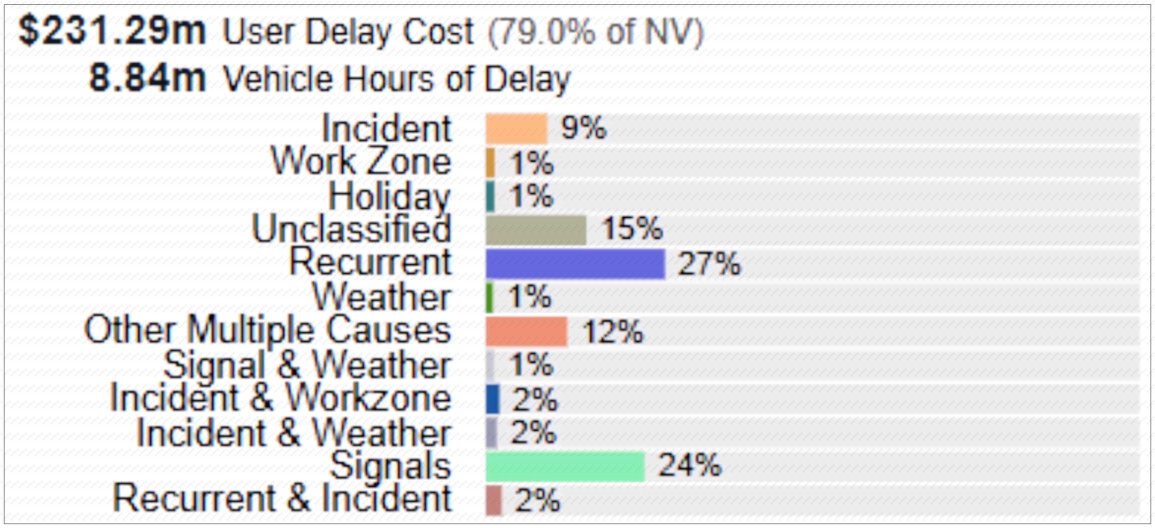


Figure 1: Estimated Congestion Causes for the National Highway System in Southern Nevada during 2019

A brief description of each source of congestion examined in the study is given below. These items were derived from sources including INRIX 1-minute probe data, Waze data, Open Street Maps data, and National Oceanic and Atmospheric Administration radar data.

Sources of Congestion:

- **Work Zones:** Interruption in traffic flow caused by a planned construction or maintenance project/activity.
- **Weather**: Interruption in traffic flow caused by inclement weather conditions.
- **Traffic Incidents:** Interruption in traffic flow caused by an unplanned road or roadside obstruction that results in travel delay.
- **Holidays:** Interruption in traffic flow caused by a scheduled occasion.
- **Signals:** Interruption in traffic flow incurred at signalized intersections.
- **Recurrent Disruption:** A predictable and regular pattern of interruption in traffic flow that results in travel delay.
- **Multiple Causes:** Disruption/congestion event caused by more than 1 factor.
- **Unclassified Disruption:** Interruption in traffic flow with no discernable cause using available data. Special events may contribute to this category.

Whatever the source, traffic congestion persistently challenges our transportation system and is responsible for gallons of wasted fuel and hours of wasted time.

Nationwide Comparison

As reported in Figure 2 below, there are some differences between Southern Nevada's congestion source composition and that of the nationwide averages. Notably, Clark County's largest contributor to delay is recurrent congestion which represents a 27% share, but this is smaller than the nationwide share of 32%. This difference is partially explained by the fact that our share of traffic signal delay is 5% greater than its nationwide share of 19%.

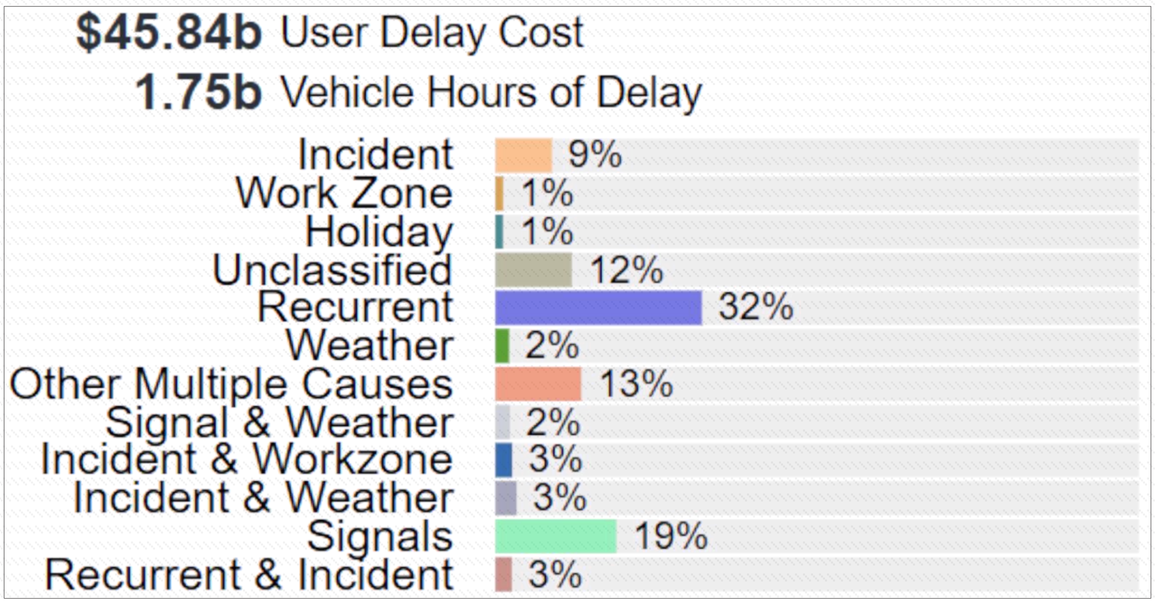


Figure 2: Estimated Congestion Causes for the National Highway System during 2019

Recent History of Congestion

The Urban Congestion Report (UCR) is produced on a quarterly basis and characterizes traffic congestion and reliability trends at the metropolitan level. UCRs were no longer published following the third quarter of 2019 possibly due to the pandemic which occurred in early 2020. The effect of the pandemic and more recent congestion performance is covered in subsequent sections.

The UCR methodology utilizes vehicle probe-based travel time data from FHWA's National Performance Management Research Data Set (NPMRDS). The production of these reports is performed by the Texas A&M Transportation Institute for the Federal Highway Administration (FHWA). The UCR averages are weighted by VMT using volume estimates derived from FHWA's Highway Performance Monitoring System (HPMS). In Figure 3, congested hours are computed as the average number of hours during weekdays (6 am to 10 pm) in which road sections are congested (i.e. speeds less than 90 percent of free-flow speed). With this definition, hours of daily congestion increased in 2016 and 2017, leveled out in 2018, and then showed signs of improvement in 2019. Figure 4 shows a similar pattern for the ratio of the peak-period travel time to the free-flow travel time during weekdays (6 am to 9 am and 4 pm to 7 pm). Finally Figure 5 states that despite variation in congestion over time, travel time unreliability steadily lessened over the same time span.

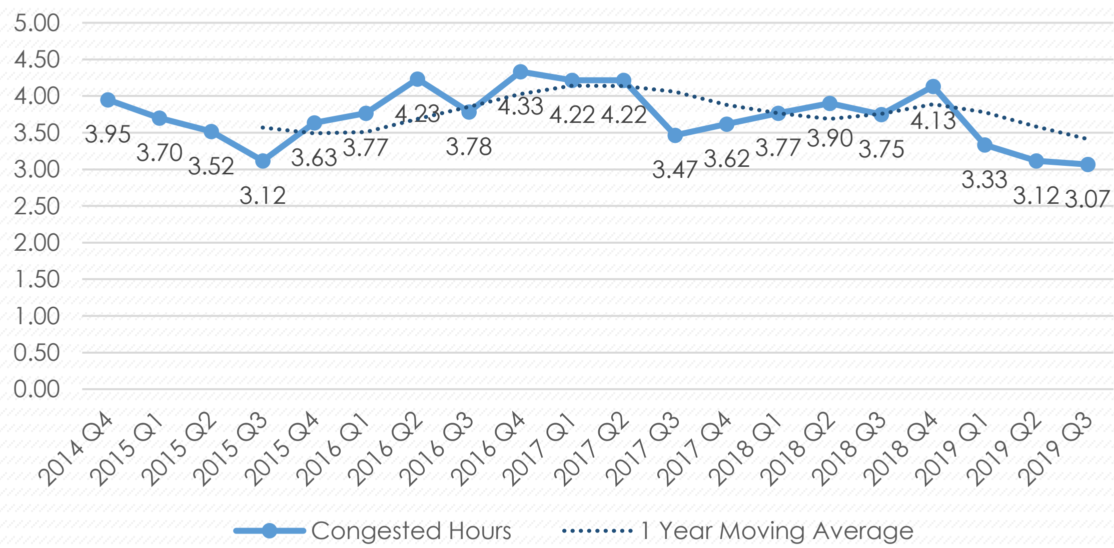


Figure 3: Average Duration in Hours of Daily Congestion in Southern Nevada, Q4 2014 – Q3 2019

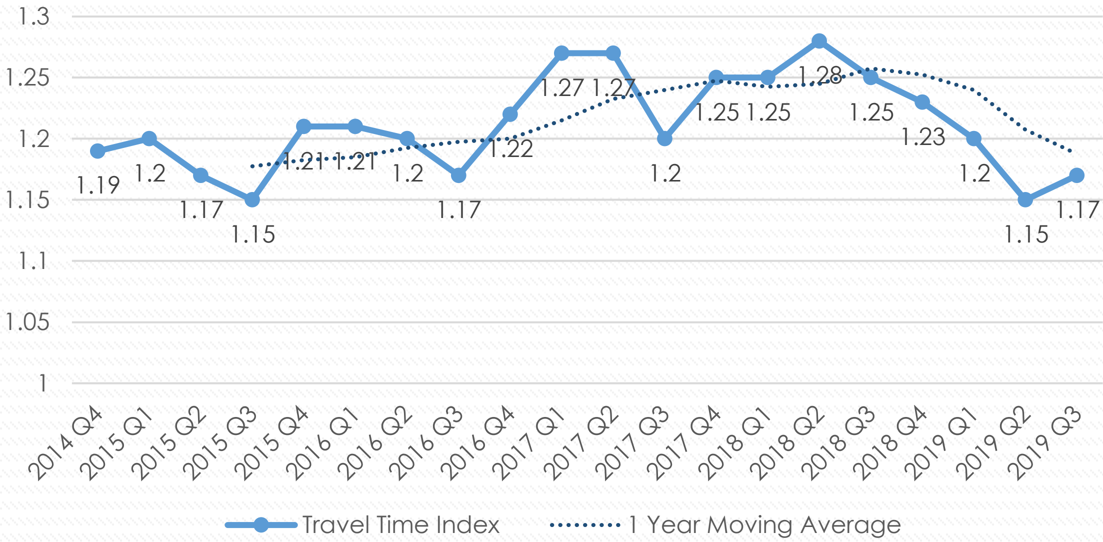


Figure 4: Ratio of Peak Period to Off-peak Travel Times in Southern Nevada, Q4 2014 – Q3 2019

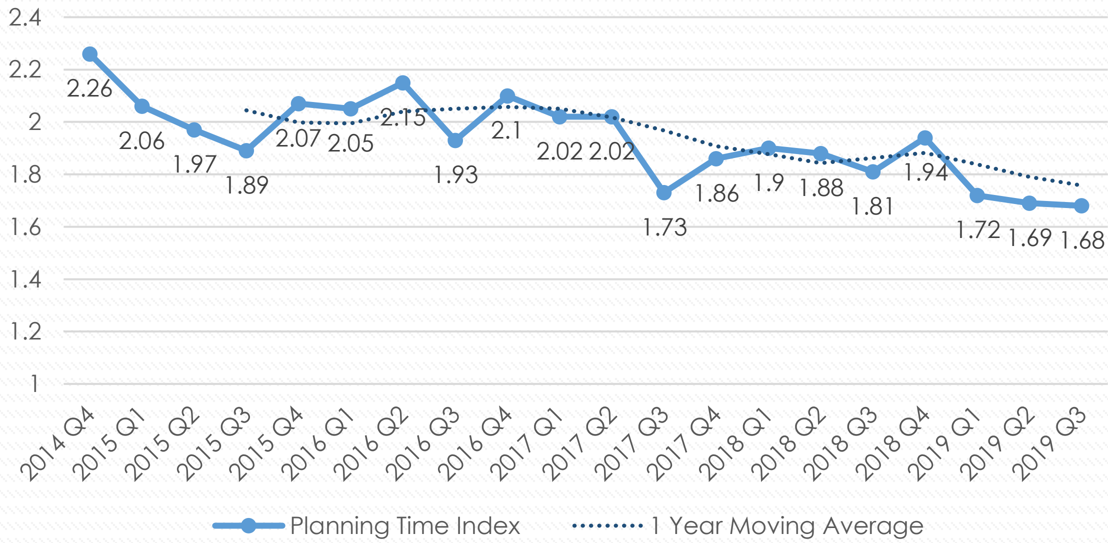


Figure 5: Unreliability (Variability) of Travel in Southern Nevada, Q4 2014 – Q3 2019

COVID-19 Impact to Vehicles Miles Traveled

As can be seen in Figure 6, when the State of Nevada issued a declaration of emergency for COVID-19 on March 12th, 2020, Vehicle Miles Traveled (VMT) in Southern Nevada plummeted. One month later, on April 12th, 2020, VMT was merely 34.1% of pre-COVID VMT.[i] As seen in Figure 7, even into 2021 the greatest reductions persisted along the resort corridor. In addition, VMT was low along commuting corridors during morning peak hours. Besides VMT, trip count and trip duration diminished, while travel speed and trip distance elevated. It wasn't until almost exactly a year later following March 15th, 2021 that VMT would recover to pre-COVID levels. Finally, Figure 8, indicates the distance a driver could travel from the city center outwards in 30 minutes in 2019, 2020, and 2021 during the PM Peak. In many parts of the metropolitan area, vehicle users were able to travel farther in 30 minutes in 2020 than in 2019 or 2021 due to reduced roadway congestion.

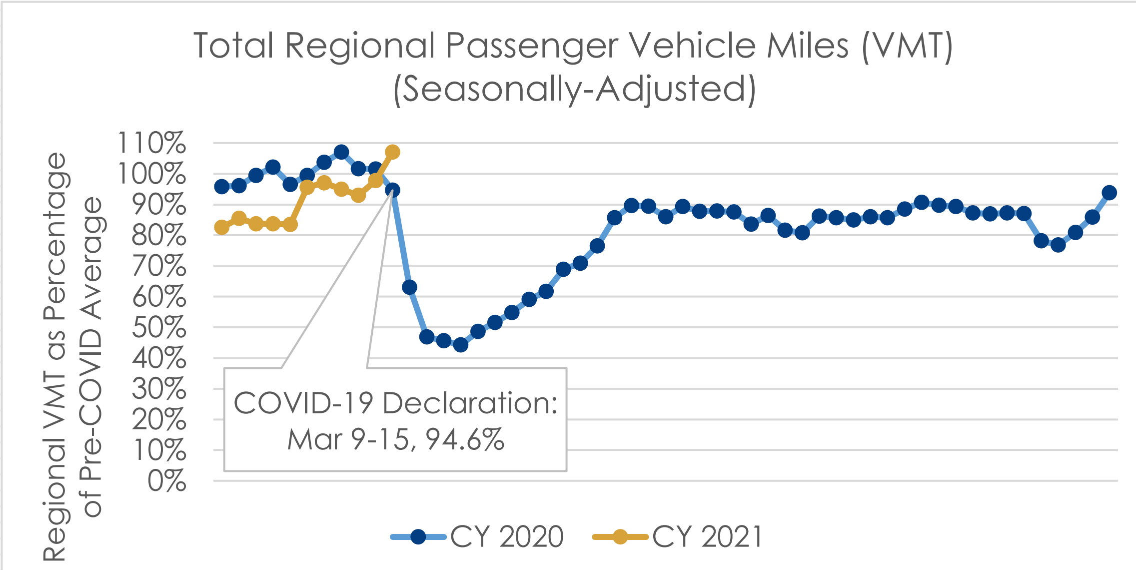


Figure 6: Impact of COVID on Vehicle Miles Traveled in Southern Nevada

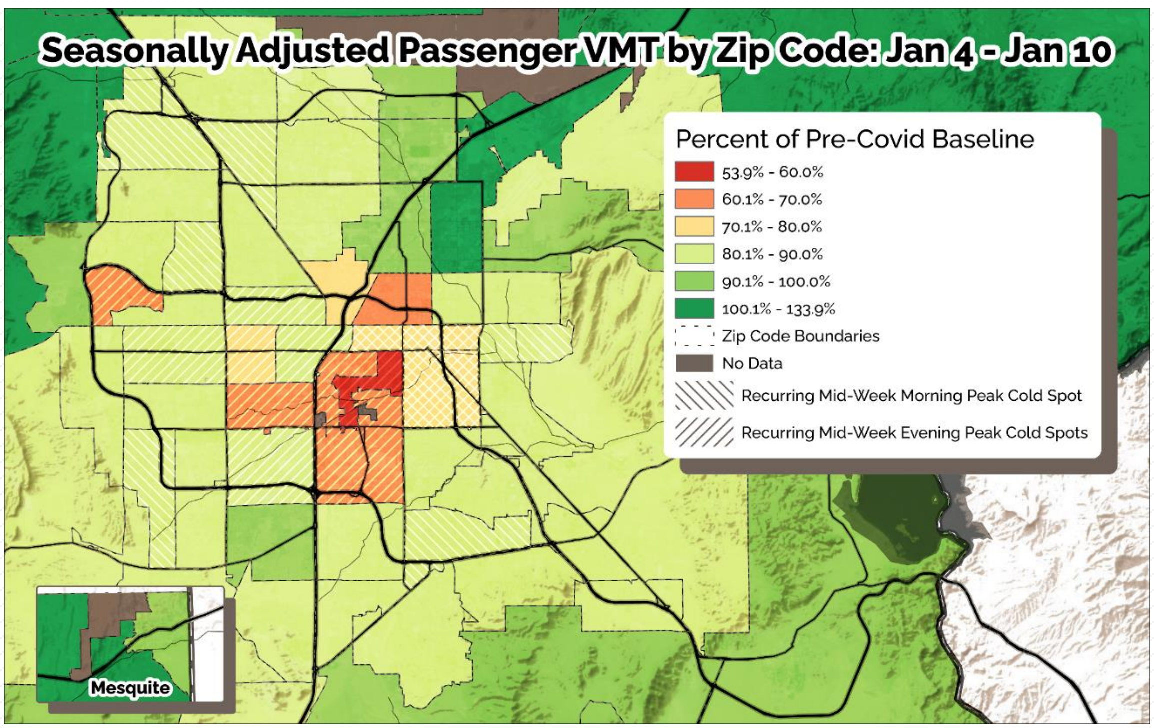


Figure 7: Vehicles Miles Traveled as a Percent of Pre-Covid Baseline by Zip Code, January 4th-10th, 2021

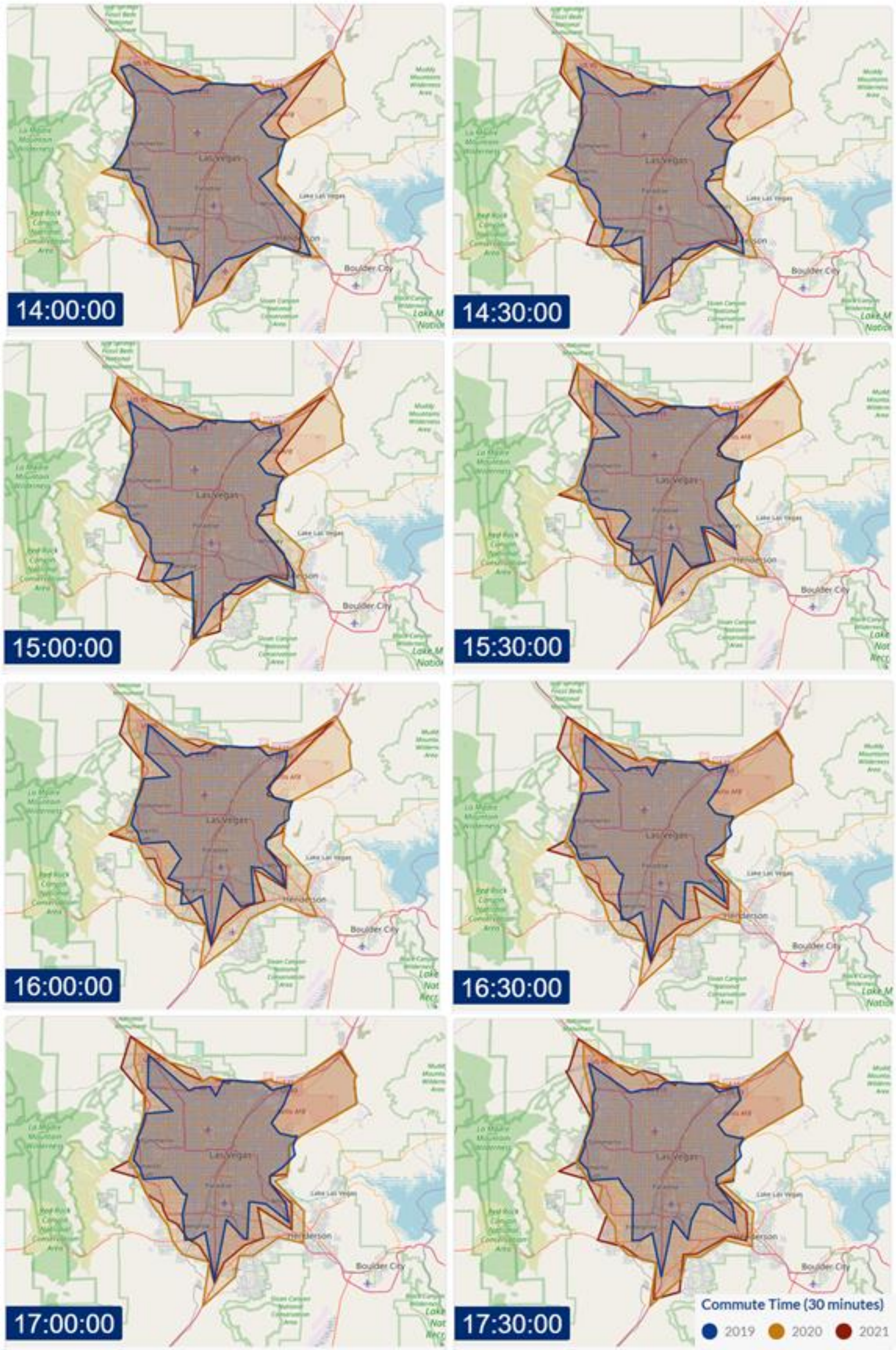
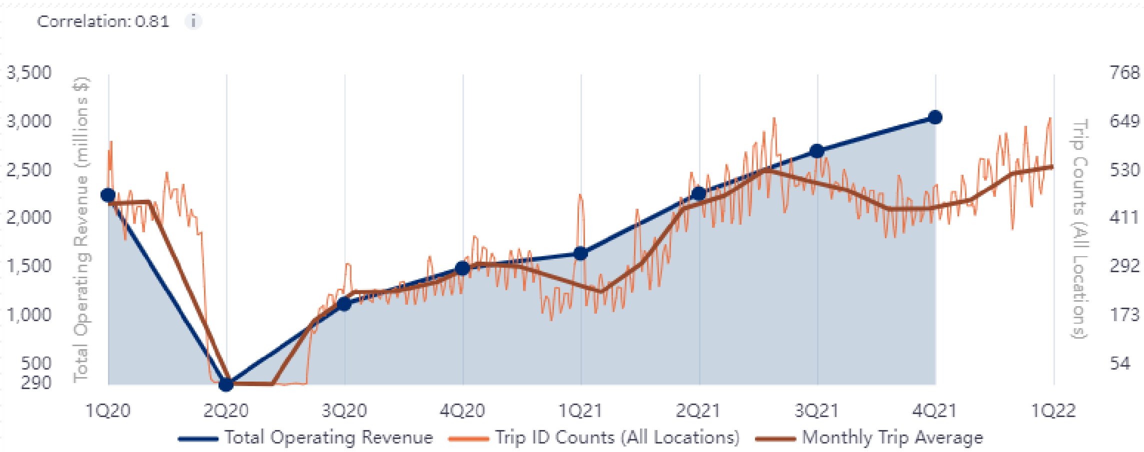


Figure 8: PM Peak 30 Minute Commute in Southern Nevada (2019-2021)

Correlation of Economic Activity and Traffic

The pandemic brought into focus the correlation between traffic volumes and economic activity. This relationship is particularly strong for hospitality industries where not only does economic activity spur demand for work based trips but also tourist trips. As stated in the previous section, the COVID-19 shutdown greatly reduced VMT. Concurrently with this change, Southern Nevada's unemployment rate jumped to 31.1% indicating a sudden contraction of economic activity.[II] Figure 9 provides anecdotal evidence of this relationship, trips taken to and from MGM Resorts International were strongly correlated with their revenue.



Location	Trip 3Q21	Trip 4Q21	Trips Change
MGM Paradise NV 89109	22K	23K	4.49%
MGM Las Vegas NV 89109	20K	24K	17.47%
MGM Beverly Hills CA 90210	490	445	-9.18%

Figure 9: Correlation of Trips to MGM Resorts and MGM Revenue[III]

Post Pandemic Congestion History

As quarterly UCR reports end after the 3rd quarter of 2019, a different source of information is needed for more recent quarters. The Center for Advanced Transportation Technology at the University of Maryland has tools on their Regional Integrated Transportation Information System (RITIS) that can produce quarterly congestion numbers using NPMRDS data. As can be seen in Figure 10 and Figure 11, RITIS produced figures differ from the UCR numbers even when selecting similar time day and week. One reason for this difference is that, *unlike UCR numbers, they are not weighted using HPMS traffic volume data.* Following the first quarter of 2021, congestion levels (see Figure 10) gradually increased to pre-pandemic levels. Meanwhile, unreliability also increased but not back to pre-pandemic levels (see Figure 11).

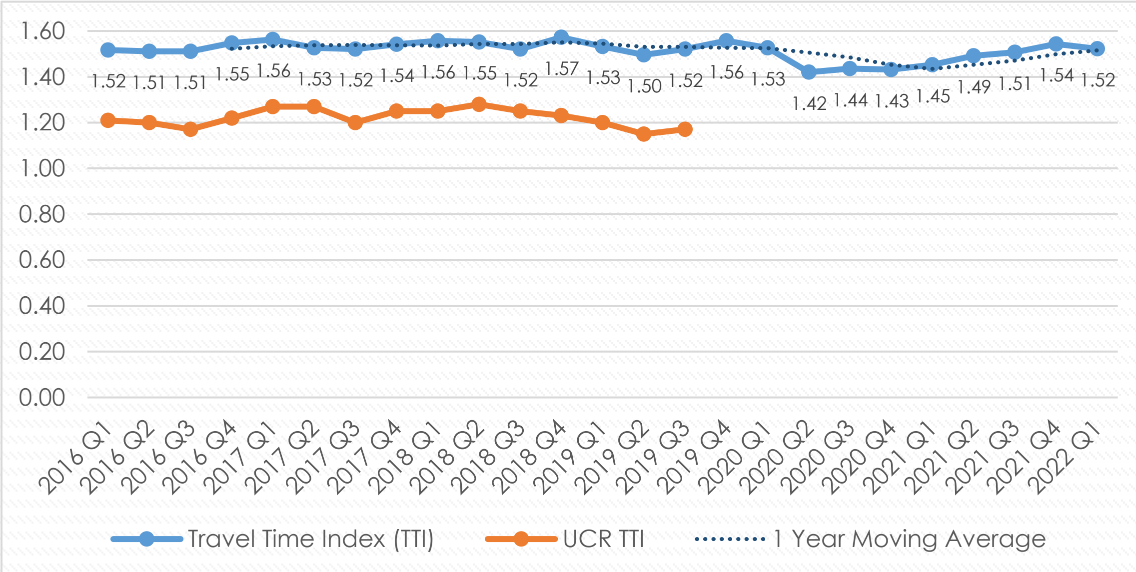


Figure 10: Ratio of Peak Period to Off-peak Travel Times in Southern Nevada, Q4 2014 – Q3 2019

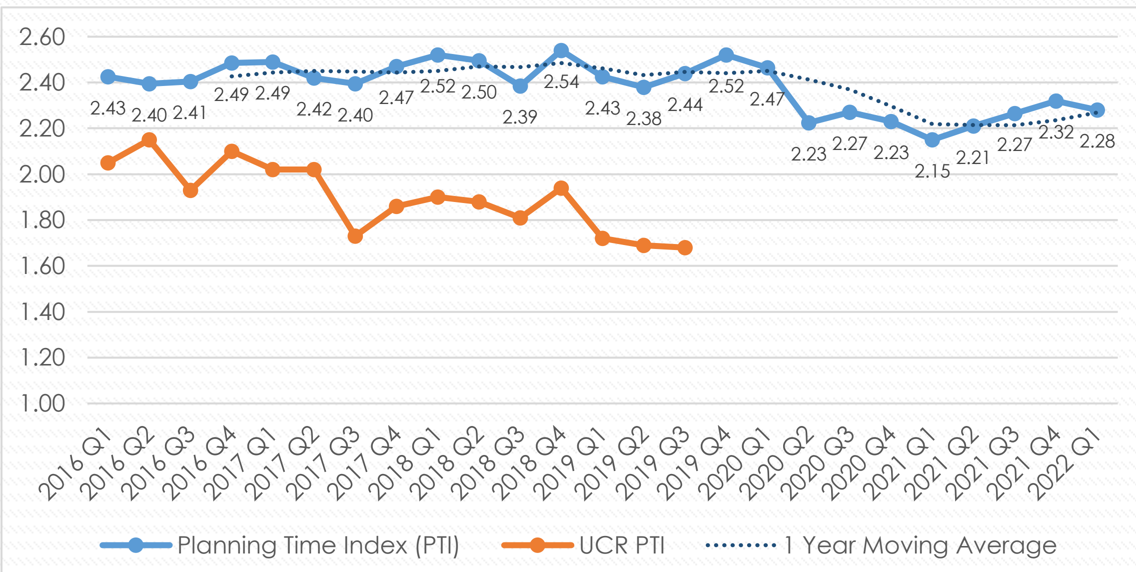


Figure 11: Unreliability (Variability) of Travel in Southern Nevada, Q4 2014 – Q3 2019

Objectives of the Congestion Management Process

The following regional objectives are defined generally. In future iterations of the CMP, they may be revised to become more specific, measurable, agreed upon, realistic, and time-bound (SMART). RTC Freeway & Arterial System of Transportation (FAST) department's forthcoming Transportation Systems Management and Operations (TSMO) Business Case study may provide regional SMART congestion management objectives. CMP objectives support RTC's vision of providing a safe, convenient and effective regional transportation system that enhances mobility and air quality for citizens and visitors.

Fulfill Legislative Requirement

The CMP exists as an administrative mechanism designed by federal legislation to mitigate the undesired impacts of traffic congestion. It is required in metropolitan regions with populations greater than 200,000. Since the 1970 census, the Las Vegas Metropolitan Statistical Area has had a population well over 200,000.[IV] As such, Southern Nevada has been designated a Transportation Management Area (TMA) requiring a CMP.

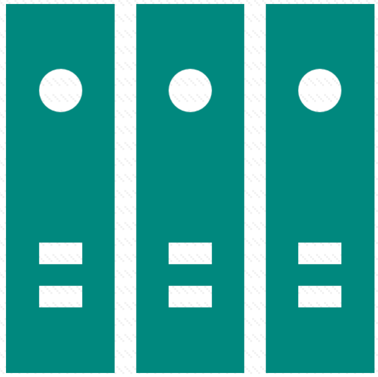
Legislative Context

The federal government moved to intervene against worsening traffic congestion by passing the 1991 transportation authorization bill known as the Intermodal Surface Transportation Efficiency Act (ISTEA). ISTEA required Metropolitan Planning Organizations to carry out a systematic and transparent process for identifying and managing congestion. Guidelines for congestion management were further developed through the subsequent passage of the Transportation Equity Act for the 21st Century (TEA-21) in 1998 and the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) in 2005.

Since 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) provides the current programmatic framework guiding the growth and development of the country's transportation infrastructure. Its policies facilitate the development of a performance-based and multimodal surface transportation program. On December 4, 2015, the Fixing America's Surface Transportation (FAST) Act was signed into law but only made minor edits to the existing provisions of MAP-21.

Summary of Current Federal Law

The following summarizes the federal code for the CMP in TMAs.[V]



a. The CMP provides for safe and effective integrated management and operation of the multimodal transportation system.

b. The CMP should result in multimodal system performance measures and strategies reflected in the RTP and TIP.

c. The level of system performance may vary by type of transportation facility, geographic location (metropolitan area or subarea), and/or time of day.

Strategies should:

1. Manage demand
2. Reduce single occupant vehicle travel
3. Improve transportation system management and operations
4. Improve efficient service integration within and across modes

d. The CMP shall be developed, established, and implemented in coordination with transportation system management and operations activities.

The CMP shall include:

1. Methods to monitor and evaluate the performance of the multimodal transportation system and its congestion;
2. A definition of congestion management objectives and appropriate performance measures that are tailored to the specific needs of the area with other stakeholders in the covered area;
3. An establishment of a coordinated program for data collection and system performance monitoring to define the extent and duration of congestion, to contribute in determining the causes of congestion, and evaluate the efficiency and effectiveness of implemented actions;
4. An identification and evaluation of the anticipated performance and expected benefits of appropriate congestion management strategies, such as demand management measures, traffic operational improvements, public transportation improvements, ITS technologies, and where necessary, additional system capacity;
5. An identification of an implementation schedule, implementation responsibilities, and possible funding sources for each strategy proposed for implementation; and
6. An implementation of a process for periodic assessment of the effectiveness of implemented strategies.

Manage Congestion Efficiently

RTC FAST's regional traffic management objectives are to manage traffic congestion by preserving existing roadway capacity and improving safety for all roadway users. *The emphasis has been on roadway and transit operations. The CMP advocates tackling congestion management using additional strategic approaches.* This will help our region become more resilient to the very real transportation challenges of today and those of the future. Increasing our administrative capacity to meet the following objectives as a region, by following a congestion management process, can assist in broadening and coordinating efficient congestion management efforts.

Develop a Structured Process for Analyzing Congestion Issues

The CMP provides a framework for identifying and responding to congestion in a consistent and coordinated fashion.

Follow an Objectives-Driven, Performance-based Approach

Through the use of performance measures, the CMP provides a mechanism for ensuring that investment decisions are made with a clear focus on desired outcomes. Screening strategies, using objective criteria, help demonstrate which approaches to congestion management are most effective over time, assess why they work (or do not), and help practitioners target locations where they may be most successful.

Promote Increased Collaboration and Coordination

The CMP brings an expanded group of partners and stakeholders into the regional transportation planning process, including land use planning agencies and agencies responsible for transportation system operations. By considering all of the factors that are important to the public, the CMP also helps to ensure that selected congestion management strategies are contextually appropriate for the community and consistent with the regional vision.

Allocate Resources More Effectively

The CMP provides a mechanism for identifying short, medium, and long-term strategies for addressing congestion on a system-wide, corridor-level, and site-specific basis. It also highlights travel demand management and operations strategies and can bring attention to issues such as transportation system reliability and non-recurring congestion, which are not well addressed through traditional transportation demand modeling.

Street Network Managed for Congestion

This report only focuses on roadways included in the CMP Network as defined in Figure 12.

CMP Network Definition

The CMP Network includes all INRIX XD (Extreme Definition) segments in Southern Nevada having consistent data since the beginning of July 2020. Inrix maintains and updates the XD network semiannually and bases them off of Open Street Maps information. RTC is reliant on NDOT purchasing XD data into the future.

National Performance Management Research Data Set

Procured and sponsored by the FHWA, the NPMRDS is an archived speed and travel time data set (including associated location referencing data) that covers the NHS. NPMRDS provides three data sets containing speeds and travel times at 5 minute intervals on over 400,000 road segments for passenger vehicles, trucks, and trucks and passenger vehicles combined.

Many of the performance measures calculated in this report are based not on XD segments but on the NPMRDS. Figure 13 illustrates the extent of the NPMRDS network which closely aligns with the NHS. The segments of the NPMRDS differ from XD segments even though they have roadways in common.

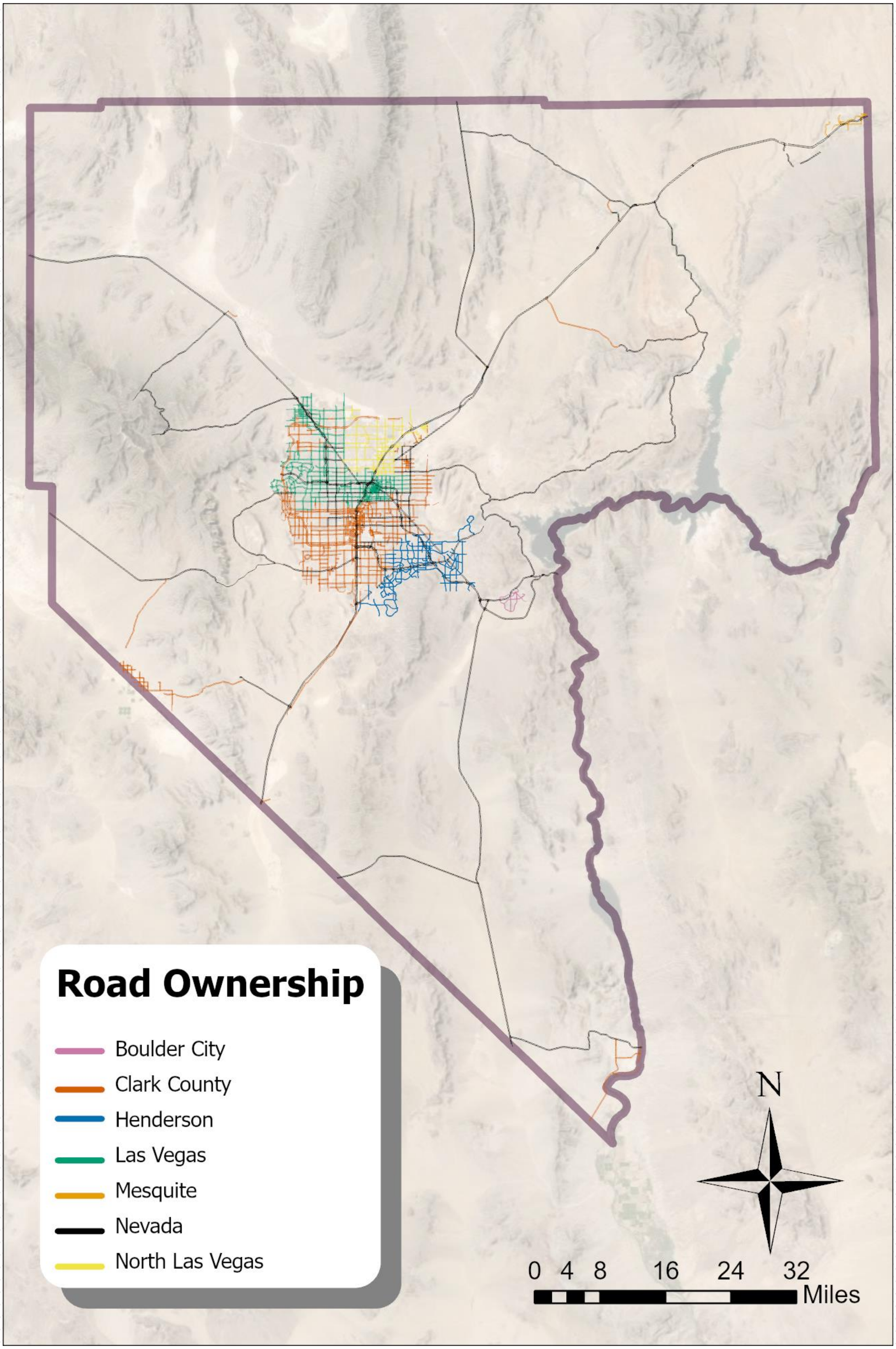


Figure 12: The CMP System Network

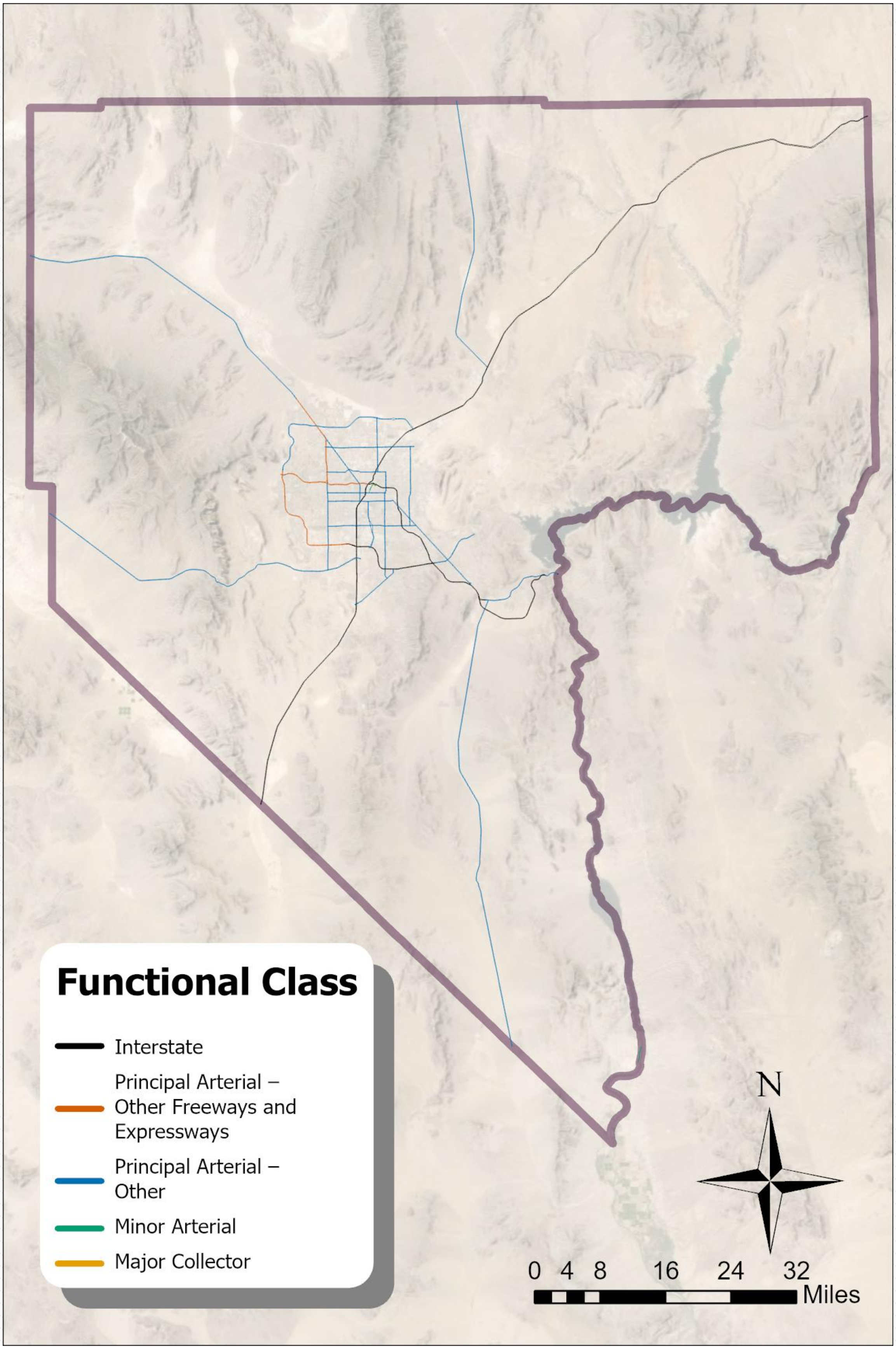


Figure 13: National Performance Management Research Data Set, 2021

Congestion Management Performance Measures

CMP performance measures monitor congestion and are dependent upon data availability. They indicate the extent and severity of congestion system wide, along corridors, road segments, or intersections. Collected over time, performance measures serve as a basis for evaluating the impact of implemented congestion management strategies.

Travel Time Reliability Metrics

The following metrics are calculated from vendor-provided data and defined by the Travel Time Reliability publication provided by the FHWA and produced by the Texas Transportation Institute with Cambridge Systematics, Inc.:

Travel Time Index — Travel time represented as a percentage of the ideal travel time (Travel Time / Free-flow Travel Time). This is a measure of congestion that focuses on each trip and each mile of travel. It is calculated as the ratio of travel time in the peak period to travel time in free-flow. A value of 1.30 indicates that a 20-minute free-flow trip takes 26 minutes in the peak hour.

Planning Time Index — near-worst case travel time as a percentage of the ideal travel time (95% Travel Time / Free-flow Travel Time). This measure includes typical delay as well as unexpected delay. For example, a planning time index of 1.60 means that, for a 15-minute trip in light traffic, the total time that should be planned for the trip is 24 minutes (15 minutes x 1.60 = 24 minutes).

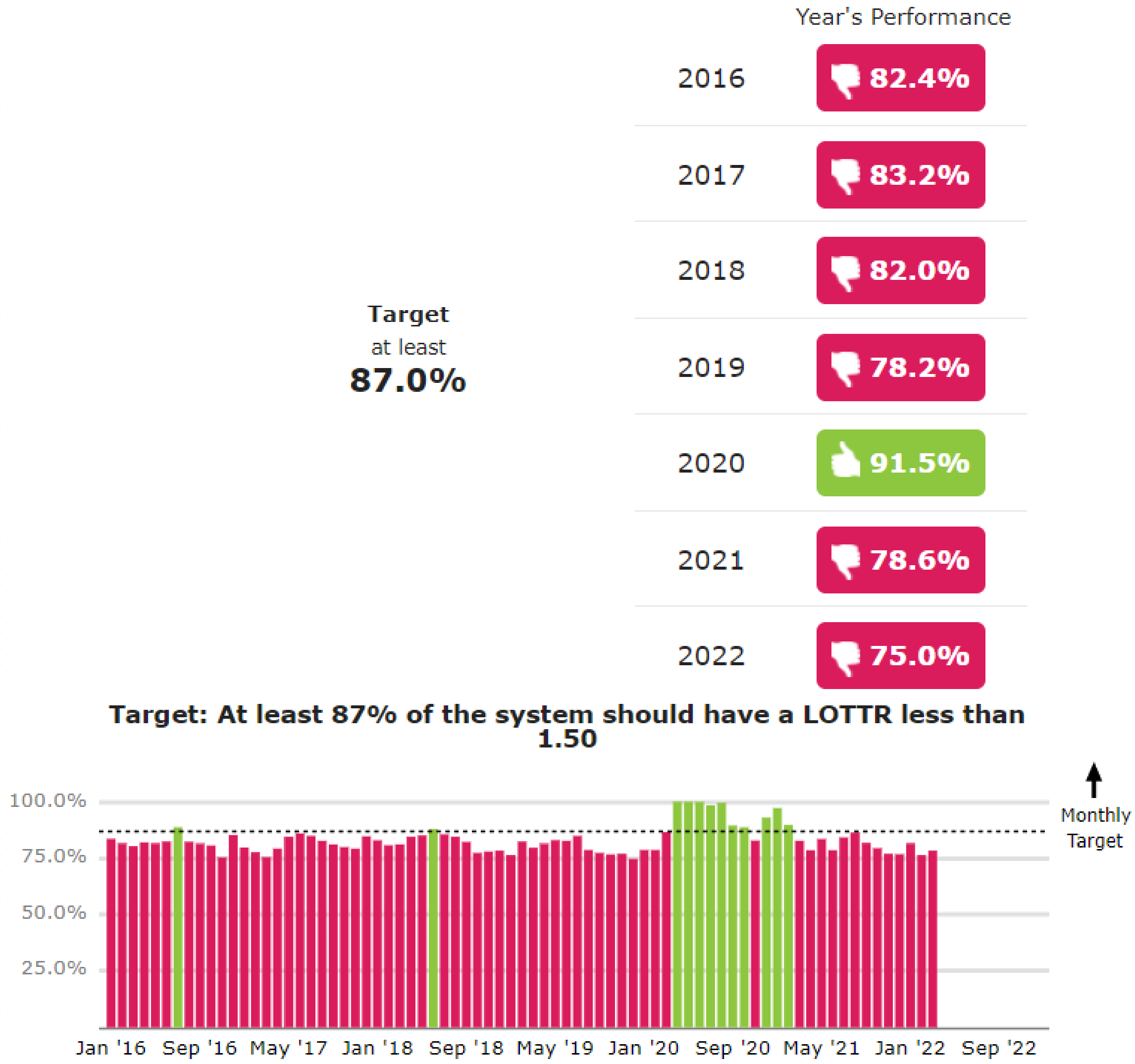
The Travel Time Index (TTI) plays a large role in creating performance rankings (see CMP Dashboard). Planning Time Index (PTI) made an appearance in the introduction of this report as a measure of unreliability.

Selected Performance Measures

The number of selected performance measures is intentionally limited in number. In addition, they are all based on data that is easy to collect and analyze. This simplified approach increases the likelihood that performance measures will be consistently updated and integrated into the decision-making process. When applicable, 2022 *statewide* performance measures targets are denoted.

Travel Time Reliability

Level of Travel Time Reliability (LOTTR) is the percent of person-miles traveled on reporting segment miles having a ratio of 80th percentile travel time to 50th percentile travel time of less than 1.5. Data are collected in 15-minute segments during all time periods between 6 a.m. and 8 p.m. local time. Figures 14 and 15 track several years of travel time reliability performance within Clark County on the interstate and non-interstate NHS respectively.



Calculated using 99.85% of miles in Regional Transportation Commission of Southern Nevada

Data source: NPMRDS INRIX (2016-2022)

Figure 14: Percent of the Person-Miles Traveled on the Interstate that are Reliable

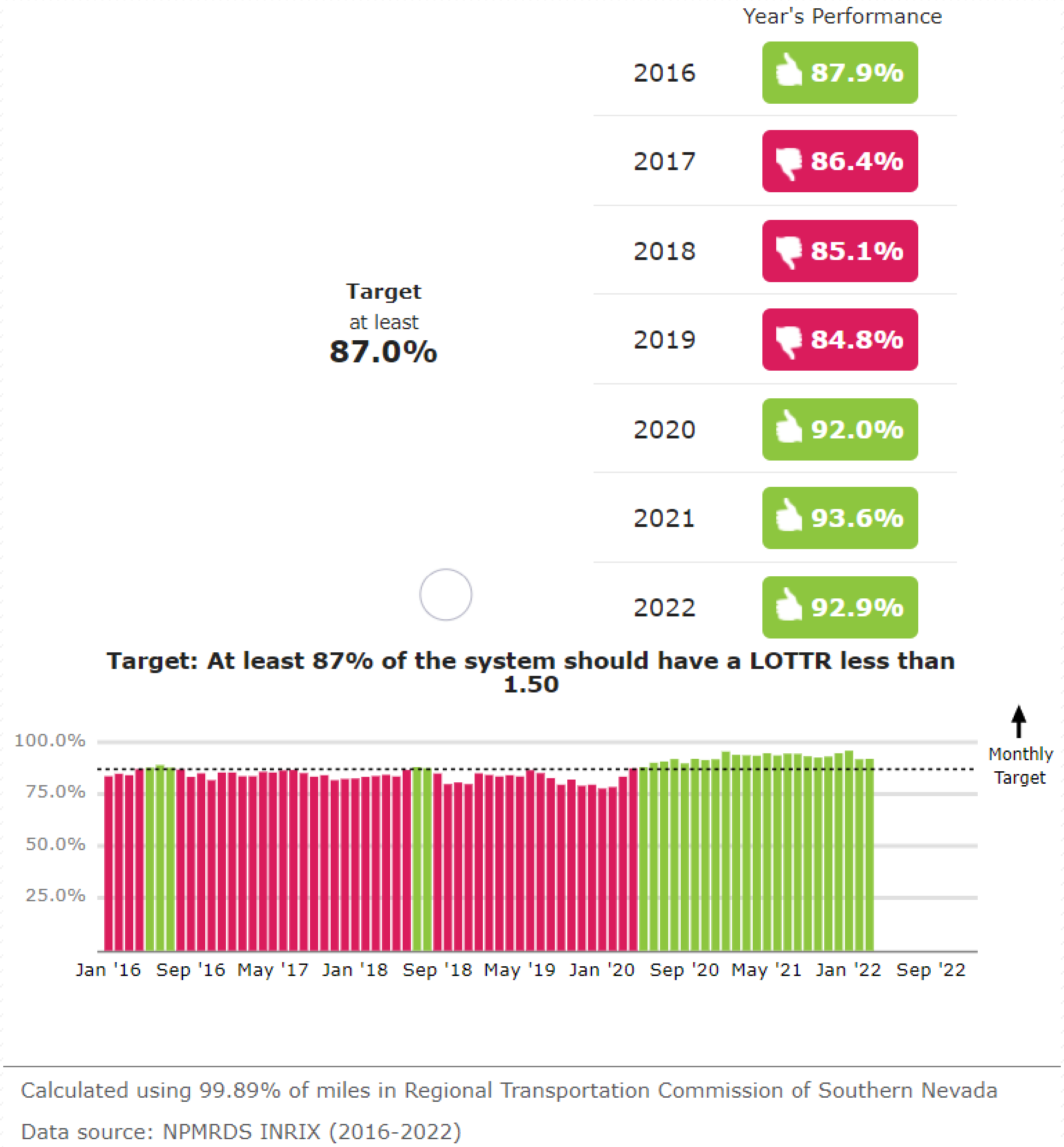


Figure 15: Percent of the Person-Miles Traveled on the Non-Interstate NHS that are Reliable

Truck Travel Time Reliability

Freight movement is assessed by the truck travel time reliability (TTTR) Index. Reporting is divided into five periods: morning peak (6-10 a.m.), midday (10 a.m.-4 p.m.) and afternoon peak (4-8 p.m.) Mondays through Fridays; weekends (6 a.m.-8 p.m.); and overnights for all days (8 p.m.-6 a.m.). The TTTR ratio will be generated by dividing the 95th percentile time by the 50th percentile time for each segment. The TTTR Index is generated by multiplying each segment's largest ratio of the five periods by its length, then dividing the sum of all length-weighted segments by the total length of Interstate. Figure 16 tracks several years of truck travel time reliability performance within Clark County.

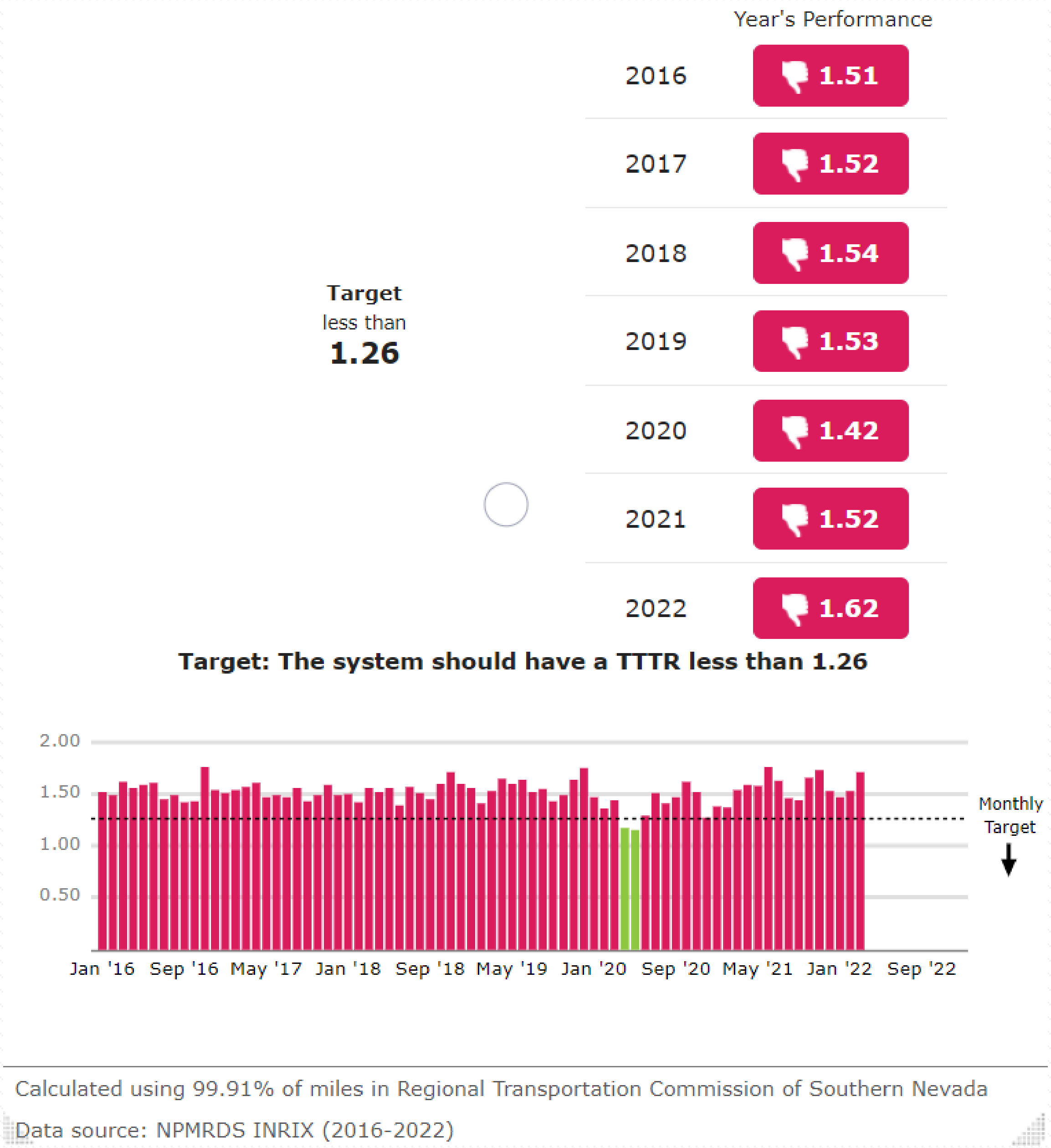
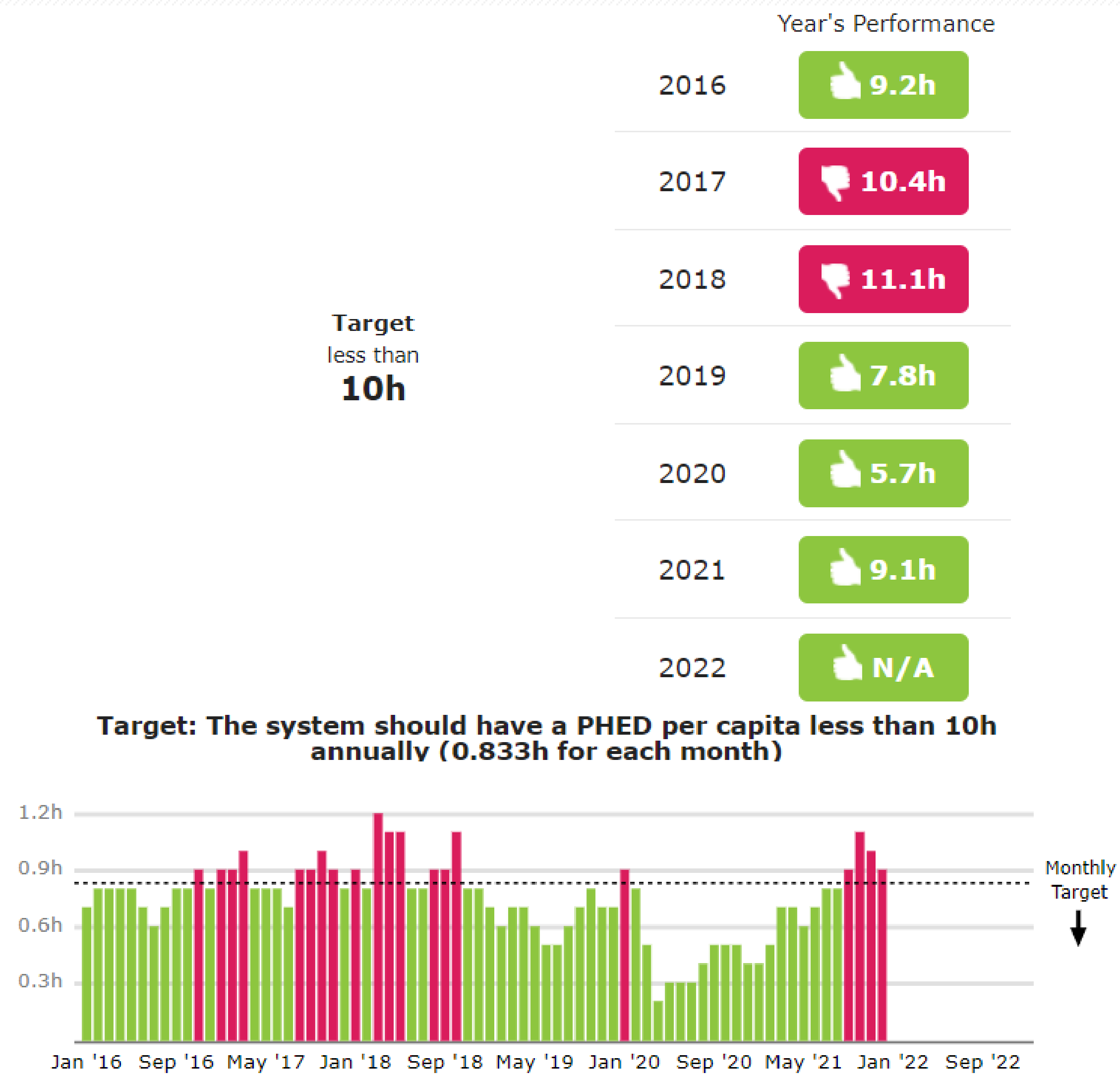


Figure 16: Truck Travel Time Reliability Index

Peak Hour Excessive Delay

Traffic congestion is measured by the annual hours of peak hour excessive delay (PHED) per capita on the NHS. The threshold for excessive delay will be based on the travel time at 20 miles per hour or 60% of the posted speed limit travel time, whichever is greater, and will be measured in 15-minute intervals. Peak travel hours are defined as 6-10 a.m. local time on weekday mornings; the weekday afternoon period is 3-7 p.m. local time. The total excessive delay metric is weighted by vehicle volumes and occupancy. Figure 17 tracks several years of peak hour excessive delay performance within the urbanized area.



Calculated using 85.06% of miles in Las Vegas--Henderson

Data source: NPMRDS INRIX (2016-2022)

Figure 17: Annual Hours of Peak Hour Excessive Delay Per Capita

RTC Transit Bus On-Time Performance

The on-time performance standard is the percentage of times that buses depart no more than 1 min before and 5 minutes after the scheduled departure time from a time point. 90 percent on-time performance is the adopted contractual standard for operating contractors. Nationally, it is a high bar to reach. Of note, the high frequency routes along the strip are not held as strictly to the on-time performance standard. Figure 18 shows that fully meeting the on-time performance target has been elusive. In recent years, the best performing month was April of 2020 at 93.9%. Unfortunately, this was the month of the

COVID shutdown which suggests that on-time performance is impacted by vehicle congestion and perhaps passenger related delays. In 2022, there was a marked increase in missed service. Bus driver shortages as well as severe supply chain impacts on transit assets (e.g. buses, parts for fleet maintenance and repairs) have contributed to this trend. Despite switching to Saturday schedules to compensate for these service constraints, in March of 2022, service interruption hours were approximately 3X higher than 2019 or 2020. As a result, on-time performance dipped below 80% through the first half of 2022.

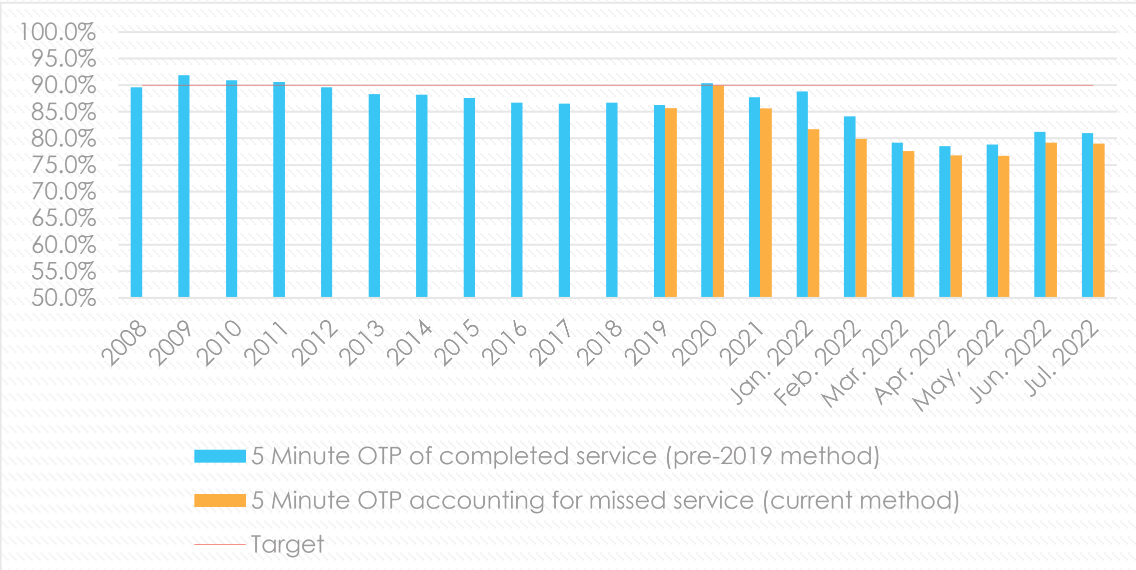


Figure 18: Monthly Bus On-Time Performance at a 5 Minute Standard

Incident Clearance Time

From 2014 to 2017, the clearance time performance measure relied solely on emergency dispatch data. With RTC's partnership with Rekor in 2018, the total number of logged incidents has more than doubled. In addition, 2018 marked the adoption of a new clearance time target for fatal crashes. Previously, the target was 90 minutes. The new target is 120. Clearance time targets for property damage only (PDO) incidents (30 minutes) and injury incidents (60 minutes) have remained the same.

Due to the adoption of the new system, there are validity concerns for the 2018 data. The data collected in 2019 and 2020 were valid and consistent. Unfortunately, the data source after the first quarter of 2021 changed. This undermined RTC's ability to continue calculating quarterly incident clearance time performance. An effort is underway to use an alternate data source to resume tracking this performance measure. Figure 19 denotes quarterly regional incident clearance time performance from the beginning of 2019 to the end of the first quarter of 2021.

Targets	Q1 '19	Q2 '19	Q3 '19	Q4 '19	Q1 '20	Q2 '20	Q3 '20	Q4 '20	Q1 '21
Total PDO Crashes	1607	1487	902	1229	1178	615	1072	1165	1217
# Cleared < 30 Min.	633	648	327	472	408	227	478	582	529
Percent	39.4%	43.6%	36.3%	38.4%	34.6%	36.9%	44.6%	50.0%	43.5%
Total Injury Crashes	657	574	452	555	438	310	440	608	514
# Cleared < 60 Min.	350	319	248	341	242	210	331	432	328
Percent	53.3%	55.6%	54.9%	61.4%	55.3%	67.7%	75.2%	71.1%	63.8%
Total Fatal Crashes	3	3	2	5	4	5	11	8	2
# Cleared < 120 Min.	2	3	0	1	0	0	4	0	2
Percent	66.7%	100.0 %	0.0%	20.0%	0.0%	0.0%	36.4%	0.0%	100.0%
Total Crashes	2267	2064	1356	1789	1620	930	1523	1781	1733
# Cleared < Target	985	970	575	814	650	437	813	1014	859
% Meeting target	43.4%	47.0%	42.4%	45.5%	40.1%	47.0%	53.4%	56.9%	49.6%

Figure 19: Quarterly Incident Clearance Time Performance Measure

Congestion Management Data

This section, the CMP Data Collection and Management Plan, outlines how the RTC determines how well the transportation system performs. It is largely dependent upon system performance data. While the data places an emphasis on peak hour congestion, *it should not be referenced with the intention of eradicating peak hour congestion for automobiles*. Rather, data should be considered to reveal sub-optimal symptoms caused by a multitude of endogenous and exogenous effects and competing interests. Maintaining a nuanced interpretation of CMP data—emphasizing the movement of people rather than vehicles—increases the likelihood of it informing the RTP and the TIP in appropriate ways.

Internally Collected Data

RTC is proud to have the component known as the Freeway and Arterial System of Transportation **(FAST)**, which is one of the first truly integrated Intelligent Transportation System **(ITS)** organizations in the country. From the FAST headquarters, RTC, NDOT and Nevada Highway Patrol personnel work to keep traffic moving on the valley's freeways and arterials. FAST is able to monitor traffic conditions in real time remotely through access to streaming data feeds from over 200 traffic cameras deployed across the region. These are complimented with traffic flow detectors embedded in the roadways which measure travel speed.

Figure 20: Picture of FAST Control Center

Data from these devices flow via fiber optic and microwave networks to the FAST control center (See Figure 20) on a continuous basis. The loops count the number of vehicles traveling across them as well as their average speed. The traffic cameras not only identify the occurrence of traffic incidents but also measure the length of delay.

<u>The data which FAST subsequently produces shows the following details:</u>

- Percent of weekdays that experience recurring congestion
- The average maximum and 95th percentile delay in congestion
- When recurring traffic delays typically start on the route
- How long traffic delays last
- Clearance time of vehicular crashes from freeway travel lanes.

Performance Monitoring and Measurement System

The FAST Dashboard (a.k.a. Performance Monitoring & Measurement System) is a web application totally designed, developed and written using in-house staff. Some of its features have been deprecated over time. As seen in Figure 21, the FAST Dashboard is built upon the enormous storehouse of raw data automatically gathered by the ITS NDOT has implemented on its freeway network in Southern Nevada. Accessible via the dashboard is a large incident dataset with more than 18,027 records collected between November of 2009 and May of 2018. FAST technicians have since migrated to logging incidents into a third party solution known as Rekor One.

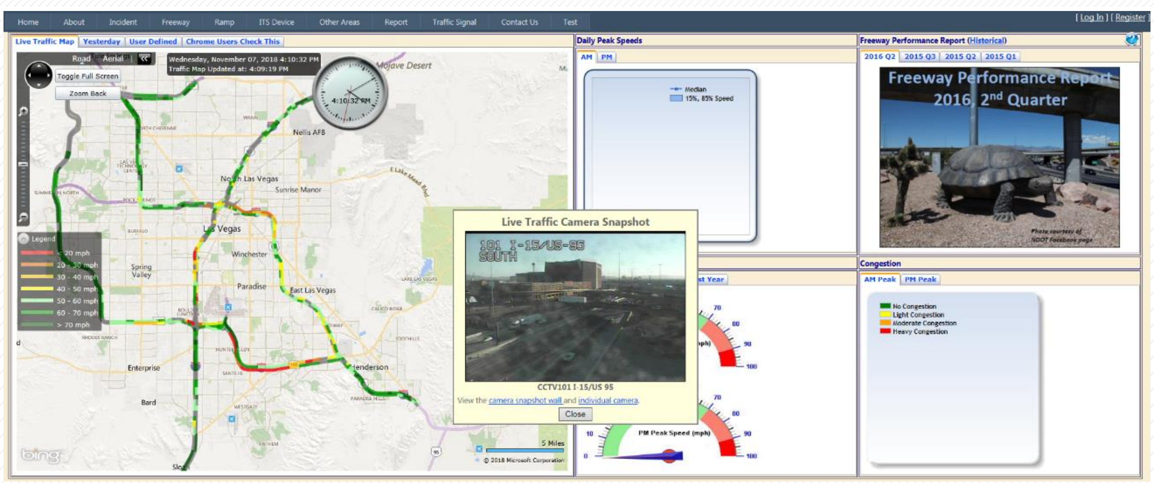


Figure 21: Screenshot of FAST Performance Dashboard

Geographic Information Systems

The complexities of construction project management do not easily lend themselves to the keeping of georeferenced records of ephemeral construction activity. The continued adoption of technological innovations would bring with it the promise of more efficient inter-agency collaboration, information dissemination, and project tracking.

Originally, RTC's GIS Division staff maintained a database of construction projects as part of the Cone Management Working Group. Due to increasing capabilities of RTC's Regional Project Coordination GIS Application, The Cone Management Working Group was dissolved in favor of individual meetings with RTC, Utilities, and Agency staff. Construction zones are defined on maps as either polygon or line features.

Externally Collected Data

Due to the private sector activity surrounding the future of transportation, it is possible that a third party solution may altogether replace the methods outlined in the Data Collection and Management Plan. There are competing companies harvesting vast amounts of transportation data and developing ever more sophisticated tools. These solutions may provide a means for RTC staff to gain a better understanding of traffic behavior over time.

RITIS

The Regional Integrated Transportation Information System **(RITIS)** is a data-driven platform for transportation analysis, monitoring, and data visualization. While RITIS began in the Nation's Capital as a way to help coordinate the real-time operations between Maryland DOT, Virginia DOT, D.C. DOT and WMATA, the system has rapidly expanded to other states and other countries. RTC uses RITIS to access archived INRIX data via their Probe Data Analytics Suite.

INRIX

Traditional road sensor networks and mobile devices collect up-to-the-minute speed data from consumer and fleet vehicles. INRIX, a private company, specializes in refining collected traffic data into a form that can be used to assess roadway conditions. RTC accesses their data through a subscription provided by NDOT.

Subscribers use web based tools to download raw data for off-line analysis or to export data summary reports. Although limited in functionality, the web service also allow users to visualize and map data such as:

- Real Time/Historical Speeds
- Travel Time Reliability Metrics
- Bottlenecks

INRIX data's granularity makes it possible to monitor not only recurring congestion but non-recurring congestion as well. It has the potential to become a valuable resource for transportation planning and operations management in Southern Nevada.

Replica

RTC entered into a two year contract with Replica in August of 2022. Replica transforms vast, disparate datasets into a holistic, up-to-date activity-based model. An activity-based model simulates the complete activities and movements of residents, visitors, and commercial vehicles in a region and season on a typical day. These simulations produce granular estimates as an output that match behavior in aggregate, but don't surface the actual movements (or compromise the privacy) of any one individual.

Rather than simply cleansing, normalizing, and scaling individual data sources, Replica uses a composite of data sources to:

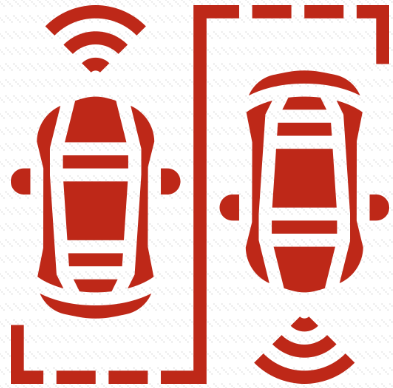
- Create a synthetic population that matches the characteristics of a given region
- Train a number of behavior models specific to that region
- Run simulations of those behavior models applied to the synthetic population in order to create a "replica" of transportation and economic patterns
- Calibrate the outputs of the model against observed "ground-truth" to improve quality

Replica attempts to have its outputs accomplish the following:

- Origin-destination pairs are consistent with human activities.
- Population demographics are accurate and correlate with appropriate movement.
- Recurring activities are coherent over time and capture a pattern of life.
- Routing between locations is consistent with local road networks and transportation options.
- The scale of population and number of trips is appropriate for a given geographic extent.

As an input into the CMP, there are many use cases of replica data. This is especially true when trying to answer questions that would be prohibitively costly and time consuming to answer any other way.

Emerging Data Sources



Ground transportation is riding a wave of an unprecedented sea change. In the information age, the RTC is presented with immense opportunities to participate in the process of providing a more environmentally friendly, economically sound and socially equitable transportation system. There is also a lot of uncertainty. To help navigate these uncharted waters, RTC places an emphasis on keeping abreast with technological innovations.

Waze

In 2016, the RTC announced a data-sharing partnership with Waze, the free, real-time crowdsourced navigation app powered by the world's largest community of drivers. The app's user interface is shown in Figure 22.

Waze's Connected Citizens Program brings cities and citizens together to answer the questions, "What's happening, and where?" Established as a two-way data share, Waze provides users with real-time, anonymous, Waze-generated incident and traffic slowdown information directly from the source: drivers themselves. The RTC provides real-time, government-reported data on road construction, traffic accidents and road closures. The breadth of utility proffered by this partnership is increasing as the relationship and platform mature.

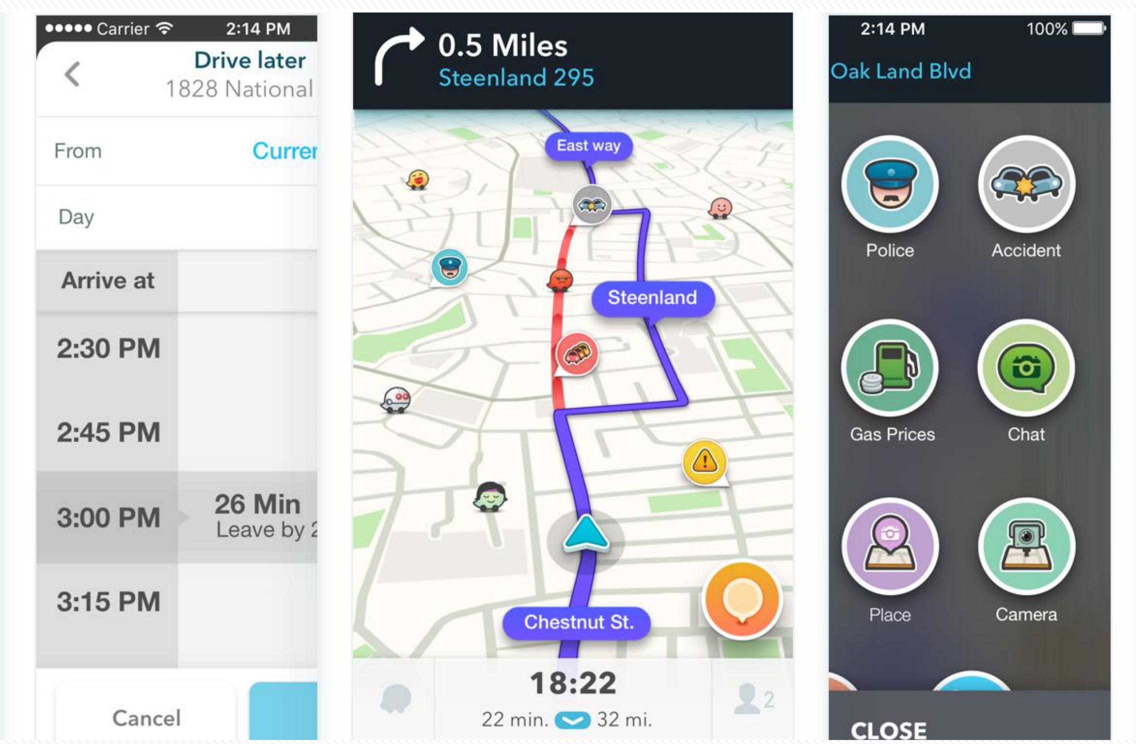


Figure 22: Waze Application's User Interface

Pilot Programs

To sample the local benefits of emerging technologies, RTC has the option to partner with companies through pilot projects. In one such pilot project, the RTC experimented with new ways to find, inspect and mitigate work zones in real time. Technologies from iCone and HAAS Alert were demonstrated on both the Rekor One (discussed in the next section) and Waze platforms. The demonstration included traffic cones, barrels, arrow boards, construction workers, and inspection vehicles – all outfitted with new technologies that can communicate their location in active construction zones with passing vehicles and traffic engineers.

Another pilot program leveraged Nexar CityStream, a platform that uses Nexar's connected vehicle network (see Figure 23), to log thousands of daily updates on the whereabouts of traffic cones in a three-square-mile area in downtown Las Vegas. The technology helps measure the effects of cones on traffic, automate the flow of data into RTC databases, determine permit compliance with lane closures, streamline construction permit management, and provide more accurate public information.

Figure 23: Dashboard Camera with Artificial Intelligence and Internet Connectivity

Data Management

The volume of transportation related data available today is astounding, and it will likely only increase in the future. A principal challenge of preparing the CMP is how to avoid the state of being data rich but information poor. To help manage this dilemma, web-based visualization tools can help bring the data together into one place and bring out insights.

Rekor One

The Rekor One Traffic Management software as a service platform logs incident and congestion logs beginning in November, 2017 until the current date. While this is the core functionality of Rekor One many other data feeds collected by FAST are incorporated into the platform (Figure 24). This includes the RTC's closed-circuit television network, dynamic message signs and freeway flow sensors. New capabilities introduced by the platform include roadway project monitoring, patrol vehicle statuses and large event tracking.

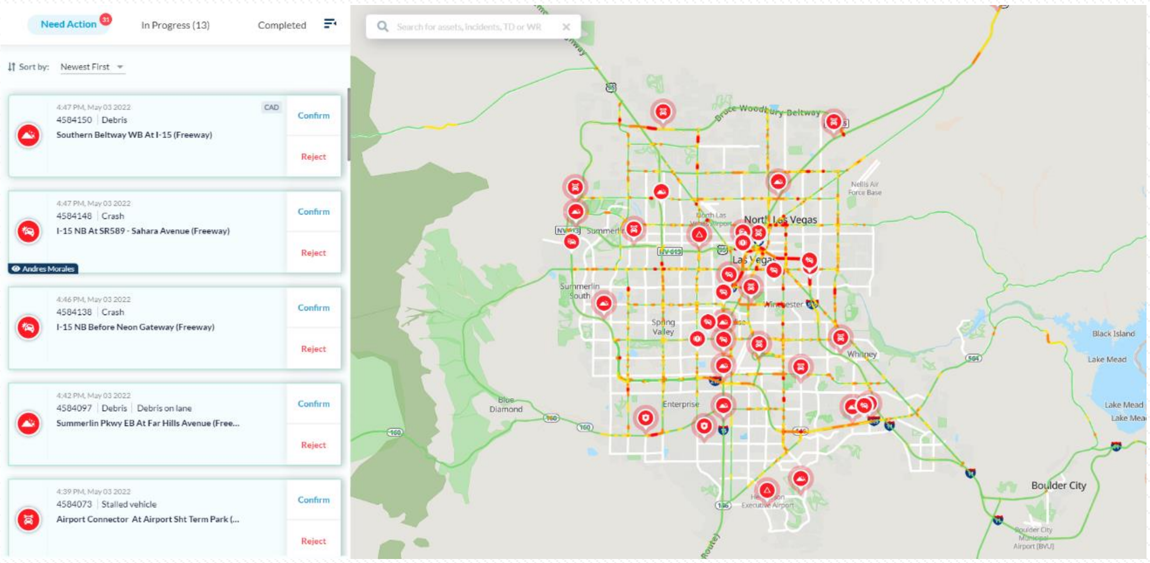


Figure 24: Screenshot of the Rekor One Platform's Live Map

FAST Data Warehouse

The RTC's information technology department has been hard at work bringing raw data from FAST sensors and other External data sources into digestible dashboards of information. These dashboards bring in, clean up, and display disparate sources of data into a common data visualization platform. While these are not published publicly, much of the progress from this effort is reflected in FAST's quarterly report contained in Appendix C.

Congestion Management Analysis

Congestion analysis answers the following questions: What congestion problems are present in the region, or are anticipated? What are the sources of unacceptable congestion? This section attempts to provide these answers, but explicitly answering these questions through analysis is challenging. One reason can be poor data. Another is due to congestion being caused by multiple intractable factors. The following are but a few of the variables that are generally accepted by transportation professionals to be associated with traffic congestion.

- **Locations of Major Trip Generators**

In order to understand congestion issues related to specific locations, it is often beneficial to have a knowledge of major trip generators and the typical traffic patterns, users, and times of high demand at these locations.

- **Seasonal Traffic Variations**

Traffic patterns can vary greatly due to seasonal changes in school-related trips, tourist/resort activity, weather conditions, and daylight conditions. When possible, data should be collected at times that will account for these variations.

- **Time-of-day Traffic Variations**

Not all locations experience their highest demand during typical peak periods, especially in areas with heavy school traffic (which often coincides with the morning peak, but has an earlier afternoon peak) or in areas with large employers with shift change times outside the typical peak period.

- **Work Trips vs. Non-work Trips**

To the extent possible, it is helpful to understand the balance between work-related trips and non-work trips within an area, as the strategies to address these different trip types may differ.

- **Non-Recurring Congestion Variation**

Crash data can identify corridors or intersections with a high frequency of crashes that cause non-recurring congestion. Safety improvements reduce potential harm and can also reduce congestion.

System-wide Overview

The INRIX 2022 Traffic Scorecard Report ranks Las Vegas as the 22nd most congested city in the United States while being the 29th most populous. Its global rank is 127th which is 4 spots ahead of Nashville, TN and 3 spots below Providence, RI. As part of the same report INRIX calculated 41 hours and $689 lost to congestion per driver. According the report, hours lost is on the rise as it is up 46% since 2021 and 155% since 2019. This coincides with peak hour speeds that appear to be down year over year in the report as shown in Figure 25. Figure 26 provides one more insight from the report by identifying frequented routes and destinations in the region.

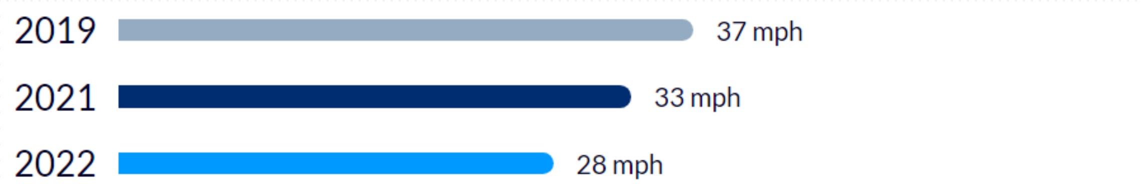


Figure 25: Speeds at the absolute worst portion of the morning and afternoon commute times in the Las Vegas Metro

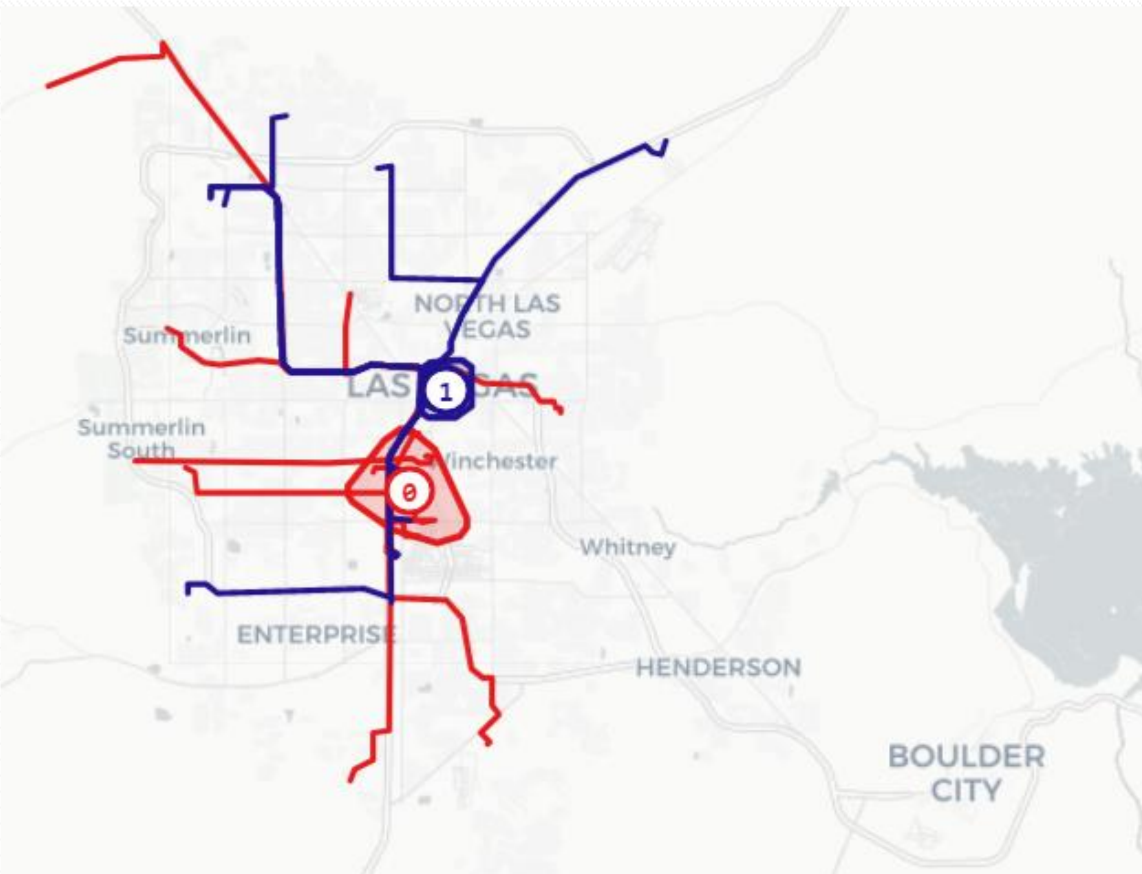


Figure 26: Frequented routes for trips to the Las Vegas Strip (0) and Downtown Las Vegas (1)

Job Flow

As illustrated in Figure 27, 95.6% of employees living in Southern Nevada work in Southern Nevada.[VI] In contrast, there is a lot of variation in job flow between different parts of the metropolitan area. Figure 28 shows the job flow characteristics of several census places in the metropolitan area (as well as Mesquite). The Venn diagrams depict the job flow as a share of employees who commute into a place to work, remain in a place to work, and leave a place to work. These categories are denoted using the same color symbology employed in Figure 27. These statistics include only the highest paying job for an individual worker (some workers have two jobs).

Figure 27: Inflow/Outflow Primary Job Counts in 2019, Clark County, Nevada

One finding appears to be that the amount of intra-place commuting is often dwarfed by the number of employees commuting in and out. This is indicative that while the metro is self-contained the communities within it are not. This could be seen as a success for providing quick and reliable travel on metropolitan highways, but it runs the risk that sustaining this dynamic into the future could become increasingly onerous for roadway users and providers.

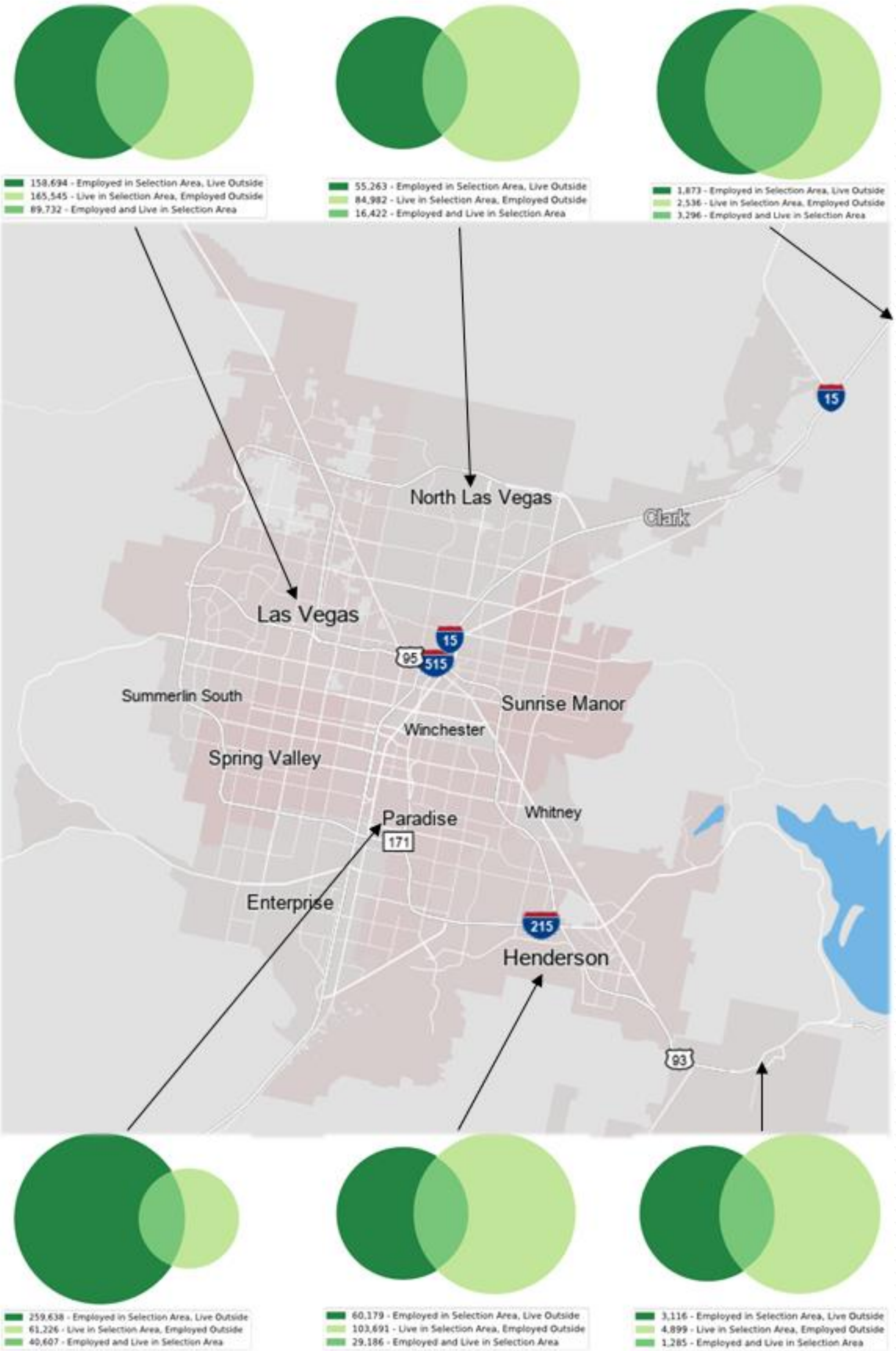


Figure 28: Inflow/Outflow Primary Job Counts in 2019 by Census Place

Telecommute Pattern

There were major shifts in travel behavior following the state of emergency declared in March of 2022. As suggested in Figure 29 (Source: Replica), included in this disruption was a 1,000 percent jump in the proportion of employees working from home. The phase shift in commuting patterns has persisted ever since along with its dissuaded congestion. Figure 30 is a map labeled with 2021 work from home commuter share estimates (%) and color-coded by the percentage point increase in work from home commuter share since 2019.

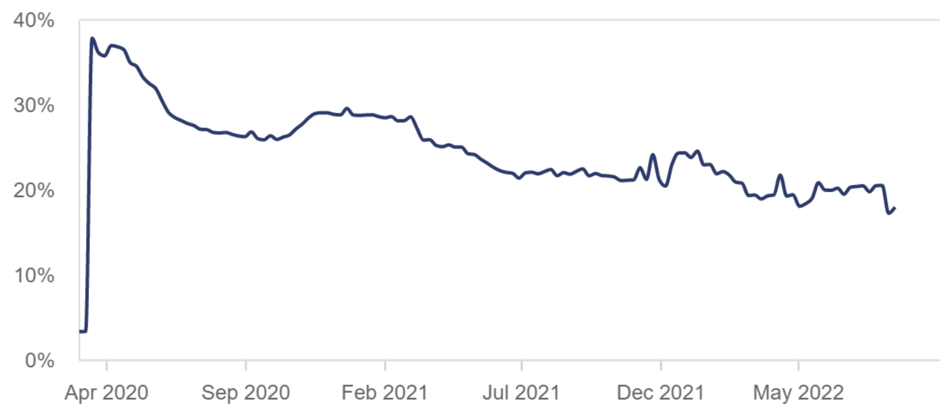


Figure 29: Proportion of Residents Working-From-Home as % of all employed residents, typical weekday, through August 19th, 2022

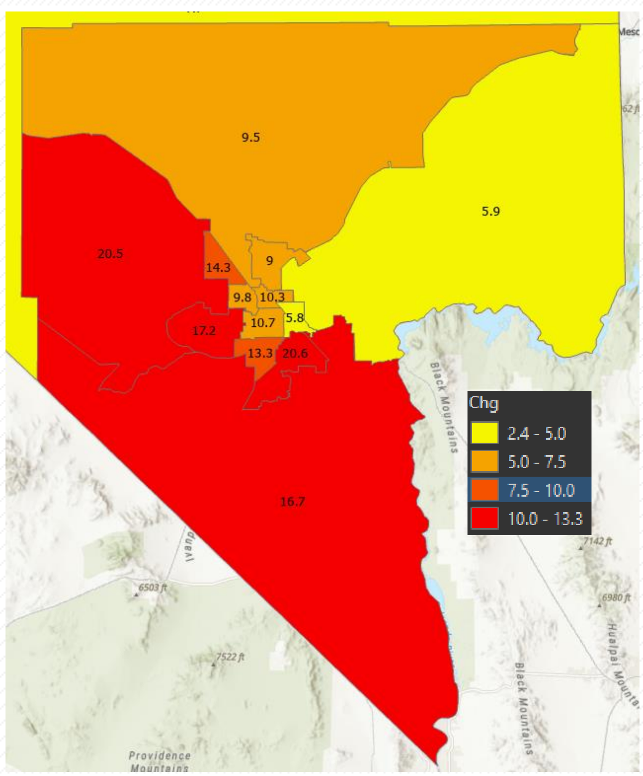
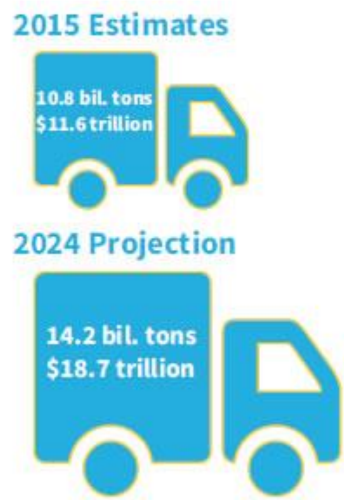


Figure 30: 2021 Work from Home American Community Survey Estimates and Change from 2019 by Public Use Microdata Area

Level of Travel Time Reliability (LOTTR)

The U.S. Department of Transportation (USDOT) defines reliability as "the degree of certainty and predictability in travel times on the transportation system." Most benefit-cost studies of mobility solutions require the monetary value of travel time (VOT) and value of reliability (VOR). Recent studies indicates that both freight shippers and commuters valued travel time reliability at least 1.5 times as much as travel time savings.[VII] Figures 31-34 provide insight on the highly valued asset of travel time reliability along Southern Nevada's NHS.

Figures 35-36 focus specifically on the travel time reliability of freight whose importance has come into greater focus due to the growth of the warehousing industry in Southern Nevada and recent supply chain disruptions. Since complex global and intermodal logistics chains require minimal disruption to ensure on-time delivery, reliability is critical. What's more, VOR has only increased over time given projected increases in freight transported by road in the United States (pictured right).[VIII] The cost associated with travelers and shipments being unreliable should lead to prioritizing travel time reliability in transportation planning. Strategies that contribute to increased reliability include congestion pricing, high-occupancy lanes, and reducing incidents and incident clearance times.



It should be noted that interstate measurements in the following pages have been impacted by a data error wherein segments were counted twice which impacts the calculated measure. This data issue is being addressed by NDOT.

Non-Interstate Travel Time Reliability

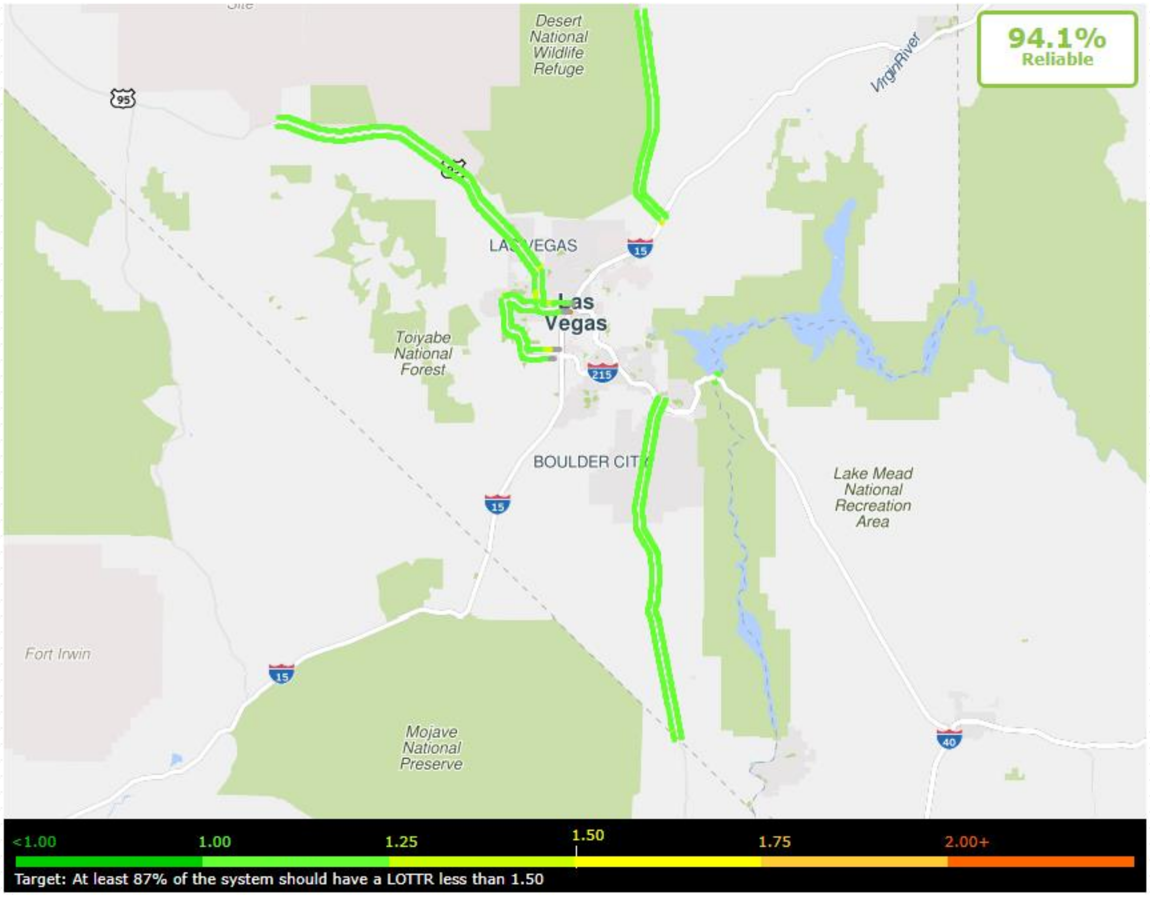


Figure 31: Percent of the Person-Miles Traveled on the Non-Interstate NHS that are Reliable, January – April, 2022

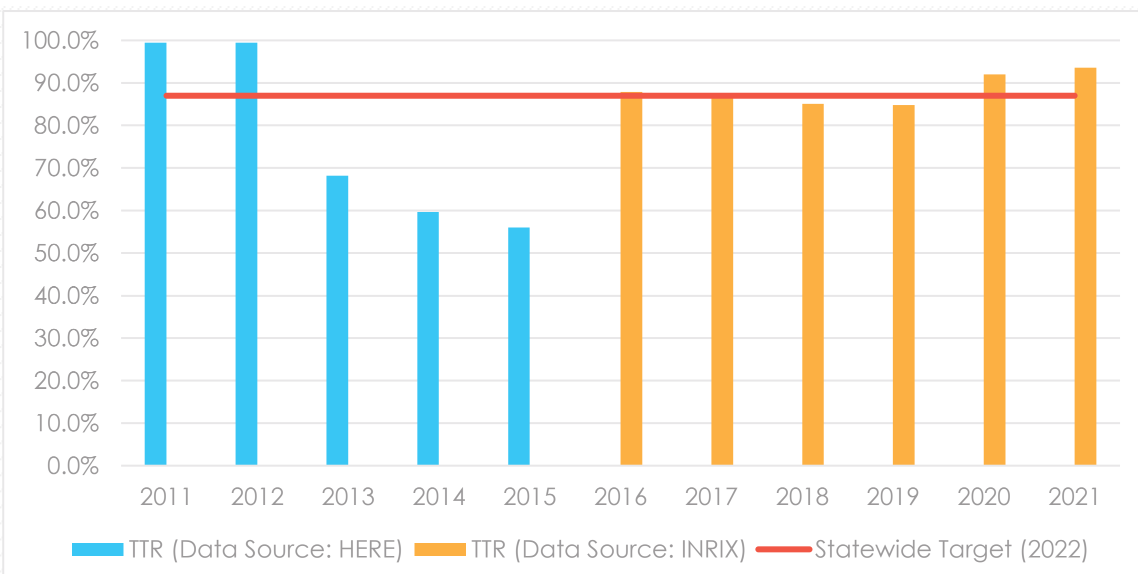


Figure 32: Percent of Person-Miles Traveled on the Non-Interstate NHS that are Reliable, 2011-2021

Interstate Travel Time Reliability

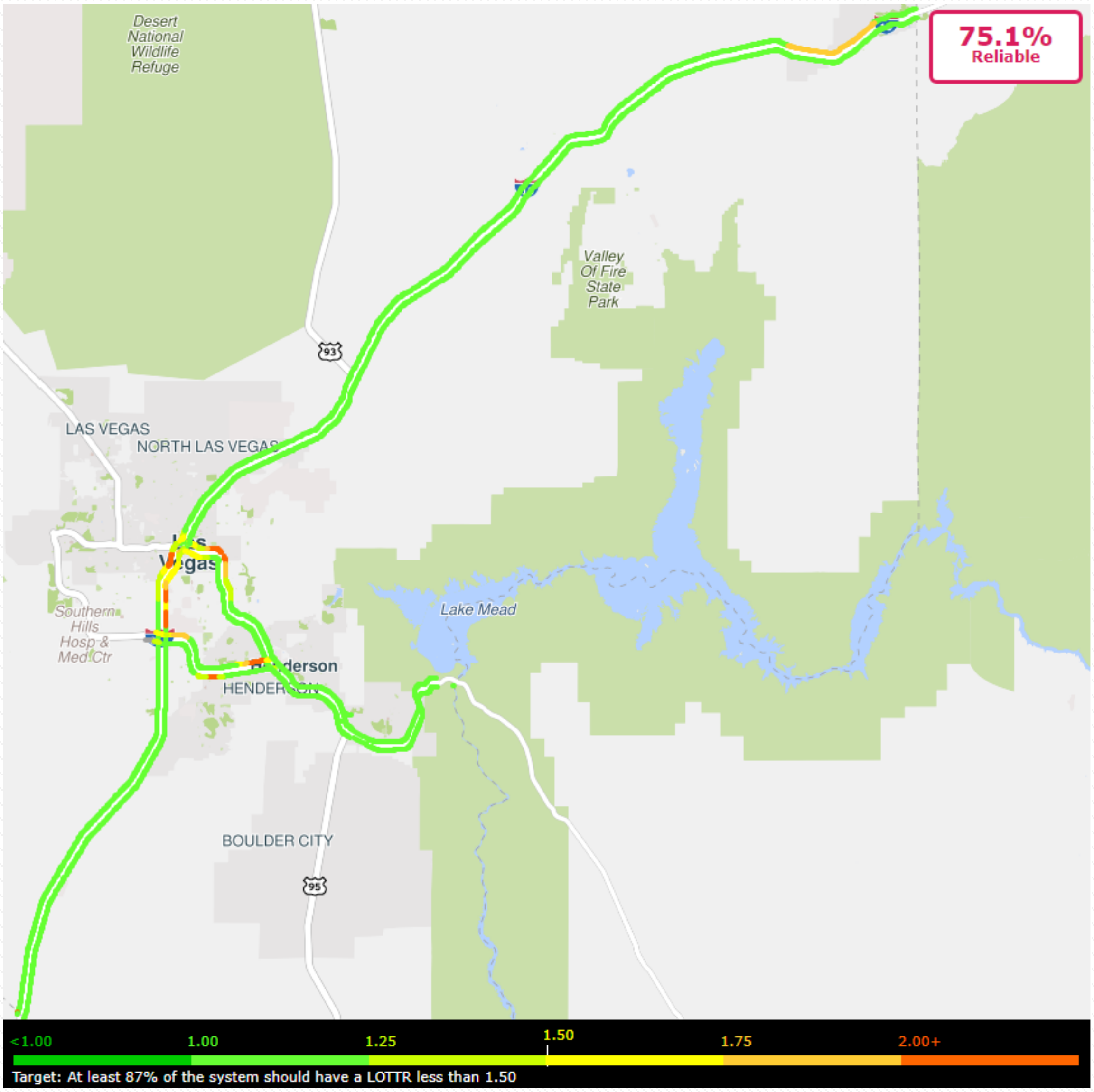


Figure 33: Percent of the Person-Miles Traveled on the Interstate that are Reliable, January – April, 2022

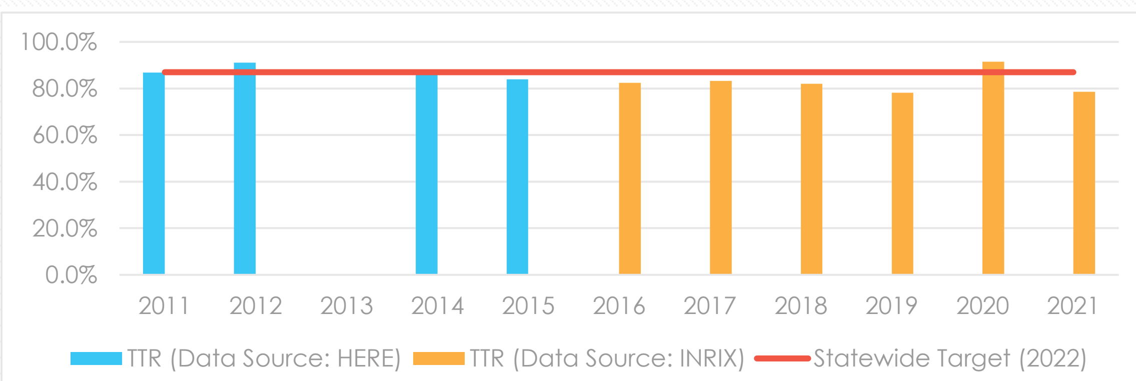


Figure 34: Percent of Person-Miles Traveled on the Interstate that are Reliable, 2011-2021

Truck Travel Time Reliability

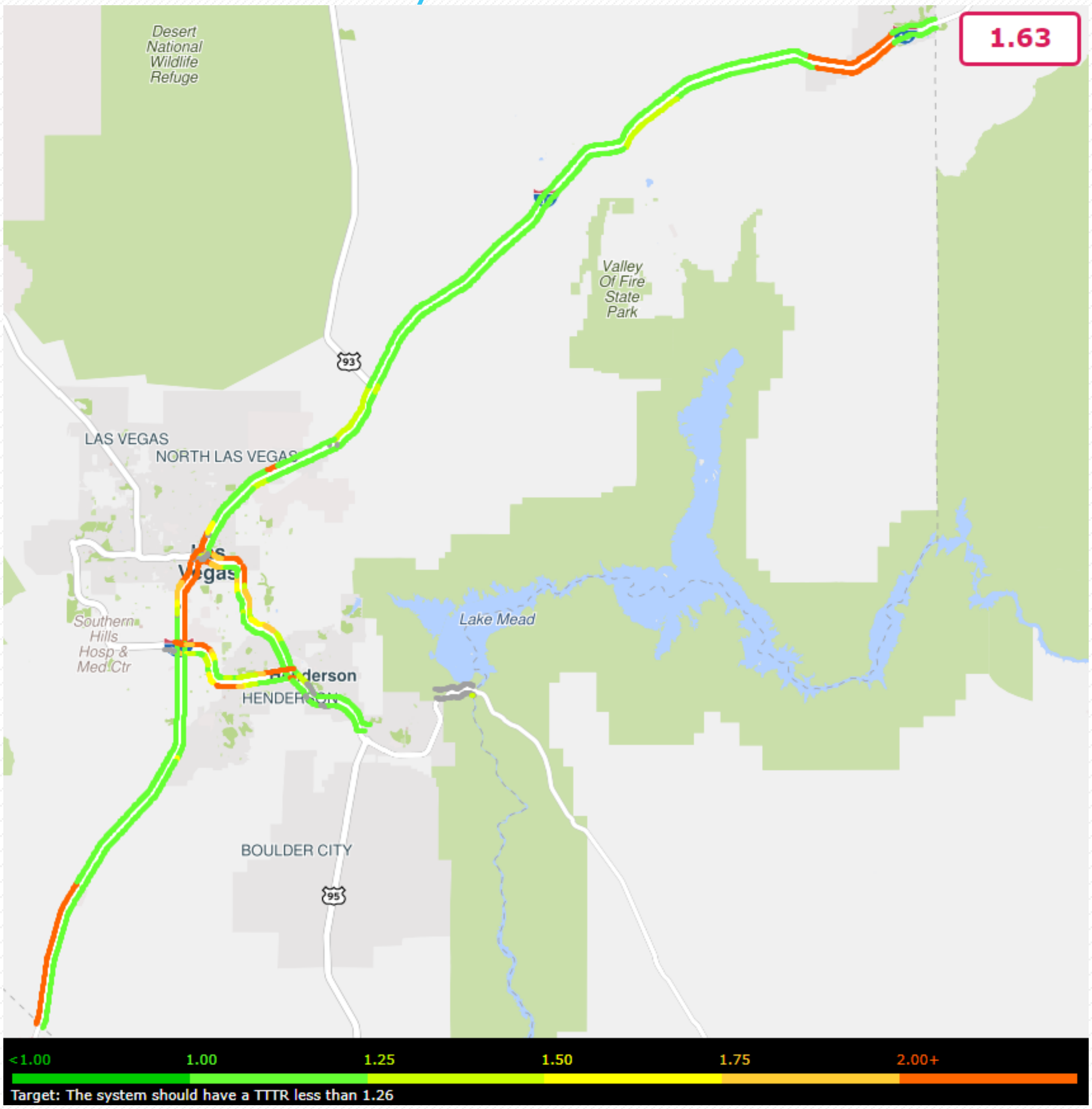


Figure 35: Truck Travel Time Reliability Index on the Interstate, January – April, 2022

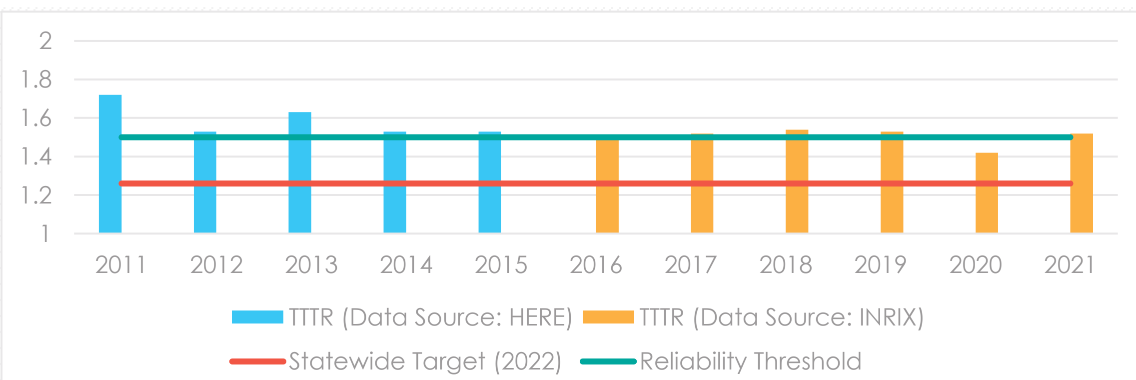


Figure 36: Truck Travel Time Reliability, 2011-2021

Segment Analysis

An analysis of a congested roadway segment for each jurisdiction, as of Q1 2022, during the PM peak will be provided in this section. *Recommendations are based on preliminary analysis and will be reviewed further by state and local agency engineering staff, who make final decisions regarding implementation.*

Methodology

The primary basis of the segment analysis methodology is the Congestion Patterns Dashboard and the RITIS Bottleneck Ranking tool. Details on these sources are given here.

Congestion Dashboard

Dashboard URL:
https://arcg.is/1K5b1S

Integration of travel speeds and other sources of data into a GIS dashboard provides an accessible starting point for more detailed research into the causes behind specific patterns of congestion. The CMP dashboard is an interactive web application configured using Operations Dashboard for ArcGIS Online. Its purpose is to provide a publicly accessible summarized history of past performance on over 16,500 road segments in Southern Nevada. In addition, the dashboard provides the forecasted level of service anticipated for the next 3 months on the basis of each roadway segment's past performance. More information about the Congestion Patterns Dashboard, including the methodologies used to create it, can be found in Appendix A.

Traffic Bottlenecks

As illustrated in Figure 37, bottlenecks are identified by comparing the reported speed to the reference speed for each segment of road. When reported speed falls below 60% of the reference speed, the road segment is flagged as a potential bottleneck. If bottleneck conditions persist for five minutes, the bottleneck is confirmed. Adjacent road segments also experiencing congestion are joined together to form a queue. When conditions have recovered for 10 minutes the bottleneck is considered clear. The duration of a bottleneck is the difference between the time when the congestion was first identified and the time when the congestion recovered.

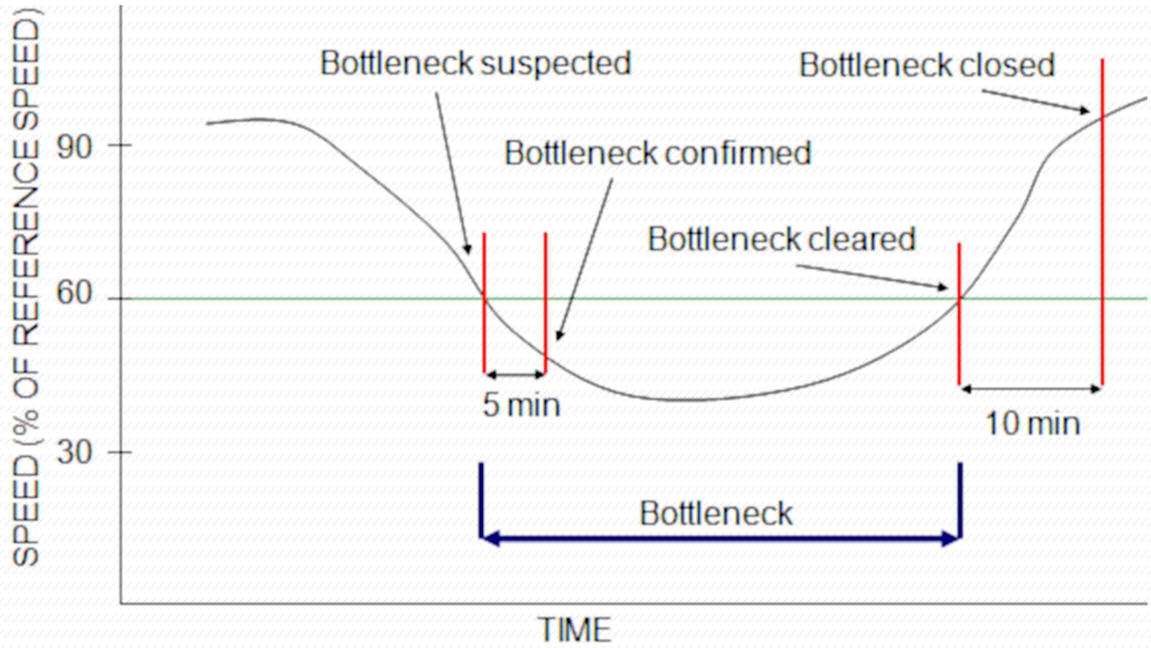


Figure 37: INRIX Bottleneck Definition

Bottleneck Metrics

INRIX aggregates bottleneck occurrences, ranks bottleneck locations and summarizes maximum queue length, average duration and total duration. In addition, their methodology produces the following metrics:

- **Base Impact** — the sum of queue lengths over the duration of the bottleneck.
- **Speed Differential** — Base impact weighted by the difference between free-flow speed and observed speed.
- **Congestion** — Base impact weighted by the measured speed as a percentage of free-flow speed.
- **Total Delay** — Base impact weighted by the difference between free-flow travel time and observed travel time multiplied by the average daily volume (AADT), adjusted by a day-of-the-week factor.

The numbers produced by these metric are not intuitively meaningful, but they do provide a scale from which to judge the relative severity of bottleneck locations. The total delay metric was used to help select the following arterial locations.

Arterials

Each analysis includes an identification of associated bottlenecks, an analysis of the four dimensions of congestion, an evaluation of the effectiveness of any known implemented congestion management strategies, and transportation planning recommendations based on the strategy tiers found in the following section of this report.

Boulder City

As seen in Figure 38, the CMP network in Boulder City is somewhat limited. Overall, Boulder City has next to no unacceptable congestion. While it appears that G Avenue and Adams Boulevard are good choices for study, these are cases where "congestion" is desirable. Along these streets near the middle school and high school there is a 15 miles per hour school zone enforced between 7:30 AM – 3:30 PM. For this reason, the alternate point of interest is the intersection of Adams Boulevard and Buchanan Boulevard.

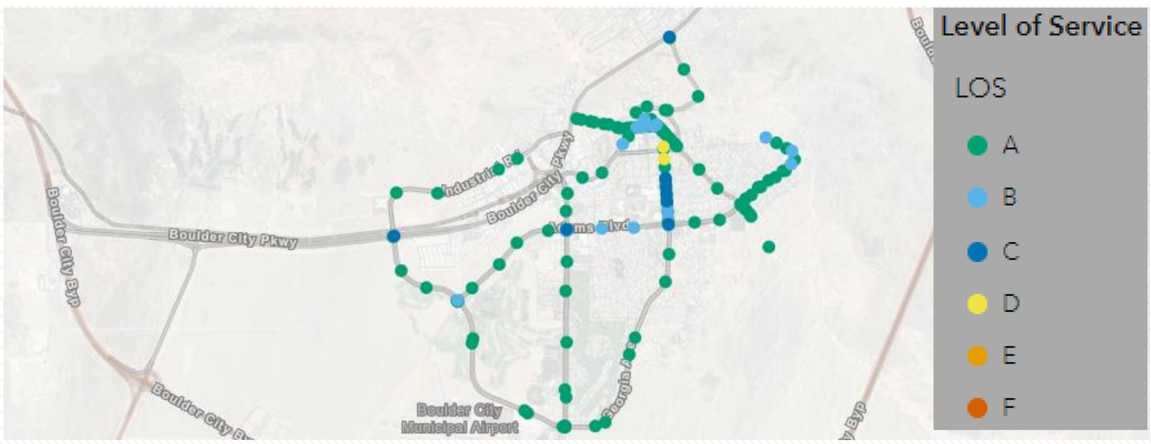


Figure 38: CMP Network in Boulder City

Adams Boulevard at Buchanan Boulevard

Extent:

Figure 39 describes depicts the extent of the intersection.

Figure 39: Aerial Image of Buchanan Avenue at Adams Boulevard

Duration:

As shown in Figure 40, bottleneck conditions occur for westbound traffic approaching Buchanan Avenue. Over the course of a year bottleneck conditions existed 2% of the time and can queue traffic for a fifth of a mile back to G Avenue. It appears that the congestion coincides with school schedules.

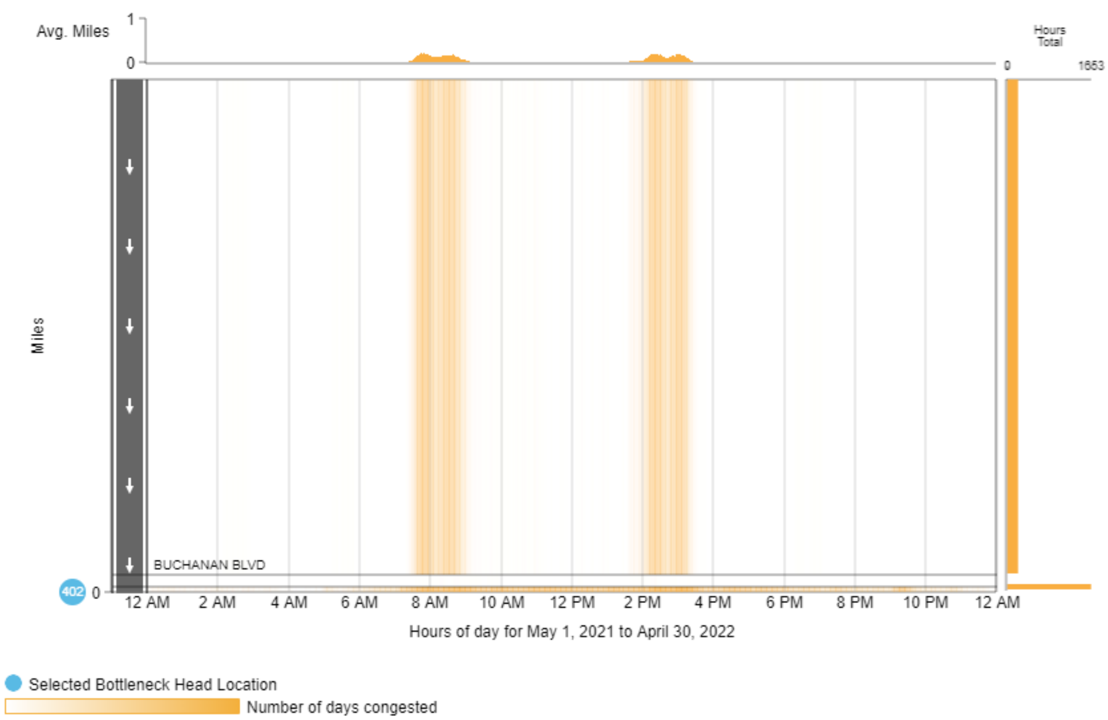


Figure 40: Bottleneck Occurrences at Adams Blvd W @ Buchanan Blvd

Intensity:

The intensity of congestion produces no more than level of service C (i.e. acceptable delay).

Variability:

The congestion is more intense during the morning peak. This could be a result of the PM Peak having a longer duration (i.e. 2-6 PM) and thus school release traffic having less of an impact on the peak average.

Strategy Effectiveness:

In fiscal year 2020, the city of Boulder City improved the bicycle facilities around this intersection. This included what appears to be new pavement of the shared-use path. In this case, this would attract more active transportation users, and more crossings by active transportation users would lower level of service for vehicles. As implied by this investment in active transportation facilities, the focus at this intersection may be active user safety and comfort.

Strategy Recommendation:

This intersection has two lanes in each direction at a four way stop. Traffic engineers might study this intersection for possible alternatives to the current configuration. If another configuration is found warranted, safety for all users should be the principal concern and be prioritized over vehicle travel times.

Figure 41 denotes a large portion of the city can access the school by walking in 30 minutes or less. Using a bike, most of the city can access the school in 20 minutes.[IX] Reducing the number of vehicle trips going to the school is feasible by carpooling and shifting trips to active modes. Boulder City's school trip active mode share in 2014 was estimated at near the regional average at 17.2%.[X] This is despite Boulder City being the only municipality in the region that has a notably shorter average school trip time (10.2 minutes versus the regional average of 16.4 minutes).[XI] Building upon this comparative advantage, bike and pedestrian safety improvements in Boulder City could reduce undesirable congestion by shifting trips to active modes. One recommend improvement at Adams Boulevard at Buchanan Boulevard is to implement the Regional Bike and Pedestrain Plan by implementing a bike lane along Buchanan Bolevard between Nevada Way and El Camino Way. This facility may be similar to the bike lane at Adams Boulevard at Georgia Avenue (pictured).

Figure 41: Walking Isochrones to Educational Land Use Cluster in Boulder City with Estimated Share of people ages 17 and under

Clark County

The CMP network in Clark County is quite extensive and includes belt loop CC-215 (Figure 42). Level of service is ample in many locations. However, the presence of the resort corridor's scenic byways places great stress on the capacity of the surrounding transportation system. Rather than detail traffic specific to resort traffic, an interconnecting arterial, Eastern Avenue, was selected for analysis.

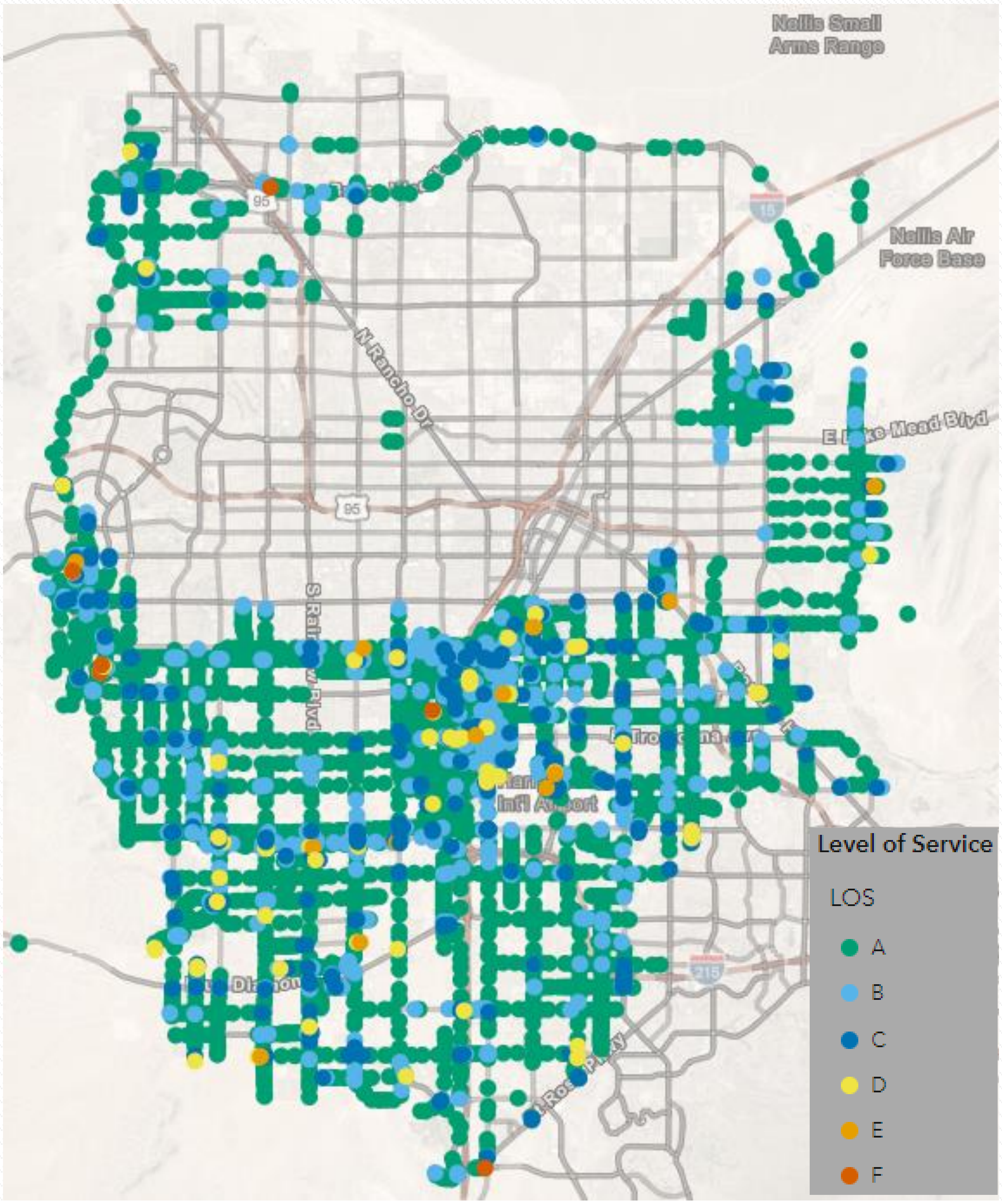


Figure 42: CMP Network Owned by Clark County

Eastern Avenue

Extent:

There are bottlenecks both northbound and southbound at CC-215. Another stretch is along Eastern Avenue between Tropicana Avenue and Warm Springs Road. A portion of this stretch is depicted in Figure 43. The most frequent bottleneck conditions occurred both northbound and southbound on the block parallel with the airport.

Figure 43: Aerial Image of Eastern Avenue between E. Tropicana Avenue and E. Sunset Road

Duration:

As shown in Figures 44 and 45, congestion conditions usually form during the PM Peak. These conditions exist 4 to 5 percent of the time both northbound and southbound at Russell Road and queues traffic an average of 1 or 2 tenths of a mile.

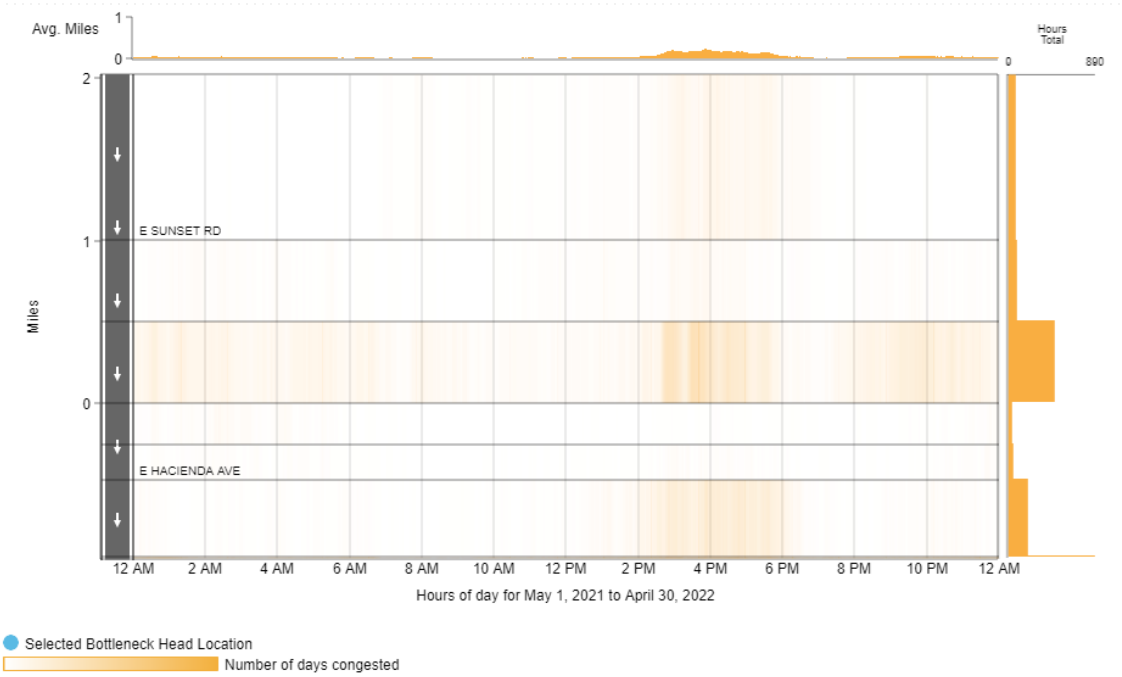


Figure 44: Bottleneck Occurrences at Eastern Avenue Northbound at E Russell Road

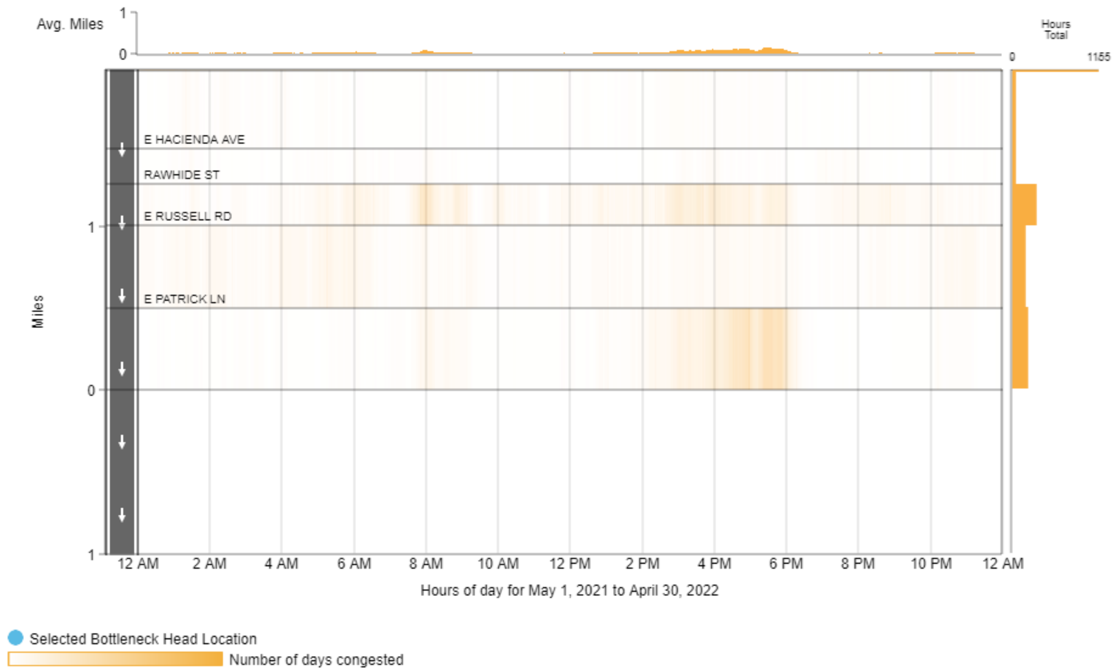


Figure 45: Bottleneck Occurrences at Eastern Avenue Southbound at E Sunset Road

Intensity:

PM peak congestion is more intense Northbound. There is Level of Service C approaching Russell Road and Level of Service D approaching Tropicana Avenue. In contrast, southbound traffic exhibits only Level of Service B. During the AM peak, level of service is generally improved, except for the northbound approach to Russell Road which retains Level of Service C.

Variability:

Beginning sometime after July 12th, 2021 level of service has likely been impacted by an arterial reconstruction project from Sunset Road to Tompkins Avenue. This project includes reconstruction and/or construction of travel lanes, turn lanes, median islands, paving of dirt roadways, or resurfacing of paved roads, roadway drainage facilities, traffic signals, signs, and striping.

Strategy Effectiveness:

An adaptive signal control pilot project has been implemented along Eastern Avenue. This project was active in October, 2020 and adjusted during 2021. A comparison was made between adaptive control software (ACS) performance and traditional time-based coordination (TBC). Buffer time (i.e. the extra time to budget to ensure on-time arrival) was 2.07 minutes going northbound and 2.57 minutes going southbound using TBC. With ACS buffer time was 1.79 and 2.07 respectively. Figure 46 depicts vehicles of hours of delay by mode operation (i.e. ACS and TBC) and hour of the day. The blue line is delay during ACS operation the other lines measure delay during

TBC operation. The benefit of ACS appears to occur during the tails of the peak period (just before and after).

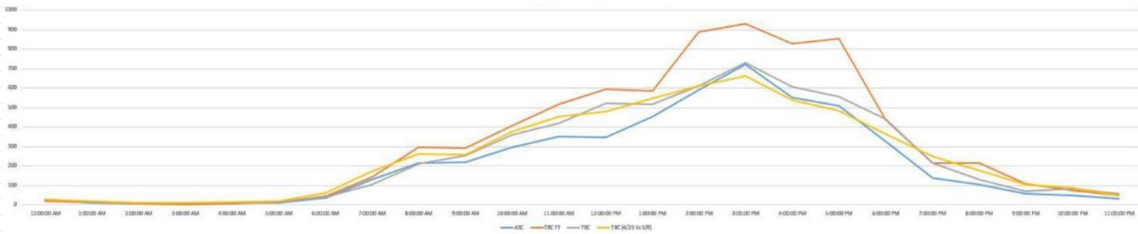


Figure 46: Vehicle Hours of Delay by Mode Operation and Hour of the Day

This strategy is extremely effective. It helps reach many commonly desired congestion management outcomes. For example, according to the estimates produced by INRIX's green calculator, the presence of ACS on Eastern Avenue over would save 465,711 user hours.

Recommendations:

The RTC's On Board Mobility Report[XII] includes phases for future transit investments in Southern Nevada. Some of these phase include improvements to the transit network along Eastern Avenue. This includes improvements along the portion of Eastern Avenue analyzed here but also the congestion located at its intersection with CC-215. Eastern Avenue was a selected priority arterial due to it being a route that would connect as many as 170,000 people to convenient and reliable transit, stimulate a dynamic and thriving economy serving 91,000 jobs, and reduce congestion along the corridor by reducing vehicle miles traveled and shifting vehicle trips to other modes.

As seen in Figure 47, the first phase (less than ten years) of the mobility plan is to introduce a Rapid Bus line to Eastern Avenue. Rapid Bus operates in mixed traffic with targeted measures to provide transit priority, such as queue jump lanes (short bus lanes to bypass backups at traffic signals) and signal priority. In 10 to 20 years, as shown in Figure 48, phase 2 of the plan would upgrade the bus service to Bus Rapid Transit.

Until the On Board Mobility Plan is implemented, the extension of adaptive signal timing along the corridor northward is recommended. This will greatly improve the roadway operations of the capacity currently being added. Implementing these short and long term recommendations may mean that additional roadway capacity might never be needed again to manage congestion along the corridor.

Figure 47: Phase 1 On Board Mobility Plan, High Capacity Transit Network

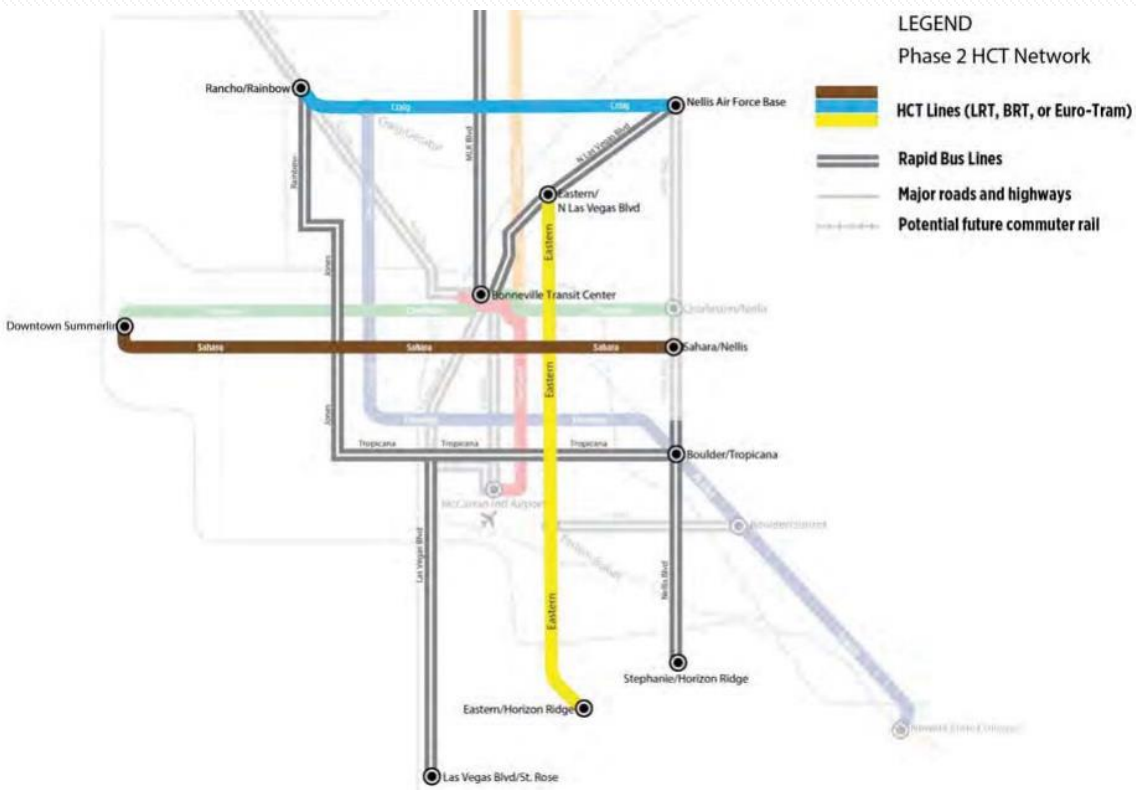


Figure 48: Phase 2 On Board Mobility Plan, High Capacity Transit Network

Henderson

The CMP network owned by the City of Henderson covers both historical and more recently developed areas (Figure 49). Points of delay include intersections along Paseo Verde Parkway and Eastern Avenue feeding into Bruce Woodbury Beltway. The worst bottlenecks occur along Green Valley parkway at intersections near I-215.

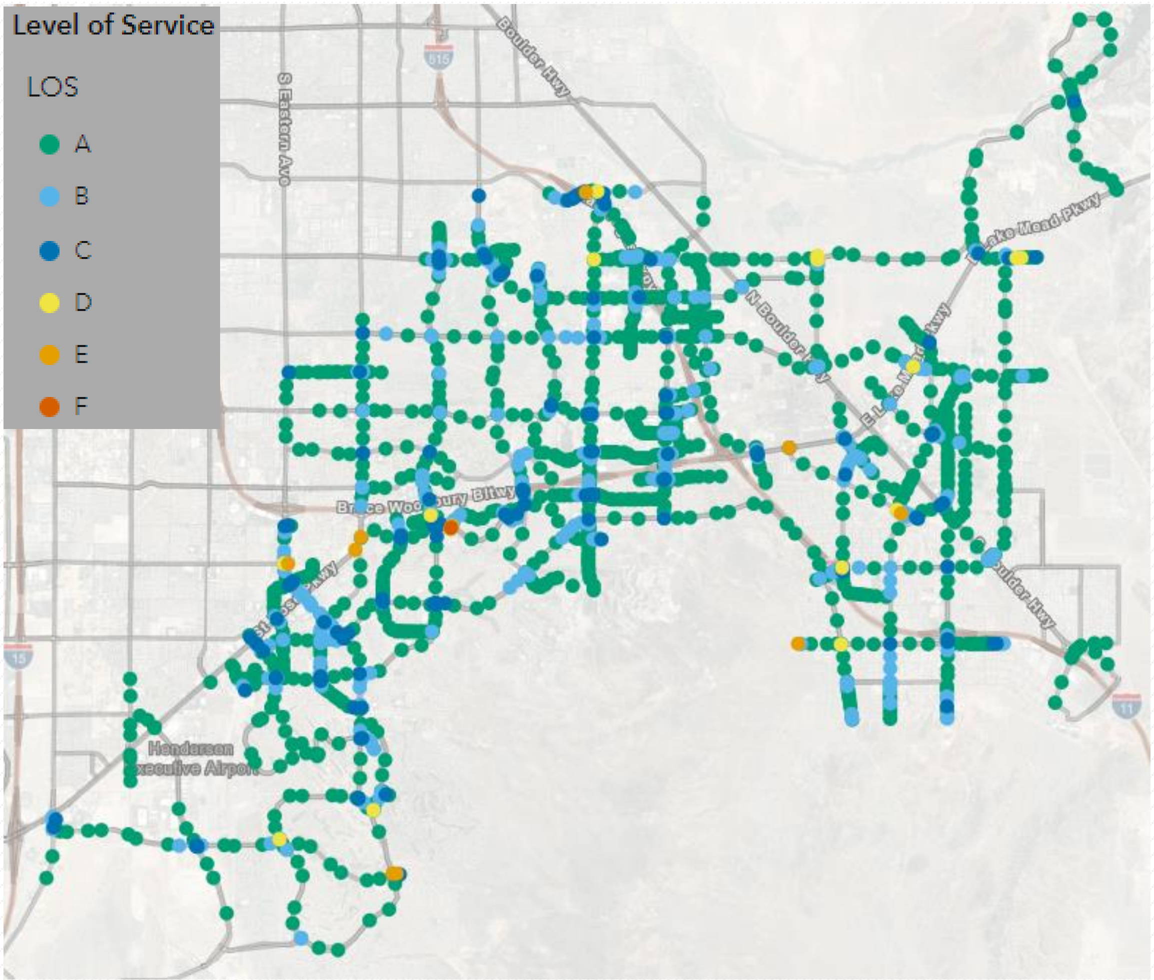


Figure 49: CMP Network Owned By City of Henderson

Green Valley Parkway

Extent:

Figure 50 shows the geographic extent of the road segments in question. Congestion conditions can form going both southbound and northbound on Green Valley Parkway at the I-215 interchange. Generally, traffic queues spill back to Horizon Ridge for northbound traffic and Windmill Parkway for southbound traffic.

Figure 50: Panoramic Photography of Green Valley Parkway (Looking East)

Duration:

As depicted in Figures 51 and 52, congested conditions usually occur during the day but clear overnight.

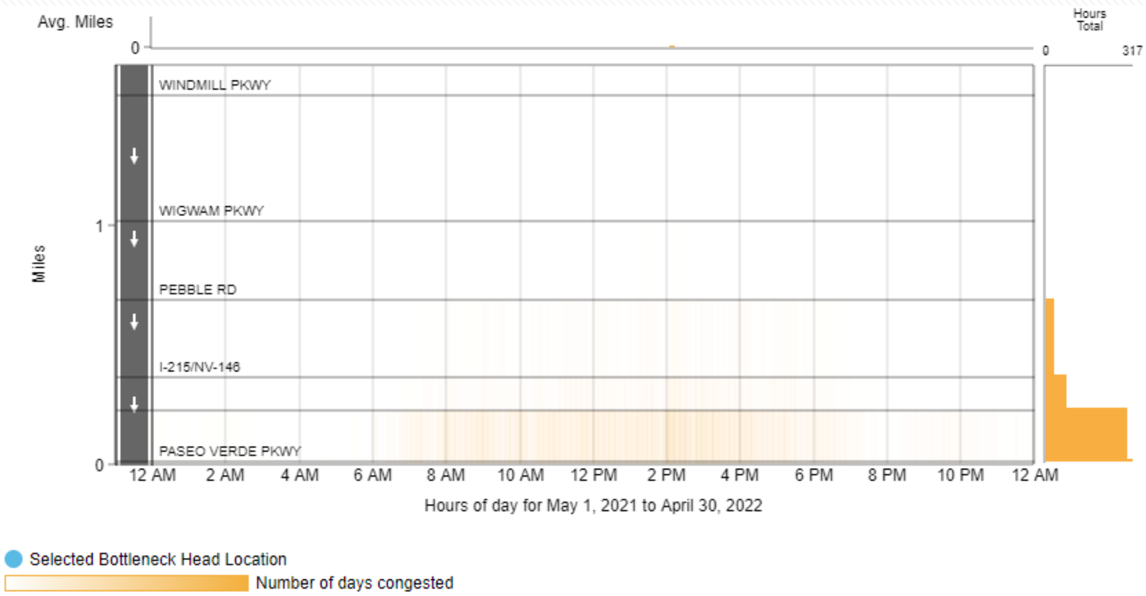


Figure 51: Green Valley Parkway Southbound at Paseo Verde Parkway

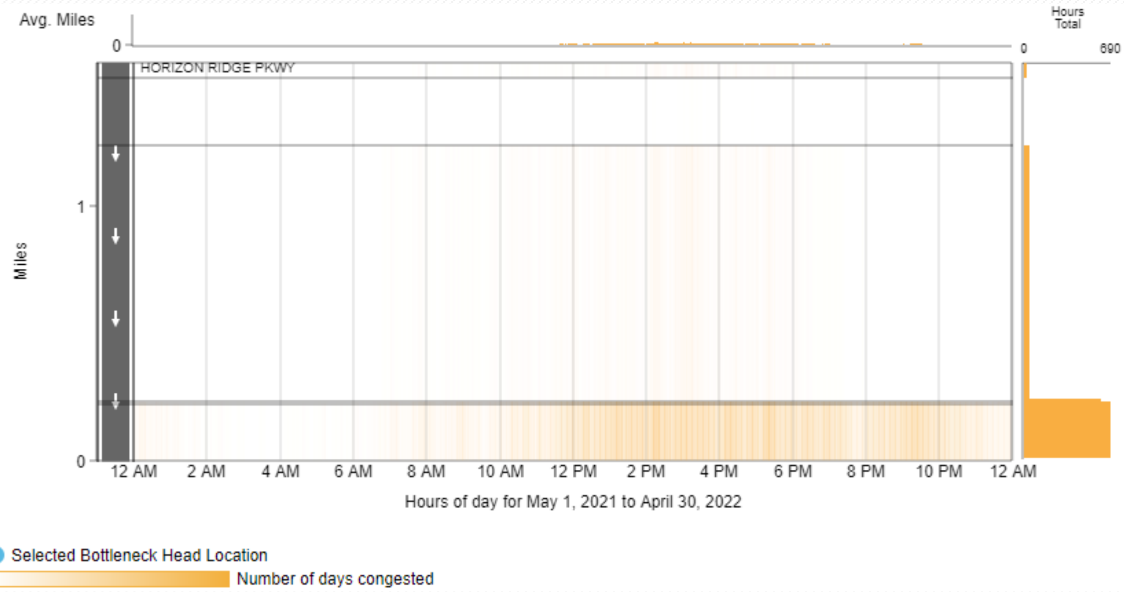


Figure 52: Green Valley Parkway Northbound at I-215

Intensity:

The intensity of congestion produces no more than level of service C (i.e. acceptable delay). This means that it takes one and half times longer to traverse these segments than during free flow conditions.

Variability:

The congestion tends to be slightly worse in the PM Peak than in the AM Peak.

Strategy Effectiveness:

Construction occurred building out Green Valley Parkway and Paseo Verde Parkway traffic improvements occurred from September of 2021 to March 2022 (Figure 53). It included fiber optic interconnect to new traffic signals at Paseo Verde/Village Park, Paseo Verde/Desert Shadow Trail, and Green Valley/Silver Knights-Bella Vista. There were also ADA upgrades and associated paving and utility. Bike Lanes have been clearly marked and crosswalk paint refreshed. It remains to be seen what impact these additional improvements will provide in terms of congestion. Despite these improvements, it's possible that congestion will worsen given the newly introduced 6,000 seat Dollar Loan Center Arena which is home to professional sports teams.

Figure 53: Aerial Photo of Newly Implemented Traffic Improvements at Green Valley Parkway and Paseo Verde Parkway

Recommendations:

The Green Valley Ranch commercial center and casino, a sports arena, community centers, and general commercial uses, on both the north and south sides of the I-215, drive traffic volumes in the area. For peak hour traffic it may be beneficial to reconsider traffic signals in the area. Three more have been recently added. This is in addition to the five which exist in quick succession over the I-215. Split failures occur a fifth of the time at Village Walk Drive. There isn't as much desire for traffic to cross Green Valley Parkway at Village Walk Drive compared to other movements. Traffic engineers could consider the intersection and perhaps modify ingress and egress to The District at Green Valley Ranch. There may be potential in using one-way roads or wayfinding to direct traffic to access points away from I-215.

Particularly during events, traffic signal timing would be advantageous in this area and would make use of fiber optic infrastructure investments. Alerting users on the I-215 of events may encourage them to use alternative routes to get their destination other than Green Valley Parkway. Also, encouraging the use of carpooling or alternate modes to the event would further mitigate event induced congestion. Of note, the arena itself has bike racks for 100 bicycles (pictured right) to encourage active transportation.

Las Vegas

As seen in Figure 54, the CMP network in the City of Las Vegas doesn't experience much in the way congestion. If there are any points in the network exhibiting poor level of service they tend to be at intersections.

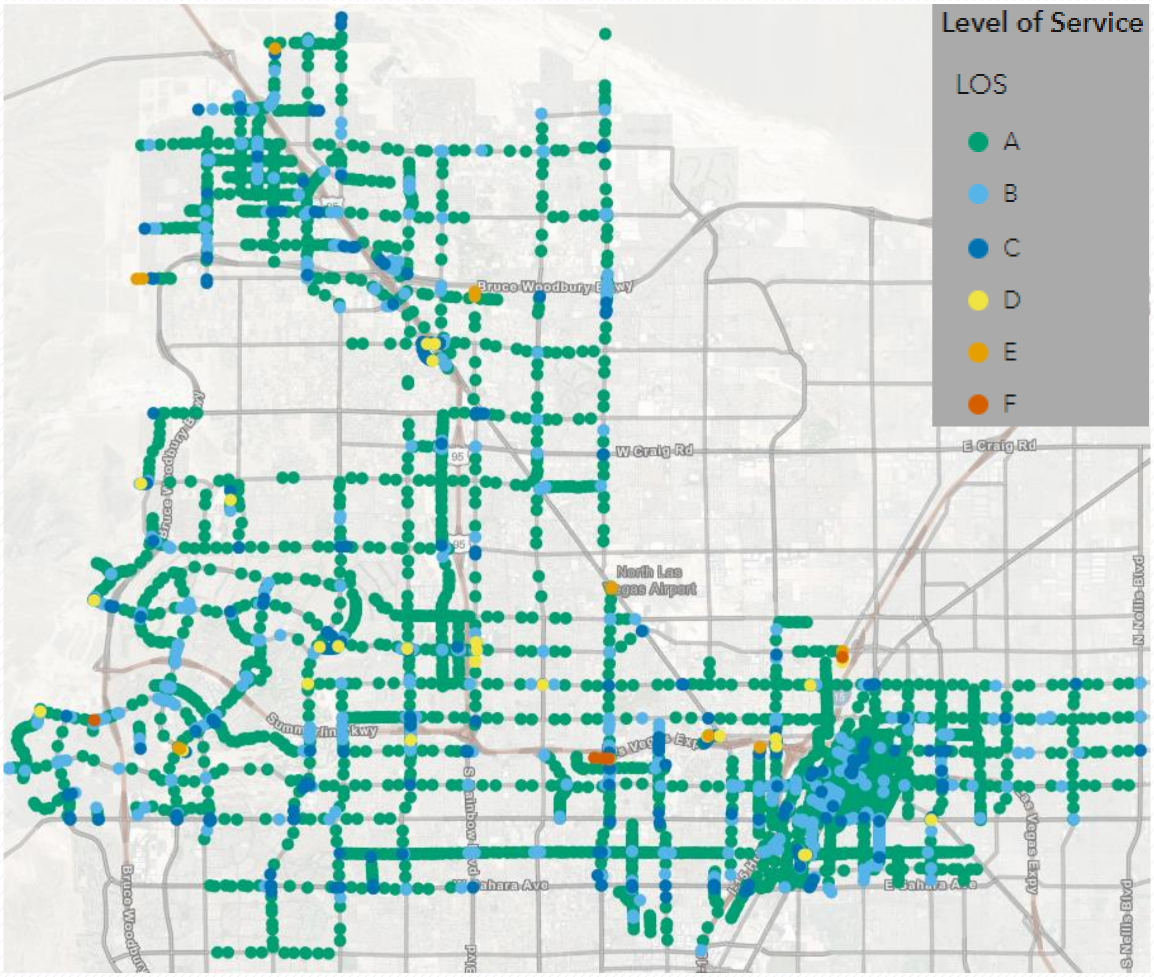


Figure 54: CMP Network Owned by City of Las Vegas

North Rainbow Boulevard

Extent:

A portion of North Rainbow Boulevard runs parallel with US-95. Bottleneck conditions can form for both northbound and southbound traffic. Figures 55 and 56, map the approximate bottleneck head locations and the maximum queue lengths upstream from those locations. However, usually traffic queues only about one tenth of a mile. The bottlenecks symbolized with blue mark the locations with the most delay in each direction.

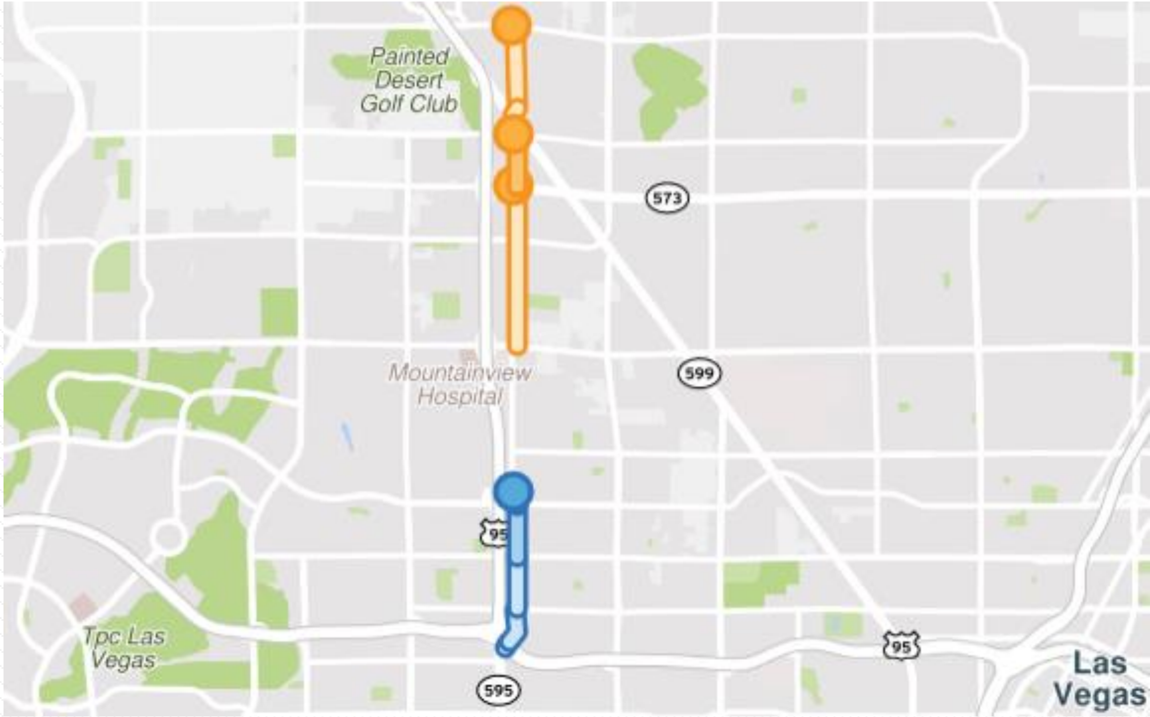


Figure 55: Northbound Bottleneck locations along N. Rainbow Blvd.

Figure 56: Southbound Bottleneck locations along N. Rainbow Blvd.

Duration:

As seen in Figures 57 and 58, Bottleneck conditions forming at Leak Mead Boulevard can persist for 6 to 9 hours a day before recovering overnight.

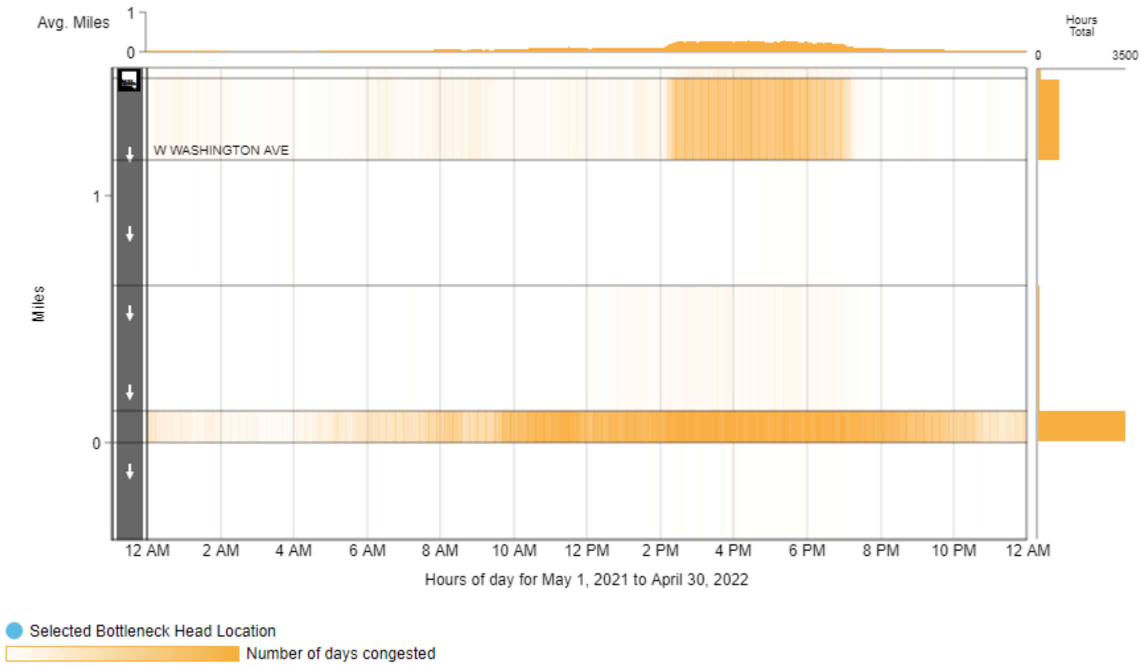


Figure 57: North Rainbow Boulevard Northbound at West Lake Mead Boulevard

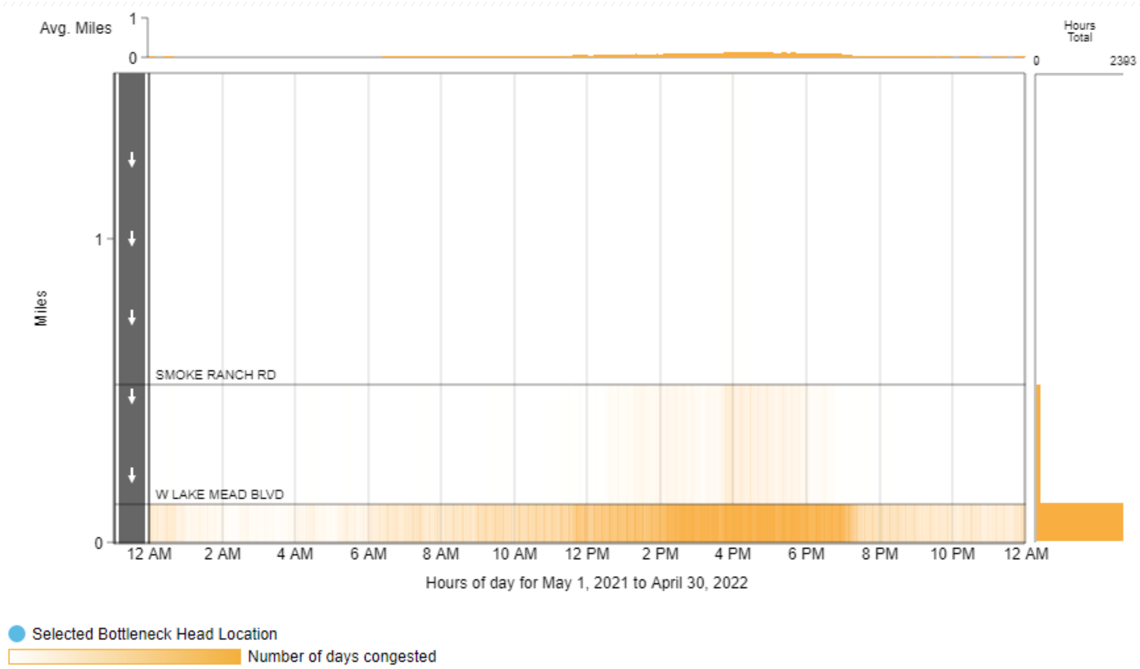


Figure 58: North Rainbow Boulevard Southbound at West Lake Mead Boulevard

Intensity:

Surrounding Lake Mead Boulevard LOS D can occur while on the other congested segments of N Rainbow Boulevard LOS C occurs.

Variability:

During the AM Peak congestion is not as intense. LOS B is common in the morning and never degrades below a C.

Strategy Evaluation:

In recent years there have been several alternative mode investments on Rainbow Boulevard. In 2015, the corridor received new or improved street lighting intended to aid in pedestrian safety. In 2019, Bus Turnouts were constructed and bus shelters were relocated between US 95 to Lone Mountain. Figure 59 is an image of the configuration of the transportation network along the most congested portions of North Rainbow Boulevard.

Figure 59: Panoramic Photo of North Rainbow Boulevard (Looking West)

Recommendations:

Beginning Q4 2022, dedicated right turn lane improvements at six intersections proceeded. Rainbow Boulevard at Cheyenne Avenue is one of the intersections to receive this treatment. Figure 60 is the configuration of this intersection as of July 1st, 2022. The most common split failure is the right turn movement going from Rainbow southbound to Cheyenne westbound (see Figure 61). In this sense, a dedicated right turn lane may be able to relieve excessive traffic queues.

The challenge of this same intersection is the lack of parity in traffic volumes between Rainbow and Cheyenne. Cheyenne traffic volumes essentially double that of Rainbow. In addition the proximity to a US-95 interchange intensifies the need of carrying traffic along Cheyenne. This is evidenced by the percent on green statistics given in Figure 62. 12% and 16% (southbound and northbound respectively) through traffic on Rainbow Boulevard arrive on green. The remaining traffic is delayed by the traffic control for an average of one minute. This could potentially explain the formation of bottleneck conditions on Rainbow upstream in both directions from the intersection.

Figure 60: Panoramic Image of Intersection of N. Rainbow Boulevard and W. Cheyenne Avenue

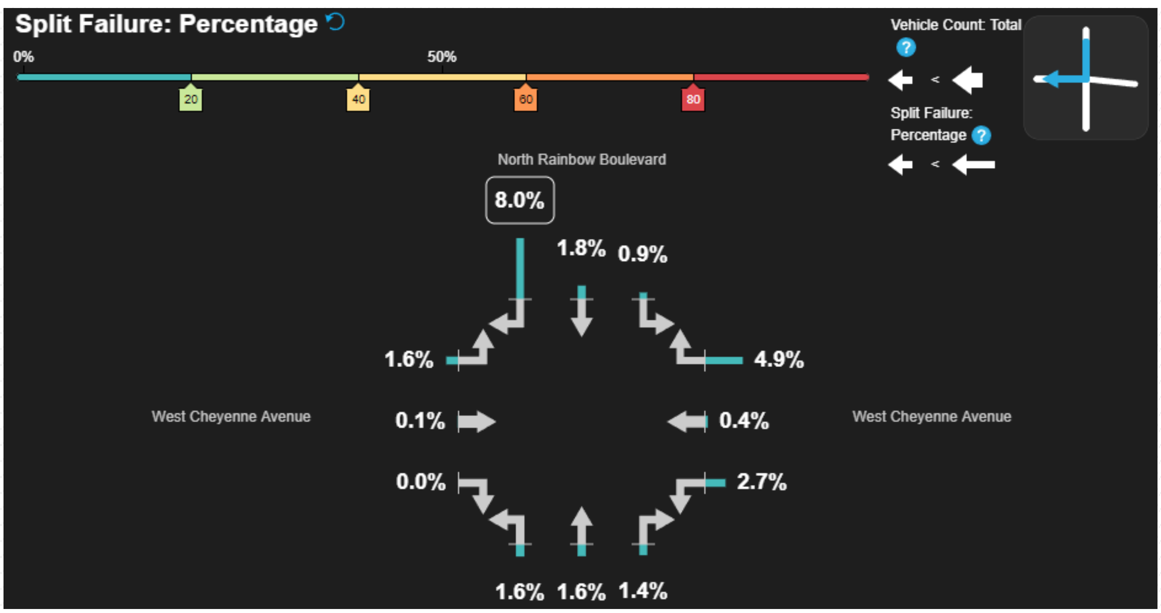


Figure 61: Split Failure Percentages at N. Rainbow Boulevard and W. Cheyenne Avenue, PM Peak Weekdays August 1st-27th, 2022

It is recommended that adaptive signal timing be considered for this intersection. Refer to the Eastern Avenue section of this report for the potential impacts of adaptive signal timing in Southern Nevada. This would optimize performance at this and other intersections along rainbow as well as perhaps that of the cross streets. It should be mentioned that the City of Las Vegas Traffic

Signal Communication System Gap Analysis identified North Rainbow Boulevard as a high priority corridor and the highest priority with an 80 foot right-of–way. Deficiencies include some of the signals having only a copper connection rather than a fiber optic one and lack of existing conduit. The analysis estimated that the corridor could be retrofitted for an estimated $4,102,160. A portion of this corridor is included in O&M #21 (2022-2024).

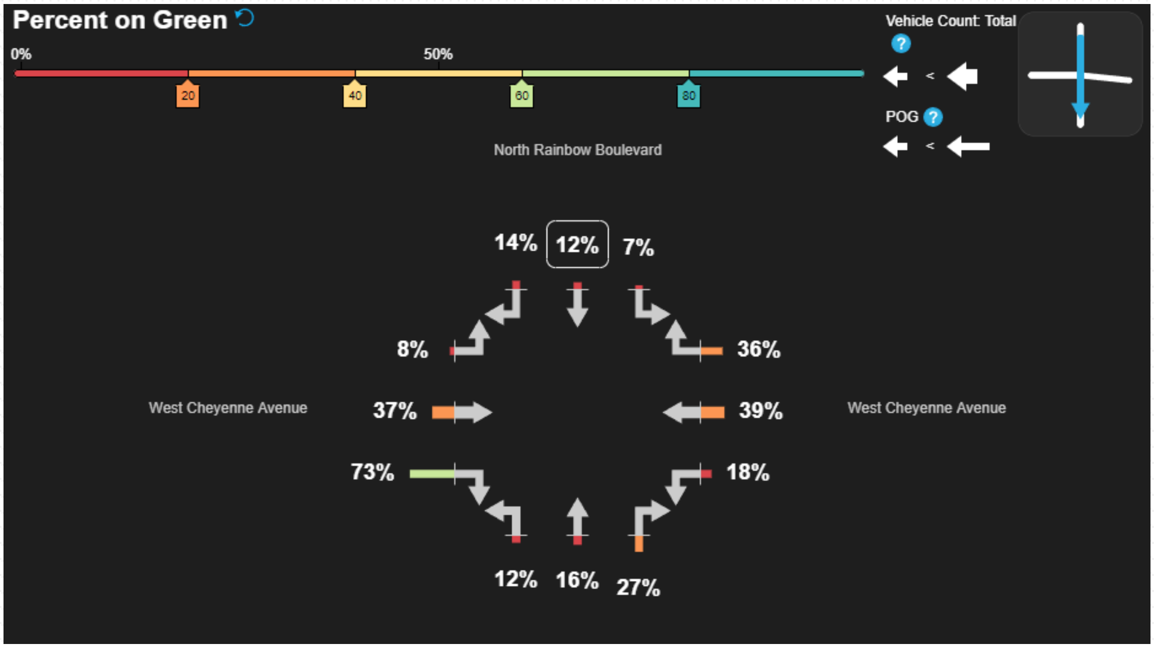


Figure 62: Percent on Green at N. Rainbow Boulevard and W. Cheyenne Avenue, PM Peak Weekdays August 1st-27th, 2022

Mesquite

Mesquite only has a few possible candidates possibly needing additional congestion management efforts (Figure 63). The intersection of Pioneer Boulevard at Falcon Ridge Parkway see slight delay during the PM Peak. There are trip attracting land uses nearby as well as an interchange with I-15. The other end of Pioneer Boulevard, at the next I-15 Exit and Sandhill Boulevard, can see slight delay at traffic lights. But the most impactful bottlenecks, not directly associated with I-15, are at the intersection of Mesquite Boulevard and N Old Mill Road.

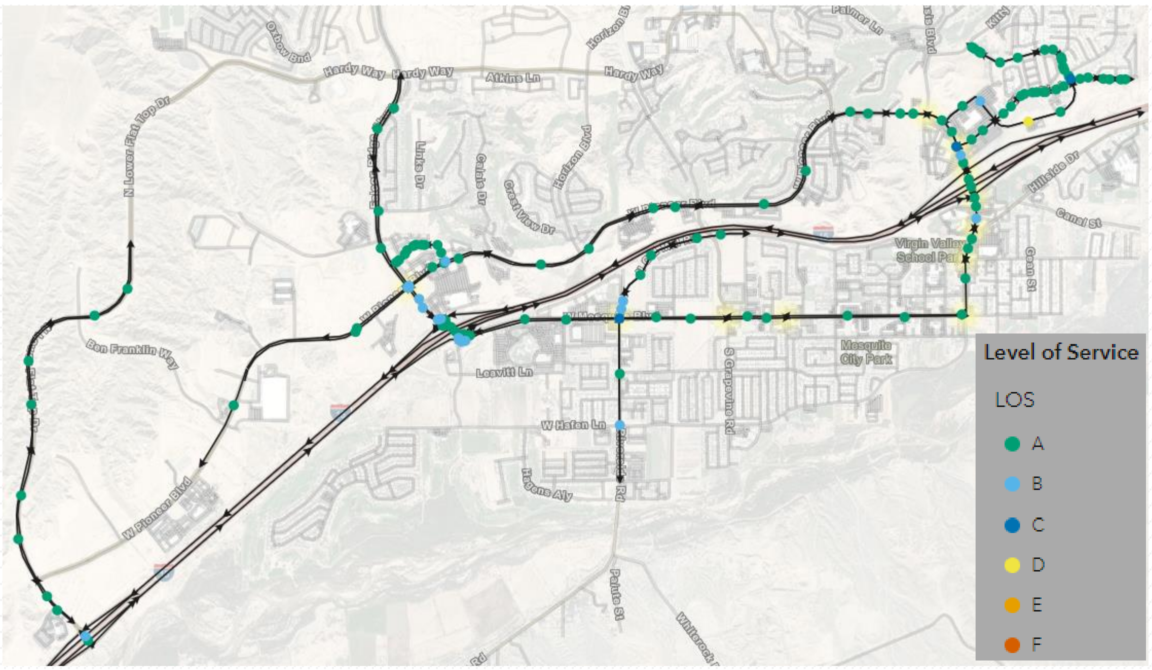


Figure 63: CMP Network Owned by Mesquite

W Mesquite Boulevard at Riverside Drive/N Old Mill Road

Extent:

Although infrequent, traffic backups can queue up in any direction in from this intersection with a maximum average queue length of 1 mile. Figure 64 shows the current configuration of the intersection.

Figure 64: Oblique Photography of Mesquite Blvd at Riverside Road/W Old Mill Road Looking Northeast

Duration:

Bottleneck conditions don't form very frequently. Specifically, eastward and northbound only about 10% of days. The segment going southbound across the intersection registers bottleneck locations on most days throughout the day (See Figure 65), but field work is needed to determine if this is in fact just an effect of the traffic signal or an INRIX data error.

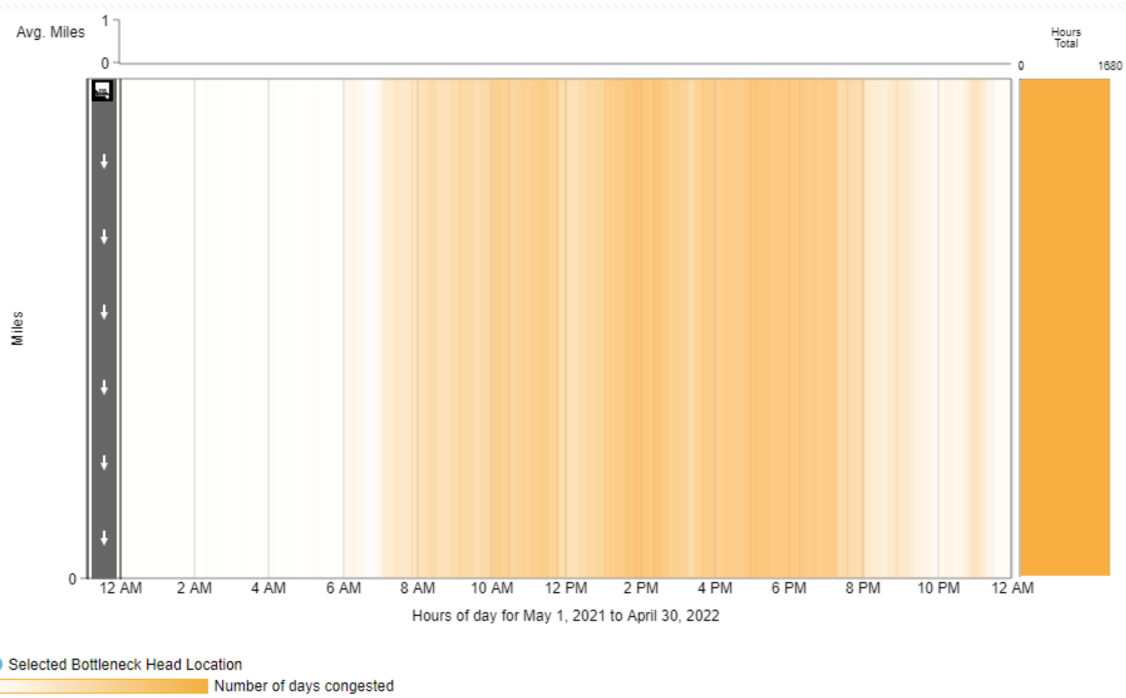


Figure 65: NV-170 Westbound @ I-15-BL/W MESQUITE BLVD/OLD MILL RD

Intensity:

Traffic intensity is not high. LOS B and LOS C occurs but only for northbound and southbound traffic at the intersection.

Variability:

The data doesn't suggest any strong traffic variability at the intersection other than a slight uptick during the PM Peak than from the AM Peak.

Strategy Evaluation:

No RTC projects have been recorded at the intersection. LOS on southbound N Old Mill Road has somewhat deteriorated since 2020, but some of this could be economic recovery from the pandemic.

Recommendations:

Mesquite's population has grown by over 20% over the last decade. This intersection touches Interstate 15 Business and Nevada State Route 170. These routes are historical as well as they were once part of US 91, which stretched from Sweetgrass, Montana to Long Beach, California. This intersection certainly will play a role in Mesquite's future. While less than expected, there is an imbalance in Average Annual Daily Traffic (AADT) at the intersection. According the HPMS, Riverside Road has a traffic volume of 4,000 verses Mesquite Boulevard's 10,000. Old Mill Road may have fewer than either of these. A review of signal timing at the intersection may help optimize minor street travel times while maintaining LOS on Mesquite Boulevard.

Nevada Department of Transportation

As seen in Figure 66, the CMP network owned by NDOT is limited mostly to the national highway system and state routes (Source: 2018 HPMS data). While NDOT has transferred road ownership in several places since 2018, NDOT still owns portions of the intersection of Charleston Blvd and Freemont Street (Figure 67).

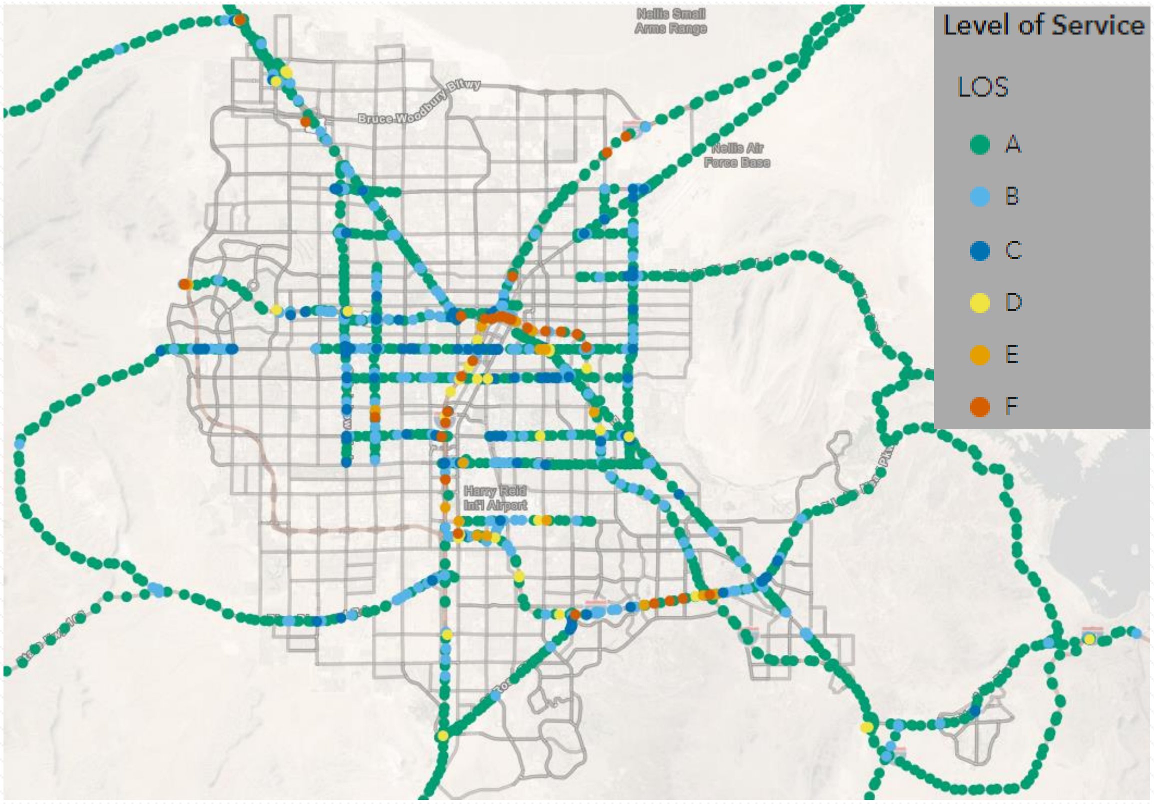


Figure 66: CMP Network Owned by Nevada DOT

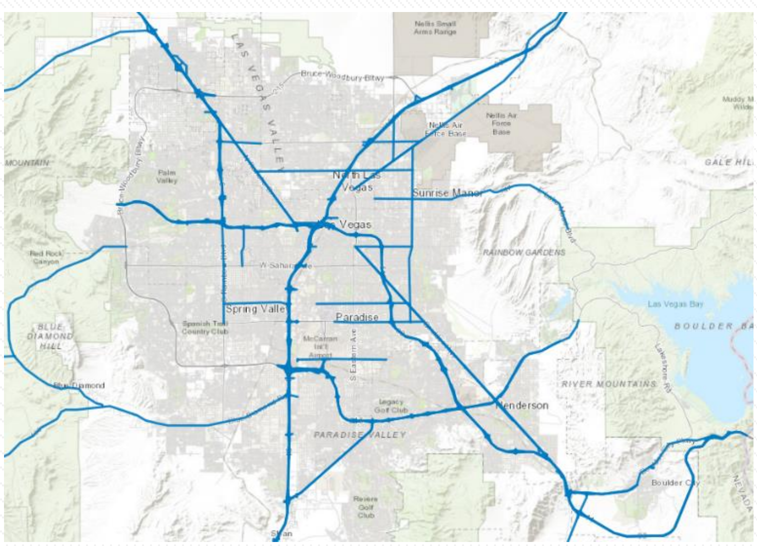


Figure 67: NDOT Ownership as of April, 2021

Charleston Boulevard @ Fremont Street

Extent:

At the intersections depicted in Figure 68, bottleneck conditions for eastbound traffic typically queues half a mile from Fremont Street to N Bruce Street, westbound traffic usually back up a quarter mile from Eastern Avenue to Fremont street, northbound traffic has the longest average queue of three-quarters of a mile back to Oakey Blvd, southbound traffic queues hardly at all from the light at Eastern and Fremont.

Figure 68: Panorama of the Intersections of Charleston Boulevard with Fremont Street and Eastern Avenue

Duration:

Congested conditions don't form until about 8 am and generally increases in intensity till 6 pm before ebbing off by 8 pm. Figures 69 and 70 show the average daily distribution for westbound and northbound traffic respectively.

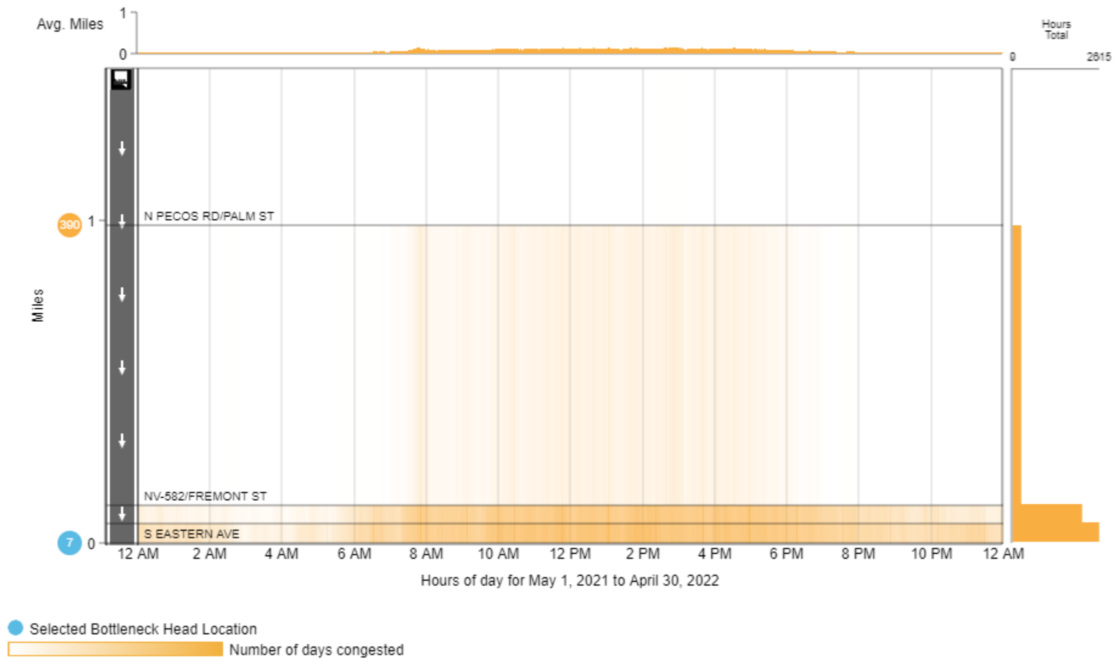


Figure 69: Bottleneck Occurrences at Charleston Boulevard Westbound at S Eastern Avenue

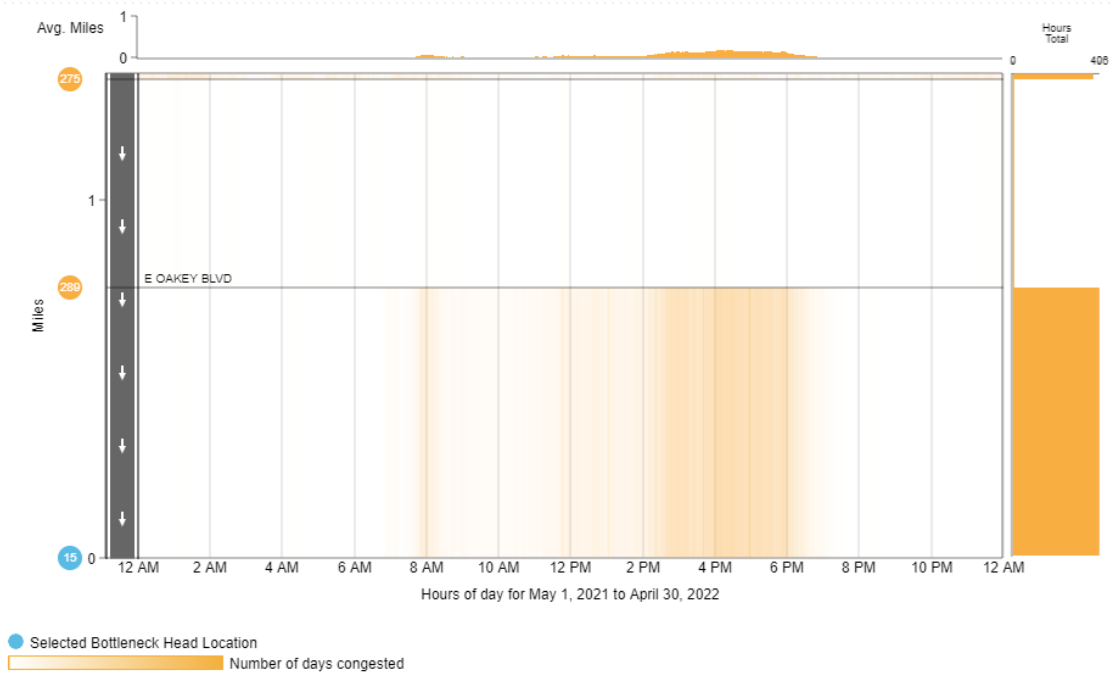


Figure 70: Bottleneck Occurrences at Fremont Street Northbound at Eastern Avenue

Intensity:

Eastbound and westbound traffic experience LOS E and D leading to and through the intersections during the PM Peak. Northbound and southbound traffic only ever dips to LOS C and D during the PM Peak.

Variability:

During the AM Peak the LOS remains LOS C or better. The only exception is the short stretch of road between Fremont and Eastern which retains LOS D and E.

Strategy Evaluation:

There have been many roadway improvement projects along Charleston Boulevard in recent years. In 2018, FAST implemented an ITS project. In the fall and summer of 2022, construction on Charleston reduced travel to one lane in each direction. There have also been Bus Stop improvements and street light improvements in the area. The effect of all these efforts have yet to improve congested conditions.

In general, the level of service has deteriorated since July of 2020 which a noticeable change often occurring in the fall of 2021. Given the current mode share and that AADT is roughly 30,000 on Charleston, Eastern, and Fremont these reinvestments into the infrastructure will be well used, but perhaps will not successfully alleviate congestion. One evidence of the ongoing difficulty of dealing with congestion at Charleston and Fremont are the signal analytics presented in Figures 71-73. The lights currently prioritize Charleston Blvd with northbound traffic having to wait the longest. Westbound traffic on Charleston most often hit green lights. It's not unusual for 1 in 20 to experience a split failure from several different approaches at the intersection. Split failures can contribute to traffic queueing.

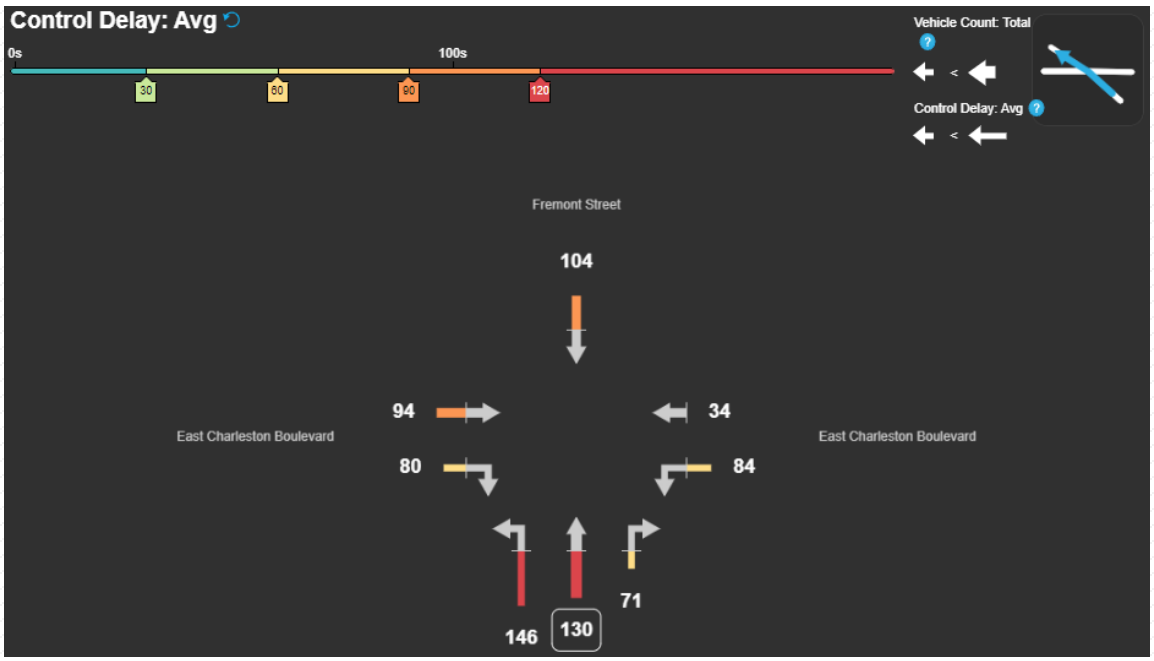


Figure 71: Average Control Delay at Charleston Boulevard and Fremont Street during the PM Peak, April 18 – May 13, 2022

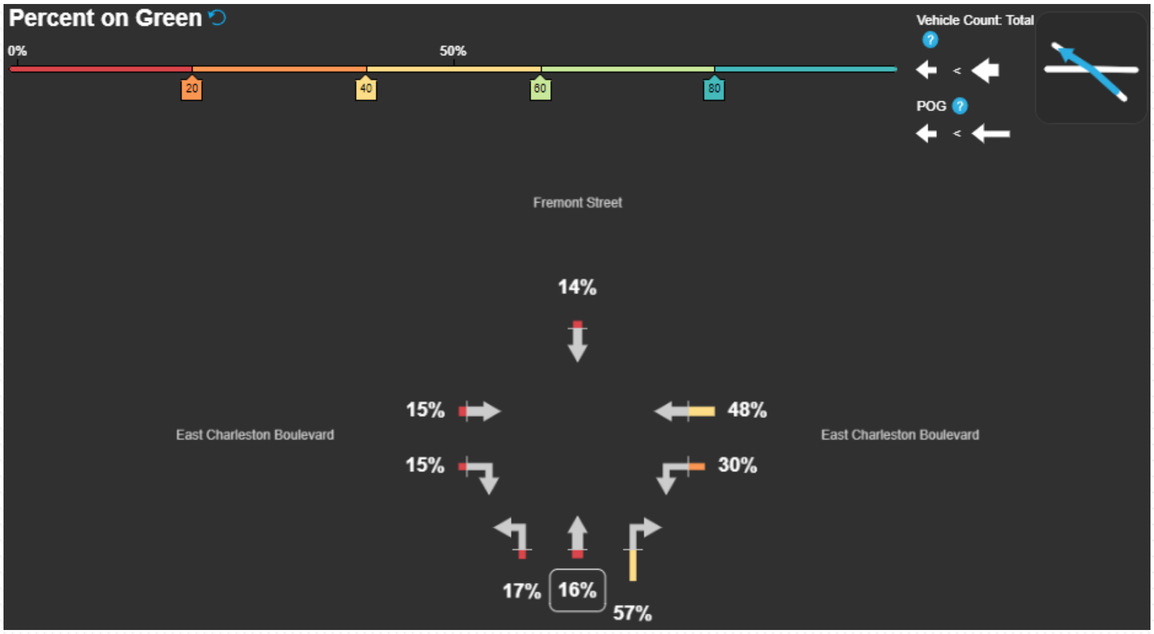


Figure 72: Percent on Green at Charleston Boulevard and Fremont Street during the PM Peak, April 18 – May 13, 2022

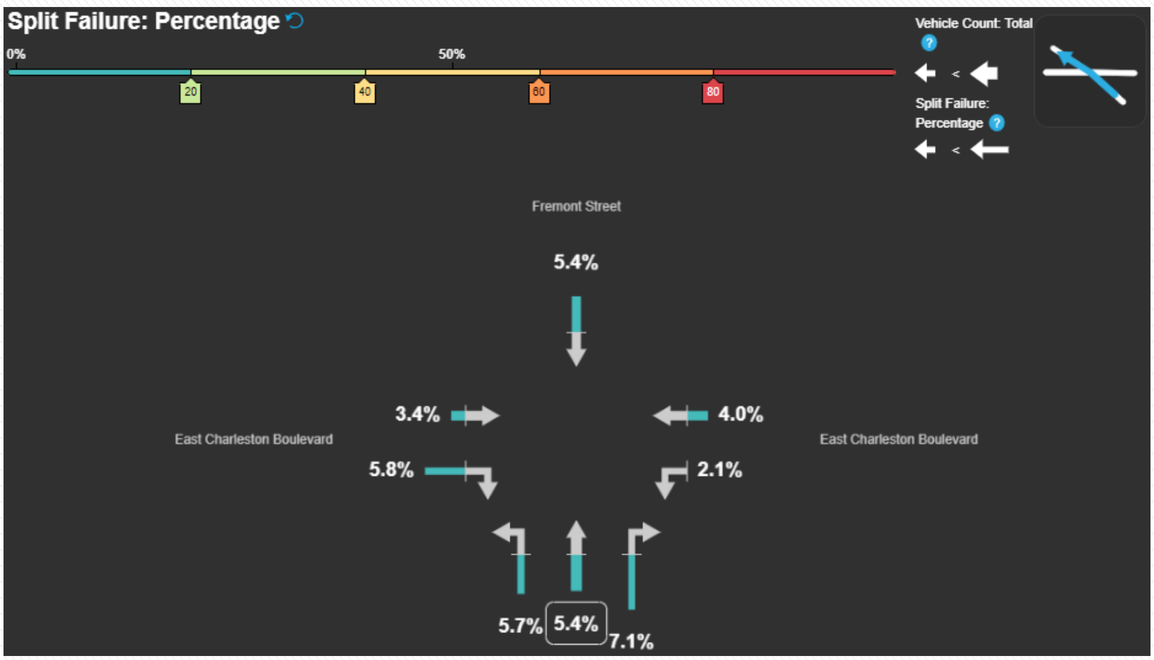


Figure 73: Split Failure Percentage at Charleston Boulevard and Fremont Street during the PM Peak, April 18 – May 13, 2022

Recommendations:

In recent years many of the empty lots have begun to be developed with both multi-family residential and commercial land uses. As seen in Figure 74, these kinds of land uses developments may in the future be serviced, as recommend by the On Board Mobility Plan, by a high capacity transit line along Charleston Boulvard and a rapid bus line on Eastern Avenue.

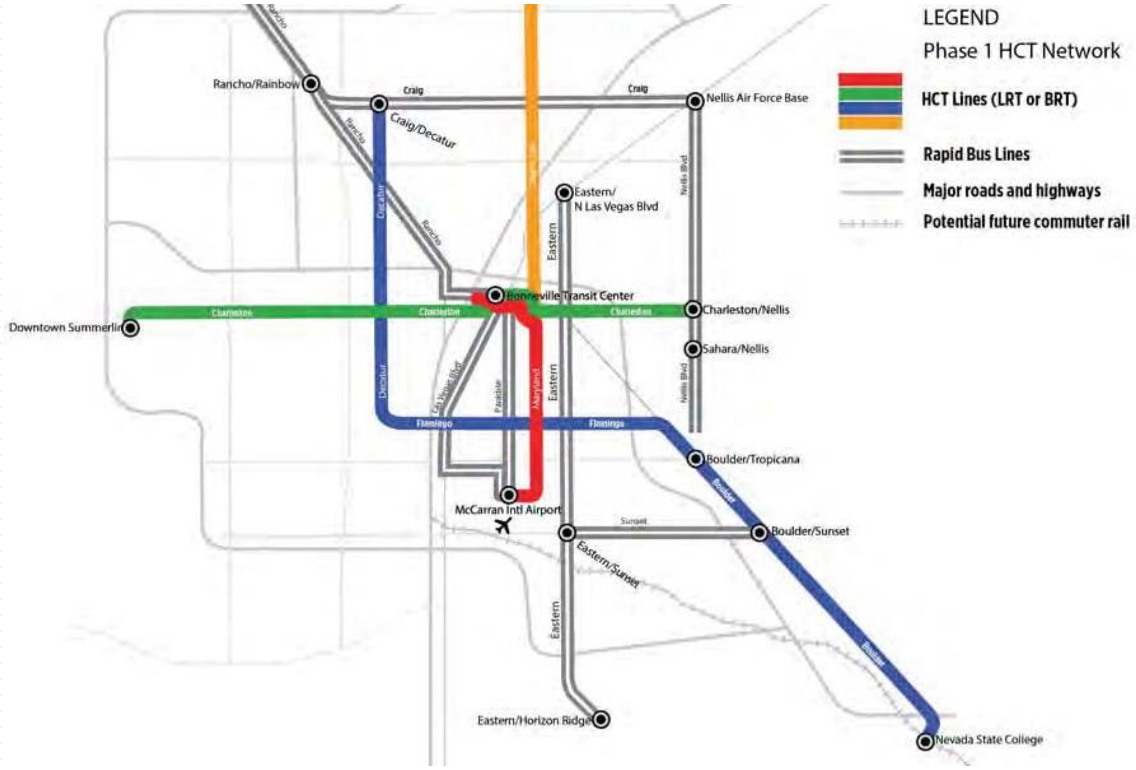


Figure 74: Phase 1 On Board Mobility Plan, High Capacity Transit Network

If these transit improvements are implemented, there is potential to disuade demand for single occupancy vehcile travel which may ultimately be the best way to reduce congestion at this location. Other possibilities for multimodal improvements could be the bike lanes and shared use path along Fremont Street. Before those major multimodal improvemnts are implemented, it may be useful to implement adaptive signal timing at the intersection to improve the signal analyics currenlty observed.

North Las Vegas

The CMP network in the City of North Las Vegas covers most arterial roads other than Cheyenne Avenue and portions of Craig Road. As suggested in Figure 75, delays tend to occur at intersections and crossings of highways or state routes. One bottleneck location triggers acceptable traffic delay along Losee Road at Craig Road, but perhaps the most pressing area with congestion management concerns is along E Lake Mead Boulevard at N Civic Center Drive.

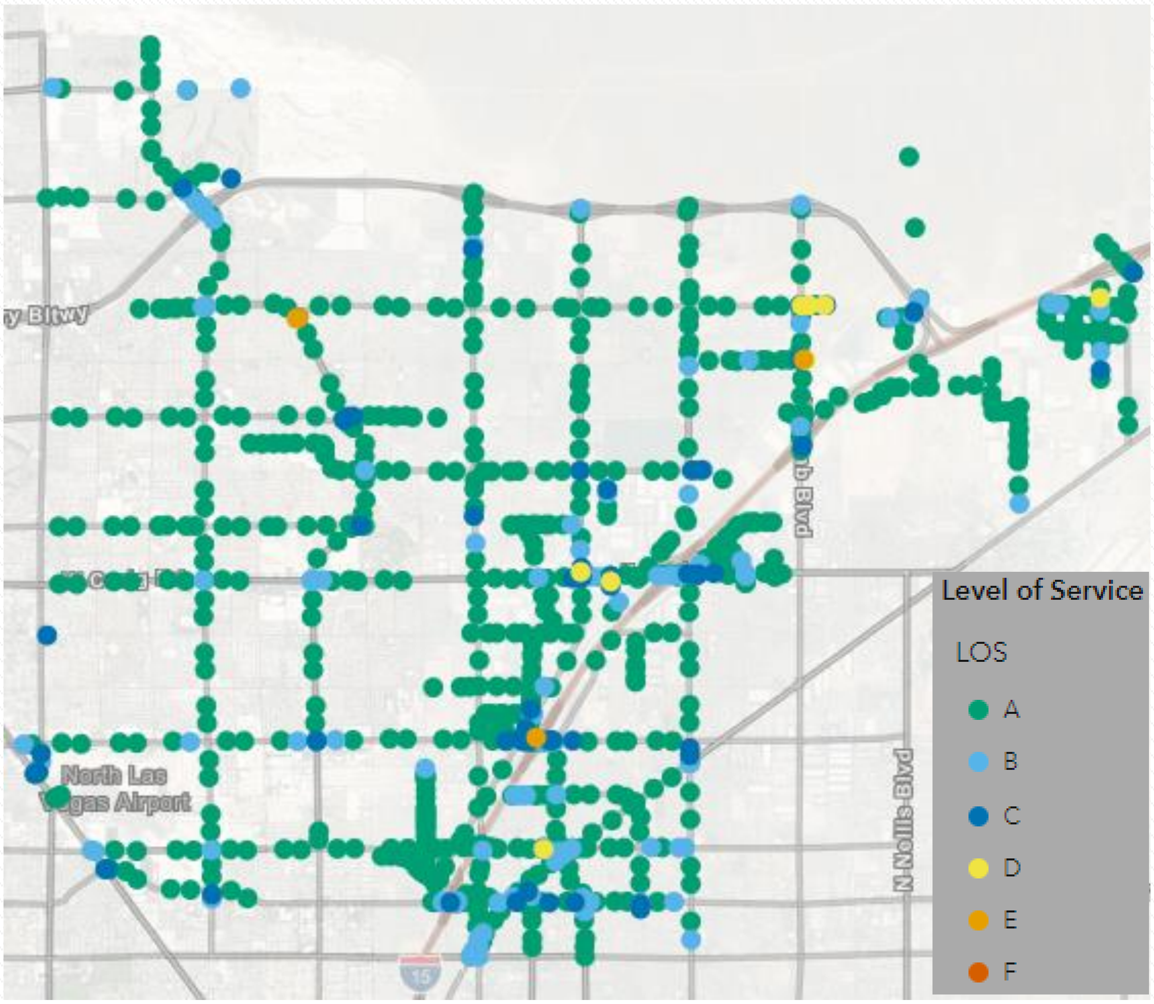


Figure 75: CMP Network in North Las Vegas

E Lake Mead Boulevard surrounding Civic Center Drive

Extent:

There are bottlenecks in all directions beginning at the intersection shown in Figure 76. Eastbound traffic queues up less than a mile. Westbound traffic has an average queue length of just a tenth of a mile. Northbound and Southbound traffic can queue half a mile.

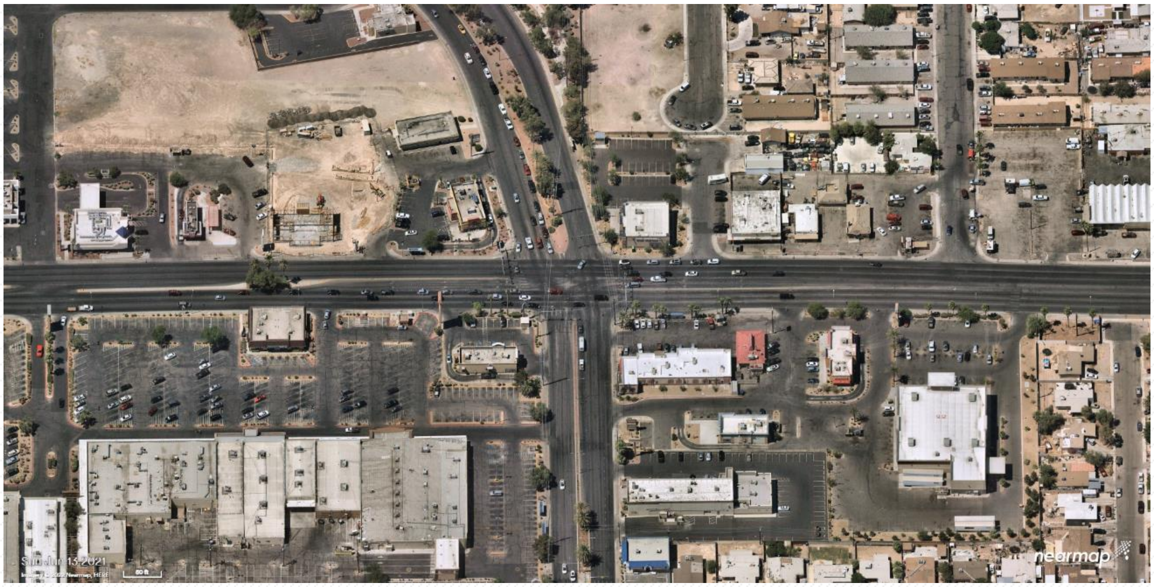


Figure 76: Panoramic Photography of E Lake Mead Boulevard at N Civic Center Drive

Duration:

Congested conditions are very infrequent on Civic Center Drive. However as seen in Figures 77 and 78, E Lake Mead Boulevard bottlenecks occur for over an hour each day during the PM Peak.

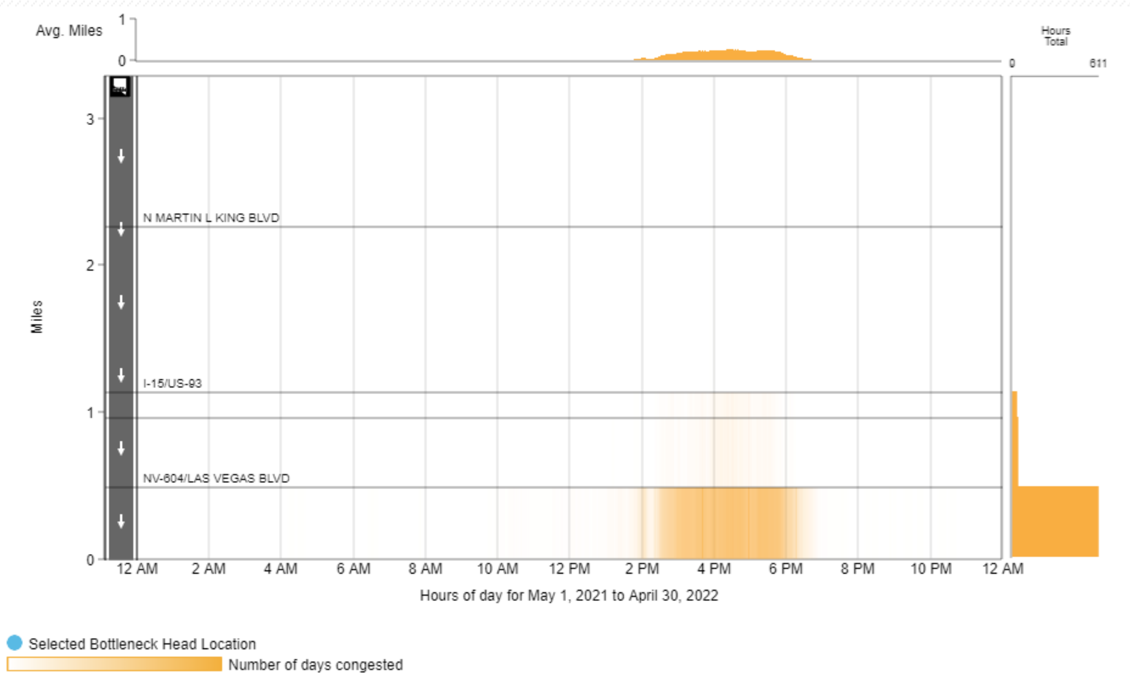


Figure 77: NV-147/E Lake Mead Boulevard Eastbound at NV-607/Civic Center Drive

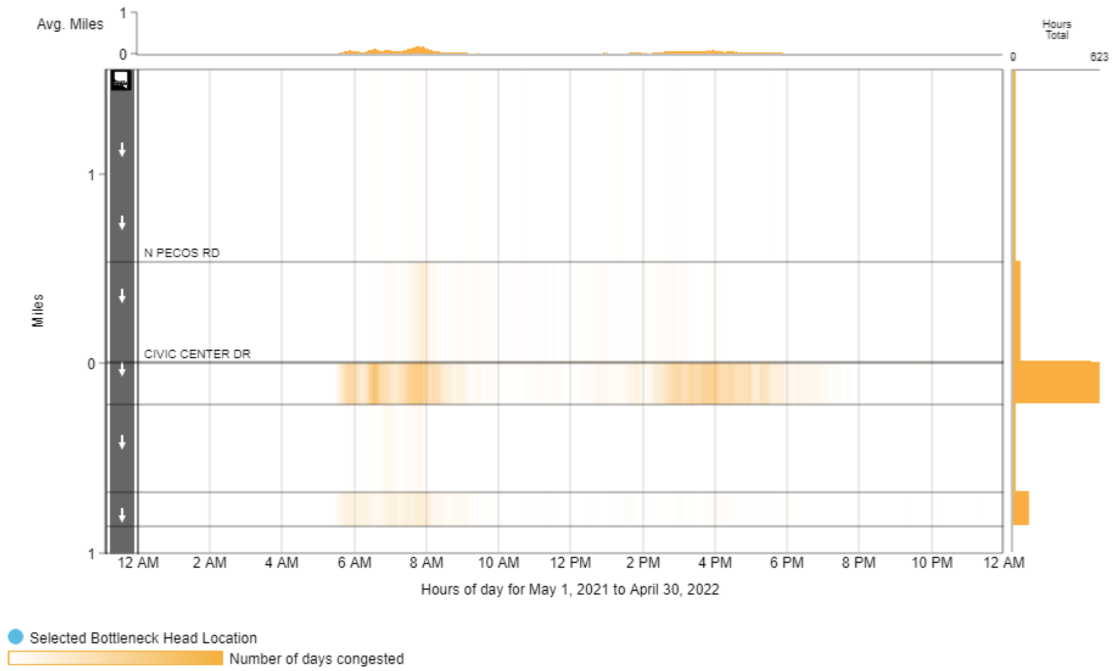


Figure 78: NV-147/E Lake Mead Boulevard Westbound at NV-607/Civic Center Drive

Intensity:

LOS B exists on all inbound segments except for a segments along E Lake Mead Boulevard which can degrade to LOS C.

Variability:

Congestion is absent during the AM Peak except for eastbound traffic. PM Peak experiences elevated congestion compared to the AM Peak.

Strategy Evaluation:

Recently, bike and pedestrian and safety improvements have happened around the intersection including midblock crossings. Otherwise, historical aerial imagery suggests that configuration at the intersection has been relatively static. It's possible that, for eastbound traffic, this intersection is impacted by traffic backing up from Las Vegas Blvd. LOS patterns don't appear to be degrading too severely over time. If anything, congestion conditions have remained more or less static.

Recommendations:

Since congestion only impacts this location during peak periods with LOS remaining in stable flow conditions, improvements appear to have focused on safety improvements.

Similar to the Eastern Avenue road segments discussed in the Clark County portion of this section of the report, improved transit service is planned through the intersection. As seen in Figure 79, the first phase (less than ten years) of the mobility plan is to introduce a Rapid Bus line to Eastern

Avenue. Rapid Bus operates in mixed traffic with targeted measures to provide transit priority, such as queue jump lanes (short bus lanes to bypass backups at traffic signals) and signal priority. In 10 to 20 years, as shown in Figure 80, phase 2 of the plan would upgrade the bus service to Bus Rapid Transit.

Figure 79: Phase 1 On Board Mobility Plan, High Capacity Transit Network

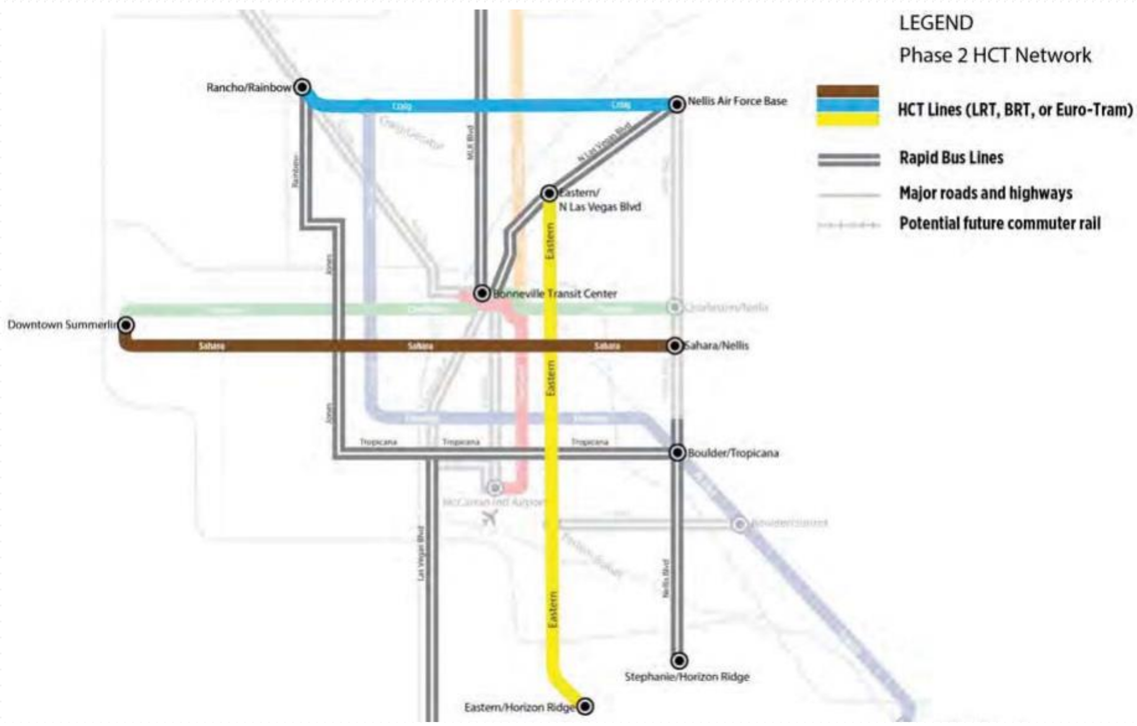


Figure 80: Phase 2 On Board Mobility Plan, High Capacity Transit Network

Strategy Implementation

The RTC identifies and implements both short and long-term policies and programs intended to promote air quality improvement, enhance mobility and increase quality of life in the region. The CMP Implementation Plan selects funding and congestion management strategies that combine to realize desired end results.

Congestion Management Strategies

As illustrated in Figure 81, The CMP uses thematically tiered strategies. Following an approach promoted by FHWA, the tiers are arranged so measures at the top take precedence over those at the bottom.

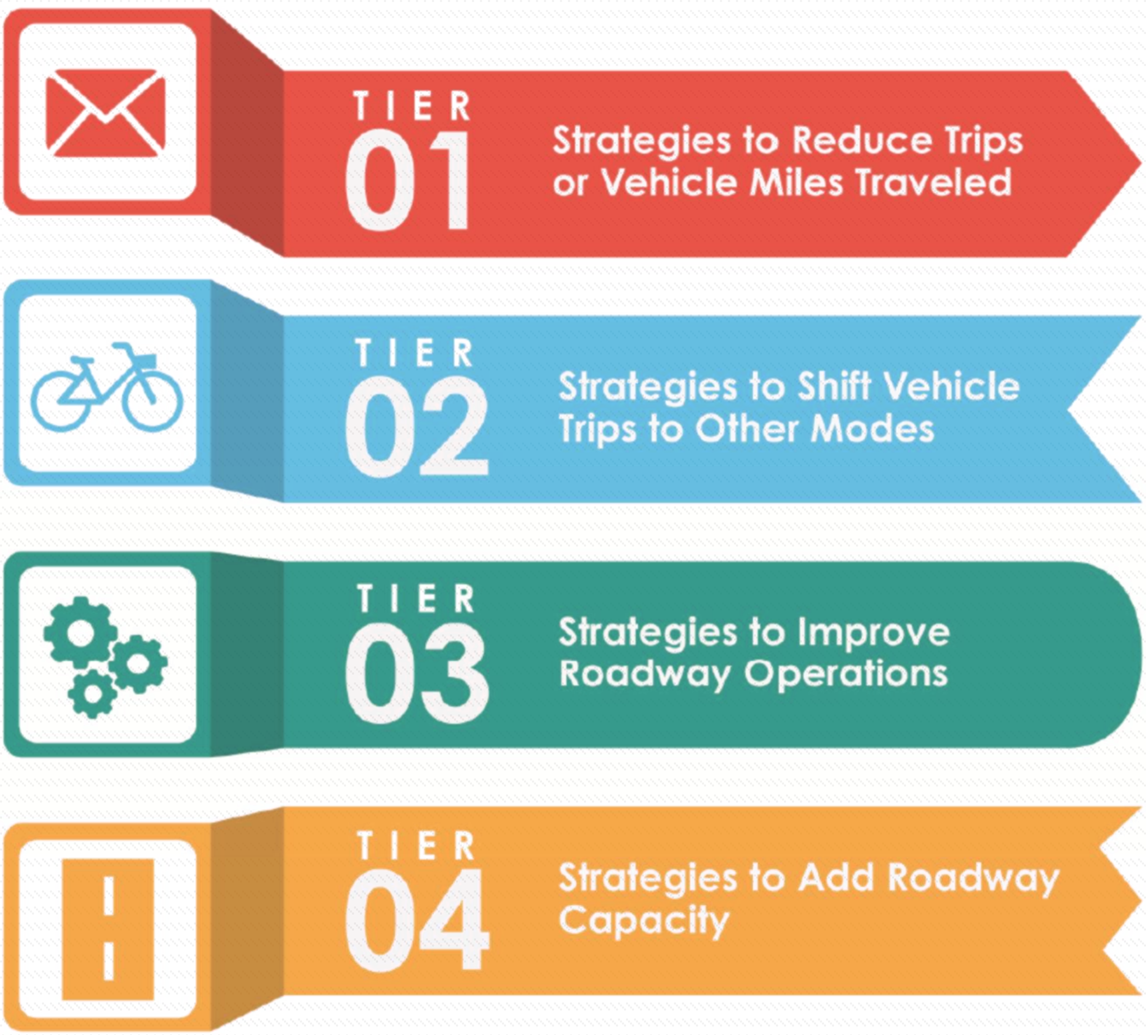


Figure 81: Congestion Management Strategy Tiers

TIER 01 Strategies to Reduce Trips or Vehicle Miles Traveled

Travel Demand Management (TDM) can help to provide travelers with more options and reduce the number of vehicles or trips during congested periods. Figure 82 illustrates the economic results of reduced demand. Unlike Figure 82, these strategies are not anticipated to reduce net demand in rapidly growing Southern Nevada. Rather, these strategies introduce a mitigating influence whose benefits become significant when accumulated over time.

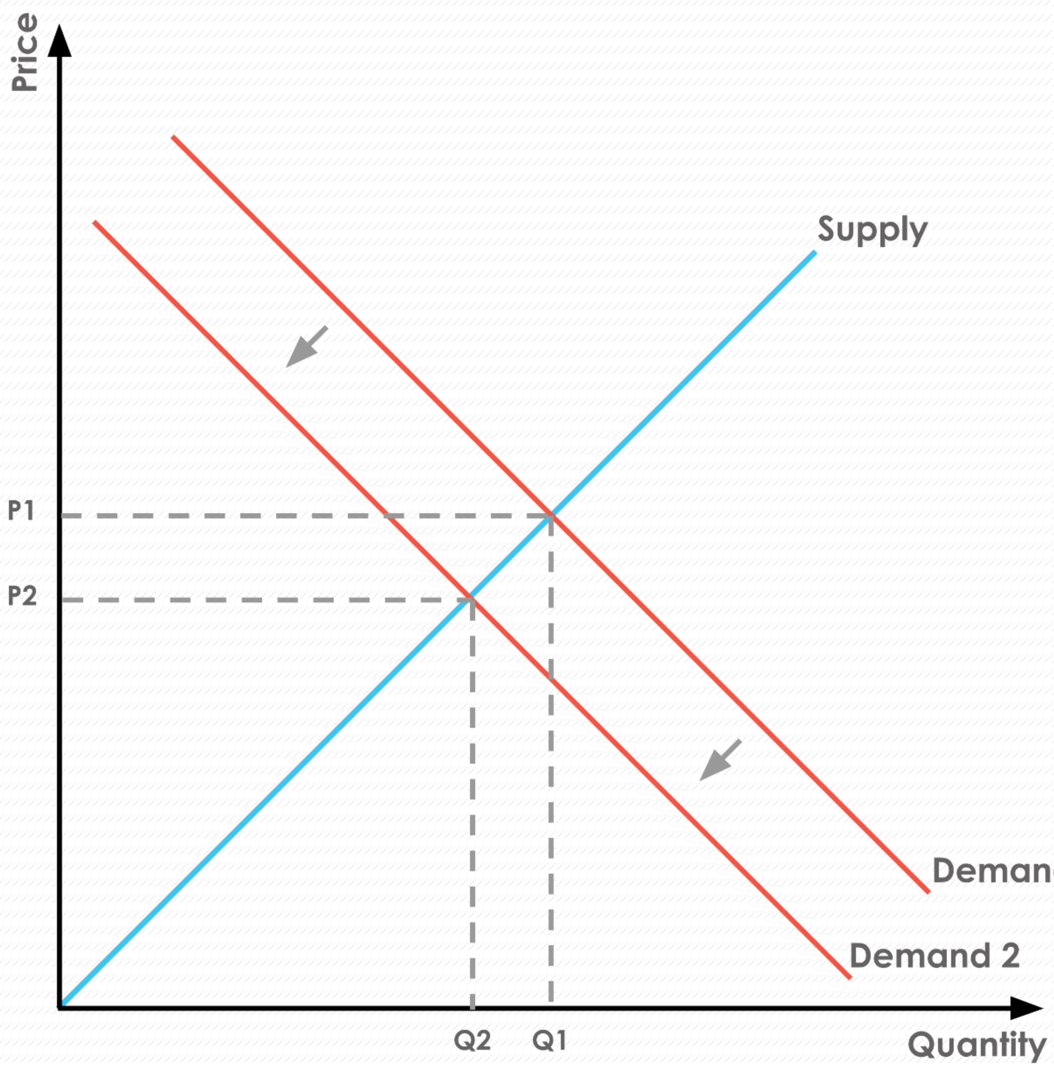


Figure 82: Generalized Effect of Dissuaded Demand on Transportation Infrastructure, Construction and Maintenance

Club Ride

The RTC has a vigorous TDM program called Club Ride Commuter Services. Established over a decade ago, Club Ride has developed a successful regional trip reduction program by targeting their message to large employers and their employees. The Club Ride program works with both groups to establish customized commute option program which incentivize use of alternative modes of transportation for getting to and from work, such as transit, carpooling, bicycling, walking, or telecommuting. It also incentives compressed work weeks as an alternate work pattern. In 2014, Club Ride had 271 participating employers and 18,143 active registrants. The Club Ride app allows users to report their commute, check out discounts, update their account, and set reminders for reporting. Figure 83 is an infographic of the programs impact from 2020-2021.

Elements of the Club Ride program have included:

1. Computerized Rideshare Matching
2. E-Z Rider Discounted Transit Passes
3. Club Ride Rewards Program
4. Guaranteed Emergency Ride Home
5. Preferential parking for carpool commuting employee
6. Vanpool subsidies

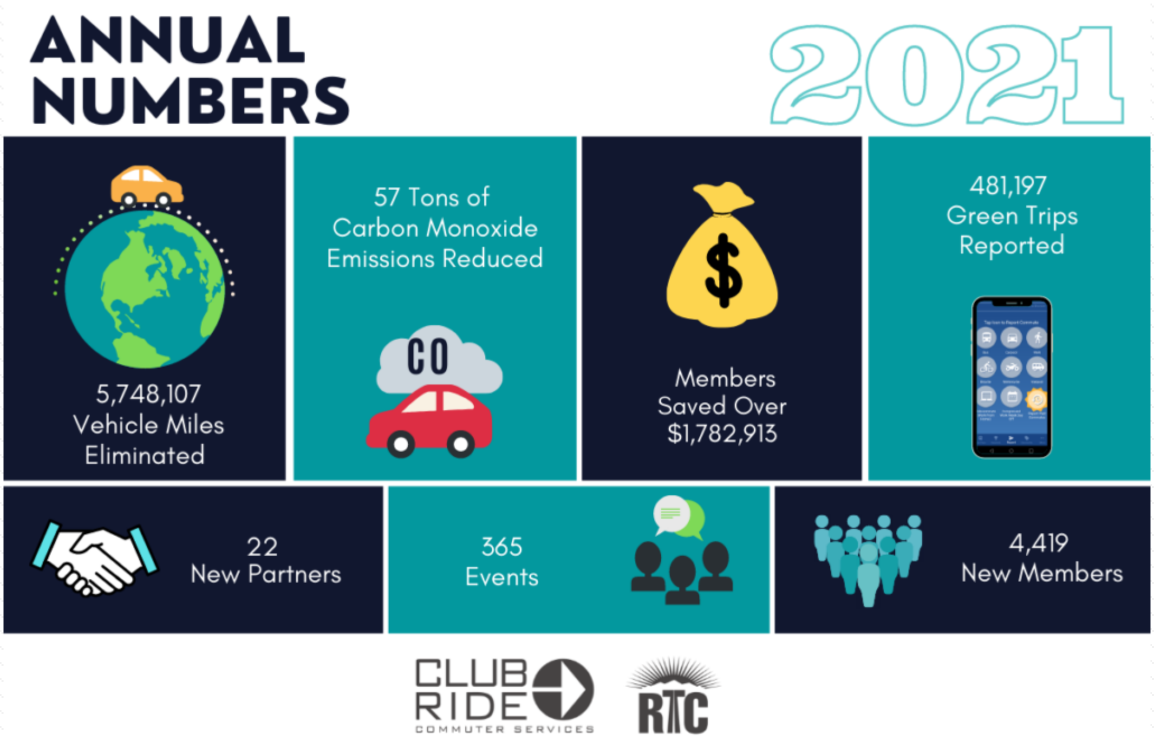


Figure 83: Club Ride's published Numbers from October 1, 2020 to September 30, 2021.

On Aug. 3, 2022, The Association of Commuter Transportation (ACT) honored the RTC's Try Transit program, enabling employers to help new and rehired employees transition back into the workforce following the pandemic by offering free 14-day transit passes. Club Ride worked with nearly 100 employers in Southern Nevada to distribute 30,000 transit passes at no cost to new and returning employees. In addition, ACT honored Club Ride for the Closer to Work campaign, which marketed new transit routes to major employers such as Amazon, Levi Strauss, and The Honest Company, providing their employees with a viable commuting option.

Park and Ride

The RTC also offers parking spaces at three of its four transit bus transfer centers (Centennial Hills, Westcliff and South Strip Transfer Terminal) for commuters to use. Centennial Hills has a significant number of commuters parking there and using vanpools to commute daily to Creech Air Force Base located 30 miles to the northwest. South Strip Transfer Terminal sees the heaviest use of its parking facilities on weekends by people traveling out of nearby Harry Reid International Airport. In addition, The RTC partners with retail locations throughout the valley to offer additional park and ride options that may be closer to residential homes. These retail sites have "donated" a certain number of parking spots within the lot that have been marked with RTC Park & Ride signage.

High Occupancy Vehicle Lanes

HOV lanes are dedicated lanes to be used exclusively by vehicles with two or more people. FHWA's Manual on Universal Traffic Control Devices denotes these preferential lanes with a white diamond. Motorcycles, Emergency vehicles responding to an emergency and public transit may also travel in HOV lanes. Trucks (vehicles with more than two axles) may not travel in HOV lanes.

HOV lanes can reduce peak-period travel time compared to general-purpose lanes and can move substantially more commuters than general-purpose lanes during peak demand periods. HOV lane users experience less congestion, arriving at their destinations more quickly than those who do not carpool. It also costs less to ride a bus or to share a ride than to drive alone every day. Other benefits include a more reliable commute and less stress. The community also benefits. HOV lanes provide a better use of infrastructure and can serve more people than general-purpose lanes.

Initially, HOV lanes were constructed on U.S. 95 from Ann Road to the Spaghetti Bowl. Project NEON converted an existing I-15 express lane to a HOV lane, constructed a new HOV interchange and added a direct connector between I-15 and US 95, In 2018, NDOT reevaluated Southern Nevada's High

Occupancy Vehicle system utilizing RTC's 2040 Regional Travel Demand Model. Based on their application of the model, NDOT proposed the long-term HOV system depicted in Figure 84.

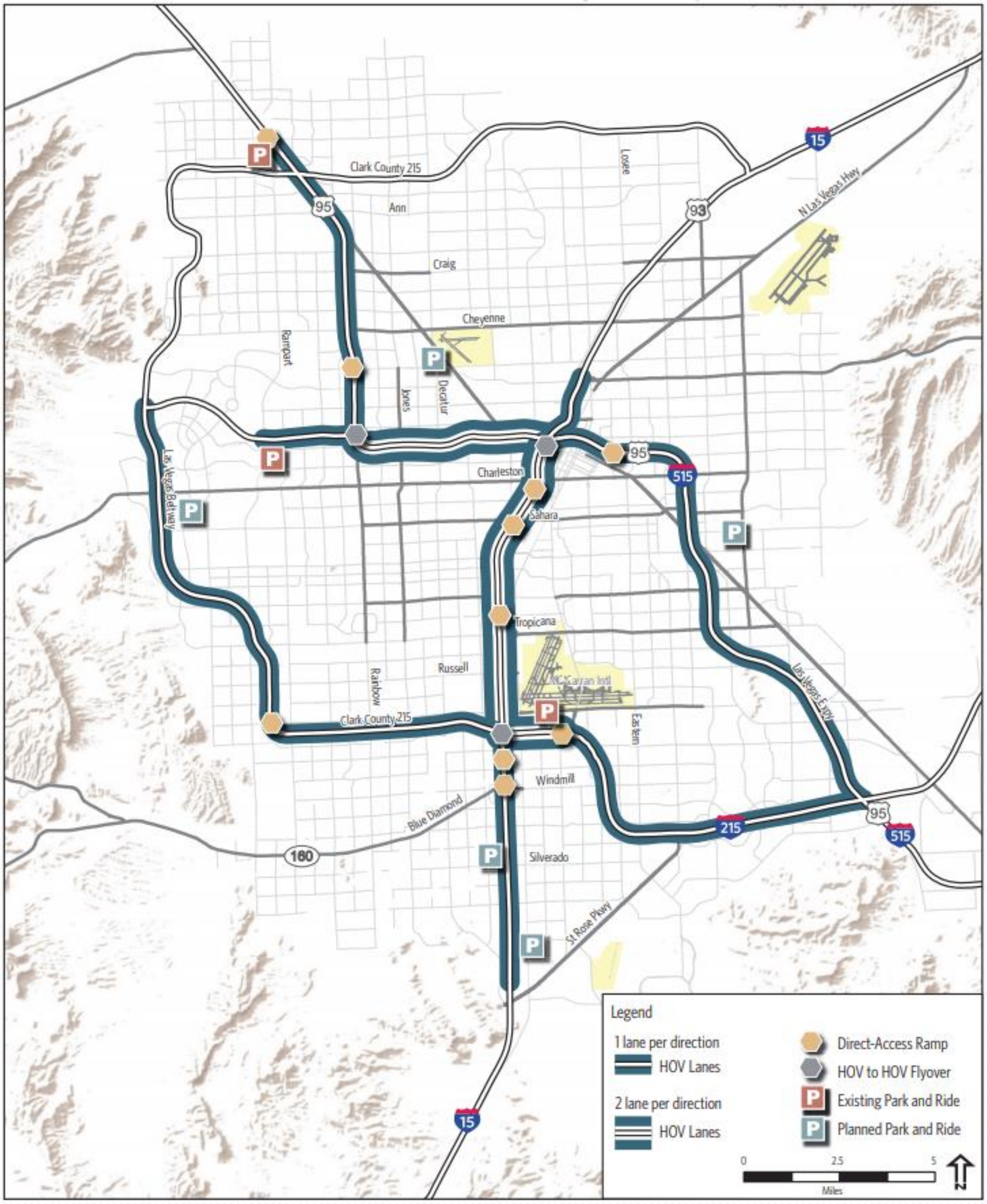


Figure 84: Proposed Long-Term HOV System[XIII]

Transit Oriented Development

Transit-oriented development (TOD) is a development pattern that incorporates a mix of residential and commercial buildings near high capacity transit. In comparison to traditional development patterns, TOD development inherently reduces person trips and vehicle miles traveled. RTC and the City of Las Vegas are the recipients of a $300,000 grant from the FTA to develop a TOD plan for Maryland Parkway. The funds are made available through FTA's Pilot Program for TOD Planning, which assists communities developing new or expanded mass transit systems. The TOD plan will evaluate development opportunities near transit stops along Maryland Parkway from Sahara Avenue through downtown Las Vegas to the Medical District. Figure 85 illustrates many of the activity centers located along the 8.7 mile transit corridor.

Figure 85: Stylized Maryland Parkway Corridor

The RTC is finalizing an environmental assessment so that RTC may begin to pursue federal funding opportunities for Bus Rapid Transit on the busy Maryland Parkway corridor. The new service would debut as early as 2024.

As conceptualized in Figure 86, the BRT will operate similar to a light rail system with a dedicated transit lanes along most of the route but with the lower cost and flexibility of a bus. Separated bike lanes are proposed on each side of the street behind the curb and at the same elevation as the sidewalk, giving bicyclists their own space and providing a buffer for pedestrians. The enhancements would take place on Maryland Parkway between Russell Road and Carson Avenue in downtown Las Vegas, with an extension to the Las Vegas Medical District and UNLV School of Medicine.

Figure 86: Bus Rapid Transit Rendering

Livable Centers

RTC's livable centers pilot program incentivizes local jurisdictions to re-envision neighborhoods as vibrant, walkable communities that offer increased mobility options, encourage healthy lifestyles and provide improved access to jobs and services. This is accomplished through jurisdictionally led Livable Centers Studies. Study recommendations become eligible for inclusion in the RTP.

Southern Nevada Strong provides guidance for the creation of livable centers including the following objectives:

- Develop and expand community-based economic development and reinvestment to support vibrant transit-supported mixed-use districts throughout the region;
- Develop housing and employment in mixed-use transit-oriented neighborhoods near job centers, schools and other services; and
- Integrate future land use planning with existing and future transportation improvements.

Development guided by livable center studies will be more conducive for reducing person trips and vehicle mile traveled than conventional development. The amount of benefit gained and cost avoided by developing livable centers becomes especially significant when aggregated in perpetuity. The Deer Springs Livable Centers Study has been completed in the City of North Las Vegas. Figure 87 defines their study area and envisions an extension to an existing transit line. Plans are in place to complete a livable centers study in Henderson's college area (Figure 88).

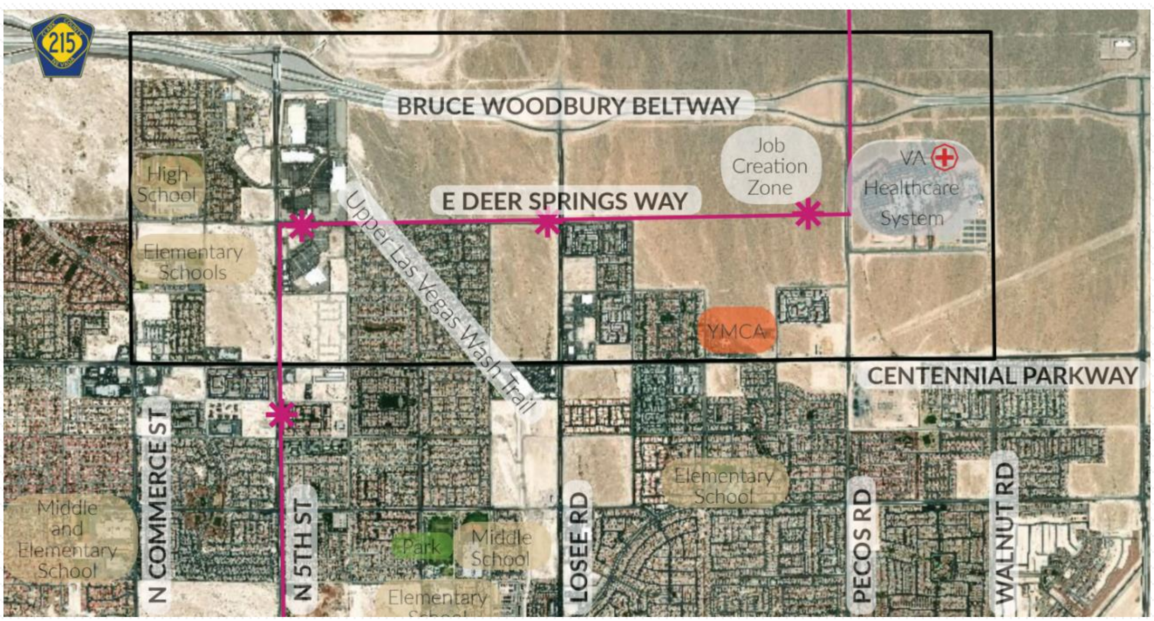


Figure 87: Deer Springs Livable Centers Study Area

Figure 88: Livable Center Study, College Area

TIER 02

Strategies to Shift Vehicle Trips to Other Modes

When deciding which mode of travel to use, a transportation system user makes mental trade-offs. Trade-offs often include trip travel time, trip safety, trip convenience, and trip price. Figure 89 illustrates the consumption of two households with identical income but different car driving preferences.[XIV] Successful tier 2 strategies will shift mode choice preferences by making non-vehicle travel a better substitute for people to use. As alternative modes become a better substitute for getting around users become more indifferent toward using a car. Since congestion is largely a function of the number of cars using a road, this often results in a reduction of congestion.

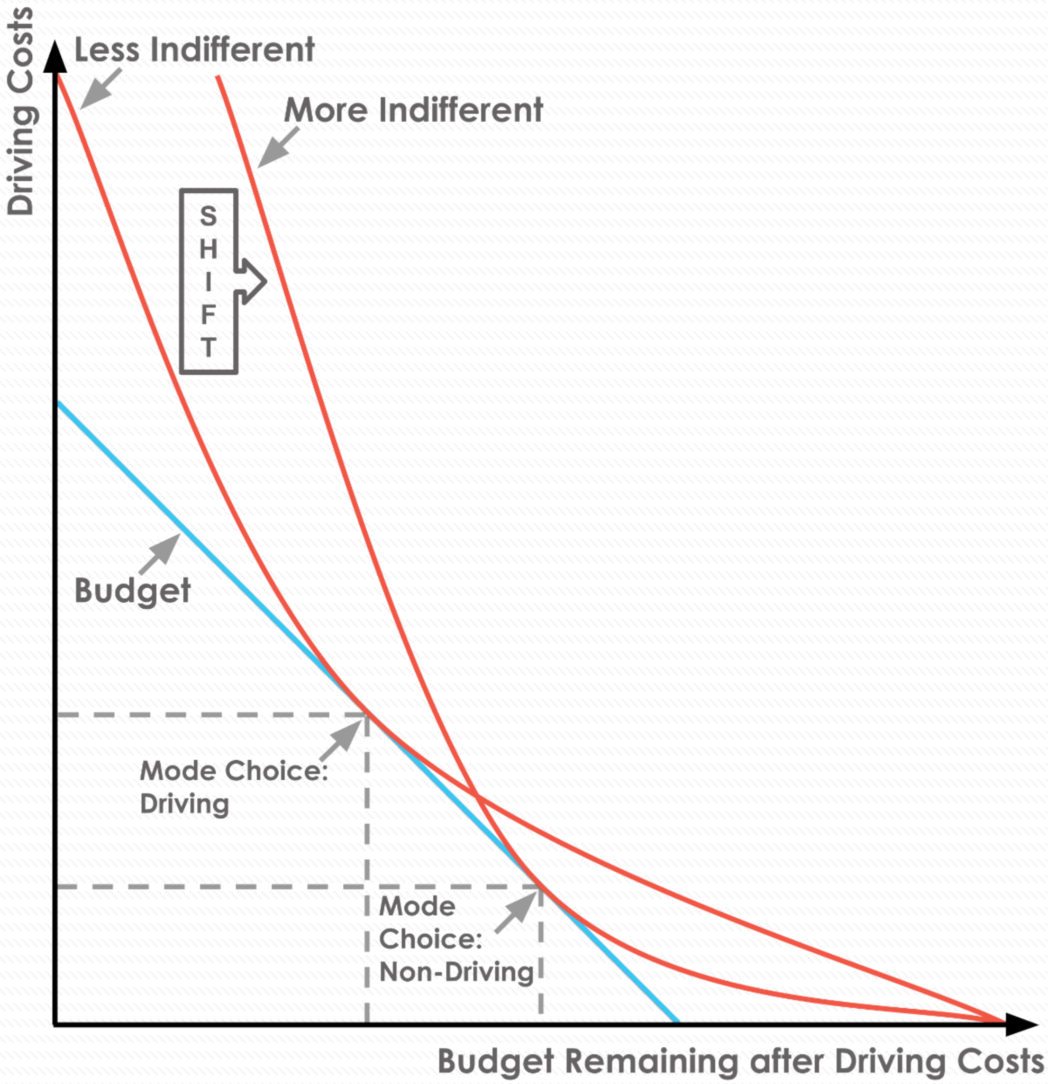


Figure 89: Indifference Curves Showing Blue Budget (time & money) Line

Make Transit Services More Appealing to More People

In 2019, the American Public Transportation Association (APTA) reported that Las Vegans could save approximately $792 per month just by switching from driving to public transit. The strong preference for driving in Southern Nevada suggests that that is a price that people are either willing to or have to pay. The two primary needs that must be met to make progress on this objective are to make transit rides considerably faster also to make the experience of riding transit more enjoyable.

Bus Route Coverage and Frequency

Increasing coverage provides better accessibility to transit to a greater share of the population. Increasing frequency makes transit more attractive to use. RTC's Service Performance & Capacity Standards provide an objective framework evaluating RTC's transit service. Boardings per revenue hour and average peak load are measurements used to evaluate each transit route's efficiency and capacity. Based on these measurements, routes are flagged as under-performing, over-performing, or over-capacity and adjusted appropriately. Regular evaluation of bus routes in this manner is a vital task in ensuring that limited resources are used as effectively and equitably as possible. Figure 90 is a sample of how bus routes are symbolized on the official system map.

Figure 90: Transit System Map Symbology

Express Bus Routes

Length of trip time has an effect in determining mode choice for individuals electing between driving and using transit. The RTC has established several express routes as overlays to the existing conventional route network. Express routes differentiate themselves from conventional routes in that they typically travel on higher speed roadways and make fewer stops. A key for reducing express bus trip times is routing them in corridors where they can operate in relatively uncongested right of way. To that end dedicated bus lanes are located on the roadway shoulder in each direction of West Sahara Avenue and also in the median of Grand Central Parkway and Casino Center Boulevard. RTC buses also make use of HOV lanes.

Private-Public Partnerships to Incentivize Express Bus Use

Similar in some ways to the Club Ride program, the Sahara Express route initiative highlighted the ease and convenience of transit by offering incentives to people who live and work along Sahara Avenue to try the service. Over ten businesses from hair salons and barbershops to restaurants, supermarkets and brewpubs teamed up with the RTC to offer "exclusive" deals for Sahara Express riders. Riders simply present their bus pass to the participating businesses to receive deals and discounts. The Sahara Express frequent service covers about 14.5 miles of the east-west route, which includes Downtown Summerlin to Lamb Boulevard.

Special Event Service

The RTC provides dedicated transit service to all of the Las Vegas Raiders, Vegas Golden Knights and UNLV Football home games played at Allegiant Stadium and T-Mobile Arena. This service known as the Game Day Express has proven to be fairly popular. The service's first departure is up to three hours before game time with additional departures every thirty minutes. The Game Day Express also provided service during the NFL Draft when it was hosted in Southern Nevada.

In 2022, Game Day Express service expanded to six locations to better meet demand. The service launches with the Raiders first preseason home game in August and ends in the spring of following year with the conclusion of the Golden Knights season.

The cost of the Game Day service is $2 per person each way with exact change. To expedite boarding, riders are advised to purchase their passes in advance on the rideRTC app.

Clean Energy Vehicles

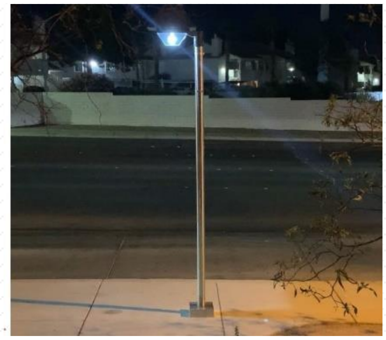
Operating a clean energy fleet makes transit a very attractive alternative for road users looking to reduce harmful pollution in their community. Since 2007, the RTC has been transitioning its fleet to a more environmentally friendly fuel called Compressed Natural Gas (CNG). As of 2020, the agency had 314 CNG buses, which made up 78% of its fixed route bus fleet with a goal of a near 100% CNG fleet by 2023. In addition, a $3.8 million grant from the U.S. Department of Transportation's (DOT) Low or No Emission Grant Program will allow the agency to deploy two hydrogen fuel cell buses and install accompanying hydrogen-fueling infrastructure.

Transit Safety

Bus Stop Safety

From roughly 2008 to 2020, the RTC has spent more than $22 million to improve rider and pedestrian safety at bus shelters and stops. The money was used to push back shelters five feet from the curb and to purchase new shelters. The RTC has now pushed back all the bus stops it could with the available right-of-way it owned or had access to. The RTC continues to work with private property owners to acquire the necessary right-of-way to push back more stops. In addition, the RTC is planning to install at least 200 additional slim line shelters at stops that currently don't have any amenities.

Beginning in 2019, the RTC started a pilot program to place bollards in front of 20 residential bus shelters. The bollards are designed to withstand an impact of a 15,000 pound vehicle traveling 50 mph. They meet the highest penetration rating for perimeter barriers subjected to vehicle impact.



Transit users want to feel safer at bus stops, especially at night. In 2020, RTC leveraged $4 million in federal grant funding for a year-long project to add and upgrade lighting at nearly 1,100 transit bus shelters across the valley (Figure 91), as well as adding 300 freestanding solar lights at stops that currently do not have a shelter. This enables drivers, as well as transit operators to better see riders waiting at the stop as they approach it but also provide back lighting to the shelters so riders can see behind the stop at night.

Figure 91: Transit Shelter with Upgraded Lighting

Communicable Disease Prevention

The FTA awarded $500,000 in funding to the RTC through the COVID-19 Research Demonstration Grant Program. The RTC used the amount to procure and install new Europay, MasterCard, and Visa (EMV) certified electronic validators on its more than 400 fixed-route buses. The new EMV-certified validators will allow the RTC to grow its contactless payment options to improve health measures, reduce passenger-loading times and increase overall operational efficiency.

Transfers

Historically, transit administration and operations estimates suggest that 60 percent of all RTC bus commuters utilize less than 10 percent of bus stops in the system. These heavily used bus stops are typically in areas where there are very busy trip destinations or transfer destinations. If transfers are necessary between bus lines, it often requires that bicyclists and pedestrians disembark on foot and cross over street intersections that are busy and congested. Thus attention needs to be given not only to improving the aesthetic quality of bus stops but also the convenience and safety of their adjacent sidewalks and crosswalk facilities.

The Bonneville Transit Terminal located in Downtown Las Vegas provides a safe opportunity to transfer between many routes. Diagramed in Figure 92, the facility features 16 on-site vehicle bays, approximately 100 double-stacked bike racks, and a self-service bike repair station. In addition, the Bonneville Transit facility houses the RTC Bike Center which offers free bike parking for up to 84 bikes at a time. The bike center offers a premium membership which provides unlimited bike repairs that fall under the scope of an average tune-up and use of the facility's shower and locker amenities.

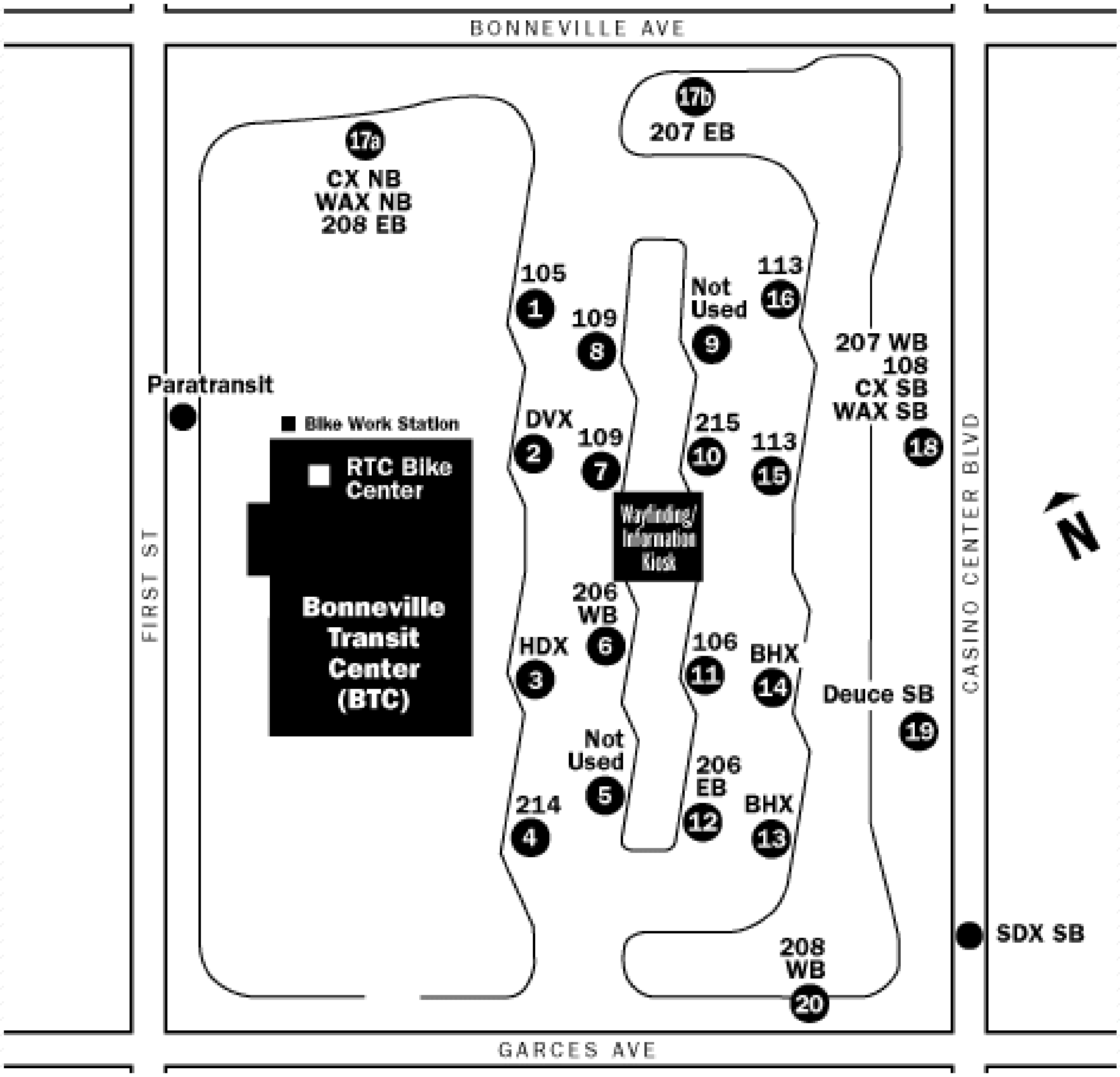


Figure 92: Bonneville Transit Center Diagram

Safety

One way RTC is trying to making transfers safer is by partnering with the Southern Nevada Pedestrian Education Task Force lead by UNLV's Transportation Research Center to promote the Dusk 2 Dawn Campaign. Figure 93 depicts some campaign materials emphasizing the peril to pedestrians overnight. As part of the campaign, drivers are reminded to slow down, be sober, and be aware of pedestrians, but the campaign also advocates that pedestrians should also take practical precautions. Of course there are limitations to what a pedestrian can do to increase their safety. As noted on the campaign website, 10 of the 78 pedestrian fatalities in 2017 *occurred on the sidewalk.*

Figure 93: Dusk 2 Dawn Campaign Material

Heat

RTC makes additional efforts to accommodate transit user safety specific to Southern Nevada. RTC's annual Summer Heat Campaign (see Figure 94) is made possible by forming partnerships with local businesses and organizations. Donated water and sunscreen, as well as Lyft discounts, help riders stay cool and protected at or on their way to transit centers and busy bus stops. Transit Ambassadors along Las Vegas Boulevard, when available, answer questions for transit riders who may be new or otherwise have a question about transit.

Figure 94: Sample Promotional Material from Annual Summer Heat Awareness Campaign

As seen in Figure 95, shade provided by transit facilities and landscaping can reduce surface temperatures by 50 or more degrees Fahrenheit. In Southern Nevada, shade is extra effective at cooling down transit users as the humidity condition makes the heat index lower than the actual air temperature (i.e. in the shade). With low humidity conditions, according to RTC calculations performed using the Rothfusz Heat Index Equation, a 110 degree day in Southern Nevada can have the same effect on a shaded and well hydrated human body as a roughly 100 degree day. Without shade, this heat index advantage is completely negated and exacerbated as the direct sunlight, rather than just the air, further warms the transit user's clothes and skin.

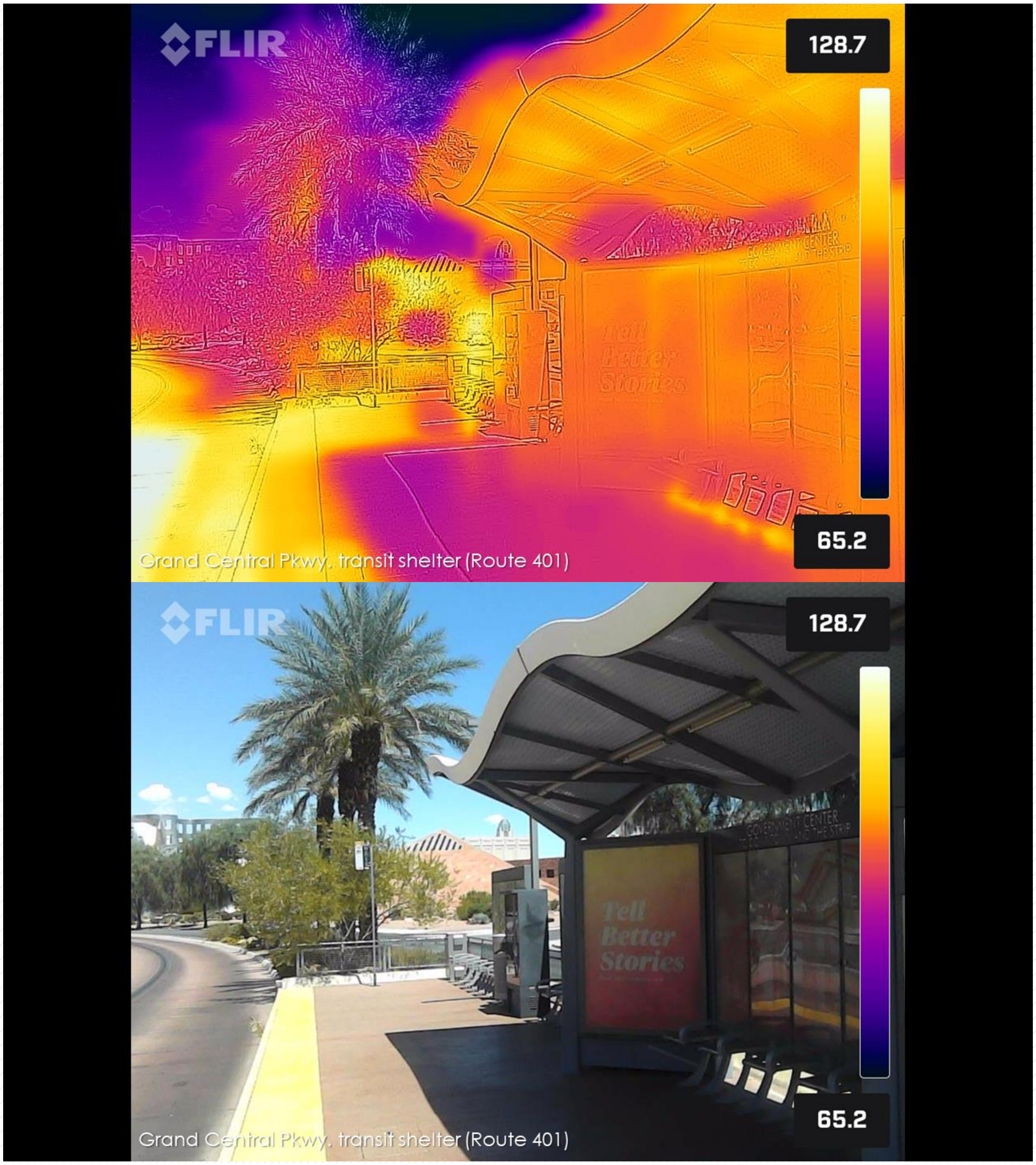


Figure 95: Transit Stop Photo Taken by a Thermal Imaging Infrared Camera

During the summer of 2022, a survey of around 1,000 fixed-route transit riders was carried out by the RTC so as to learn more about how heat impacts the public transit experience (including first- and last-mile transfers). The survey also provides insights into what measures riders would most like see implemented that could provide respite from summer heat (Figure 96). The public input received from the survey will inform future transportation studies, funding opportunities, and measures the RTC and its regional partners could take to improve the comfort and safety of its riders.

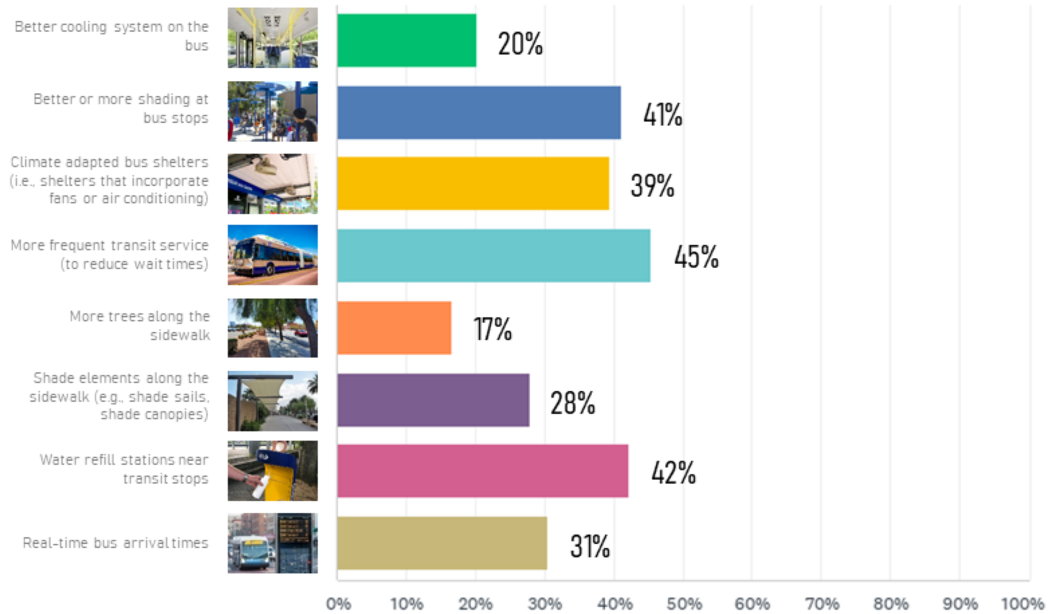


Figure 96: "Which of the following measures would you like to see most to help provide relief during the summer while toking RTC public Transit?"

Smartphone Friendly Transit

More than 70 percent of RTC transit customers use smartphones which have access to internet directly over their cellular network or via complementary WIFI provided inside RTC buses, transit centers, and park and rides. Since launching in 2016, the Masabi developed rideRTC app has been downloaded over 360,000 times, and customers have purchased more than 1.8 million passes on the app. The app allows users to easily buy and use contactless transit passes from their smartphone. Improving the quality and all-inclusiveness of the app is an important strategy for attracting more transit users. In pursuit of this objective, RTC has added a feature by which transit users can pay for transit passes on the app with cash at nearly 350 vendors signed onto the InComm Payments' VanillaDirect cash-in payment platform.

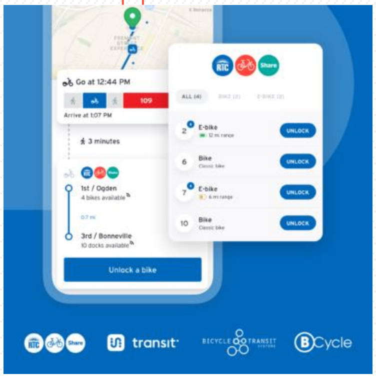
Transit Watch App

The Transit Watch app developed by The Brass Star Group enables passengers to report non-emergency incidents such as transit-related offenses, suspicious activity and safety issues. Reports from the app go directly to the RTC security's contractor dispatch center, which reviews the submissions and directs them to the appropriate agency, such as the Las Vegas Metropolitan Police Department. This service allows those with concerns about using transit to have confidence that it will be a safe and comfortable experience. In its first year of the app's release in December 2018, there were more than 4,900 downloads.

RTC Transit Watch

In support of transit security efforts, the RTC was selected for a $7.475 million Bus and Bus Facilities grant from the U.S. Department of Transportation. The funding was awarded for the installation of livestreaming security cameras on both the fixed-route and paratransit fleet.

Transit App



RTC partnered with Transit in 2016 for the trip planning portion of the rideRTC app. The app also provides real time information on bus location and projected arrival times. In 2018, Transit expanded its functionality by debuting a feature that makes it easier for users to make informed transportation decisions based on flexibility and cost. Using the app's interface in Figure 97, Transit users can plan, book, and pay for a ride from either Uber or Lyft, while getting real-time updates on their RTC connection—all in one app. This feature reduces waiting times and allows customers to compare options for connecting to transit. The app promotes ride hail as a vital first and last mile link which reduces congestion and makes it feasible to get around without your own car. Transit's multimodal trip planner also suggests trips that combine transit with options to take short trips. For example, transit account holders can buy bike share passes and unlock a bike with just a few taps to enhance their transit needs.

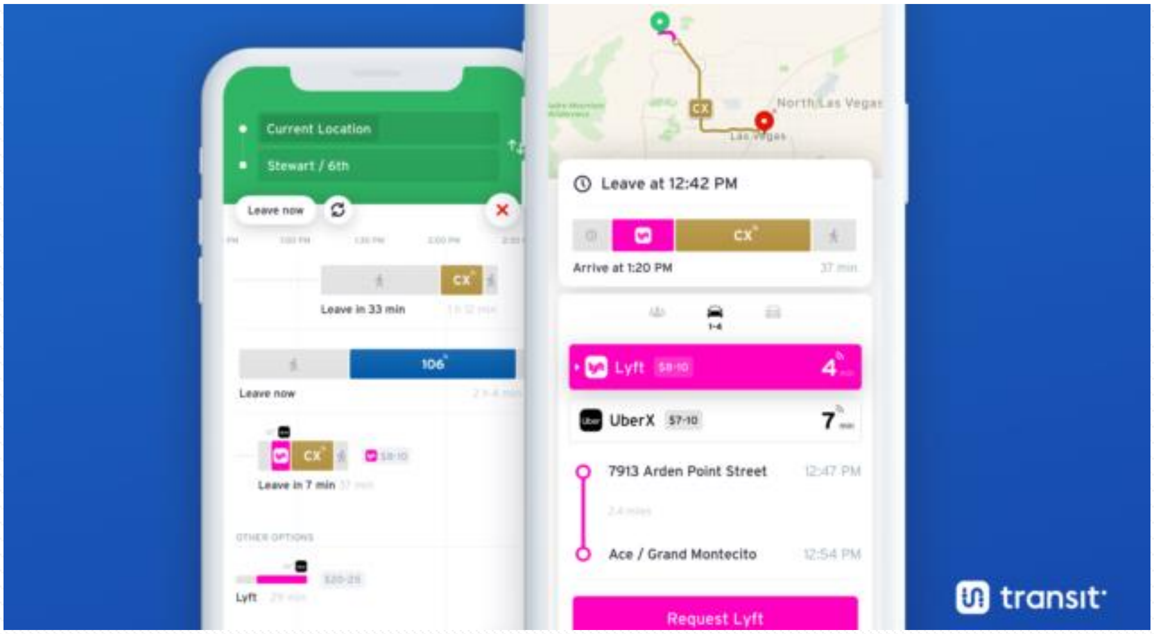


Figure 97: Transit App User Interface with Uber, Lyft, and RTC Bike Share Options

Lyft App

Since late 2020, the transportation network company Lyft has partnered with the Regional Transportation Commission of Southern Nevada (RTC) to add local public transit information in-app. This new feature allows riders to compare more of their transportation options within the Southern Nevada area in one seamless experience.

The updated app puts mobility options front and center, and makes it easier for riders to make informed decisions about how to get from point A to point B quickly, affordably, and sustainably. The Transit feature allows riders to see upcoming departures nearby for RTC transit routes. Riders can easily see transit lines and approaching vehicles on the map or they can easily enter a destination for a complete itinerary from start to finish.

For nearby destinations, Lyft shows walking directions alongside transit and rideshare options. With this partnership, Las Vegas joined 15 other cities across North America who have Lyft's Transit feature available.

Uber App

Since early 2020, RTC passes have been available for purchase on the Uber (a transportation network company) App. Las Vegas was the second city in the world to offer transit riders the opportunity to use journey planning and purchase passes through the Uber App. This collaboration makes commuting via transit and rideshare services more cost-effective and time-efficient. Figure 98, is photograph of a promotional bus used to raise awareness of the partnership.

Figure 98: RTC/Uber Partnership Promotional Bus

Libby App

Since the fall of 2021, RTC has had a partnership with the Las Vegas-Clark County Library District. As a result, transit riders in the Las Vegas metropolitan area can access free movies, eBooks, audiobooks and magazines by downloading the Libby app. Riders access the Libby app with RTC Wi-Fi or scan the QR code inside each bus. While here, Las Vegas visitors may also enjoy temporary access via a seven-day pass to the Library District’s Libby app. Users can download titles for offline use and all items are automatically returned at the end of the lending period, which guarantees no late fines. This offer of free entertainment can make transit more appealing than other modes.

RTC Bike Share App

The official RTC Bike Share app allows users to find nearby stations and bikes, purchase passes, and contact customer support with a few taps on their phone. As an improvement over its processor, the BCycle app, the RTC Bike share app provides additional security and fraud protection during bicycle check out. This is an important step toward reducing bike share system theft costing the program $80,000-$100,000 annually. By limiting bike share theft, less money would go to replacing stolen bikes which can then be invested toward bike share expansion.

Once the RTC Bike Share App is fully adopted, those that are already using the BCycle app will still be able to, but no new users will be able to register an account on that platform.

Make Active Transportation More Appealing to More People

There are many challenges faced by pedestrians attempting to navigate roadways, cross at intersections, or access the transit system in the Las Vegas Valley. To test out possible solutions, RTC has recently lead temporary low-cost demonstration (i.e. tactical urbanism) projects that increase pedestrian comfort to better understand their potential success. Permanently applying street treatments, like that depicted in Figure 99, would increase bicyclist and pedestrian comfort and safety which would encourage people to choose active modes of transportation.

Figure 99: Temporary Sidewalk Extension at Cambridge St. and Katie Ave.

Complete Streets

Since 2012, RTC has had a complete streets policy. Complete Streets are roadways designed to safely and comfortably accommodate all users, regardless of age, ability or mode of transportation. A Complete Street roadway typically includes sidewalks and sidewalk amenities, transit shelters and amenities whenever there is a route along the corridor, and provisions for bicycle facilities where appropriate. These welcoming elements attract a greater diversity of modes to the facility.

The policy will allow the implementing entities to incorporate the subsequently adopted “Complete Streets Design Guidelines for Livable Communities” into all phases of development and redevelopment whenever possible. The following five areas are identified as strategic points of public agency intervention:

- Long-Range Community Visioning and Goal Setting
- Local Agency Plans
- Policies and Standards
- Coordination with Private Development
- Investment in Public Streets

Complete Street Developments

More recently, Clark County expanded its commitment to Complete Streets by passing the Safer Sidewalk Ordinance that would require roadways that are 60 feet or wider to have detached sidewalks. Detached sidewalks provide a landscaped buffer between roadways and walking paths to provide a much-needed separation for walkability in neighborhoods, as well as offer an added aesthetic benefit.

Figure 100 contains images of one of Clark County's major street improvements along Fort Apache Road, between Alexander Road and CC-215. These upgrades boasted major improvements for pedestrian safety such as adding bike lanes, bike buffers, which provide additional space between drivers and bicyclists, landscaped median islands and detached sidewalks.

Figure 100: Complete Street Elements on Fort Apache Road in Clark County

Another example in the region is the City of Henderson's recently upgraded Greenway Road between Horizon Ridge Parkway and College Drive (see Figure 101). The project improvements included re-paving Greenway, as well as adding roundabouts at Heather Drive, Mission Drive and Paradise Hills Drive. Additional upgrades included the addition of ramps, detached sidewalks, upgraded LED streetlights, and added ADA improvements. As seen in Figure 102, The City of Las Vegas has also provided detached sidewalks along Alta Drive. Of course, not all implemented complete street improvements are included in this report, but periodic updates on complete street projects can be found on RTC's blog.

Figure 101: Complete Street Elements on Greenway Road in City of Henderson

Figure 102: Complete Street Elements on Alta Drive in City of Las Vegas

Bike Share

Since 2016, RTC Bike Share has provided an easy way for residents and tourists to ride to and from the many attractions, restaurants, bars and shops that the City of Las Vegas downtown area has to offer. Bike share users can also easily connect to numerous RTC transit lines through the Bonneville Transit Center. There are 21 stations (see Figure 103) and more than 200 bikes currently in service. Since its launch, more than 76,000 passes have been sold, and over 176,000 trips have been taken. Providing an option for electric bicycles has increased its appeal to more users as evidence by the fact that they are rented 2.5 times more often.

RTC is planning to expand the RTC Bike Share service area by adding one to three new stations in downtown Las Vegas. This is following the opening of its first station west of the I-15 as seen in Figure 104. Before making any decisions on the new stations, the RTC will seek local input on the desired locations based on four available spaces. The proposed stations include:

- Alta Drive, between Shadow Lane and Martin Luther King Boulevard
- East Fremont Street, between Bruce Street and North 21st Street
- Martin Luther King Boulevard, near Pinto Lane
- South 13th Street, near East Clark Avenue and The Center

One station will be partially funded by a Southern Nevada Health District grant. The remaining stations will be contingent upon approval of additional funding.

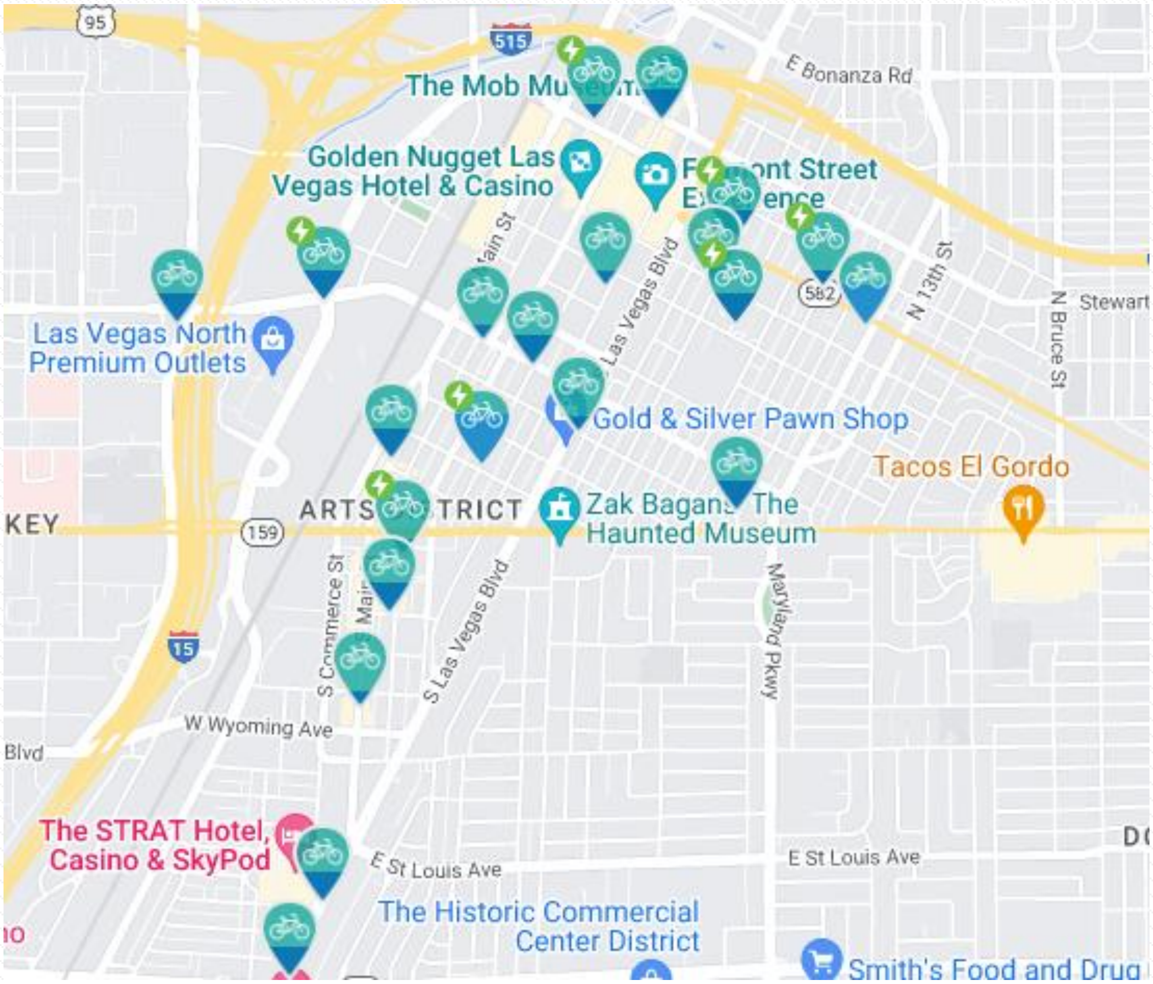


Figure 103: RTC Bike Station Map as of September 7th, 2022

Figure 104: Summer of 2022 RTC Bike Share Station Launch Event at Martin Luther King Jr. and Alta.

Bike and Pedestrian Facility Inventory

The RTC in partnership with Mandli Communications, Inc. developed a regional GIS dataset, webpage, and online interactive map of existing bicycle and pedestrian facilities for use in regional roadway and trail planning. In order to collect this dataset, Mandli drove most collectors and arterials in urbanized Southern Nevada using a specially outfitted remote sensing vehicle. The result of this collection is a very detailed point cloud of the built environment along the collection corridors (See Figure 105).

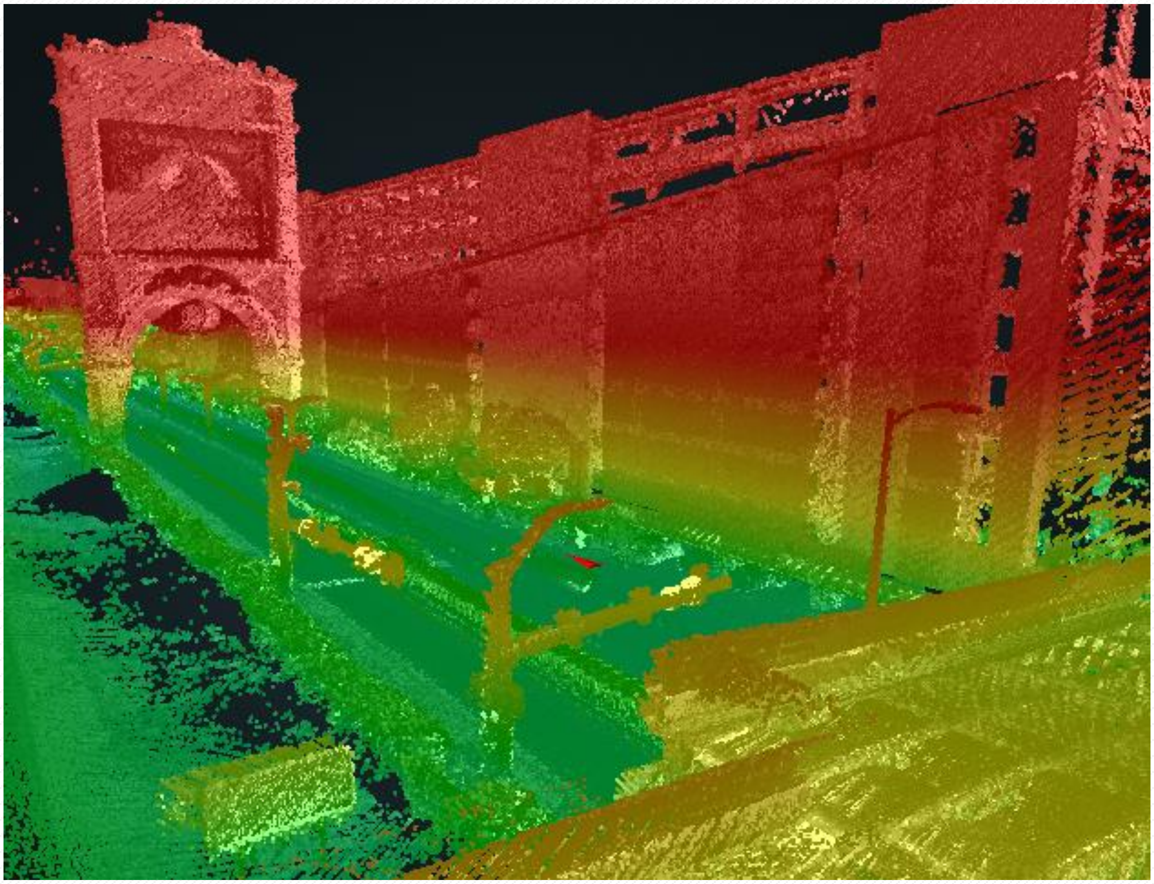


Figure 105: Lidar Point Cloud Collected on Frank Sinatra Drive

Point clouds can be processed with software to extract features of interest. In this case, it was used to identify bicycle and pedestrian facilities. The data is also detailed enough to answer not only where facilities are but what is the state of their repair. For example the data makes it possible to evaluate ADA infrastructure deficiencies (e.g. overly steep ramps or excessive sidewalk lippage). This dataset provides RTC and its partners with an unprecedented understanding of the state of the bicycle and pedestrian network in Southern Nevada. This will help the RTC plan and advocate for infrastructure improvements that improve safety, fill gaps in the network, and increase the level of comfort experienced by active transportation users.

TIER 03 Strategies to Improve Roadway Operations

Tier 3 strategies focus on getting more out of what we have rather than building new infrastructure. Many of these operations-based strategies are supported by the use of Intelligent Transportation Systems (ITS).

The Freeways and Arterials System of Transportation (FAST) has an extensive amount of ITS equipment and technology deployed in the field along regional freeway corridors and at many signalized intersections. These systems have many components, including vehicle sensors, electronic variable message board signs, streaming video cameras, controls, and communication technologies. ITS strategies are sets of components working together to provide information and allow greater control and operation.

Traffic Incident Management

Traffic Incident Management (TIM) in Nevada is a partnership between the Department of Public Safety, NDOT, fire, EMS, police, environmental agencies, the towing and recovery industry, and the media. These partners have formed multi-disciplinary TIM coalitions to facilitate the planned and coordinated process to detect, respond, and clear traffic incidents so traffic flow may be restored as safely and as quickly as possible.

The Southern Nevada TIM Coalition was the first in Nevada and formed in January, 2008. The Southern TIM Coalition now includes hundreds of trained responders from a variety of agencies and disciplines in the region who meet bimonthly to implement safe, quick clearance policies that support coordinated and cohesive management of traffic during a crash. In 2009, the coalition executed an Open Roads Agreement which formalized a commitment to re-open roadway as soon as possible following a crash or traffic incident.

Vehicular crash statistics can be utilized to identify corridors or intersections with a high frequency of crashes that cause non-recurring congestion. Safety improvements at these locations can reduce not only harm to individuals, but also congestion. The Nevada Strategic Highway Safety Plan outlines numerous safety improvement actions for a variety of circumstances.

Additionally, it is important to monitor the cumulative time it takes to clear vehicles and debris from a crash scene to allow traffic to flow again. Southern Nevada FAST has established agreements with emergency services and towing companies regarding time benchmarks for crash clearance on the regional freeway system.

Response

FAST works closely with the NDOT Freeway Service Patrol by alerting them to incidences of disabled vehicles observed through the monitoring system. The Freeway Service Patrol provides free assistance during incidents to improve safety and reduce delay. When the Patrol responds to non-emergency incidents, these incidents are cleared more quickly as a result of their assistance. The deployment of the Freeway Service Patrol to non-emergency situations allows for emergency responders to be available for actual emergencies, rather than disabled vehicles.

I addition, FAST uses a software platform from Rekor, the leading provider of Artificial Intelligence (AI)-driven mobility solutions for smart cities. Rekor's unique ability to report in real time the location of crashes by analyzing data from a variety of sources – including in-vehicle navigation devices, traffic detectors, Waze, INRIX and other telematics providers – enables faster validation and response to roadway incidents. Here in Southern Nevada, that equates to up to 12 minutes faster on average. This means faster treatment for those injured in crashes, the quicker clearance of incidents, and swifter restoration of normal traffic flow. As an additional benefit, these improvements reduce the chance of secondary accidents and prevent millions of dollars in commerce-related delays.

Prevention

Rekor can also be leveraged to prevent traffic incidents from happening in the first place. A program to use this functionality on US-95 and I-15 began in late 2019 and lasted through the end of 2020. Here's how it worked:

- Rekor used AI-based insights to identify critical areas on Las Vegas interstates that were at a higher risk of crashes. They focused crash prevention activities on three key corridors of I-15 Northbound, I-15 Southbound, and US-95 Southbound.
- Using this information, Nevada Highway Patrol (NHP) and NDOT coordinated to build raised platforms (i.e. strategic traffic management sites (STMS)) where NHP troopers could be safely positioned while remaining highly visible to oncoming traffic. The goal of NHP's presence was to heighten driver vigilance and encourage speeding drivers to slow down.
- RTC, in tandem, coordinated using dynamic messaging signs (DMS) to alert the public of police presence ahead.

The intended effect of these coordinated actions is to reduce abrupt driving behavior and varied/high speeds which in turn prevents crashes.

The goal of the program was to reduce crashes across selected high-risk corridors by 5%. The preventative activities ended up being so effective that it reduce crashes by more than three times the original goal at 18%. This reduction in traffic incidents is partially attributable to a 43% decline in the number of drivers going over the speed limit. The economic savings were equally as significant. An original investment of $188,970 turned into over $3,000,000 in savings due to crashes prevented. Figure 106 summarizes the methodology Rekor followed to estimate cost-savings and return on initial investment using crash data provided by NHP and USDOT's "Benefit-Cost Analysis Guidance for Discretionary Grant Programs."

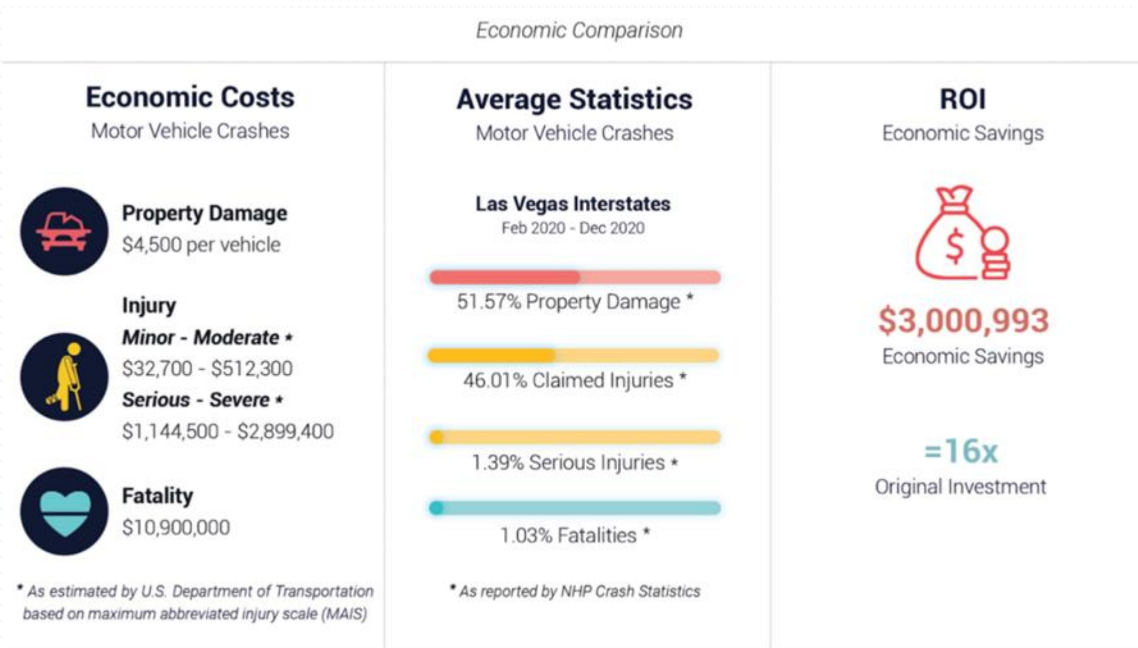
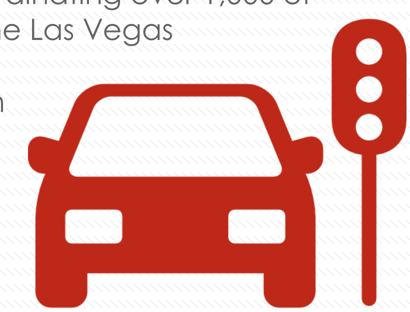


Figure 106: Benefit-Cost Analysis of Traffic Incident Prevention Strategy

This ongoing effort was recognized at the Oct. 18th, 2021 Nevada Traffic Safety Summit when the RTC was awarded the "Nevada Traffic Safety Project of The Year" award. This award, sponsored by NDOT and the Nevada Department of Public Safety (DPS), recognizes individuals and organizations that have made an outstanding effort to eliminate serious injury and fatal crashes on Nevada roadways.

Traffic Signal Timing

FAST has responsibility for programming and coordinating over 1,000 of the approximately 1,200 signalized intersections in the Las Vegas Valley. Using a connection from a remote server to traffic signal controllers, data log enumerations (with 1/10th second resolution time-stamps) are retrieved and stored on a web server at the FAST Traffic Operations Center about every 15 minutes. FAST's extensive fiber optic network carries the roughly 11.4 megabytes of data generated by each signal every day. Software customized by FAST allows RTC staff to graph and display the data and provide the results on the FAST Signal



Performance Metric website. This service is offered to the local entities for application to their traffic signal infrastructure.

Since this system's implementation, traffic signal timing has been managed to reduce fuel consumption, incidence of traffic collisions, travel time, unnecessary stops and vehicular emissions.

The Southern Nevada FAST center already has many arterial corridors linked to their control center by fiber optic line to allow for oversight and adjustment of signalized intersections. Signals can be set to run on different pre-timed plans or to run based on actuation from specific events, such as the arrival of a vehicle, a transit bus, a pedestrian or an emergency vehicle. The phasing plans can be optimized for ongoing conditions.

Signal Connections

Figure 107 is the result of a RTC funded project whose goal was to develop a time-phased implementation plan to expand Arterial Management System (AMS) network connectivity via fiber optic communications to all traffic signal systems operated and maintained by the City of Las Vegas (City). As infrastructure complexity and data volume expands, communication via fiber optic is necessary due to data limitations of copper interconnect cable and wireless radio communications. By knowing the current extent of their fiber optic network and the connection status of each traffic signal, the city of Las Vegas can begin programming projects to complete their traffic signal communication system. Across the metropolitan area, this type of effort is ongoing.

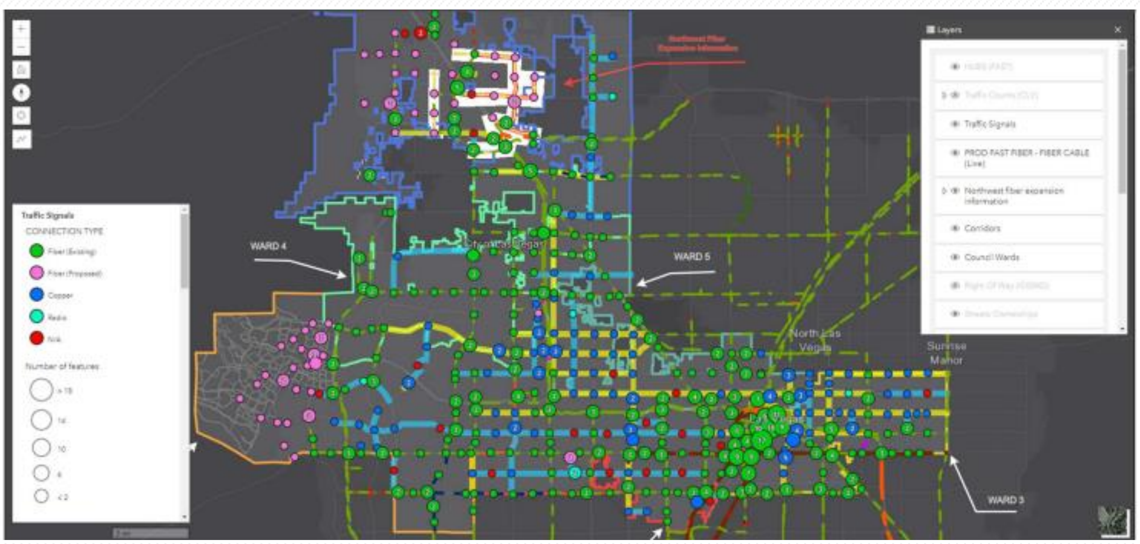


Figure 107: Traffic Signal Communication System Gap Analysis in City of Las Vegas

Adaptive Signal Timing

Using various signal timing metrics, FAST is able to occasionally improve signal timing. However, an emerging technology known as adaptive signal timing could improve signal timing as frequently as needed. A pilot project from January 15th, 2021 to May 1st, 2021 implemented Rhythm Engineering adaptive signal timing on a portion of Eastern Avenue which leverages artificial intelligence technology. Figure 108 contains the before and after traffic flow on Eastern Avenue between Pebble Road and Summit Grove Drive. The pilot seemed a success as travel times reduced by around 25%, and stops reduced by 50% in both directions.

Period	Speed (mph)	Travel Time(s)	Stop%	Stop Time(s)	Travel Time Index (TTI)
Before	22.5	517	27.4%	165	2.1
After	29.1	392	15.8%	88	1.59
Difference %	29.0%	-24.2%	-42.2%	-46.8%	-24.2%

Figure 108: Adaptive Signal Timing Work on Eastern Ave from Pebble Road to Summit Grove Drive, 2019 vs. 2022

Traffic Signal Performance Monitoring

Another challenge of signal timing, is knowing what signals need adjusting. As another pilot project, RTC experimented with monitoring 65 intersections comprising 686 left turn, thru, and right turn movements. The average control delay per vehicle is calculated at every one of these intersections. This number is used to determine each intersection's level of service (LOS) which describes operational conditions within a traffic stream. See Figure 109, for the signals monitored and their LOS on April 29th, 2022. At level of service D cars may occasionally wait through more than one signal cycle before proceeding. At level of service F the intersection is congested as queues fail to clear. Figure 110, shows the distribution of traffic signals at each level of service on a single Friday. Knowing the average LOS and the LOS of each turning moment can be helpful for prioritizing improvements at signals causing the most congestion.

Figure 109: Avg. Control Delay per Vehicle Level of Service (LOS), April 29th, 2022

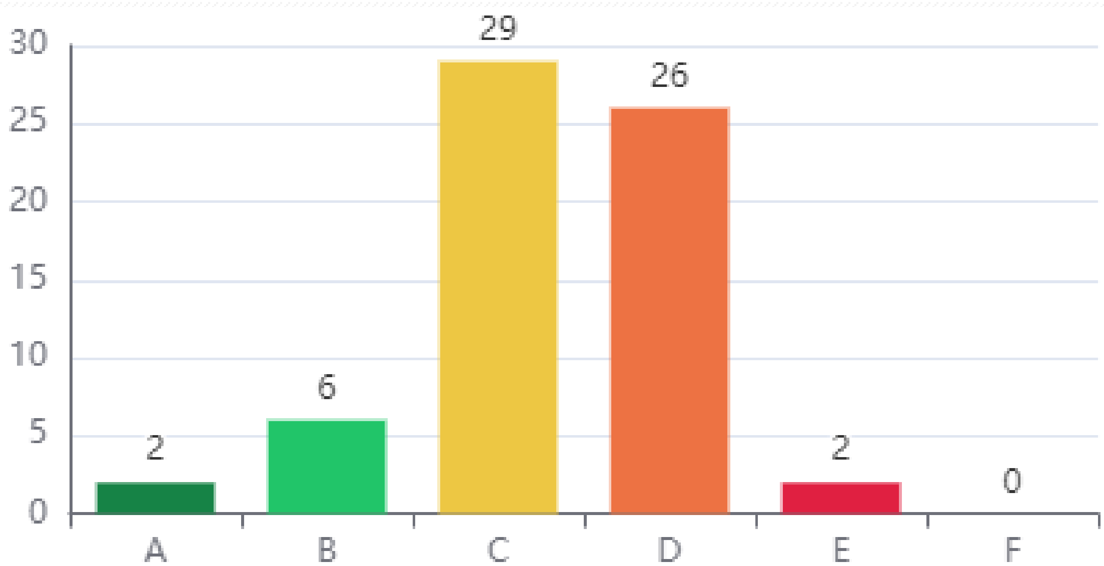


Figure 110: Intersection Counts By Level of Service (LOS), April 29th, 2022

Advanced Traveler Information Systems

Nevadans and surface transportation users across the country sardonically refer to the traffic cone as the official state flower. The frustration encapsulated in this quip stems from not being forewarned of its existence or not knowing why a construction zone is in place. The RTC is committed to using technology to assist commuters impacted by construction zones and other sources of non-recurring congestion. As a result, Southern Nevada drivers have many tools at their disposal to help them plan a safe commute.

An Advanced Traveler Information System (ATIS) is any system that acquires, analyzes, and presents information to assist freeway travelers in moving from an origin to their desired destination. Relevant information may include locations of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions.

Before Driving

Since 2015, the goal of RTC's Seeing Orange campaign is to provide residents with information about the various construction projects occurring throughout the valley. Via the SeeingOrangeNV.com website, users can access a project map, leave comments and receive replies directly from RTC's Traffic management Center.

Travelers can also subscribe to freeway traffic alerts which offer up to the minute information regarding I-15, 215, and US-95 traffic incident reports. Within seconds, subscribers receive messages on their cell phones via email or text messaging. As shown in Figures 111 and 112, RTC will also push out travel forecasts ahead of scheduled busy travel weeks.

Figure 111: 2022 Memorial Day Week Travel Forecast

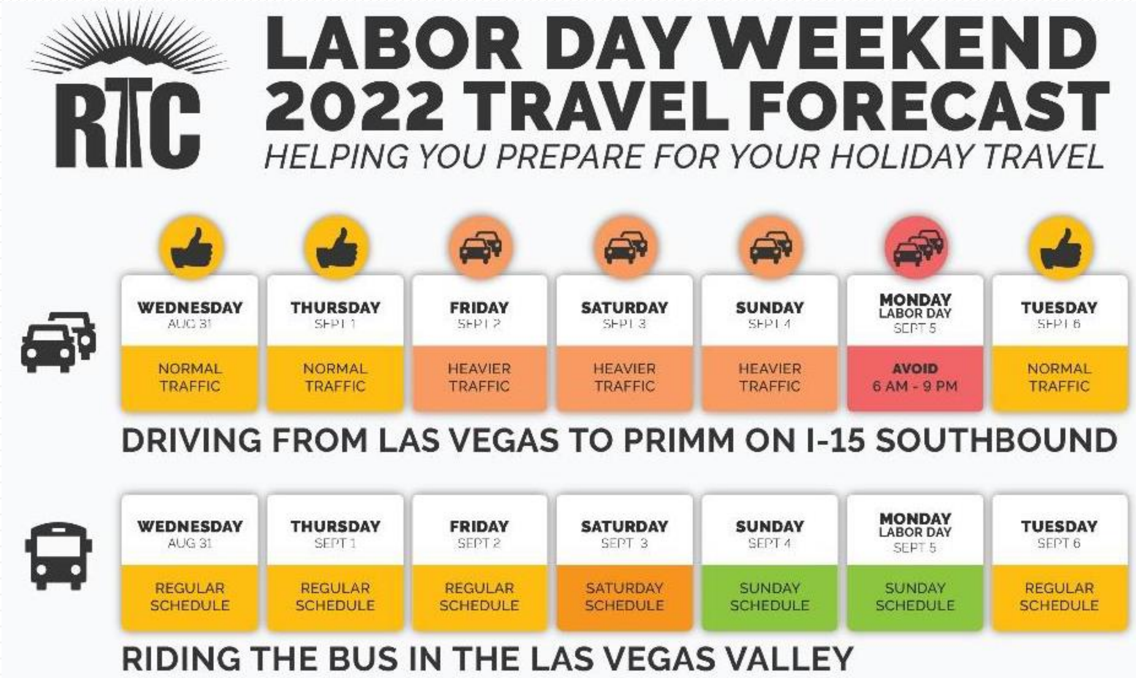


Figure 112: 2022 Labor Day Weekend Travel Forecast

While Driving

RTC's data sharing partnership with Waze provides drivers with a succinct and thorough overview of current road conditions in Southern Nevada. Waze's smart phone app is an effective way to arm residents with information about current road conditions and construction projects. The app's ability to forewarn and dynamically route motorists in real time makes it a great way to ease commutes around the valley. RTC is experimenting with emerging work zone detection and reporting technologies to further expand the utility of the Waze platform.

In 2019, 42 full-color displays known as active traffic management (ATM) signs began to be operational. As seen in Figure 113, these signs work best when installed in a series. These ATM signs join more than 80 dynamic message and travel time signs in use on regional freeways. These electronic message signs provide motorists with information such as alternate route detour information, information on special events, potential hazards ahead or emergency closures. This has the effect of improving roadway operations by directing traffic and preventing crashes. Figure 114 is a map of all dynamic messaging signs managed by FAST.

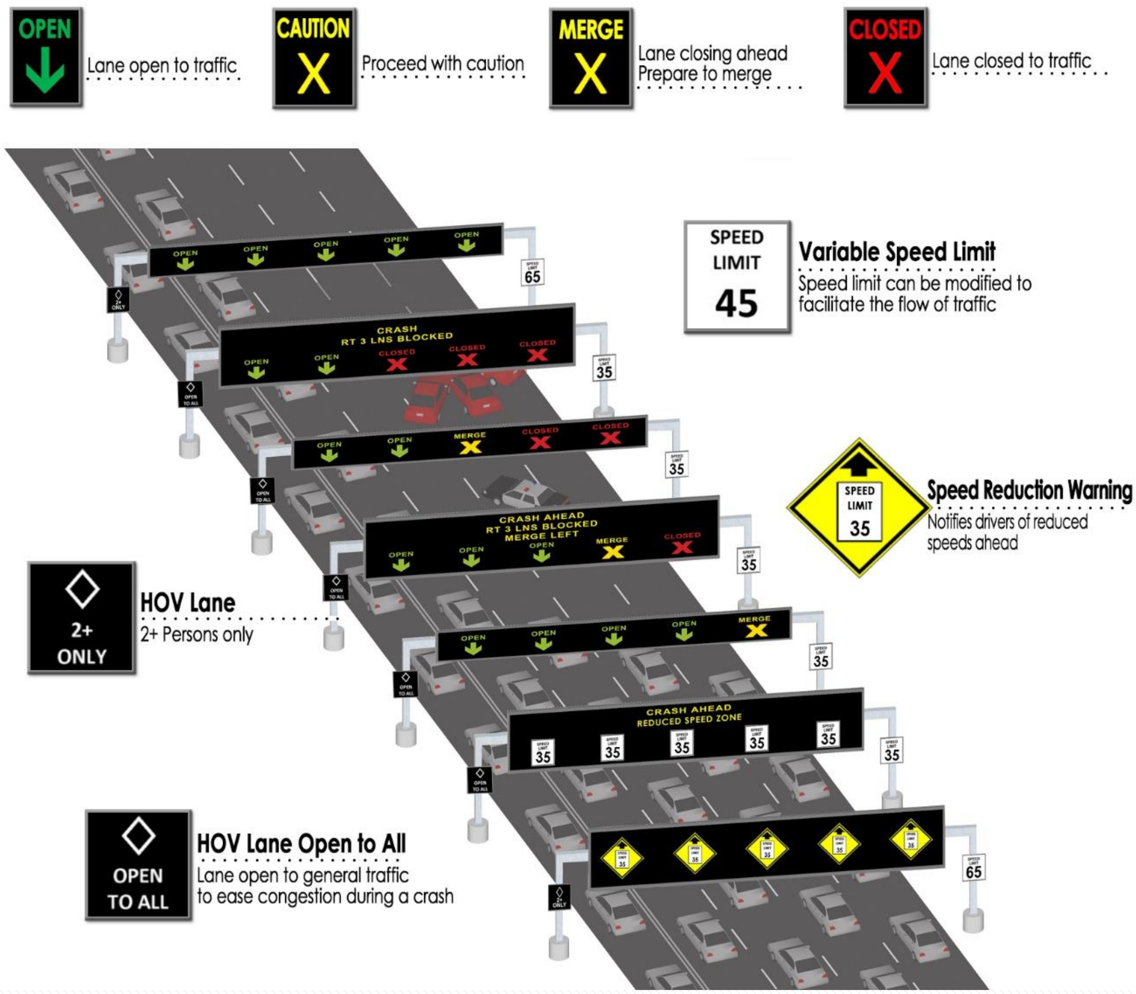


Figure 113: Conceptual Deployment of Active Traffic Management (ATM)

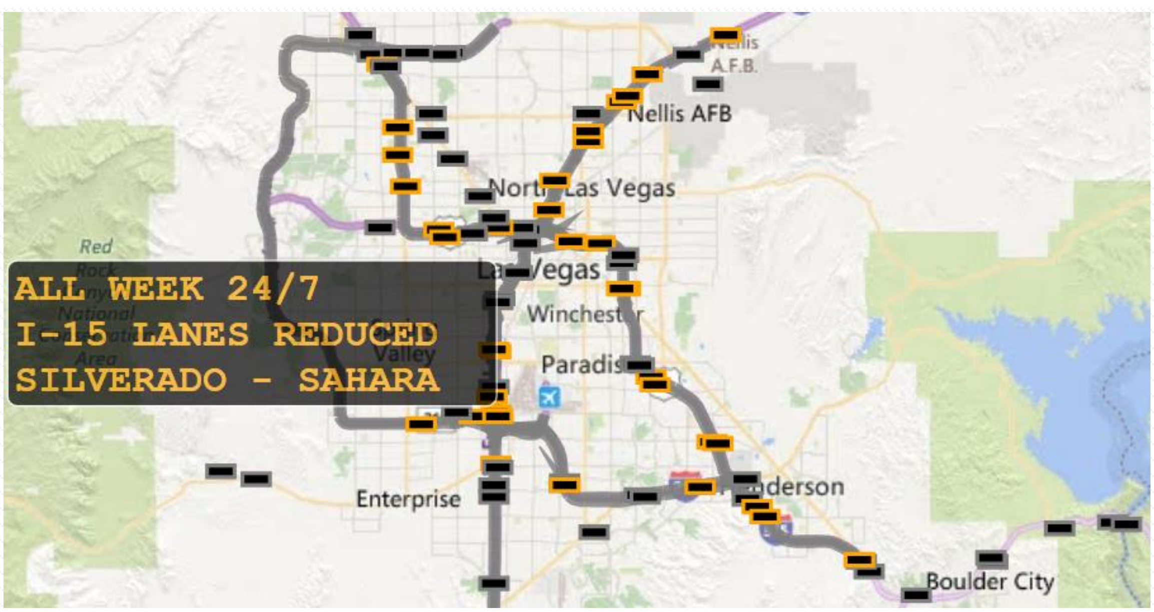


Figure 114: FAST Managed Dynamic Message Signs

TIER 04 Strategies to Add Roadway Capacity

Tier 4 strategies involve the construction of new lanes for vehicular traffic. Selecting from this tier should be preceded by considering the applicability of demand management measures from the three tiers listed earlier. Capacity adding strategies should be considered only after the demand management options have been deemed unfeasible.

Bottleneck Removal

This strategy is aimed at correcting short segments of roadway which have temporary lane reductions or other design limitations that cause physical capacity to be limited. As heavier flows of upstream traffic arrive at the bottleneck point, vehicles can back up due to the sudden constriction.

Channelization

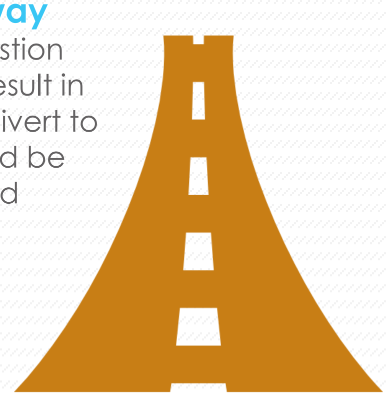
This separates turning traffic from the through lanes at intersections. This can take the form of lane markings or in some instances concrete islands. Pedestrian safety needs to be considered if placing right turn channels.

Intersection Improvements

Intersections can be widened and lanes re-striped to increase capacity as well as safety. Elements of this may include the construction of left (and/or right) turn lane(s), widening the shoulders, or applying changes to the traffic control.

New Travel Lanes Added Along an Existing Roadway

This will provide increased capacity and reduce congestion and travel delays for existing levels of traffic. It could also result in less traffic on parallel side streets and arterials as vehicles divert to the widened road. However, the cost of construction could be high depending on the amount of right of way needed and impediments.



Extended Roadway

This is a new road along a separate right of way to serve newly developed or developing areas or an extension of an existing roadway to complete a network. It is applicable to areas experiencing new development or relieving an existing severely congested corridor. Cost depends on the amount of right-of-way needed and the scale of construction impediments.

Capacity Adding Projects

Capacity adding projects are relatively common and numerous. This report will only briefly cover a few of the highest profile freeway projects. The public can view current projects planned and under construction with this web map.

Project NEON

Project Neon is the largest public works project in Nevada history. It entails a nearly $1 billion widening of 3.7 miles of Interstate 15 between Sahara Avenue and the "Spaghetti Bowl" interchange in downtown Las Vegas. It's the busiest stretch of highway in Nevada with 300,000 vehicles daily, or one-tenth of the state population, seeing 25,000 lane changes an hour. Traffic through the corridor is expected to double by 2035.

As seen in Figure 115, project Neon was completed in 2019. The complexities of the project influenced traffic patterns in different ways throughout its construction.

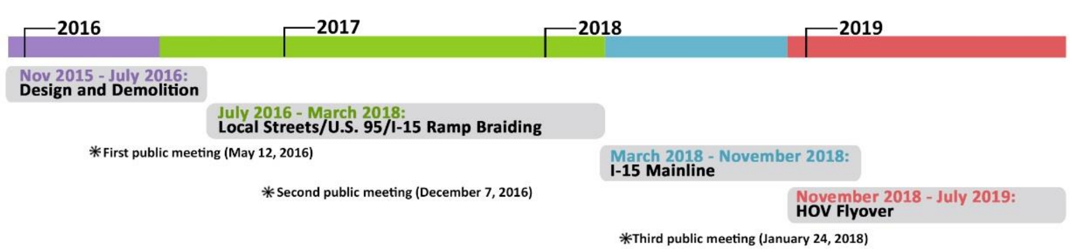


Figure 115: Project Neon's Timeline

Interstate-515

The 2020s will be a decade of capacity expansion on Interstate 515. Already the construction impacts of viaduct rehabilitation on congestion have been felt on I-515 near the spaghetti bowl. This project includes adding capacity by adding a southbound auxiliary lane between I-15 and Eastern Avenue with the stated goal of improving traffic flow and travel time reliability, improving overall safety, minimizing property acquisition and environmental impacts, and accommodating future infrastructure improvements. The same project also widens Eastern Avenue southbound off-ramp to two lanes.

The follow up to this project will be an I-515/Charleston Interchange project which includes the following capacity building components:

- Widen and reconstruct Charleston Boulevard from Honolulu Street to Sacramento Drive
- Increase number and length of turn lanes from Charleston Boulevard to I-515 ramps
- Add one auxiliary lane in each direction on I-515 from Charleston Boulevard to Eastern Avenue
- Widen I-515/Charleston Boulevard interchange ramps
- Widen I-515/Eastern Avenue interchange northbound off-ramp

The stated benefits of the added capacity include more efficient access to I-515 for area residents and businesses, better travel time reliability, longer merging lengths between Charleston Boulevard and Eastern Avenue, and improved air quality from more freely flowing traffic.

Figure 116 below outlines the other planned construction projects slated for the 2020s.

Figure 116: Planned Construction along Interstate-515

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Congestion Management Funding

<u>RTP projects can be funded by any of the following means:</u>

1. Congestion Mitigation Air Quality funding (CMAQ)
2. Surface Transportation Program (STP)
3. Transportation Alternatives Program (TAP)
4. Other Funding Options (e.g. Grants)

Congestion Mitigation Air Quality Improvement Program

The CMAQ Program was created under the Intermodal Surface Transportation Efficiency Act of 1991. Subsequently, it has been reauthorized under each of the following federal transportation bills. The CMAQ program supports two goals of the USDOT: improving air quality and relieving congestion. The CMAQ program provides funding for a broad array of projects that accomplish these goals. By distributing funds toward CMAQ projects, state and local governments can improve air quality, make progress towards achieving attainment status and ensure compliance with the transportation conformity provisions of the Clean Air Act. RTC often utilizes local jurisdiction funds combined with CMAQ funds to fund congestion management projects.

Congestion Mitigation and Air Quality Project Selection

The FHWA mandates that projects be prioritized based on the cost effectiveness of emission reductions. This mandate was strengthened with the passage and implementation of MAP-21. During the project selection process, projects are evaluated based on their cost effectiveness. Priority consideration is given to those projects which result in the most emissions reductions for the least amount of CMAQ funds expended.

<u>There are seven different types of CMAQ projects implemented by local agencies in Clark County:</u>

1. Intersection modifications, including HOV direct connections from freeways
2. Bicycle lane and pedestrian improvements
3. ITS improvements that focus on improved signal coordination resulting in an increase in travel speed and a reduction in idle delay.
4. Installation of bus turnouts in places where transit vehicles use general purpose travel lanes to board and alight passengers;
5. Purchase of electric vehicles **(EV)** or installation of EV charging stations
2. Transportation Demand Management;
3. Electric and natural gas vehicle purchases.

Several projects have been funded between 2018 and 2022 using CMAQ funding. A brief summary of the most impactful project follows.

Recent Projects

Particulate emissions reductions resulted from a region-wide project to purchase clean diesel street sweepers by local entities; Clark County, City of Las Vegas, City of Henderson, and the City of North Las Vegas. These street sweepers not only reduced diesel particulate emissions from the vehicles, but also enabled more of Southern Nevada's roadway network to be maintained and cleaned to prevent the re-entrainment of dust. Further particulate reductions stemmed from an improved RTC Transit Fleet and the continued Club Ride Program. For Carbon Monoxide, Nitrogen Oxide and Volatile Organic Compounds pollutants, the Swenson Street ITS project, the Club Ride Program and a North 5th Street Signalization project were the most effective. The recent track record is in line with the general wisdom that ITS, TDM, bicycle and pedestrian projects, and intersection modifications are typically among the most cost effective projects.

The 2015-2019 transportation improvement program shows the following amounts of expenditure using CMAQ funds during the years occurring before the pandemic (Figure 117). The total amount represents about 5% of all programmed expenditures outlined in the TIP for this period.

Fiscal Year	Programmed CMAQ Funds
2015	$19,831,726
2016	$25,653,110
2017	$18,384,711
2018	$20,725,000
Total Programmed CMAQ Funds for 2015-2019	$89,594,547
All Programmed Funds for 2015-2019	$1,827,838,953

Figure 117: RTC CMAQ funding for 2015-2019

Future Projects

Improving air quality, just like traffic congestion, continues to be a challenge in Southern Nevada and CMAQ continues to be an important funding source to draw from. Included in the Figure 118 are the project type categories identified for funding in RTCSNV's federal fiscal year (FFY) 2021-2025 TIP program (program current as of September 24, 2020) and an identification if they are anticipated to contribute to achieving the 2- year and 4-year targets for the traffic congestion and on-road mobile source emissions reduction measures.

Project Category	Number of Projects	VOC Benefit	NOx Benefit	CO Benefit	PM_{10} Benefit	PHED Benefit	Non-SOV Travel Benefit
Bicycle & Pedestrian	6	Yes	Yes	Yes	Yes	No	Yes
High Occupancy Vehicles	0	Yes	Yes	Yes	Yes	Yes	Yes
Street Sweepers	0	No	No	No	Yes	No	No
Intersection Improvement	4	Yes	Yes	Yes	No	Yes	No
Signal Interconnect and ITS	1	Yes	Yes	Yes	No	Yes	No
Electric Vehicles	2	Yes	Yes	Yes	No	No	No
Bus Turnouts	6	Yes	Yes	Yes	No	Yes	No
Transit Fleet	1	Yes	Yes	Yes	Yes	No	Yes
Transportation Demand Management	2	Yes	Yes	Yes	Yes	Yes	Yes
High Capacity Transit	1	Yes	Yes	Yes	Yes	Yes	Yes

Figure 118: Description of Projects in FFY 2021-2025 TIP Program

Complete Streets Program

The RTC contributes to the funding of complete streets alongside its six member agencies and with contributions from the community. The mechanism whereby a resident can contribute to the Complete Street Program happens as they registering their vehicle in the State of Nevada. During the registration process they may be asked if they would like to donate $2 to the Complete Streets Program. Further opportunities to contribute occur during registration renewal completed either online at dmv.nv.gov or at any DMV kiosks.

Grant Funding

Federal legislation often presents many opportunities to acquire funding for transportation projects. One such grant offered by the Rebuilding American Infrastructure with Sustainability and Equity (RAISE) program helps communities move forward on projects that modernize roads, bridges, transit, rail, ports, and intermodal transportation and make our transportation systems safer, more accessible, more affordable, and more sustainable. Beginning at the end of 2021, this national program has an additional $7.5 billion available over five years.

The RAISE program evaluates on several criteria, including safety, environmental sustainability, quality of life, economic competitiveness and opportunity, partnership and collaboration, innovation, state of good repair, and mobility and community connectivity. Within these areas, the Department considers how projects will improve accessibility for all travelers, bolster supply chain efficiency, and support racial equity and economic growth – especially in historically disadvantaged communities and areas of persistent poverty.

Awarded Grants

In 2022, the City of Las Vegas was awarded $23,900,000 in RAISE grant money to put toward adding complete street elements along Stewart Avenue (See Figure 119). Specifically, the project includes: the installation of a protected two-way cycle track (east of Eastern Avenue), sidewalk widening and obstruction removal to meet or exceed ADA accessibility guidelines, upgraded lighting, bus stop improvements and amenities, the addition of significant landscaping and street trees, prediction technologies for cyclists and pedestrians near intersections, and a corridor-wide speed limit reduction.

The project is anticipated to bolster a neighborhood corridor serving underserved residents in the local community. The project will also create safe, accessible, non-motorized transportation options by reducing vehicle speeds, creating a dedicated bike lane, improving sidewalks, removing obstructions, and planting hundreds of street trees.

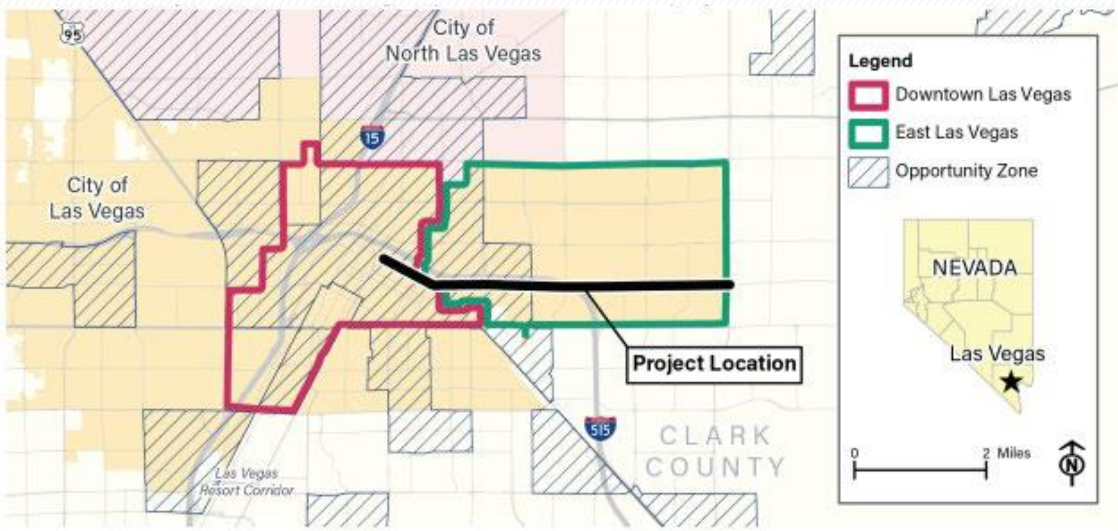


Figure 119: Map of the Extent of Stewart Avenue receiving complete street funding from the RAISE Program

Traffic Operations

Advanced Transportation and Congestion Management Technologies Deployment Grant

RTC, NDOT, and partners received a $6 million grant to expand emerging technologies on Las Vegas freeways. The five-mile expansion will extend west of downtown Las Vegas between I-15 and Summerlin Parkway on U.S. 95, a critical corridor that carries approximately 230,000 vehicles daily. These technologies will mitigate congestion, decrease the number of crashes, and reduce travel times on the freeway.

Some technologies that will be deployed along U.S. 95 include wrong-way sensors that alert drivers immediately if they're traveling in the wrong direction; occupancy detection sensors in HOV lanes that collect data to reduce congestion and emissions; and overhead signs that warn motorists about incidents, speed reduction and lane closures ahead to mitigate crashes resulting from sudden braking. Figure 120 is an image of a similar sign already deployed on I-15.

Figure 120: Active Traffic Management Sign installed in Southern Nevada

The $6 million in funding comes from the FHWA Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program established under the "Fixing America's Surface Transportation" (FAST) Act. The ATCMTD program funds early deployments of forward-looking technologies that can serve as national models. During this round of funding, the FHWA evaluated 46 ATCMTD applications, nation-wide, requesting more than $205 million and awarded $49.6 million to 10 projects nationwide. The expansion of the existing project is estimated to cost approximately $15 million, with a 60-percent local and 40-percent federal split.

Community Traffic Safety Grant

The Community Traffic Safety Grant program, funded by NHTSA, funds projects, programs and research that help achieve the mission of zero traffic deaths. Awarded projects address the troubling rise in roadway fatalities by implementing the three pillars of the Road to Zero strategy: double down on what works, advance technology, and prioritize safety.

Following a successful pilot program, jointly implemented by Nevada Highway Patrol, RTC and NDOT, that showcased the use of artificial intelligence with intelligent roadway design and strategic policing to decrease speed on high-risk roads, Southern Nevada was awarded $188,970 in grant funding to expand the program in 2019. This funding was used to build five new Strategic Traffic Management Sites on US-95 and I-15 similar to the one pictured in Figure 121.

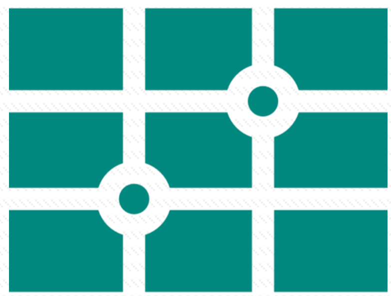
Figure 121: Strategic Traffic Management Site Used by the Nevada Highway Patrol to Prevent Crashes

Congestion Management Strategy Evaluation

The primary goal of this action is to ensure that implemented strategies are effective at addressing congestion as intended, and to make changes based on the findings as necessary. To evaluate effectiveness it's best to take a closer look at implemented congestion management strategies on a corridor by corridor basis as was done in the Segment Analysis portion of this report.

Besides corridor evaluations, historical performance measures (see section on performance measures) can evaluate the aggregate effectiveness of regional congestion management investments relative to the past. As for anticipating the future effectiveness of planned congestion management investments, the RTC's travel demand model can be of use.

Travel Demand Model Forecasts



As part of the process of developing the RTP, the RTC relies on a sophisticated travel demand model to simulate future transportation conditions. The model is valuable for forecasting the ratio of estimated traffic volumes to transportation facility capacities.

Figures 122-124 demonstrate differences in congestion outcomes based upon "No Build", "Build", "On Board" (i.e. high capacity transit) scenarios, respectively. Scenarios change the input parameters of a model simulation and vary its outputs. In this case, congestion severity is influenced by the exclusion (i.e. No Build Scenario) or inclusion (i.e. Build Scenario or On Board Scenario) of planned road network and transit projects. As would be expected, loading increased future year traffic volumes onto a static "No Build" network causes the congestion severity to intensify. Through this exercise, the model emphasizes the anticipated effectiveness of implementing planned congestion management strategies to the regional road network.

There are limitations to using the travel demand model is this way. While it forecasts effectiveness, it doesn't readily forecast cost effectiveness. There may be a more cost effective set of congestion management strategies to achieve the same transportation outcomes. In addition, while the model does account for transit activity, it isn't as sensitive to the effects of other congestion mitigation activities. In particular, it struggles to account for technological changes which may occur between the present and future year. Nonetheless, it does provide an expectation of future traffic congestion given the assumption that current economic, transportation and land use patterns will largely remain the same in forthcoming decades.

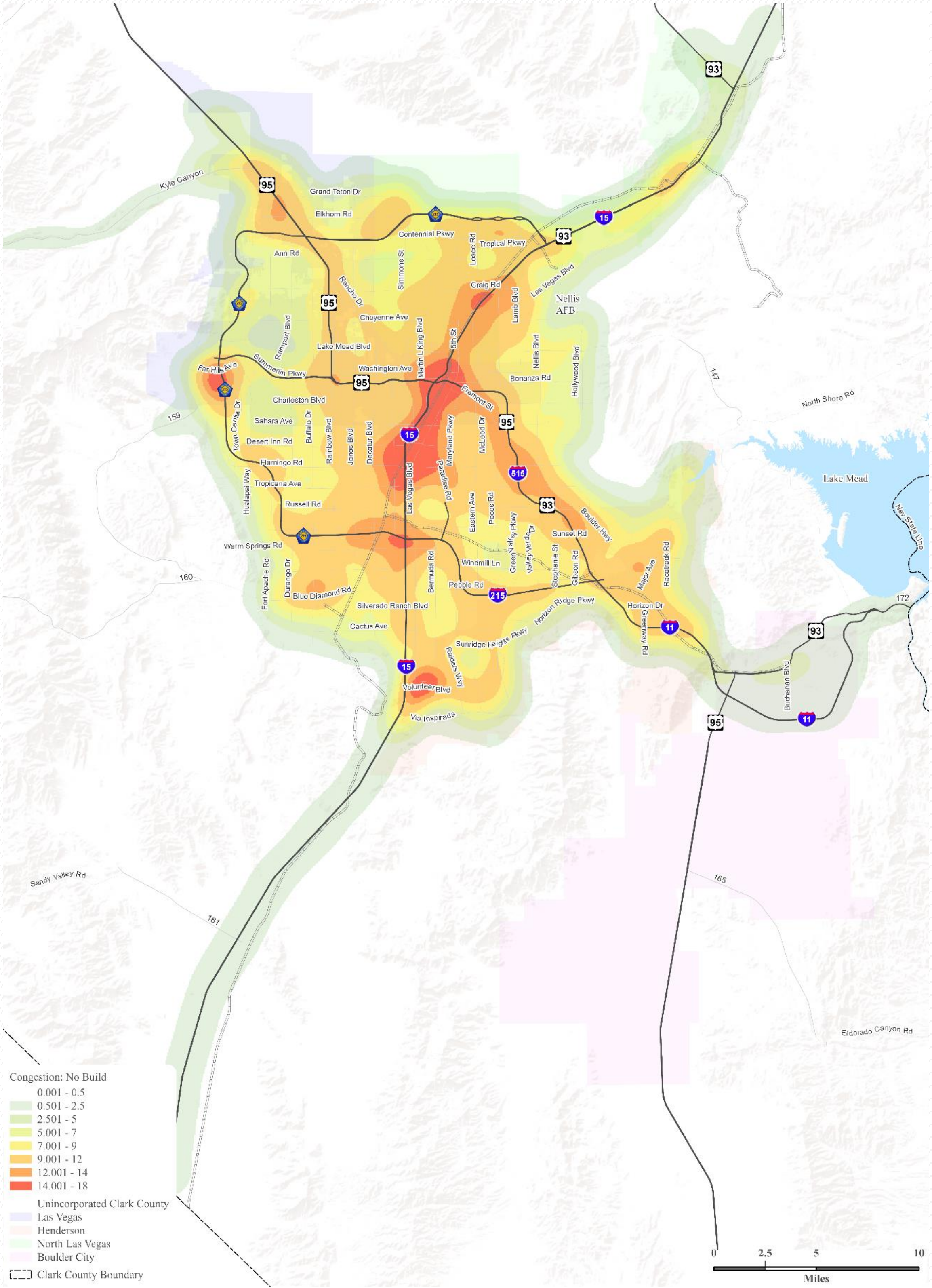


Figure 122: No Build Scenario—Modeled 2050 Demand with Existing Networks

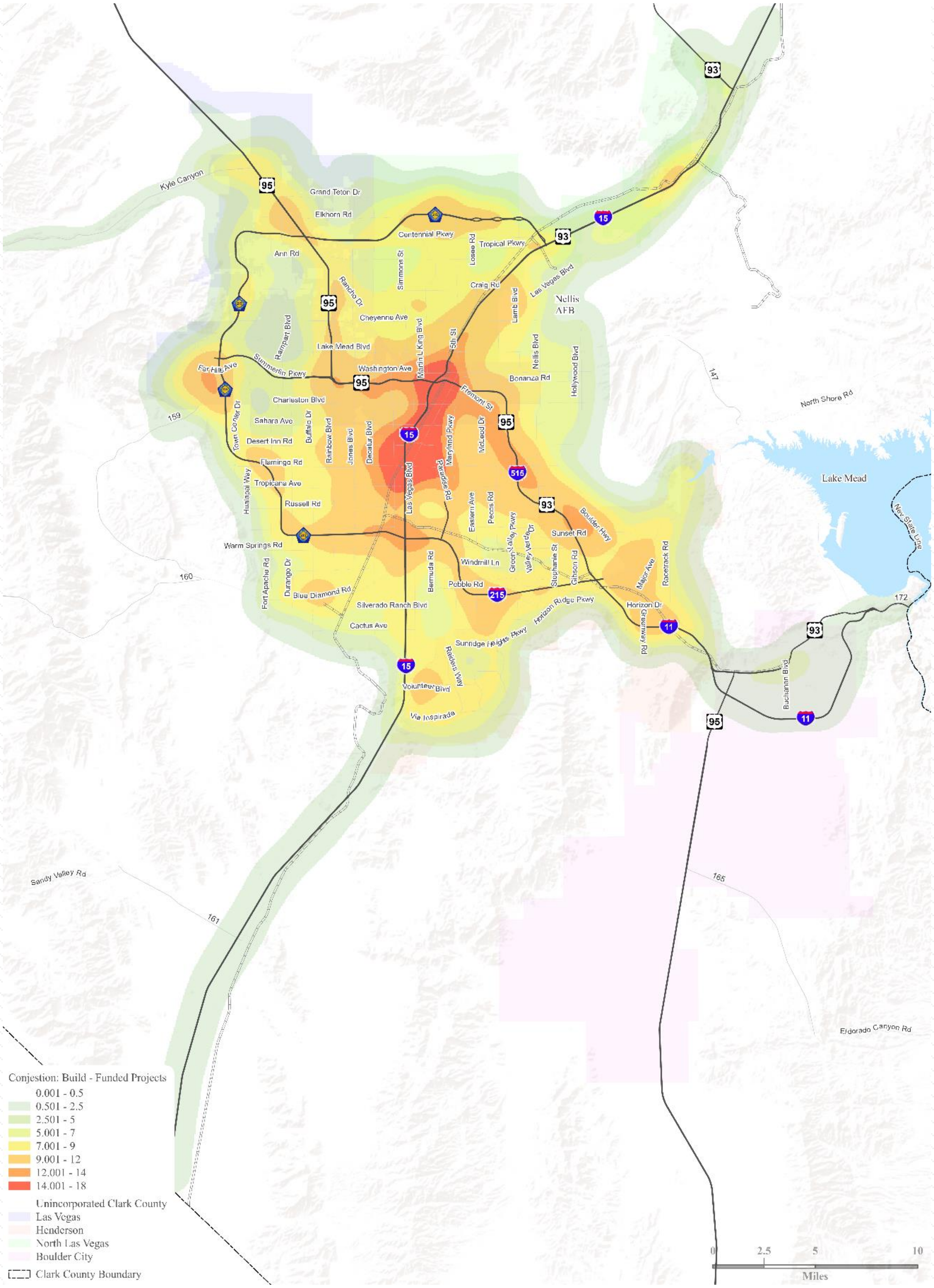


Figure 123: Build Scenario—Modeled 2050 Demand with 2050 Networks

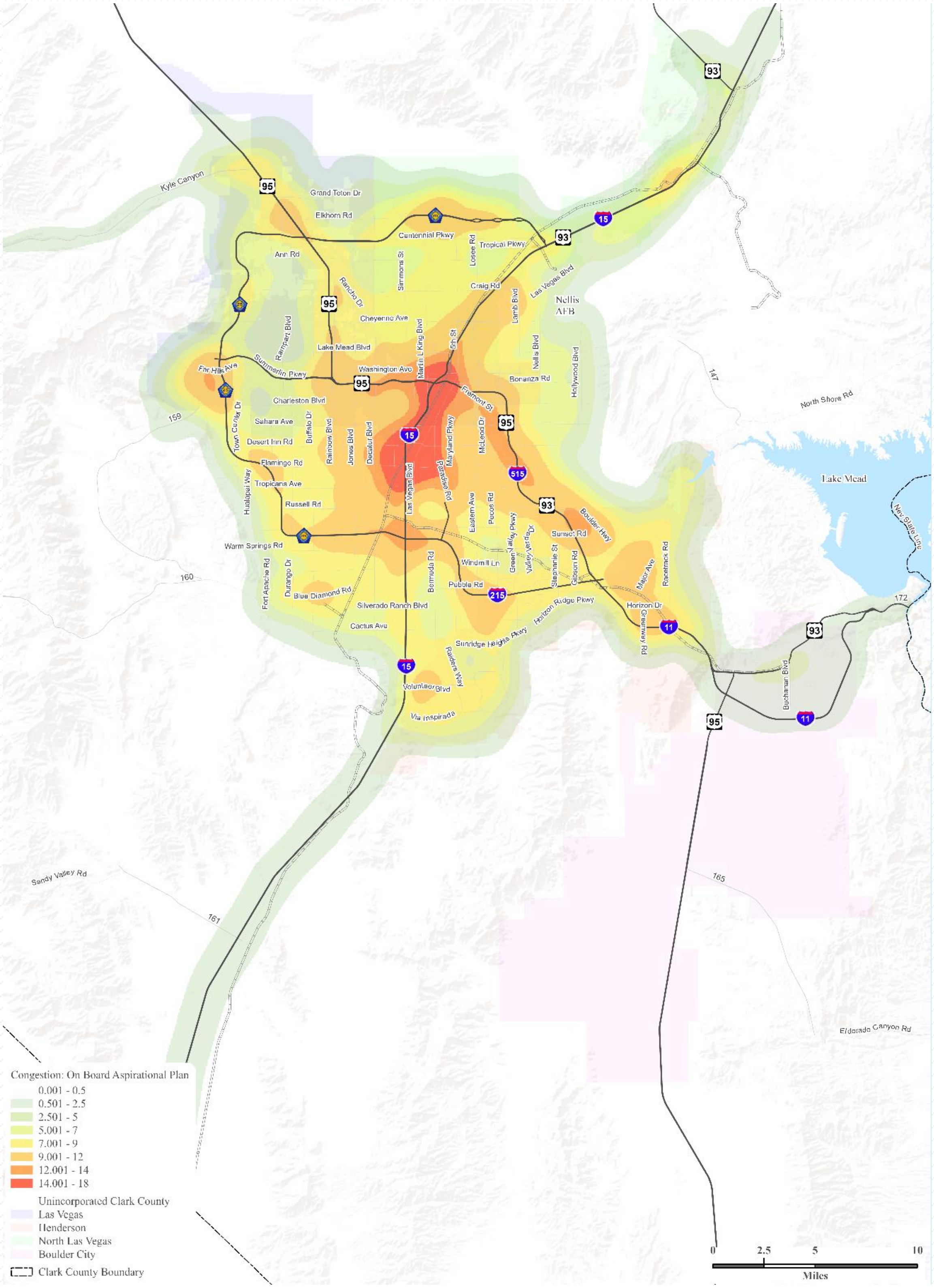


Figure 124: Build Scenario—Modeled 2050 Demand with On Board Aspirational Transit Plan Network

Conclusion: A 3C CMP

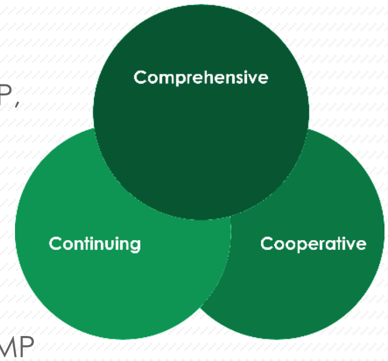
Congestion Management represents a comprehensive, continuing, and cooperative (3C) process that supports the needs, vision, and goals of the region.

Comprehensively Planning

The Regional Transportation Plan (RTP), the Transportation Improvement Program (TIP), the Unified Planning Work Program (UPWP) and the CMP are tools that implement strategies pursuant to adopted objectives. Each action of the CMP is both supportive of and supported by the RTP, TIP and UPWP (Figure 125).[XV]

Figure 125: 8 Elements of the CMP

Continually Planning



A continuing planning process requires that the RTP, TIP, UPWP and CMP receive updates on a periodic basis. Depending on regional air quality attainment status, the RTP cycle is every five (attainment) or four (non-attainment) years. *As for the CMP, it must, at minimum, be updated often enough to provide recent information as an input to each RTP update.* To fulfill this requirement, it is prudent to update the CMP at least 1 year prior to each scheduled RTP update. However, more frequent updates provide RTC with timelier feedback.

Cooperatively Planning

As depicted in Figure 126, the RTC manages transit, traffic and metropolitan planning, and administers Southern Nevada Strong, a collaborative program dedicated to bettering Southern Nevada. It's the only agency in the country to handle all four of these functions within a single organization.

Figure 126: Primary Functions of the Regional Transportation Commission of Southern Nevada

Despite having many capabilities in-house, collaboration with partners—including state, regional and local transportation facility owners and operators—enhances data collection, analysis, and strategy implementation.

A 3C Congestion Patterns Dashboard

While the CMP is only updated once per RTP cycle (i.e. every 3 to 4 years), the CMP's companion web application will be updated quarterly as new speed data is generated by INRIX. Figure 127 is screenshot of this application entitled the Southern Nevada Congestion Patterns Dashboard. More information about the dashboard can be found in Appendix A.

Making this update schedule routine will help ensure ongoing congestion management coordination between agency partners and broaden opportunities to more comprehensively evaluate the before and after effects of site specific congestion management strategies over time. Findings derived from such evaluations are invaluable for making wise adjustments to the objectives and strategies of subsequent iterations of the CMP and the greater transportation planning process in fabulous Southern Nevada.

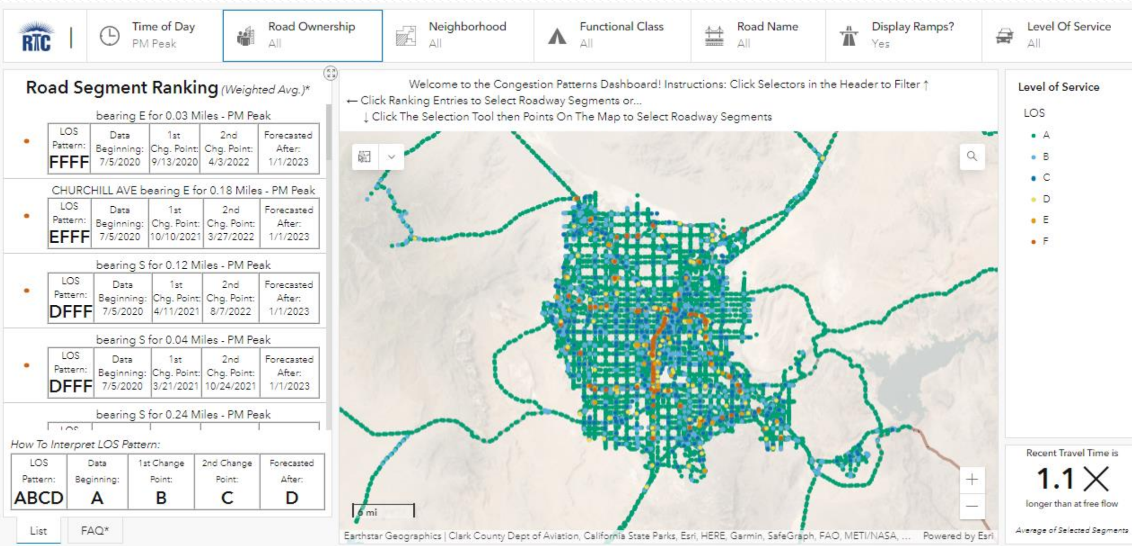


Figure 127: Screenshot of the Southern Nevada Congestion Patterns Dashboard

Appendix A

Congestion Patterns Dashboard FAQ

Q: What is Level of Service (LOS)?

A: Level of service (LOS) is a qualitative measure used to relate the quality of motor vehicle traffic service (see following list). Unlike school grades, a letter grade of A is not always the optimal target. During peak periods, LOS C, D, and E may be more appropriate targets depending on roadway characteristics and context.

LOS A = Free Flow (no delay)
LOS B = Stable Flow (slight delays)
LOS C = Stable flow (acceptable delays)
LOS D = Approaching unstable flow (tolerable delay)
LOS E = Unstable flow (less tolerable delay)
LOS F = Forced flow (jammed)

Q: How were Levels of Service Determined?

A: Levels of Service that are based solely on speed (i.e. not including volume, etc.) are determined by Travel Time Index* thresholds determined by research to approximate traditional LOS. Different threshold ranges are applied depending on whether the flow is considered interrupted or uninterrupted. See the following for sources and specifics.

Interrupted Flow †
- LOS A = 0.00 - 1.25
- LOS B = 1.25 - 1.49
- LOS C = 1.49 - 1.97
- LOS D = 1.97 - 2.50
- LOS E = 2.50 - 3.25
- LOS F = 3.25 - ∞

Uninterrupted Flow ‡
- LOS A = 0.000 - 1.083
- LOS B = 1.083 - 1.300
- LOS C = 1.300 - 1.444
- LOS D = 1.444 - 1.625
- LOS E = 1.625 - 1.857
- LOS F = 1.857 - ∞

*Travel Time Index:
Observed Travel Time / Free Flow Travel Time
†Interrupted Flow (Highway Capacity Manual, 6th Ed.):
Roadways with traffic signals and stop signs.
‡Uninterrupted Flow (SHRP 2 L08)
Roadways with no fixed causes of delay external to the traffic stream.

Q: What is a LOS Pattern?

A: See the following question.

Q: What is the basis for Road Segment Rankings?

A: Rankings are based on a weighted average of three mean shift periods with two change points (see Figure 128 below). The weights are based on the length of each mean shift period in weeks. To emphasize recent performance, the weight for the most recent mean shift period is squared. Forecasted LOS, following the three mean shift periods, are not included in roadway segment rankings.

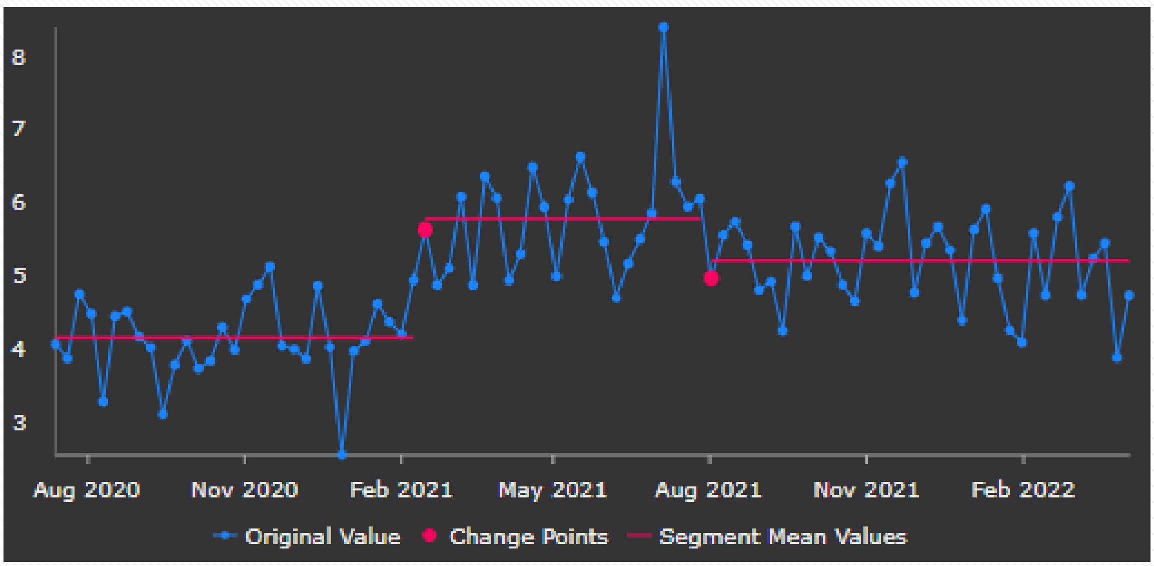


Figure 128: Example of Time Series Change Point Detection Analysis

Q: How were the forecasts calculated?

A: Forecasts are based on past weekly values for each road segment, and they provide a predicted LOS in the following quarter. Three forecasting techniques were calculated for each road segment (i.e. exponential smoothing, curve fit, and random forest). For each location, the forecast method providing the smallest validation root mean square error (RMSE) is selected. Figure 129, demonstrates a parabolic curve fit forecast for a system to system ramp.

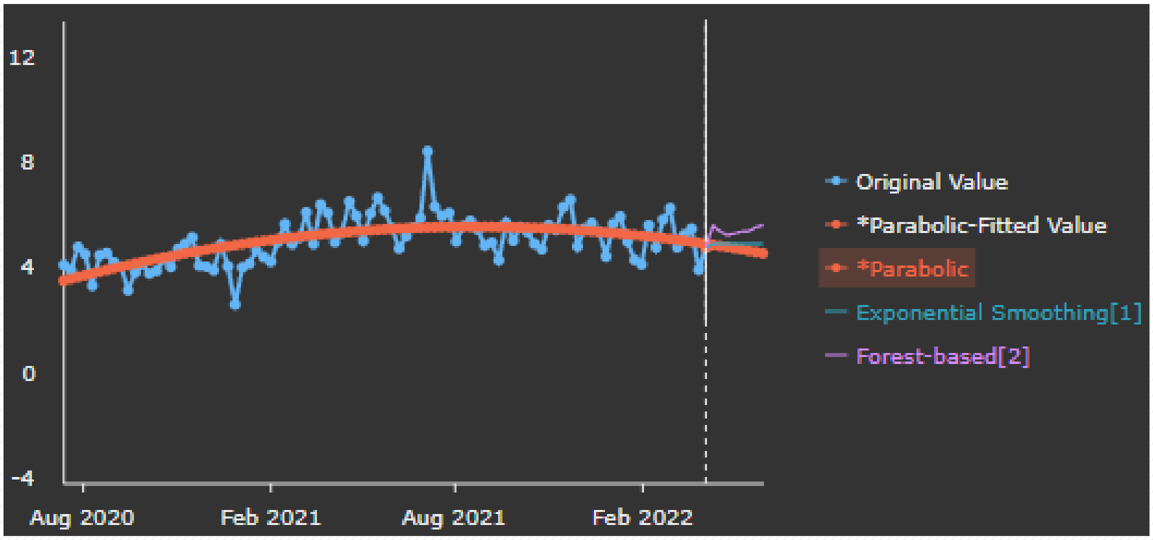


Figure 129: Exit 42B - PM Peak Forecast

Q: What hours of the day comprise AM Peak and PM Peak?

A: Peak hours match the same hours identified in the 2014 Household Travel Survey. According to the diurnal weights, for all trip purposes, derived from the survey, PM Peak hours consist of about 33% of daily trips while AM Peak consists of about 16% of daily trips.

AM Peak = Weekdays, 7-9 AM

PM Peak = Weekdays, 2-6 PM

Q: What source was used to determine Roadway Ownership?

A: Roadway Ownership was applied to roadway segments from the Highway Performance Monitoring System (HPMS) with additional checks against the NDOT road ownership database. This is NOT an authoritative source of roadway ownership information and is subject to errors.

Q: What are Neighborhoods and who defined them?

A: Roadway Segments were assigned a neighborhood based on the boundaries of adopted planning areas in each of Southern Nevada's local governments' adopted comprehensive plans. Otherwise, highways were divided into chunks and given casual names to describe them.

Q: Who determined functional classification for roadway segments?

A: Road segment classification is provided by INRIX and delivered as-is.

Q: Who determined the names of roadway segments?

A: Road segment names are provided by INRIX and delivered as-is.

Q: Why are points used to represent linear roadway segments?

A: Since LOS can vary directionally on bidirectional roadways it would be difficult to display all the information on the map due to overlapping lines. Using points and directional arrows allows for displaying all the information simultaneously on a map. The point closest to the arrow denotes the direction of travel.

Disclaimer:

Calculations using data provided as-is by INRIX. For example, due to underlying errors in the source data, congestion levels are high in Sandy Valley, NV, but they are unlike to be so in actuality. For reasons such as this, field verification is recommended.

Known Issues:

Off-ramps are assigned LOS on the uninterrupted flow scale (see Q2 above). The interrupted flow scale may have been a more appropriate categorization for off-ramps. Therefore, it is recommended that off-ramps be evaluated based on their travel time index values.

Appendix B

List of Figures

Appendix C: FAST Quarterly Report

RTC FAST

Quarterly Report

July / August / September 2022

Freeway Management Executive Summary

(July to Sept 2022)

Real-Time Traveler Information

- Over 2,780 messages were sent out via #FASTAlert Tweets and Freeway Traffic Alerts (via email and text messages)
- Over 1,060 unique messages were posted on the DMS/Gantry Signs

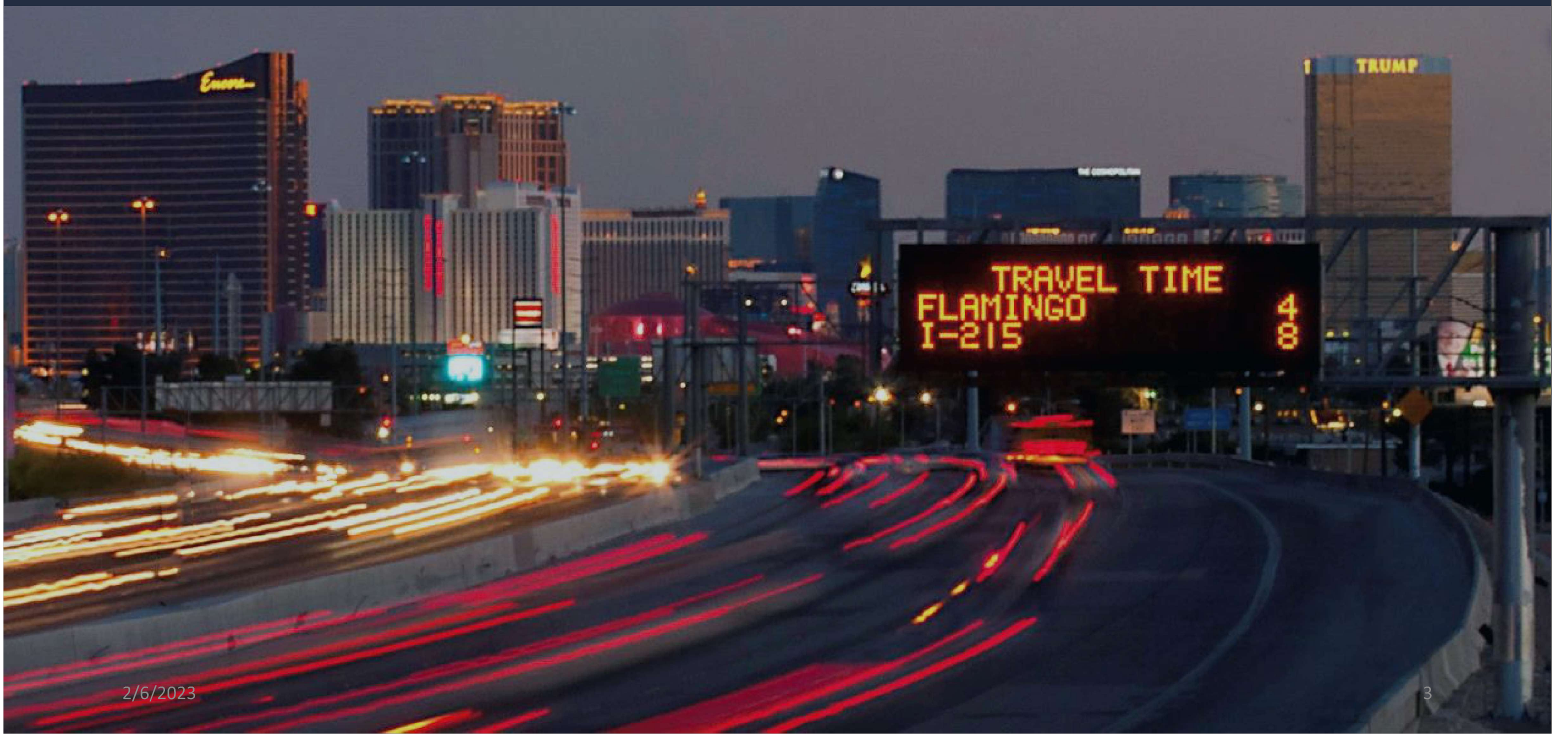
Traffic Incident Management

- The network experienced consistent crashes during the day from 6 am to 7pm. An increase in crashes occurred at 7am to 8am and between 2pm to 6pm.
- Crash frequency was consistent Monday thru Friday with Thursday being the highest.
- A decrease in Rekor data crashes was experienced in July-Sept 2022 (1,856) versus April-June (2,375).
- There were 36 secondary crashes resulting after an initial crash, which equated to 1.94% of the total number of crashes. Crash data from NV Department of Safety's Brazos database and Rekor was used to identify the secondary crashes.

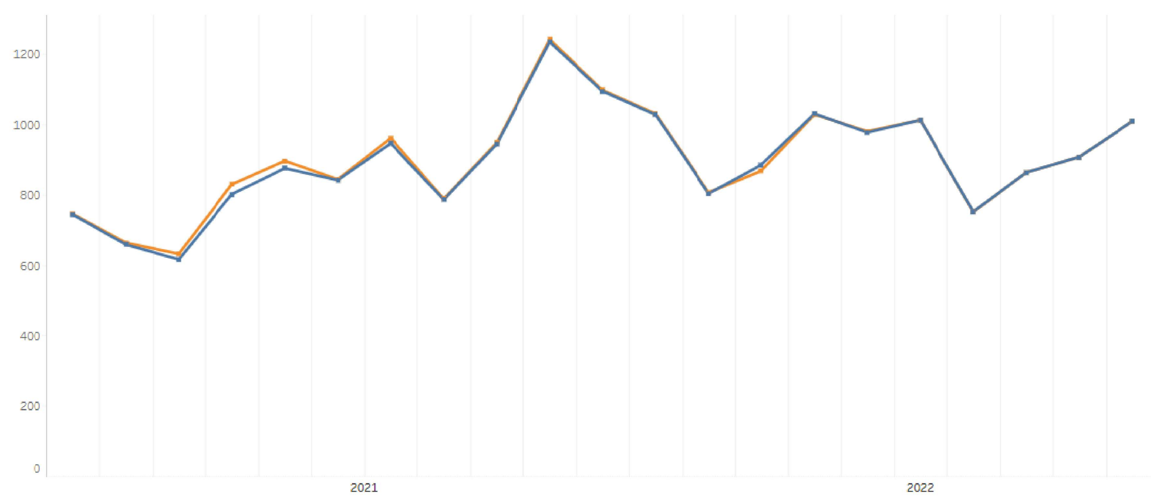
Active Traffic Management

- From July to September 2022, the HOV lane was open to all 338 times with 58 days of activation. This increase is due to construction at I-15/Tropicana and a ATM Programming issue which has been resolved.

Real-Time Traveler Information



Freeway Traffic Alerts & Tweets



2021	January	Februa..	March	April	May	June	July	August	Septe..	October	Novem..	Decem..
#FASTAlert Twitter	744	659	617	802	876	842	947	787	945	1,235	1,095	1,028
Freeway Traffic Alert	746	664	633	830	897	844	962	789	949	1,242	1,098	1,031

2022	January	Februa..	March	April	May	June	July	August	Septe..
#FASTAlert Twitter	804	886	1,031	978	1,013	753	864	908	1,009
Freeway Traffic Alert	807	869	1,029	981	1,013	752	864	908	1,009

Public engagement is critical to successful traffic operations. FAST provides traffic alerts via #FASTAlert on Twitter and Freeway Traffic Alerts via text messages, e-mail distributions, and Waze. These messages include crash information, travel times, construction alerts, weather alerts, and special event details.

Freeway Traffic Alerts & Tweets

RTC/FAST Unique Number of Incident Notifications to the Public by Day of Week & Month in 2022

	Jan	Feb	Mar	Apr	Mar	Jun	Jul	Aug	Sep	Grand Total
Sunday	101	75	67	85	105	40	88	58	65	684
Monday	119	86	115	123	154	85	93	113	125	1013
Tuesday	88	99	154	128	144	124	98	124	122	1081
Wednesday	126	113	165	120	133	145	121	131	129	1183
Thursday	97	102	170	110	119	109	137	127	171	1142
Friday	96	134	137	169	108	87	129	117	203	1180
Saturday	134	94	113	124	88	81	97	83	80	894
Grand Total	761	703	921	859	851	671	763	753	895	7177

RTC/FAST Unique Incidents Notification Methods to the Public by Month & Service in 2022

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Grand Total
GOVDELIVERY	**590**	**652**	**850**	**781**	**782**	**611**	**700**	**706**	**806**	**6478**
CONSTRUCTION		1		1				1	4	7
INCIDENT	590	651	850	780	782	611	700	705	802	6471
WAZE	**761**	**703**	**920**	**858**	**850**	**671**	**763**	**753**	**891**	**7170**
CONSTRUCTION		1		1				1	14	17
INCIDENT	761	702	920	857	850	671	763	752	877	7153

Incident - Events which impact travel lanes include crashes, police activities, or other unplanned emergencies.

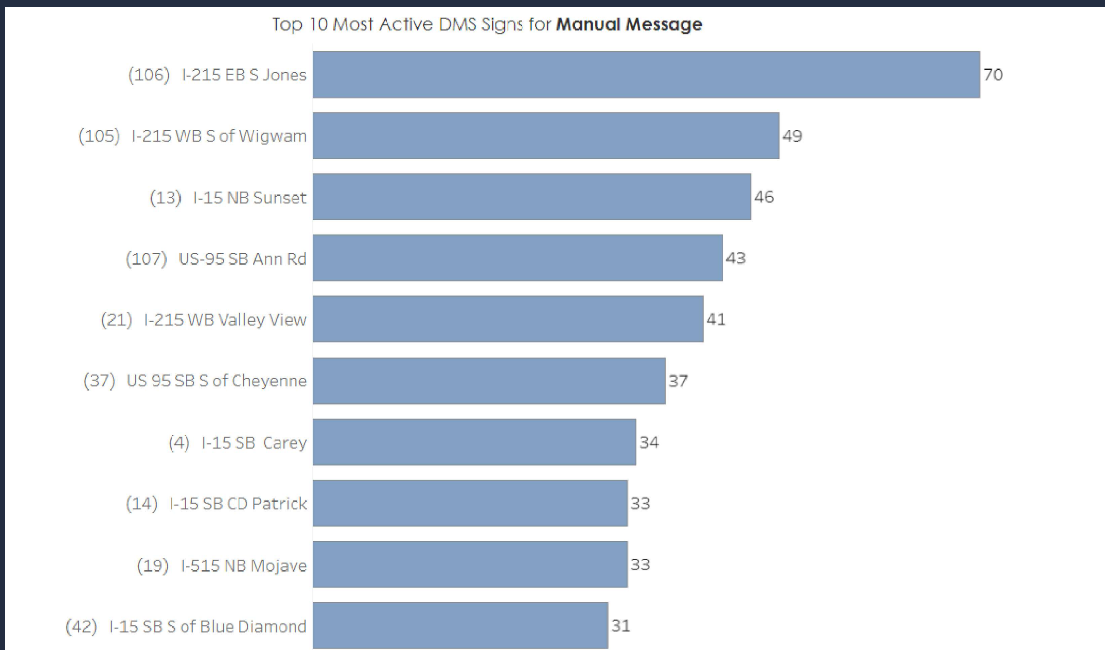
Overhead Digital Display Traveler Information

DMS are the most visible tool for traveler information dissemination. The DMS are used for congestion warnings, lane and ramp closure information, and advisory to use other routes. The ability to quickly alert motorists of a problem ahead using the DMS and Gantries is a successful strategy for minimizing the impact of an incident on traffic flow. The Digital Displays have demonstrated the following benefits:

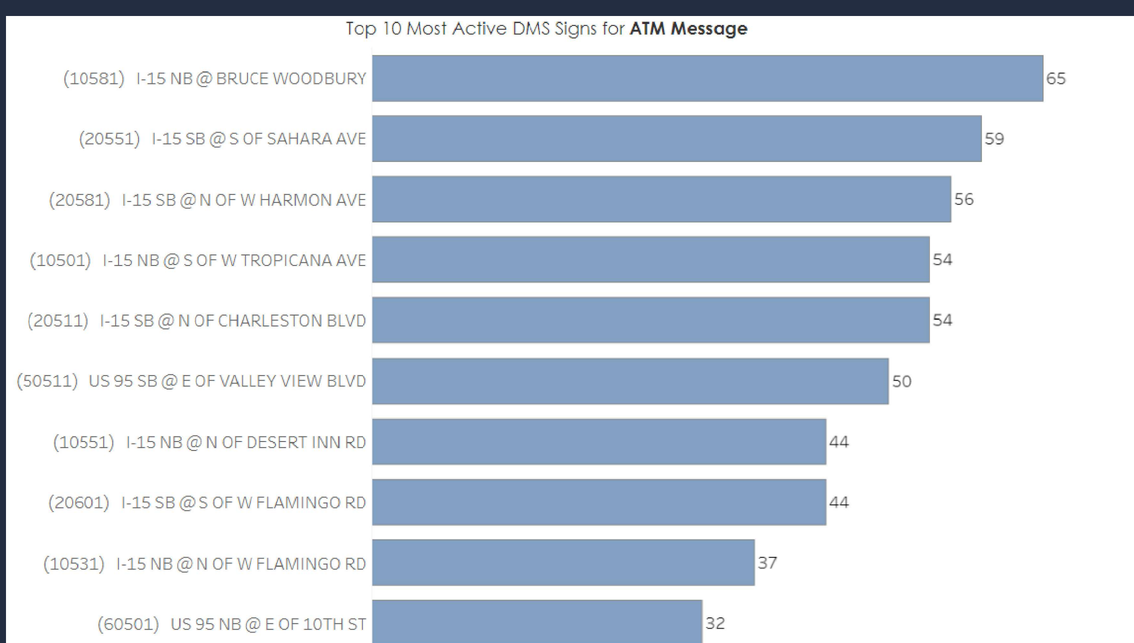
- Reduction of speeds as vehicles approach congested areas, resulting in fewer secondary crashes;
- Increased diversion to other routes during incidents, resulting in better traffic network performance;
- Increased lane changes away from lanes that are closed downstream, resulting in safer merging operations;
- Improved traffic operations during special events; and
- Increase awareness & guidance for construction zones .

1,062 Unique Messages were posted.

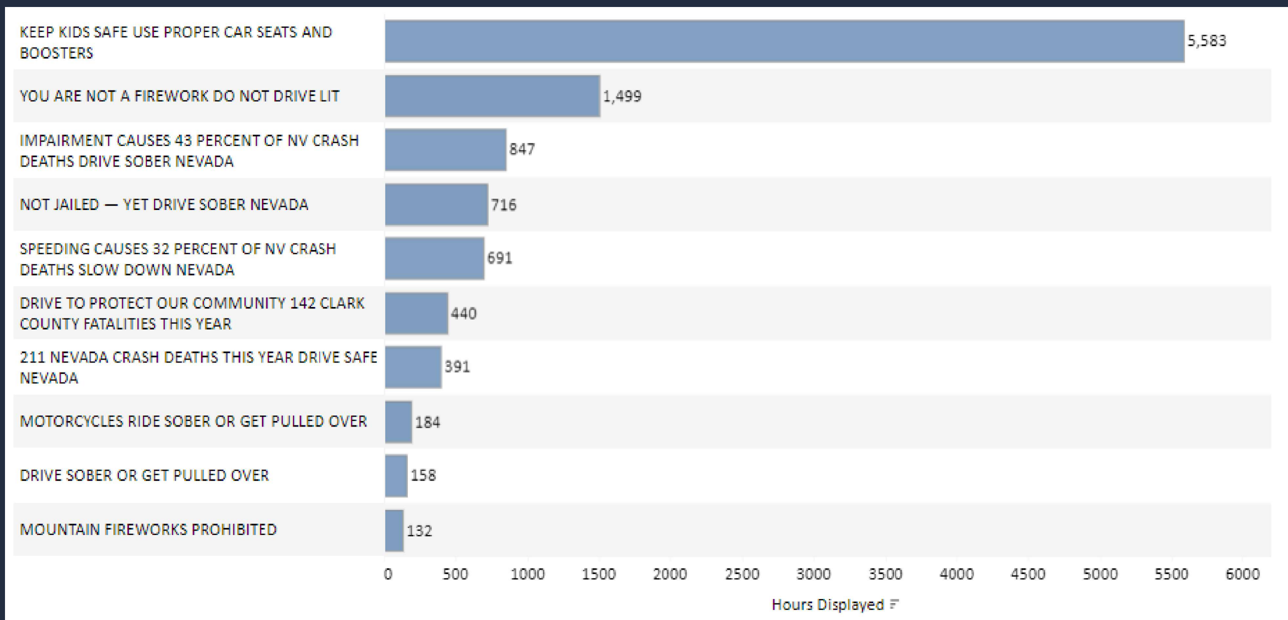
Manual Messages Posted on DMS



Manual Messages Posted on ATM Signs

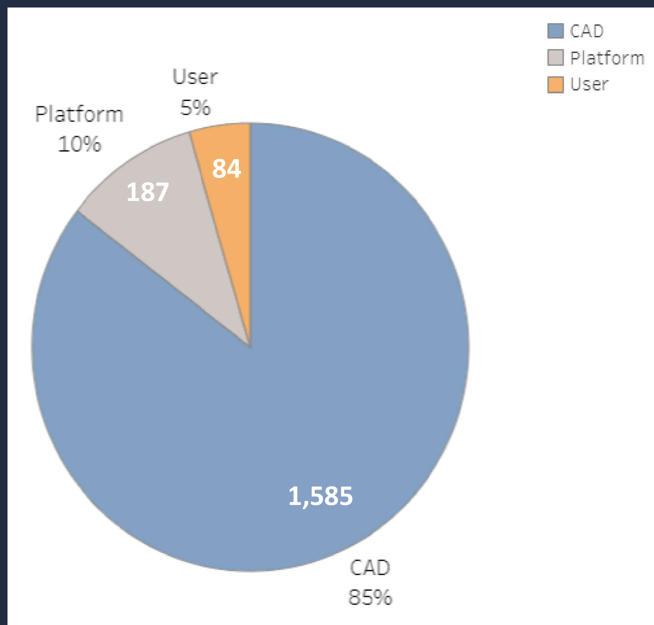


DMS Campaign Outreach



Traffic Incident Management

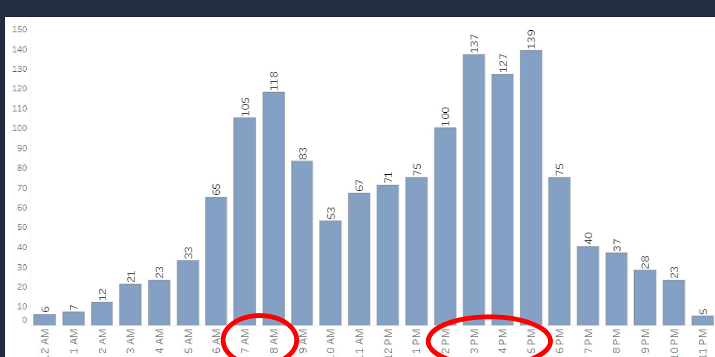
Sources of Identification



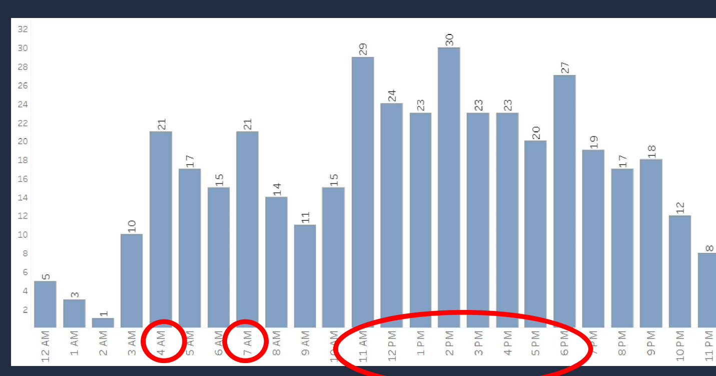
- CAD is NSP's Spillman Platform
- Platform is RTC's Rekor Platform
- Users include the RTC FAST and VegasRoads team members within the TMC Control Room

Crashes per Hour Weekdays vs Weekends (July-September 2022)

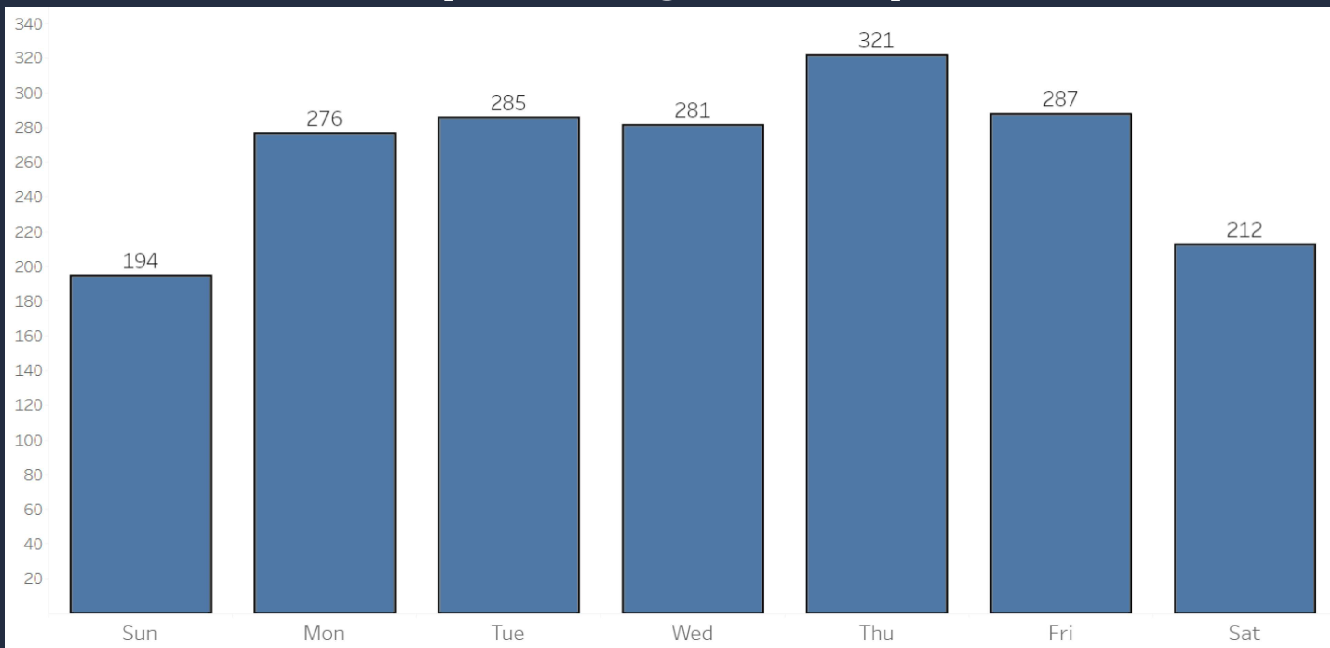
Weekdays



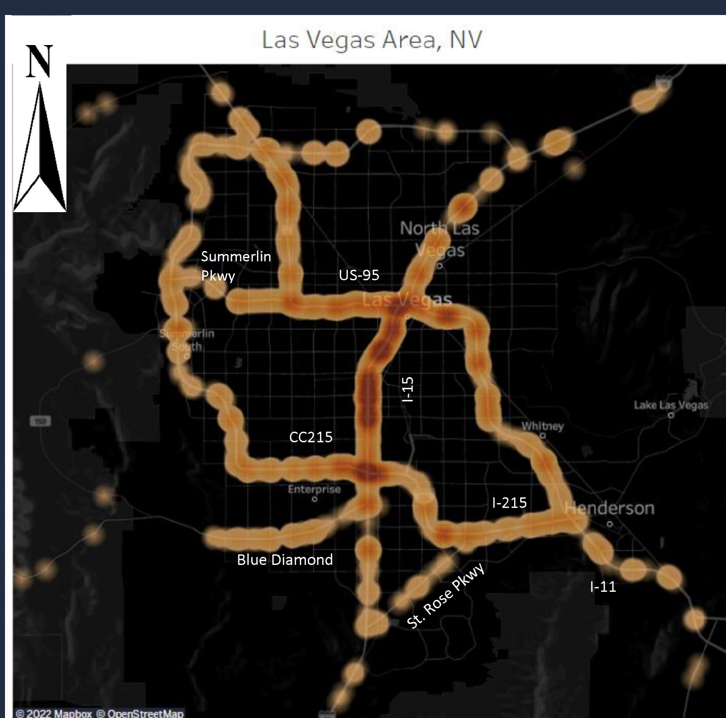
Weekends

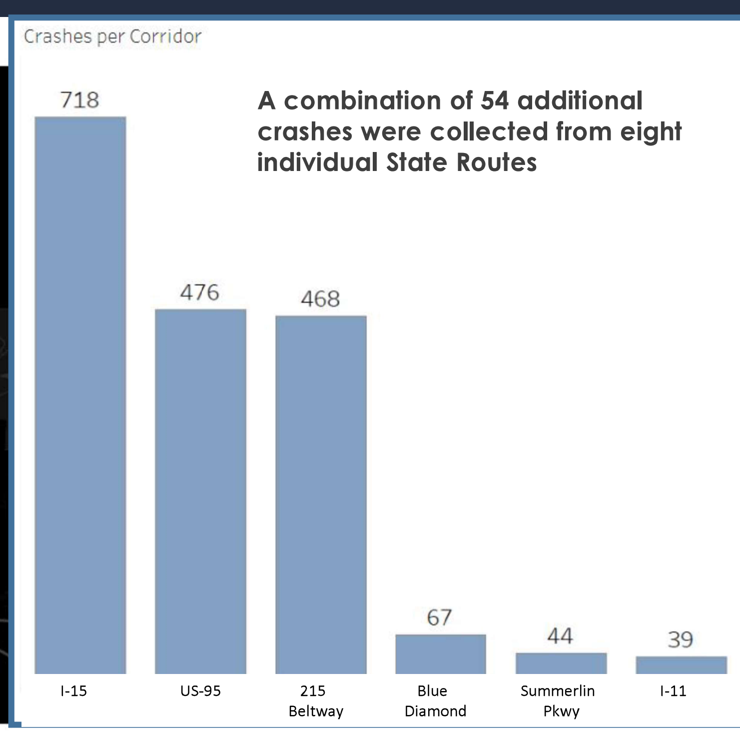


Crashes per Day of Week (July-August 2022)



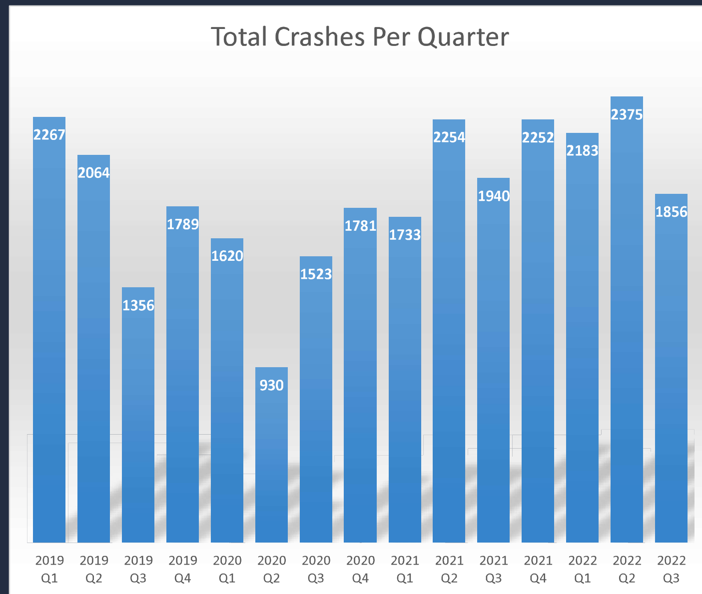
Crash Heat Map, July to Sept 2022





Total Crashes Per Quarter

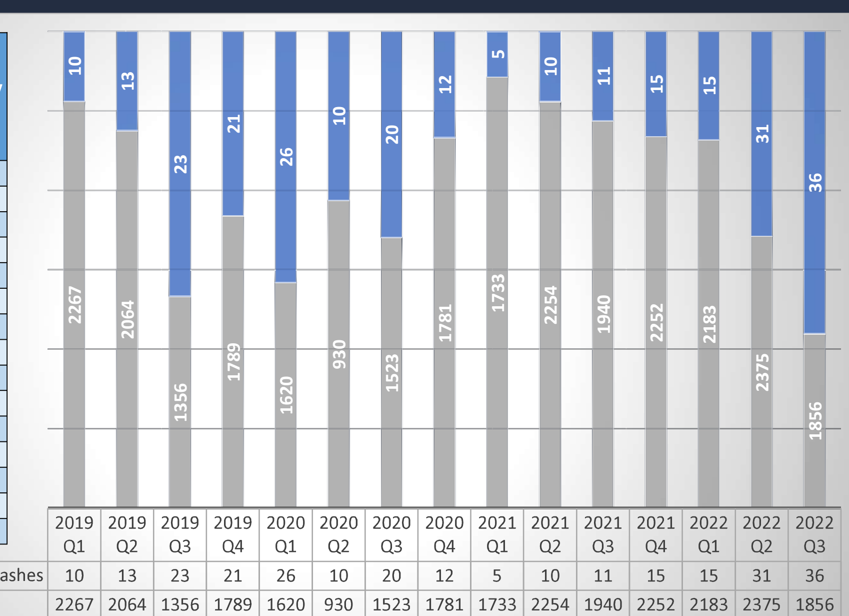
Calendar Year Quarter	Total Crashes	%Change of Total Crashes From Previous Quarter	%Change of Total Crashes from Previous Year Quarter
2019 Q1	2267		
2019 Q2	2064	-8.95%	
2019 Q3	1356	-34.30%	
2019 Q4	1789	31.93%	
2020 Q1	1620	-9.45%	-28.54%
2020 Q2	930	-42.59%	-54.94%
2020 Q3	1523	63.76%	12.32%
2020 Q4	1781	16.94%	-0.45%
2021 Q1	1733	-2.70%	6.98%
2021 Q2	2254	30.06%	9.21%
2021 Q3	1940	-13.93%	27.38%
2021 Q4	2252	16.08%	26.45%
2022 Q1	2183	-3.06%	25.97%
2022 Q2	2375	8.80%	5.37%
2022 Q3	1856	-22%	-4%



**Calendar year quarters*

Secondary Crashes Per Quarter

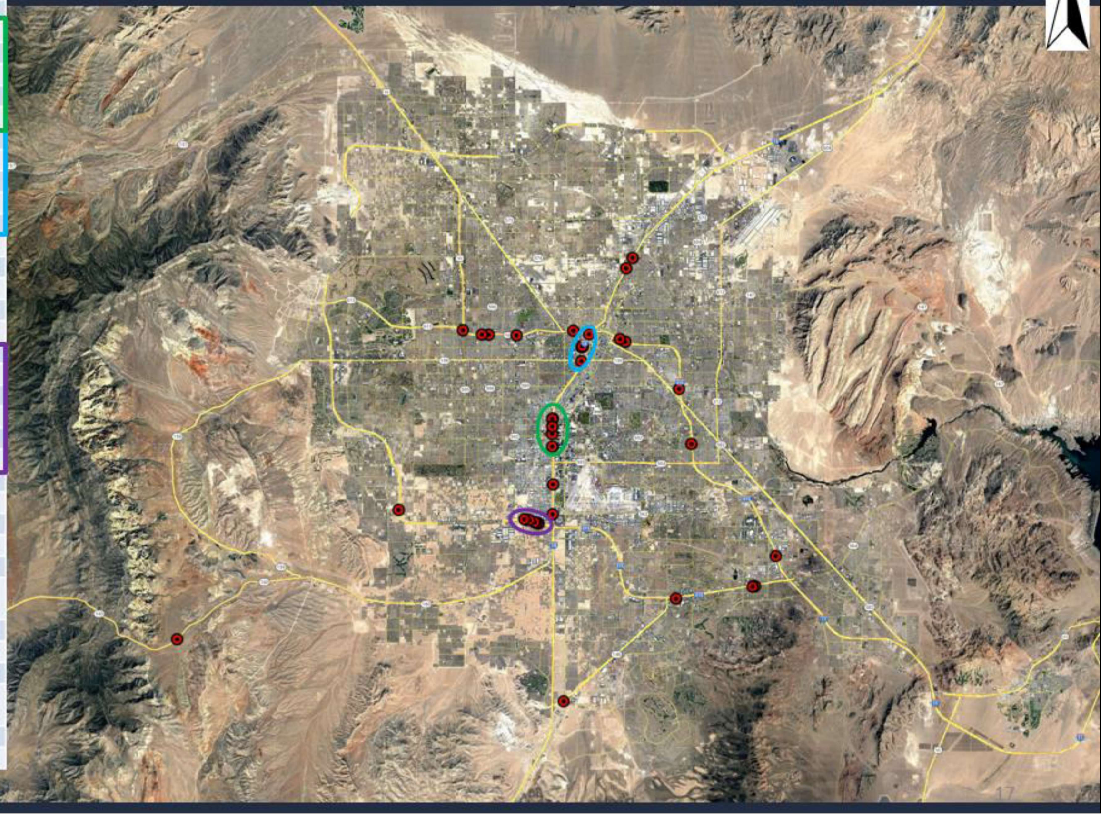
Calendar Year Quarter	Total Crashes	Number of Secondary Crashes	%Secondary Crashes
2019 Q1	2267	10	0.44%
2019 Q2	2064	13	0.63%
2019 Q3	1356	23	1.70%
2019 Q4	1789	21	1.17%
2020 Q1	1620	26	1.60%
2020 Q2	930	10	1.08%
2020 Q3	1523	20	1.31%
2020 Q4	1781	12	0.67%
2021 Q1	1733	5	0.29%
2021 Q2	2254	10	0.44%
2021 Q3	1940	11	0.57%
2021 Q4	2252	15	0.67%
2022 Q1	2183	15	0.69%
2022 Q2	2375	31	1.31%
2022 Q3	1856	36	1.94%



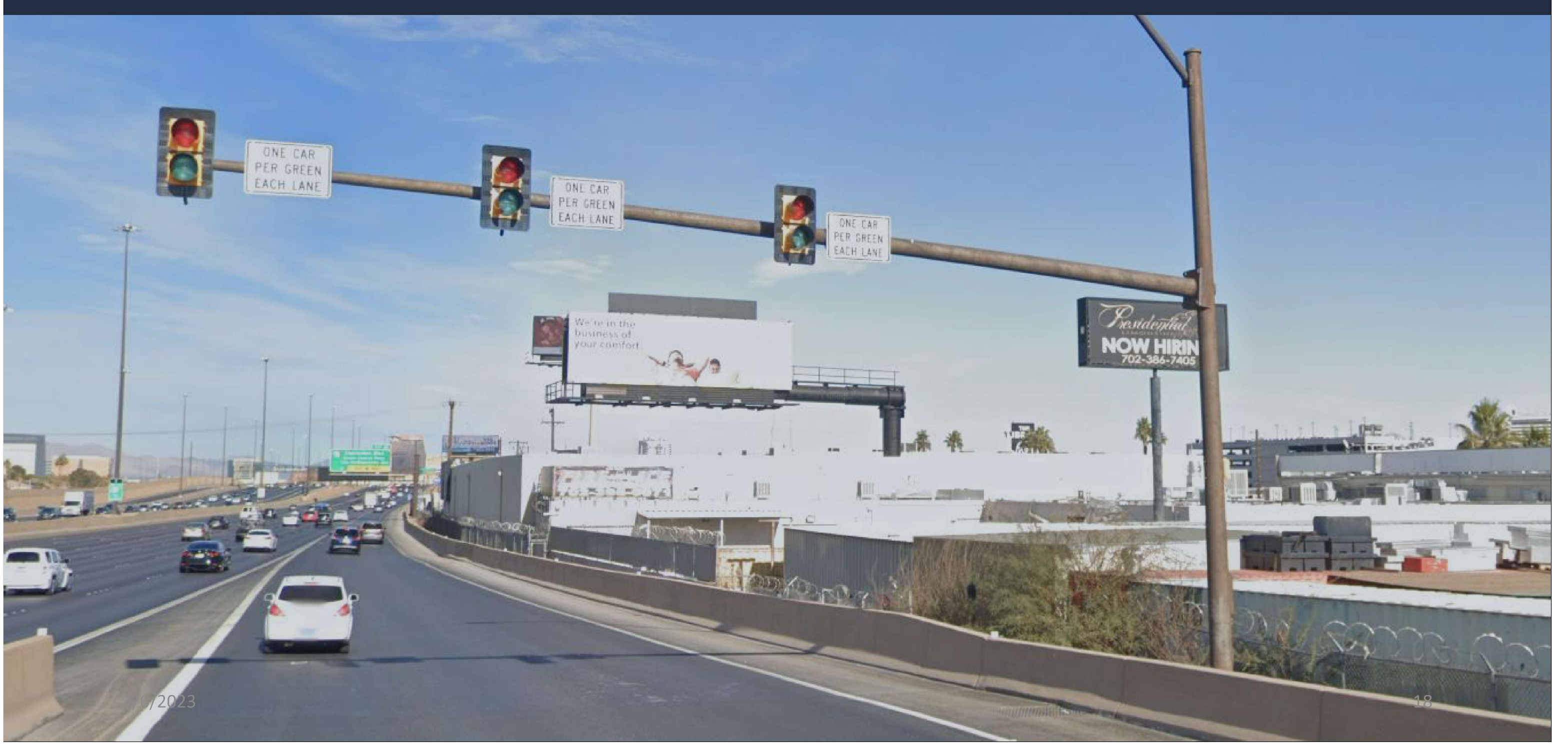
Changes in how secondary crashes are collected resulted in increased secondary crashes identified. During previous quarters, secondary crashes were obtained solely from the Rekor Platform. This data relied on FAST operators identifying if a collision appeared to be a secondary crash. In the Q2 and Q3 reporting, Rekor Platform data was combined with the correlated official NHP Brazos crash report to identify more accurate secondary crash results, which improved secondary crash identification.

Rekor ID	Corridor	Crossroad
5943763	Blue Diamond	Mile Marker 17
5830569	I 15	I-215
6313793	I 15	Russell Rd
6223581	I 15	Flamingo Road
6210682	I 15	Flamingo Road
5902115	I 15	Spring Mountain Road
5369167	I 15	Spring Mountain Road
6209039	I 15	Spring Mountain Rd
6018533	I 15	Charleston Blvd
5351370	I 15	US-95
6083190	I 15	US-95
6083455	I 15	US-95
6360879	I 15	US-95
6213905	I 15	Cheyenne Ave
5452892	I 15	SR-574/Cheyenne Ave
5609009	S 215	St Rose Pkwy
6120649	S 215	Stephanie Street
6120049	S 215	Stephanie Street
5918129	S 215	I-15 Exit 12A
6027665	S 215	I-15 Exit 12A
5675952	S 215	I-15
5720410	S 215	Decatur Boulevard
5695523	S 215	Decatur Boulevard
5569107	S 215	Decatur Boulevard
5437336	S Las Vegas Blvd	St Rose Pkwy
5635127	US 95	Sunset Rd
5490938	US 95	Flamingo Road
6374707	US 95	Boulder Hwy
5864270	US 95	Eastern Ave
5864412	US 95	Las Vegas Boulevard North
5627697	US 95	US-95
5761830	US 95	Jones Blvd
6323392	US 95	Jones Blvd
5597140	US 95	Martin L King Boulevard Off Ramp
6037751	US 95	Rainbow Blvd
6014205	W 215	Sunset Road

Secondary Crash Locations



Active Traffic Management



I-15 NB HOV Open to All Counts

Asset ID	Gantry Name	Corridor Name	Travel Direction	HOV Open To All Count
1061	I-15 NB @ N of Alta Dr	I-15 NB	NB	8
1060	I-15 NB @ N of Charleston Blvd	I-15 NB	NB	6
1059	I-15 NB @ S of Charleston Blvd	I-15 NB	NB	6
1058	I-15 NB @ S of Oakey Rd	I-15 NB	NB	6
1057	I-15 NB @ N of Sahara Ave	I-15 NB	NB	6
1056	I-15 NB @ S of Sahara Ave	I-15 NB	NB	7
1055	I-15 NB @ N of Desert Inn Rd	I-15 NB	NB	11
1054	I-15 NB @ S of W Spring Mtn Rd	I-15 NB	NB	15
1053	I-15 NB @ N of W Flamingo Rd	I-15 NB	NB	17
1052	I-15 NB @ S of W Flamingo Rd	I-15 NB	NB	18
1051	I-15 NB @ S of W Harmon Ave	I-15 NB	NB	19
1050	I-15 NB @ S of W Tropicana Ave	I-15 NB	NB	21

- This table provides the number of times the HOV lane was opened on NB I-15.
- The HOV lane was opened the most from Tropicana Ave to Desert Inn Rd
    - HOV open to all increased in this areas due to two factors-
        1. The I-15 Tropicana construction project
        2. System issues with the ATM KITS system requiring the reposting of construction zone restrictions (HOV messaging) during and after a traffic incidents that impacted the corridor and required ATM messaging
            - This issue was addressed with the vendor and has been corrected.

I-15 SB HOV Open to All Counts

Asset ID	Gantry Name	Corridor Name	Travel Direction	HOV Open To All Count
2063	I-15 SB @ N of W Russell Rd	I-15 SB	SB	5
2062	I-15 SB @ N of W Hacienda Ave	I-15 SB	SB	5
2061	I-15 SB @ N of W Tropicana	I-15 SB	SB	6
2060	I-15 SB @ S of W Flamingo Rd	I-15 SB	SB	19
2059	I-15 SB @ N of W Flamingo Rd	I-15 SB	SB	42
2058	I-15 SB @ S of Spring Mtn Rd	I-15 SB	SB	43
2057	I-15 SB @ N of Spring Mtn Rd	I-15 SB	SB	39
2056	I-15 SB @ N of Desert Inn Rd	I-15 SB	SB	6
2055	I-15 SB @ S of Sahara Ave	I-15 SB	SB	5
2054	I-15 SB @ N of Sahara Ave	I-15 SB	SB	2
2053	I-15 SB @ S of Charleston Blvd	I-15 SB	SB	4
2052	I-15 SB @ just S of W Charleston..	I-15 SB	SB	4
2051	I-15 SB @ N of Charleston Blvd	I-15 SB	SB	4

This table provides the number of times the HOV lane was opened to all on SB I-15.

The HOV lane was opened the most on I-15 SB from Spring Mtn. to Flamingo.

US-95 NB & SB HOV Open to All Counts

Asset ID	Gantry Name	Corridor Name	Travel Direction	HOV Open To All Count
6055	US 95 NB @ E of Rancho Dr	I-515 NB	NB	0
6054	US 95 NB @ W of MLK Blvd	I-515 NB	NB	0
5054	US 95 SB @ E of MLK Blvd	US-95 SB	SB	1
5053	US 95 SB @ E of Rancho Dr	US-95 SB	SB	3
5052	US 95 SB @ W of Rancho Dr	US-95 SB	SB	4
5051	US 95 SB @ E of Valley View Blvd	US-95 SB	SB	3
5050	US 95 SB @ W of Valley View Blvd	US-95 SB	SB	3

This table provides the number of times the HOV lane was opened to all on US-95.

Unplanned Incidents

Significant Crashes (July thru September 2022)

	Location	Severity	Incident sub-type	Date	Start Time	Duration	Impact	News Coverage
1	I-15 NB at Spring Mountain	Injury Crash	Crash Related to Shooting at Cromwell Casino	9/29/2022	3:16 AM	5h 40 m	Partial Closure	https://news3lv.com/news/local/1-person-injured-in-shooting-near-las-vegas-strip-victim-dropped-off-at-hospital-lvmpd-metro-police-southern-nevada-crime
2	215 Western Beltway/ Sunset Rd	Critical Incident	Suicidal Subject	7/26/2022	5:23 AM	3h 53m	Full closure in both directions	https://www.ktnv.com/traffic/police-activity-reported-on-western-beltway-of-i-215-near-sunset-rd
3	I-15 NB near MM 112	Injury Crash	Construction Zone Crash	9/11/2022	5:00 PM	1h 30m	Blocking open lane in the construction zone	N/A

Crashes were selected based on traffic impacts that provided good examples of coordination, needed resources, and Traffic Incident Management (TIM) procedures as well as incidents that provided opportunities to discuss needed improvements with TIM procedures and/or multi-agency coordination.

I-15 NB at Spring Mountain - Injury Crash

Date: Thursday, September 29, 2022 3:15 am

Corridor(s): I-15 NB

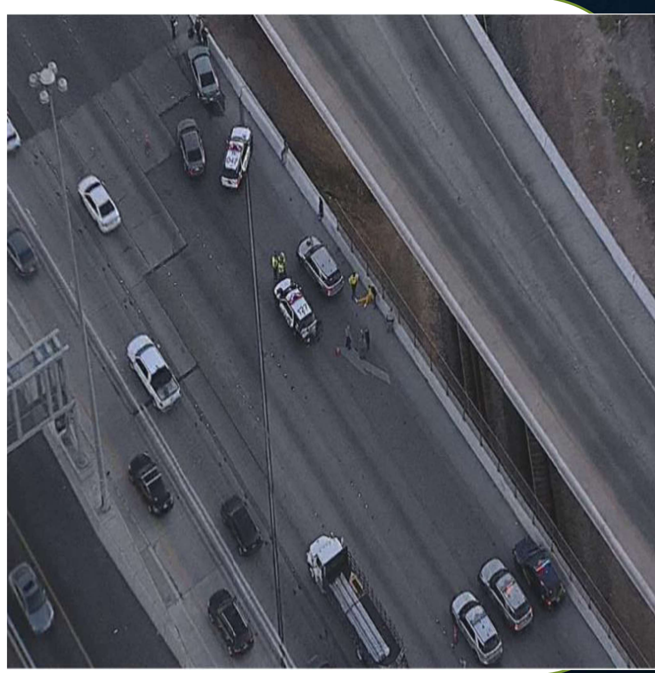
Reason: Partial Closure on I-15 NB

Duration: 5 hours 54 minutes, 3:15 am – 9:09 am

Agencies Involved: Las Vegas Metro Police, RTC FAST, NDOT, FSP, Nevada State Police (aka NHP)

ITS Devices Used:

- DMS – 1 (NB 15 Blue Diamond), 13 (NB 15 Sunset Rd), 105 (WB 215 Eastern Ave), 106 (EB 215 at Jones Blvd)
- Gantries Used : I-15 NB from Tropicana to Spring Mountain
- CCTV Cameras – System wide camera network to monitor system. 114-121 (along I-15 NB/SB), 500-502 (I-215 at I-15 EB/WB), 601-608 (I-215 from Las Vegas Blvd to Windmill Ln EB/WB and also Airport connector ramps from Airport)



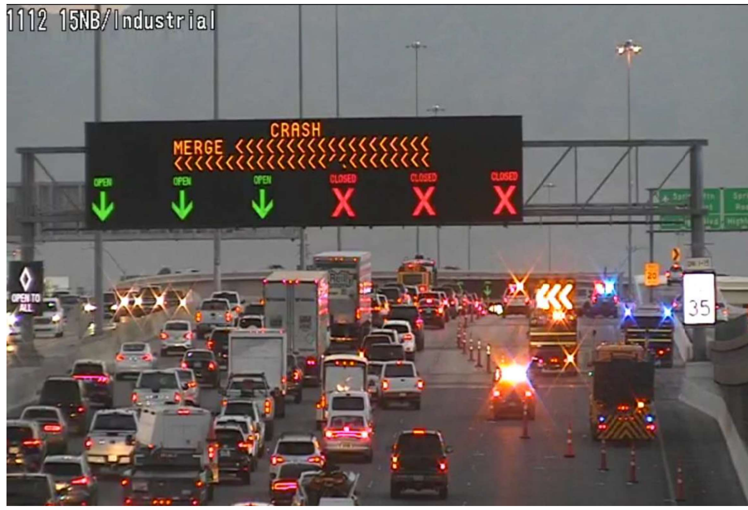
I-15 NB at Spring Mountain - Injury Crash

Scene/Event Synopsis:

- Injury crash involving at least 2 vehicles causing the closure of the 3 right lanes on Northbound I-15. It was later determined that the vehicles may have been involved in a shooting that occurred at the Cromwell located at Flamingo Rd & Las Vegas Blvd earlier that morning. Las Vegas Metro Police arrived on the scene to take over the investigation.

FAST Response:

- Traffic signal team was advised to monitor intersections for increased queueing on ramps
- Gantry Modifications: Activated pre-warning yellow caution arrows prior to the crash scene on NB I-15 at Tropicana Ave and Flamingo Rd in addition to pre-warning crash messages. At the scene, added a red X for lane closures of the right lanes
- Waze Alerts: sent out alerts every 30-45 minutes and once the scene was cleared
- Sent #FASTAlert Text Messages, Email Messages, and Tweets



I-15 NB at Spring Mountain - Injury Crash
SWOT Analysis

Strengths-

- NHP and LVMPD did an excellent job in managing the scene and reducing the size of the incident as it was mitigated by opening additional travel lanes when able.
- Traffic signal staff were available to monitor and adjust intersection timing at I-15 NB and SB on/off ramps to allow the increased queues at Russell Rd, Tropicana Ave, and Flamingo Rd.
- LV Roads posted gantry messaging on the NB I-15 corridor for pre-warning from Flamingo Rd to Tropicana Ave. FAST staff then made adjustments to the NB I-15 gantries and added DMS messaging on NB I-15 at Blue Diamond Rd and on EB/WB I-215 DMS boards at Jones Blvd, Eastern Ave, and Gibson Rd.

Weaknesses-

- FAST signal technicians had signal system (ATMS) go offline which affected their ability to make any changes to intersections.
- Minimum Estimated Closure TIME (MECT) – MECT is a TIM supported strategy where upon arrival to an incident first responders conduct a scene size up assessment and provides a Minimum Estimated Closure Time notification. This advance notification assist all other responding agencies to assess required resources to manage the long term closures and allows for transportation agencies the ability to develop a traffic impact plan to mitigate current and future congestions throughout the incident operational period.

Opportunities-

- Continue to build relationships with agencies and increase awareness of all resources that RTC/FAST can provide such as signal timing monitoring/adjustments as well as advanced pre-warning messaging.

Threats –

- There were concerns about potential secondary crashes due to the location of the incident, time (during peak morning travel), and reduction of lanes (from 6 to 3). Additionally, the traffic queues at ramp terminals signals created spillback at the on/off ramps along the corridor. There was no capability to alter the timing of traffic signals due to the program being down.

I-15 NB at Spring Mountain - Injury Crash
SWOT Analysis

Recommendations:

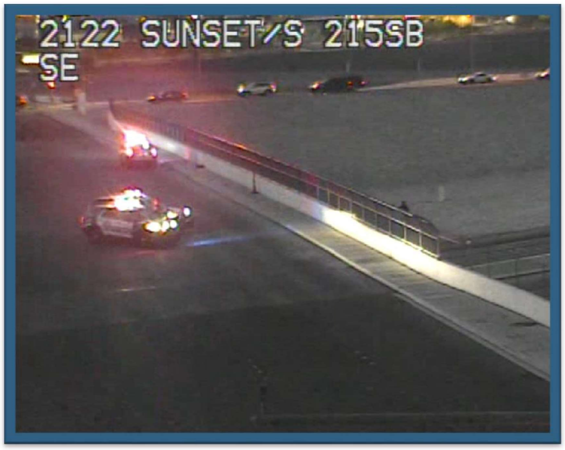
Interagency Operations- Establish a procedure to gain early notification of Minimum Estimated Closure Times (MECT) from emergency responders on seen. Without this information other responding agencies can not establish a plan for long-term closures. Resources needed as per MUTCD requirements are delayed, Transit bus routes are significantly delayed, advance Dynamic Messaging Systems (DMS) notifications are not expanded, GPS navigation devices are not updated to prevent traffic from entering these long term closures and the media is unable to inform the commuting public.

Significant Crashes (July thru September 2022)

	Location	Severity	Incident sub-type	Date	Start Time	Duration	Impact	News Coverage
2	215 Western Beltway/ Sunset Rd	Critical Incident	Suicidal Subject	7/26/2022	5:23 AM	3h 53m	Full closure in both directions	https://www.ktnv.com/traffic/police-activity-reported-on-western-beltway-of-i-215-near-sunset-rd

215 Western Beltway/Sunset Rd – Critical Incident

- **Date:** Tuesday, July 26, 2022 5:15 am
- **Corridor(s):** 215 Western Beltway closed in both directions from Russell Rd to Durango Dr. Additionally, Sunset Rd was closed from 215 Beltway to Quarter House Ln.
- **Reason:** Full Closures of 215 Western Beltway and Sunset Rd due to a suicidal subject on the bridge.
- **Duration:** 3 hours 53 minutes, 5:23 am - 9:16 am
- **Agencies Involved:** RTC FAST, LVMPD, NSP
- **ITS Devices Used:**
  - DMS – none available
  - Gantry – none available
  - CCTV Cameras – System-wide camera network to monitor roadways. 2227 Sunset Rd/NB 215 ramp, 2122 Sunset Rd/SB 215 ramp, 2036 Durango Dr/WB 215 ramp, 2226 Durango Dr/EB 215 ramp, 2193 Russell Rd/ NB 215 ramp, 2194 Russell Rd/SB 215 ramp, 2141 Tropicana Ave/ NB 215 ramp, 2142 Tropicana Ave/SB 215 ramp, 2478 Ft Apache/Sunset, 2999 Fort Apache Rd/NB 215



215 Western Beltway/Sunset Rd – Critical Incident

Scene/Event Synopsis:

- Suicidal subject on Sunset Rd Bridge over 215 Beltway. The Beltway was closed in both directions from Russell Rd to Durango Dr.

FAST Response:

- Traffic Signal Timing modifications made to Sunset Rd approaching the 215 Beltway area, Russell Rd and 215 Beltway area, Durango Dr and 215 Beltway area, Tropicana Ave and 215 Beltway area.
- Waze Alerts: sent out alerts every 30-45 minutes and once the scene was cleared
- Sent #FASTAlert Text Messages, Email Messages, and Tweets

215 Western Beltway/Sunset Rd – Critical Incident

SWOT Analysis

- **Strengths:**
  - Once advised of incident, Traffic Signal Team was immediately advised to begin making signal timing changes for ramps on Sunset Rd, Russell Rd, Durango Dr, and Tropicana Ave to facilitate active traffic management.
  - NSP were able to divert traffic using the auxiliary road (Rafael Rivera Wy/Roy Horn Wy) along 215 Beltway.
- **Weaknesses-**
  - No DMS boards are available in or around the affected area for advanced notification purposes.
- **Opportunities-**
  - Continue to build relationships with partner agencies to provide consistent updates of duration of closure.
- **Threats-** Potential for secondary crashes due to the buildup of queues along 215 Beltway and lack of DMS advance messaging.
  - Traffic traveling the wrong way on the Tropicana on-ramp to SB 215 Beltway
- **Recommendations:**
  - **Interagency Operations-** Establish a procedure to gain early notification of Minimum Estimated Closure Times (MECT) from emergency responders on seen. Without this information, other responding agencies can not establish a plan for long-term closures. Resources needed as per MUTCD requirements are delayed, Transit bus routes are significantly delayed, advance Dynamic Messaging Systems (DMS) notifications are not expanded, GPS navigation devices are not updated to prevent traffic from entering these long-term closures and the media is unable to inform the commuting public.

Significant Crashes (July thru September 2022)

	Location	Severity	Incident sub-type	Date	Start Time	Duration	Impact	News Coverage
3	I-15 NB near MM 112	Injury Crash	Construction Zone Crash	9/11/2022	5:00 PM	1h 30m	Blocking open lane in the construction zone	N/A

I-15 NB near MM 112 – Injury Crash

Date: Sunday, September 11, 2022 5:00PM

Corridor(s): I-15 North, SR-170 MP 112 (South of Mesquite)

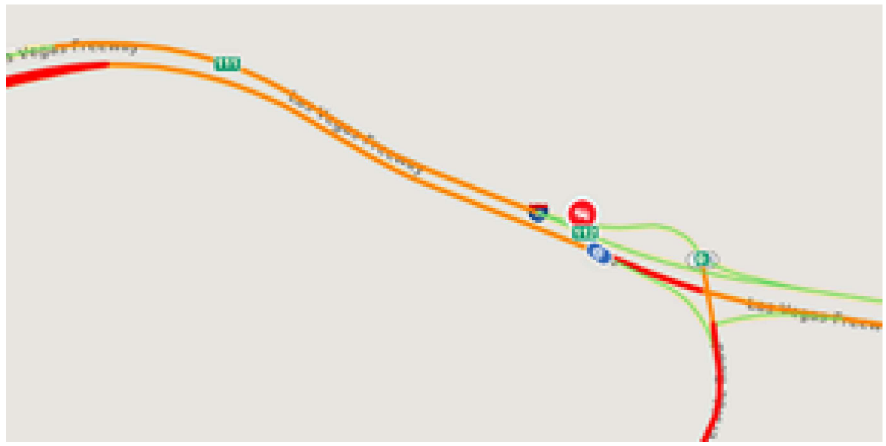
Reason: Injury Crash in Construction Zone with Full blockage of Highway in NB direction

Duration: 1.5 hours, 5:06 pm-6:38 pm

Agencies Involved: NDOT, RTC FAST, NHP

ITS Devices Used:

DMS – 58, 16, & 17 (DMS 93 offline)
CCTV Cameras – 330, 329

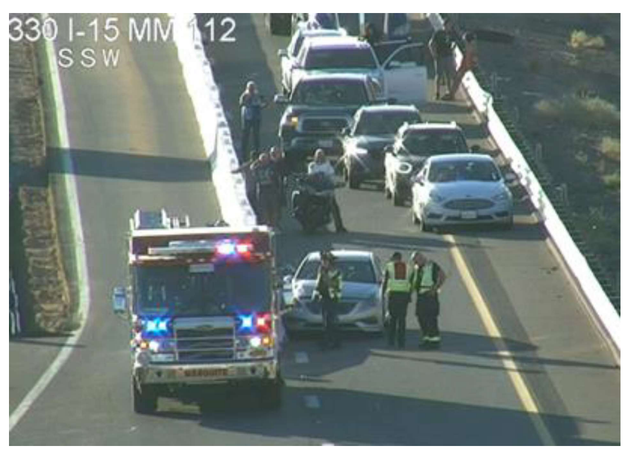


I-15 NB near MM 112 – Injury Crash

- **Scene/Event Synopsis-**

Active construction zone paving operation with highway reduced to one lane with lanes separated by a hard barrier.

Vehicle collided with a tractor trailer prior to SR-170 exit ramp. The subject was transported by air unit from the scene.



- **FAST Response:**
    - DMS Safety/Detour Messaging
    - Waze Alerts #FASTALERT Twitter, SMS Text Messages, & Email Messages
    - Admin/Media Alert/Documentation, Email-Freshdesk
    - NHP Dispatch Communication/Advisement

I-15 NB near MM 112 – Injury Crash
SWOT Analysis

Strengths-

- Good Communication with NHP Dispatch, Rural DMS 16 & 17 online.
- The camera feed was stable with a clear view of the incident location.

Weaknesses-

- DMS 93 (Speedway) Offline, Lack of additional upstream DMS.
- TIM safety concerns identified
  - Quick clearance - Did not push the vehicle off roadway resulting in it blocking all NB travel lanes. Once traffic was allowed to go around the vehicle, there was no traffic control setup to protect the scene.

Opportunities-

- Ability to build relationships with partner agencies to increase their understanding of the value in the quick clearance of blockages and providing estimated times of roadway closure and the resources FAST can help provide with public notifications.

Threats-

- Long-term traffic impact due to vehicle left in a single construction zone lane with little coordination for clearing lanes
- No traffic control established in travel lanes (Scene Safety Risk)

I-15 NB near MM 112 – Injury Crash

Recommendations-

- **TMC Operations-** Repair and increase Rural ITS infrastructure/communications in area. Develop Detour Scenarios & Rural/ETO response Plans.

- **Interagency Operations-** Address TIM safety considerations such as setting up traffic control to protect the incident, wearing traffic vest, and exercising quick clearance strategies. Cross agency communication with Minimum Estimated Closure Times (MECT) notification to aid in the ability to initiate appropriate long term or **singular traffic failure point** resolution traffic plans. This information will also help us coordinate with I-15 Coalition Partners, commercial and passenger vehicles traveling through Nevada.

Data Source Notes

- **Real-Time Traveler Information**
  - #FASTAlert Data was obtained from RTC's GovDelivery Account.
  - DMS and Gantry message data was obtained from KITS.
  - DMS data does not include test messages.
  - New Govdelivery & Waze data for incidents versus construction
- **Traffic Incident Management**
  - Filtered crash data was downloaded from Rekor and Brazos to prepare this Quarterly Report.
  - Crash data filters included:
    - Time Period of Current Quarter
    - Type = Crash
    - Status = Completed
    - Severity = Property, Injury, and Fatal
    - Corridor and Crossroad = I-15, US-95, I-515, I-11, Blue Diamond, Summerlin Pkwy, Beltway, 215, Ramp Terminals, St Rose Parkway, CD Road
    - Source = CAD, Platform, FAST users, and VegasRoads users. *It does not include FSP.*
    - End Reason = Incident Resolved, Incident with no Traffic Impacts, Not Requested, and Other
- **Active Traffic Management**
  - HOV Lane Use Data was obtained from KITS.
  - Crash and Construction Project summaries were obtained from Rekor and RTC's FreshDesk Platform.
- **Secondary Crashes**
  - Rekor Platform
  - Brazos crash data maintained by the Department of Public Safety Office of Traffic Safety

Endnotes

[I] INRIX Trip Trends, seasonally adjusted VMT compared to pre-COVID baseline
[II] United States Bureau of Labor Statistics, Not seasonally adjusted Unemployment Rate
[III] INRIX Trips for Financial Services, Market Trends Sample
[IV] United States Census Bureau. Table 16, Summary of General Characteristics: 1970. The Nineteenth United States Census, Nevada 30 - 23.
[V] Federal Highway Administration and Federal Transit Administration. Statewide Transportation Planning; Metropolitan Transportation Planning. Final Rule. § 450.322
[VI] OnTheMap, U.S. Census
[VII] Does Travel Time Reliability Matter? – Primer, FHWA, October 2019
[VIII] Bureau of Transportation Statistics. (2017). Freight Facts and Figures 2017, U.S. Department of Transportation, Washington, DC. Available online: https://www.bts.gov/sites/bts.dot.gov/files/docs/FFF_2017.pdf, last accessed May 22, 2018.
[IX] Open Route Service, isochrones calculation, May 10th, 2022, Mode "Road Bike"
[X] 2014 Southern Nevada Household Travel Survey
[XI] 2014 Southern Nevada Household Travel Survey
[XII] https://onboardsnv.com/
[XIII] Nevada DOT 2018 HOV Plan Addendum
[XIV] Generalized from The Multiple Discrete-Continuous Extreme Value Model with fixed costs, Reto Tanner and Denis Boldue, https://mpra.ub.uni-muenchen.de/id/eprint/41452
[XV] Federal Highway Administration. Figure 2, Congestion Management Process: A Guidebook