RE IMAGINE BOULDER HIGHWAY

BOULDER HIGHWAY

Multimodal Transportation Investment Study

APRIL 2020

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EXECUTIVE SUMMARY

Boulder Highway, or State Route 582, is a major 15.4-mile-long arterial located on the east side of the Las Vegas Valley. The highway was built in 1931 and the original purpose was to connect the Five Points area, which is at Charleston Boulevard and Fremont Street intersection near Downtown Las Vegas, to Railroad Pass in Henderson and later extended to provide access for the construction of the Hoover Dam. Development over the years along the highway was auto-oriented and has created a corridor that encourages high-speed travel. The roadway's expansive footprint also contributes to high speeds and an elevated number of crashes and pedestrian fatalities. In September 2015, the Southern Nevada Pedestrian Safety Task Force raised awareness of this problem and recommended that the reasons for these fatalities on Boulder Highway be examined.

The purpose of the Boulder Highway Multimodal Corridor Investment Study is to develop a plan that would identify and analyze potential improvements to Boulder Highway. The intention of these improvements is to improve safety for all modes of travel along the corridor by transforming the character of Boulder Highway from a corridor designed for vehicle travel to a urban corridor able to support and encourage all modes of transportation.

This report shows how the Boulder Highway can be re-imagined and by allocating the right-of-way based on the needs of all users. The report also identifies overall transportation system and safety improvements and cost estimates. Special consideration is given to technology solutions specifically suited to the corridor. The study also evaluates the impact on traffic operations along Boulder Highway resulting from possible major developments on adjacent land.

The Boulder Highway Multimodal Transportation Investment Study (MTIS) is a coordinated effort among many local agency staff, elected officials, business owners, advocacy groups, and other stakeholders who actively participated in the development of this study under the leadership of the Regional Transportation Commission of Southern Nevada (RTC) and Nevada Department of Transportation (NDOT).

A Technical Advisory Committee (TAC) was created with representatives from partner agencies, the Boulder Highway Coalition, Town Board representatives, and major businesses along the corridor. Stakeholder engagement was supported by an extensive public outreach effort.

Stakeholders and the public were actively engaged in a six-step process that corresponded to phases, decision points, and outcomes along the way.

GOALS AND VISION

The first step in the process focused on identifying the important issues, the biggest challenges, and the stakeholder aspirations to create a livable corridor. Through open conversations, stakeholders identified what will make this plan successful, which ultimately led to defining the goals shown in Figure ES.1.

These goals are an indication that mere safety improvements are not sufficient. Reliable and timely access to services, employment centers, and educational opportunities is needed to enhance the economic outlook of the corridor.

To determine changes needed on the current Boulder Highway transportation infrastructure and supporting policies and strategies to accomplish the goals, the stakeholders took a deep look into what the future might look like and developed a vision for the corridor. The 15.4-mile long corridor Boulder Highway traverses many communities with different contexts. The six character areas shown in Figure ES.2 were defined for the Boulder Highway study area based on land use context categories.

For each segment of the corridor stakeholders anticipated changes to the current land use composition and build form. These changes are envisioned to be supported by a multimodal boulevard that maintains consistency through the entire length while using design elements to distinguish context areas. Five options were developed by the stakeholders to convey their vision for the corridor.

FIGURE ES.1 CORRIDOR GOALS

CURRENT PROBLEMS

Identifying the problems Boulder Highway faces today that might prevent the communities from accomplishing the goals and corridor vision is the starting point in developing solutions. The data collected, and the analysis of the existing conditions led to the development of clear and straightforward problem statements that are linked directly with the identified goals.

Managing Walking Distances. The configuration of Boulder Highway and the long distances of buildings from the pathways discourage the use of crosswalks.

Infrastructure Continuity, ADA Accessibility, and Sidewalk Design. Lack of sidewalk continuity, ADA Accessibility, and poor sidewalk design from the age of this corridor contribute to increased pedestrian travel time between destinations and make pedestrian journeys along the corridor difficult.

Ease of Street Crossing. Pedestrians have difficulty negotiating large, complex intersections and crossing the street at controlled and uncontrolled locations.

Lack of Roadway Pedestrian-Scale. This is observed along the entire corridor and is more critical in areas with high pedestrian activity. The ample ROW promotes high vehicular speed and low reaction time, which has resulted in higher numbers of fatal accidents and serious injuries.

Transit Trip Reliability. People count on reliable transit to get where they need to be within an expected period of time. Factors identified to have a large impact on transit trip reliability include: inconveniently low frequency on crossing/connecting bus routes, long street crossing distances, and long signal cycle lengths that increase pedestrian delay.

Limited Transit Stop Amenities. Transit stops do not fully serve travelers' needs and have limited amenities.

Exposure to Climate Events. People walking and bicycling are more vulnerable to the effects of climate and weather while traveling.

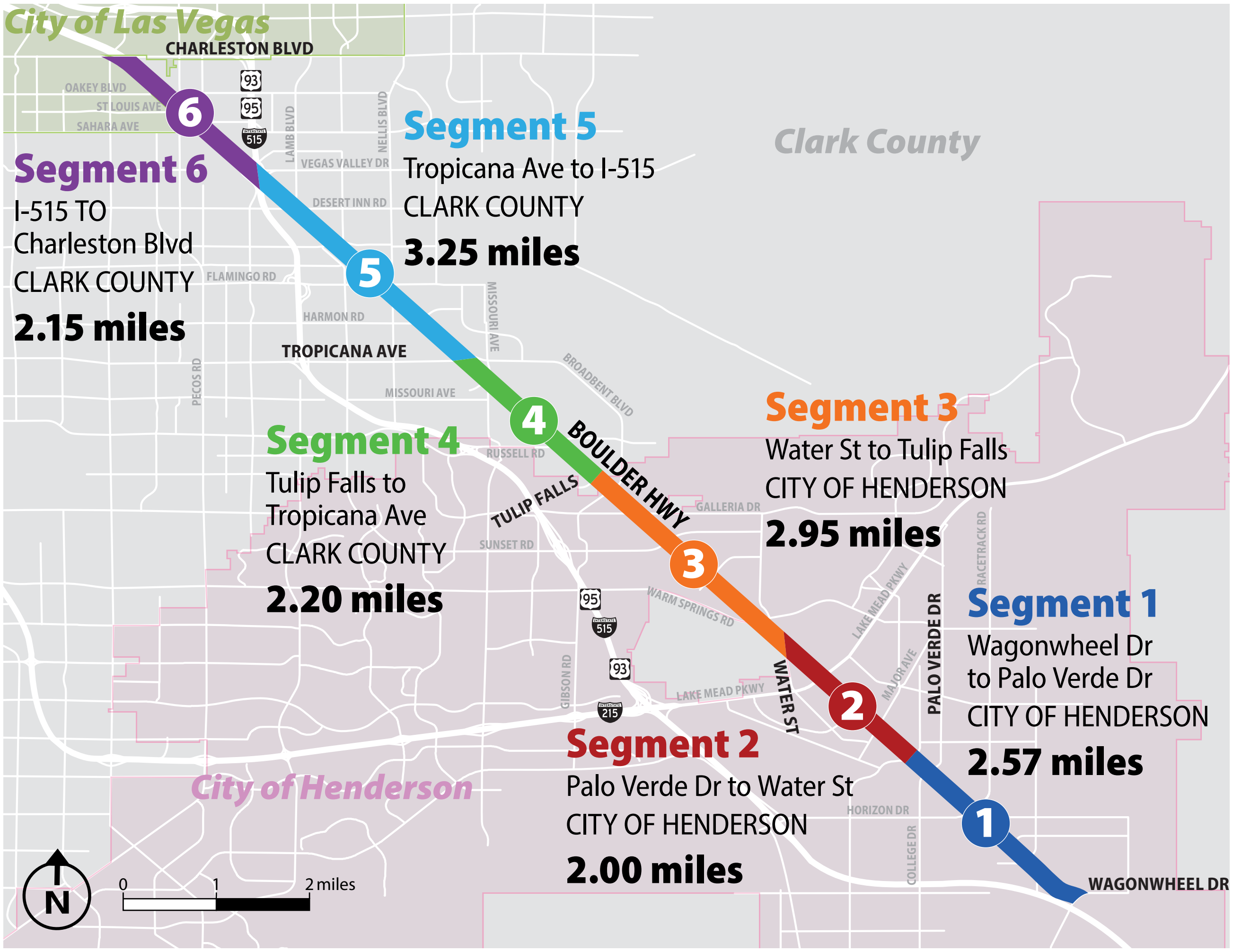

FIGURE ES.2 CHARACTER AREAS ALONG BOULDER HIGHWAY

Access to Desired Uses. Access to desired uses is challenging for pedestrians, bicyclists, and transit users because of long distances from transit stations and pedestrian and bicycle facilities.

Inconsistent Lighting and Insufficient Visibility. Lighting is not consistent along the corridor. While many signalized intersections have sufficient lighting, this is not the case away from these locations. This situation places alternative modes at a disadvantage compared to vehicular traffic.

Access Management and Driveways. Closely spaced driveways increase the number of conflict points for vehicles, pedestrians, and bicyclists.

Side Street Access. While the corridor favors traffic progression along Boulder Highway, analysis indicates that the predominant trips on this corridor are from local side streets. This results in challenges making right turns from side streets and creates operational challenges at skewed intersections.

The corridor vision developed by the stakeholders and the identified problems guided the process of developing a tool box of solutions for pedestrian and bicycle facilities, transit, demand management, and lighting. These solutions were methodically integrated into a series of options that were evaluated based on the established goals and led stakeholders to the development of a preferred concept.

PROPOSED CONCEPT

The proposed concept aims at transforming Boulder Highway into a boulevard. Boulevards are tree lined roadways that utilize medians, landscaping and other streetscape features to separate the modes of transportation. Through separating modes, the concept will repurpose existing street space to accommodate a more efficient means of transportation and increase accessibility to locations along the corridor. The concept is a traditional boulevard that maintains the existing minimum 178-foot-right-of-way and utilizes these features to separate realms for higher speed through vehicular traffic and slow-paced vehicular-bicycle-pedestrian movements as shown in Figure ES.3.

The distinct transportation realms provide a high degree of flexibility, offering the local agency stakeholders the opportunity to configure the spaces within the realms in a manner that is best suited for their existing or future uses while maintaining a level of consistency along the 15.4 mile corridor.

The through realm is located in the center of the roadway and is designed for two lanes of traffic and a center running transit lane for the entire length of the corridor. The proposed concept aims at implementing a system that would potentially meet the requirements of Bus Rapid Transit (BRT) and allowing flexibility for other types of transit vehicles, such as rail. Medians and center stations will provide traffic calming effects and allow for shorter crossing distances from the pedestrian realm. Narrower travel lane widths can also be implemented to further reduce vehicular speed and crossing distances which will improve pedestrian safety in the corridor. Investment in ITS infrastructure and implementation of several ITS strategies will be integrated with this concept to improve travel reliability for vehicular traffic on the corridor.

The pedestrian realm is a slower speed zone on both sides of the roadway and intends to increase the safety and security of pedestrians and cyclists, comfort, and improve access to desired land uses. This realm supports land uses and activities that are conducive to transit and increases accessibility for alternative modes. In return, increased accessibility will help raise property values and attract new

FIGURE ES.3 TRADITIONAL BOULEVARD CONCEPT

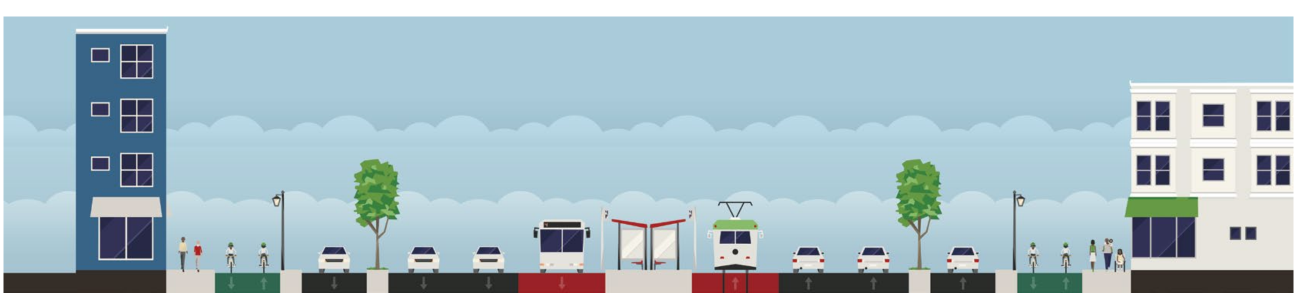

FIGURE ES.4 MULTI-WAY BOULEVARD

development along the corridor. The reconfiguration of the corridor will allow for addressing all ADA deficiencies through the design process by implementing the most current design standards. The traditional boulevard concept shown in Figure ES 3 includes dual cycle tracks, wide sidewalks, pedestrian scale lighting and landscaping or linear parks. This concept can be easily transformed into a multiway boulevard concept by reconfiguring the pedestrian realm to incorporate access lanes, as shown in Figure ES.4. The access lanes can be utilized to address access management issues arising from closely spaced driveways or where additional capacity is needed.

The concept also recommends pedestrian crossings every ⅛ to ½ mile and light-emitting diode (LED) corridor wide lighting and smart lighting for the entire length of the corridor. The increased frequency will reduce the need for pedestrians to cross at undesignated locations reducing the potential for crashes LED roadway lighting and pedestrian-scale lighting will improve uniformity, eliminate dark spots and enhance pedestrian visibility at night. Smart lighting, designed to increase brightness in presence of pedestrians, will be incorporated at the pedestrian crossing locations and transit stations.

The proposed concept that encourages mixed-use development, parks and open space, and changes in built form are envisioned to promote the use of alternative travel modes, maintain vibrancy of the corridor, and improve quality of life.

IMPLEMENTATION PLAN

The implementation of the proposed concept will require continuous involvement of state and local agencies, as well as the stakeholders along the corridor. As part of this plan a policy framework was developed to make the implementation of this plan feasible. This framework includes the plan components, implementation phasing, steps to be taken to implement this plan, and associated costs of implementing identified components of this plan. The implementation of the proposed concept of Boulder Highway will be conducted in three phases: Early Action, Phase I, and Phase II, offering the flexibility of implementing the concept in sections depending on the amount of funding available at a point in time.

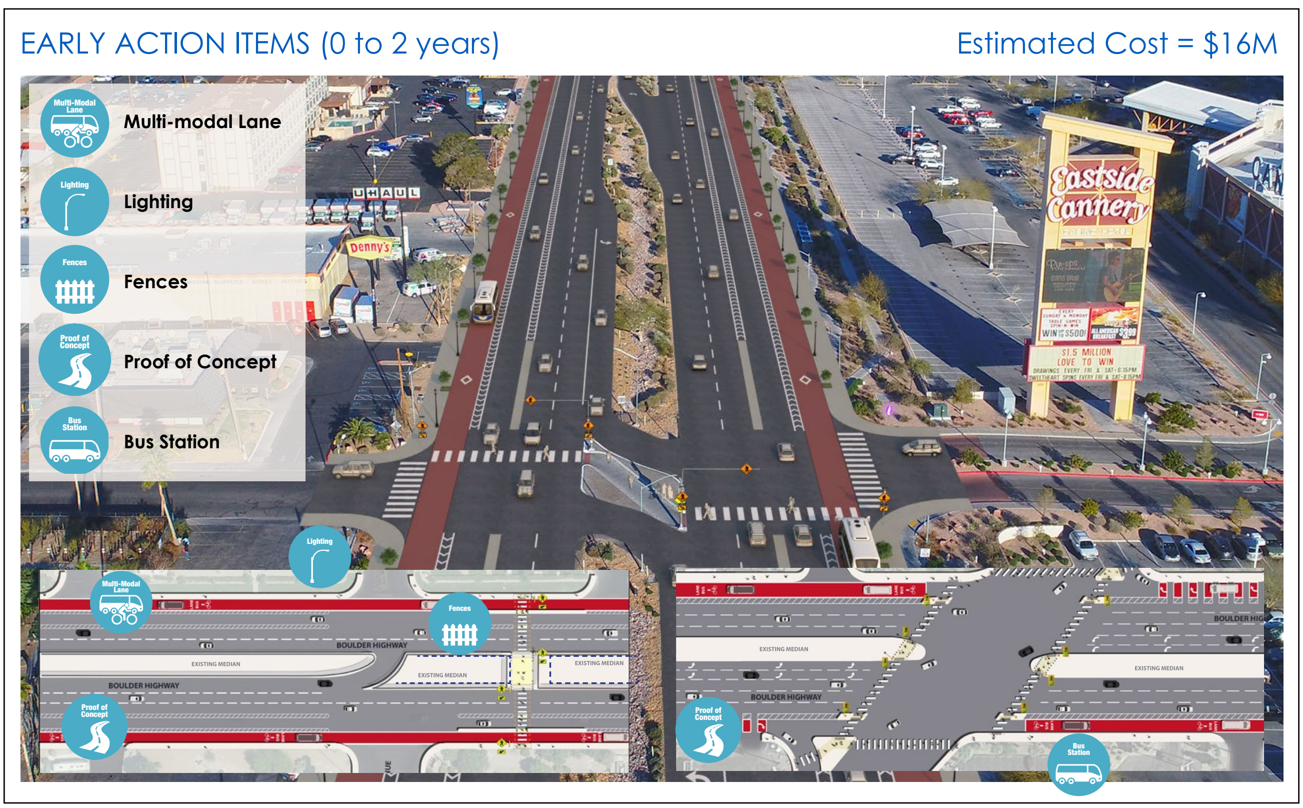

FIGURE ES.5 EARLY ACTION PHASE IMPROVEMENTS AND COST ESTIMATE

PHASE 1 - COMPLETE STREETS (2 to 5 years) Estimated Cost = $85-90M

FIGURE ES.6 PHASE I IMPROVEMENTS AND COST ESTIMATE

The Early Action Phase will address safety issues of high importance in the corridor and will set the stage for the subsequent implementation phases. Figure ES.5 shows the improvements proposed for this phase.

Phase I will focus on implementing Complete Streets improvements in the proposed concept. During this phase, the transit vehicles will operate in dedicated side running guideway which will use the space that is ultimately dedicated for bicycles until Phase II. Figure ES.6 shows the improvements proposed for this phase.

Phase II focuses on implementing the remaining components of the ultimate concept, including the center-running BRT, conversion of side-running transit lane to cycle track, and deployment of Connected Vehicles and Autonomous Vehicles (CVAV). Figure ES.7 through Figure ES.11 show some visual examples of how the concept can be implemented along the corridor.

FIGURE ES.7 PHASE 2 IMPROVEMENTS AND COST ESTIMATE

FIGURE ES.8 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE WITH ACCESS LANE LAYOUT

FIGURE ES.9 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE WITH ACCESS LANE LAYOUT

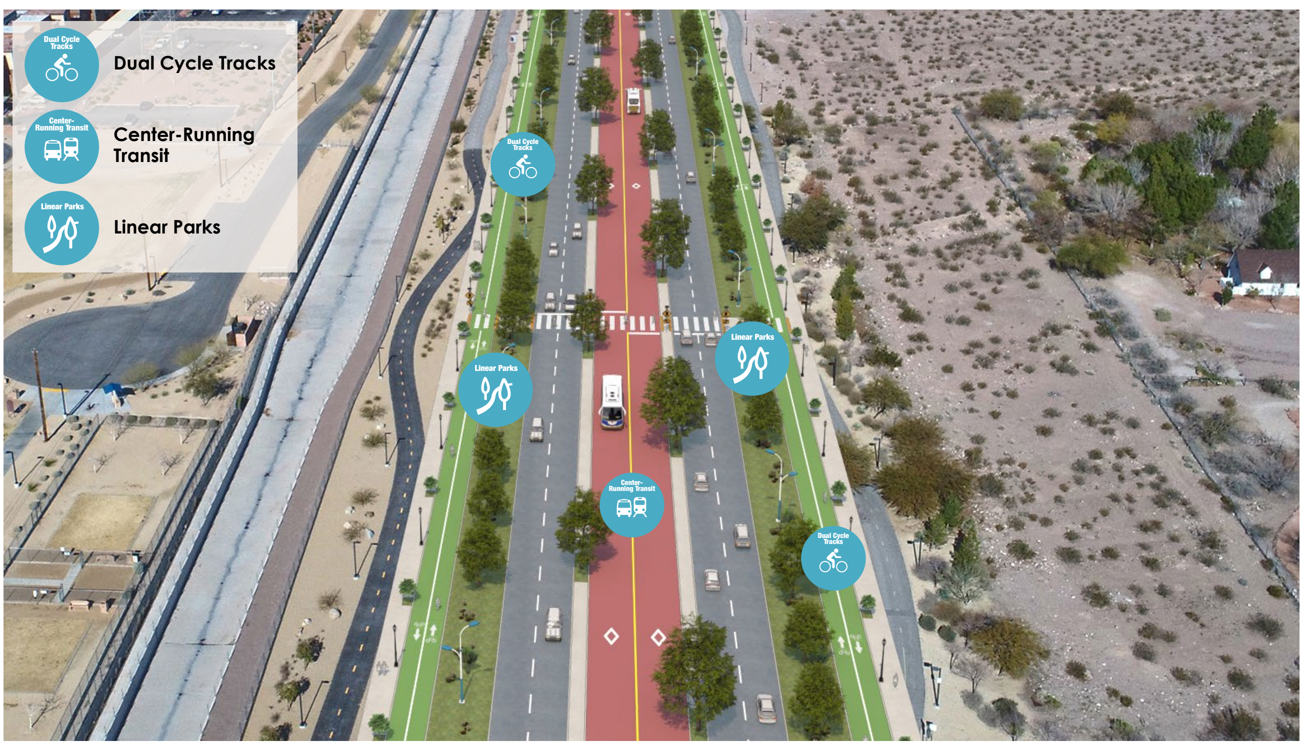

FIGURE ES.10 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE LAYOUT

FIGURE ES.11 ULTIMATE CONCEPT – THREE GENERAL PURPOSE LANES LAYOUT

PUBLIC FEEDBACK

Stakeholders, property owners, and members of the community were asked to rate each solution with a thumbs up, thumbs down, or neutral response. Results of the public feedback are shown in Figure ES.12 below.

In the final phase of the public engagement stakeholders, property owners and members of the community were asked to review the plan with included costs and phasing and provide general feedback. Approximately 86.6% of participants on the public engagement events had a positive feedback on the plan and 8% had a neutral response.

This study is only the first step in improving safety and reliability, supporting a transit culture, and promoting the economic redevelopment. It is important to focus on accomplishing the ultimate goals identified in this study. Government agencies, led by the RTC, continue to work toward identifying funding sources that will make this vision a reality.

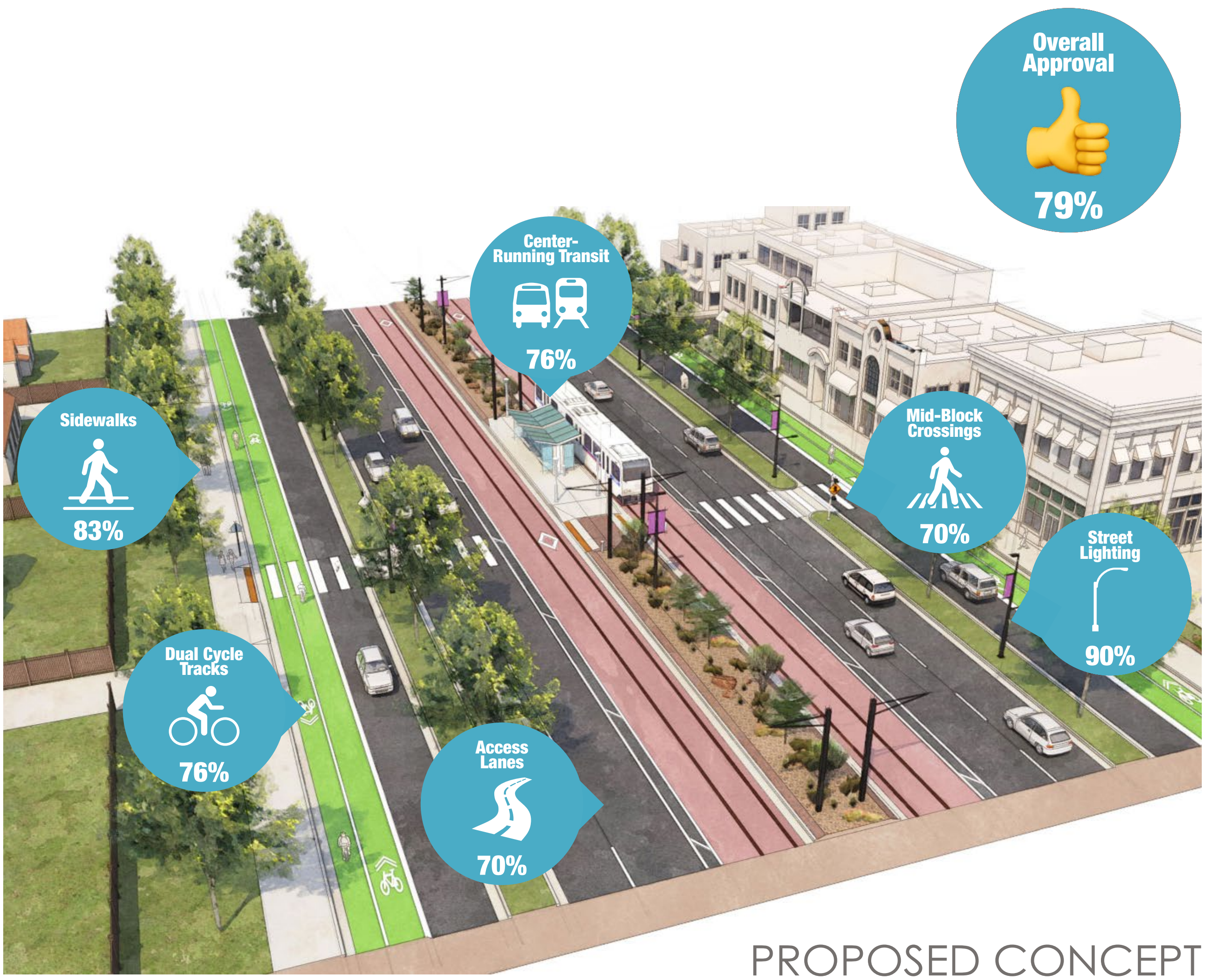

FIGURE ES.12 PROPOSED CONCEPT AND PUBLIC FEEDBACK

ACKNOWLEDGEMENTS

This plan is jointly sponsored by the Regional Transportation Commission of Southern Nevada (RTC) and the Nevada Department of Transportation (NDOT) with the support of the City of Henderson (COH), Clark County (CC), and the City of Las Vegas (CLV). This plan is the result of dedication and effort from many stakeholders. Without their support, this study would not have been possible. The RTC, on behalf of leading agencies, is grateful for their participation and would like to thank those who contributed in developing this plan..

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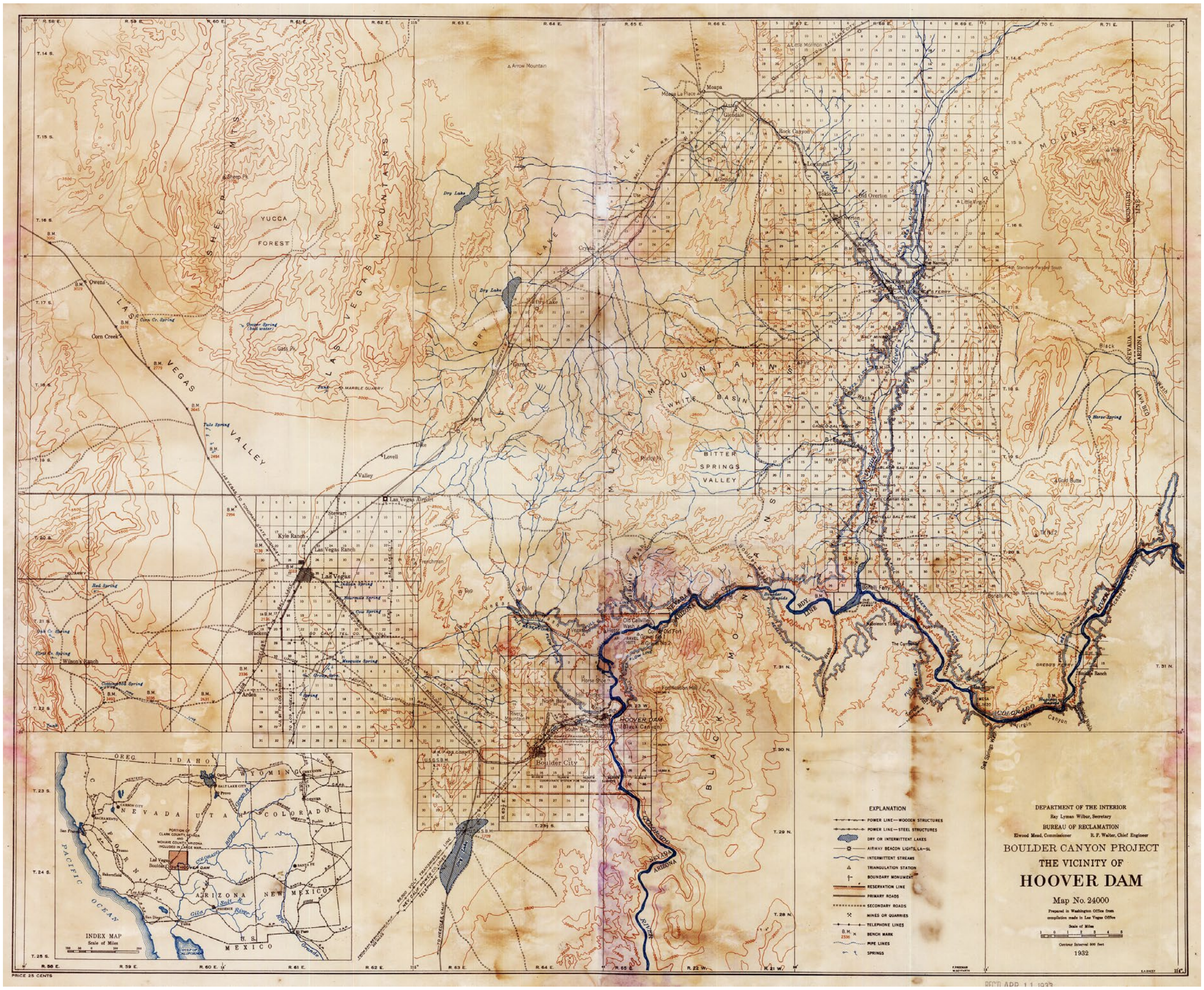

FIGURE 1.1 TOPOGRAPHIC MAP OF BOULDER CANYON PROJECT

1.0 INTRODUCTION

In their quest to reduce pedestrian fatalities along Boulder Highway, state, regional, and local governments in Southern Nevada have taken engineering and enforcement steps to improve pedestrian safety and lower vehicle speeds. While these steps have been applauded by the community, these measures are not sufficient to address the root of the mobility and safety problems the communities along Boulder Highway are facing. This report will show the transformations needed along Boulder Highway and how the stakeholders and communities are re-imagining this important street within their neighborhoods.

1.1 BACKGROUND

Boulder Highway, or State Route 582, is a major 15.4-mile-long arterial located on the east side of the Las Vegas Valley. It was built in 1931 and the original purpose was to connect the Five Points area, which is at Charleston Boulevard and Fremont Street near Downtown Las Vegas, to Railroad Pass in Henderson. Years later, the highway was extended to provide access for the construction of the Hoover Dam. Figure 1.1 shows a 1932 topographic map of the Boulder Canyon Project, Hoover Dam area.

The highway was built with no attention to topography, simply as a facility to efficiently move people and materials over long distances. Boulder Highway is the former U.S. Highway 93 (US 93) and the former U.S. Highway 95 (US 95) before they were moved to the current freeway alignment shared with Interstate 515 (I-515). Over the course of its history, commercial, recreational, industrial, and residential development have occurred along the corridor resulting in an increasing number of signalized and unsignalized access points along the route.

Development over the years along the highway was auto-oriented and has created a corridor rooted in high-speed travel. The roadway's expansive footprint also contributes to high speeds and an elevated number of crashes and pedestrian fatalities. Today, Boulder Highway maintains the same name as 84 years ago, but it does not maintain the same function. While Boulder Highway serves as critical transportation and drainage infrastructure, its current typography may act as a barrier to the human-scale sense of place and other urban design-related aspects that make a corridor attractive to community-oriented development. Because of this, an increasing urgency exists to enhance the mobility of residential, employment, and commercial users along the corridor.

1.1.1 BOULDER HIGHWAY COALITION

Based on Nevada Department of Transportation (NDOT) data collected between 2011 and 2016, 116 pedestrians were struck on Boulder Highway. Of these 116 people, 31 were killed and 18 were seriously injured (Source: NDOT Zero Fatalities). In September 2015, the Southern

Nevada Pedestrian Safety Task Force raised awareness of this problem and recommended that the reasons for these fatalities on Boulder Highway be examined. On January 27, 2016, nearly 70 stakeholders gathered for the Boulder Highway Coalition day-long summit. Engineers, planners, law enforcement, elected officials, and advocates came to the table to discuss ways to improve Boulder Highway and develop strategies to reduce the high number of pedestrian fatalities. Many ideas were discussed at the day-long summit, culminating in both short- and long-term goals and plans for the corridor, as shown in Figure 1.2.

Short-Term Goals

- Utilize pedestrian safety zone law to enhance safety message
  - Increase enforcement of actions putting lives in jeopardy
  - Increase penalties for violations
- Enhance pedestrian lighting and add median lighting corridor-wide
- Using delineators, take away inside travel lanes to reduce distance for crossing, Make street safer and determine feasibility of long-term plan
- Video public service announcements on buses about safe crossing in English and Spanish
- Broaden education efforts to include area businesses, schools, weekly housing facilities and developers as partners to deliver safety message
- Increase awareness of life's fragility by using alert system on cell phones to notify residents of every road fatality community-wide

Long-Term Goals

- Redesign Boulder Highway using a complete streets approach:
  - Reduce and narrow travel lanes
  - Add wider sidewalks and protected bike lanes
  - Add more crosswalks and shorten crossing distances at intersections
  - Add rapid flashing beacon signals to all crosswalks
  - Add art and landscaping to support calming effect and enhance beauty
- Reduce speed limit to 35 mph
- Consider alternative intersections such as roundabouts
- Working with neighborhoods, rename Boulder Highway to remove "highway" to reflect revised character of corridor
- Adopt smart growth strategies to assure land use and zoning work for the betterment of the area

FIGURE 1.2 BOULDER HIGHWAY COALITION GOALS

Source: NDOT, Zero Fatalities Newsletter.

The short-term goals focused on improvements that address immediate safety concerns and tools to increase pedestrian and driver awareness and education. Strategies recommended by the Boulder Highway Coalition resulted in a decision to reduce the speed limit to 45 miles per hour (mph) and begin the study and design process of installing eight mid-block crossings along Boulder Highway, shown in Figure 1.3.

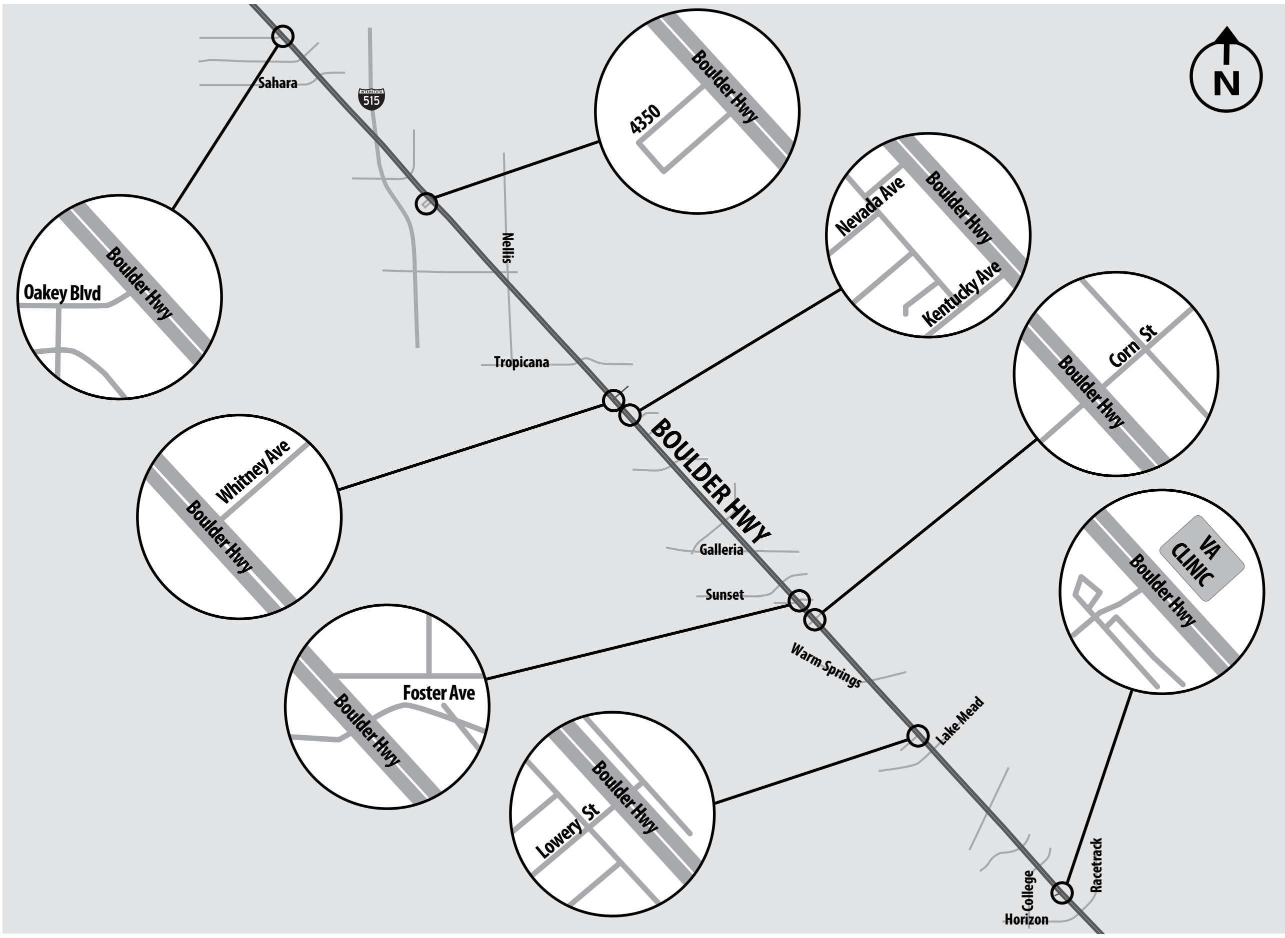

FIGURE 1.3 MID-BLOCK PEDESTRIAN CROSSINGS INSTALLED ALONG BOULDER HIGHWAY

1.2 PURPOSE OF THE STUDY

The long-term goals set by the Boulder Highway Coalition initiated this study. Under the leadership of the Regional Transportation Commission of Southern Nevada (RTC), NDOT, the City of Henderson (COH), Clark County (CC), and the City of Las Vegas (CLV) maintain jurisdiction over Boulder Highway and surrounding areas. The study is a coordinated effort among many local agency staff, elected officials, business owners, advocacy groups, and other stakeholders who actively participated in the development of this study.

The purpose of the Boulder Highway Multimodal Corridor Investment Study is to develop a plan that would identify and analyze potential improvements to Boulder Highway between Wagonwheel Drive and Charleston Boulevard.

The intention of these improvements will be to improve safety for all modes of travel along the corridor by transforming the character of Boulder Highway from a corridor rooted in vehicle travel to an urban corridor able to support and encourage all modes of transportation. The result of the study is a new vision for Boulder Highway, which aims at improving safety, encouraging active transportation, and elevating the transit ridership experience.

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2.0 PLANNING FRAMEWORK

Boulder Highway serves many communities, businesses, and jurisdictions within the Las Vegas Valley, all having common and distinguishing aspirations for this corridor. Understanding these aspirations is key to tailoring a process that engages all stakeholders and builds consensus towards a successful vision for the corridor.

2.1 PLANNING CONTEXT

Before developing an engaging planning process that would help guide the study team and stakeholders, it is important to review existing initiatives, previous studies, and documents that support this process. This review ensures that the process considers the recommendations of these initiatives, previous studies, and plans while, at the same time, recognizing the changing conditions in the study area and the resulting changes to the relevance of some of these older documents. Appendix A of this report reviews and highlights those studies or plans that are relevant to this Boulder Highway Multimodal Transportation Investment Study. While all of these documents are important to understand the planning context, the documents described below are considered key to setting the framework for the success of this study.

2.1.1 ACCESS2040—ENHANCING MOBILITY FOR SOUTHERN NEVADA RESIDENTS

Access2040 is the Regional Transportation Plan for Southern Nevada. RTC develops this plan to guide the maintenance and implementation of Southern Nevada's future multimodal transportation system. As described by the RTC, "Access2040 is the primary vehicle through which the RTC's continuous, cooperative, and comprehensive planning process is implemented."

Access2040 sets the regional goals by which all investment in transportation infrastructure is guided. These goals include:

- Strengthen regional economic competitiveness
- Maintain and enhance quality of life for Southern Nevadans
- Ensure sustainable use of infrastructure and resources

To implement this vision and plan, Access2040 established a set of strategies that also are applicable and guide the Boulder Highway Multimodal Transportation Investment Study . These strategies are shown in Figure 2.1, below.

ACCESS2040 STRATEGIES	
Primary Strategies	**Secondary Strategies**
Improve Safety	Improve Access to Essential Services
Manage Congestion	Provide Accountable & Transparent Planning Process
Enhance Multimodal Connectivity	Improve Freight Movement
Maintain Current Infrastructure	Improve Public Health Related to Transportation
	Conserve & Protect Natural Resources
	Use Innovative Planning to Address Emerging Technologies & Trends

FIGURE 2.1 ACCESS2040 STRATEGIES
Source; RTC of Southern Nevada

2.1.2 NEVADA'S STRATEGIC HIGHWAY SAFETY PLAN

Nevada's Strategic Highway Safety Plan (SHSP) is a comprehensive statewide safety plan. This plan has established statewide goals and critical emphasis areas focusing on the four Es of traffic safety: Engineering, Education, Enforcement, and Emergency Medical Services/ Emergency Response/Incident Management.

The overall goal for Nevada is Zero Fatalities. The plan has set annual targets that aim at reducing traffic-related fatalities and serious injuries by 50 percent by the year 2030.

Within this plan, Nevada has identified six critical emphasis areas. These emphasis areas, shown in Figure 2.2, help direct resources and focus implementation efforts.

FIGURE 2.2 SHSP CRITICAL EMPHASIS AREAS
Source: NDOT

Through the SHSP, state and local agencies identify the greatest causes of fatalities and serious injuries on Nevada roadways, with the purpose of developing a coordinated framework and strategies for reducing the crashes that cause fatalities and serious injuries.

2.1.3 RTC'S COMPLETE STREETS POLICY AND GUIDELINES

RTC and its regional partners launched the Complete Streets Initiative in 2010. A Complete Streets Study was completed in 2012, with the purpose of providing guidance to the local and regional agencies looking into incorporating Complete Streets design concepts into their standard practices.

The momentum generated by this study culminated with the approval of a Complete Streets Policy in June 2012. The Complete Streets Policy outlines the RTC's vision, goals, objectives, and policies for fully integrating modal options and supporting projects that enhance walking and bicycling infrastructure.

Following this policy, a Complete Streets Design Guidelines for Livable Communities, shown in Figure 2.3, was published in November 2012. This manual offers a template for local agencies/entities to begin updating existing street design manuals.

FIGURE 2.3 COMPLETE STREETS DESIGN GUIDELINES FOR LIVABLE COMMUNITIES

2.1.4 SOUTHERN NEVADA STRONG

Southern Nevada Strong (SNS) is a regional planning effort funded by a grant from the Sustainable Communities Partnership. This planning effort seeks to better integrate reliable transportation, housing, and job opportunities. This will help Southern Nevada build a foundation for long-term economic success and community prosperity. In this process, SNS has been coordinating with regional partners to demonstrate how bringing together local community, business, and political leaders helps in developing a vision for the future and how working together helps in achieving the regional goals. SNS has completed in-depth research and analysis of the region in the areas of economy, jobs, transportation, environment, and community health. The SNS plan outlines the regional goals and presents a set of strategies that local agencies can select to achieve their goals.

The Southern Nevada Vision for the future is: "In 2035, the Southern Nevada region has a strong entrepreneurial spirit sustaining its high quality of life. This vibrant, unique region is characterized by a resilient economy, excellent educational opportunities, urban and natural amenities, and integrated transportation networks."

Supporting "future investment in a multimodal transportation system that is safe, efficient, accessible, equitable" that aligns with the strategies for reinvesting in existing communities is considered a key element of Southern Nevada region prosperity that supports the SNS vision.

2.2 PLANNING PROCESS

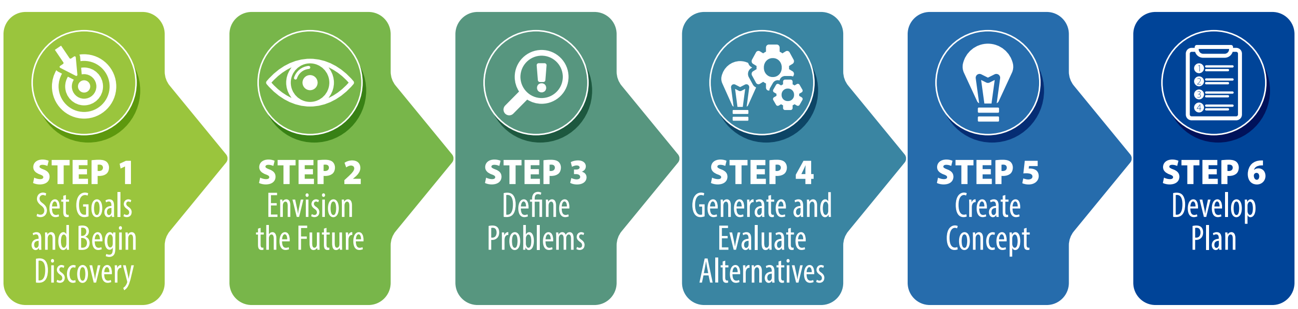

FIGURE 2.4 PLANNING PROCESS

Effective consensus building requires thoughtful consideration of all stakeholders. Under the leadership of the RTC, the study team established an inclusive stakeholder process with the ultimate goals of developing an implementable plan that has the support of all stakeholders. The process, shown in Figure 2.4, consisted of six unique steps that correspond to phases, decision points, and outcomes along the way.

STEP 1
SET GOALS AND BEGIN DISCOVERY

Stakeholders: The initial step in the process focused on exploring important issues in this corridor and the largest challenges for stakeholders to consider. Through open conversations, stakeholders identified what will make this plan successful, which ultimately led to defining the goals shown in Chapter 3 of this report.

Technical Team: The information obtained from stakeholders served as a starting point for the technical team to better target data collection (Appendix B) and analysis of existing conditions (summarized in Appendix C through Appendix G).

Public and Stakeholder Engagement Team: The team developed a survey and gathered public feedback on the issues surrounding Boulder Highway.

STEP 2
ENVISION THE FUTURE

Stakeholders: An interactive workshop was key to engaging stakeholders and better understanding opportunities and challenges of the corridor. It also led to discussions of existing and potential land uses along Boulder Highway. Through a streetscape activity, stakeholders focused on visually articulating their long-term aspirations for the corridor, which are shown in Chapter 3 of this report. The graphically articulated vision then was taken by the team to a wider range of stakeholders and elected officials for feedback through 30 one-on-one interviews.

Technical Team: Intensive data analysis and street and activity observations were conducted along Boulder Highway as part of the continuing effort of data collection and analysis.

Public and Stakeholder Engagement Team: One-on-one interviews were conducted to gather stakeholder feedback on the results of the visioning exercise.

STEP 3
DEFINE PROBLEMS

Stakeholders: The work of the technical team in exploring existing conditions culminated with the third stakeholder meeting, where stakeholders worked on defining problems shown in Chapter 4 of this report and mapping them throughout the corridor. When the problems were defined, the stakeholders were ready to move to the next phase of determining solutions for these problems. Stakeholders agreed to use the established goals and a set of indicators representing these goals as a metric to evaluate the solutions to these identified problems.

Technical Team: The technical team summarized the results of the data collection and analysis and presented them to stakeholders. This analysis resulted in defined problem statements, as shown in Chapter 4. Further, the team detailed the evaluation criteria to be used in the selection of the preferred solution, as shown in Chapter 5 and Appendix I.

Public and Stakeholder Engagement Team: This team completed and summarized public feedback on issues facing Boulder Highway.

STEP 4
GENERATE AND EVALUATE ALTERNATIVES

Stakeholders: During the fourth meeting, through interactive activities, stakeholders evaluated the feasibility and applicability of a Tool Box of Solutions developed by the technical team for each mode of transportation along each segment of the corridor to address safety, mobility, access management, and intersection types. At the fifth meeting, stakeholders reviewed the draft concept and made recommendations, requesting the technical team to reflect those changes in the proposed concepts.

Technical Team: A Tool Box of Solutions, shown in Chapter 5, was developed by the technical team and presented to the stakeholders at the fourth meeting. The stakeholder feedback was summarized, and the criteria developed in Step 3 were used to evaluate these solutions and prepare a draft concept for stakeholders to review.

STEP 5
CREATE CONCEPT

Stakeholders: The proposed draft concept was presented to stakeholders at the sixth meeting, where an informal agreement was reached.

Technical Team: The technical team took the results of the evaluation process and stakeholder feedback from the previous step and developed the proposed concept, as shown in Chapter 6.

Public and Stakeholder Engagement Team: The proposed concept was presented to stakeholders for feedback in one-on-one interviews, to the RTC Board, and to the public through an eight-month-long process.

STEP 6
DEVELOP PLAN

Stakeholders: The implementation and phasing plan first was presented to agency stakeholders and, after refinements, the plan was presented to the stakeholders at the seventh and final meeting.

Technical Team: The technical team developed an implementation and phasing plan, including cost estimates, as shown in Chapter 7.

Public and Stakeholder Engagement Team: The implementation and phasing plan was presented to the RTC Board and the general public.

2.3 PUBLIC AND STAKEHOLDER ENGAGEMENT

A successful planning process and study outcome requires effective stakeholder involvement. From defining what success looks like for the corridor to the vetting of solutions, all plan components benefit from collective ideas and viewpoints of diverse communities inside and outside RTC and partner agencies. Therefore, soliciting meaningful participation from internal RTC and partner agency disciplines, technical advisory committees, business leaders, community groups, and the wider public was a focal point of this study.

The outcome of this study would not have been possible without the active participation and engagement of many stakeholders and the public. Under the leadership of the RTC, the study team developed an ambitious Public and Stakeholder Engagement Plan that was the cornerstone of a broad and successful stakeholder and public engagement campaign.

Public and Stakeholder Engagement Plan Objectives

- To gather input from the impacted communities regarding their desires and vision for the Boulder Highway corridor with emphasis on the following categories:
  - Overall Concept and Landscaping
  - Pedestrian and Overall Safety
  - Public Transit Options
  - Land Use and Economic Development
- To educate and engage the community early, and to maintain ongoing two-way communication about the progress of the study.
- To listen, acknowledge, and respond promptly to public questions and issues.

2.3.1 STAKEHOLDER ENGAGEMENT

At the initiation of this study, the team developed a stakeholder list that included individuals or entities that may be directly or indirectly impacted by any improvements on Boulder Highway; may represent or have an interest in the project area, including elected officials who represent constituents within the project area; may be residents along the corridor; or may commute or own businesses along the corridor.

Boulder Highway stakeholders engaged through the process and tactics used are shown in Table 2.1, below.

TABLE 2.1 STAKEHOLDERS

Category	Engagement (Tactics)	Name	
Partner Agencies	Workshops Public Meetings	RTC Nevada Department of Transportation City of Henderson	Clark County City of Las Vegas
Other Agencies	Workshops Public Meetings	Clark County School District Clark County Water Reclamation District Clark County Health District Nevada Highway Patrol	Metro Police Department City of Henderson Chamber of Commerce LVMPD Southeast Area Command
Elected Officials	Briefings Presentations (upon request)	Las Vegas City Council Clark County Commissioners Las Vegas Mayor	Henderson City Council Henderson Mayor
Groups and Organizations	Presentations (upon request) Public Meetings/Open House Coffee/brown bag events	Boulder Highway Coalition	
Businesses	Interviews Public Meetings/Open House Coffee/brown bag events Survey Marketing activations	Sam's Town Hotel and Casino Eastside Cannery Casino Arizona Charley's Boulder NP Centerline Holdings (former site of the Showboat Hotel and Casino) Long Horn Hotel and Casino Joker's Wild Casino/Boyd Gaming	Boulder Market Place Boulder Station Casino Sunset Station Casino Henderson Hospital Dignity Health-St. Rose Dominican, Rose de Lima Campus (Henderson) St. Peter the Apostle Church (Henderson)
Neighborhoods and HOAs	Coffee/brown bag events Public/community meetings Open house Survey	Pittman neighborhood (Henderson) Cadence Development /Landwell Company	
Public	Public Meetings/Open House Survey Marketing activations Community events and festivals	Bicyclists Commuters Pedestrians Transit riders Students	

A Technical Advisory Committee (TAC) was created with representatives from partner agencies, the Boulder Highway Coalition, Town Board representatives, and major businesses. The increased interest of the larger group of stakeholders blurred the separation line between the TAC and the larger group of stakeholders. Therefore, the meetings and workshops organized throughout the course of the study were open to both groups, allowing the study team to effectively engage the larger group and gain their consensus.

To facilitate a transparent, inclusive, and accessible process that provides a forum for engaging all potentially interested parties, the stakeholders and partner agencies were engaged in the process through interactive meetings and workshops, as described in Section 2.2. In addition to these activities, the study team also conducted two phases of one-on-one interviews with key stakeholders. A detailed summary of the one-on-one stakeholder interviews is provided in Appendix K of this report.

2.3.2 PUBLIC ENGAGEMENT

The public engagement activities were conducted in three phases, as described below.

Phase 1. December 2017–February 2018

The purpose of the initial public engagement efforts was to understand the community's greatest concerns within the corridor. A survey was developed for members of the community to identify challenges along the corridor and then rank potential solutions to those challenges. Engagement activities and performance results are shown in Figure 2.5.

ENGAGEMENT ACTIVITIES:

- Community events & transit outreaches
- Making News story shared with jurisdictions & elected officials
- New project website with background information, NDOT short-term projects, contact form and direct link to survey
- Email blast to TAC members, jurisdictions, stakeholders. Stakeholders also shared the eblast with business community and neighborhoods.
- Press release to local transportation reporters
- Social media organic posts
- Digital geo-targeted ads

PERFORMANCE RESULTS

- Captured 1,700 surveys
- Collected 200 emails
- 10 Community Events
- 11 Bus Stop Activations

FIGURE 2.5 PHASE 1 PUBLIC ENGAGEMENT ACTIVITIES

Phase 2. December 2018–January 2019

The purpose of the second phase of public engagement efforts was to share a draft concept plan and gauge public approval and proposed solutions. Stakeholders, property owners, and members of the community were asked to rate each solution with a thumbs up, thumbs down, or neutral response. Results would be used to move the plan forward into cost and phasing, or to make necessary adjustments. Engagement activities and performance results are shown in Figure 2.6.

ENGAGEMENT ACTIVITIES:

- Community events & transit outreaches
- Making News story shared with all jurisdictions & elected officials
- Updated project website with direct link to survey
- Email campaign to TAC members, jurisdictions, stakeholders, and public who have shared email to date
- Press release and media pitch
- Social media organic posts
- Social media geo-targeted digital ads

PERFORMANCE RESULTS

- Captured 1,922 surveys
- Collected 975 emails
- 12 Community Events
- Shared in RTC Making News & Commissioner Gibson December newsletters

FIGURE 2.6 PHASE 2 PUBLIC ENGAGEMENT ACTIVITIES

Phase 2 was covered by five media methods, including:

- *Las Vegas Review-Journal*—https://www.reviewjournal.com/news/news-columns/road-warrior/deadly-stretch-of-boulder-highway-in-las-vegas-being-reimagined-1557732/
- Channel 13—https://www.ktnv.com/news/making-boulder-highway-safer
- Channel 8—https://www.8newsnow.com/news/local-news/rtc-shares-ideas-to-make-boulder-highway-safer/
- *Las Vegas Sun*—https://lasvegassun.com/news/2018/dec/26/rtc-seeking-public-input-on-boulder-highway-projec/
- *US News*—https://lasvegassun.com/news/2018/dec/26/rtc-seeking-public-input-on-boulder-highway-projec/

Phase 3. September – October 2019

The purpose of the final phase of public engagement efforts was to share the final concept plan that includes costs and phasing for public feedback. While the final plan did not change from the draft, stakeholders, property owners and members of the community were asked to review the plan with included costs and phasing and provide general feedback. Results will be included in the final plan and contacts will be used in the design and engineering of the corridor.

ENGAGEMENT ACTIVITIES:

- Two community events/public meetings
- Blog story & press release shared with local transportation reporters, jurisdictions & elected officials
- New interactive project website with concept elements, costs and phasing as well as a feedback form.
- Email blast to TAC members, jurisdictions, stakeholders and approximately 900 community members who shared their contact information previously.
- Social media organic posts
- Digital geo-targeted ads

PERFORMANCE RESULTS

- Captured 504 comments
- Collected 504 emails
- Attended two community events and pushed heavy digital ads and website engagement

FIGURE 2.7 PHASE 3 PUBLIC ENGAGEMENT ACTIVITIES

Phase 3 Media coverage included:

- LVRJ—https://www.reviewjournal.com/traffic/boulder-highway-to-get-major-makeover-in-southern-nevada-1677516/
- KNPR—**RTC Wants Public Input On Boulder Highway Plans** - September 25, 2019 https://knpr.org/headline/2019-09/rtc-wants-public-input-boulder-highway-plans
- KNPR—**Boulder Highway** - September 24, 2019 https://mms.tveyes.com/Transcript.asp?StationID=6780&DateTime=9%2F24%2F2019+5%3A35%3A44+PM&Term=RTC&PlayClip=TRUE

Public feedback for each phase is presented in the following chapters of this report.

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3.0 RE-IMAGINING BOULDER HIGHWAY

Boulder Highway is a symbol of an era where streets were designed to enable the fast and efficient movement of vehicles. The stakeholders in Southern Nevada, through the visioning process described in this section, demonstrated that they are prepared to embrace the opportunity to redesign Boulder Highway as a safe and livable street that balances the needs of all users.

3.1 DEFINING SUCCESS

The need to address safety concerns surrounding Boulder Highway and the stakeholder aspiration to create a livable corridor led to the articulation of the goals shown in Figure 3.1 that guided this study and the development of a new concept for Boulder Highway.

- **Provide Safe Non-motorized Travel**
- **Improve Vehicle Safety**
- **Support Transit Culture**
- **Reliable Movement of People on the Corridor**
- **Support Economic Re-development**

FIGURE 3.1 CORRIDOR GOALS

These goals—set by stakeholders—are an indication that mere safety improvements are not sufficient. Reliable and timely access to services, employment centers, and educational opportunities is needed to enhance the economic outlook of the corridor. This can be accomplished only through investing in healthy, safe, and walkable streets and safe and reliable transportation choices. To determine changes needed in the current Boulder Highway transportation infrastructure and supporting policies and strategies to accomplish this, the study had to take a deep look into what the future might look like.

The ultimate vision of transforming Boulder Highway into a safe and reliable street for all users that supports transit culture and promotes economic development requires shifting the overall measures of success to Public Health and Safety, Quality of Life, Sustainability, and Social Equity (Figure 3.2).

MEASURES OF SUCCESS

PUBLIC HEALTH AND SAFETY

Street design must promote safe environments for all users and offer healthy choices that facilitate active transportation, such as walking, bicycling, and using public transit. Streets should improve access to healthy food options, mitigate noise levels, and provide landscaping and trees that improve air and water quality.(1)

QUALITY OF LIFE

Streets can encourage social interaction and designs that offer natural surveillance and help build stronger, safer communities.(2)

SUSTAINABILITY

Promoting sustainable transportation modes through well-designed streets can lower carbon emissions and improve overall air quality. Incorporating trees and landscaping can improve water management, foster biodiversity, and increase access to the natural environment.(1)

Street projects that increase safety, improve public realm quality, and welcome multimodal use have positive economic effects such as higher retail sales and increased property values. Investment in streets has long-term economic benefits.(3)

SOCIAL EQUITY

Cities must ensure that their most valuable public spaces offer safe and equitable use to all, regardless of ability, age, or income, empowering the most vulnerable users with safe and reliable mobility choices.(1)

FIGURE 3.2 MEASURES OF SUCCESS

Sources:

(1) Global Designing Cities Initiative, Shifting the Measure of Sucess (https://globaldesigningcities.org/)

(2) Jane Jacobs, The Death and Life of Great American Cities (New York: Vintage Books, 1961)

(3) CABE, Paved with Gold: The Real Value of Street Design Briefing. Publication (London: Commission for Architecture and the Built Environment, 2007)

Accomplishing the goals set for Boulder Highway is a stepwise process that builds on both the analysis of safety and mobility needs and a detailed evaluation of area characteristics and context. Development of any safety countermeasures and Complete Streets solutions might not be the sole response to addressing the needs. Therefore, close coordination between transportation professionals, land use planners, and stakeholders to evaluate the area characteristics and what the future brings was considered critical to ensure an integration of land use and transportation throughout the development of this plan.

3.2 ENVISIONING THE CONTEXT OF PLACE

Boulder Highway traverses many communities with different contexts. Understanding the context and how that context might change in the future is the first step in re-imagining Boulder Highway.

Six character areas were defined for the Boulder Highway study area based on three land use context categories. Analysis of the categories shown in Figure 3.3 helped established boundaries for character areas along Boulder Highway.

LAND USE

- Corridor land uses
- Adjacent land uses
- Districts
- Zoning

BUILT FORM

- Physical characteristics
- Building placement
- Building height

STREETSCAPE

- Street composition
- Pedestrian and bicycle facilities
- Right of Way

FIGURE 3.3 LAND USE CONTEXT CATEGORIES

The six character areas shown in Figure 3.4 range between 2 miles and 3.25 miles in length. Some of their boundaries land on major street intersections whereas others fall on minor streets, yet ultimately the boundaries are determined by the categories described above.

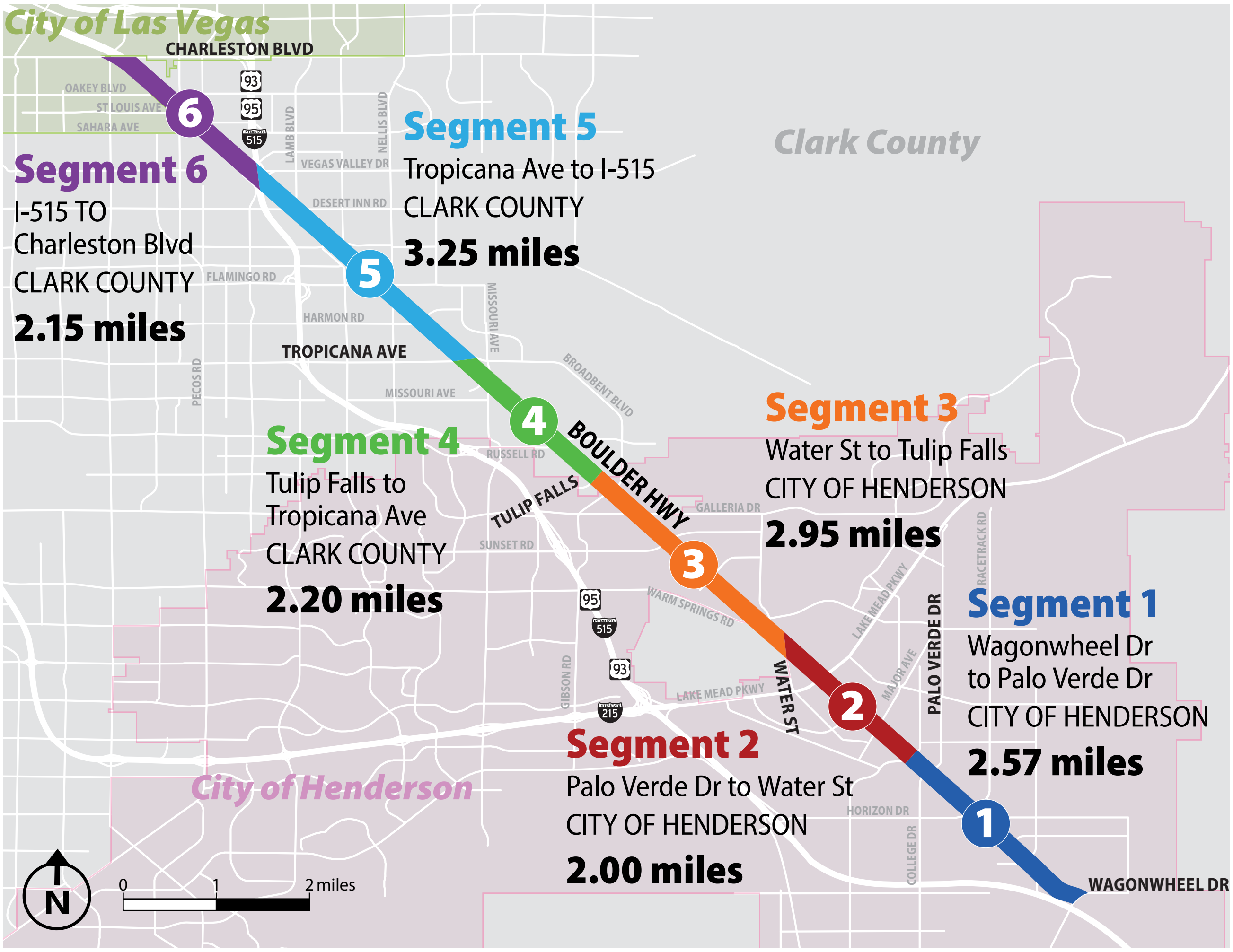
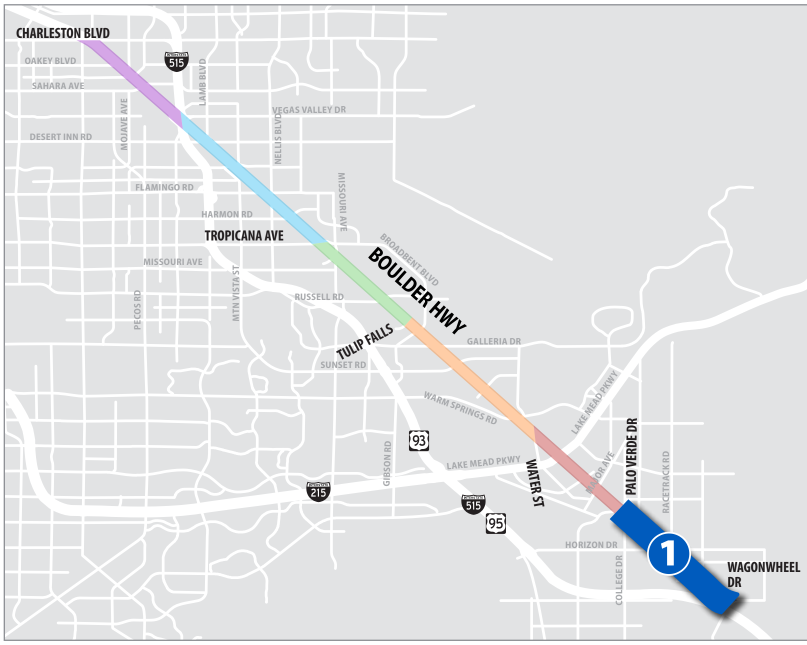


FIGURE 3.4 CHARACTER AREAS

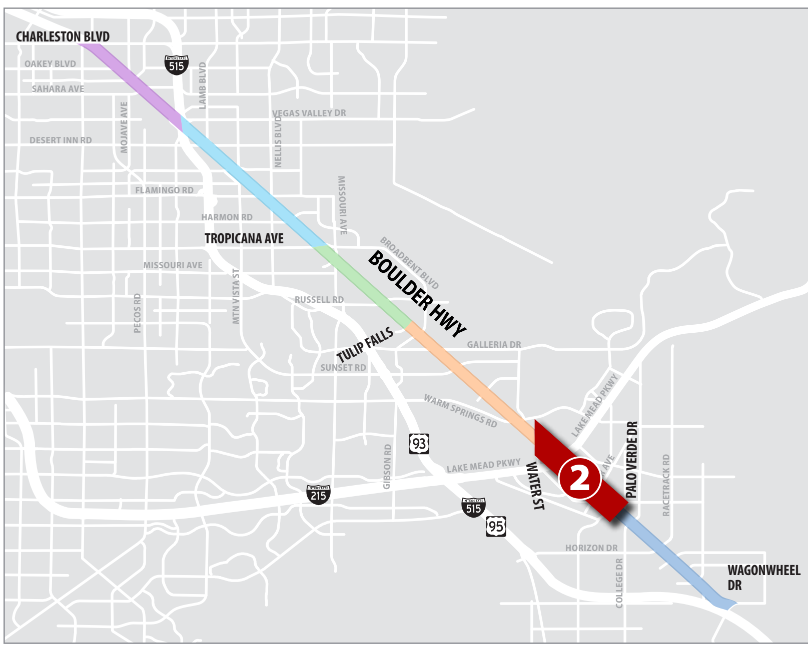
An analysis of context for each character area is presented in Appendix B of this report.

To achieve the goals of the corridor and transform Boulder Highway to a safe and vibrant street, corridor stakeholders envision changes to occur to the current land use composition and build form. These changes for each segment of the corridor are shown in Figure 3.5 to Figure 3.10, below.



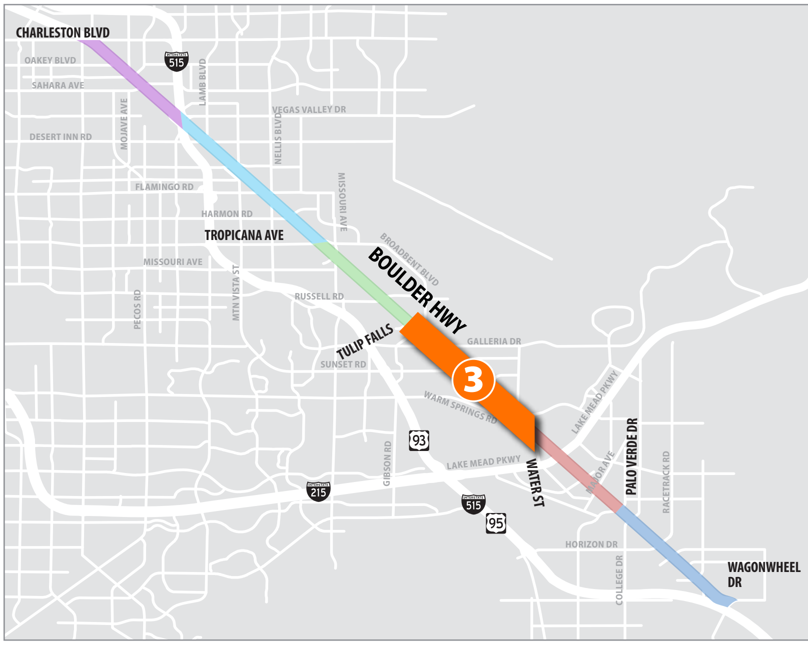
- **Mixed-use** with medium-density housing to fill in the vacant areas
- Incorporate **green space** along the southwest side of the street
- Incorporate more **open space** for residential areas in the utility/ drainage area
- Infill with **low-density** development on the northeast side

FIGURE 3.5 SEGMENT 1 LAND USE AND BUILT FORM VISION



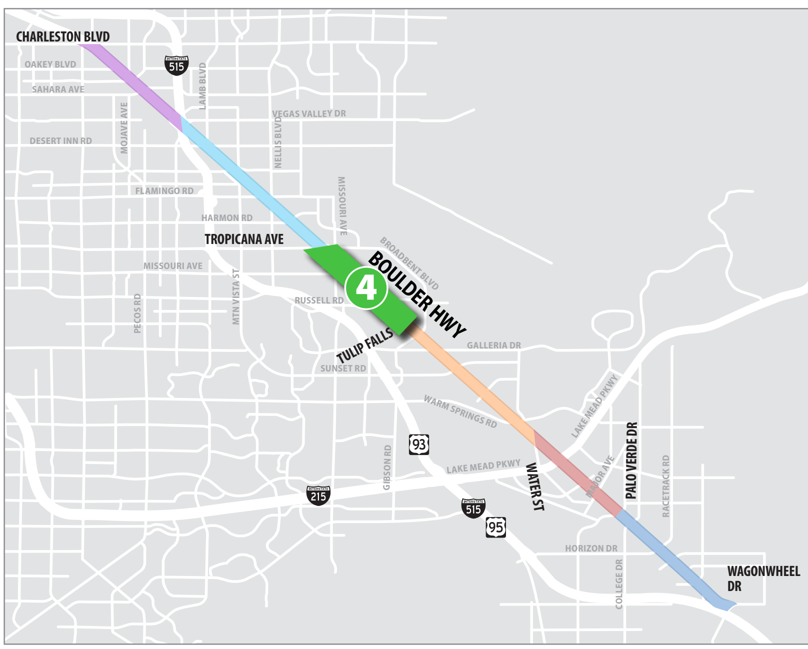
- Line the corridor with **commercial uses**
- Incorporate **high density mixed use** buildings
- Consider **selling ROW** for development on the southwest side of the street
- Line the northeast side of the street with **mixed-use buildings** with **minimal setbacks**
- Provide **open space** in front of residential dwellings on the southwest side of the street

FIGURE 3.6 SEGMENT 2 LAND USE AND BUILT FORM VISION



- Incorporate **mixed-use** buildings in Pittman Neighborhood
- Incorporate more **commercial** near activity areas
- Target area as an **employment center**
- Include more **park space**
- **Adaptive re-use** of industrial warehouse buildings into neighborhood amenities
- **Rezone industrial uses** along the southwest side of Boulder Highway
- Allow buildings **to front** Boulder Highway on both sides

FIGURE 3.7 SEGMENT 3 LAND USE AND BUILT FORM VISION

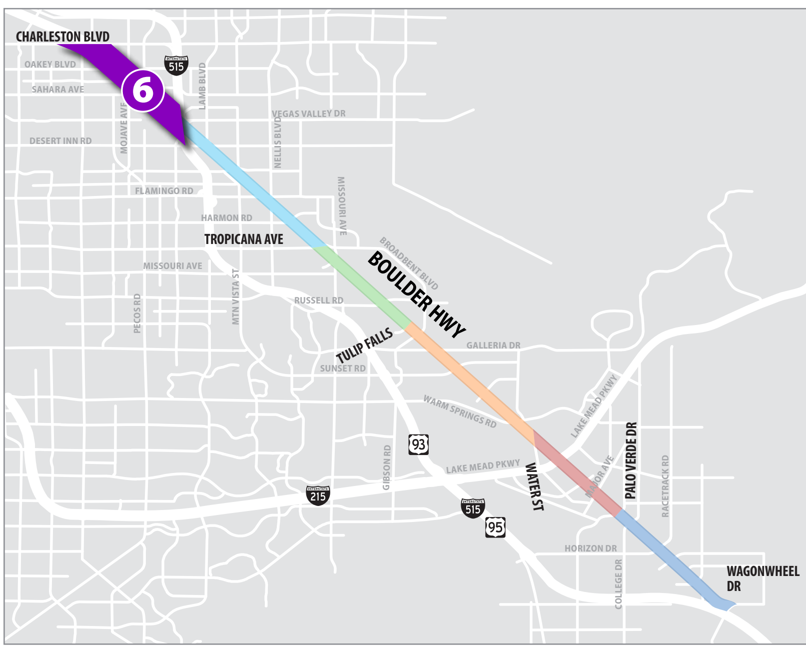


- Create a node at Tropicana to create an **activity center**
- Allow buildings to **front Boudler Highway** on both sides of the street
- Incorporate **park space** between development and the ROW

FIGURE 3.8 SEGMENT 4 LAND USE AND BUILT FORM VISION

- Provide **mixed-use infill** development in vacant lots along Boulder Highway
- Continue developing area with **medium density** buildings that abut the ROW
- **Infill** parking lots that front on Boulder Highway with **mixed use** development

FIGURE 3.9 SEGMENT 5 LAND USE AND BUILT FORM VISION



- Develop the open area with **mixed-use development**
- **Sell the ROW** to private developers to pay for public improvements
- Target **high density commercial** development with **minimal setbacks**
- Incorporate **mixed use** and **open space** near the ROW

FIGURE 3.10 SEGMENT 6 LAND USE AND BUILT FORM VISION

3.3 VISUALIZING THE FUTURE

To accomplish the goals, stakeholders envision a multimodal boulevard that maintains consistency through the entire length while using design elements to distinguish context areas. Through separating modes, the stakeholder's vision is to repurpose existing street space to accommodate a more efficient means of transportation and increase accessibility to locations along the corridor. The increase of space allocated to pedestrians, bicyclists, and transit will translate into shorter crossing distances for pedestrians, an increased number of crossings, and lower vehicle speeds.

In return, increased accessibility will impact property values and attract new development along the corridor. Land use strategies that encourage mixed-use development, parks and open space, and changes in built form are envisioned to promote the use of alternative travel modes, maintain vibrancy of the corridor, and improve quality of life.

The vision for the land use and built form context categories was integrated into a streetscape visioning activity (Figure 3.11) by positioning building types in the private realm with various setbacks from the ROW. Combinations of Complete Streets components were developed by stakeholders, reflecting their vision of the corridor.

FIGURE 3.11 STAKEHOLDERS WORKING ON A STREETSCAPE EXERCISE

The existing conditions layout of the corridor shown in Figure 3.12 was used to build upon and develop recurring features captured for the entire layout of the Boulder Highway as described below.

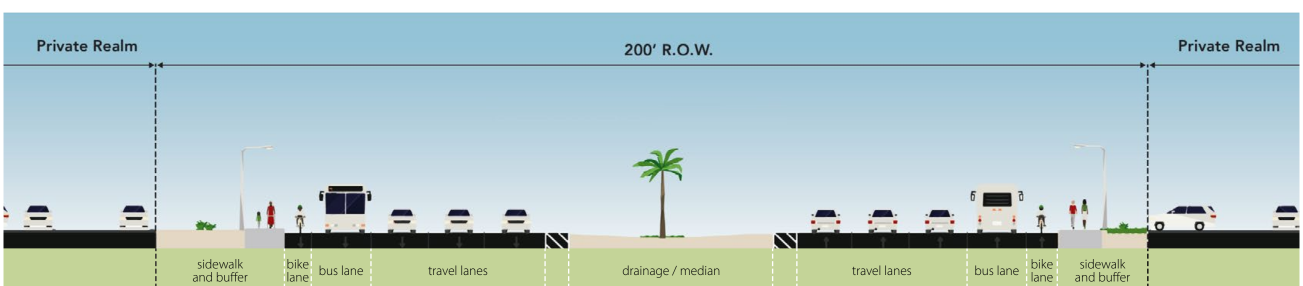


FIGURE 3.12 EXISTING CONDITIONS OF CORRIDOR

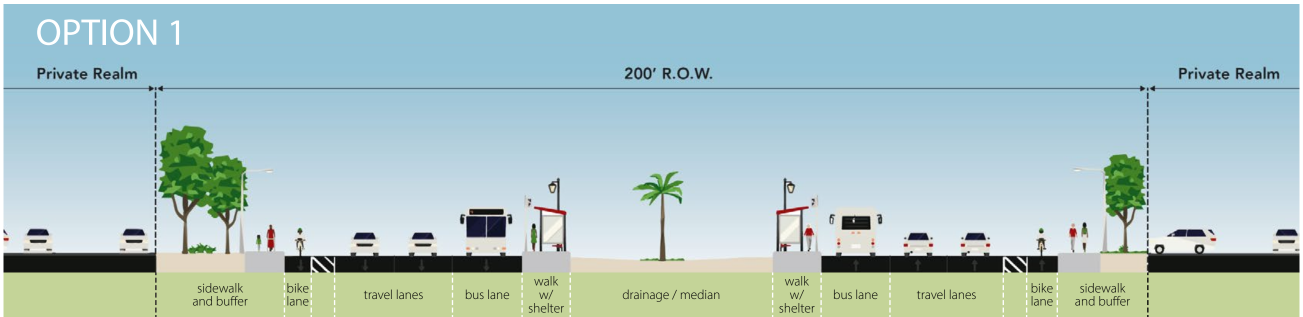


FIGURE 3.13 STREETSCAPE OPTION 1

The first option shown in Figure 3.13 explores using the existing curb-to-curb proportions while re-allocating travel modes. The median remains intact, yet sidewalks are added to each side to provide access to the center-running bus lanes. On each side of the street, there are two travel lanes and one bicycle lane separated by a striped buffer. The pedestrian space remains the same, but includes more vegetation. Other recommendations for this option that are not clearly depicted include:

- Retain the natural drainage throughout
- Introduce mid-block crosswalks to raised bus shelters
- Revert engineered drainage channel to a natural channel in the southern segment
- Keep in mind oncoming traffic from Interstate 11 (I-11)

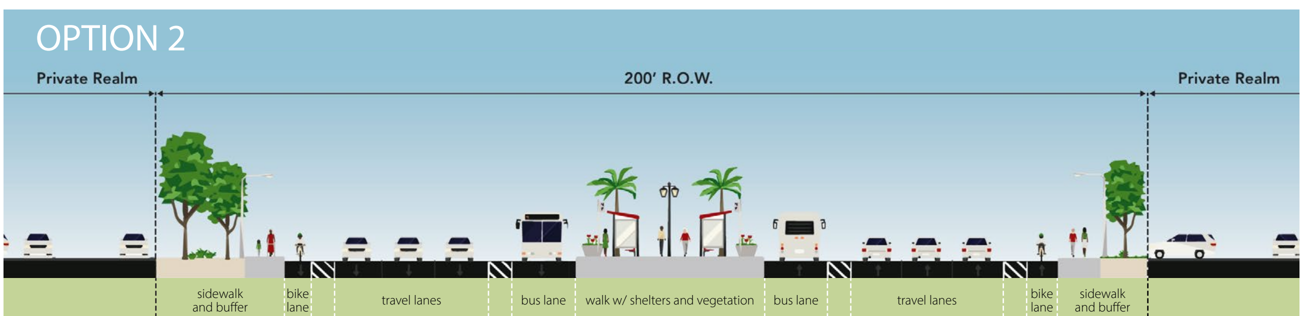


FIGURE 3.14 STREETSCAPE OPTION 2

In Option 2, shown in Figure 3.14, the natural median becomes a central pedestrian walk with amenities. Most notably, the walk provides access to the buses operating down the center of Boulder Highway. Striped buffers separate the bus and bicycle lanes from three lanes of automobile traffic on both sides. Although the lane count stays the same throughout the corridor, lane widths are reduced to slow traffic speeds. The pedestrian realm remains intact, but includes more vegetation. Other recommendations for this option that are not clearly depicted include:

- Apply a boulevard treatment along the whole corridor
- Maintain the entire median area for pedestrians with more crossings and refuges
- Add more lighting

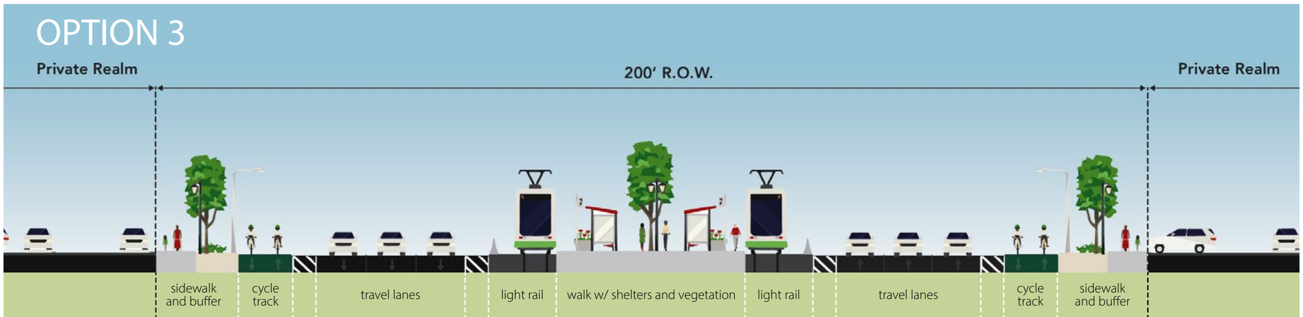


FIGURE 3.15 STREETSCAPE OPTION 3

Option 3, shown in Figure 3.15, proposes center-loaded transit with pedestrian amenities. Light-rail operates on either side of the center walk and is separated from automobile traffic by a striped buffer and a barrier. Three lanes remain on either side of the median, but are reduced in width to lower travel speeds. Buffered bicycle tracks operate on both sides of the corridor. The sidewalks now abut the ROW line and are separated from the bicycle tracks by planted buffers. Other recommendations for this option that are not clearly depicted include:

- Discontinue the use of palm trees in planting palettes
- Increase access to transit and bicycle tracks
- Reduce crossing times for pedestrians

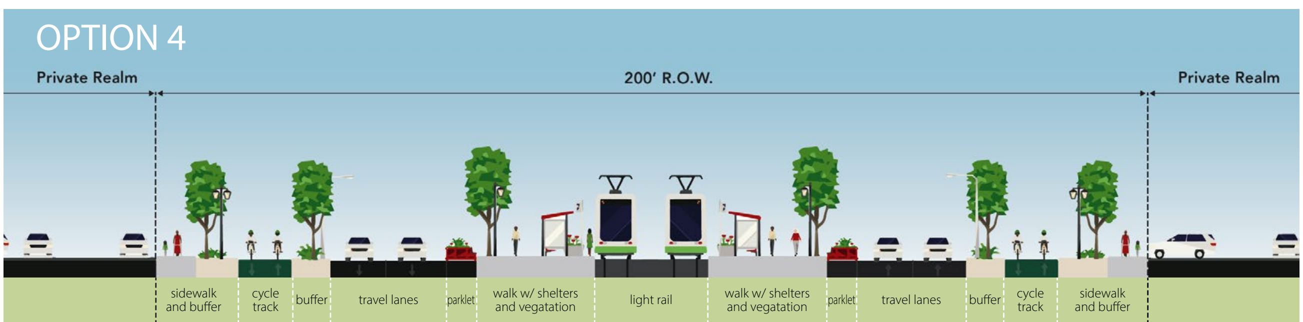


FIGURE 3.16 STREETSCAPE OPTION 4

Option 4, shown in Figure 3.15, re-allocates the median for light-rail transit. Two pedestrian walkways with amenities are located on either side of the tracks and serve both as light-rail platforms and sidewalks. Two lanes of traffic operate on either side of the center transportation modes. Parklets and occasionally food trucks face inward toward transit, establishing another pedestrian amenity. Bicycle tracks surrounded by vegetative buffers flank the far ends of the corridor. Finally, sidewalks are positioned at the ROW edges. Other recommendations for this option that are not clearly depicted include:

- Apply the same multimodal transportation theme along entire corridor
- Design streetscape as a transportation boulevard, not a "highway"
- Make user friendly to all modes of transportation

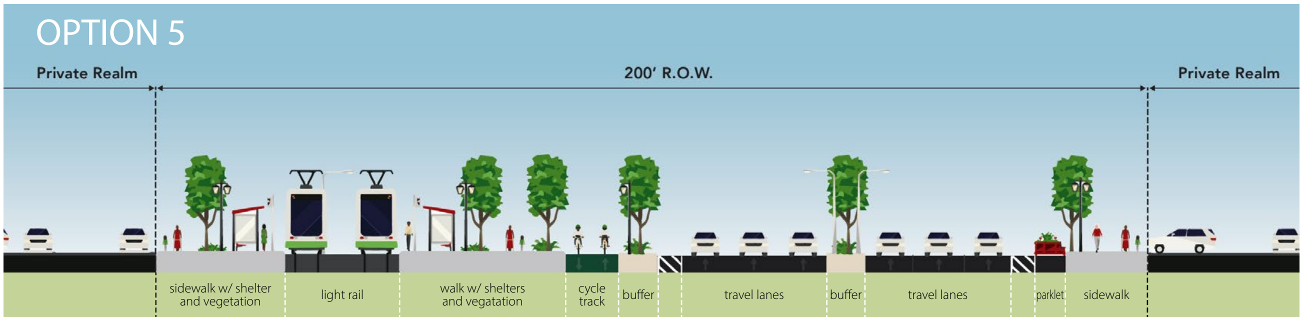


FIGURE 3.17 STREETSCAPE OPTION 5

Option 5, shown in Figure 3.17, separates transportation modes along the corridor. Light-rail and automobile transportation occupy opposing sides of the corridor. Large walkways with amenities, vegetation, and access to transit exist on the southwest side of the street. A bicycle track occurs in the center separated from automobiles by a vegetative buffer. Six lanes of traffic with reduced widths are focused on the northeast side with a small buffered median. Finally, a widened sidewalk containing amenities and parklets borders the streetscape. Other recommendations for this option that are not clearly depicted include:

- Establish a linear park and electric corridor feeling when on Boulder Highway
- Keep the existing drainage channel and utilities intact when possible

3.4 STAKEHOLDER FEEDBACK

Following the visioning workshop, the study team conducted stakeholder interviews to discuss general issues facing Boulder Highway and gather feedback on the five visioning options the TAC developed, possibly allowing a preferred option to be identified.

Option 4—with its "Boulevard" characteristics of narrowed roadway lanes, greater amounts and different locations of landscaping, physical separation between modes of transportation, e.g., two-way bicycle tracks separated by a physical barrier or a "parklet" from roadway lanes, and use of light rail in the median—was almost universally perceived by stakeholders as the preferred future scenario for Boulder Highway of all the five options presented.

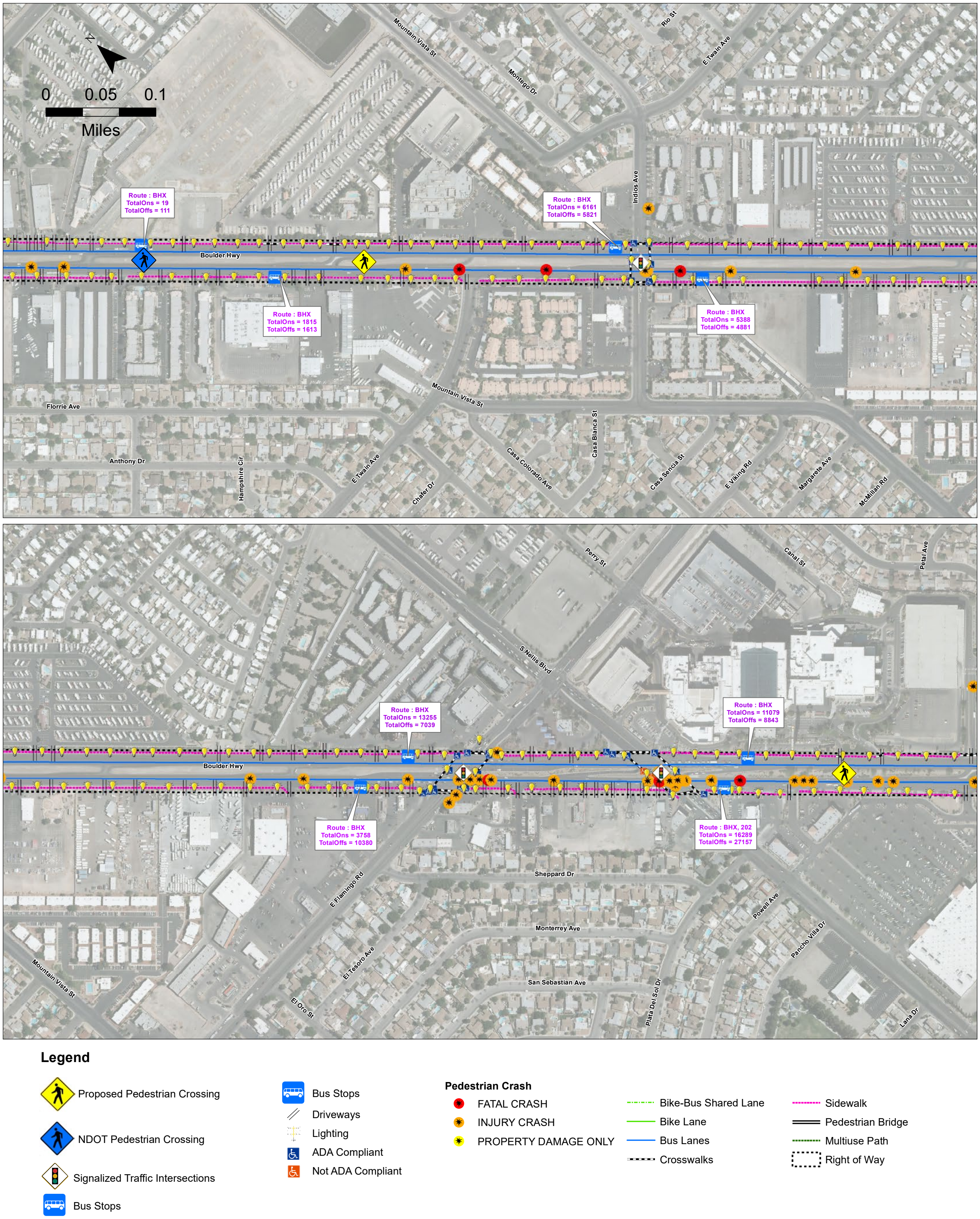


FIGURE 4.1 GIS INVENTORY

4.0 DEFINING THE PROBLEMS

Identifying the problems Boulder Highway faces today that might prevent the communities from accomplishing the goals and corridor vision is the starting point in developing solutions. This chapter describes how the study team—in close collaboration with stakeholders—developed clear and straightforward problem statements that are linked directly with the identified goals.

4.1 DISCOVERY METHODS

The process of problem identification was based on empirical observations of data and information collected from a variety of sources, multimodal analysis, safety analysis, roadway conditions analysis, field observations, and video documentation. Detailed summaries of the data collected, analysis methodologies used to evaluate the existing multimodal and safety conditions of the corridor, and the results are provided in Appendix C through Appendix G of this report.

A geographic information system (GIS) platform for data gathering and analysis was used to accommodate this complex and interrelated information. The GIS platform was developed and refined through stakeholder dialogue that supported the technical evolution of the information and its representation.

Figure 4.1, left, depicts some of the GIS information displayed on this platform. This platform improved the collective understanding of the spatial relationship of data and safety events.

To further its understanding of mobility choices and barriers, the study team also benefitted from the work of an Atkins intelligent mobility team. This team used immersive learning methods and video documentation to move beyond the limits of traditional engineering problem solving to explore real barriers to mobility on the corridor first-hand. A summary of this work can be found here.

FIGURE 4.2 LINK TO BOULDER HIGHWAY IDEATION EVENT SUMMARY

The team's finding were vetted during the first phase of public engagement activities, in Section 4.3 below, and shows public perception of some of the problems identified along Boulder Highway.

4.2 PROBLEM STATEMENTS

Problem statements represent core issues identified collaboratively by the study team and project stakeholders. In total, 11 unique problem statements were identified. Each of these statements and a discussion about their relevant topics are discussed below. Note that these problem statements are presented in no particular order.

MANAGING WALKING DISTANCES

Pedestrians cross the street outside of marked or controlled crosswalks because of the following issues:

- Crosswalks do not follow desired pedestrian lines
- Long distances exist between controlled crossings (Figure 4.3)

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	HIGH
Improve Vehicle Safety	HIGH
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	MEDIUM
Support Economic Re-development	LOW

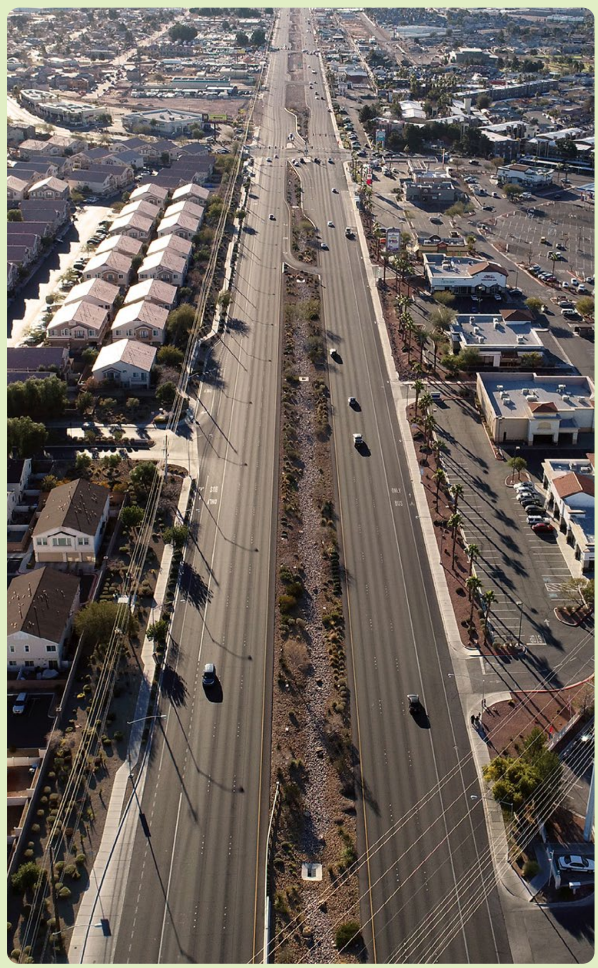


FIGURE 4.3 LONG WALKING DISTANCES WITHOUT PEDESTRIAN CROSSINGS

INFRASTRUCTURE CONTINUITY, ADA ACCESSIBILITY, AND SIDEWALK DESIGN

Travelers back track to get to an acceptable facility or take risks to get to a destination because of:

- Sidewalks are incomplete or bike lanes simply end (Figure 4.4).
- Street furniture and infrastructure sometimes block the sidewalk (Figure 4.5).
- Ramps or other accessible features are absent or poorly placed.
- Much of the existing pedestrian and bicycle infrastructure predates the Americans with Disabilities Act (ADA) and presents challenges for pedestrians with disabilities (Figure 4.6).
- Entire corridor lacks facilities that accommodate sight-impaired pedestrians.
- Frequent driveways create uneven pedestrian paths.

GOAL PROHIBITIVE IMPACT LEVEL

- Provide Safe Non-motorized Travel — HIGH
- Improve Vehicle Safety — LOW
- Support Transit Culture — HIGH
- Reliable Movement of People on the Corridor — HIGH
- Support Economic Re-development — HIGH

FIGURE 4.5 STREET FURNITURE BLOCKING SIDEWALK

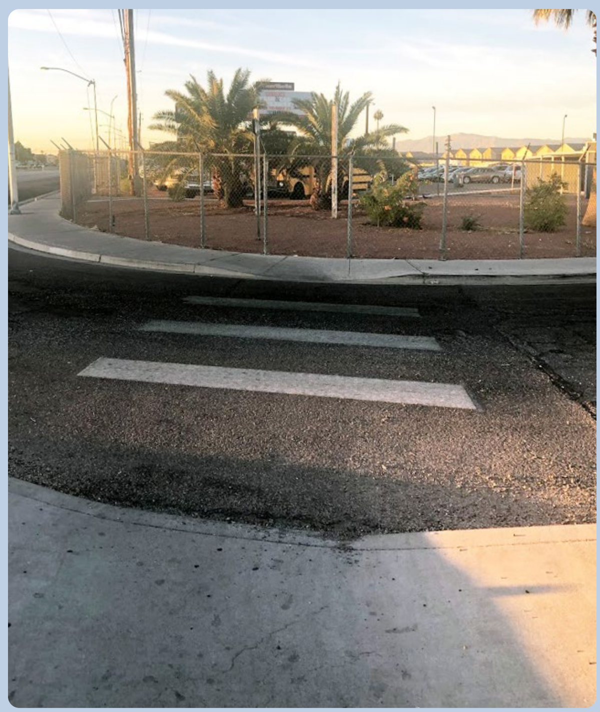


FIGURE 4.6 ADA NON COMPLIANT PEDESTRIAN RAMP

FIGURE 4.4 SIDEWALK INCOMPLETE

EASE OF STREET CROSSING

Pedestrians have difficulty negotiating large, complex intersections and crossing the street at controlled and uncontrolled locations because of:

- Insufficient information about expectations, such as two-stage crossing at large, complex signalized intersections
- Long traffic signal cycles
- Lack of proper mid-block signals that notify them to stop walking
- Lack of crosswalks (or protected crosswalks) near necessary and busy mid-block transit stops
- Long crossing distances (Figure 4.7)
- Physical barriers, such as flood control facilities (Figure 4.8)
- Lack of protected mid-block pedestrian refuge (Figure 4.9)

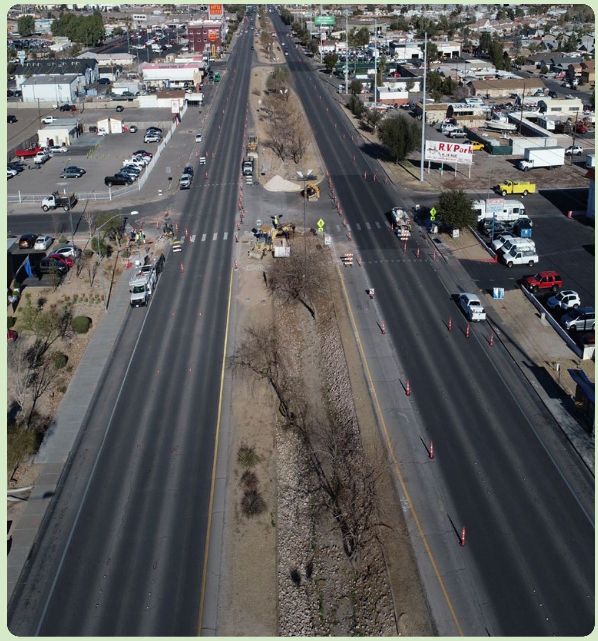


FIGURE 4.8 PHYSICAL BARRIER

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	HIGH
Improve Vehicle Safety	HIGH
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	HIGH
Support Economic Re-development	HIGH

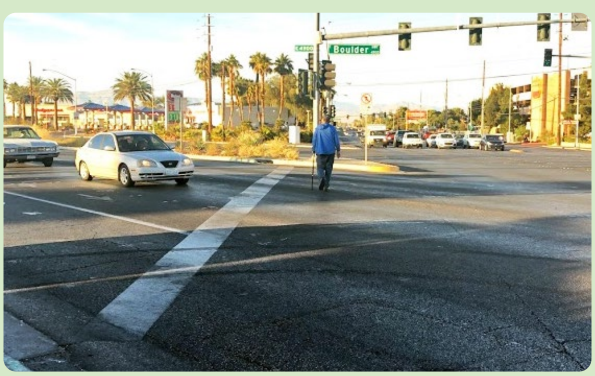


FIGURE 4.7 LONG CROSSING DISTANCES

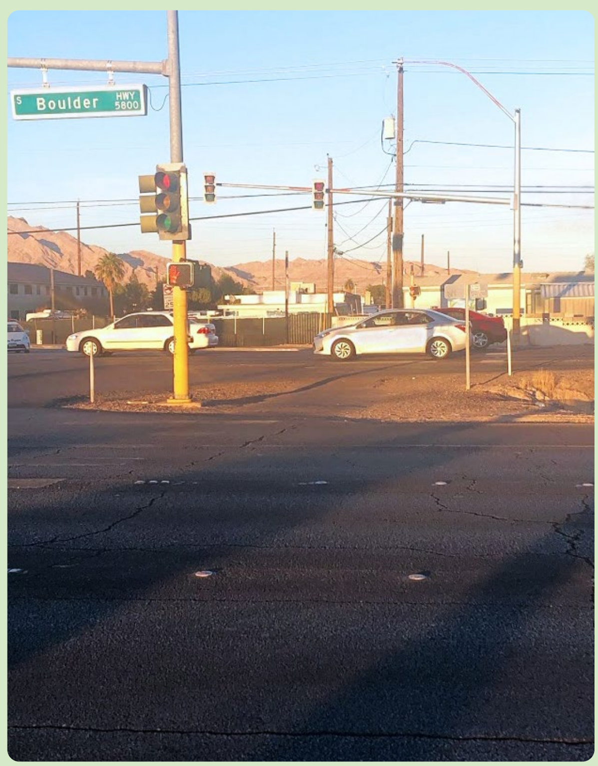


FIGURE 4.9 NON PROTECTED PEDESTRIAN REFUGE AREA

LACK OF PEDESTRIAN-SCALE DESIGN

Lack of pedestrian-scale design is observed along the entire corridor and is more critical in areas with high pedestrian activity. The ample ROW promotes high vehicular speed and low reaction time, which has resulted in higher numbers of fatal crashes and serious injuries.

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	HIGH
Improve Vehicle Safety	HIGH
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	MEDIUM
Support Economic Re-development	HIGH

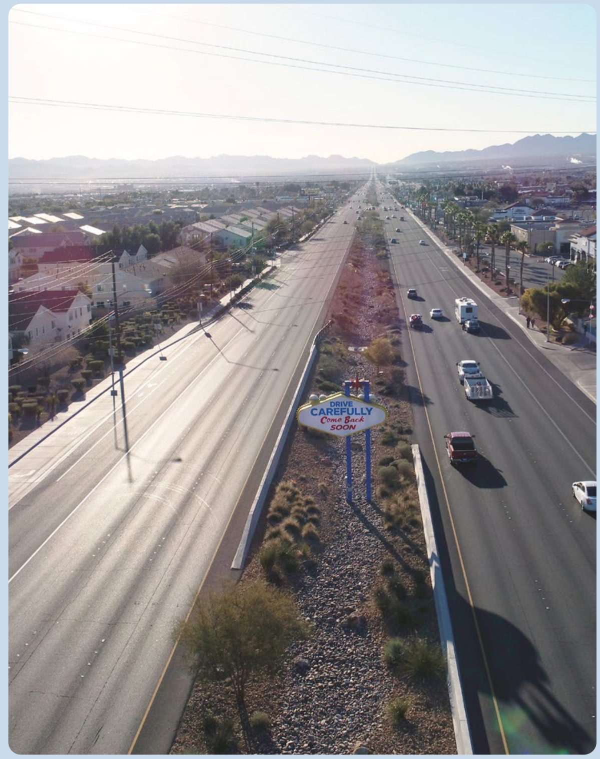


FIGURE 4.10 LACK OF PEDESTRIAN SCALE DESIGN

TRANSIT TRIP RELIABILITY

People count on reliable transit to get where they need to be within an expected period of time. Several factors have been identified to have a large impact on transit trip reliability along Boulder Highway, including:

- Inconveniently low frequency on crossing/ connecting bus routes
- Long crossing distances
- Long signal cycle lengths that increase pedestrian delay

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	HIGH
Improve Vehicle Safety	LOW
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	HIGH
Support Economic Re-development	HIGH

LIMITED TRANSIT STOP AMENITIES

Transit stops do not fully serve travelers' needs. Some stops lack one or more of the following:

- Complete and equitable traveler information (wayfinding, destination maps, accessible route-finding tools, bus scheduling, and announcements)
- Enhanced personal security and comfort
- Ample seating for waiting passengers
- Ample lighting (picture at galleria)
- Access to water or restroom facilities

GOAL PROHIBITIVE IMPACT LEVEL

Provide Safe Non-motorized Travel	HIGH
Improve Vehicle Safety	LOW
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	MEDIUM
Support Economic Re-development	HIGH

FIGURE 4.11 LIMITED TRANSIT STOP AMENITIES

EXPOSURE TO CLIMATE EVENTS

People walking and bicycling are more vulnerable to the effects of climate and weather while traveling. Some problems that were observed include:

- Lack of protection from climate events, especially heat exposure
- Sustained heat—urban heat island effect due to limited landscaping increases temperatures into the evening
- The roadway facility is subject to flooding, which especially increases the risk for pedestrians and bicyclists

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	MEDIUM
Improve Vehicle Safety	LOW
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	HIGH
Support Economic Re-development	HIGH

ACCESS TO DESIRED USES

Access to desired uses is challenging for pedestrians, bicyclists, and transit users because of long distances from transit stations and pedestrian and bicycle facilities.

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	MEDIUM
Improve Vehicle Safety	LOW
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	HIGH
Support Economic Re-development	HIGH

FIGURE 4.12 LONG DISTANCES FROM TRANSIT TO CORRIDOR ATTRACTIONS

INCONSISTENT LIGHTING AND INSUFFICIENT VISIBILITY

Lighting is not consistent along the corridor. While many signalized intersections have sufficient lighting, this is not the case away from these locations. This situation places alternative modes at a disadvantage compared to vehicular traffic. The following issues are observed along the corridor.

- There are areas along the corridor where lighting is non-existent (Figure 4.13).
- The distance between lights varies along the corridor.
- Lighting is non-existent in the proximity of some transit stations (Figure 4.14).

GOAL PROHIBITIVE IMPACT LEVEL

Goal	Impact Level
Provide Safe Non-motorized Travel	MEDIUM
Improve Vehicle Safety	LOW
Support Transit Culture	HIGH
Reliable Movement of People on the Corridor	HIGH
Support Economic Re-development	HIGH

FIGURE 4.13 LIGHTING NONEXISTENT IN AREAS WITHOUT SIDEWALK

FIGURE 4.14 LIGHTING NONEXISTENT NEAR TRANSIT STATION

ACCESS MANAGEMENT AND DRIVEWAYS

Closely spaced driveways increase the number of conflict points for vehicles, pedestrians, and bicyclists. (Figure 4.15)

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	HIGH
Improve Vehicle Safety	HIGH
Support Transit Culture	LOW
Reliable Movement of People on the Corridor	MEDIUM
Support Economic Re-development	HIGH

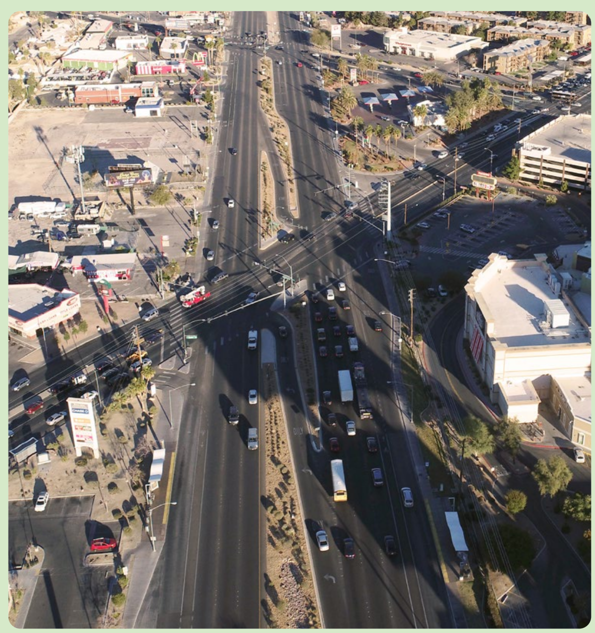
FIGURE 4.15 CLOSELY SPACED DRIVEWAYS

SIDE STREET ACCESS

While the corridor favors traffic progression, through the use of coordinated signals, along Boulder Highway, analysis indicates that the predominant trips on this corridor are from local side streets. This results in challenges making right turns from side streets and creates operational challenges at skewed intersections. (Figure 4.16)

GOAL PROHIBITIVE IMPACT LEVEL	
Provide Safe Non-motorized Travel	LOW
Improve Vehicle Safety	MEDIUM
Support Transit Culture	LOW
Reliable Movement of People on the Corridor	HIGH
Support Economic Re-development	MEDIUM

FIGURE 4.16 SKEWED INTERSECTION



4.3 PUBLIC INPUT

During Phase 1 of Public Engagement as described in Chapter 2 a survey was developed to have members of the community identify challenges along the corridor and rank potential solutions to those challenges. Almost 70% of respondents indicated they do not feel safe on Boulder Highway. The results of responses are shown in Figure 4.17 below. Almost 80% of respondents identified the following as mobility challenges on Boulder Highway: lack of lighting, long walk times to crosswalks, too few crosswalks, and the long time required to cross the road.

To address these challenges the community views "Provide safe walking and Biking" and "Support a transit culture" as the most important solutions. The results of the survey are shown in Figure 4.18 below.

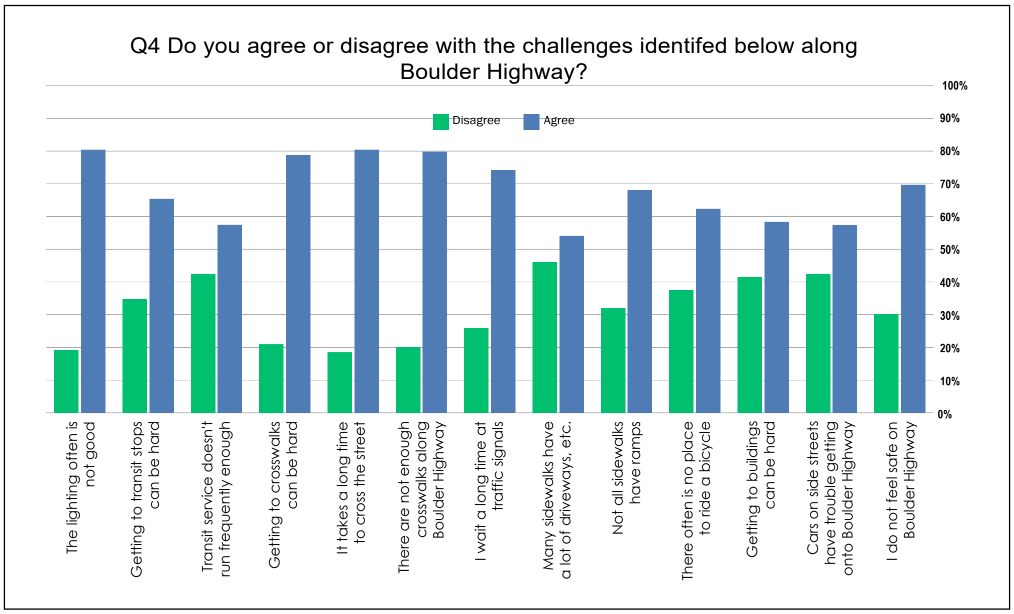


FIGURE 4.17 SURVEY RESPONSES ON CHALLENGES IDENTIFIED ON BOULDER HIGHWAY

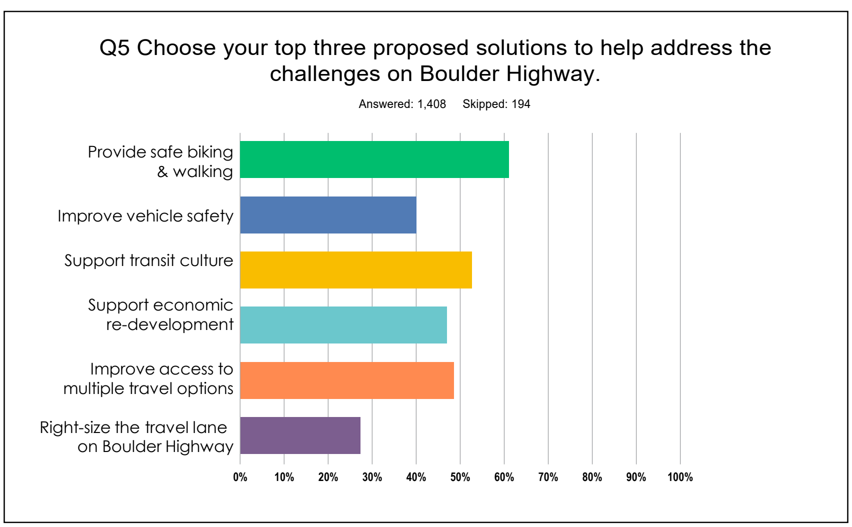


FIGURE 4.18 SURVEY RESPONSES TO PROPOSED SOLUTIONS ON BOULDER HIGHWAY

5.0 CONCEPT DEVELOPMENT

The corridor vision developed by the stakeholders guided the process of developing the preferred concept. (The vision concepts provide the direction the local agencies and other stakeholders would like the corridor transformation to take. More in-depth evaluation is needed to determine what types of Complete Streets, transit, technology, and access management treatments should be incorporated in the concept and where in the corridor certain treatments will most benefit the goals.) This chapter presents the methodology and the process that led stakeholders to the development of a preferred concept.

The development of the preferred concept followed a multi-step process that integrated stakeholder vision and technical analysis to address problems the corridor is facing, as well as to accomplish the corridor goals. Figure 5.1 shows the steps followed on the concept development process.

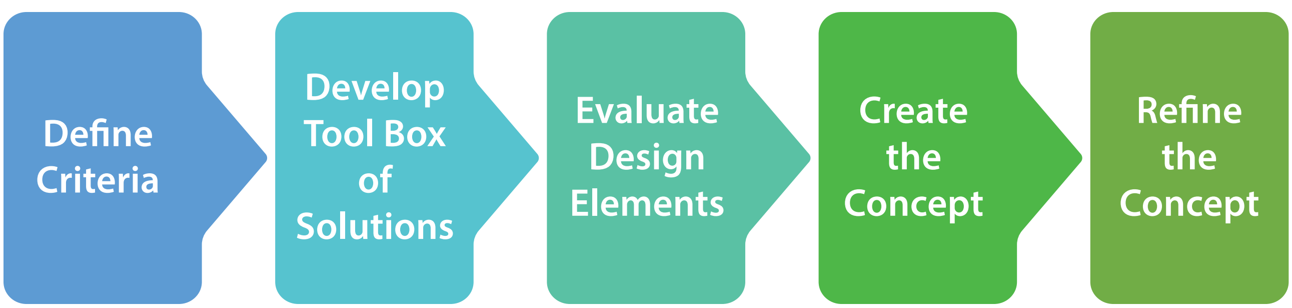


FIGURE 5.1 CONCEPT DEVELOPMENT PROCESS

5.1 CRITERIA AND INDICATORS

Early in the study process, stakeholders and the study team used the goals, indicators, and evaluation criteria identified at the beginning of the process outlined below and described in detail in Chapter 2 and Appendix I of this report to guide the evaluation process.

PROVIDE SAFE NON-MOTORIZED TRAVEL

Making pedestrian and bicycle travel safe, comfortable, and enjoyable will lead to an increased use of these modes.

TABLE 5.1 CRITERIA AND INDICATORS—PROVIDE SAFE NON-MOTORIZED TRAVEL

Criteria	Indicators
Conflict zones between motorized and non-motorized traffic	number of driveways, driveway frequency, vicinity to travel lanes, intersection configuration
Desire line connectivity/mid-block and travel time	reduction in travel time between two attraction points
Pedestrian and bicycle visibility	lighting level, availability, type and shadows
Level of pedestrian and bicycle risk	predicted crashes
Safe access to transit stations	lighting availability and level, continuous sidewalks, mid-block crosswalk, signage, pedestrian clearance times

IMPROVE VEHICLE SAFETY

Generate a vehicular environment that allows for safe and reliable operations in the same space as the other modes of travel.

TABLE 5.2 CRITERIA AND INDICATORS—IMPROVE VEHICLE SAFETY

Criteria	Indicators
Conflict points at intersections	number of conflict points, turning angles
Level of vehicle safety	predicted crashes
Intersection operations	delay
Driveway conflict points/access management	number of access points, distance, type, compliance with standard
Lighting	availability, level, type

SUPPORT TRANSIT CULTURE

Create a set of strategies and improvements that makes travel using transit attractive and accommodating for daily activities.

TABLE 5.3 CRITERIA AND INDICATORS—SUPPORT TRANSIT CULTURE

Criteria	Indicators
Improve transfer time and consistency	travel distance and time between stations, mid-block crossings
Access to information and trip planning	information consistency (printed vs. electronic), equal access to information
Access to amenities	strategies and policies that address the needs of travelers
Safe access to transit stations	lighting availability, level, and type, mid-block crossings, continuous sidewalk

ENABLE RELIABLE MOVEMENT OF PEOPLE IN THE CORRIDOR

TABLE 5.4 CRITERIA AND INDICATORS—ENABLE RELIABLE MOVEMENT OF PEOPLE IN THE CORRIDOR

Criteria	Indicators
Improve transfer time and consistency	travel distance and time between stations, mid-block crossings
Vehicle travel time reliability	reliability, expected crashes
Vehicle operations at intersections	delay

SUPPORT ECONOMIC REDEVELOPMENT (TIER 2)

TABLE 5.5 CRITERIA AND INDICATORS—SUPPORT ECONOMIC DEVELOPMENT

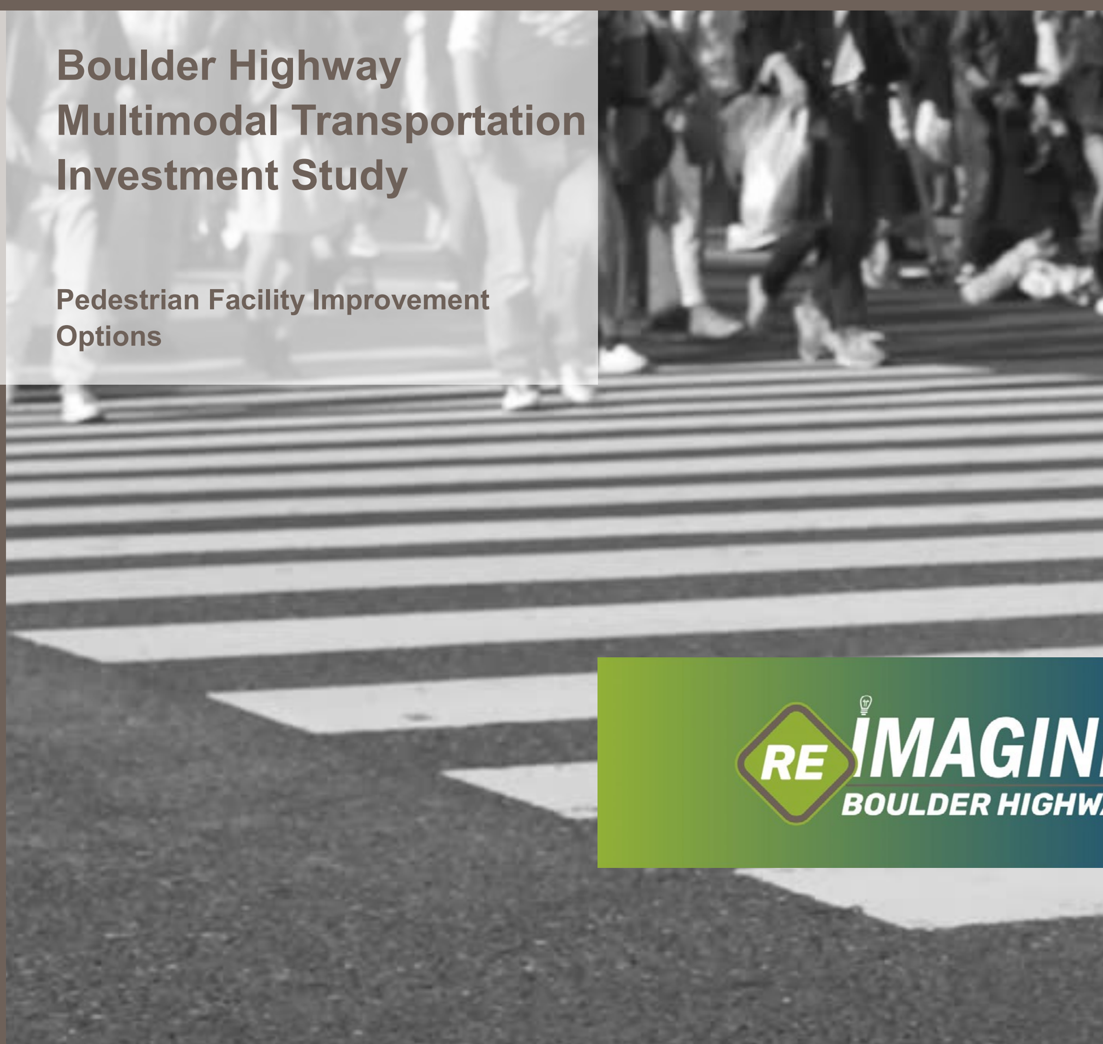
Criteria	Indicators
Land use and built form supportive of a multimodal corridor	development code, landscaping requirements, sidewalk requirements, access requirements, parking requirements
Multimodal access—achieving access to desired uses	integration of all modes of travel, travelers of all capabilities, and accommodating all trip purposes
Node/intersection connectivity to surrounding land uses within each context zone	development code
Pedestrian and bicycle desire line connectivity	reduction in travel time between two attraction points
Multimodal circulation—route choice opportunities to achieving access while getting to your destination	qualitative assessment of experience applied to built environment—can be assessed through public engagement activities

5.2 TOOL BOX OF SOLUTIONS

A range of solutions that have the potential to address identified problems and could potentially improve conditions on Boulder Highway was created to guide the process of selecting a preferred concept. The solutions include a comprehensive list of different infrastructure and technology options that can improve the travel conditions for at least one mode of travel on Boulder Highway and address the goals. For analysis purposes, these solutions were divided into five groups, including: pedestrian facilities, bicycle facilities, transit improvements, travel demand management improvements, and lighting improvements. Technology solutions were integrated into each of these tool boxes.

RTC

Pedestrian Facility Improvements Toolkit



Boulder Highway Multimodal Transportation Investment Study

Pedestrian Facility Improvement Options

REIMAGINE BOULDER HIGHWAY

Pedestrian Facility Design

Daylighting

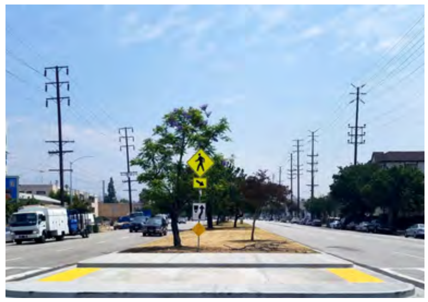
"Daylighting" refers to combining several traffic calming and sight distance improvements at a roadway intersection to improve the visibility of pedestrians in the crosswalk and street corners. Daylighting treatments can include a combination of crosswalk enhancements, lighting, and curb bulb-outs/ smaller curb radii to slow turning speeds. This treatment could be applied at specific intersections where pedestrian activity is anticipated.

Benefits:

- Can have traffic calming benefits
- Shortens the crossing distance for pedestrians
- Improves sight distance

Key Considerations:

- Requires reconfiguration of the intersection approach
- Can impact the turning radii for large vehicles including buses



Pedestrian Refuge Island

A pedestrian refuge island is a curbed space in the center median of a roadway where pedestrians can wait and negotiate one direction of vehicular travel at a time. A median refuge can create a visually narrow space for drivers and can increase the visibility of people crossing to drivers. Artistic Pedestrian Shade Structures can be incorporated at these locations to provide shade and increase visibility of crossing.

Benefits:

- Can have traffic calming benefits
- Shortens the crossing distance for pedestrians
- Improves sight distance

Key Considerations:

- Requires reconfiguration of the intersection approach
- Can impact the turning radii for large vehicles including buses

Ultra-wide Crosswalk

An ultra-wide crosswalk widens the striping for pedestrian crossing such that people are able to cross simultaneously side-by-side. This treatment can increase crossing comfort and allows for a greater visual of the crossing. Typically applied at high volume crossings to allow many people to cross at the same time.

Benefits:

- Improves visibility for crossing areas
- Can have a positive impact on crossing compliance

Key Considerations:

- Additional striping area to maintain
- Requires modification of the curb ramp to be fully accessible

High Quality Furniture Zone

A high quality furniture zone provides design and comfort amenities to increase physical separation from vehicular traffic and provides features for relief from traffic stress or other environmental factors (wind, heat, rain, etc.). Generally applied adjacent to commercial retail areas or park land where more pedestrian activity is likely to occur.

Benefits:

- Provides human-scale features in the street design
- Can provide relief from extreme weather
- Provides space for other cultural elements, such as public art

Key Considerations:

- High cost of design and construction

Grade-Separated crossings

Grade-separated crossings provide a way for pedestrians and cyclists to use a bridge or underpass to cross a roadway. These structures can vary greatly in engineering and architectural design and must be designed to be sensitive to the existing context.

Underpasses are typically less expensive and often utilize existing drainage features, but can lack person comfort. Overpasses provide better personal comfort, but require additional height to achieve vertical clearance for vehicles. This can have implications regarding accessibility for all users and abilities.

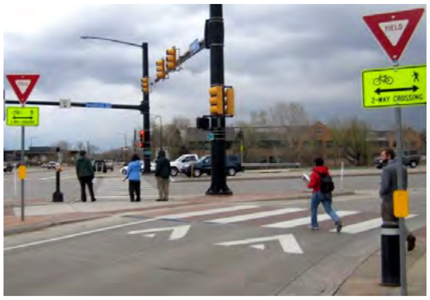
Both overpasses and underpasses require careful consideration when choosing appropriate locations that connect to the existing non-motorized network.

Benefits:

- Provides full separation for crossing pedestrians and cyclists
- Can become gateway or cultural landmark

Key Considerations:

- High cost of design and construction
- Can create issues for mobility-impaired users
- Underpasses can create personal security issues if not designed properly



Raised Crosswalk

A raised crossing is a vertical rise in the crosswalk or intersection material, designed to slow traffic and increase the visibility of people crossing the street.

Benefits:

- Provides traffic calming where mid-block driveways cross the lane

Key Considerations:

- Can create some drainage challenges at intersections

Pedestrian-priority signal timing

Pedestrian priority signal timing gives pedestrians the ability to add a pedestrian crossing phase, through the use of push-button activation or detection. Typically allows for additional lead time in the pedestrian crossing phase and may include an all red signal phase when pedestrians can cross in all directions. This can be useful at signal locations where inconsistent pedestrian flow does not require a regular pedestrian interval.

Benefits:

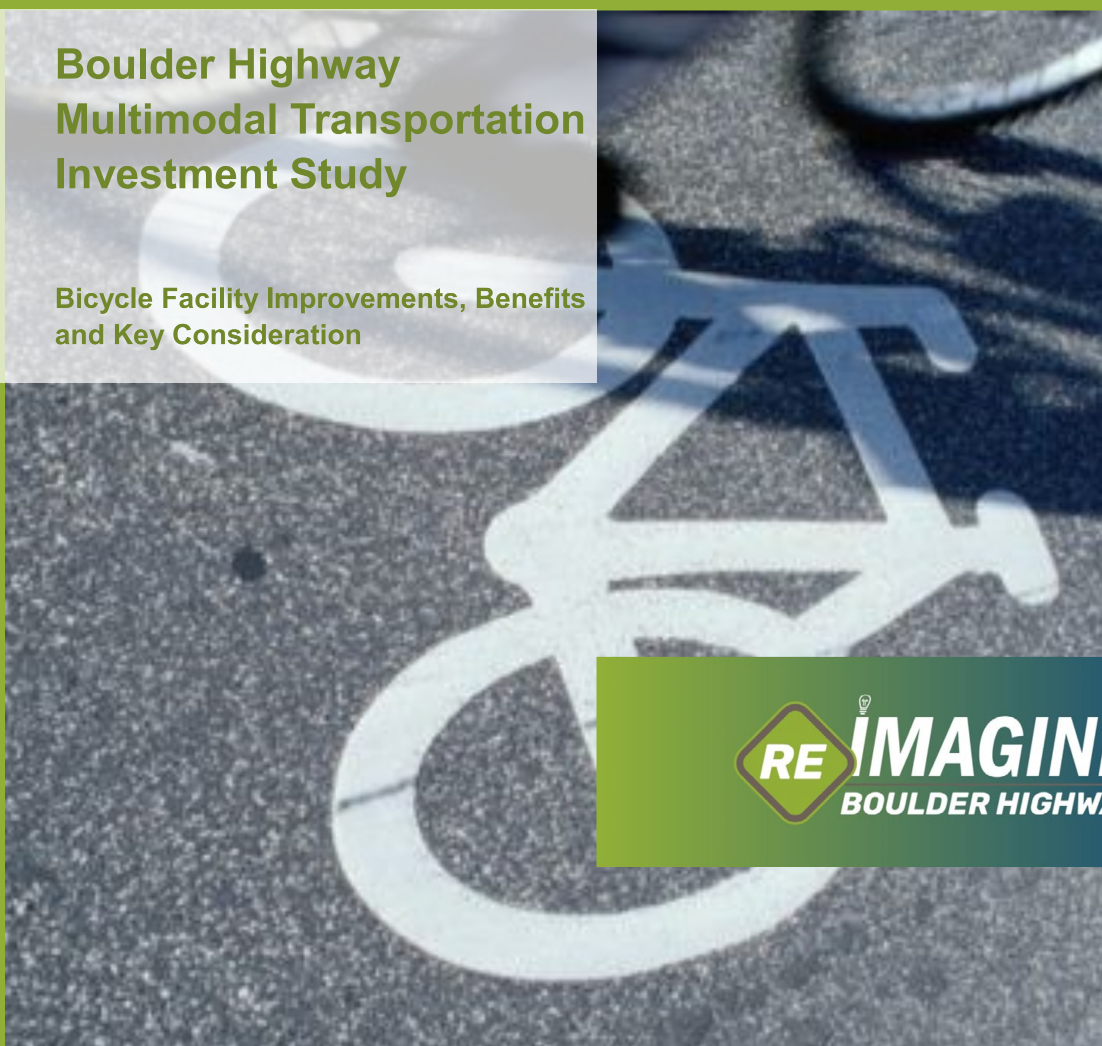
- Allows pedestrians to have adequate crossing time and less delay at intersections
- Can improve crossing compliance

Key Considerations:

- Impacts vehicle traffic operations
- Cost of detection or controllers

RTC

Bicycle Facility Improvements Toolkit



Boulder Highway Multimodal Transportation Investment Study

Bicycle Facility Improvements, Benefits and Key Consideration

REIMAGINE BOULDER HIGHWAY

Bicycle Facility Design

Two-way Cycle-track

A two-way cycle track provides bicycle lanes in each direction and is separated from the vehicle travel lanes using a curb and/or landscaping features. The typical width ranges from 10 to 14 feet not including the buffer space. Bicycle lanes are also typically separated from a pedestrian and furniture zone. Likely to include striping, wayfinding, and special intersection treatments. Signalization at intersections is highly recommended.

Benefits:

- Full separation from vehicle traffic is most comfortable for cyclists of all ages and abilities

Key Considerations:

- Requires additional treatments, such as dedicated bike signals to ensure safety of bicycles

Protected Bike Lane

A protected bike lane is a single direction lane for cyclists that has a physical barrier separating the cycling traffic from the vehicular traffic. Typical lane widths are greater than six feet with vertical separation from traffic of greater than two feet. Special consideration for intersection design is recommended. Signalization at intersections is desirable.

Benefits:

- Separation from vehicle traffic is most comfortable for cyclists of all ages and abilities

Key Considerations:

- Requires additional treatments, such as dedicated bike signals to ensure safety of bicycles

Buffered Bike Lane

A buffered bike lane is a single direction lane for cyclists that creates separation from vehicular traffic through the use of lane markings and striping. Flexible delineators are often added to provide increased separation. Typical lane widths are greater than six feet with a buffer width of greater than two feet. Intersection treatment should include a dedicated right turn lane with a continuous through lane for cyclists.

Benefits:

- Low cost; long-term flexibility

Key Considerations:

- Striping does not deter use of the lane as a vehicle acceleration/ deceleration lane on high-speed corridors.

Conventional Bike Lane

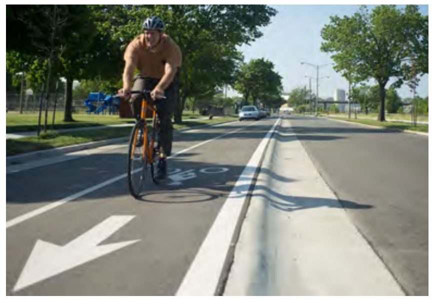
A conventional bike lane is a single direction lane for cyclists separated from vehicular traffic through the use of lane markings and striping. Typical lane widths are greater than six feet. Intersection treatment should include a dedicated right turn lane with a continuous through lane for cyclists.

Benefits:

- Low cost; minimal space needed for dedicated bicycle lane

Key Considerations:

- Not comfortable for cyclists adjacent to high speed and/or heavy traffic corridors



Raised Bike Lane

A raised bike lane can be used in combination with a cycle-track or a protected bike lane facility to provide additional separation from vehicular traffic.

Benefits:

- Provides traffic calming where mid-block driveways cross the lane

Key Considerations:

- Can create some drainage challenges at intersections

Multi-use Path

A multi-use path provides the most separation for cyclists from vehicular travel lanes and is the most comfortable in terms of traffic impacts on cycling experience. Multi -use paths are generally shared with pedestrians, and have possible delineations particularly at conflict points. A typical multi-use path is 10 to 14 feet with an additional width for clear zones on either side of the path. Special considerations for roadway crossings are needed.

Benefits:

- Greatest separation from vehicular traffic

Key Considerations:

- Design challenges at roadway crossings to create visibility and sight stopping distance.
- High cost

Other Bicycle Amenities

Secure Bike Parking

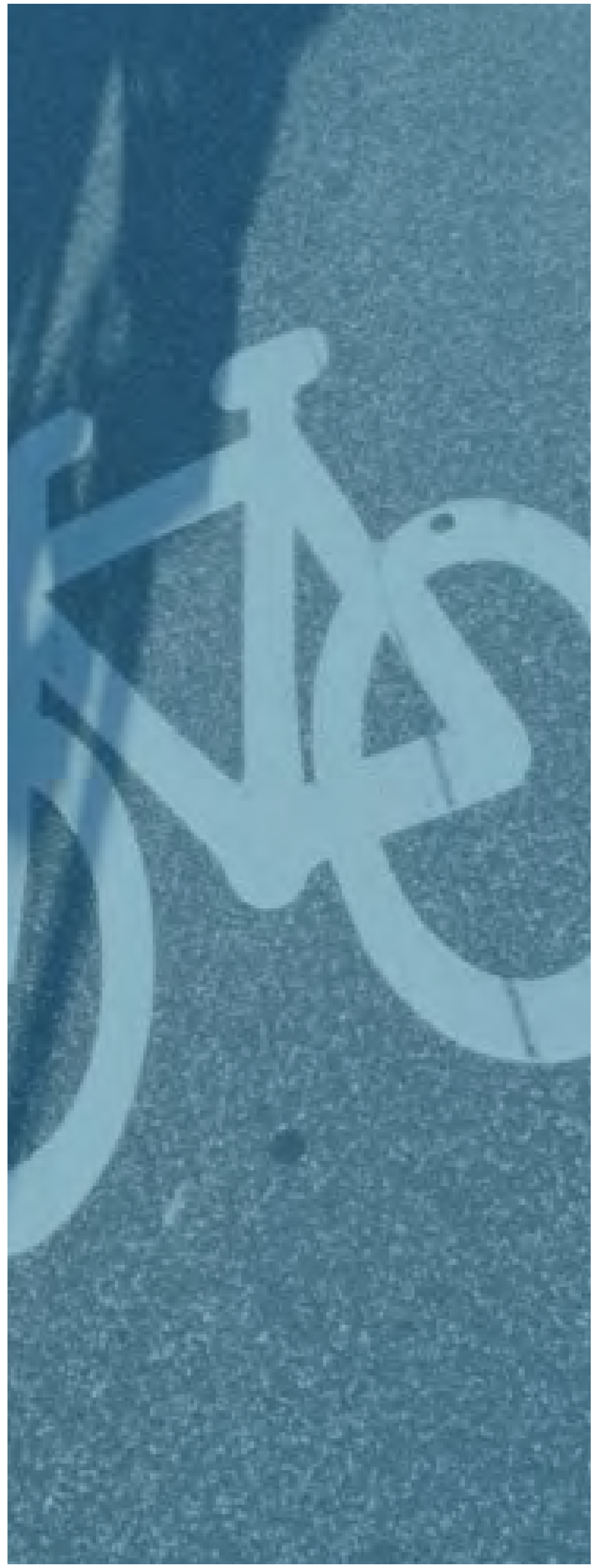
Secure bike parking allows registered users to access a protected area where many bicycles are stored. Such facilities can be integrated with transit station features or can be on their own.

Benefits:

- Provides long-term security for bicycle storage

Key Considerations:

- Space required exceeds standard bicycle racks
- Requires power and user registration program management
- Requires an access control system, maintenance and oversight of secure bicycle parking rooms.



RTC

Transit Facility Improvements Toolkit

Boulder Highway Multimodal Transportation Investment Study

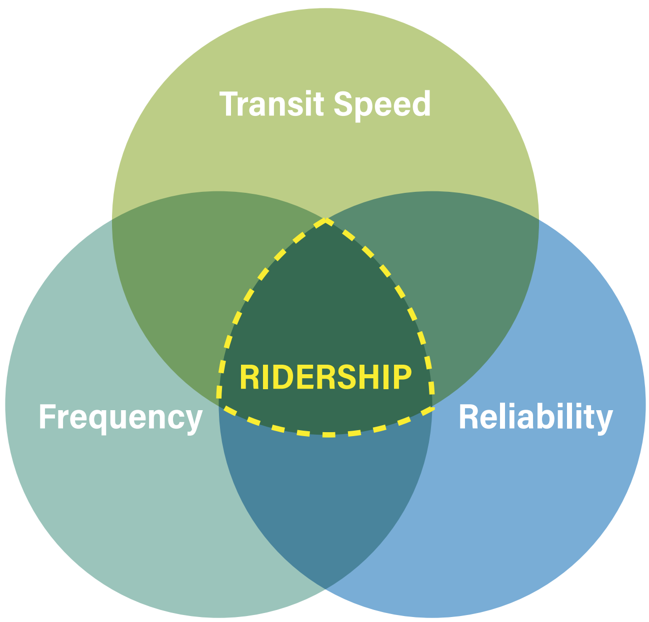
Transit Guideway Options and Practical Solutions

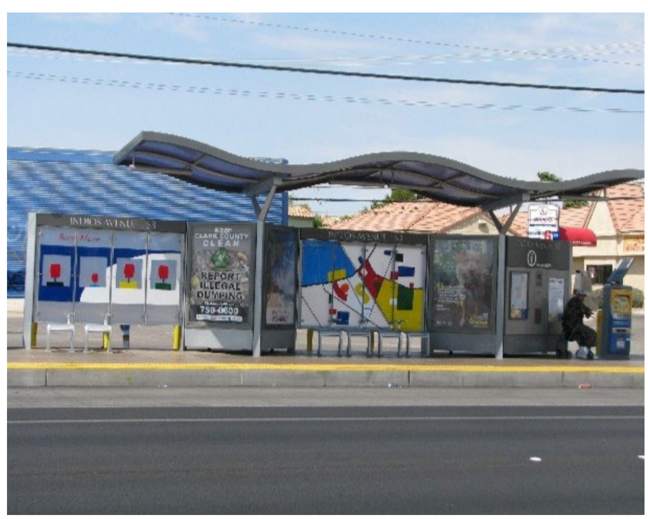
RE IMAGINE BOULDER HIGHWAY

Transit Speed, Frequency and Reliability

Field observations, and transit data collected along Boulder Highway demonstrate the difficulty of travelers to reach their destination on time. Reaching a destination on time is fundamental to improving and increasing the ridership along this corridor and fostering a transit culture.

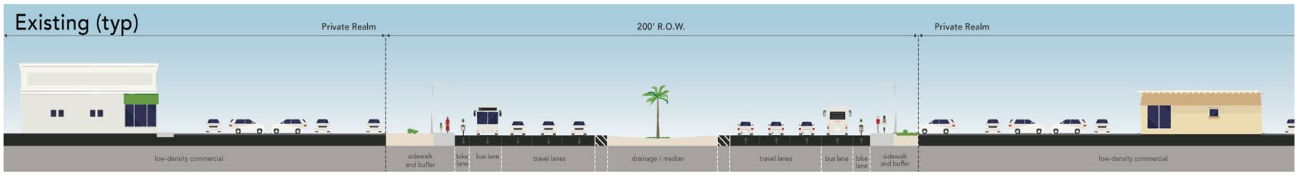
Speed, Frequency, and Reliability are direct measures of this goal.



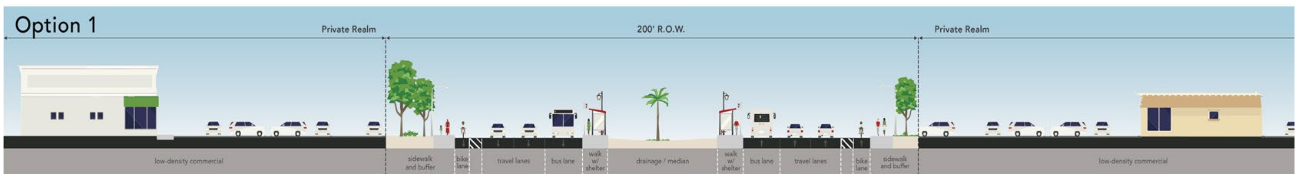


Practical Solutions	Benefits	Considerations
Dedicated Transit Lane • Extend the dedicated bus lane along the corridor. • Lanes may be located on curb side or on a median. • These lanes may have complementary effects with other transit elements such as off-board fare payment and TSP.	* Reduce transit delay and improve performance. * Keeps transit separated from traffic, minimizes conflict and improves safety. * Increase passenger convenience.	* Subject to encroachment due to illegal parking or stop. * Requires turning provisions for vehicles to avoid conflict. * Installation should be coordinated with land-use regulations.
Transit Signal Priority (TSP) Allows transit vehicles to communicate with traffic signals along their routes. • Works by either shortening the Red light or lengthening the Green light. • May in some cases have its own traffic signal.	* Reduction in travel time: • **20%** reduction in travel time achieved through combined TSP and off-board payment in New York. • **30%** reduction in travel time achieved through TSP in Los Angeles. * Improves system performance and reliability.	* In some cases, TSP might generate delay to vehicle. * Requires on-board system. * Additional delay for vehicles
Station Spacing and Location • Reduce number of stops. • Locate the stops: * At a location that minimizes pedestrian walking distances - Typically at the far side of the intersection. - In the median, if center running is possible. - At a location that serves major trip generators and attractors. • Major effect on average speed. • Effective use of priority measures such as TSP.	* Improves transit speed and performance. * Improves travel time and system reliability. * Avoids duplicate coverage. * Maximizes TSP performance.	* Increased coverage gaps for origin/destination connections. * Longer walking distance to stops. * Potential challenge for bicycle and pedestrian connections.
Off-board Fare Collection and All-door Boarding • Improvement on fare collection process such as pre-payment fares, self-service fare collection and smart cards. • Allowing passengers to board through any door.	* Reduces dwell times * Improves passenger convenience. * Improves transit speed performance. * Reduces congestion at busy stops. * All-door boarding	* Installation of new equipment (off-board and fare payment machines) at transit stops. * Security enforcement. * Maintenance of the equipment. * Fare evasion
Bus Frequency • Reduce waiting time at the transit station.	* Contributes in reducing overall travel time by shortening waiting time. This is more critical when transit trip is combined with longer walking trips or difficulty navigating big intersections such as Boulder Highway. * Improves trip reliability.	* Requires an increase of vehicle fleet. * If not properly supported by land use policies it might not prove beneficial to increasing ridership.

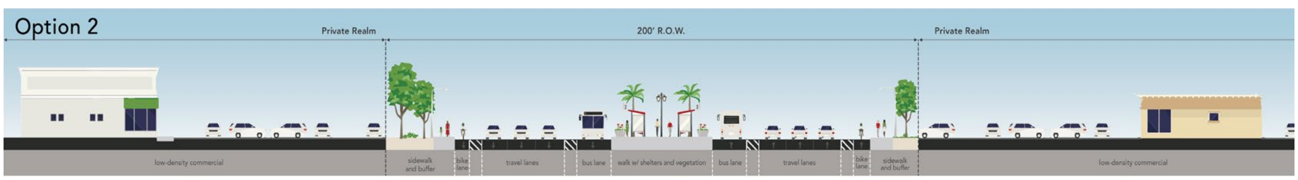
Transit Guideway Options for Boulder Highway



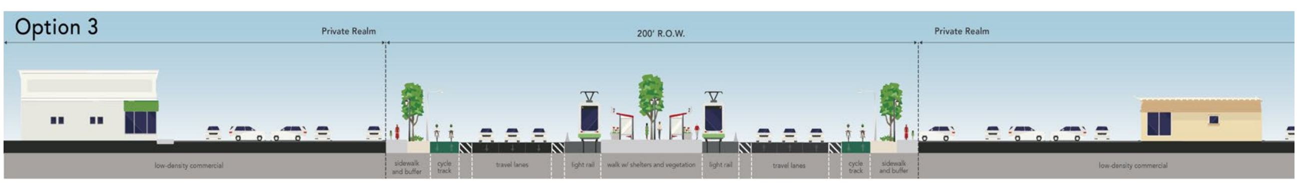
Bus Rapid Transit—Curbside Lanes



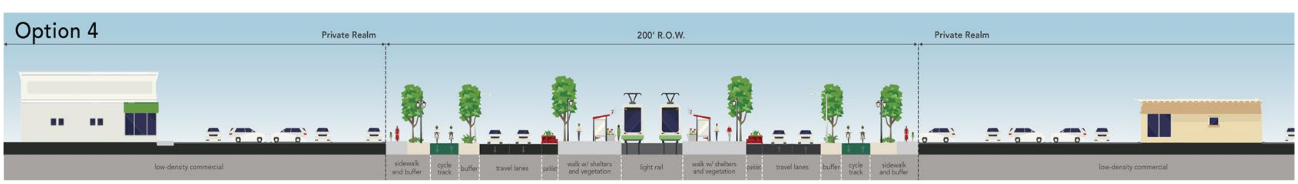
Bus Rapid Transit—Existing Inside Travel Lane



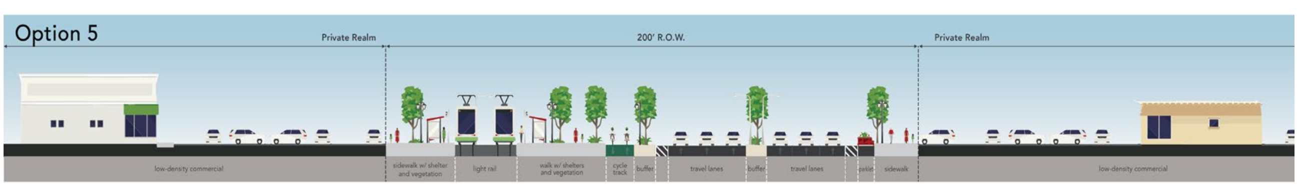
Bus Rapid Transit—New Inside Lane with Inside Stations



Light Rail Transit—Adjacent to Roadway with Inside Stations

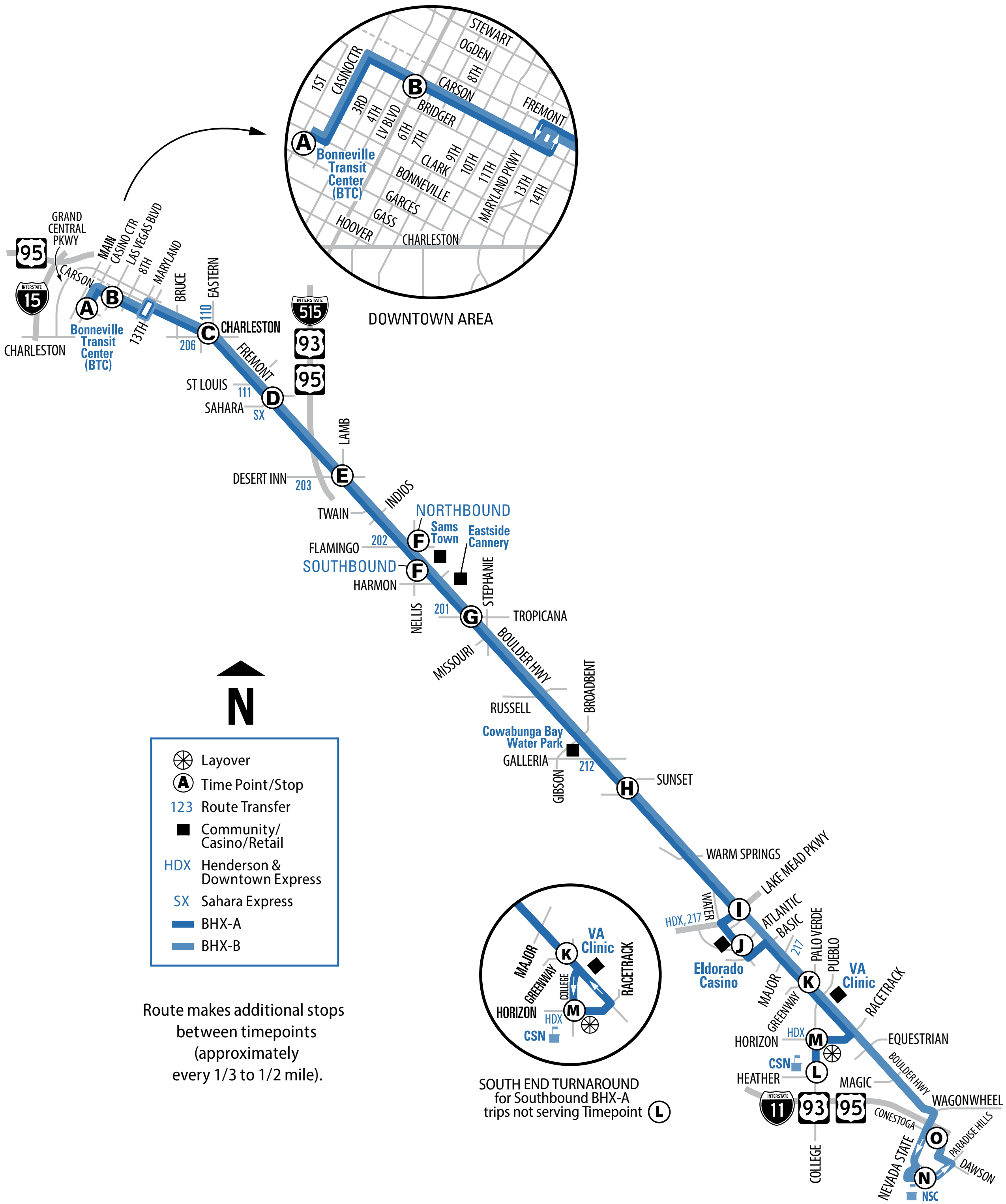


Light Rail Transit—In Median with Outside Stations



Light Rail Transit—Offset to One Side of Right-of-Way with Outside Stations

Overview	Benefits	Considerations
• BRT operates in curb lanes shared with turning traffic at driveways and cross streets. • Section includes bicycle lanes and attached walkways.	• Provides economical initial premium transit service.	• BRT movement conflicted by cross street and driveway turning traffic. • Lower travel speed is less attractive to riders. • Some users must cross entire roadway.
• BRT operates in existing inside travel lane with no buffer and with stations in the median; removes one travel lane in each distance. • Section includes buffered bicycle lanes and attached walkways.	• BRT is free from curbside lane traffic friction. • Slightly higher transit operating speed; reduced travel time is more attractive to users. • Provides opportunity for midblock refuges.	• Relatively low cost, but requires transit vehicles with left side entrance. • Reduced vehicle capacity due to BRT lane. • Left turning traffic must cross BRT lane. • All users must cross half the roadway.
• BRT operates in added inside lane separated by a buffer and with stations in the median. • Section includes buffered bicycle lanes and attached walkways.	• BRT is free from curbside lane traffic friction. • Slightly higher transit operating speed; reduced travel time is more attractive to users. • Provides opportunity for midblock refuges.	• Moderate cost, due to BRT mode and less road reconstruction. • Room for left turns is restricted. • All users must cross half the roadway.
• Light Rail Transit (LRT) operates in new added inside lane separated by a buffer and with stations in the median. • Includes 2-way buffered cycle track on each side of the road-way and attached walkways.	• LRT is free from curbside lane traffic friction. • Slightly higher transit operating speed; reduced travel time is more attractive to users.	• Highest cost, due to LRT mode and road reconstruction. • Room for left turns is restricted. • All users must cross half the roadway.
• LRT located in median with stations to the outside. • Roadways are reduced to 2 lanes each way to accommodate parklets. • Includes 2-way protected cycle tracks in each direction and detached walkways.	• LRT is free from curbside lane traffic friction. • Places rail side-by-side for higher speed away from traffic; single pedestrian guideway crossing location. • More room for left turns.	• Higher cost, due to LRT and road reconstruction. • LRT conflicts with cross street turning traffic. • All users must cross half the roadway.
• Light Rail Transit (LRT) is placed on one side of road. • One directional roadway is shifted to be adjacent to other directional roadway. • Includes one 2-way protected cycle track and detached walkways.	• Good LRT access for one side of the corridor. • Places rail side-by-side for higher speed away from traffic; single pedestrian guideway crossing location.	• Highest cost, due to LRT and more reconstruction. • Issue with property access at driveways and with cross street turning traffic. • Some users must cross entire roadway.



DOWNTOWN AREA
STEWART
OGDEN
8TH
CARSON
FREMONT
1ST
CASINO CTR
3RD
4TH
LV BLVD
6TH
7TH
BRIDGER
9TH
CLARK
10TH
11TH
BONNEVILLE
MARYLAND PKWY
13TH
14TH
GARCES
GASS
HOOVER
CHARLESTON
Bonneville Transit Center (BTC)
GRAND CENTRAL PKWY
MAIN
CASINO CTR
LAS VEGAS BLVD
8TH
MARYLAND
BRUCE
EASTERN
13TH
110
206
CHARLESTON
FREMONT
ST LOUIS
111
SAHARA
SX
LAMB
DESERT INN
203
INDIOS
TWAIN
NORTHBOUND
Sams Town
Eastside Cannery
FLAMINGO
202
SOUTHBOUND
HARMON
STEPHANIE
NELLIS
201
TROPICANA
BOULDER HWY
MISSOURI
BROADBENT
RUSSELL
Cowabunga Bay Water Park
GALLERIA
212
GIBSON
SUNSET
WARM SPRINGS
LAKE MEAD PKWY
WATER
HDX, 217
ATLANTIC
BASIC
217
PALO VERDE
PUEBLO
Eldorado Casino
VA Clinic
MAJOR
GREENWAY
RACETRACK
EQUESTRIAN
HORIZON
HDX
CSN
HEATHER
MAGIC
BOULDER HWY
WAGONWHEEL
CONESTOGA
PARADISE HILLS
DAWSON
NEVADA STATE
NSC
COLLEGE
SOUTH END TURNAROUND for Southbound BHX-A trips not serving Timepoint L
N
Layover
Time Point/Stop
123 Route Transfer
Community/ Casino/Retail
HDX Henderson & Downtown Express
SX Sahara Express
BHX-A
BHX-B
Route makes additional stops between timepoints (approximately every 1/3 to 1/2 mile).

RTC

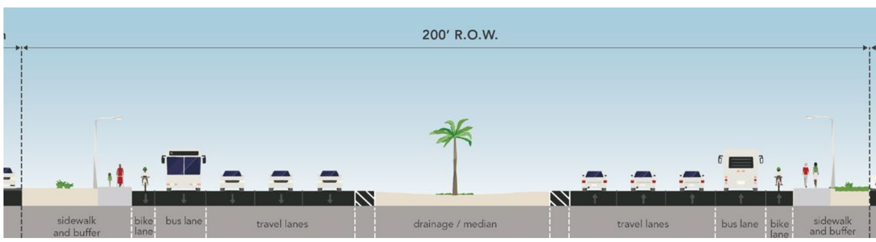
Travel Demand Management and Improvements Toolkit

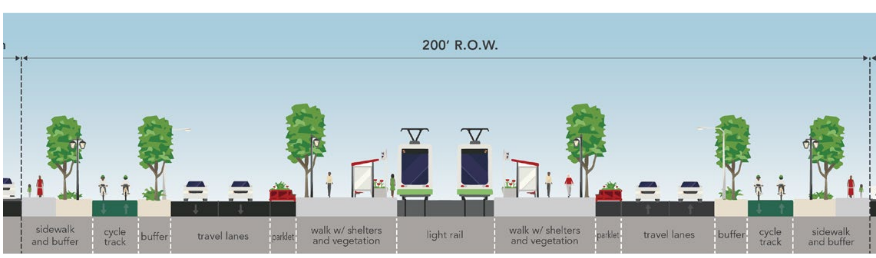
Boulder Highway Multimodal Transportation Investment Study

Existing Conditions, Future Growth in Demand and Innovative Solutions for Congestion Management

REIMAGINE BOULDER HIGHWAY

Travel Demand Management and Improvements





Existing	**Existing Number of Lanes**
	Capacity (vehicles per hour per lane)
	Existing AM(PM)
	Existing Traffic Performance volume/ capacity (Level of Service)
	Constrained Location
Future Land Use Growth	Population Net Growth
	% Population Increase
	Employment Net Growth
	% Employment Increase
3 Lane Option	Future AM(PM) Peak Volumes
	Future Traffic Performance volume/ capacity (Level of Service)
	Excess demand in percentage
	Constrained Location
2 Lane Option	Future Capacity
	Future Traffic Performance volume/ capacity (Level of Service)
	Excess demand in percentage
	Constrained Locations

Segment 1: Wagonwheel Drive to Palo Verde Drive	Segment 2: Palo Verde Drive to Water Street	Segment 3: Water Street to Tulip Falls Drive	Segment 4: Tulip Falls Drive to Tropicana Avenue	Segment 5: Tropicana Avenue to I-515	Segment 6: I-515 to Charleston Boulevard
2	**2**	**3**	**3**	**3**	**3**
825vphpl	825vphpl	975vphpl	975vphpl	975vphpl	975vphpl
896(972)vph	912(993)vph	841(1035)vph	903(1367)vph	1414(1713)vph	1511(2246)vph
AM = 0.39 (LOS A) PM = 0.59 (LOS A)	AM = 0.47 (LOS A) PM = 0.58 (LOS A)	AM = 0.29 (LOS A) PM = 0.35 (LOS A)	AM = 0.31 (LOS A) PM = 0.47 (LOS A)	AM = 0.48 (LOS A) PM = 0.59 (LOS A)	AM = 0.52 (LOS A) PM = 0.77 (LOS C)
None	None	None	None	None	None
14,583	2,544	29,686	7,138	2,987	10,822
35.90%	13.59%	206.17%	20.50%	4.01%	15.51%
6,364	3,552	11,362	4,175	1,636	4,051
117.11%	62.68%	90.84%	54.20%	15.70%	20.93%
970(1279)vph	1744(1843)vph	1854(1961)vph	2125(2274)vph	2159(2388)vph	2007(2911)vph
AM = 0.60 (LOS A) PM = 0.77 (LOS C)	AM = 0.60 (LOS B) PM = 0.77 (LOS C)	AM = 0.65 (LOS B) PM = 0.67 (LOS B)	AM = 0.73 (LOS C) PM = 0.78 (LOS C)	AM = 0.74 (LOS C) PM = 0.82 (LOS D)	AM = 0.69 (LOS B) PM = 1.00 (LOS E)
None	None	None	None	None	None
None	None	None	None	None	NB Boulder Highway at I-515 Ramps
825vphpl	825vphpl	825vphpl	825vphpl	825vphpl	825vphpl
AM = 0.60 (LOS A) PM = 0.77 (LOS C)	AM = 1.06 (LOS E) PM = 1.12 (LOS F)	AM = 1.15 (LOS F) PM = 1.19 (LOS F)	AM = 1.29 (LOS F) PM = 1.38 (LOS F)	AM = 1.31 (LOS F) PM = 1.45 (LOS F)	AM = 1.22 (LOS F) PM = 1.76 (LOS F)
None	AM = 6%(105 vph) PM = 9% (152 vph)	AM = 15%(140 vph) PM = 19%(297 vph)	AM = 29%(412 vph) PM = 38%(589 vph)	AM = 31% (446 vph) PM = 45% (669 vph)	AM = 22% (291 vph) PM = 76% (1195 vph)
None	Water St to Lake Mead Blvd	Tulip Falls to Galleria Dr. and Warm Springs to Water St	Tropicana Ave to Tulip Falls Dr.	I-515 to Tropicana Ave	St Louis to I-515 Ramps

Key Considerations

A key recommendation for safety and mobility improvements on Boulder Highway was to consider reducing the number of lanes on this arterial. The continued growth in demand is inevitable; however, technology offers innovative solutions to service the growing demand that can be used as an alternative to the conventional approach of increasing capacity. Below is a list of recent technological solutions that could be considered for capacity management on Boulder Highway at the time of growth in demand:

Adaptive Signal Control Technology

By receiving and processing data from strategically placed sensors to optimize and update signal timing settings, it can be determined when and how long lights should be green to accommodate current traffic patterns, promote smooth flow and ease traffic congestion.

Connected and Autonomous Vehicles

Vehicles that use several communication technologies to communicate with the driver, other cars on the road, and the road infrastructure (such as signalized intersections or road signage, and the Cloud). This technology helps reduce travel time and congestion and helps improve safety for all road users.

Slot-based Intersection

The advancements in technology might make it possible for smart intersections to be in place by year 2040. Currently MIT has been researching the potential of slot-based intersections. Self-driving cars would cross intersections at an assigned time similar to slot-based management currently used in air traffic. When approaching an intersection, the self-driving car would access request from a central control system and will be assigned a specific slot to pass through the junction on first-come first-served basis. This type of smart intersection is expected to double the capacity of the intersection. However, interaction of this type of technology with pedestrians might still need to be explored.

Advanced Traveler Information

A system that acquires, analyzes and presents information such as locations of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions to travelers en route from origin to destination.

Variable Speed Limit Signs

Signs that can be changed to alert drivers when traffic congestion is imminent. Sensors along the roadway detect when congestion or weather conditions exceed specified thresholds and automatically reduce the speed limit to slow traffic and postpone the onset of congestion.

Multimodal Traffic Management

Planning and strategies that provide information on the available modes of transportation and connections as an alternative to cars. Improving the BRT operations by providing dedicated running ways along the entire corridor is a strategy that may increase ridership and transit mode share. Additionally, high capacity transit is being considered as a viable alternative for this corridor. Selection of supportive land use strategies might also influence the increase in ridership and mode share. Dallas light rail system for example currently has an estimated 30% mode share.

Multimodal Intelligent Traffic Safety System

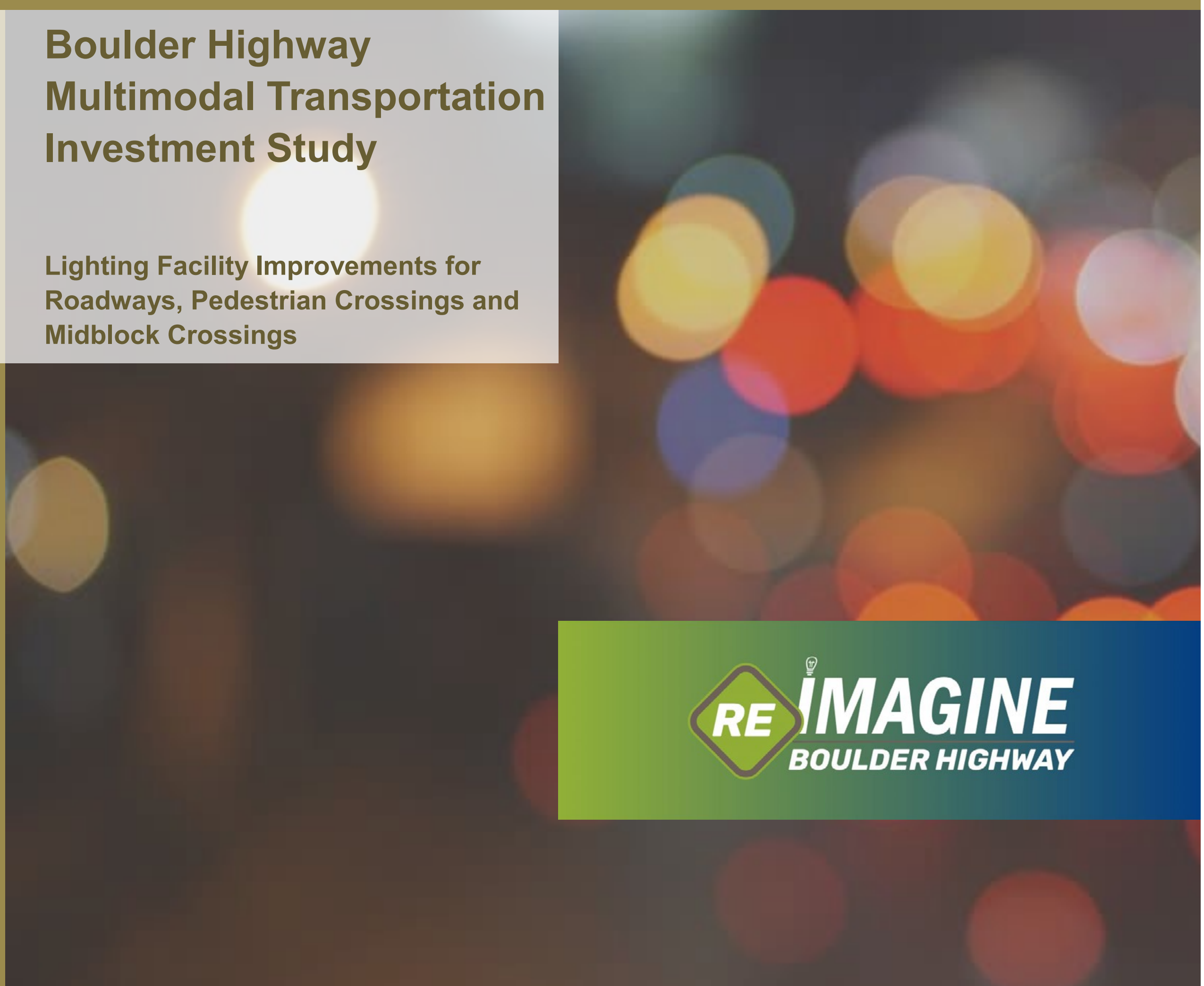
The next generation of traffic signal systems that provides a comprehensive traffic information framework to service all modes of transportation. The vision for this application is to provide an overarching system optimization that accommodates signal priority for transit, freight and pedestrian movements and preemption for emergency vehicles, while maximizing overall arterial network performance.

RTC

Lighting Facility Improvements Toolkit

Boulder Highway Multimodal Transportation Investment Study

Lighting Facility Improvements for Roadways, Pedestrian Crossings and Midblock Crossings

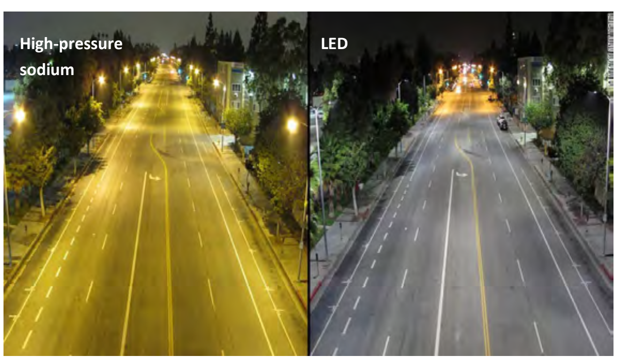


REIMAGINE BOULDER HIGHWAY

Lighting Facility Design

Roadway Lighting

- **LED Lights:** There are various LED cobra-heads that can replace a high-pressure sodium luminaire on a one-to-one basis, thus reducing operating and maintenance costs. **Light Timings:** Lights should be on from dusk to dawn.
- **Additional Alert Devices:** Devices used to alert drivers must also be increased. At the minimum, pedestrian crossing signs must be 36 by 26 inches for of 40 mph speeds.
- **On Pavement Symbols and Markings:** Pavement word symbols can be added to enhance pedestrian visibility, and zebra or ladder style crossings should be considered.



High-pressure-sodium vs. LED luminaire, before and after

Midblock Crossing

- **In-Pavement lights:** On both sides of the crosswalk, directed towards oncoming traffic and can be activated by passive or active sensors. Once activated, the lights flash at a constant rate. These lights are typically at crosswalks without stop control devices.
- **In-Pavement and Flashing Beacon**: On mid-block crossings, they are activated by motion sensors. These in-pavement lights are available solar powered.
- **Overhead lighting:** Provides light to pedestrian who are crossing the street at night and warns oncoming vehicles. Overhead lighting can be activated passively or by pushing a button.
- **High-intensity activated crosswalk:** Includes a sign instructing motorists to “stop on red” and a “pedestrian crossing” overhead sign, can be activated passively or by a pedestrian pushing a button. When activated, an overhead signal begins flashing yellow and then solid yellow, advising drivers to prepare to stop. It then switches to a solid red light and shows the pedestrian a “Walk” indication. Finally, it shows a flashing red signal indicating that motorists may proceed when safe after coming to a complete stop. The pedestrian sees a flashing “Don’t Walk” sign indicating the number of seconds left to cross.
- **LED Warning Systems:** Operates in a similar way to the overhead lighting system but provides an LED sign that warns approaching drivers that a pedestrian is crossing the street.

Pedestrian Lighting

- **Additional Pedestrian Lighting:** Additional pedestrian lighting at signalized intersections and mid-block crossings should be installed to provide proper illumination for pedestrians.

- **Adaptive lighting:** It will reduce intensity when no pedestrians are present and is now available with motion control on LED luminaires.

- **Illumination standards:** Vertical illumination shall be measured at 5 feet above the pavement, with a minimum 2.3 foot-candles average initial vertical illumination, and shall follow the IES illumination levels.

- **Double Arm Light Poles:** Provide a double-arm pole with one luminaire facing the roadway at a higher height and a second luminaire facing the sidewalk with a lower height wattage.

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Intersection Types Toolkit

RTC

Boulder Highway Multimodal Transportation Investment Study

Proposed types of intersection configurations

REIMAGINE BOULDER HIGHWAY

Alternative intersection configurations that have the potential to improve both safety and operations along the corridor were explored during the study process. A detailed description of the analysis conducted is provided in Appendix I. In addition to the current signalized intersections, two alternative intersection types were identified from the analysis process: roundabouts and Michigan u-turns (MUT) with high-visibility crosswalks.

Roundabouts

A roundabout is a type of circular intersection where traffic travels counterclockwise around a center island. Vehicles entering the roundabout yield to the circulating traffic in the roundabout. Curvature of the roundabout helps in reducing vehicular speeds to 15 mph to 25 mph. Accessible pedestrian crossings typically are accommodated in advance of the entry to the roundabout. A truck apron is provided on the center island to accommodate the wider truck turning radius.

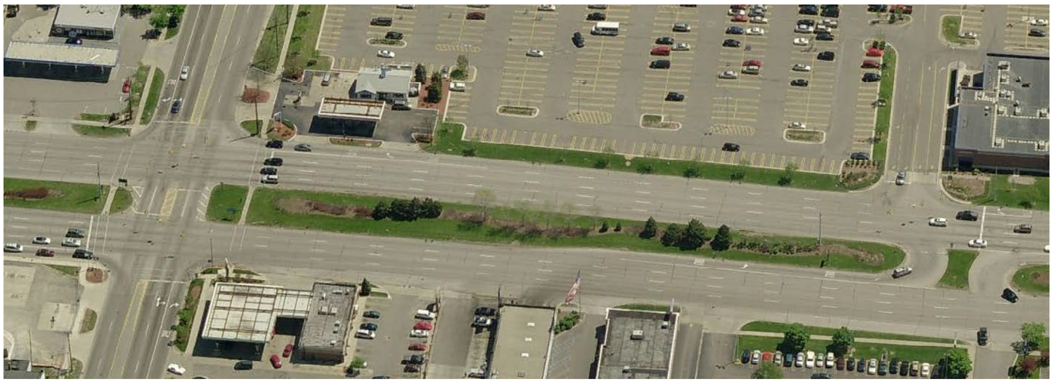
Roundabouts can be single lane or multi-lane and accommodate three to six incoming legs. One of the challenges of multi-lane roundabouts is drivers moving between lanes to exit. To overcome this issue, turbo roundabouts were introduced in the late '90s, requiring drivers to choose their direction before entering the roundabout.

Benefits of roundabouts include:

- Safer than conventional signalized intersections. They have 8 conflict points compared to 32 conflict points at conventional intersections thereby increasing safety.
- Reducing the types of crashes in which people are seriously injured or killed by 72 percent to 82 percent compared to stop-controlled or signalized intersections (FHWA).
- Not requiring drivers to stop, reducing the overall delay at intersections and improving efficiency of the system.
- Complementing other transportation objectives, such as Complete Streets, multi-modal networks, and corridor access management (FHWA).
- Costing less to build and maintain than a traditional signalized intersection.
- Providing an opportunity to incorporate public space and art is more aesthetically appealing than at signalized intersections.

Key considerations of roundabouts are:

- Multi-lane roundabouts are perceived as difficult to navigate by some drivers and may require additional outreach. Lane changing due to unfamiliarity can result in an increase of sideswipe crashes. Turbo roundabouts can be used to mitigate these crashes.
- If center-running transit or bicycle tracks are implemented, signal equipment needs to be installed to stop the traffic circulating in the roundabout.
- Two-level roundabouts can be a solution at locations with extremely high crossing traffic, such as Lake Mead Parkway.
- Roundabouts need to be adapted to the context of the area.



Michigan U-Turn with High-Visibility Crosswalks

The Median U-Turn (MUT) Intersection, also known as a Michigan U-Turn, is an innovative intersection that displaces left turns at an intersection with indirect left turns using a U-turn movement in a wide median (Figure 5.3). In addition to other operational conditions, because there is already a wide median at certain intersections along Boulder Highway, that makes this type of intersecton a good alternative to signalized intersections. The MUT intersection eliminates left turns on one or both intersecting streets, thus reducing the complexity of the intersection by reducing the number of traffic signal phases, pedestrian crossing distances, and conflict points at the main crossing intersection. This results in improved intersection operations and safety. This type of intersection can accommodate the needs of all users.

Benefits of MUT intersections include:

- Improving safety of both pedestrians and vehicles. MUT intersections have half the number of conflict points as a traditional signalized intersection.
- Reducing crashes due to left-turn movements at traditional intersections by 70 percent. Left-turn crashes account for 20 percent of fatal crashes at signalized intersections (FHWA https://safety.fhwa.dot.gov/intersection/conventional/signalized/).
- Improving efficiency and reduce congestion. The MUT allows the intersection to operate with fewer phases, which increases the available green time. The removal of left-turn lanes from the intersection reduces the length of pedestrian crossing distances, which also may contribute to increased intersection efficiency. Studies have shown a 20 percent to 50 percent improvement in intersection throughput. (Savage, W.F., "Directional Median Crossovers," Journal of Traffic Engineering, 44(11) (1974)).

Key considerations of MUTs are:

- An excellent choice for intersections with moderate to heavy through traffic and a moderate number of left turns.
- Lanes can be incorporated to accommodate turning truck traffic or u-turning vehicles.

5.3 CONCEPT DEVELOPMENT AND EVALUATION PROCESS

The stakeholders' vision to maintain a consistent look along the entire length of the corridor made concept development difficult, considering the length of the corridor, the change in context, and competing preferences of stakeholders. To overcome this issue, the study team followed a layered approach that allowed the natural evolution of the preferred corridor concept. Figure 5.2 shows the main drivers of the preferred concept selection process: Stakeholder and Public Input, Corridor Goals, and Land Use Context.

Stakeholder input at the beginning and the end of the process was considered key to reaching a consensus on the preferred concept. The development of a preferred concept was initiated during the second workshop. Using the design options developed during the visioning workshop shown in Chapter 3 and the tool box of solutions detailed in this chapter, and with the help of focus-area experts, stakeholders navigated the problem solving for each segment of the corridor. Case studies focused on how well the options can accommodate mid-block crossings, how they can impact intersections and ROW, and how they can address access management. The case studies helped stakeholders identify strengths and weaknesses of implementing the options on each segment of the corridor. The workshop provided the opportunity for stakeholders to focus on pedestrian and bicycle safety, transit facilities improvements, and roadway facilities improvements.

Following the workshop, the individual tool box design elements were evaluated by the study team using Criterium DecisionPlus software. Because of the number of tool box design elements identified, it was necessary to complete an initial level of evaluation prior to packaging them into corridor alternatives. Scoring criteria for each of the project's goals and indicators were entered into the software to rank individual tool box design elements. The software has the flexibility to conduct sensitivity analysis to evaluate how the weighting of each goal would impact the results. Based on the resulting scores, this process allowed the project team to identify those design elements that best met the project's stated goals while minimizing the number of potential corridor alternatives to be evaluated in the future.

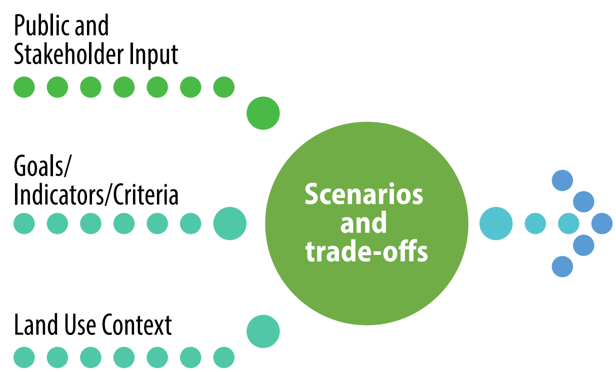


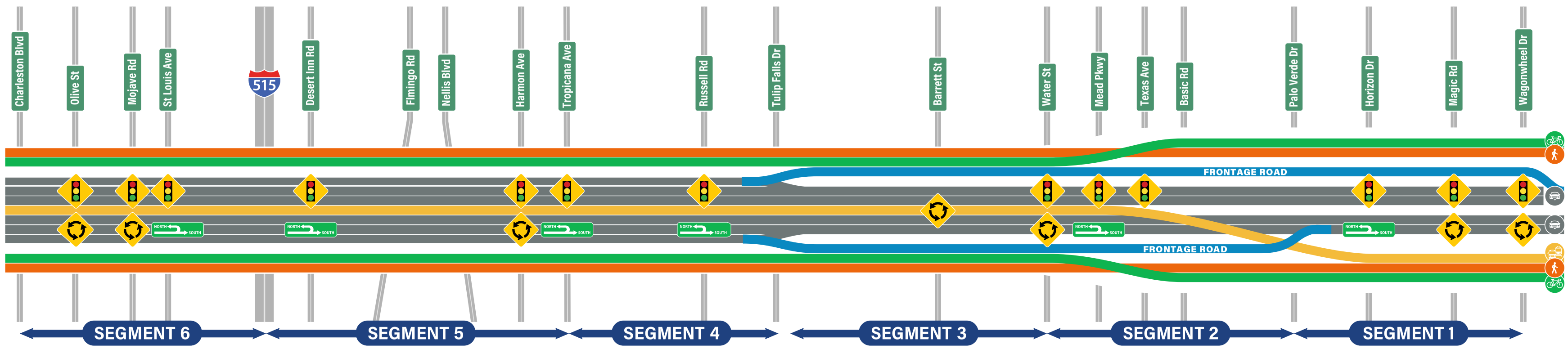
FIGURE 5.2 EVALUATION PROCESS

Due to the length and land-use diversity of the project corridor, it was necessary to account for the idea that there is likely not one ideal corridor alternative that is appropriate for each of the six segments of Boulder Highway. As noted in Chapter 3, each of these segments was analyzed and a character zone profile, shown in Figure 3.4, was created to ensure that design elements and, ultimately, the corridor alternatives reflected the individual needs of different segments of the roadway. Within the evaluation criteria, character zones/segment needs were captured through the creation of additional criteria and measures of effectiveness unique to each character zone.

A summary of results of this evaluation is provided in Appendix I.

5.4 CREATING THE INITIAL CONCEPT

The results of the stakeholder workshop were used then to package the selected design elements for each segment. The tool box design element evaluation process ensured that elements included within the alternative cross-sections met the project's goals and objectives. Therefore, the primary focus of the alternative cross-section analysis was to arrange these elements into a combination that best reflected the community values. In total, seven different cross-sections, shown in Appendix I, were evaluated. The evaluation of cross-sections was done in a qualitative manner based on stakeholder input from Workshop 2 and one-on-one stakeholder interviews. Figure 5.3 shows the recommended design options by mode based on the evaluation.



	SEGMENT 6	SEGMENT 5	SEGMENT 4	SEGMENT 3	SEGMENT 2	SEGMENT 1
CHARACTER ZONE	Urban Mixed-use 75% Parks & Open Space 25%	Urban Mixed-use 85% Parks & Open Space 15%	Urban Mixed-use 90% Parks & Open Space 10%	Urban Mixed-use 50% Light Industrial 5% Suburban 10% Parks & Open Space 20%	Urban Mixed-use 52% Parks & Open Space 48%	Urban Mixed-use 40% Parks & Open Space 60%
DESIGN OPTIONS (BY MODE): GP lanes	Three 10-12 foot GP lanes with street lighting	Three 10-12 foot GP lanes with street lighting	Three 10-12 foot GP lanes with street lighting	Two 12 foot GP lanes with frontage roads and street lighting	Two 12 foot GP lanes with frontage roads	Two 12 foot GP lanes with frontage roads
Transit	Center-running	Center-running	Center-running	Center-running	Transit all on one side or center running transit (likely transitioning between center-running and all on one on side within this segment)	Transit all on one side
Bicycle	Two-way protected bicycle lane or one-way protected bicycle lanes	Two-way protected bicycle lane or one-way protected bicycle lanes	Two-way protected bicycle lane or one-way protected bicycle lanes	Two-way protected bicycle lane or one-way protected bicycle lanes	Two-way protected bicycle lane or one-way protected bicycle lanes	Off-street trail or two-way protected bicycle lane
Pedestrian	1 - Crossings every 500-1000 feet 2 - RRFBs or mid-block traffic signals 3 - 8-10 foot sidewalks 4 - Ped scale lighting 5 - Streetscaping	1 - Crossings every 500-1000 feet 2 - RRFBs or mid-block traffic signals 3 - 8-10 foot sidewalks 4 - Ped scale lighting 5 - Streetscaping	1 - Crossings every 500-1000 feet 2 - RRFBs or mid-block traffic signals 3 - 8-10 foot sidewalks 4 - Ped scale lighting 5 - Streetscaping	1 - Crossings every 500-1000 feet 2 - RRFBs or mid-block traffic signals, or grade separation 3 - 8-10 foot sidewalks 4 - Ped scale lighting 5 - Streetscaping	1 - Crossings every 500-1000 feet 2 - RRFBs or grade separation 3 - 8-10 foot sidewalks 4 - Ped scale lighting 5 - Streetscaping	1 - Crossings every 500-1000 feet 2 - RRFBs or grade separation 3 - 10+ foot sidewalks 4 - Ped scale lighting 5 - Streetscaping

RRFB: Rectangular Rapid Flashing Beacon

GP: General Purpose

Signalized intersection

Roundabout

Michigan U-turn

FIGURE 5.3 RECOMMENDED DESIGN OPTIONS

5.5 REFINING THE CONCEPT

The results of the evaluation shown in Figure 5.5 were presented to stakeholders for further refinement. While the selection of pedestrian, bicyle, and transit improvements gained general acceptance by stakeholders, the biggest disparity among stakeholders included:

- Number of lanes
- How the concept would better address the access management issues
- Lane width
- Intersection types
- Location of transit lanes in the southern portion

Considering that Boulder Highway crosses many jurisdictions and neighborhoods with different characters, it was determined that the lane widths and the intersection types will be determined by each local agency in coordination with NDOT during the design process.

Understanding the stakeholder's concerns, the study team returned to the drawing board to formulate a solution that would have the buy-in of all stakeholders. Further analysis of traffic data, as described in Appendix H, indicates that two travel lanes in each direction would provide enough vehicle capacity for southern sections of the corridor. The reduction in vehicle capacity in conjunction with fast and reliable transit and sound land-use policies will provide an incentive for travelers to use alternative modes of transportation.

The discovery process in other sections of the corridor indicated that 40 percent of traffic uses the right-hand lane to access properties along Boulder Highway. This may provide an opportunity to use access roads as a strategy that will channelize this traffic, address the access management issues, and shorten pedestrian crossing distances.

Stakeholders' recommendations acknowledge the impact of future advancements in technology, and their decisions are based on what might happen in the future. In the long term, the reduced number of through vehicle lanes will not necessarily reduce the overall person capacity of Boulder Highway, but would provide better utilization of alternative modes. Additionally, the implementation of traffic management strategies will provide opportunities to increase the vehicular capacity of a two through lane arterial and signalized intersections. The proposed concept is described in detail in Chapter 6.

6.0 LOOKING AHEAD

The proposed concept aims at transforming Boulder Highway into a boulevard that incorporates center-running transit service. Boulevards are tree-lined, wide roadways that separate realms for through traffic and slow-paced vehicular-bicycle-pedestrian movements. This concept provides each jurisdiction along the 15.4-mile-long roadway the opportunity to adapt the configuration to the context and surrounding land uses within the established realms.

TRADITIONAL BOULEVARD CONCEPT

The proposed boulevard concept is based on maintaining the existing minimum 178-foot-right-of-way and defining the space allocated into two realms: through realm and pedestrian realm. These distinct realms (illustrated in Figure 6.1) create a high degree of flexibility, offering local agency stakeholders the opportunity to configure the spaces within the realms in a manner that is best suited for their uses while maintaining a level of consistency throughout the corridor. Furthermore, this design ensures that the goals of the Boulder Highway study are achieved

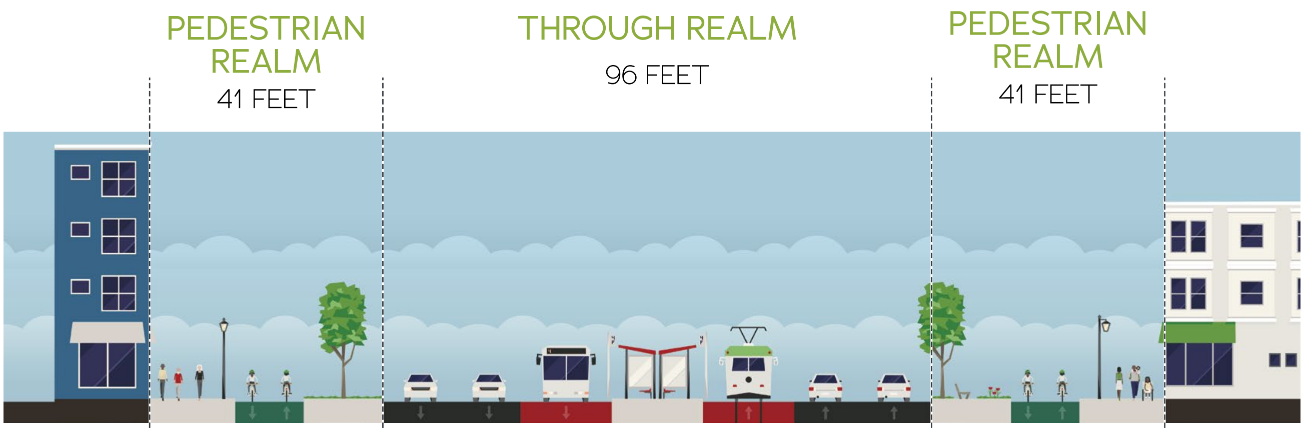


FIGURE 6.1 TRADITIONAL BOULEVARD LAYOUT

now, and into the future as the corridor develops and re-develops. The center median may be used exclusively by transit, or become a pedestrian promenade or a linear park with trees, grass, shrubs, and benches between transit stations as shown in Figure 6.1. Transit ways are located on both sides of the median adjacent to two travel lanes within the through realm. The pedestrian realm is characterized by wide landscaped areas or linear parks, wide sidewalks, and elevated bicycle lanes or tracks. New buildings are anticipated to be located adjacent to the sidewalk

MULTIWAY BOULEVARD

This type of boulevard, shown in Figure 6.2, is unique because it reconfigures the pedestrian realm in a way that separates through traffic from slow-paced local traffic. Tree-lined and landscaped medians separate the two through travel lanes from slower traffic accommodated in the parallel access road. Medians can vary in width accommodating landscaping and amenities such as benches and trash bins. Access roads generally allow one travel lane and parking when needed. This type of boulevard is also designed for recreation.

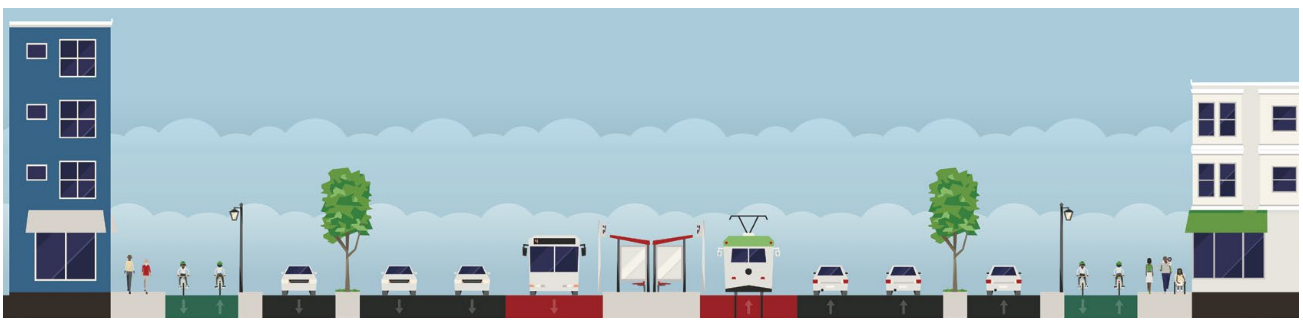


FIGURE 6.2 MULTIWAY BOULEVARD LAYOUT

PEDESTRIAN REALM

The pedestrian realm, is a slower speed zone on either or both sides of the roadway. This zone has pedestrian and bicycle facilities, and linear parks, or a local-access road for vehicles. Physically separated from through traffic, this realm can be configured in multiple ways depending on the desires of local agency stakeholders while still maintaining a consistent character throughout the corridor as shown in Figure 6.3.

Providing a slower speed realm creates a safe and comfortable place for bicyclists and pedestrians. Because all traffic is moving slower in this area, non-motorized travel can be safely accommodated in a variety of ways including dedicated or shared spaces.

The slower speed realm allows vehicles to interact with each other and other users at an appropriate and safe speed. Access lanes address the safety and access management issues arising from closely spaced driveways.

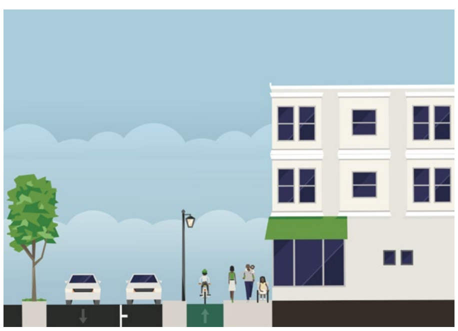
The pedestrian realm can be configured and reconfigured in multiple ways, and it can accommodate a wide variety of contexts, community, and business needs.

Providing a slower speed realm on Boulder Highway reduces the roadway's barrier effect on transit users. This realm supports land-uses and activities that are conducive to transit. Furthermore, the realm is in close proximity to the transit-way so as to support the culture of taking transit for all trip purposes.

The pedestrian realm ensures that all modes of travel are safely accommodated, reducing risk and exposure. This guarantees a greater choice in travel options both now and in the future.

One-way cycle track with linear park

Access road with two-way cycle track adjacent to parking



Access road with parking and one-way cycle track

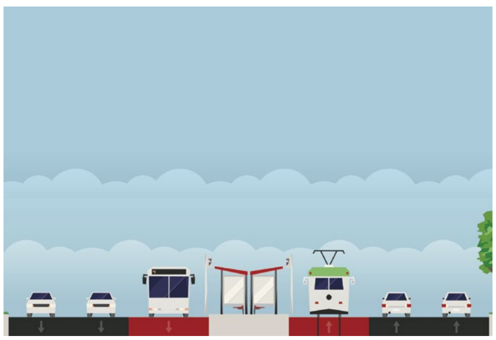
Sharrow access road with parking and landscaped median

FIGURE 6.3 PEDESTRIAN REALM

PROJECT GOALS:

- Provide safe non-motorized travel
- Improve vehicle safety
- Reliable movement of people on the corridor
- Support economic re-development
- Support transit culture

Center-running transit separated by medians



Center-running transit with station

Center-running transit with pedestrian promenade

FIGURE 6.4 THROUGH REALM

THROUGH REALM

The through realm is located in the center of the roadway and is designed for through vehicles as well as high capacity transit. This space allows Boulder Highway to continue to accommodate regional travel while maintaining the multimodal and local placemaking elements critical to a safe and vibrant corridor. Pedestrian promenades may also be accommodated within the center median.

The configuration of the through realm supports "Zero Fatalities" vision. Medians separating the pedestrian realm, through travel lanes, and transit-way provide pedestrian refuge islands, have a traffic calming effect, and reduce the distance between the pedestrian realm and the transit-way. Pedestrians can safely cross the roadway in multiple stages rather than having to navigate the entire roadway at once. Reduced travel lane widths further contribute to traffic calming.

Mode separation, through the use of medians, reduces conflicts between vehicles and other users and allows for more controlled and predictable roadway crossings. Additionally, medians act as visual barriers, naturally reducing vehicle speeds.

Supporting through traffic and transit in dedicated center running lanes allows for a greater variety of economic uses throughout the corridor. Bus rapid transit and light rail attract public and private development.

Center running transit in the through realm allows for faster transit speeds and increased ridership. Center stations allow for shorter distances from the pedestrian realm and provide opportunities for landscaping and public art. The relocation of stations to the center median allows for sidewalk space to be freed for retail and activation.

The through realm supports the smooth flow of through traffic by removing conflicts created by local accesses and non-motorized travelers. Center-running transit in dedicated lanes, combined with Intelligent Transportation Systems (ITS), ensure increased transit reliability.

SEGMENT 1

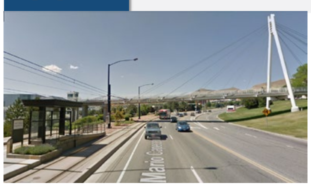
Wagonwheel Dr to Palo Verde Dr

Segment Length: 2.57 miles

Recommended Design Options (By Mode)

1 — **Two 10 to 12-foot General Purpose lanes.**

2 — **Center-running ART/BRT/ or LRT**



Center running transit in dedicated lanes will be extended through this area to connect to the Nevada State College. A premier transit service in this area would respond to the increasing residential and commercial land uses and would allow for reliable transit movement with minimal impact to private vehicle through-put.

3 — **Off-street trail or two-way protected bicycle lane**

Two-way Protected Bike Lanes

A two-way protected bike lane or "cycle track" in this area would function well with transit design option chosen. Local connectivity is well supported through the two-direction travel. Signalization at intersections is highly recommended.

Multiuse Trail

A multiuse trail would be appropriate in areas that connect to open space or where land is not yet developed.

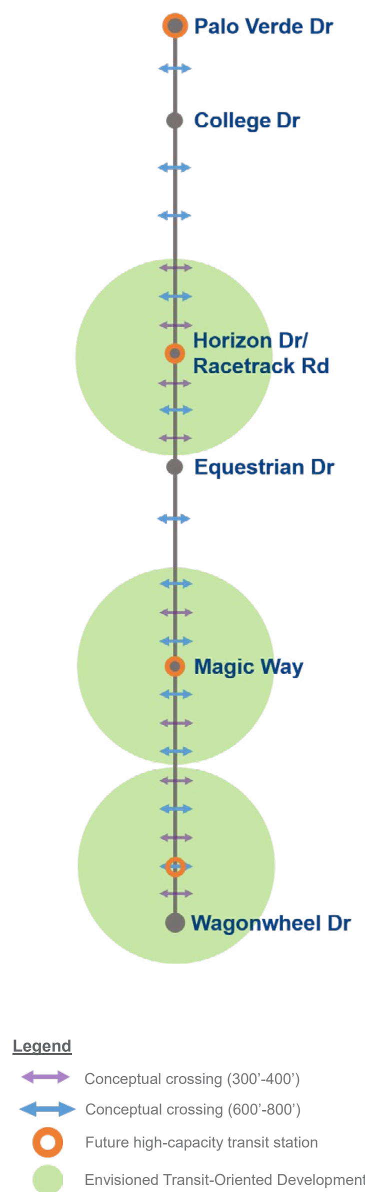
4

- **Frequent crossings**
- **RRFBs or grade separation**
- **10+ foot sidewalks**
- **Pedestrian scale lighting**
- **Streetscaping**

Crossing frequency may vary in this area responding directly to how the adjacent land will be developed. In the envisioned TOD areas, crossing frequencies of 300 to 400 feet would facilitate crossing compliance and enhance permeability of the roadway. In areas that do not develop, strategically located grade-separated crossings between high-use pedestrian generators provide the safest and most comfortable crossing.

Identified Character Zone

Urban Mixed Use	40%
Parks and Open space	60%
Light Industrial	0%
Suburban	0%



SEGMENT 2

Palo Verde Dr to Water St

Segment Length: 2.00 miles

Recommended Design Options (By Mode)

1

Two 10 to 12-foot General Purpose lanes with an additional access lane to control access as needed.

2

Center-running ART/BRT/ or LRT

Center running transit on this area would respond well to existing and any additional mix urban land development. Center transit median would also serve as a median refuge for frequent crossings within envisioned TOD areas.

3

Two-way protected bicycle lanes or one-way protected bicycle lane

Two-way Protected Bike Lanes

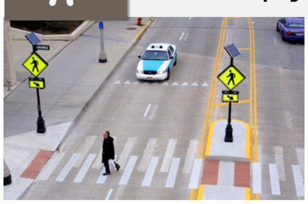
A two-way protected bike lane adjacent to more developed land would provide quick and comfortable access to employment, entertainment, and commercial services. Local connectivity is well supported through the two-direction travel. Signalization at intersections is highly recommended.

One-way Protected Bike Lanes

A one-way protected bike lane may be preferred in each direction and would function well with access roads, in sections of the segment with less right-of-way.

4

- **Frequent crossings**
- **RRFBs or grade separation**
- **8-10 foot sidewalks**
- **Pedestrian scale lighting**
- **Streetscaping**



Crossings Frequency

Crossing frequency may vary in this area responding directly to the adjacent type of land use. Near Lake Mead Pkwy, where there is a higher density of commercial use and an envisioned TOD, crossing frequencies of 300 to 400 feet would facilitate crossing compliance and enhance permeability of the roadway. North and south of the envisioned Lake Mead TOD, crossing frequency may be reduced to moderate due to less foot traffic.

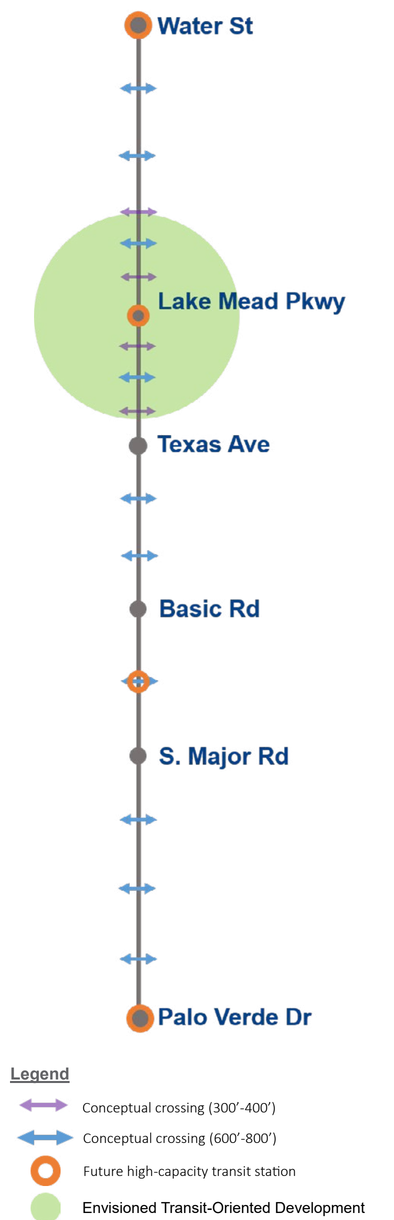
Identified Character Zone

Urban Mixed Use 52%

Parks and Open space 48%

Light Industrial 0%

Suburban 0%



SEGMENT 3

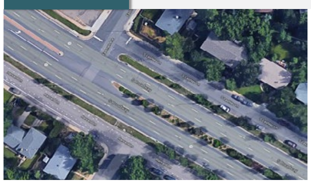
Water St to Tulip Falls

Segment Length: 2.95 miles

Recommended Design Options (By Mode)

1

Two 10 to 12-foot General Purpose lanes with lighting and a third access lane in both directions to manage access and provide additional capacity.



Access lanes in this area allow better access control on Boulder Highway while creating local access to the nearby angled street grid of the Pittmann neighborhood near to Barrett St access lanes can also facilitate bicycle movements and provide additional capacity.

2

Center-running ART/BRT/ or LRT

Locating a bus or rail guideway in the center median allows transit to move efficiently between more frequent stops in this segment.

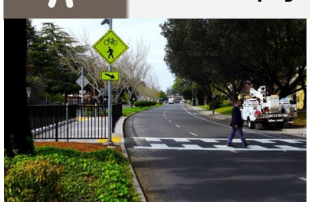
3

Two-way protected bicycle lanes or one-way protected bicycle lane

A bicycle lane with physical protection from the general purpose traffic is preferred in this segment. A one- or two-way protected bike lane adjacent to more developed land would provide quick and comfortable access to employment, entertainment, and commercial services particularly within envisioned TOD areas at Warm Springs Rd, Barrett St, Sunset Rd, and Gibson Rd.

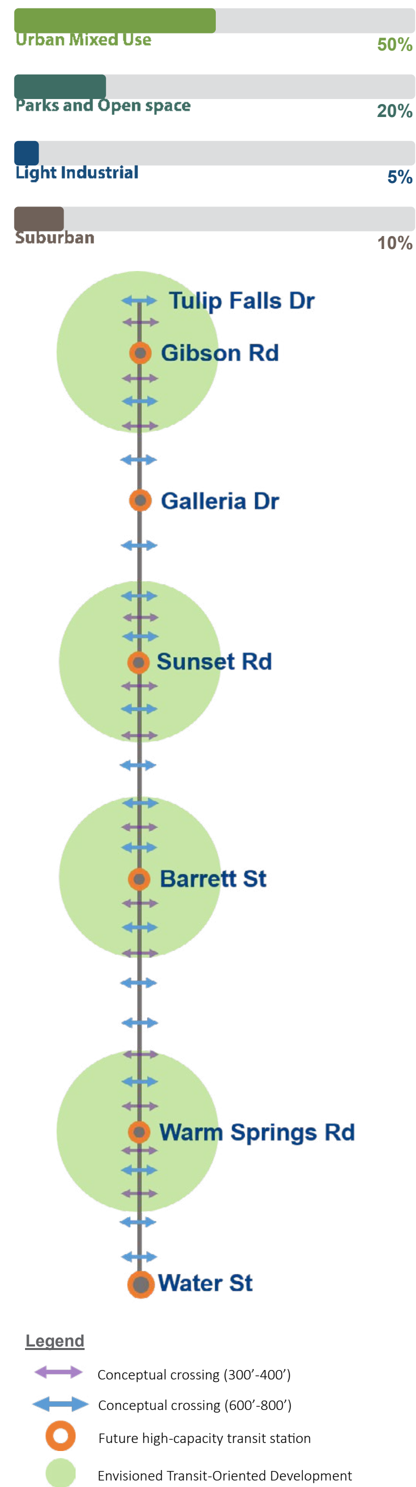
4

- **Frequent crossings**
- **RRFBs or mid-block traffic signals, or grade separation**
- **8-10 foot sidewalks**
- **Pedestrian scale lighting**
- **Streetscaping**



Rectangular Rapid Flashing Beacons (RRFBs) provide protected crossings in sections of Boulder Highway where the signalized crossing frequency is less than the ideal condition, depending on the urban character and nearby land uses. RRFBs are most effective when they are actuated by a user, either as a push-button or through detection and can be solar-powered, minimizing the need for utility work.

Identified Character Zone



SEGMENT 4

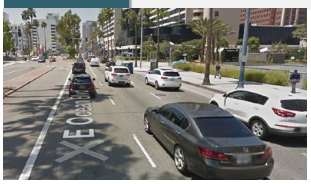
Tulip Falls to Tropicana Ave

Segment Length: 2.20 miles

Recommended Design Options (By Mode)

1

Two 10-12 foot General Purpose lanes with street lighting and access lanes to manage access and provide additional capacity.

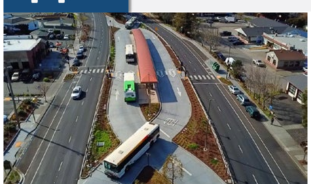


Three General Purpose Lanes

Increasing development densities and vehicle demand would be supported by three general purpose traffic lanes. A lane width of less than 12 feet can be used to encourage slower speeds in areas where more bicycle and pedestrian activity is anticipated, such as within envisioned TOD areas of Russell Rd and Tropicana Ave.

2

Center-running ART/BRT/ or LRT



Center-running Transit Lanes and Mid-Block Crossings

Transit lanes would exist in the center median with regular stops at Russell Rd, Hamilton Ave and Tropicana Ave. Center transit median would also serve as a median refuge for frequent crossings within envisioned TOD areas.

3

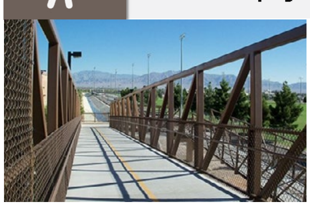
Two-way protected bicycle lanes or one-way protected bicycle lane

Two-way Protected Bike Lanes

A two-way protected bike lane adjacent to more developed land would provide quick and comfortable access to employment, entertainment, and commercial services. Local connectivity is well supported through the two-direction travel. Signalization at intersections is highly recommended.

4

- **Frequent crossings**
- **RRFBs or mid-block traffic signals, or grade separation**
- **8-10 foot sidewalks**
- **Pedestrian scale lighting**
- **Streetscaping**

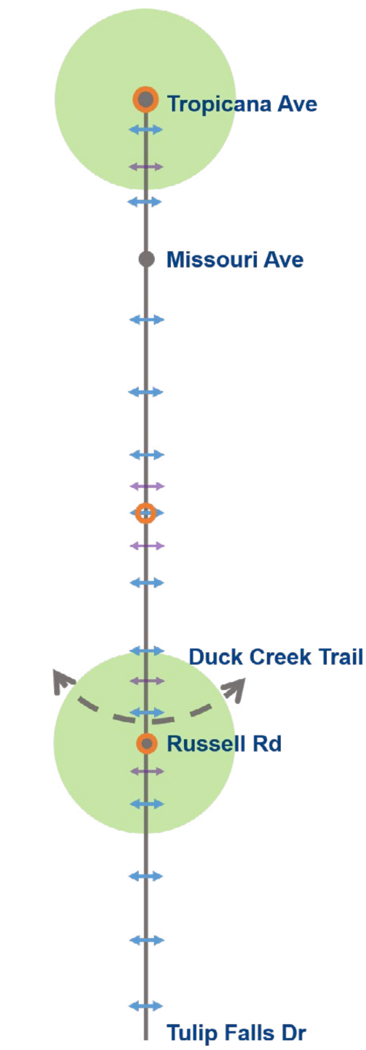


Pedestrian and Bicycle Crossings

A grade-separated crossing at Duck Creek with direct access to the Russell Rd transit station would support regional recreational travel between corridor and Clark County Wetlands Park to the east. In most other areas through this segment, at-grade crossings are preferred as signalized or through the use of activated rectangular rapid flashing beacons (RRFBs).

Identified Character Zone

Urban Mixed Use	90%
Parks and Open space	10%
Light Industrial	0%
Suburban	0%



Legend

- Conceptual crossing (300'-400')
- Conceptual crossing (600'-800')
- Future high-capacity transit station
- Envisioned Transit-Oriented Development

SEGMENT 5

Tropicana Ave to I-515

Segment Length: 3.25 miles

Recommended Design Options (By Mode)

1

Three 10-12 foot General Purpose lanes with street lighting, and/or
Two 10-12 foot General Purpose lanes with access lanes and street lighting

2

Center-running ART/BRT/ or LRT

Transit lanes would exist in the center median with stops at Tropicana Ave, Nellis Blvd, and Desert Inn Rd. Center transit median would also serve as a median refuge for frequent crossings within envisioned TOD areas. General purpose lane reduction strategies may be explored in the transit analysis process to increase mode share.

3

Two-way protected bicycle lanes or one-way protected bicycle lane

A bicycle lane with physical protection from the general purpose traffic is preferred in this segment. A one- or two-way protected bike lane adjacent to developed land would provide quick and comfortable access to employment, entertainment, and commercial services particularly within envisioned TOD areas at Tropicana Ave, Nellis Blvd, and Desert Inn Rd.

4

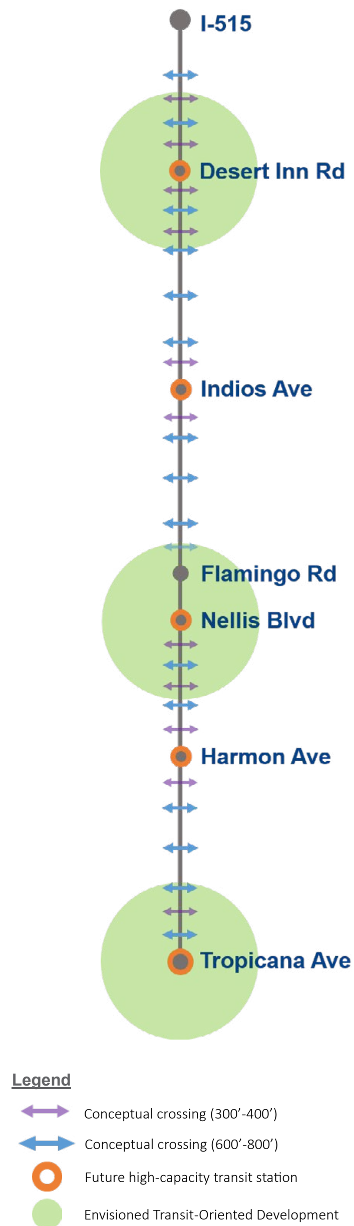
- **Frequent crossings**
- **RRFBs or mid-block traffic signals**
- **8-10 foot sidewalks**
- **Pedestrian scale lighting**
- **Streetscaping**

Moderate to High-quality Streetscaping
Where more street activity is anticipated and desired, the use of a wide (8 to 10-foot) sidewalk and high quality landscaping and street furniture can create better separation from vehicle traffic and can respond to nearby entertainment venues and commercial services.

Pedestrian-scale Lighting
Using pedestrian-scale lighting in areas with high pedestrian generators, such as at transit stations, casinos, and commercial services, can increase person comfort and visibility at roadway crossings.

Identified Character Zone

Urban Mixed Use	85%
Parks and Open space	15%
Light Industrial	0%
Suburban	0%



SEGMENT 6

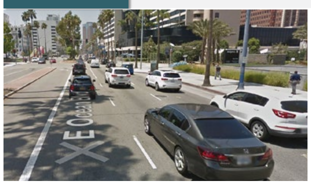
I-515 to Charleston Blvd

Segment Length: 2.15 miles

Recommended Design Options (By Mode)

1

Three 10-12 foot General Purpose lanes with street lighting
And/or
Two 10-12 foot General purpose lanes with street lighting and access lane



Three General Purpose Lanes

Vehicle demand would be supported by three general purpose traffic lanes. North of Sahara Ave the roadway will transition to two general purpose lanes. A lane width of less than 12 feet can be used to encourage slower speeds in areas where more bicycle and pedestrian activity is anticipated, such as within envisioned Transit Oriented Development (TOD) areas of Russell Rd and Tropicana Ave.

2

Center-running transit

Transit lanes would exist in the center median with regular stops at Sahara Ave, St. Louis Ave, and Olive St. Center transit median would also serve as a median refuge for frequent crossings within envisioned TOD areas. General Purpose lane reduction strategies could be used to increase mode share.

3

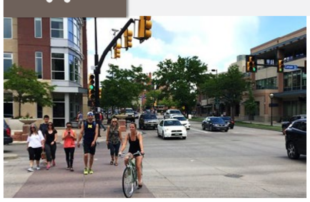
Two-way protected bicycle lanes or one-way protected bicycle lane

Two-way or one-way protected Bike Lanes

A bicycle lane with physical protection from the general purpose traffic is preferred in this segment. As much of this segment is within the typical two-mile cycling range of Downtown Las Vegas a one- or two-way protected bike lane would provide comfortable bicycle travel between this segment and Downtown.

4

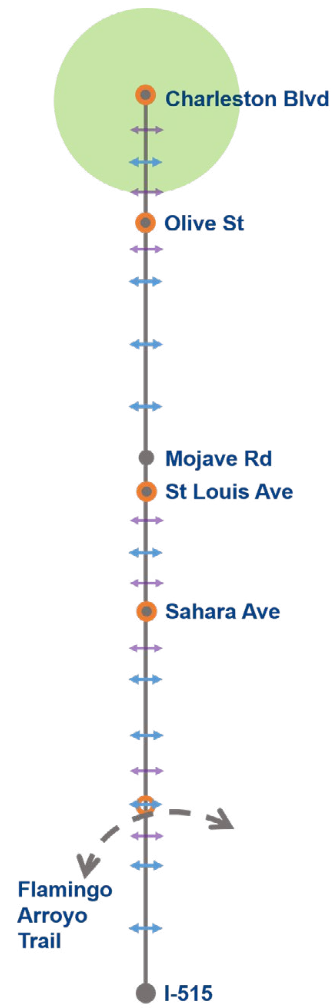
- **Frequent crossings**
- **RRFBs or mid-block traffic signals**
- **8-10 foot sidewalks**
- **Pedestrian scale lighting**
- **Streetscaping**



Improvements to the grade-separated crossing at the Flamingo Arroyo Trail would help people access the crossing from Boulder Highway and from the center median where transit users can have direct access to nearby neighborhoods and services in the corridor. In most other areas through this segment, at-grade crossings are preferred as signalized or through the use of activated rectangular rapid flashing beacons (RRFBs).

Identified Character Zone

Urban Mixed Use	75%
Parks and Open space	25%
Light Industrial	0%
Suburban	0%



Legend

- Conceptual crossing (300'-400')
- Conceptual crossing (600'-800')
- Future high-capacity transit station
- Envisioned Transit-Oriented Development

6.1 CORRIDOR-WIDE LIGHTING AND SMART LIGHTING

Light-emitting diode (LED) lighting is proposed for the entire length of the corridor. Two types of lighting are proposed along the corridor: roadway lighting and pedestrian-scale lighting. These types of lighting will provide lighting not only in areas of the corridor where lighting does not exist currently, but they also will improve lighting uniformity, eliminate dark spots, and enhance pedestrian visibility. Smart lighting is proposed to be used along the corridor to increase visibility of pedestrians primarily at the crossing locations and transit stations. Increased lighting intensity will alert drivers that pedestrian are presents.

6.2 TRANSIT

Corridor stakeholders are committed to implement a high-quality transit system that will promote economic development and foster a transit-oriented culture. Although the future vision of many stakeholders is to see high-capacity transit for the corridor, the current status of land development and ridership projections do not warrant this type of transit at this time. The proposed concept aims at implementing a system that would potentially meet the requirements of Bus Rapid Transit (BRT). The concept will extend the dedicated bus lanes for the entire length of the corridor and provide sufficient space for converting these lanes to be suitable for other types of transit vehicle, such as rail. The concept proposes a center station that will be used by both directions of travel. Station locations will be revisited within the framework of the BRT alternative analysis process and transit-oriented development (TOD) analysis. However, it is recommended for stations to be in close proximity to intersections to minimize transfer time. The proposed BHX route will extend from Boneville Transit Center using the current alignment to Nevada State College in Henderson. To reduce transit vehicle travel time and increase reliability, the concept proposes a Transit Signal Priority (TSP) system be implemented along the corridor.

6.3 PLANNING FOR CONNECTED AND AUTONOMOUS VEHICLES

The future evolution of transportation and mobility is an important national dialogue sparked by rapid advancements in technology. These advancements are transforming not only the automotive industry but also are shifting social attitudes toward transportation. Several tool box improvements are recommended for implementation as part of the proposed concept to ensure that the corridor goals are met.

Out of several emerging trends, three are expected to have a transformative effect on mobility and safety: advancements in connected vehicles, the shift in mobility preferences, and the emergence of autonomous vehicles.

Connected Vehicles

Connected vehicles (CVs) use different types of communication technologies and data to communicate with the users, other cars, infrastructure, and the Cloud. This solution can be used not only to improve safety, but also to improve mobility, efficiency, and travel time. Industries using this technology will better serve their customers' needs. There are several communication types for this technology, including:

- V2I: Vehicle to Infrastructure
- V2V: Vehicle to Vehicle
- V2C: Vehicle to Cloud [also known as Vehicle to Network (V2N)]
- V2P: Vehicle to Pedestrian
- V2X: Vehicle to Everything

In addition to the most popular types listed above, there are other innovations already being used or in the process of development such as Vehicle to Grid (V2G), Brain to Vehicle (B2V) and Platooning.

Mobility Preferences

The younger generations are shifting their mobility preferences and looking at transportation as a service they pay for instead of owning a car. In fact, a majority of millenials prefer to use a smartphone for planning their travel. Technology is a critical part of the transportation evolution, but it is people and their behavior toward this new offering and the service it can provide that will play a huge role in the adaptation and roll out of the technology solutions. Mobility as a Service (MaaS) focuses on providing a single platform for combining all transportation options and presenting them to the customer in a simple and completely integrated manner—the emphasis being on how to get from Point A to Point B rather than the individual transportation modes and services used. Intelligent mobility and MaaS are developing rapidly and providing exciting opportunities for customers, authorities, and businesses. At the heart of MaaS is enabling every user to be able to choose how to undertake any journey, along with the flexibility to alter their journey if necessary while on the move. This is a key shift from the block provision of transport to a much more flexible and customer-centered means of providing mobility within a dynamic system.

Autonomous Vehicles

Autonomous, fully automated, AV, or "self-driving"—these vehicles operate without direct driver interaction and input to control the steering, acceleration, and braking. They are designed in a manner in which the human driver is not expected to continuously monitor the roadway while in self-driving mode. There are several levels of automation defined to provide the transportation industry with standardization and consistency. These definitions are:

- Level 0: No Automation—The human driver is driving.
- Level 1: Driver Assistance—The presence of an Advanced Driver Assistance System (ADAS) that will assist the human driver with either steering or acceleration/braking.
- Level 2: Partial Automation—The ADAS will perform both steering and acceleration/braking; the human driver, however, must continue monitoring the environment and perform the rest of the driving tasks.
- Level 3: Conditional Automation—The presence of an Automated Driving System (ADS) on the vehicle that can perform all aspects of driving under some circumstances; the human driver must, however, continue monitoring the environment and be ready to take control upon ADS's request.
- Level 4: High Automation—The ADS will perform both driving and monitoring of the driving environment, and the human driver is only required to pay attention under special circumstances.
- Level 5: Full Automation—The ADS will perform both driving and monitoring of the driving environment under all circumstances. At this level, occupants are passengers and will not be involved in the driving and monitoring of the driving environment.

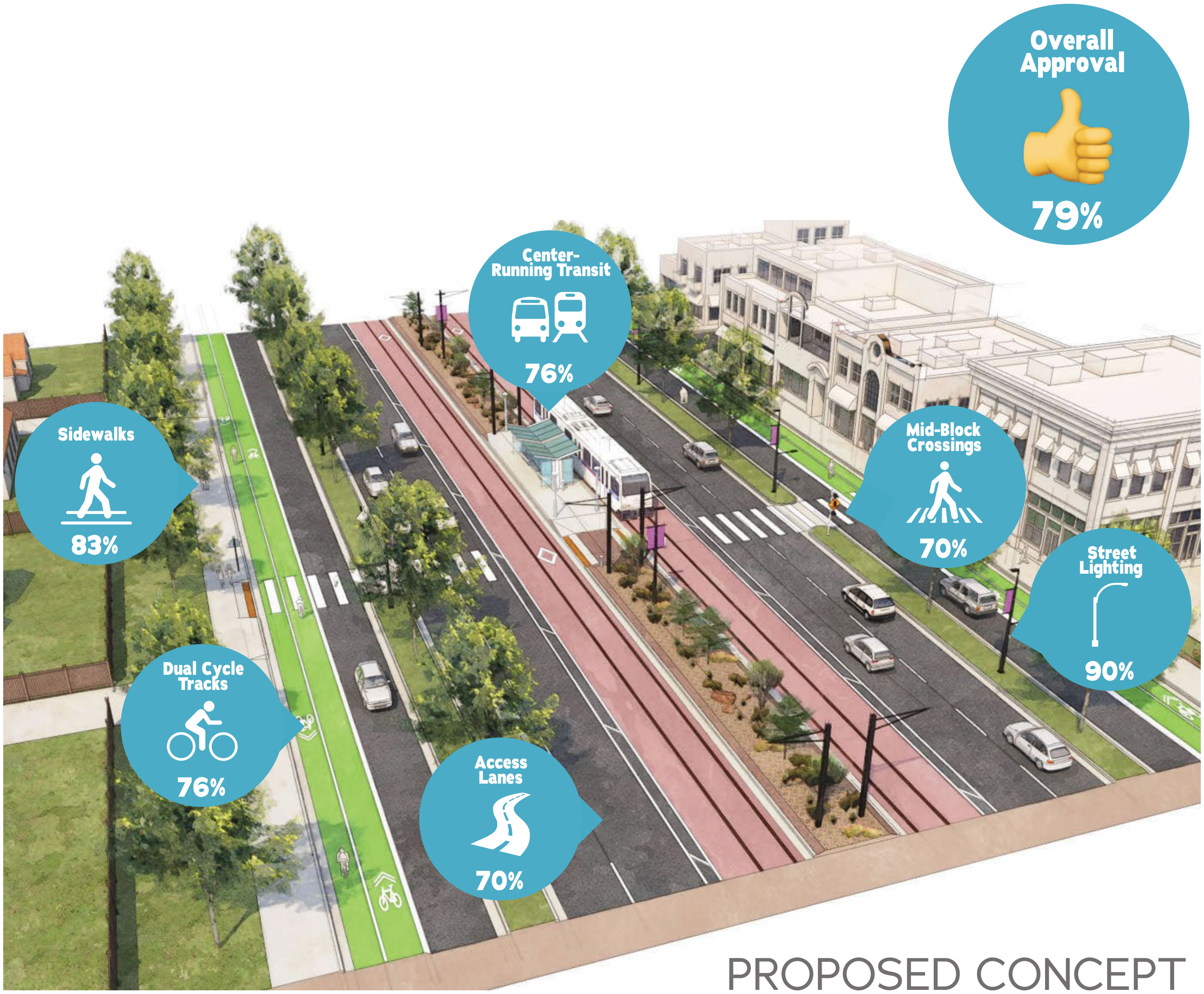
The scope, magnitude, and timeline of these changes is not known yet; however, the stakeholders on Boulder Highway understand that the transformation of Boulder Highway needs to enable these new advancements and leverage current technologies that improve safety and reliability. The following are a set of solutions recommended by the stakeholders.

Goal	Solution	Implementation Needs
1 and 2	Smart and LED Lighting	Power and communication infrastructure
1 and 4	Transit Station Security Monitoring Devices	Communication, software, hardware
4, 5	Active Traffic Management (ATM)—Transit Signal Priority (TSP)	TSP Policy, TSP Analysis, Communication infrastructure
5	ATM—Adaptive Signal Timing	Adaptive Signal Analysis, Communication infrastructure
4	Application for Transit Information	Systemwide application software and dissemination platform
1,2	Advanced Bicycle Signals	Sensors, communication, and hardware
1,2,5	Wayfinding	Wayfinding plan
1,2	Pedestrian and Bicycle Presence Sensors	Sensors and communication infrastructure to alert drivers
5	ATM—Lane Management and Speed Limit Management	Communication infrastructure, data analytics platforms
1,2,5	In-Vehicle Telematics	Communication network and infrastructure
3,4	Smart Amenities	Communication infrastructure, processors, and communications hardware to provide trash receptacles, wi-fi, charging stations, shade

6.4 PUBLIC AND STAKEHOLDER FEEDBACK

Phase 2 of the Public Engagement focused on sharing the draft concept plan and gauging public approval and proposed solutions. Stakeholders, property owners, and members of the community were asked to rate each solution with a thumbs up, thumbs down, or neutral response. Results of the public feedback are shown in Figure 6.5 below.

FIGURE 6.5 COMMUNITY FEEDBACK ON THE CONCEPT



7.0 IMPLEMENTATION PLAN

The implementation of the proposed concept along Boulder Highway is a process that will require continuous involvement of state and local agencies, as well as the stakeholders along the corridor. This chapter describes the policy framework that would make the implementation of this plan feasible, the plan components, implementation phasing, steps to be taken to implement this plan, and associated costs of implementing identified components of this plan.

7.1 POLICY FRAMEWORK

The RTC, NDOT, and the local entities in Clark County have a well-established precedent that high-priority, large projects with a regional impact on transportation across many different jurisdictions are built using a mix of funding sources with several participating funding partners. Examples of such projects that have been built with multiple funding sources are the Bruce Woodbury Beltway (Interstate 215 and Clark County 215) and the Beltway Interchanges, new interchanges with I-15, I-515, the North 5th Street Superarterial, Boulder Highway BRT Phase 1, Sahara BRT, Flamingo BRT, and MAX BRT along Las Vegas Boulevard North.

The Boulder Highway Vision Concept is a major regional project since it runs through three separate municipal jurisdictions, it involves multiple modes of transportation, and several different public and private entities play a role in what happens in the ROW of Boulder Highway. To get the funding necessary to build the project, the respective policy boards and private utility companies and stakeholders may have to agree that the project is a high enough priority that other competing projects in their respective capital improvement budgets might need to be delayed so that the Boulder Highway Vision Concept can proceed.

This policy framework outlines the goals, decision makers, policy issues, eligible funding sources, and recommended implementation steps to make the Boulder Highway Vision Concept come to fruition.

GOALS

- Provide safe non-motorized travel
- Improve vehicle safety
- Support economic redevelopment
- Support transit culture
- Enable reliable movement of people on the corridor

DECISION MAKERS—INSTRUMENTS OF GOVERNANCE

Decision-making bodies:

- City of Henderson
- City of Las Vegas
- Clark County
- Nevada Department of Transportation
- Regional Transportation Commission of Southern Nevada

Other major stakeholder groups that influence the decision makers:

- Clark County Regional Flood Control District
- NV Energy
- Southwest Gas
- Las Vegas Valley Water District
- Clark County Water Reclamation District
- Gaming
- Private Businesses
- Residents

POLICY ISSUES

Policy issues to be resolved before implementation can proceed include:

- Who will pay to relocate/remove or underground utilities if needed/desired and how will those costs be determined?
- Who will pay for an underground concrete box for flood control in the median of Boulder Highway?
- How will the project be divided into phases and what will each phase constitute?
- How will the phases of the project be funded and who will pay for what costs?
- Who will be the lead agency for each phase of the project?

ELIGIBLE FUNDING SOURCES

Each of the below-listed sources of funds is eligible to be expended for either all, or portions, of the work involved in bringing the Concept Vision of Boulder Highway to a reality.

Eligible federal funding sources:

- Surface Transportation Block Grant Program (STP)
- National Highway Performance Program
- Highway Safety Improvement Program
- Transportation Alternatives Program
- Congestion Mitigation and Air Quality Improvement Program (CMAQ)
- BRIDGE (Tiger) Grants
- Federal Transit Administration Capital Improvement Grant Funds (New Starts, Small Starts)
- Federal Transit Administration 5309 Bus Discretionary Fund
- Federal Transit Administration Clean Vehicles Fund
- Transportation Investment Finance and Infrastructure Act Funds (TIFIA)

Eligible state sources of funding:

- State Fuel Tax
- Leaking Underground Storage Tank fund
- Transportation Network Company Registration and Per Ride Funds
- Fuel Revenue Indexing (State Portion)

Eligible local sources of funding:

- Local Option Fuel Taxes
- Fuel Revenue Indexing Funds (RTC and Clark County)
- RTC Sales Tax (Transit)
- Transient Lodging Taxes (Non-Resort Corridor)
- General Fund Revenues (Cities and Clark County)
- Ad Valorem Capital Tax
- Residential Construction Tax (Cities and Clark County)
- Jet Aviation Fuel Tax (Clark County & RTC)
- Question 10 Sales Tax Funds (Roadway Portion)
- RTC Complete Streets Fund
- Redevelopment District Tax Increment Financing Funds (City of Henderson Only)
- Clark County Development Tax
- Motor Vehicle Privilege Tax

Eligible special tax incentive funds to support redevelopment:

- New Markets Tax Credits
- Opportunity Zone Funds

Private funds:

- Special Improvement Districts
- Business Improvement Districts
- Private Capital

7.1.1 IMPLEMENTATION STEPS

The steps shown in Figure 7.1 and detailed below are recommended to be followed by the RTC, NDOT and other local agencies to ensure seamless implementation of the proposed concept.

STEP 1—Gain State, Regional, and Local Agency Boards Approval and Supports

The RTC staff presents the final study to the RTC Board of Commissioners and request their support and funding commitment for the project. If support is obtained, the project sponsors will attend each respective public policy board (NDOT, City of Las Vegas, Clark County, City of Henderson, Regional Flood Control District, Las Vegas Valley Water District), and present the Vision Concept for Boulder Highway and ask for each board's concept approval and high-priority support and funding commitments to the concept.

STEP 2—Develop Financing Plan

When concept approval has been obtained, the RTC, through its Executive Advisory Committee (EAC), is recommended to create and convene a "working group" made up of RTC, NDOT, Clark County, City of Henderson, and City of Las Vegas personnel to pursue a plan of finance and an overall project timeline and phasing plan for the implementation of the Boulder Highway Vision Concept. As part of this work, the working group also is recommended to identify a lead entity for project design and construction by project phase.

STEP 3—Share the Plan

RTC will share the draft final concept, financing plan, project phasing plan, and project schedule with Boulder Highway non-government stakeholders.

STEP 4—Obtain Approval of Financial Plan

The finance plan, phasing plan, and project schedule timeline will be presented to the RTC Committees—Executive Advisory Committee, Metropolitan Transportation Planning Committee, Southern Nevada Strong Steering Committee, etc., to secure Committee support and approvals. Project sponsors then will take the finance plan, phasing plan, and project schedule back to each policy board to confirm support and approval to proceed.

STEP 5—Coordination

RTC or the identified lead agency will present the Boulder Highway Vision Concept to the Regional Project Coordination Committee to begin the discussion of how utilities can be identified and discuss how to proceed with any necessary removal and/ or relocation of utilities in this corridor.

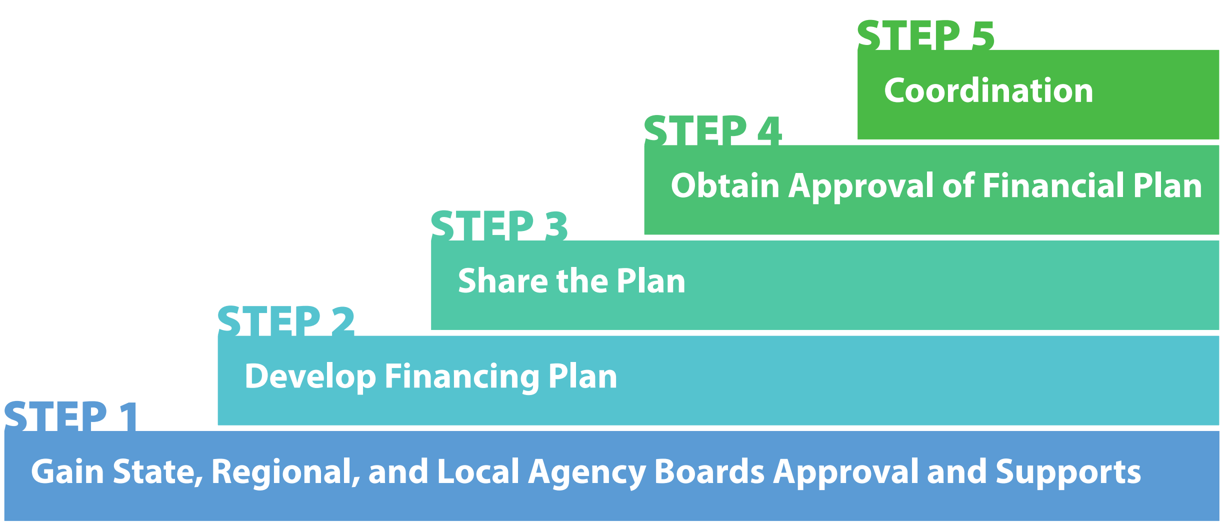


FIGURE 7.1 DECISION STEPS LEADING TO IMPLEMENTATION

7.2 IMPLEMENTATION AND PHASING PLAN

The implementation and phasing plan will assist the government stakeholders and proposed working group to develop a financing plan, prioritize components, and allocate the appropriate funding. The project components were selected based on two primary criteria: time of implementation during project lifecycle and funding source. The components identified include:

- Studies and Preliminary Engineering
- Roadway Design and Construction
- Street Amenities
- Transit
- ITS and Emerging Technologies

The broad scope, jurisdictional boundaries, and number of agencies and stakeholders involved, add to the complexity of how the proposed concept will be implemented.

The ultimate concept can be fully implemented in one phase if funding is available. However, a four-step process and three major implementation phases are presented to ensure timely implementation of the proposed concepts.

This plan offers the flexibility of implementing the concept in sections depending on the amount of funding available at a point in time. Figure 7.2 shows the implementation plan components and implementation phases.

The first step ensures a financial plan is in place and adopted by the RTC of Southern Nevada and incorporated into the regional transportation plan and TIP. Projects are then ready for advancement into the development phase and the National Environmental Policy Act (NEPA), if applicable. The financial plan will be updated before each subsequent phase to make sure the budgets are in place.

The three main project implementation phases include:

- Early Action Phase: 0 to 2 years
- Phase I: Near term (2 to 5 years)
- Phase II: Long Term (5 to 10 years)

7.2.1 EARLY ACTION PHASE

The Early Action Phase will address safety issues of high importance in the corridor and will set the stage for the subsequent implementation phases. A description of main activities during this phase is provided below and Figure 7.2 shows the improvements proposed for this phase.

	$ Step 1: Budget Allocation Planning	Step 2: Early Action (0-2 years)	P1 Step 3: Phase 1—Complete Street (2-5 years)	P2 Step 4: Phase 2—Ultimate (over 5 years)
Agencies Working Group	Prepare financial plan/ Adopt RTP	Update Financing Plan	Update Financing Plan	
Studies and Preliminary Engineering		Utility & ROW Plan Cost: $1.5M Design Standards Cost: $150,000	Transit AA	
Roadway Design and Construction		Mid Block Crossings, Multimodal Lane, Fencing, Crossing and Station Lighting, Proof of Concept. Cost: $16M	Sidewalks, Multimodal Lane, Corridor Smart Lighting, Traffic Signals & ITS Communications Infrastructure. Cost: $85-$90M	Center - Running Transit way, Stations and Amenities, Transit Signals, Cycle Tracks, Additional Crossings. Cost: $40M (BRT)
Street Amenities		Linear Park Plan, Wayfinding and Amenities Plan	Linear Parks, Interactive Wayfinding, Smart Amenities	Linear Parks, Interactive Wayfinding, Smart Amenities
Transit		TSP Policy Cost: $100,000	Traveler Information Station Security Upgrades	TSP Implementation ITS Transit Elements
ITS and Emerging Technology		ITS Plan Cost: $100,000, Adaptive Signal POC, CV POC	Adaptive Traffic Signal Control Cost: $250,000, CVAP Plan Cost: $300,000	CVAV Deployment

FIGURE 7.2 IMPLEMENTATION AND PHASING PLAN

EARLY ACTION ITEMS (0 to 2 years) Estimated Cost = $16M

FIGURE 7.3 IMPROVEMENTS DURING EARLY ACTION PHASE

Preliminary Engineering

Utility coordination and ROW. The NDOT Boulder Highway ROW between Charleston Blvd. and Wagonwheel Dr. is comprised of easement, license, fee, and claimed prescriptive rights. This complexity—coupled with licenses, leases, or unauthorized uses within the ROW—makes it essential to identify stakeholder interests of lands within the project limits. Stakeholder conflicts affect project schedules; therefore, identifying stakeholder interests and potential conflicts in the early stages will allow realistic project phasing, costs, and construction schedules to be created. Conducting preliminary engineering activities focused on utilities and ROW is proposed to be initiated in this phase to determine the impacts to overall project cost and steps to be taken during Phase I Design and Construction of Complete Streets.

Create design guidelines or standards. Boulder Highway is currently under NDOT ownership and crosses multiple jurisdictions. The stakeholders' vision is to maintain a uniform layout and yet to have the flexibility to reflect the character of neighborhoods this arterial crosses. Prior to initiating design activities, it is recommended for local agencies to establish a set of guidelines for Boulder Highway that promotes good urban design practices. The document should provide clear instructions to planners, designers, and developers on how to incorporate design principles specific to the success of Boulder Highway. The guidelines/standards should be the same across each jurisdiction yet adopted separately.

Street amenities. The proposed concept includes linear parks, wayfinding, and street amenities. These components are closely related to the neighborhood character and will be developed and funded at the local agency level. To allow for simultaneous implementation of these components with the Complete Streets improvements of Phase I, it is proposed that a Linear Park Plan and Wayfinding and Amenities plan be coordinated by the local agencies prior to Phase I activities.

Transit. To establish the goal of promoting a transit culture in the corridor, stakeholders envisioned the implementation of a center running BRT that will be a catalyst for TOD with the potential of an increased ridership and conversion to high-capacity transit in the future. One of the key components of BRT is TSP, which will enable shorter travel time for transit users and increased travel reliability. Currently, none of the transit routes in the Las Vegas Valley use TSP. To allow for future implementation of BRT along Boulder Highway, stakeholders recommended the development a TSP Policy by RTC and local agencies during the Early Action Phase.

ITS and emerging technologies. To better define the scope of ITS infrastructure needed to be installed along the corridor, an ITS Plan is recommended in the Early Action Phase of the project. This plan will determine the current state of the ITS infrastructure, evaluate the readiness for technology deployment, identify gaps, and provide recommendations for implementation.

Adaptive Traffic Signal Control Proof of Concept. To improve reliability for all modes of transportation along the corridor, the implementation of an Adaptive Traffic Signal Timing system is recommended. During the Early Action Phase, an Adaptive Traffic Signal Proof of Concept Study is recommended to evaluate benefits, sofware and hardware, implementation strategy, and cost estimate.

CV Early Deployment Proof of Concept with current technology. CV technlogy is rapidly evolving, so it is beneficial for local agencies to better understand the potential safety and operations benefits of this technology and how to plan for future deployment. To pave the way for future deployment, a Proof of Concept study is proposed to evaluate the current state of technology and partners, identify performance measures, collect pre-deployment data, identify use cases for the study, implement a pilot project, and evaluate results.

7.2.2 PHASE I—COMPLETE STREETS IMPLEMENTATION

Phase I will focus on implementing Complete Streets improvements in the proposed concept. During this phase, the transit system will operate in a dedicated lane, where a center-running transit guideway will be built. It will use the space that is ultimately dedicated for bicycles until Phase II. All corridor signals, smart lighting, signals and ITS communications infrastructure, and adaptive traffic signal control will be in place. Parallel to the design and construction of Complete Streets treatments, local agencies will work toward construction of linear parks and installation of wayfinding and smart amenities. Figure 7.4 shows the improvements proposed for this phase.

FIGURE 7.4 IMPROVEMENTS DURING PHASE I

Transit. The goal of the RTC is to seek federal funding for development of a center-running BRT. For this project to be funded through federal funding, a transit alternative analyis and NEPA study needs to be conducted to justify the benefits this investment will bring and identify actions to minimize any environmental impacts due to the implementation of this project. To pave the way for the implementation on Phase II, the NEPA study is proposed to begin during Phase I of the project.

CVAV Implementation Plan. Identifying strategies that will make the corridor compatible with future emerging technologies will be the goal of a Connected Vehicle/ Autonomous Vehicle (CVAV) Implementation Plan that will be initiated during this phase. NDOT and local agencies may choose to evaluate the need for this plan to be conducted at the regional or street level. In addition to reviewing the state-of-the art and -practice, the plan will define the vision for success; identify performance measures; identify policy and legislative changes, stakeholders and responsibilities, required infrastructure changes; prioritize implementation locations; and collect pre-deployment data.

7.2.3 PHASE II—ULTIMATE CONCEPT

This phase focuses on implementing the remaining components of the ultimate concept, including the center-running BRT, conversion of side-running transit lane to bicycle track, and deployment of CVAV. Figure 7.5 through Figure 7.9 show the ultimate concepts for the corridor..

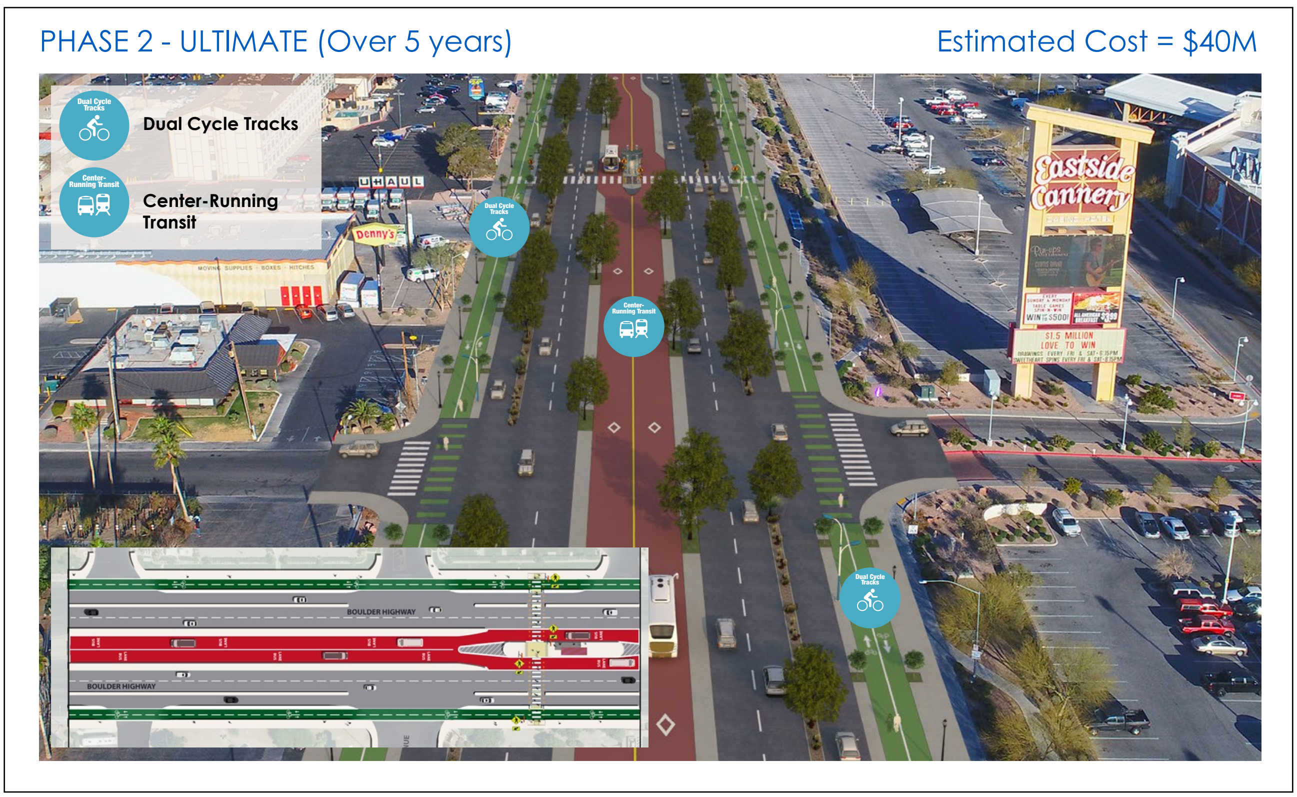


FIGURE 7.5 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE LAYOUT

FIGURE 7.6 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE WITH ACCESS LANE LAYOUT

FIGURE 7.7 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE WITH ACCESS LANE LAYOUT

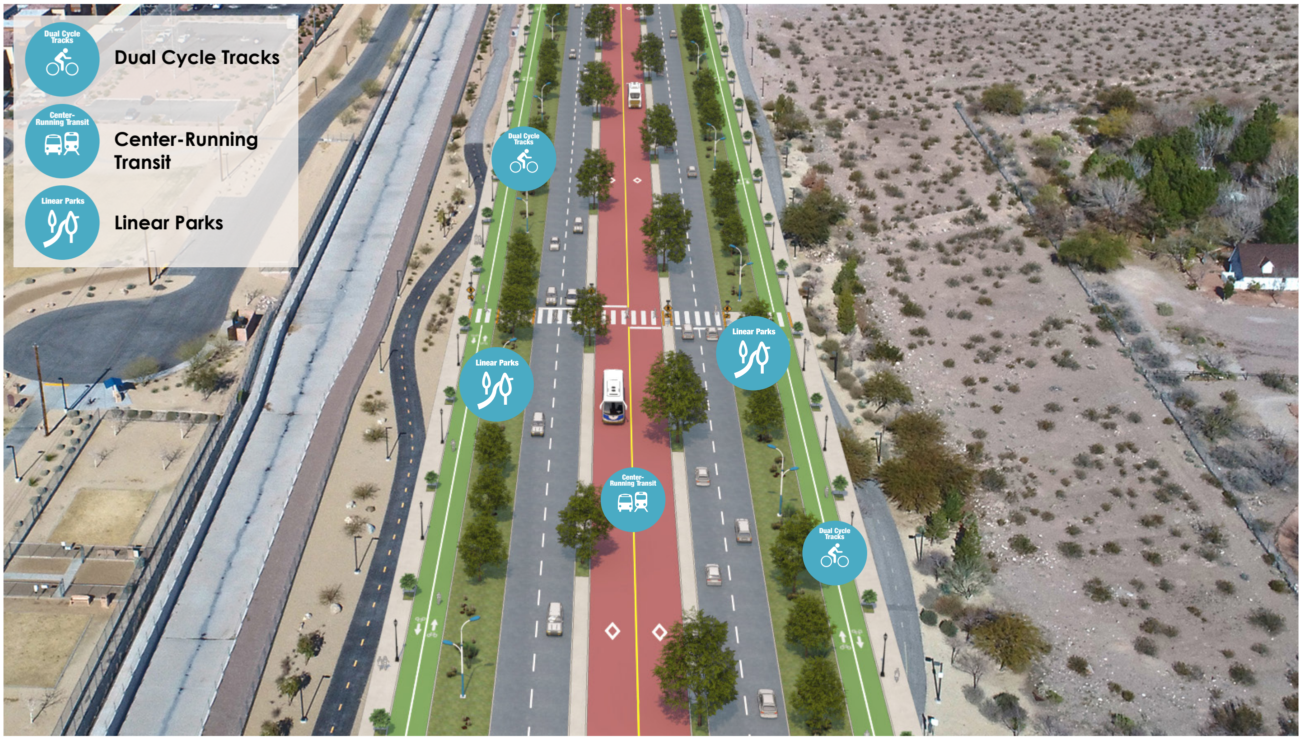


FIGURE 7.8 ULTIMATE CONCEPT - TWO GENERAL PURPOSE LANE LAYOUT

FIGURE 7.9 ULTIMATE CONCEPT – THREE GENERAL PURPOSE LANES LAYOUT

CVAV Deployment. During this phase, it is anticipated that local agencies will identify a preferred concept, will implement the changes required for the infrastructure, such as signage, ITS devices, DSRC, fiber, power, etc., and will perform system deployment, monitoring, and integration into existing systems.

7.2.4 PUBLIC FEEDBACK

On the final phase of the public engagement stakeholders, property owners and members of the community were asked to review the plan with included costs and phasing and provide general feedback. Approximately 86.6% of participants attending public engagement events had positive feedback on the plan and 8% had a neutral response. The results of the feedback are shown in Figure 7.10 below.

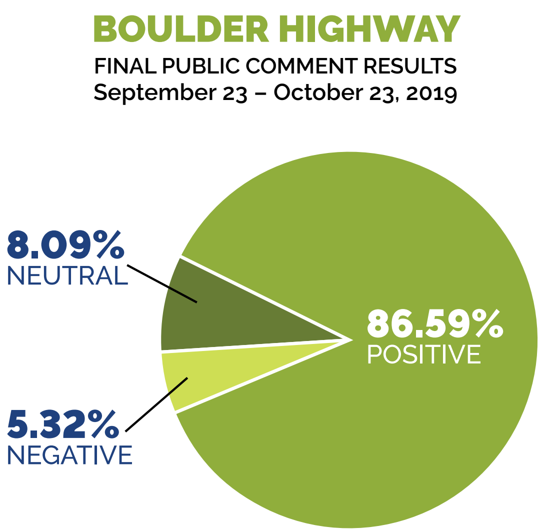


FIGURE 7.10 PUBLIC FEEDBACK ON THE CONCEPT AND IMPLEMENTATION PLAN.

7.3 LAND USE AND ZONING

Implementation of this plan and corridor vision will not be possible without the support of sound land use plans and policies. Several strategies were discussed among stakeholders; however, it was determined that the development or updating of land use plans along the corridor will remain at the local agency level. The Southern Nevada Planning Coalition and Southern Nevada Strong can be used as forums to share plans and strategies.

To determine the desired built form for the corridor, land use typologies can be established. These typologies will assess land use relationships and recommend how and where growth in the corridor should occur. These can be part of a larger planning effort or a more narrowly focused project. Regional examples include:

- Phoenix General Plan Update: Centers, Place Types, and Infrastructure
- Southern Nevada RTC High-Capacity Transit: TOD Typologies

As the corridor develops, a review of the current zoning districts along the corridor might be required to recommend changes (rezoning, overlay zones, new zones, etc.) that align with desired land uses and built form.

7.4 RIGHT OF WAY DISPOSAL OPTIONS

The proposed concept along Boulder Highway intends to use up to 178 feet of the current ROW. Ongoing discussions are in place for NDOT to relinquish either the entire ROW or the excess ROW and transfer it to local agencies. There are many locations along the corridor where the ROW is substantially larger that the proposed footprint and other locations where the fronting properties have already built landscaping and parking spaces within the current ROW. Boulder Highway is a very old arterial and establishing the ROW rights will be an onerous process. When the rights are established by the proposed early action study, NDOT and local agencies will have a better understanding of strategies to move forward with disposing of excess ROW.

To promote economic development in the corridor that supports a transit culture, several options were considered.

Public Space. One option would be using the excess ROW to accommodate additional pedestrian and public spaces, such as gathering plazas, linear parks, vendor space, gardens, and planting.

Land Lease. The excess ROW can be used as a mechanism to generate funding for the adjacent public space improvements. Leasing the ROW to development will increase the density along the corridor and provide opportunity for additional funding

..

7.5 IN CONCLUSION

Many actions have been taken in terms of engineering improvements and enforcement to reduce the overall number of crashes and fatalities along Boulder Highway since the initiation of this study. The concept developed by the stakeholders during the course of this study pushed the envelope, requiring a major transformation of Boulder Highway. This study is only the first step in improving safety and reliability, supporting a transit culture, and promoting the economic redevelopment. Today, Boulder Highway still faces many of the same issues that triggered the initiation of this study. It is important to focus on accomplishing the ultimate goals. Government agencies led by the RTC continue to working toward funding and continued partnerships that will make this vision a reality.

8.0 RESOURCES

Akers, M. (2017, March 3). *Boulder Highway pedestrian deaths nearly a tenth of the state's total since 2006*. Retrieved from Las Vegas Sun: https://lasvegassun.com/news/2017/mar/03/boulder-highway-pedestrian-safety-gets-renewed-att/

Alta Planning and Design. (2019). *Pedestrian Comfort Study and Demonstration Projects Draft*. Las Vegas: The Regional Transportation Commission of Southern Nevada. Retrieved from https://assets.rtcsnv.net/wp-content/uploads/sites/4/2019/07/01113434/Pedestrian-Comfort-Study-Draft-Report-and-Appendices-4-23-19B.pdf

CH2MHill. (2016). *City of Las Vegas Mobilitiy Master Plan.* Las Vegas: The City of Las Vegas.

City of Henderson. (2008). *Boulder Highway Corridor Investment Strategy*. Henderson: City of Henderson. Retrieved from https://www.cityofhenderson.com/docs/default-source/community-development-docs/special-projects/bhc_frmwk_plan_adopted12_08.pdf?sfvrsn=4

City of Henderson. (2009). *Boulder Highway Landscape Design Manual.* Henderson: City of Henderson. Retrieved from https://www.cityofhenderson.com/docs/default-source/Parks-Recreation/park-planning/bhldm_adopted_6-9-09.pdf?sfvrsn=6

City of Henderson. (2014). *Boulder Highway/Gibson Opportunity Site Implementation Strategy.* Henderson: City of Henderson. Retrieved from http://sns.rtcsnv.com/wp-content/uploads/2016/04/SNS-Boulder-Highway-Final.pdf

City of Henderson. (2014). *Downtown Henderson Master Plan.* Henderson: City of Henderson. Retrieved from https://www.cityofhenderson.com/docs/default-source/community-development-docs/development-code/downtown-master-plan

City of Henderson. (2017). *Henderson Comprehensive Plan.* Henderson : City of Henderson. Retrieved from https://www.cityofhenderson.com/docs/default-source/community-development-docs/comprehensive-plan/henderson-strong-comprehensive-plan.pdf?sfvrsn=3

CLR Analystics. (2012, January). *Traffic Signal Alert System for Smartphone Users*. Retrieved from CLR Analytics Projects: http://www.clranalytics.com/projects/smartphone-applications/SBIR-smartphone-2011

Corwin, S., Kelly, E., Vitale, J., & Cathles, E. (2014, September 24). *The Future of Mobility*. Retrieved from Deloitte Insights : https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/transportation-technology.html

Federal Highway Administration. (2014). *Median U-Turn Intersection Informational Guide.* Portland: Federal Highway Administration. Retrieved from https://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14069_mut_infoguide.pdf

Federal Highway Administration. (2016, March 8). *Summary Report: An Evaluation of Signing for Three-Lane Roundabouts* . McLean: Federal Highway Administration. Retrieved from https://www.fhwa.dot.gov/publications/research/safety/10030/10030.pdf

Federal Highway Administration. (n.d.). *Capacity Analysis for Planning of Junctions (Cap-X) Tool*. Retrieved from Federal Highwya Administration Software : https://cms7.fhwa.dot.gov/research/resources/software/capacity-analysis-planning-junctions-cap-x-tool

Federal Highway Administration. (n.d.). *Median U-Turn Interesection - An Innovative, proven solution for improving safety and mobility at intersections.* Federal Highway Administration. Retrieved from https://safety.fhwa.dot.gov/intersection/innovative/uturn/brochures/mut_brochure/mut_brochure.pdf

Federal Highway Administration. (n.d.). *Signalized Intersections*. Retrieved from Federal Highway Administration Intersection Safety: https://safety.fhwa.dot.gov/intersection/conventional/signalized/

Federal Highway Administration. (n.d.). *U-Turn-based Intersections*. Retrieved from Federal Highway Administration Intersection Safety: https://safety.fhwa.dot.gov/intersection/innovative/uturn/

Fedreal Highway Administration. (n.d.). *Roundabouts and Mini Roundabouts* . Retrieved from Federal Highway Administration Intersection Safety: https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/

HDR. (2012). *Boulder Highway Frontage Road Study.* Las Vegas: Regional Transportation Commision of Southern Nevada. Retrieved from https://assets.rtcsnv.net/wp-content/uploads/sites/4/2019/06/23142652/Boulder-Highway-Frontage-Road-Study-Report_Nov-20121.pdf

Howard Industries. (n.d.). *Pedestrian Crosswalk Sign System*. Retrieved from Howard Industries : http://pedestriancrosswalk.com/

Institute of Traffic Engineers. (1974). Directional Median Crossovers. *Journal of Traffic Engineering*, 21-23.

Kimley Horn and Associates, Inc. (2011). *Road Safety Audit Report - SR 582 (Boulder Highway) In Clark County from Harmon to Desert Inn/Lamb.* Las Vegas: Nevada DOT.

Kimley Horn and Associates, Inc. (2013). *Before and After Conditions Report - Boulder Highway.* Las Vegas: Regional Transportation Commission of Southern Nevada. Retrieved from https://assets.rtcsnv.net/wp-content/uploads/sites/4/2019/06/23142133/REPORT-Boulder-Highway.pdf

Lucas, J. (2017, October 9). *Smart Zebra crossing LED lights* . Retrieved from The Sun: https://www.thesun.co.uk/tech/4641687/smart-zebra-crossing-led-lights/

Marroquin, A. (2017, March 12). *NDOT project aims to keep pedestrians safe on Boulder Highway*. Retrieved from Las Vegas Review - Journal: https://www.reviewjournal.com/news/news-columns/road-warrior/ndot-project-aims-to-keep-pedestrians-safe-on-boulder-highway/

National Center for Transit Research. (2016). *Implications to Public Transportation of Emerging Technologies.* Tampa: National Center for Transit Research. Retrieved from https://www.nctr.usf.edu/wp-content/uploads/2016/11/Implications-for-Public-Transit-of-Emerging-Technologies-11-1-16.pdf

Regional Transportation Commission of Southern Nevada . (2017). *Regional Bicycle & Pedestrian Plan for Southern Nevada.* Las Vegas: Regional Transportation Commission of Southern Nevada . Retrieved from https://assets.rtcsnv.net/wp-content/uploads/sites/4/2019/06/24162244/1-RTC-RBPP-April-2017-Final-Chapters-1-8.pdf

Regional Transportation Commission of Southern Nevada. (2017). *Access 2040: Enhancing Mobility for Southern Nevada Residents* . Las Vegas: The Regional Transportation Commission of Southern Nevada. Retrieved from https://assets.rtcsnv.net/wp-content/uploads/sites/4/2019/06/20093531/Access2040_adopted.pdf

Rosch, D. (2016, February 26). *Speed limit enforced on Boulder Highway following latest fatal accident*. Retrieved from News 3 Las Vegas: https://news3lv.com/news/local/law-enforcement-city-planners-work-to-improve-boulder-highway-safety

Sohrweide, T. (n.d.). *City Improves Pedestrian Safety with Promising Technology*. Retrieved from SEH: http://www.sehinc.com/news/city-improves-pedestrian-safety-promising-technology

Transoft Solutions . (n.d.). *Turbo Roundabout*. Retrieved from Turbo Roundabout: http://www.turboroundabout.com/turbo-roundabout.html

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APPENDIX A—

LITERATURE REVIEW

Appendix A. Literature Review

A.1. Studies, Plans, and Programs

The Boulder Highway multimodal transportation corridor investment study builds upon previous efforts and lays its foundation on previous existing plans and policies. Boulder Highway is a Nevada Department of Transportation (NDOT)-owned facility which passes through several jurisdictions and falls within the Regional Transportation Commission of Southern Nevada (RTC) metropolitan planning organization (MPO) planning boundary. Many stakeholders have developed numerous plans, programs, and studies identifying elements of the land use and transportation vision, goals, action plans, and outcomes for the corridor. Relevant studies were reviewed to understand the previous and on-going efforts, solutions previously considered, recommended future solutions, and in-progress projects recommended from previous efforts. These studies provide a starting point for this study.

The following sections are brief summaries of the relevant documents reviewed.

A.1.1. Regional Transportation Commission of Southern Nevada

Boulder Highway Before and After Conditions Report (2013)

Purpose: The Boulder Highway Before and After Conditions Report is a study prepared for the RTC. The study is intended to document and review trends in ridership and corridor operations both prior to and after the expansion of the regional Bus Rapid Transit (BRT) system. The results of the study were used to assist in future transit planning and investment decisions.

Relation to Boulder Highway Multimodal Transportation Investment Plan (MTIP): The Boulder Highway Before and After Conditions Report identified travel time conditions before and after the BRT system. There was a minimal increase in vehicle travel times in the After Study from June 2010 through May 2011. In addition, vehicle occupancy increased from an average of 1.27 per vehicle to 1.31 per vehicle during this time period. Decreasing vehicle volumes and increasing vehicle occupancy shows the trend toward multimodal travel along the corridor, with fewer people choosing to drive alone.

Access2040: Enhancing Mobility for Southern Nevada Residents Regional Transportation Plan for Southern Nevada 2017-2040 (2017)

Purpose: Access2040 is the Regional Transportation Plan for Southern Nevada. RTC develops this plan to guide the maintenance and implementation of Southern Nevada's future multimodal transportation system. As described by the RTC, "ACCESS2040 is the primary vehicle through which the RTC's continuous, cooperative, and comprehensive planning process is implemented".

Relation to Boulder Highway MTIP: The Access2040 sets the regional goals by which all investment in transportation infrastructure are guided. These goals include:

- Strengthen regional economic competitiveness
- Maintain and enhance quality of life for Southern Nevadans
- Ensure sustainable use of infrastructure and resources

To implement this vision and plan the Access 2040 established a set of strategies that are also applicable and guide the Boulder Highway MTIP. These strategies are shown in Figure 1 below.

ACCESS 2040 STRATEGIES	
Primary Strategies	**Secondary Strategies**
Improve Safety	Improve Access to Essential Services
Manage Congestion	Provide Accountable & Transparent Planning Process
Enhance Multimodal Connectivity	Improve Freight Movement
Maintain Current Infrastructure	Improve Public Health Related to Transportation
	Conserve & Protect Natural Resources
	Use Innovative Planning to Address Emerging Technologies & Trends

Figure 1 Access 2040 Strategies

The plan notes Boulder Highway as a corridor of particular importance for both safety and multimodal improvements. Boulder Highway is listed as a project outside of the reach of investment; however, it is identified as a potential project that supports the long-term transportation future for Southern Nevada.

RTC Regional Bicycle Pedestrian Plan 2017 (2017)

Purpose: The Regional Bicycle and Pedestrian Plan (RBPP) for Southern Nevada provides a framework for improving the bicycle and pedestrian environment throughout Southern Nevada.

Relation to Boulder Highway MTIP: The RBPP lists Boulder Highway as a road diet candidate and a priority crash corridor. The goals for the identified corridors and intersections include:

- Improve comfort and safety for bicyclists and pedestrians
- Improve bicycling and walking access to community destinations including connections to transit
- Encourage broader participation, appreciation, and awareness of bicycling and walking
- Recognize the transportation system's impact on air quality and community health

To implement this vision and plan, the RBPP established a set of strategies that are also applicable and guide the Boulder Highway MTIP. These strategies are shown in Table 1 on the following page. The table contains the high priority bicycle facility recommendations map which recommends an on-street facility along sections of Boulder Highway.

Table 1 Regional Bicycle and Pedestrian Plan Strategies

Regional Bicycle and Pedestrian Plan Strategies	
Safety	1. Construct pedestrian refuge islands and raised medians (High Priority) 2. Develop and implement roadway, intersection, horizontal curves, and pedestrian lighting standards (High Priority) 3. Implement traffic calming techniques (High Priority) 4. Improve geometry of pedestrian and bicycle facilities at signalized intersections 5. Install pedestrian and bicycle facilities at signalized intersections 6. Install or upgrade traffic and pedestrian signals 7. Install pedestrian hybrid beacons 8. Provide crosswalk enhancements 9. Provide sidewalks/walkways and curb ramps

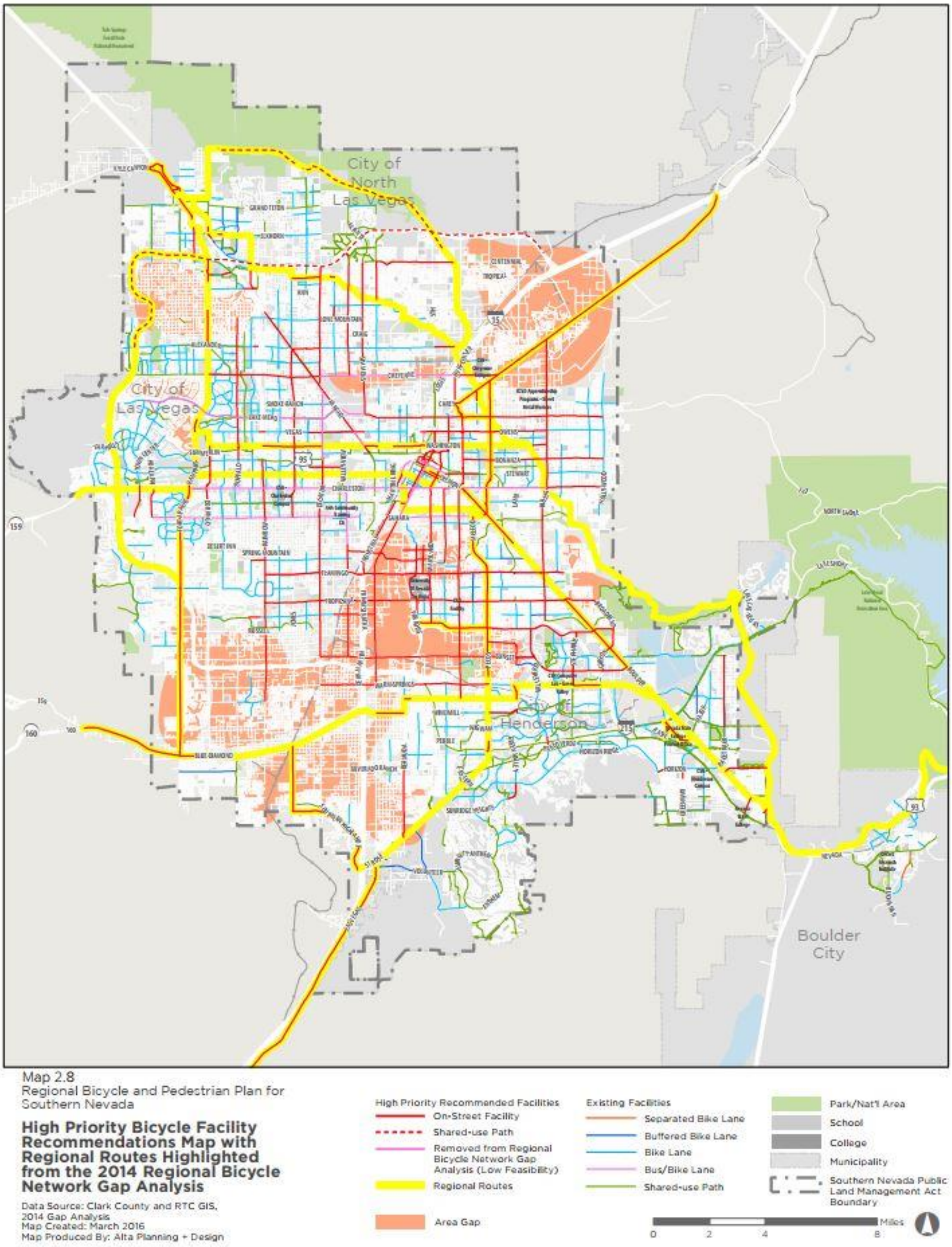


Figure 2 **RBPP High Priority Bicycle Facility Recommendations**

On Board Future Transit Plan (Ongoing)

Purpose: On Board is RTC transit's future transit plan, encompassing improvements to the current system, new high capacity transit service, and accompanying land use changes.

Relation to Boulder Highway MTIP: On Board identifies Boulder Highway as a transit corridor suited for high-capacity transit service. On Board defines various types of transit-oriented development (TOD), and locates multiple future TOD investments on the Boulder Highway corridor. Downtown Henderson is planned to use a downtown TOD typology, characterized by mixed-use development and increased residential and job density. Other locations along Boulder Highway are identified for TOD including a town center at Flamingo Road and a medical center at St. Rose Dominican Hospital.

Southern Nevada Pedestrian Comfort Study and Demonstration Project (2019)

Purpose: The Pedestrian Comfort Study identifies innovative strategies to address challenges of the pedestrian environment in Southern Nevada. The accompanying toolbox is tailored to the unique needs of Southern Nevada.

Relation to Boulder Highway MTIP: This project installed temporary pedestrian improvements at several locations for the public to experience new infrastructure and offer feedback. Conceptual drawings for Boulder Highway were created with improvements including:

- Shade structures
- High visibility trail crossing
- Median refuge
- Pedestrian signage

Due to challenges encountered during implementation, the improvements did not advance to final design and installation.

A.1.2. Nevada Department of Transportation

Boulder Highway Road Safety Audit Report (2011)

Purpose: The Road Safety Audit Report covers Boulder Highway in Clark County from Harmon to Desert Inn Rd/ Lamb Blvd.

Relation to Boulder Highway MTIP: This report describes conditions on Boulder Highway as related to pedestrian safety. A number of recommendations for improving pedestrian safety were made that can be used to inform this project. The recommendations fall within two categories: priority 1 and priority 2. Priority 1 recommendations can be addressed in the immediate future by NDOT maintenance staff. Priority 1 recommendations are:

- Perform a study on the implementation of split pedestrian phasing when crossing Boulder Highway.
- Replace the crosswalk markings, yellow median nose markings, and raised pavement markers on the medians on the side streets of signalized intersections.
- Perform an access management study to review the spacing and location of existing driveways and access opportunities for combination and/or elimination of existing driveways and a preliminary cost estimate.
- Perform a lighting level analysis to review the light levels compared to current standards.

- Replace curb ramp on the northeast corner of Indios intersection to align with crosswalks.
- Rectify signal operation at Indios so the pedestrian indication for crossing east/west on the north leg responds to the push button on the northwest corner or median.
- Replace the street light luminaire on the northwest corner at Indios above the signal pole.
- Replace the drainage grate on the north side of the northwest corner of Indios to have perpendicular slots or retrofit the grate to be compatible with bicycle travel.
- Conduct a study to analyze the pedestrian and motor vehicle traffic volumes at the Twain intersection and analyze if, where, and the type of pedestrian crossing that should be installed.
- Install sidewalk panel and relocate push button on northwest corner of Nellis to be Americans with Disabilities Act (ADA) compliant.
- Adjust the Bus Only signs on the mast arm at signalized intersections so they are below the luminaire and potentially tilt them back slightly so light from above illuminates signs.
- Review signal timing along the corridor to see if modifications can be made to reduce rear end and angular crashes.

Priority 2 recommendations are improvements that require some engineering design and can be included in future projects as funding becomes available. Priority 2 recommendations are:

- Upgrade lighting per recommendations from the Priority 1 study of the lighting levels.
- Implement any recommendations form the Priority 1 study for a crossing at Twain.
- Evaluate and modify the southbound to westbound right turn geometry at Flamingo to provide better sight visibility of pedestrians. The recommendation is to remove the existing pork chop island and expand the corner; however, further review is needed to determine impact to stop bars, crosswalks, and the existing signal pole. This recommendation is also applicable to the northbound to eastbound right turn.

A.1.3. City of Henderson

Boulder Highway Corridor Investment Strategy (2008)

Purpose: Building on previous City of Henderson plans (e.g. 2006 City of Henderson Comprehensive plan), the purpose of the Boulder Highway Corridor Investment Strategy is to develop an investment strategy and action plan that addresses the corridor regarding land use, transportation, urban design, and market. The goal for the City of Henderson is to revitalize the corridor through new investments and redevelopment in targeted locations.

Relation to Boulder Highway MTIP: The Multimodal Design Principles assist in the preparation of street cross-sections and street improvement plans as the corridor develops. The seven principles are displayed in Table 2 on the following page.

Table 2 Multi-Modal Design Principles

Multi-Modal Design Principles	
Principle C1	Support multi-modal street and intersection design within the corridor
Principle C2	Incorporate parkway streets where right-of-way (ROW) width and access constraints permit. See Figure 3 below.
Principle C3	Design safe and convenient pedestrian crossings
Principle C4	Provide direct connections between the corridor and existing neighborhoods
Principle C5	Provide high-frequency feeder buses to support rapid transit service
Principle C6	Provide small-scale park and ride facilities along the corridor
Principle C7	Provide reduced parking alternatives for transit-supportive development along the corridor

Figure 3 Key Features of the Parkway Concept

This study also developed a concept design for the intersection of Boulder Highway and Water Street, which will change from three legs to four legs when Water Street is extended to the eastern side of Boulder Highway. The conceptual design of the Water Street intersection is shown below in Figure 4.

Figure 4 **Conceptual Compact Intersection Design for Water Street/Boulder Highway**

Boulder Highway Landscape Design Manual (2009)

Purpose: The Boulder Highway Landscape Design Manual enhances the image of the Boulder Highway Corridor right-of-way and intersecting streets established in the Boulder Highway Corridor Investment Strategy. Building on the Boulder Highway Improvement Project Design Manual (1992) and the Boulder Highway Beautification Millennium Edition Design Manual (1999), the Design Manual intends to replace the preceding manuals.

Relation to Boulder Highway MTIP: The landscape standards and guidelines intend to provide a direction that will help achieve the multi-modal park concept. The Green Framework principles of the Boulder Highway Landscape Design Manual are found below in Table 3.

Table 3 **Green Framework Goals and Principles**

Green Framework Goals	
GF1	Establish the corridor as a true linear park
GF2	Establish a hierarchy of landscape enhancements along the corridor
GF3	Integrate the desert environment into the corridor
GF4	Continue to expand trail and pathway linkages to the corridor to provide recreational opportunities for area residents
GF5	Identify future park sites to serve corridor residents
GF6	Establish clear gateways to the corridor

Boulder Highway Frontage Road Study (2012)

Purpose: The Boulder Highway Frontage Road Study was produced by the RTC for the City of Henderson. The study develops the frontage road alignments that were conceptualized in the Boulder Highway Corridor Investment Strategy into more defined engineering alignments for use by City of Henderson during their review and comment on future development plans that are brought before the City for approval.

Relation to Boulder Highway MTIP: These frontage roads would enhance access to major cross streets and allow development to utilize the Boulder Highway frontage for buildings and walkways rather than vehicle access. Frontage roads have been identified to improve traffic flow along the corridor by separating high and low speed vehicles and have been recommended where there is available right-of-way. Low speed local traffic would use the frontage road to access businesses along Boulder Highway while through traffic would remain in the travel lanes. Splitting up the vehicle lanes in the corridor also improves pedestrian experience by shortening crossing distances. Conceptual plans for frontage roads were developed in accordance.

Water Street District Pedestrian and Bicycle Master Plan (2013)

Purpose: The Water Street District Pedestrian and Bicycle Master Plan strives to establish the policies, programs, design criteria, and projects that will create a walkable, safe, pedestrian-oriented space that supports multimodal travel and uses streetscape to convey the district's special character.

Relation to Boulder Highway MTIP: The values outlined in the plan are useful to inform this project. Strategies to improve conditions in the master plan are shown below in Table 4:

Table 4 Water Street District Improvement Strategies

Improvements	
Pedestrian Safety	Landscape buffers, curb extensions, raised medians and pedestrian refuge, raised crosswalks/raised intersections, pedestrian-scale lighting, parking lot striping for pedestrians, education, signage, and pedestrian overcrossing
Bicycle Safety	Bicycle parking and availability of easy, safe, convenient, and comfortable streets, lanes, and trails
Access	Complete street elements
Connectivity	Safe, comfortable, and connected bicycle routes and facilities, connected shared-use paths with the Water Street District, gateways, transit, trails and sidewalks, activity centers, and lively public spaces

Boulder Highway/Gibson Opportunity Site Implementation Strategy (2014)

Purpose: This study focused on the Boulder Highway/Gibson Road/Broadbent Boulevard intersection and surrounding land owned by the City of Henderson. Located at the northern end of Boulder Highway within the City of Henderson, the implementation strategy focuses on creating a pedestrian-friendly multi-modal environment.

Relation to Boulder Highway MTIP: Proposed pedestrian and bicycle safety improvements include:

- Dedicated bicycle lanes
- On-and-off street shared-use pathways
- Better access to bus stops
- Lower speed limits
- Trees and landscaping for more attractive streetscapes
- Wider sidewalks
- Designated cross-walks
- Improved lighting

New cross-sections for Gibson Road and Boulder Highway are proposed in the plan to improve multimodal access. Proposed cross-sections 1 and 2 are shown below in Figure 5 and Figure 6. In addition, **Error! Reference source not found.** on the following page Figure 7 shows the proposed land use concept for the Boulder Highway and Gibson Road intersection.

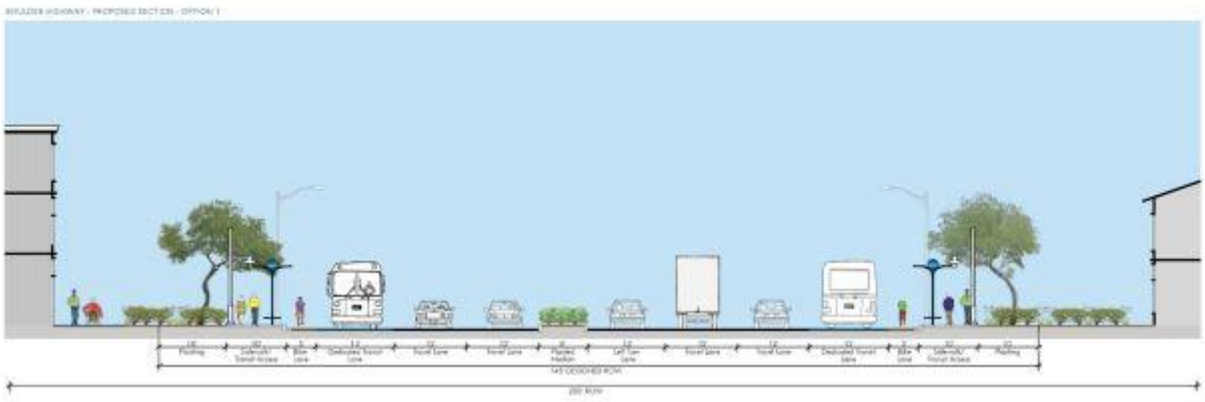


Figure 5 Proposed Cross-Section Option 1

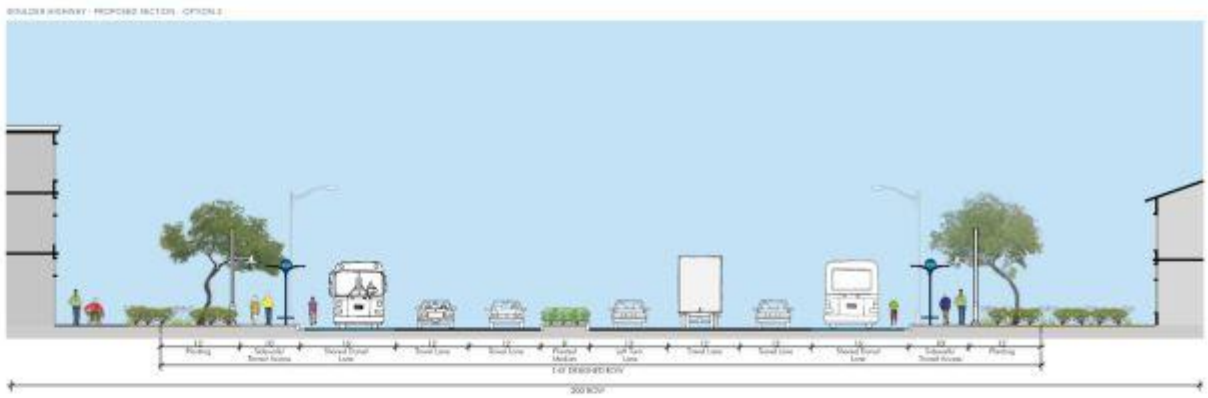


Figure 6 Proposed Cross-Section Option 2

Figure 7 **Boulder Highway/Gibson Land Use Concept**

Downtown Henderson Master Plan (2014)

Purpose: The Downtown Henderson Master Plan provides necessary standards for the five districts listed in the Downtown Investment Strategy. The plan provides the framework and guidance to meet the visions and goals outlined in the Downtown Investment Strategy which includes an authentic downtown core, community gathering place, community of mixed-use choice, desirable place to call home, and a place for new investment and reinvestment.

Relation to Boulder Highway MTIP: The Downtown Henderson Master Plan encourages more walking and mass transit use to reduce vehicular use in the five districts. This includes creating a walkable, high-density, transit-oriented development on Boulder Highway, as it is the eastern border to the five districts. The planned redevelopment will be supported by improvements to Boulder Highway, which will play a key role in transforming the character of the area.

Henderson Comprehensive Plan 2017

Purpose: The Henderson Comprehensive Plan demonstrates a strong desire from the community to address safety concerns and create space for all road users by applying complete streets concepts. The plan also describes a desire to improve connectivity and access for all modes.

Relation to Boulder Highway MTIP: Boulder Highway is identified as a key corridor to be redesigned to achieve these goals. Improvements to Boulder Highway include:

- Reduce the width of the corridor while providing safer and more comfortable pedestrian and bicycle facilities
- Target complete street improvements, enhanced pedestrian crossings, lighting and signage in nodes identified for high intensity and mixed-use development
- Provide light rail transit in dedicated right-of-way along the corridor with well-designed and identifiable transit stops, shelters, and other amenities

City of Las Vegas Mobility Master Plan (2016)

Purpose: The 2016 City of Las Vegas Mobility Master Plan describes the city's vision for transportation infrastructure. Key areas for improvement include transit improvements, bicycle facility improvements, vehicular mobility improvements, and pedestrian safety/complete streets improvements.

Relation to Boulder Highway MTIP: Boulder Highway is specifically mentioned as a corridor designated for regional, high-capacity transit and implementation of complete streets design components to address all four key improvement areas on the corridor.

Implications to Public Transportation of Emerging Technologies (2016)

Purpose: This report dissects how the influx of new technology solutions may impact traditional public transportation services.

Relation to Boulder Highway MTIP: As stated in the report, it is a critical need for public transit stakeholders to engage in exploring opportunities and implications that are occurring currently and may materialize in the future. To incorporate new technologies the report suggests:

- Thinking about technology change from the perspective of impacts on mobility rather than the impacts on public transportation
- Reorganizing the stakeholder community around mobility-related objectives rather than modes or technologies

A.2. Newspaper Articles

Speed limit enforced on Boulder Highway following latest fatal incident – Channel 3 News article (2016)

An article from February 2016 documents the unsafe conditions for pedestrians on Boulder Highway, caused by high speeds and a large number of pedestrians crossing in between controlled intersections. The need for pedestrian safety improvements on Boulder Highway is discussed following the death of a pedestrian who was hit and killed by a vehicle the week the article was published. A University of Nevada, Las Vegas (UNLV) researcher notes that 20 percent of pedestrian fatalities in Clark County occurred on Boulder Highway. The need for a redesign of the corridor to slow traffic and improve safety for pedestrians is discussed.

"Boulder Highway pedestrian deaths nearly a tenth of the state's total since 2006" – Las Vegas Sun (2017)

This article notes the prevalence of fatal crashes on Boulder Highway – which saw 9 percent of all auto-pedestrian deaths in Nevada between 2006 and 2017 – and describes some of the steps being taken to reduce dangerous behavior. Eight crossing locations were to be improved in fall 2017 with better lighting, crosswalks, sidewalks, and median enhancements. As the nature of the corridor has changed from a high-speed highway to a community route, better pedestrian facilities are needed to improve safety of crossings and reduce jaywalking.

"NDOT project aims to keep pedestrians safe on Boulder Highway" – Las Vegas Review-Journal (2017)

This article notes the dangerous conditions for pedestrians on Boulder Highway, underscored by the many auto-pedestrian crashes on the corridor. NDOT's project to improve pedestrian safety at eight different locations on Boulder Highway are discussed. Interviews with local residents show support for improving pedestrian crossings on Boulder Highway.

APPENDIX B—
LAND USE ANALYSIS

Appendix B. Land Use

Six character areas were defined for the Boulder Highway study area based on physical characteristics. Analysis of the following categories helped established boundaries for character areas along Boulder Highway.

1. Land Use
   - Corridor land uses
   - Adjacent land uses
   - Districts
   - Zoning

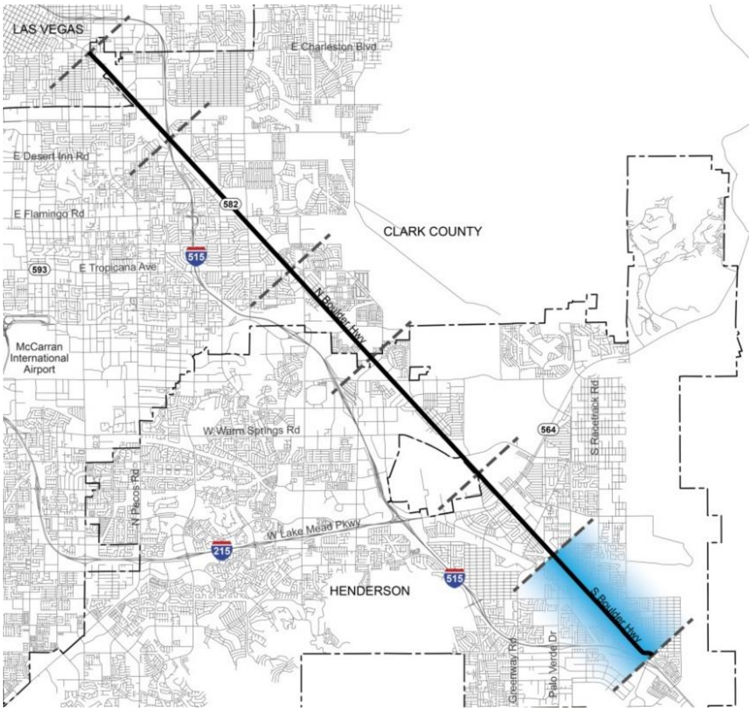
2. Built Form
   - Physical characteristics
   - Building placement
   - Building height

3. Streetscape
   - Street composition
   - Pedestrian and bicycle facilities
   - Rights-of-way

The six character areas range between 2 and 3.25 miles in length. Some of their boundaries land on major street intersections whereas others fall on minor streets, yet ultimately the boundaries are determined by the categories described above. The following six character areas are listed from southeast to northwest:

1. Wagonwheel Dr. to Palo Verde Dr.
2. Palo Verde Dr. to Water St.
3. Water St. to Tulip Falls Dr.
4. Tulip Falls Dr. to Tropicana Ave.
5. Tropicana Ave. to I-515 crossing
6. I-515 crossing to Charleston Blvd.

B.1. Character Area 1: Wagonwheel Dr. to Palo Verde Dr.



Segment Length: 2.5 miles

B.1.1. Land Use

Corridor land uses

The primary land uses along Character Area 1 are commercial and vacant uses. Secondary uses are light industrial, medium density residential, and institutional.

Adjacent land uses

Predominant land uses that make up the majority of the area behind the corridor are low density residential and medium density residential.

Districts

Notable districts supporting the Character Area are the River Mountain Neighborhood and the Black Mountain Neighborhood.

Zoning

Zoning along this segment of Boulder Highway includes, Corridor/Community Mixed-Use (*Henderson MC)* with an MC Activity Center overlay at Racetrack Dr. and College Dr.

B.1.2. Built Form

Physical characteristics

There is either a lack of a building presence on the corridor or low building density. The only major intersection with commercial development is the Racetrack Dr./Horizon Dr. crossing. Nearby places with established character include Clark County Museum, Heritage Park, and the Boulder Horizon Shopping Center.

Building placement

There are between 200 and 500-foot setbacks from Boulder Highway.

Building height

There are entirely single-story structures.

B.1.3. Streetscape

Street composition

This segment has four lanes, a partially landscaped median and either two or four exclusive turn lanes at intersection approaches.

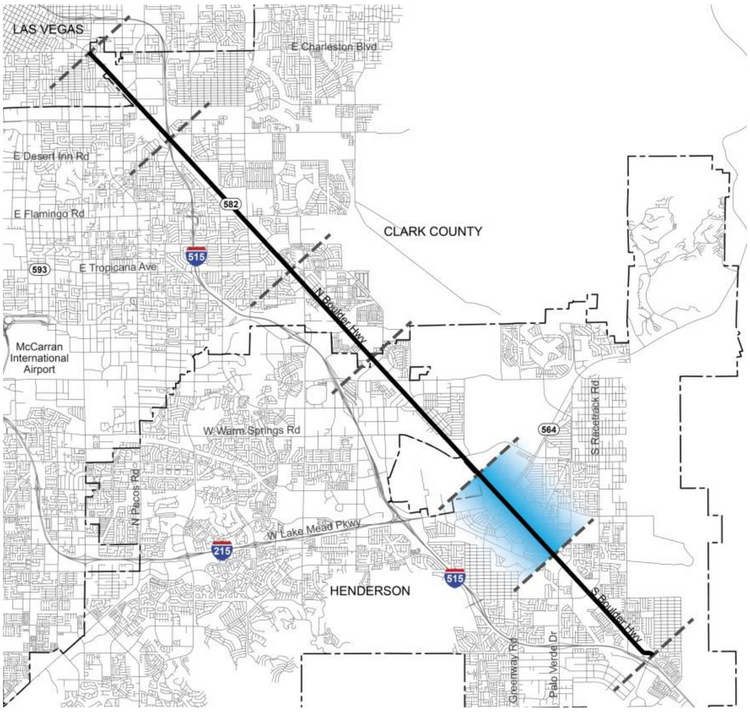
Pedestrian and bicycle facilities

Pedestrian and bicycle facilities include the Boulder Highway Trail (running on both sides of the road) and infrequent pedestrian crossings.

Rights-of-way

The rights-of-way range between 320 and 670 feet (includes frontage roads and utilities) with the most common being 490 feet.

B.2. Character Area 2: Palo Verde Dr. to Water St.



Segment Length: 2 miles

B.2.1. Land Use

Corridor land uses

The primary land uses along Character Area 2 are low density residential (on the southwest side) and commercial (on the northeast side). Secondary uses are vacant and office.

Adjacent land uses

Predominant land uses that make up the majority of the area behind the corridor are institutional, office, and medium density residential.

Districts

Notable districts supporting the Character Area are the Valley View Neighborhood and the Townsite Neighborhood (Downtown Henderson).

Zoning

Zoning along this segment of Boulder Highway includes Corridor/Community Mixed-Use (*Henderson MC)* with an MC Activity Center overlay throughout; Low Density Single Family Residential 6 *(Henderson RS-6)* (6 du/acre); Downtown Residential *(Henderson DR);* and Downtown Mixed-Use *(Henderson DX).*

B.2.2. Built Form

Physical characteristics

The built form is diluted due to the lack of concentrated uses. This segment of the corridor has moderate building density. Major intersections with commercial development are Lake Mead Pkwy. and Major Ave..

Nearby places with established character include Henderson Shopping Plaza, Boulder Marketplace, Victory Village Shopping Plaza, Dignity Health Hospital, Government Buildings, Eldorado Casino, and Morrell Park.

Building placement

There is an average of around 100-foot setbacks for commercial uses (includes vegetative buffer and frontage road). In addition, there is an average of around 500-foot setbacks for residential uses (includes BH Trail and frontage road).

Building height

There are predominantly single-story structures, some 2-3-story structures at major intersections, and buildings with large accent facades.

B.2.3. Streetscape

Street composition

This segment has six lanes, a median with landscaping at major intersections, a frontage road and between two and 3 turn lanes at Boulder Highway approaches at the intersections.

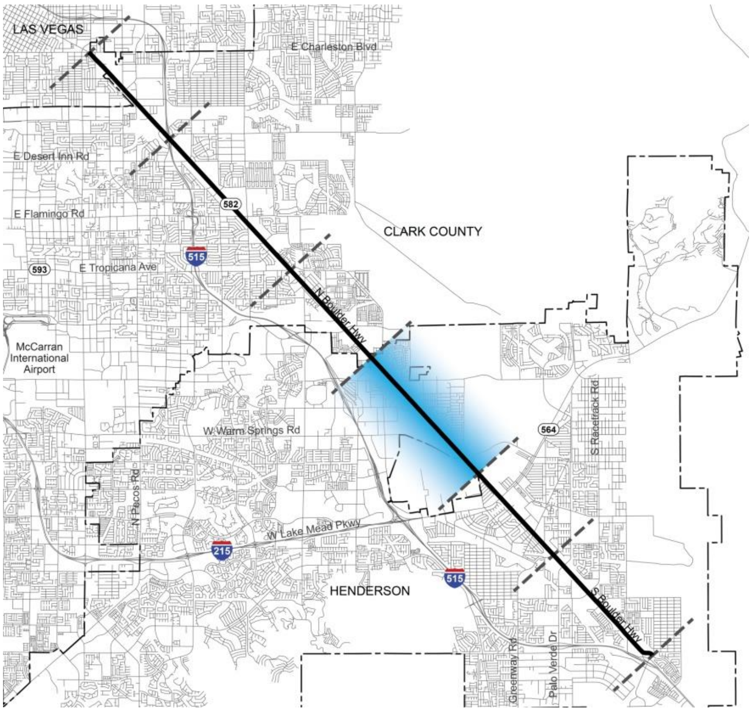
Pedestrian and bicycle facilities

Pedestrian and bicycle facilities include the Boulder Highway Trail (running on the southwest side of the road), sidewalks near major intersections, and pedestrian crossings becoming more frequent moving northwest.

Rights-of-way

The rights-of-way range between 225 and 450 feet (includes frontage roads and utilities) with the most common being 400 feet.

B.3. Character Area 3: Water St. to Tulip Falls Dr.



Segment Length: 3 miles

B.3.1. Land Use

Corridor land uses

The primary land uses along Character Area 3 are commercial and vacant. Secondary uses are heavy industrial and medium density residential.

Adjacent land uses

Predominant land uses that make up the majority of the area behind the corridor are low density residential, vacant, industrial, and parks/open space.

Districts

Notable districts supporting the Character Area are the Pittman Neighborhood, Black Mountain Industrial Center, Midway Neighborhood, and Cadence Master Planned Community.

Zoning

Zoning along this segment of Boulder Highway includes Corridor/Community Mixed-Use (*Henderson MC)* with an MC Activity Center overlay north of Foster Dr.; Planned Community *(Henderson PC)*; and Highway Commercial (*Henderson CH).*

B.3.2. Built Form

Physical characteristics

The built form is strongest in the Pittman Neighborhood but nonexistent otherwise. This segment of the corridor has relatively low to moderate building density. Major intersections with commercial development are Warm Springs Rd., Sunset Rd., and Galleria Dr.. Nearby places with established character include the Jokers Wild Casino, Wells Park, Cowabunga Bay Water Park, the Bird Viewing Preserve, and Rodeo Park.

Building placement

There is a range between 20 and 200-foot setbacks for commercial uses and an average around 100-foot setbacks for residential uses.

Building height

There are predominantly single-story structures, some 2-3-story structures, and buildings with large accent facades.

B.3.3. Streetscape

Street composition

This segment has six lanes, a median with landscaping and a bio-swale, a frontage road, and between two and six turn lanes at intersections.

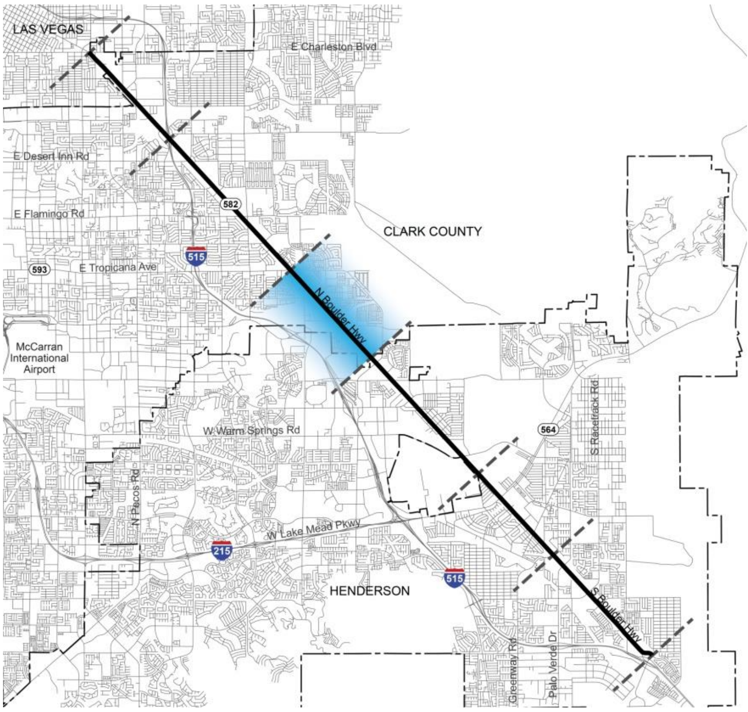
Pedestrian and bicycle facilities

Pedestrian and bicycle facilities are limited to attached sidewalks in the Pittman Neighborhood and on-street bicycle shoulders.

Rights-of-way

The rights-of-way range between 200 and 400 feet (includes frontage roads and utilities) with the most common being 200 feet.

B.4. Character Area 4: Tulip Falls Dr. to Tropicana Ave.



Segment Length: 2.25 miles

B.4.1. Land Use

Corridor land uses

The primary land uses along Character Area 4 are commercial, vacant, and medium density residential. A secondary use is light industrial.

Adjacent land uses

Predominant land uses that make up the majority of the area behind the corridor are low density residential, medium density residential, parks and vacant.

Districts

Notable districts supporting the Character Area are the unincorporated Town of Whitney, the Whitney Ranch Neighborhood, and the Edward Clark Generating Station.

Zoning

Zoning along this segment of Boulder Highway includes General Commercial District (*Clark Co. C-2)*, and General Highway Frontage District (*Clark Co. H-2).*

B.4.2. Built Form

Physical characteristics

A lack of concentrated uses and single driveway entrances yields discontinuity in the Character Area's built form. This segment of the corridor has relatively low to moderate building density. Major intersections with commercial development are Russell Rd. and Tropicana Ave.. Nearby places with established character include Sam Boyd Stadium, Russell Road Recreation Complex, Whitney Park, the Sienna Suites Hotel, and the Boulder Marketplace Shopping Center.

Building placement

There is a range between 20 and 200-foot setbacks for commercial and residential uses with an average around 80-foot setbacks along the segment.

Building height

There are predominantly two-story residential and single-story commercial structures and various buildings with large accent facades.

B.4.3. Streetscape

Street composition

This segment has six lanes, a median without landscaping, a dedicated bus lane, occasional on-street parking, and between two and six turn lanes at intersections.

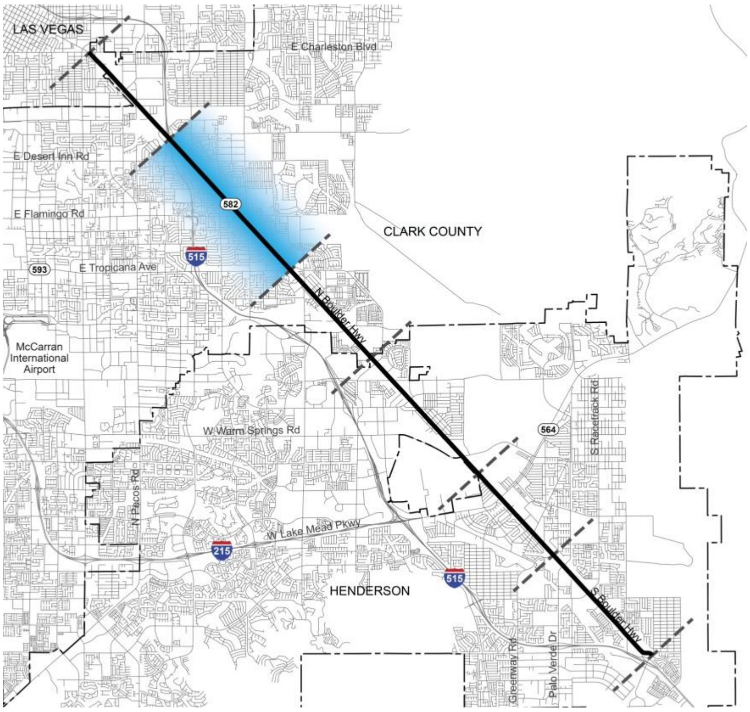
Pedestrian and bicycle facilities

Pedestrian and bicycle facilities include attached sidewalks with frequent gaps on both sides of the street, occasional pedestrian crossings, and bicycle lanes/bicycle lane located in the shoulders.

Rights-of-way

The rights-of-way range between 190 and 210 feet with the most common being 200 feet.

B.5. Character Area 5: Tropicana Ave to I-515 crossing



Segment Length: 3.25 miles

B.5.1. Land Use

Corridor land uses

The primary land uses along Character Area 5 are commercial and medium density residential. Secondary uses include light industrial, office, and vacant.

Adjacent land uses

Predominant land uses that make up the majority of the area behind the corridor are low and medium density residential, institutional, and commercial.

Districts

Notable districts supporting the Character Area are the Whitney Neighborhood, the Royal Links Golf Club, a commercial service district of Boulder Highway, and large casino properties.

Zoning

Zoning along this segment of Boulder Highway includes General Commercial District (*Clark Co. C-2)*; General Highway Frontage District (*Clark Co. H-2)*; and Limited Resort and Apartment District *(Clark Co. H-1)*.

B.5.2. Built Form

Physical characteristics

The built form of this segment is defined as a service commercial corridor with occasional casinos and apartment complexes. This segment of the corridor has moderate building density. Major intersections with commercial development are Tropicana Ave., Harmon Ave., Flamingo Rd., and Desert Inn Rd.. Nearby places with established character include Sam's Town Gambling Hall, the Eastside Cannery Casino, a Walmart Supercenter, numerous RV Parks, and the Boulder Station Casino Hotel.

Building placement

The most common setback for commercial and residential uses is around 50 feet, yet casinos and large retail uses range between 200 and 300-foot setbacks.

Building height

There is a wide range of building heights in this Character Area. Residential units are predominantly two-stories; small hotels are two to five-stories; casino structures vary between one and 16-stories; and service commercial/light industrial uses are mostly single-story structures.

B.5.3. Streetscape

Street composition

This segment has six lanes, medians with and without landscaping, a dedicated bus lane, and between two and six turn lanes at intersections.

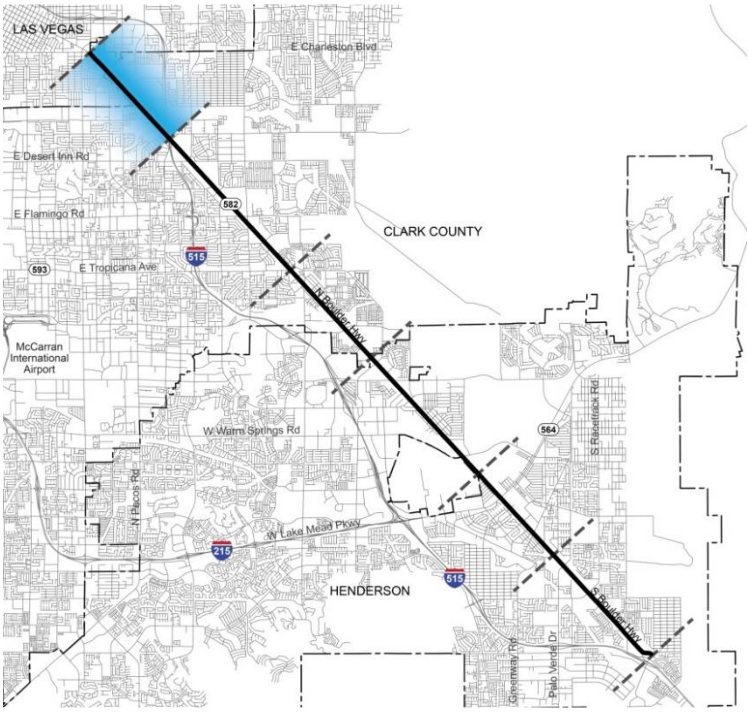
Pedestrian and bicycle facilities

Pedestrian and bicycle facilities include a continuous attached sidewalk with frequent driveway cuts on both sides of the street, occasional pedestrian crossings, and bicycle lanes/bicycle lane located in the shoulders.

Rights-of-way

The rights-of-way range between 200 and 210 feet with the most common being 200 feet.

B.6. Character Area 6: I-515 crossing to Charleston Blvd



Segment Length: 2.25 miles

B.6.1. Land Use

Corridor land uses

The primary land uses along Character Area 6 are commercial uses. Secondary uses include medium density residential, office, and vacant.

Adjacent land uses

Predominant land uses that make up the majority of the area behind the corridor are low and medium density residential, institutional, and commercial.

Districts

Notable districts supporting the Character Area are the unincorporated Town of Winchester, the Showboat Neighborhood, and a service commercial district of Boulder Highway.

Zoning

Zoning along this segment of Boulder Highway includes General Commercial District (*Clark Co. C-2)*; General Highway Frontage District (*Clark Co. H-2)*; General Commercial (*Las Vegas C-2)*; and Single Family Residential *(Las Vegas R-1).*

B.6.2. Built Form

Physical characteristics

The built form of this segment is an undescriptive commercial service corridor with surface parking and vacant lots. This segment of the corridor has relatively low building density. Major intersections with commercial development are Sahara Ave and Charleston Blvd Nearby places with established character include Justice Myron E. Leavitt & Jaycee Community Park, a car dealership park, and various mobile home communities.

Building placement

Commercial uses range between 20 and 200-foot setbacks without consistency.

Building height

There are predominantly single-story structures, some with large accent facades.

B.6.3. Streetscape

Street composition

This segment has six lanes, medians with and without landscaping, a dedicated bus and bike lane, and between two and seven turn lanes at intersections.

Pedestrian and bicycle facilities

Pedestrian and bicycle facilities include a continuous attached sidewalk with frequent driveway cuts on both sides of the street, occasional pedestrian crossings including access to the Flamingo Arroyo Trail, and bike lanes.

Rights-of-way

The rights-of-way range between 105 and 210 feet with the most common being 200 feet.

APPENDIX C—

DATA COLLECTION AND SPATIAL ANALYSIS OF DATA

Appendix C. Data Collection and Spatial Analysis of Data

Multiple spatial data were collected and compiled into a Geodatabase in ArcGIS to facilitate the evaluation of existing and future conditions of Boulder Highway. These data represent the multimodal facilities, traffic and transit characteristics, pedestrian and bicycle facilities, and crashes information for Boulder Highway. With this Geodatabase, maps were developed for each segment or the corridor to represent and study existing conditions of the corridor. Table 1 shows a summary of the data available on the Geodatabase.

Table 1. Geodatabase Data

Data Component	Data Description	Source
Intersection	Control, Vehicle Counts, Pedestrian Counts, Level of Service	Google Earth Imagery, field counts, Multimodal Analysis
Bicycle Routes	Location, Type, Level of Service	Google Earth Imagery, Multimodal Analysis
Pedestrian Facilities/Sidewalks	Location, Level of Service	Google Earth Imagery, Multimodal Analysis
Transit Stops	Locations, Boarding, Alighting	Regional Transportation Commission of Southern Nevada (RTCSNV)
Traffic Volumes	Annual Average Daily Traffic (AADT), Intersection Turning Movement Counts	NDOT Traffic Records Information Access (TRINA), Field Traffic Counts
Driveways	Location, Design Element Data	Google Earth Imagery
Pedestrian Ramps	Location, American with Disabilities Act (ADA) Compliance	Google Earth Imagery, Field Observations
Roadway Lights	Location	Google Earth Imagery
Crashes	Location, Type, Severity.	NDOT
Transit Routes	Locations, Lanes, Frequency, Ridership	RTCSNV
Crosswalks and Midblock Crossings	Locations, Pedestrian Counts	Google Earth Imagery, Field Traffic Counts, NDOT
Pedestrian Bridges	Locations	Google Earth Imagery
Roadway	Number of Lanes	Google Earth Imagery

Maps were utilized throughout the study process by the technical team and stakeholders to define problems, identify solutions, and develop an implementation plan. Due to the size of the corridor, maps and geodatabases are provided electronically to the RTC and NDOT and can be provided to the local agencies upon request.

Multimodal data were collected at major intersections and at key locations for the multiple modes of transportation along the corridor. The following Table 2 shows the type, source, period, and location of the data collected and Tables 3 through 5 show the location of data collected.

Table 2. Multimodal Data

Type	Source	Time/Period	Location
Pedestrian Counts	Field Counts	May 2nd and 3rd, 2017. Between 7:00 a.m. and 9:00 a.m., and 4:00 p.m. and 6:00 p.m.	16 signalized intersections and 3 mid-block crossings
Bicycles Counts	Field Counts	May 2nd and 3rd, 2017. Between 7:00 a.m. and 9:00 a.m., and 4:00 p.m. and 6:00 p.m.	16 signalized intersections and 3 mid-block crossings
Vehicle Counts	Field Counts	May 2nd and 3rd, 2017. Between 7:00 a.m. and 9:00 a.m., and 4:00 p.m. and 6:00 p.m.	31 signalized intersections
24 Hour Counts	Field Counts	May 2nd, 2017. 24-hour counts.	7 locations between major intersections
AADT	TRINA	2017	Count stations on Boulder Highway
Origin and Destinations Trips (O-D)	RTC Travel Demand Model	Peak periods between 7:00 a.m. and 9:00 a.m., and 4:00 p.m. and 6:00 p.m.	Traffic Analysis Zones along the corridor
Transit Ridership	Regional Transportation Commission of Southern Nevada (RTC)	March, 2017	RTC Fixed Route Monthly Service Report
Vehicle Classification	Field Counts	May 2nd, 2017. 24-hour counts.	7 locations between major intersections
Pedestrian Facilities	Google Earth	2017 Imagery	Existing pedestrian facilities along the corridor

Table 3. Peak Hour Count Locations

Count Period	Peak Hour Count Locations
AM and PM peak periods 7:00 am to 9:00 am 4:00 pm to 6:00 pm * Pedestrian and bicycle counts	Boulder Highway and Wagonwheel Dr.*
	Boulder Highway and Magic Way
	Boulder Highway and Equestrian Dr.
	Boulder Highway and Racetrack Rd.
	Boulder Highway and College Dr.
	Boulder Highway and Greenway Rd.
	Boulder Highway and Major Ave.
	Boulder Highway and Basic Rd.
	Boulder Highway and Texas Ave.
	Boulder Highway and Lake Mead Pkwy.*
	Boulder Highway and Water St.
	Boulder Highway and Warm Springs Rd.
	Boulder Highway and Barrett St.
	Boulder Highway and Sunset Rd.*
	Boulder Highway and Galleria Dr.*
	Boulder Highway and Broadbent Blvd.
	Boulder Highway and Russell Rd.*
	Boulder Highway and Missouri Ave.*
	Boulder Highway and Tropicana Ave.*
	Boulder Highway and Harmon Ave.*
	Boulder Highway and Nellis Blvd.*
	Boulder Highway and Flamingo Rd.*
	Boulder Highway and Indios Ave.*
	Boulder Highway and Desert Inn Rd.*
	Boulder Highway and NB I-515 on/off ramps*
	Boulder Highway and SB I-515 on/off ramps*
	Boulder Highway and Sahara Ave.*
	Boulder Highway and St Louis Ave.
	Boulder Highway and Mojave Rd.
	Boulder Highway and Olive St.
	Boulder Highway and Charleston Blvd.*

Table 4. Peak Hour Midblock Pedestrian Count Locations

Count Period	Midblock Pedestrian and Bicycle Count Locations
AM and PM peak periods	Boulder Highway crosswalk between Kentucky Ave and Nevada Ave.
7:00 am to 9:00 am	Boulder Highway and Whitney Ave.
4:00 pm to 6:00 pm	Boulder Highway and Sun Valley Dr.

Table 5. Classification Count Locations

Count Period	Classification Count Locations
24 Hour Period	South of Lake Mead Pkwy.
	Lake Mead Pkwy to Galleria Dr.
	Galleria Dr to Russell Rd.
	Russell Rd to Tropicana Ave.
	Tropicana Ave to Flamingo Rd.
	Flamingo Rd to I-515
	I-515 to Sahara Ave.

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APPENDIX D—

TRAVEL PATTERNS AND MULTIMODAL ANALYSIS

Appendix D. Travel Patterns and Multimodal Analysis

The purpose of this section is to evaluate existing travel patterns and multimodal operations along Boulder Highway. These analyses were performed based on the data collected as shown in Appendix C. The travel patterns were analyzed using the Regional Transportation Commission of Southern Nevada (RTCSNV) 2015 TransCAD model released in February of 2017.

D.1. Travel Patterns

The purpose of the travel patterns analysis is to identify trends for all modes of transportation along the corridor. The different travel patterns identified for the corridor are shown below.

D.1.1. Vehicle Travel Patterns

Annual Average Daily Traffic Patterns

Historical trends show that the daily vehicular traffic volumes have remained almost steady with a slight decrease in year 2010. Figure 1 shows the existing Annual Average Daily Traffic (AADT) trends along Boulder Highway.

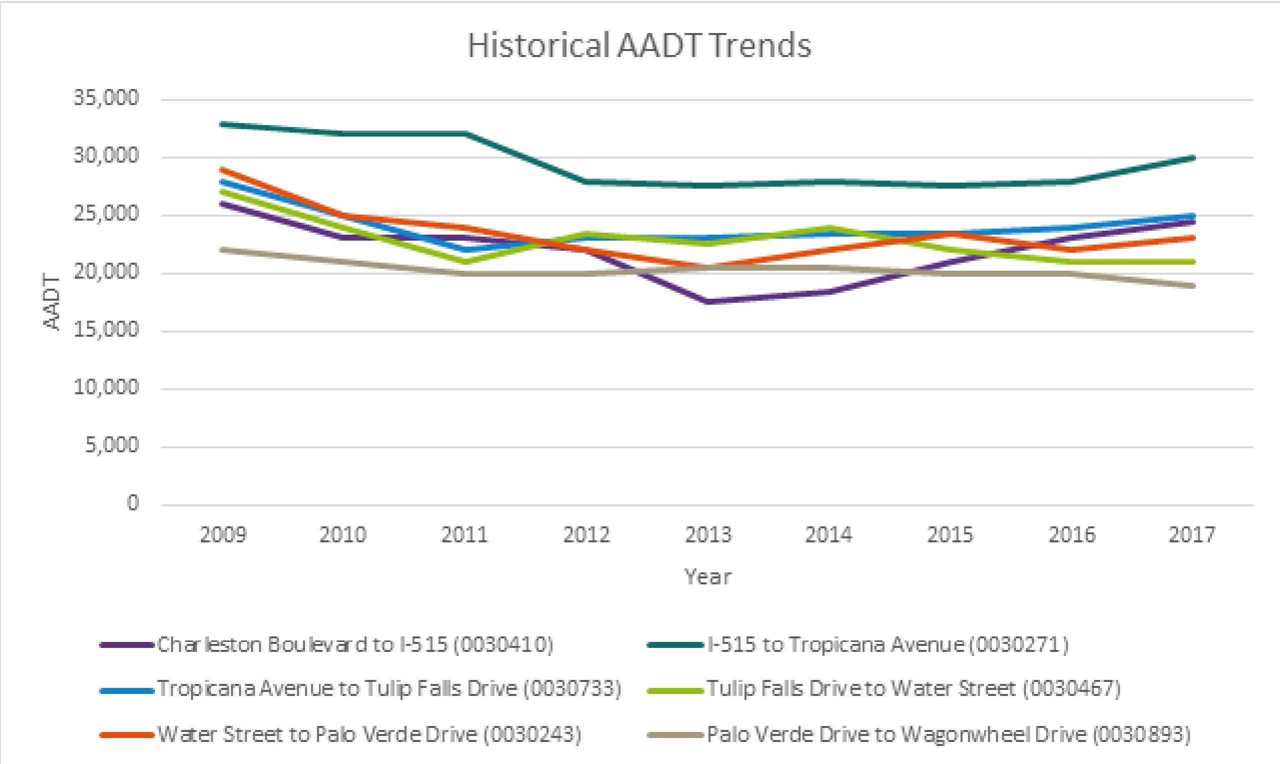

Figure 1. Historical AADT Trends

Hourly Traffic Counts Patterns

Vehicular traffic along Boulder Highway within the study area varies by both location and time of day. Based on traffic count data collected on Tuesday, May 2, 2017, Boulder Highway carries between approximately 11,000 and 19,000 vehicles per day on each direction. Figure 2 shows that vehicle volumes are lowest on the southern portion of the corridor and gradually build toward the north. The highest traffic volumes were observed at the northern most portion of the study corridor north of I-515.

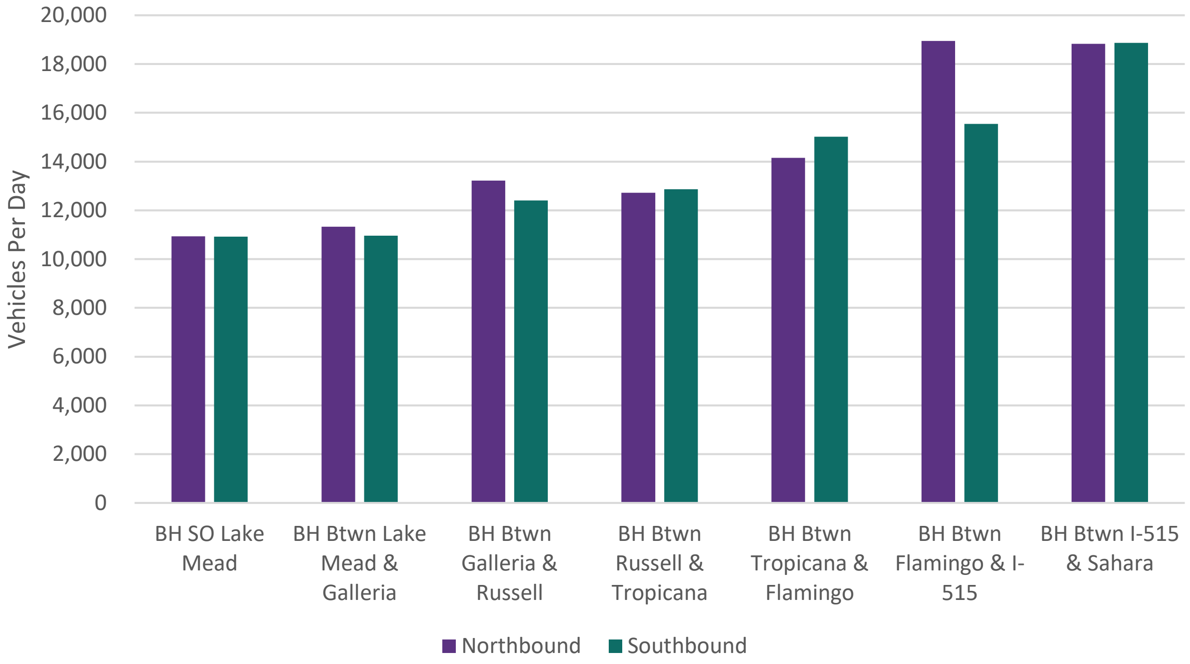

Figure 2. Boulder Highway ADT by Location

In addition to the location on the corridor, traffic also varies by time of day. There are two distinct peak traffic periods which reflect the morning and evening commuting periods. On Boulder Highway, the morning peak hour is at approximately 7:00 a.m. and the evening peak hour is at approximately 4:00 p.m. and 5:00 p.m., depending on the segment and travel direction. Data also indicates that the evening peak is slightly stronger than the morning peak. Figure 3 and Figure 4 summarize the hourly traffic flows by time of day for the northbound and southbound travel directions respectively.

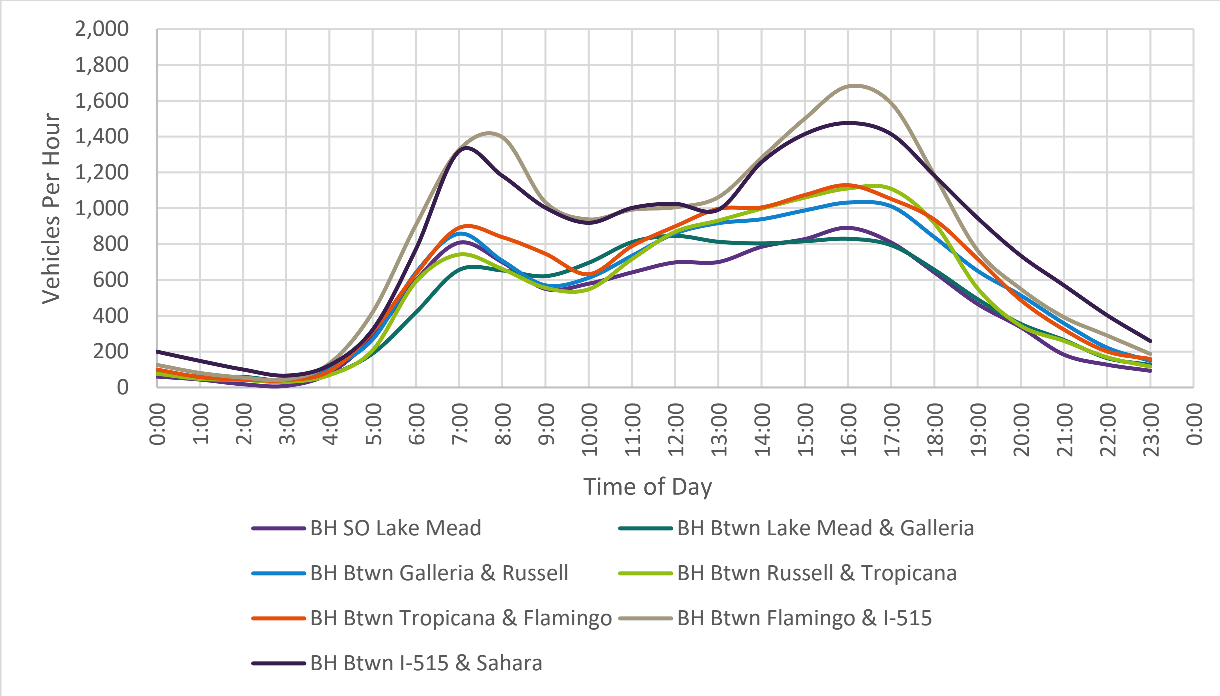

Figure 3. Northbound Traffic on Boulder Highway by Time of Day

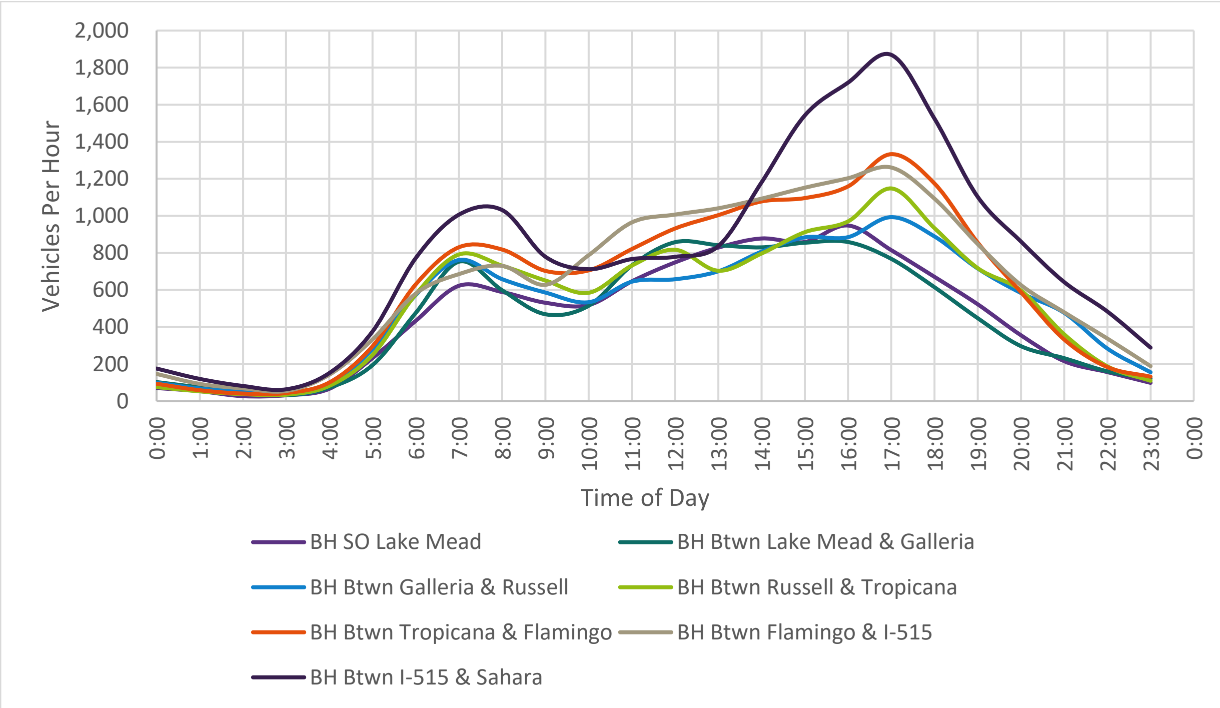

Figure 4. Southbound Traffic on Boulder Highway by Time of Day

Origin and Destination Patterns

The Origin and Destination (OD) analysis from RTC's Travel Demand Model (TDM) showed that the trip length average is less than 2 miles for the majority of the trips with origins and attractions adjacent to or along Boulder Highway. Additional trips were observed between the Casino areas on Boulder Highway and Las Vegas Boulevard Resort Corridor, indicating that a significant amount of trips follow an east to west pattern. Figure 5 through Figure 14 show the OD travel patterns along the corridor. These figures depict the trips produced in the different Traffic Analysis Zones (TAZ) of the TDM and attracted to the corridor as well as the trips produced in the corridor and attracted to the different TAZ's.

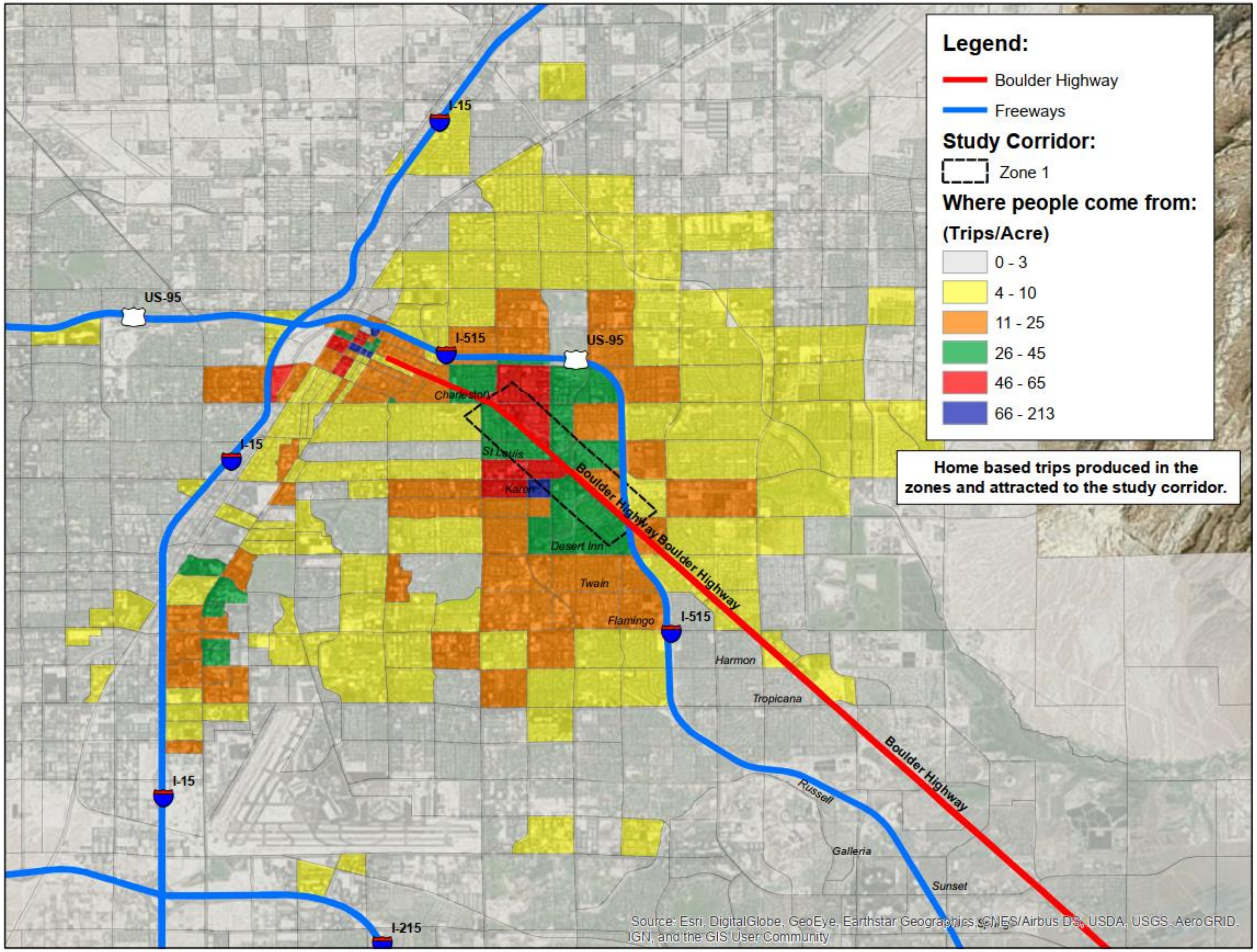

Figure 5. Zone 1 – Home Based Trips Produced in the Zones and Attracted to the Study Corridor

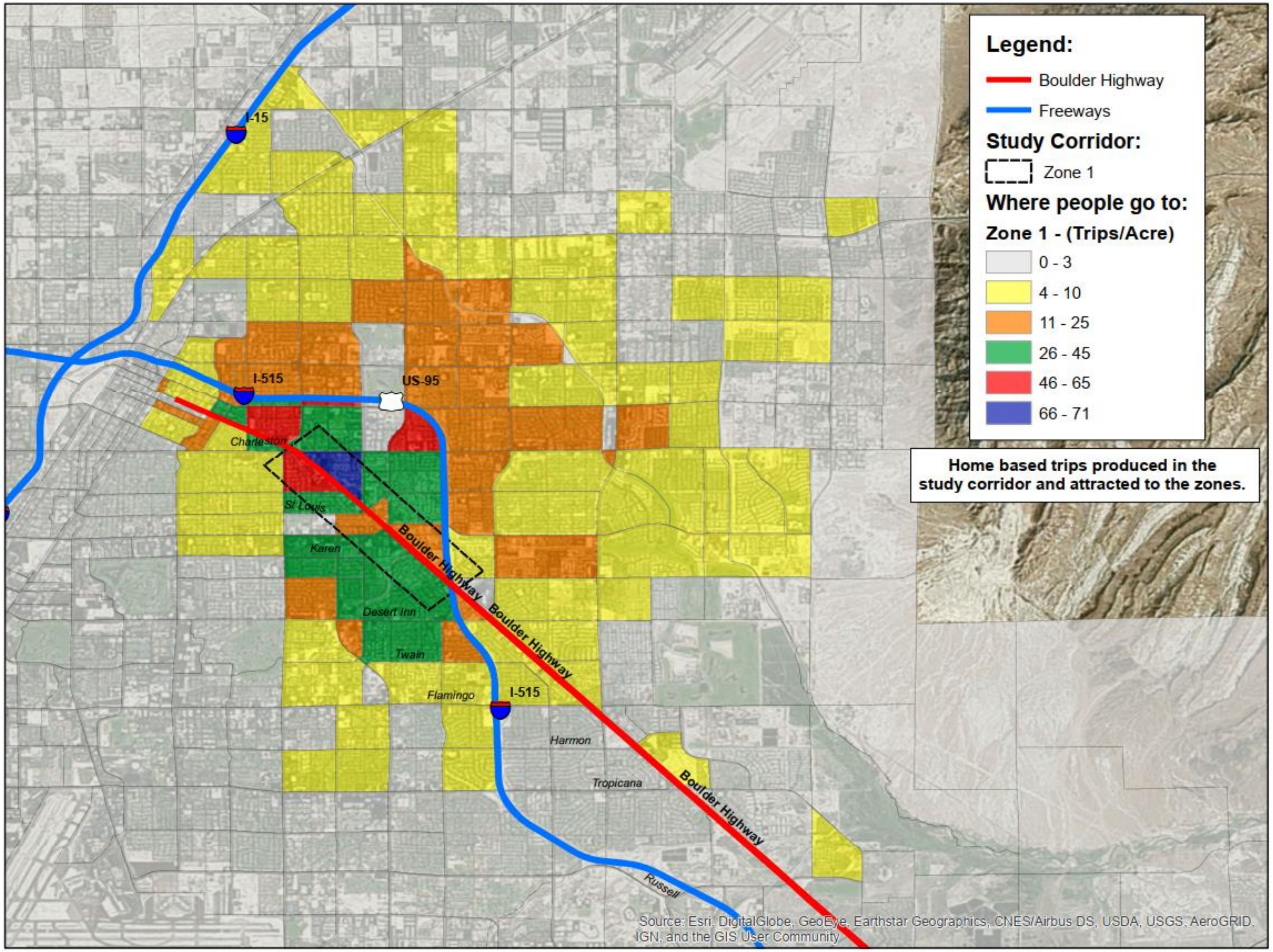

Figure 6. Zone 1 – Home Based Trips Produced in the Study Corridor and Attracted to the Zones

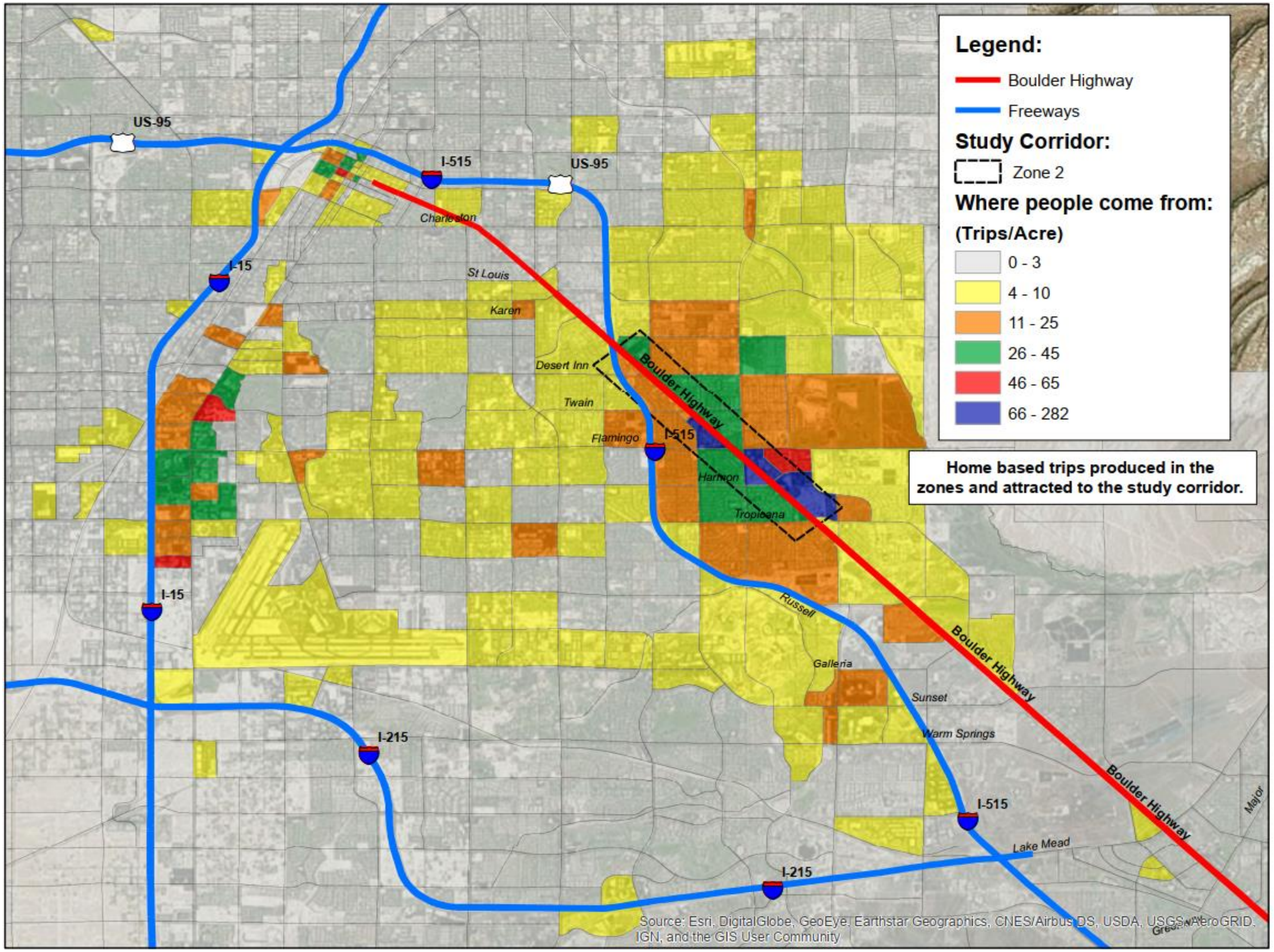

Figure 7. Zone 2 – Home Based Trips Produced in the Zones and Attracted to the Study Corridor

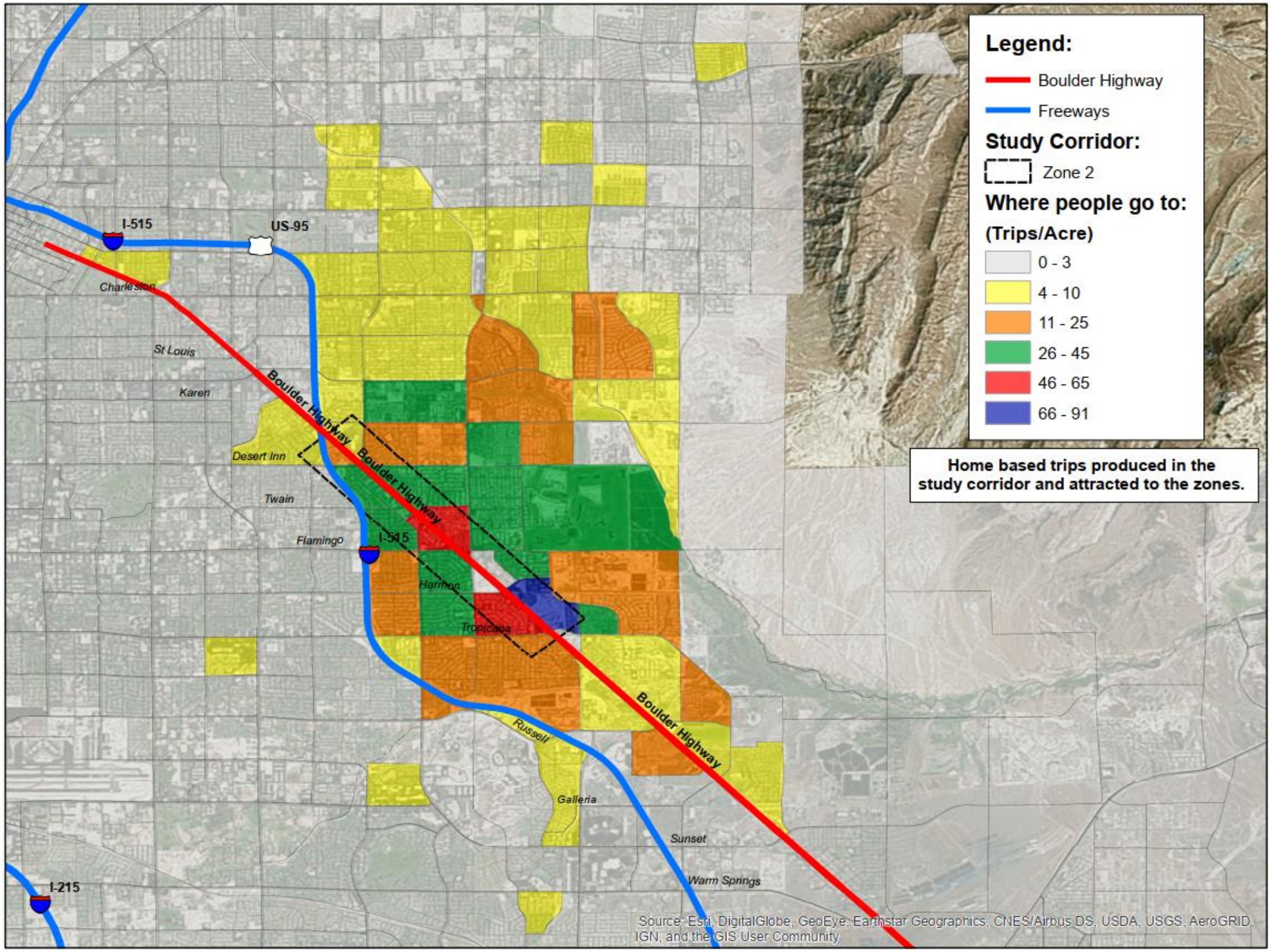

Figure 8. Zone 2 – Home Based Trips Produced in the Study Corridor and Attracted to the Zones

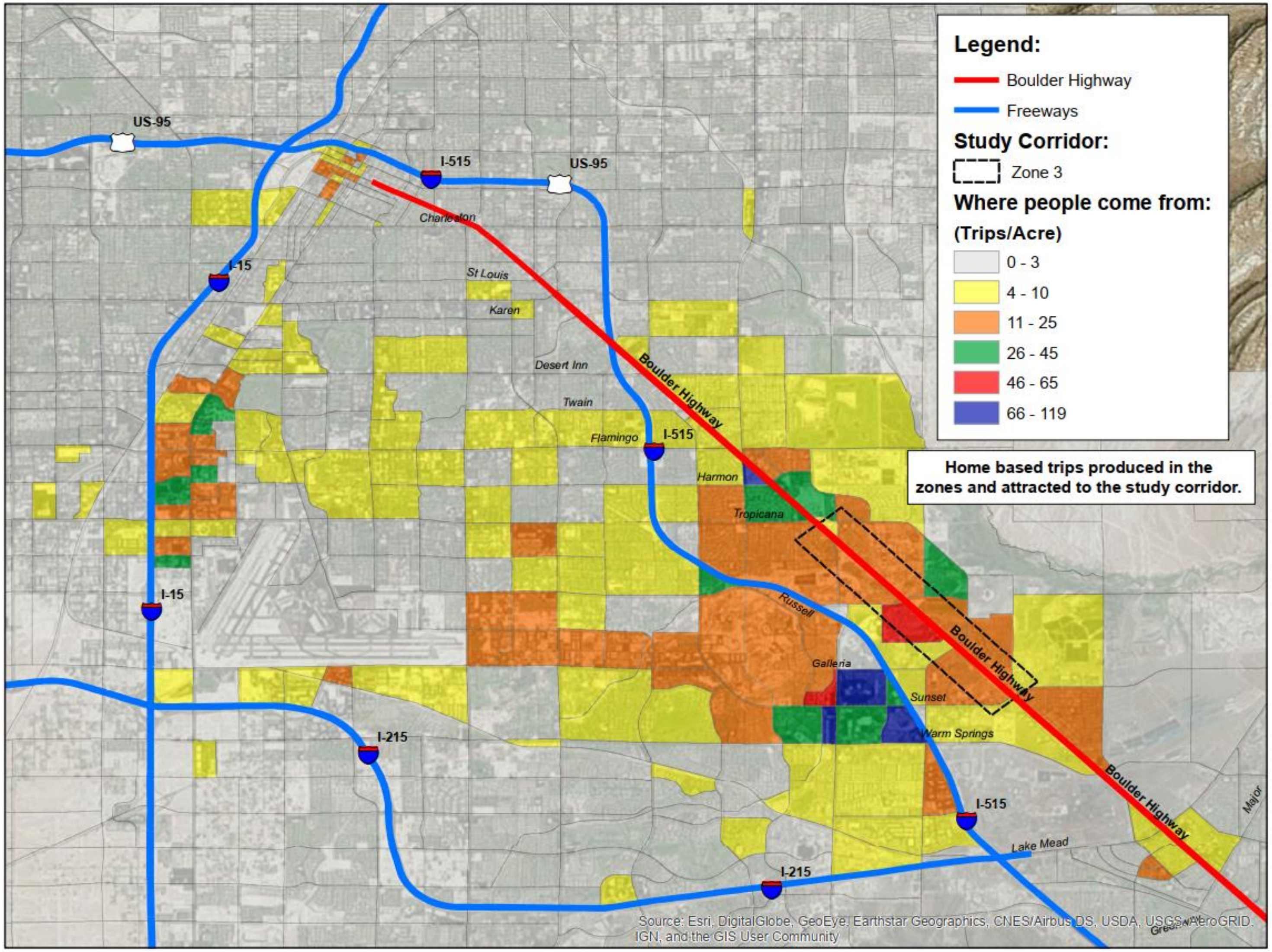

Figure 9. Zone 3 – Home Based Trips Produced in the Zones and Attracted to the Study Corridor

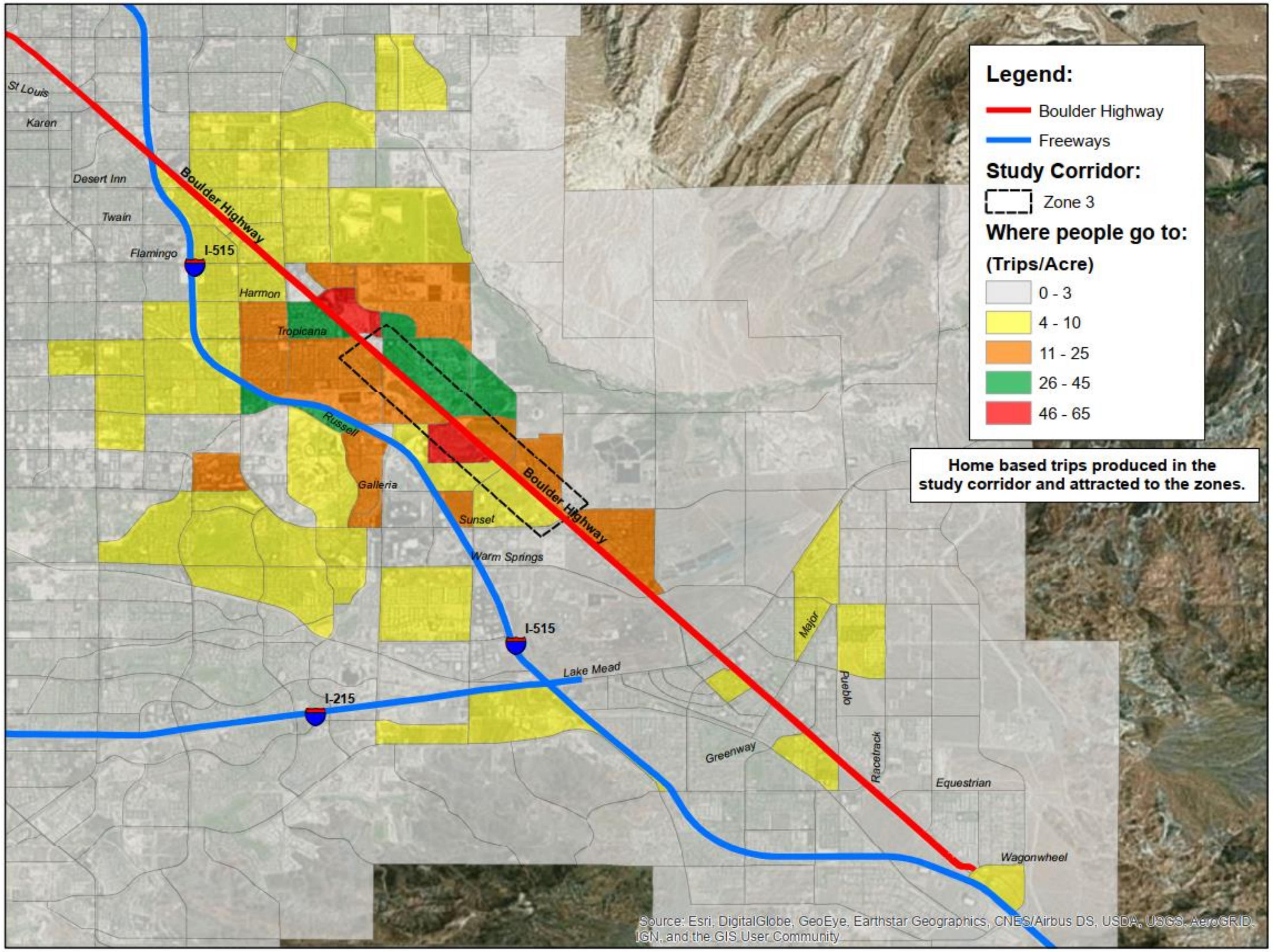

Figure 10. Zone 3 – Home Based Trips Produced in the Study Corridor and Attracted to the Zones

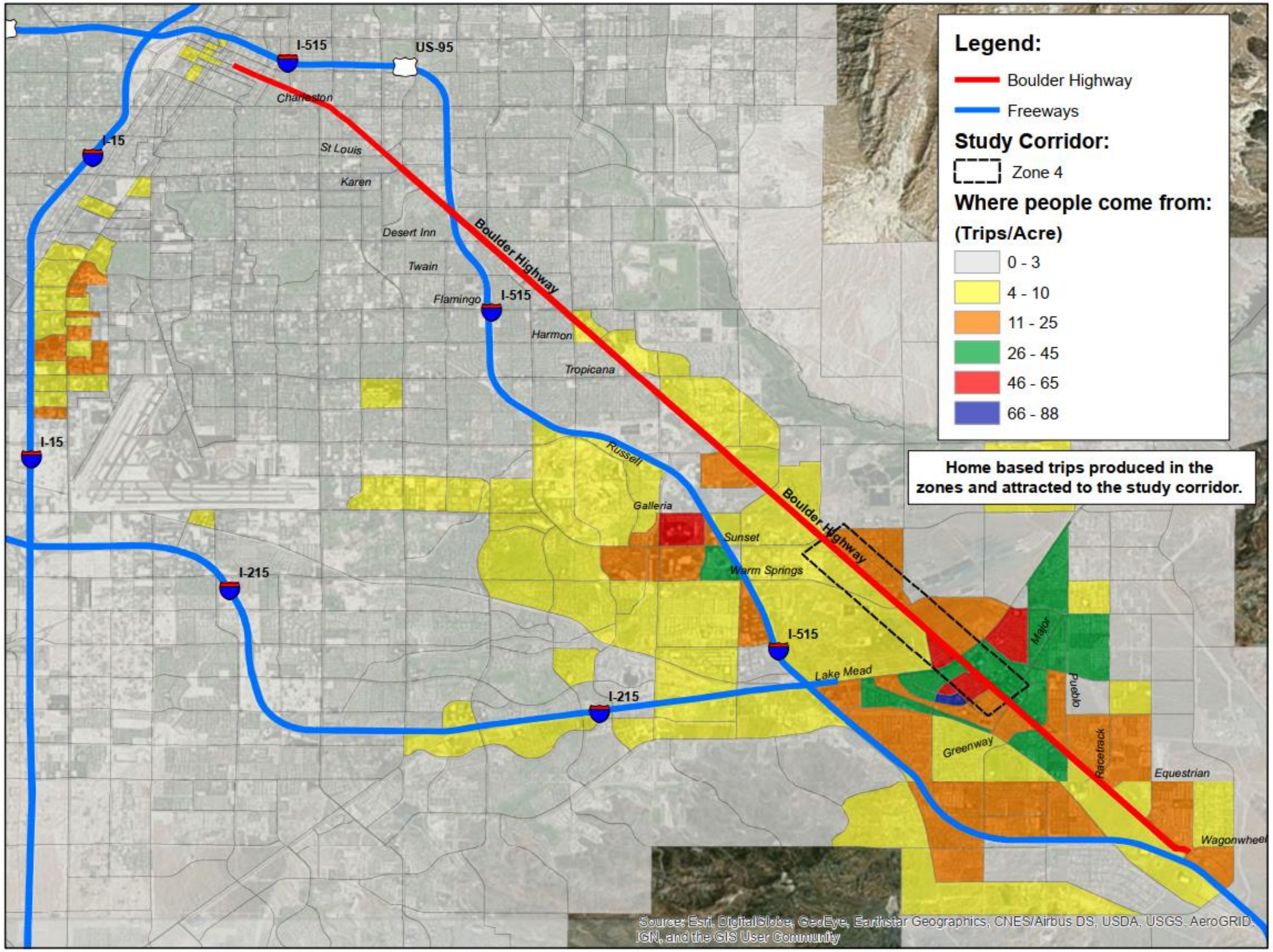

Figure 11. Zone 4 – Home Based Trips Produced in the Zones and Attracted to the Study Corridor

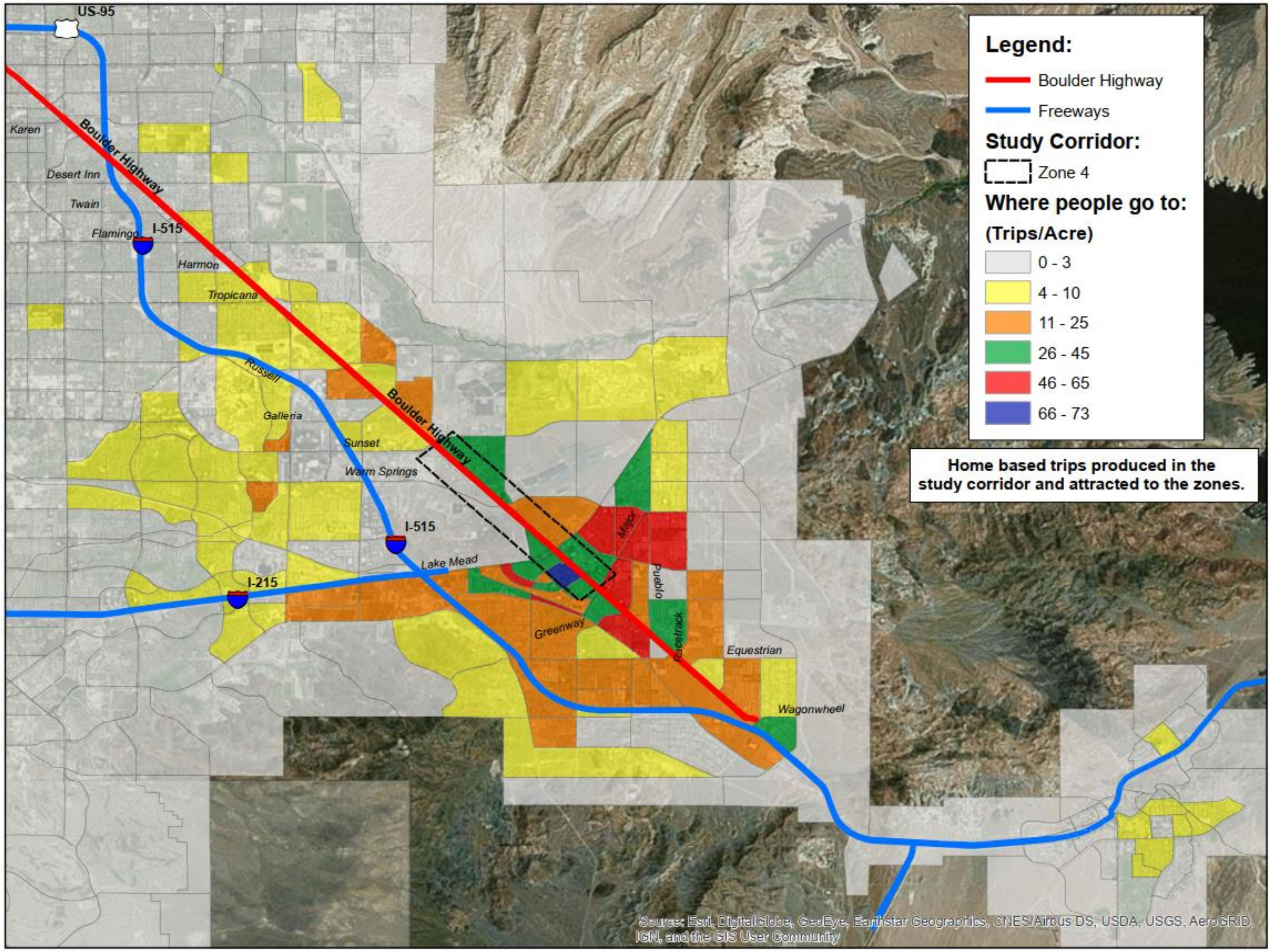

Figure 12. Zone 4 – Home Based Trips Produced in the Study Corridor and Attracted to the Zones

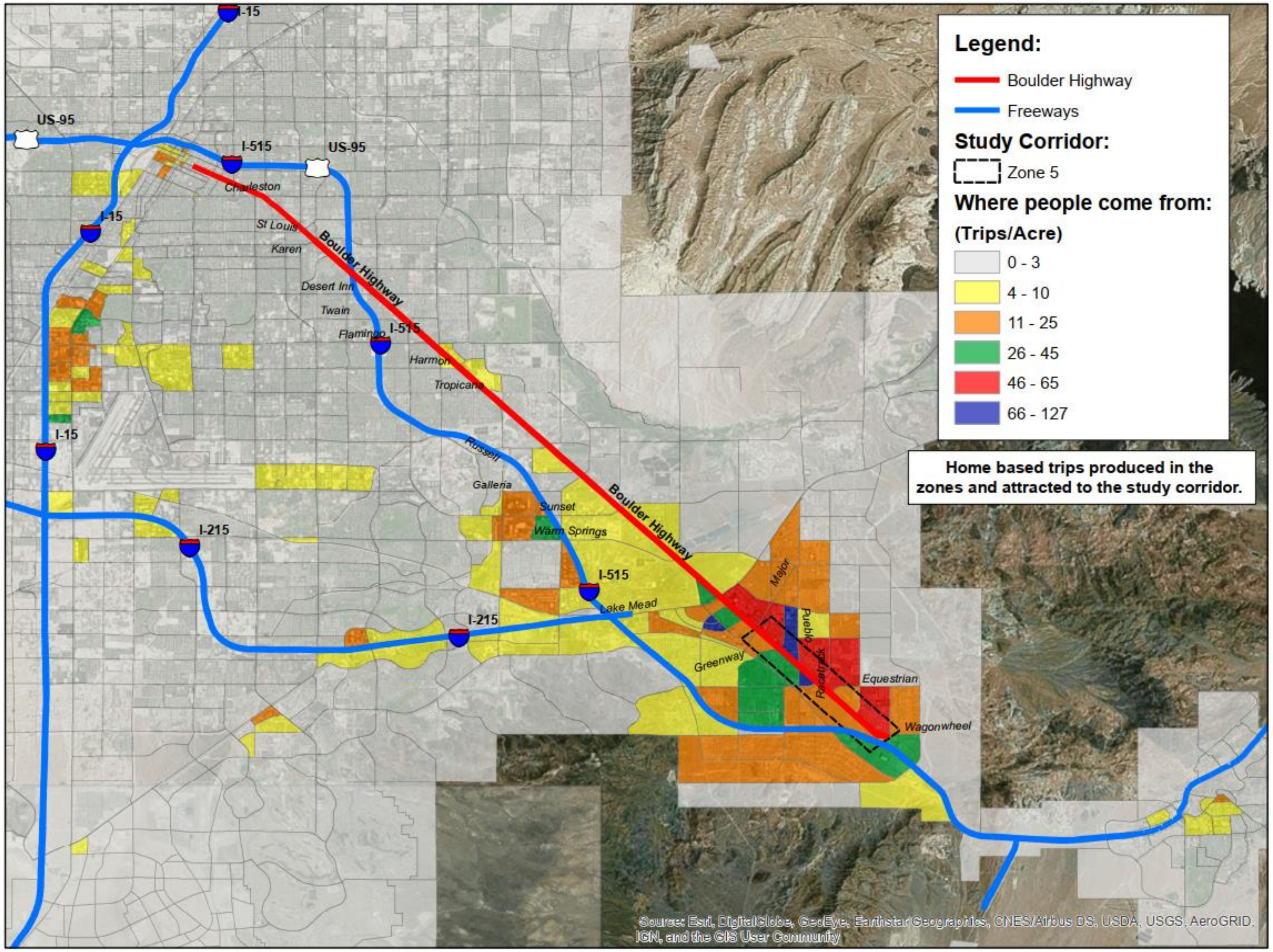

Figure 13. Zone 5 – Home Based Trips Produced in the Zones and Attracted to the Study Corridor

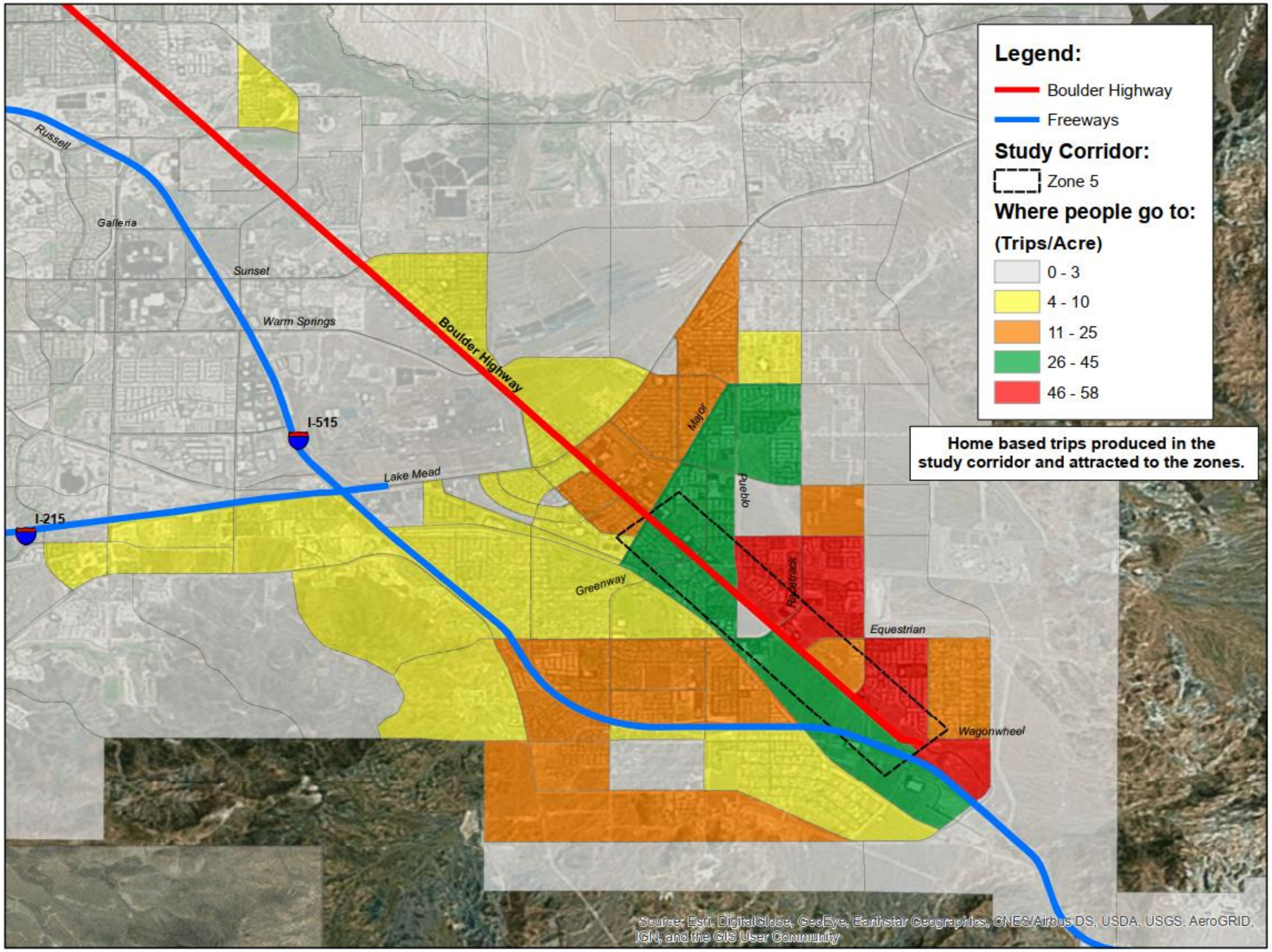

Figure 14. Zone 5 – Home Based Trips Produced in the Study Corridor and Attracted to the Zones

D.1.2. Pedestrian Travel Patterns

Boulder Highway supports a great deal of pedestrian activity, from local walking trips by people accessing commercial services, to transit riders making transfers between bus routes, and to visitors accessing hotels and casinos. This pedestrian activity is evidenced by the user behavior on the corridor, documented in this case through pedestrian count data at major intersections.

Pedestrian count data was collected at 16 of the 31 signalized intersections in the study area. An additional three pedestrian crossing counts were collected at midblock locations where some pedestrian crossing control exists. Counts were collected on Tuesday February 5, 2017 and Wednesday May 3, 2017 between 7:00 a.m. and 9:00 a.m., and 4:00 p.m. and 6:00 p.m., which represent the morning and evening peak periods for vehicle traffic. The total number of pedestrian crossings at major intersections is shown in Figure 15.

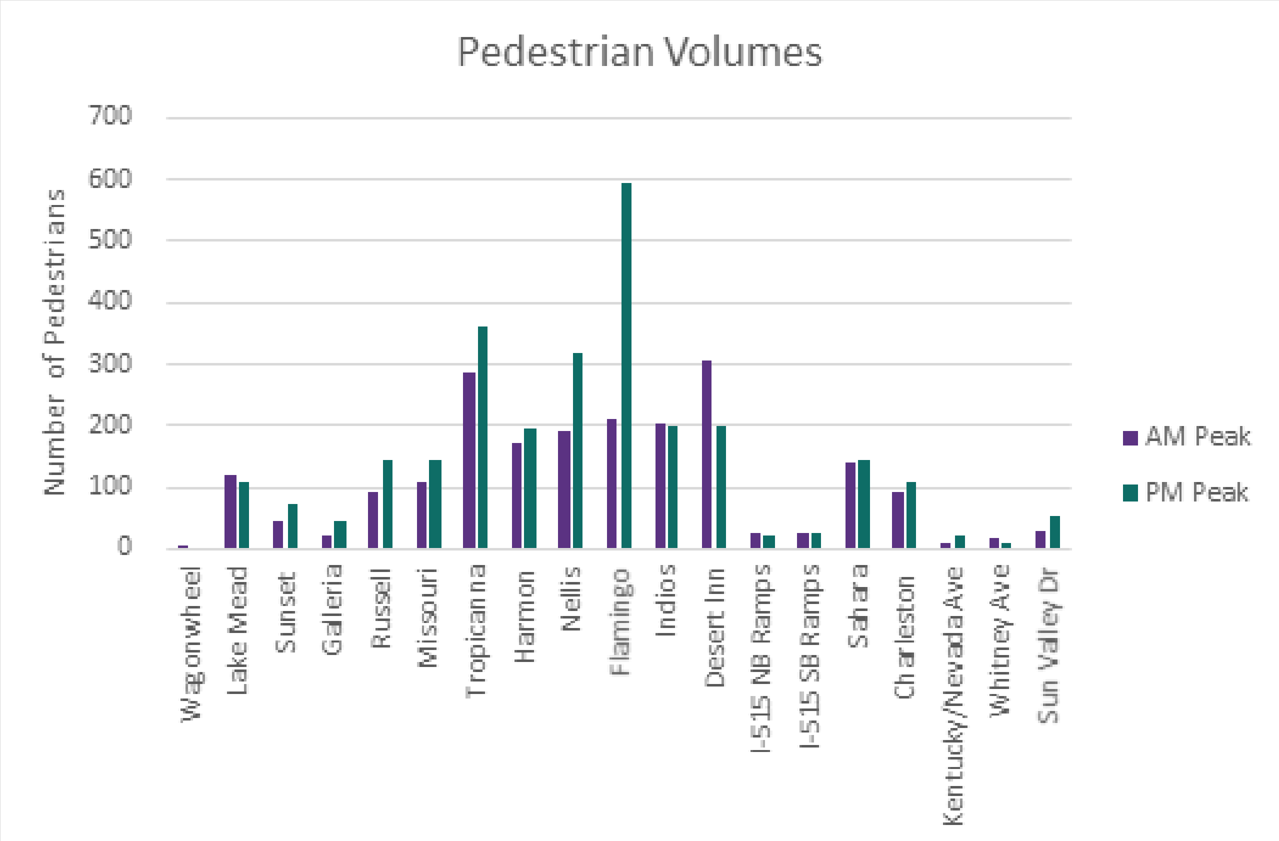

Figure 15. Pedestrian Volumes at Signalized Intersections

The area between Tropicana Avenue and Desert Inn Road, a 2.7-mile stretch, experienced the highest number of pedestrian crossing movements with approximately 170 to 300 pedestrian crossings observed during the morning peak period and approximately 200 to 600 observed during the evening peak. The highest morning peak crossing counts were observed at Desert Inn Road with 305 pedestrians crossings during the two-hour period. The highest evening peak crossing counts were observed at Flamingo Road with 594 pedestrians crossing during the two-hour period.

The lowest pedestrian crossing counts were observed at the Wagonwheel Drive intersection with five pedestrians crossing during the morning peak and zero pedestrian crossings during the evening peak. Low crossing numbers were also observed at the interchange ramps with Interstate 515 (I-515), with approximately 25 pedestrians crossing at both the northbound and southbound ramp terminals during both peak periods.

D.1.3. Bicycle Travel Patterns

Bicycle counts were collected at 16 intersections and 3 mid-block crossing locations along the corridor for the morning and afternoon peak periods. Figure 16 shows the morning and afternoon pedestrian counts.

It was observed that the trends of the bicycle counts are consistent with the traffic counts that have the highest volumes during the afternoon. The highest bicycle counts were observed at Sahara Avenue with 21 bicycles during the morning period and 34 bicycles observed during the afternoon period followed by Flamingo Road with 19 bicycles during the morning and 25 bicycles during the afternoon. The lowest bicycle counts were observed at Wagonwheel Drive.

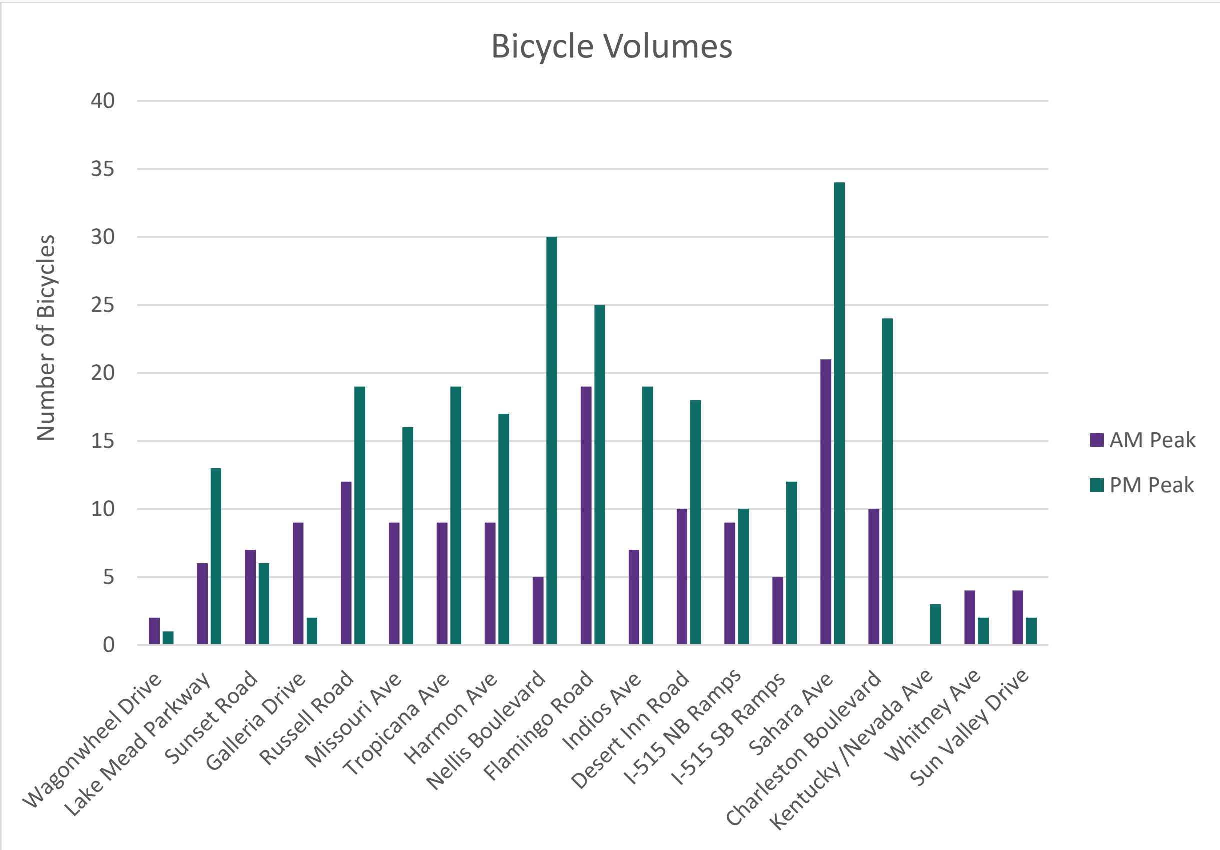

Figure 16. Bicycle Volumes at Signalized Intersections

D.1.4. Transit Travel Patterns

Transit service along this corridor is provided by the Regional Transportation Commission of Southern Nevada (RTC).

The overall route structure of the Regional Transportation Commission of Southern Nevada (RTC) system resembles a grid, with most routes running direct alignments north-south or east-west. Figure 17 shows the transit system serving Boulder Highway classified by frequency, and highlights bus stop locations along the corridor. Frequent services are defined by RTC as any service that runs every 20 minutes or less. An additional three classifications of routes; services every 20-30 minutes, services every 30-60 minutes and hourly services, have been defined based on natural breaks in the existing service frequency.

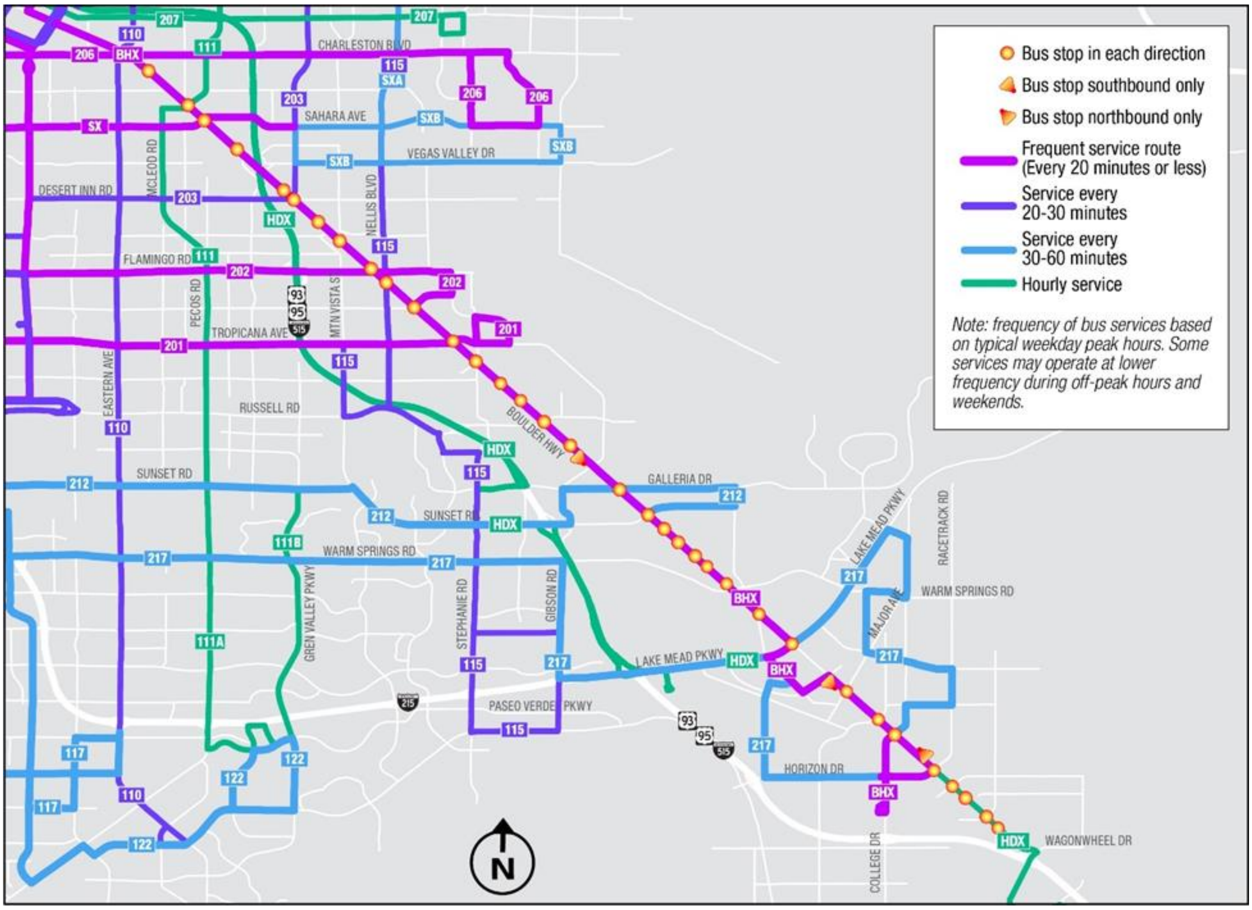

Figure 17. Existing Transit Network serving Boulder Highway

The main route operating along the Boulder Highway study corridor is the Boulder Highway Express (BHX), an arterial express route. The Henderson Downtown Express (HDX) also runs along the alignment within the study area limits in the City of Henderson. Very little RTC service overlaps with Route BHX along Boulder Highway. Key service characteristics of each of these services on Boulder Highway include:

Route BHX:

- Runs from the Bonneville Transit Center in downtown Las Vegas to Horizon Drive/College Drive in the City of Henderson, following Boulder Highway for a majority of the alignment.
- Operates 24 hours a day, 7 days a week.
- Operates at 15-minute headways during the day on weekdays, with hourly headways overnight.

- Intersects with RTC routes 206 (Charleston), 111 (Pecos/Green Valley Pkwy), SX (Sahara Express), 203 (Spring Mountain/Desert Inn/Lamb), 202 (Flamingo), 115 (Nellis/Stephanie), 201 (Tropicana), 212 (Sunset), and 217 (Warm Springs/Downtown Henderson).

Route HDX:

- Runs from the Bonneville Transit Center in downtown Las Vegas to Utah Street/Northridge Drive in Boulder City.
- Operates express (non-stop) service along I-515, providing local pick-up/drop-off service within Boulder City, the City of Henderson, and near the Galleria at Sunset.
- Operates 7 days a week.
- Provides northbound hourly service from approximately 4:30 a.m. to 10:00 p.m., and southbound hourly service from approximately 6:00 a.m. to 10:00 p.m.

There are many other transit services crossing the corridor. Table 1 outlines the transit services within, or crossing, the study area.

Table 1. Transit Services near Study Area

	Service	Primary Route	Direction of Travel	Start Location	End Location
Express Routes	BHX	Boulder Hwy	North/South	Bonneville Transit Center	Horizon & College
	HDX	Hwy 93/Hwy 95/ Boulder Hwy	North/South	Bonneville Transit Center	Utah & Northridge
	SX	Sahara	East/West	Pavilion Center & Summerlin Centre	Vegas Valley & Sloan
Local Routes	110	Eastern Ave	North/South	Civic Center & Cheyenne	Eastern & Horizon Ridge
	111	Green Valley/ Pecos	North/South	Pecos & Craig	Green Valley Ranch Resort
	115	Nellis/Stephanie	North/South	Craig & Las Vegas Blvd	Stephanie & Horizon Ridge
	117	Las Vegas Blvd S/Silverado Ranch	North/South	McCarran International Airport	Eastern & Serene
	122	S. Maryland Pkwy/Horizon Ridge	North/South	McCarran International Airport	Paseo Verde & Carnegie
	201	Tropicana	North/South	Tropicana & Fort Apache	Andover (After loop)
	203	Spring Mountain/ Desert Inn/ Lamb	East/West & North/South	Town Center & Twain	Lamb & Craig
	206	Charleston	East/West	Pavilion Center & Summerlin Centre	Charleston & Sloan
	207	Alta/Stewart	East/West	Alta & Rampart	Stewart & Nellis
	212	Sunset	East/West	Fort Apache & Sunset	Boulder Hwy & Sunset
	217	Warm Springs/ Downtown Henderson	East/West	Northbound Dean Martin Alongside Silverton	College & Boulder Hwy

RTC provided system ridership data at the route and stop level for March 2017. The Boulder Highway corridor shows strong transit ridership, as compared with the overall RTC system.

Route Boulder Highway Express (BHX) is RTC's sixth-highest ridership route, with over 10,000 average weekday boarding.

Table 2. Route BHX Ridership and Productivity

Day	Boarding per Revenue Hour	Average Daily Boarding (rounded)
Weekday	48.51	10,540
Saturday	49.77	9,550
Sunday	42.05	7,610

Source: March 2017 RTC Fixed Route Monthly Service Report

As shown on Table 2 weekend ridership is nearly as strong as weekday, showing a robust all-week demand for service. In terms of boarding per revenue hour, a common measure of transit service effectiveness, Route BHX generates over 42 boardings per hour throughout the week, with Saturday utilization even stronger than weekday at nearly 50 boarding per hour. These values exceed RTC's monthly system average of 40.5 boarding per revenue hour.

Boarding activity appears strongest between approximately Tropicana Avenue and Sahara Avenue, with several stops exceeding 500 boardings per day. The highest-activity locations correspond with intersecting routes, particularly where the BHX intersects with other routes running at 15-minute headways. Key boarding locations include:

- Boulder at Tropicana, with over 750 weekday BHX boardings, as well as over 750 weekday boardings on Route 201 (Tropicana)
- Boulder at Nellis, with over 825 weekday BHX boardings, as well as over 575 weekday boardings on Route 115 (Nellis/Stephanie)
- Boulder at Flamingo, with over 575 weekday BHX boardings, as well as nearly 900 weekday boardings on Route 202 (Flamingo) within the intersection's vicinity
- Boulder at Desert Inn/Lamb, with over 550 weekday BHX boardings, as well as over 300 weekday boardings on Route 203 (Spring Mountain/Desert Inn/Lamb)
- Boulder/Fremont at Sahara, with over 430 weekday BHX boardings, as well as over 370 weekday boardings on Route SX (Sahara Express)
- Two notably high-ridership stops without intersecting routes included Boulder at Russell (over 340 weekday boardings) and Boulder at Indios (over 380 weekday boardings). *(Source: Ordered by Direction Ridership by Stop, March 2017)*

According to March 2017 data, Route BHX carries the highest number of both bicycle and wheelchair customers of any route in the RTC system. *(Source: March 2017 Keycode Report)*

Route HDX, which operates along a portion of the Boulder Highway corridor within the City of Henderson, carries just over 1,000 passengers on an average weekday, with approximately 750 and 625 passengers on Saturday and Sunday, respectively. The most active boarding location within the Boulder Highway project area is Water at Army/Atlantic (approximately 0.35 miles from Boulder Highway), with over 75 weekday boardings. This stop location also generates over 280 weekday boardings on routes BHX and 217.

GIS data containing ridership information for all transit services in the greater Las Vegas area was obtained from RTC for the month of March 2017. This data allowed boarding and alighting for each stop in the study area to be analyzed. Figure 18 shows average daily boarding and alighting for a weekday. For graphical simplicity, bus stops on either side of the corridor were condensed to one point in the middle of the corridor and boarding and alighting data combined to show the locations along the corridor with the highest ridership activity. Typically, the highest boardings and alightings on Boulder Highway were observed in locations where transit routes intersect or where significant development surround the transit stops. The northern portion of the corridor, north of Russell Road, experiences significantly higher boarding and alighting than the remainder of the corridor.

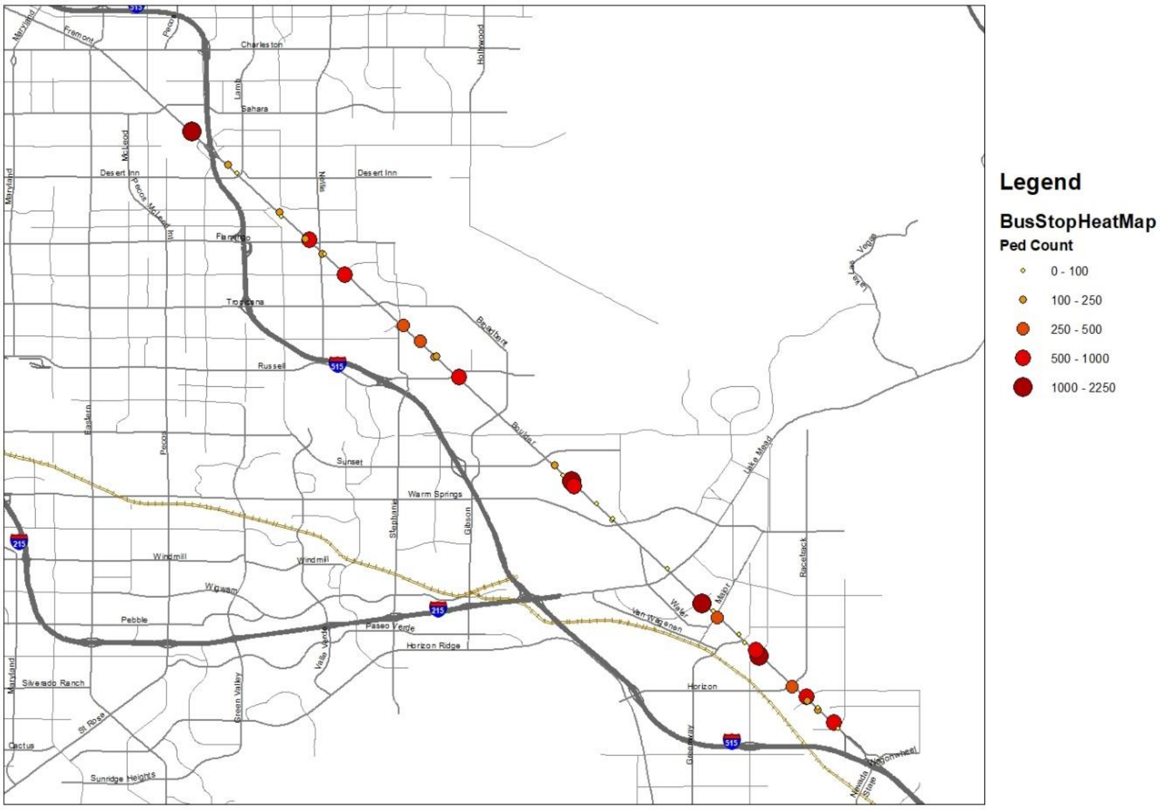

Figure 18. Transit Boarding and Alighting by Location

The highest transit boarding and alighting on Boulder Highway are observed between Tropicana Avenue and Flamingo Road. There are several bus routes that cross the corridor within this area. Route 201 and Route 202, both of which are high frequency routes, run east-west on Tropicana Ave. and Flamingo Rd. respectively, and intersect the high frequency service on Boulder Highway. Route 115 also runs through this area on Nellis Blvd.

The southbound bus stop at Nellis Blvd./Boulder Highway recorded the highest combined number of boardings and alightings in the study area with approximately 920 weekday alightings and 550 weekday boardings. The westbound stop at Tropicana Ave./Andover Dr., just west of Boulder Highway, recorded approximately 750 weekday boardings and 200 weekday alightings. Similarly, the two westbound bus stops on Flamingo Rd., on either side of Boulder Highway, have 470 and 330 weekday boardings respectively. The SX Sahara Express and the 203 RTC bus route intersect Boulder Highway at Sahara Ave. and Desert Inn Rd. respectively. High boarding and alighting are also observed at these locations.

South of Russell Road, bus boardings and alightings, in both north and south directions, were lower than the remainder of the corridor. An exception to this are the bus stops located near Russell Rd. and Sunset Rd. and Lake Mead Pkwy. Route 217 and Route 212 RTC bus services intersect Boulder Hwy. at Sunset Rd and Lake Mead Parkway respectively. Accumulating northbound and southbound stops, there were approximately 700 weekday boardings and alightings recorded at Russell Rd./Boulder Hwy., 800 weekday boardings and alightings recorded at Sunset Rd./Boulder Hwy. and approximately 630 weekday boardings and alightings recorded at Lake Mead Pkwy./Boulder Hwy.. With the exception of bus stops at Galleria Dr, Major Road, and Palo Verde which recorded a northbound and southbound cumulative 260, 220 and 300 weekday boardings and alightings respectively, all other stop locations in the southern section of corridor recorded between 12 and 200 weekday transit users.

D.1.5. Freight Travel Patterns

The peak hour patterns of freight movement in the corridor were determined using peak hour turning movement counts and vehicle classification data. As shown in 0, overall, trucks make up between 2.5 percent of traffic on the northern most portion of Boulder Highway and 4.5 percent of traffic on the southernmost portion of the corridor. The highest number of trucks enter and exit Boulder Highway at I-515.

Figure 19. Freight Movement on Boulder Highway

As shown in Figure 19, the number of trucks decreases by 150 vehicles passing I-515 interchange in the northbound direction and increases by 162 vehicles when passing I-515 interchange in the southbound direction. This is expected given the regional significance of the I-515.

On Boulder Highway itself, the lowest truck percentages are seen north of I-515, and the highest truck percentages are near Lake Mead Parkway. This is explained with the decrease in volume in the southern portion of the corridor, while the overall truck volumes do not change significantly south of I-515 interchange.

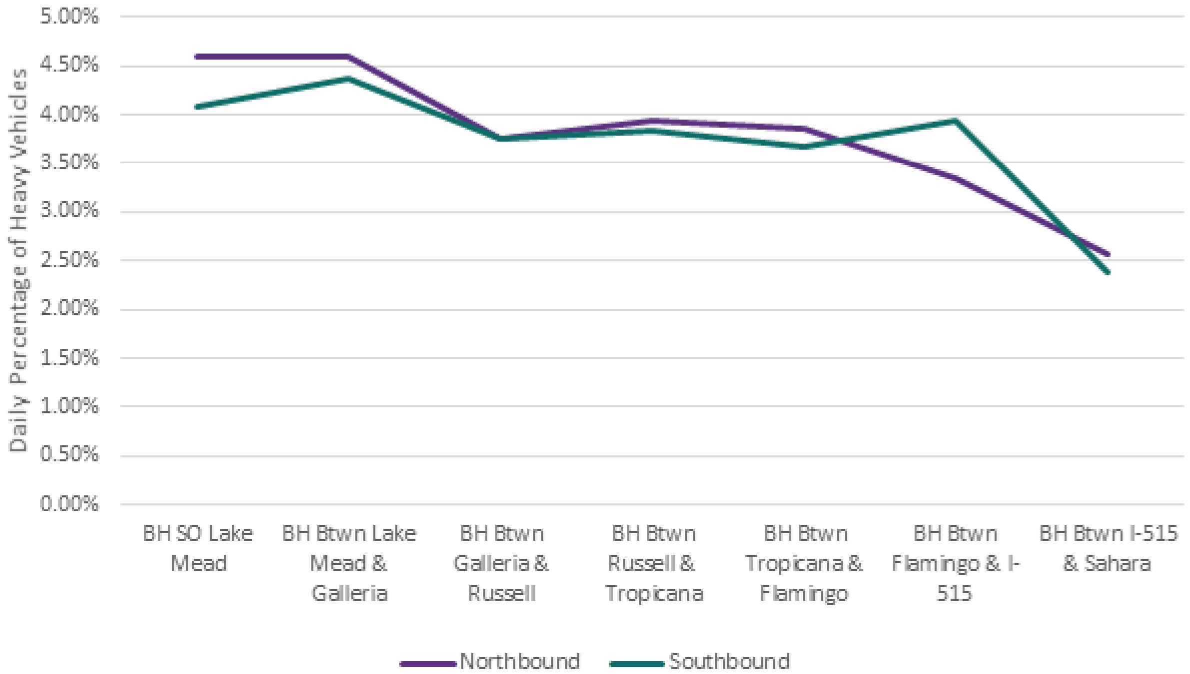

Figure 20. Daily Heavy Vehicle Percentage by Location

This trend is reversed if truck volumes are examined in absolute numbers. The highest number of trucks is observed near the I-515 interchange with Boulder Highway and decreases in both directions moving away from the interstate. This indicates that many heavy vehicles are using Boulder Highway to access the interstate. Figure 21 and 21 summaries this truck volume data.

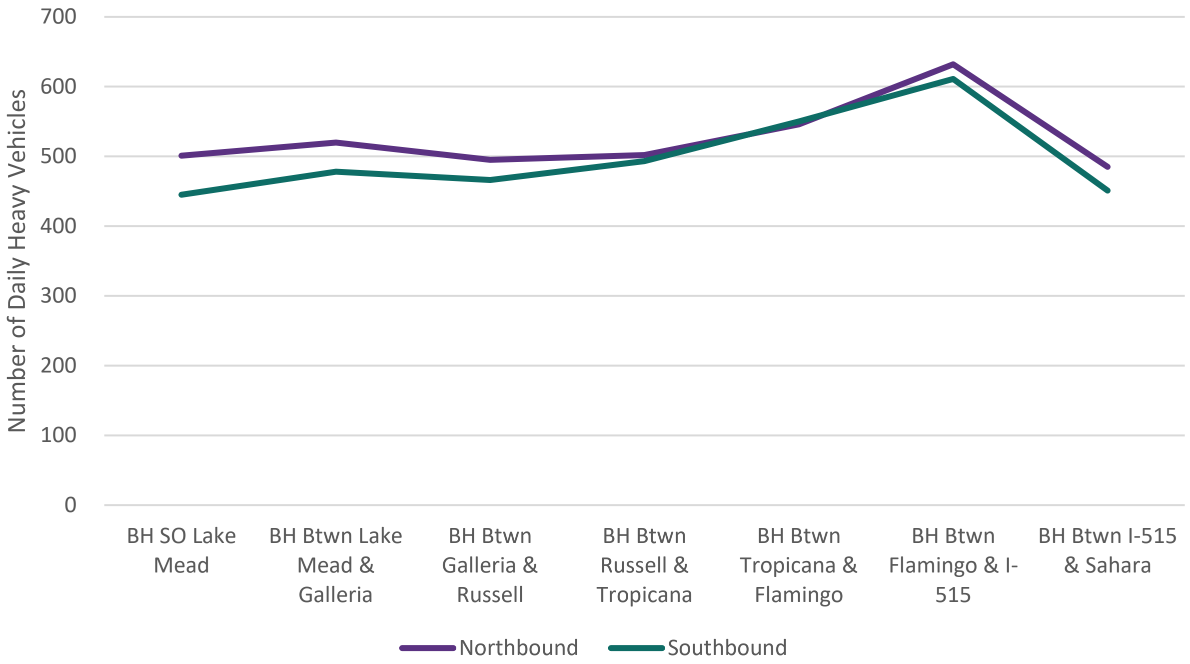

Figure 21. Daily Heavy Vehicles by Location

In addition to daily truck volumes, truck data also was analyzed by time of travel. Two distinguished patterns are observed for the northbound and southbound heavy vehicle traffic. Two distinguished peaks are observed in the northbound direction at 7:00 a.m. and 1:00 p.m. In the southbound direction heavy vehicle traffic peaks at 7:00 a.m. and then decreases with smaller peaks occurring at noon and 2:00 p.m. Between 4:00 p.m. and 6:00 p.m. heavy vehicle volumes, in both directions, decrease rapidly and remain consistently low throughout the overnight hours. This traffic pattern is consistent across the corridor. Figure 22 summarizes the total number of heavy vehicles observed on the corridor.

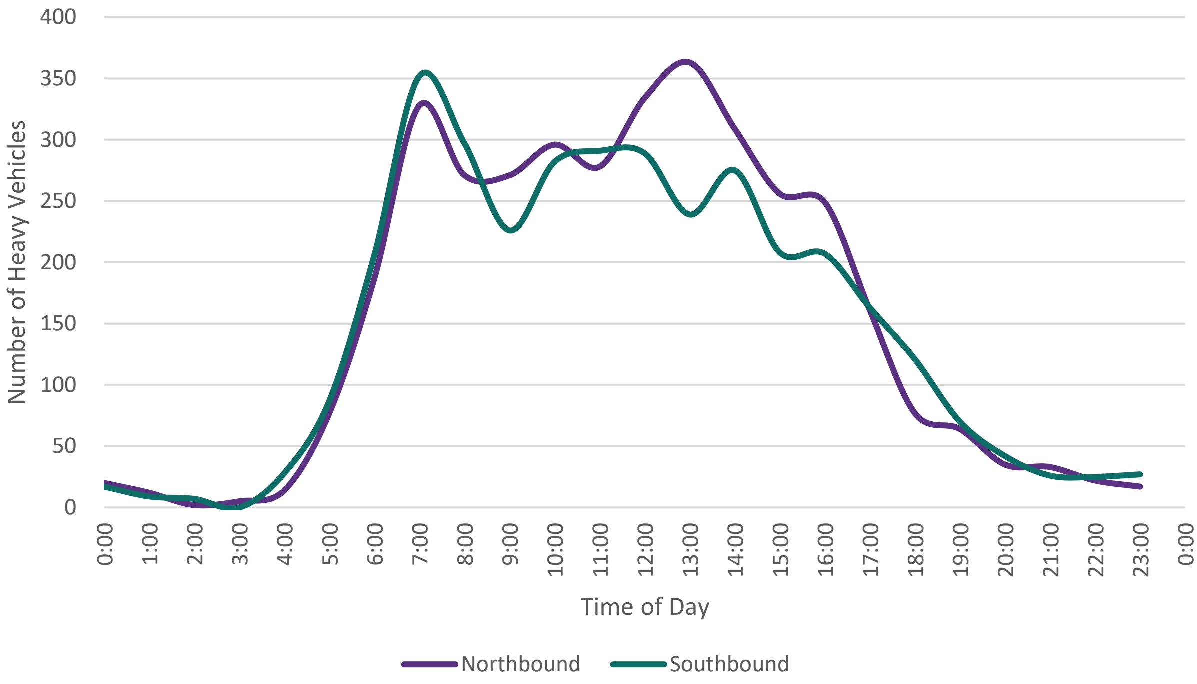

Figure 22. Heavy Vehicles by Time of Day

D.1.6. I-515 Closure Effects on Boulder Highway

I-515 intersects Boulder Highway twice in the project area: once just north of Wagonwheel Dr. at the southern end of the corridor and again between Desert Inn Rd and Sahara Ave. In between, I-515 runs roughly parallel to Boulder Highway. As a route of national importance, it is critical to ensure traffic on I-515 is not impeded. In the event of a closure on I-515 between its two connections with Boulder Highway, there is the potential to use Boulder Highway as an alternate route to I-515.

To understand the traffic impact on Boulder Highway when there are closures on I-515, incident reports were analyzed to find times when closures of varying degrees have occurred on I-515. Closures of 3, 4, 6, and 8 lanes were analyzed. However, negligible impacts were observed along Boulder Highway due to the 3, 4, and 6 lanes closures. The analysis for the 8-lane closures is presented below. Vehicle speed was used as performance measurement to evaluate the level of congestion on Boulder Highway.

The 8-lane closure on I-515 occurred on Wednesday September 29, 2016. Speed on Boulder Highway was compared to March 15, 2017, a Wednesday where no major incidents occurred. The lane closure on I-515 happened in the middle of the day, so travel times are compared for the noon to 1 PM hour. In the event of the lane closure, speeds were lower northbound and southbound on Boulder Highway north of Harmon Avenue. Higher southbound volumes caused intersections at Lake Mead Parkway and Horizon Drive to have reduced speeds during the closure. Figure 23 shows speeds on Boulder Highway on September 29, 2016 and March 15, 2017 respectively.

Past closures on I-515 of up to eight lanes have caused relatively small changes in speeds on Boulder Highway, indicating that Boulder Highway adequately serves as an alternate route for I-515.

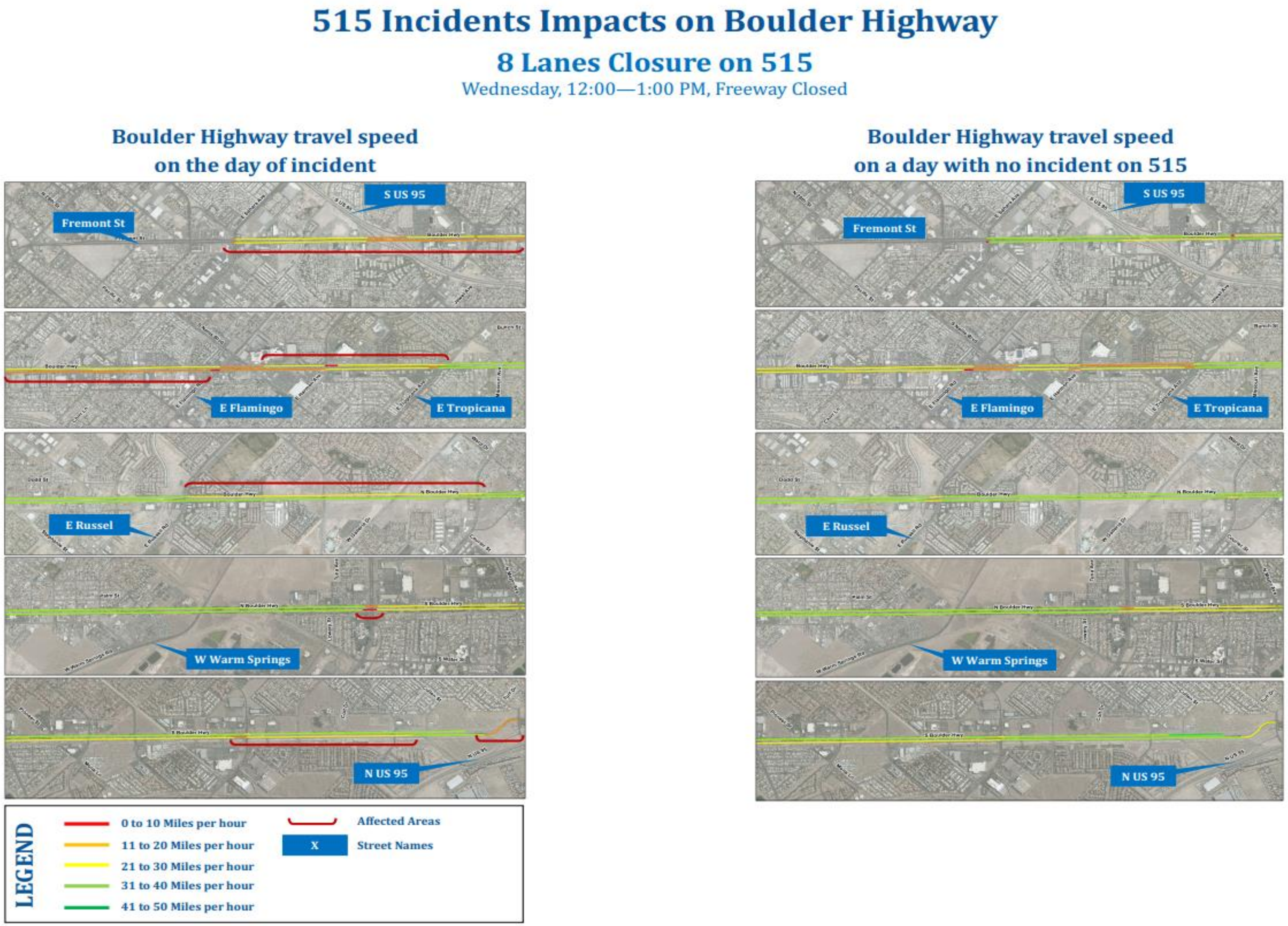

Figure 23. Eight Lanes I-515 Closure

D.2. Multimodal Operations Analysis

D.2.1. Pedestrian Traffic Operational Analysis

Methodology

To assess how well the corridor supports people walking, this report documents the level of pedestrian comfort determined using the Pedestrian Performance Measures (PPM). Building on prior sections of this report that document the general roadway character and facility type, the following sections present the findings of the analysis of pedestrian facilities.

It should be noted that some conditions of pedestrian activity and comfort have not been addressed in this section. The Boulder Highway has a high occurrence of jaywalking – people crossing where there is no existing pedestrian crossing control. While jaywalking occurrences have been widely observed and reported as anecdotal evidence, this study did not comprehensively measure jaywalking activities through counted observations. This study instead uses PPM to assess how the corridor supports people crossing at designated crosswalks. Additionally, this section does not specifically address pedestrian safety. The topic of safety is discussed comprehensively in Appendix E of this report.

Pedestrian facility conditions are discussed in terms of the linear sidewalk facilities, adjacent to the roadway, and the intersection facilities.

To understand how well the existing pedestrian facilities are performing and to provide a baseline for future alternative comparison to existing conditions, this study utilized a facility performance assessment tool that objectively measures characteristics of the corridor that impact pedestrian mobility and comfort. Characteristics known to impact pedestrian comfort include the following:

- Continuity of facility
- Width of facility
- Potential for conflicts with motor vehicles
- Pedestrian amenities – lighting, landscaping
- Pedestrian comfort – benches, shade trees
- General condition of facilities
- Support of intermodal connections, such as connections to bicycling and public transit

The PPM is a points-based model which assigns a score for certain features of the pedestrian infrastructure. Based on the total score, the model assigns a pedestrian level of service to the facility. The PPM methodology was applied to the Boulder Highway to provide a relative score for each sidewalk segment. The scores used for this analysis are shown in Table 3. Based on the total score per segment the LOS for each segment is assigned using Table 4.

Table 3. PPM Model Points

PPM Scores	Pedestrian LOS Inputs	Score
Facility (max 10)	Not continuous or non-existent	0
	Continuous	5
	Min. 5' wide and barrier free	2
	Sidewalk width > 5'	1
	Off-street/parallel alternative facility	1
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)	1
	Ped. Signal delay 40 seconds or less	0.5
	Reduced turn conflict implementation	0.5
	Crossing width 60' or less	0.5
	Posted speed <= 35mph	0.5
	Median present	1
Amenities (max 2)	Buffer not less than 3'5"	1
	Benches or pedestrian scale lighting	0.5
	Shade trees	0.5
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes	0
	D and <6 travel lanes	1
	A, B, or C and <6 travel lanes	2
Maintenance (max 2)	Major or frequent problems	-1
	Minor or infrequent problems	0
	No problems	2
TDM/Multi-Modal (max 1)	No support	0
	Support exists	1
	Maximum Score	**21**

Table 4. Level of Service Based on Scoring

PPM Score	LOS
21-17	A
14-16.9	B
11-13.9	C
7-10.9	D
3-6.9	E
≤ 3	F

Originally developed for the City of Gainesville, Florida, by the University of Florida, this methodology was chosen over others, such as the Highway Capacity Manual's Pedestrian Level of Service model, because of its ability to evaluate the corridor on a block-by-block basis and capture elements of the pedestrian experience beyond a simple point-to-point travel evaluation. The points-based methodology of the PPM model was reviewed by the Sacramento Area Council of Governments' study entitled, Application of New Pedestrian Level of Service Measures. The study compared the PPM model to the HCM's Pedestrian Level of Service (PLOS) model and determined them to be equally useful in their ability to evaluate pedestrian facilities. Additionally, the criteria evaluated in the PPM model, summarized above, are very similar to those evaluated by many civic pedestrian planning documents, including the City of Seattle, Washington's Pedestrian Master Plan, and the City of San Francisco, California's Better Streets Plan. Although neither of these documents specifically utilizes the PPM scoring model, they place importance on the same aspects the model evaluates. The PPM model simply gives the ability to consistently measure the features and amenities that are widely accepted to be a necessary part of a high-quality pedestrian facility.

Analyses and Results

To fully capture the pedestrian experience across the corridor, two pedestrian level of service analyses were conducted. The first analysis, using the standard PPM methodology, was applied to a corridor-wide evaluation. This resulted in an overall pedestrian LOS B for the corridor. The second analysis modified the PPM methodology and applied it to individual segments of the roadway. A modification was required to the original PPM model because it does not traditionally distinguish between the different conditions on each side of a street. Because of the variability in sidewalk characteristics between the east and west side of Boulder Highway, the PPM model was modified to supplement the analysis. It was determined that this modification would be applicable for use on this project as long as the modification was applied consistently to both existing conditions and any future alternatives considered. The results of the modified segment analysis are shown in Table 6 and Figure 24. The individual scoring, included as Tables 7 to 11, show the points each segment received for each criterion evaluated. Signalized intersections were used as the start and end points of segments along the corridor.

Table 5. Pedestrian Performance Measures LOS

ID	Segment Description (Length) (Scored South to North; score includes crossing to the north)	EastSd PPM Level	WestSd PPM Level
1	Wagonwheel Dr to Magic Way (0.7 miles)	D	F
2	Magic Way to Equestrian Dr (0.6 miles)	B	F
3	Equestrian Dr to Racetrack Rd (0.3 miles)	B	B
4	Racetrack Rd to Pueblo Blvd (0.67 miles)	B	B
5	Pueblo Blvd to Palo Verde Dr (0.3 miles)	B	B
6	Palo Verde Dr to Major Ave (0.5 miles)	F	B
7	Major Ave to Basic Rd (0.3 miles)	F	C
8	Basic Rd to Texas Ave (0.3 miles)	C	C
9	Texas Ave to Lake Mead Pkwy (0.25 miles)	F	C
10	Lake Mead Pkwy to Water St (0.58 miles)	D	C
11	Water St to Warm Springs Rd (0.46 miles)	F	D
12	Warm Springs Rd to Barrett Street (0.75 miles)	E	F
13	Barrett Street to Sunset Rd (0.66 miles)	F	F
14	Sunset Rd to Galleria Dr (0.5 miles)	F	F
15	Galleria Dr to Broadbent Blvd (0.44 miles)	F	F
16	Broadbent Blvd to Russell Rd (0.85 miles)	F	F
17	Russell Rd to Missouri Ave (1.1 miles)	D	D
18	Missouri Ave to Tropicana Ave (0.4 miles)	D	C
19	Tropicana Ave to Harmon Ave (0.67 miles)	C	C
20	Harmon Ave to Nellis Blvd (0.45 miles)	C	C
21	Nellis Blvd to Flamingo Rd (0.18 miles)	C	C
22	Flamingo Rd to Indios Ave (0.6 miles)	C	C
23	Indios Ave to Lamb Blvd (0.8 miles)	C	C
24	Lamb Blvd to Vet. Memorial Hwy Ramp (0.45 miles)	C	D
25	Vet. Hwy Ramp to Ramp (0.16 miles)	C	C
26	Vet. Hwy Ramp to Sahara Ave (0.85 miles)	F	D
27	Sahara Ave to St Louis Ave (0.27 miles)	C	D
28	St Louis Ave to Mojave Rd (0.1 miles)	C	D
29	Mojave Rd to Lowes (0.55 miles)	D	D
30	Lowes to Charleston Blvd (0.32 miles)	D	D

Table 6. Segment 1 – Palo Verde Dr to Wagonwheel Dr Scores

PPM Scores	Pedestrian LOS Inputs	Wagonwheel Dr to Magic Way		Magic Way to Equestrian Dr		Equestrian Dr to Racetrack Rd		Racetrack Rd to Pueblo Blvd		Pueblo Blvd to Palo Verde Dr	
		East	West	East	West	East	West	East	West	East	West
Facility (max 10)	Not continuous or non-existent		0		0						
	Continuous	0		5	0	5	5	5	5	5	5
	Min. 5' wide and barrier free	2		2		2	2	2	2	2	2
	Sidewalk width > 5'	1		1		1	1	1	1	1	1
	Off-street/parallel alternative facility	1		1		1	1	1	1	1	1
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)	1		1		1	1	1	1	1	1
	Ped. Signal delay 40 seconds or less	0		0		0	0	0	0	0	0
	Reduced turn conflict implementation	0		0		0	0	0	0	0	0
	Crossing width 60' or less	0		0		0	0	0	0	0	0
	Posted speed <= 35mph	0		0		0	0	0	0	0	0
	Median present	1		1		1	1	1	1	1	1
Amenities (max 2)	Buffer not less than 3'5"	1		1		1	1	1	1	1	1
	Benches or pedestrian scale lighting	0		0		0	0.5	0	0.5	0	0
	Shade trees	0		0		0	0	0	0	0	0
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes										
	D and <6 travel lanes					1			1		
	A, B, or C and <6 travel lanes	2		2			2	2		2	2
Maintenance (max 2)	Major or frequent problems										
	Minor or infrequent problems	0		0		0		0		0	
	No problems										
TDM/Multi Modal (max 1)	No support										
	Support exists	1		1		1	1	1	1	1	1
	Total Score	**10**	**0**	**15**	**0**	**14**	**15.5**	**15**	**14.5**	**15**	**15**
	Level of Service	**D**	**F**	**B**	**F**	**B**	**B**	**B**	**B**	**B**	**B**

Table 7. Segment 2 – Water St to Palo Verde Dr Scores

PPM Scores	Pedestrian LOS Inputs	Palo Verde Dr to Major Ave		Major Ave to Basic Rd		Basic Rd to Texas Ave		Texas Ave to Lake Mead Pkwy		Lake Mead Pkwy to Water St	
		East	West	East	West	East	West	East	West	East	West
Facility (max 10)	Not continuous or non-existent	0		0				0			
	Continuous		5		5	5	5		5	0	5
	Min. 5' wide and barrier free		2		2	2	2		2	2	2
	Sidewalk width > 5'		1		1	1	1		1	1	1
	Off-street/parallel alternative facility		1		1	1	1		1	1	1
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)		1		1	1	1		1	1	1
	Ped. Signal delay 40 seconds or less		0		0	0	0		0	0	0
	Reduced turn conflict implementation		0		0	0	0		0	0	0
	Crossing width 60' or less		0		0	0	0		0	0.5	0.5
	Posted speed <= 35mph		0		0	0	0		0	0	0
	Median present		1		1	1	1		1	1	1
Amenities (max 2)	Buffer not less than 3'5"		1		1	0	1		1	1	1
	Benches or pedestrian scale lighting		0		0	0	0		0.5	0	0
	Shade trees		0		0	0	0		0	0	0
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes				0	0	0	0	0	0	0
	D and <6 travel lanes		1								
	A, B, or C and <6 travel lanes										
Maintenance (max 2)	Major or frequent problems										
	Minor or infrequent problems					0				0	
	No problems										
TDM/Multi Modal (max 1)	No support										
	Support exists		1		1	1	1		1	1	1
	Total Score	**0**	**14**	**0**	**13**	**12**	**13**	**0**	**13.5**	**8.5**	**13.5**
	Level of Service	**F**	**B**	**F**	**C**	**C**	**C**	**F**	**C**	**D**	**C**

Table 8. Segment 3 – Broadbent Rd to Water St Scores

PPM Scores	Pedestrian LOS Inputs	Water St to Warm Springs Rd		Warm Springs Rd to Barret St		Barret St to Sunset Rd		Sunset Rd to Galleria Dr		Galleria Dr to Broadbent Rd	
		East	West	East	West	East	West	East	West	East	West
Facility (max 10)	Not continuous or non-existent	0		0							
	Continuous		2.5	0	0						
	Min. 5' wide and barrier free		2	2							
	Sidewalk width > 5'		1	1							
	Off-street/parallel alternative facility			0							
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)		1	0							
	Ped. Signal delay 40 seconds or less		0	0							
	Reduced turn conflict implementation		0	0							
	Crossing width 60' or less		0	0.5							
	Posted speed <= 35mph		0	0							
	Median present		1	0							
Amenities (max 2)	Buffer not less than 3'5"		1	1							
	Benches or pedestrian scale lighting		0	0							
	Shade trees		0	0							
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes		0	0							
	D and <6 travel lanes										
	A, B, or C and <6 travel lanes										
Maintenance (max 2)	Major or frequent problems										
	Minor or infrequent problems										
	No problems										
TDM/Multi Modal (max 1)	No support										
	Support exists		1								
	Total Score	**0**	**9.5**	**4.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Level of Service	**F**	**D**	**E**	**F**	**F**	**F**	**F**	**F**	**F**	**F**

Table 9. **Segment 4 – Tropicana Ave to Broadbent Rd Scores**

PPM Scores	Pedestrian LOS Inputs	Broadbent Rd to Russell Rd		Russell Rd to Missouri Ave		Missouri Ave to Tropicana Ave	
		East	West	East	West	East	West
Facility (max 10)	Not continuous or non-existent						
	Continuous	0	0	2.5	2.5	2.5	5
	Min. 5' wide and barrier free			2	2	2	2
	Sidewalk width > 5'			1	1	1	1
	Off-street/parallel alternative facility			0	0	0	
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)			1	1	1	0
	Ped. Signal delay 40 seconds or less			0	0	0	0
	Reduced turn conflict implementation			0	0	0	0
	Crossing width 60' or less			0.5	0.5	0	0
	Posted speed <= 35mph			0	0	0	
	Median present			0	0	0	1
Amenities (max 2)	Buffer not less than 3'5"			0	0	0	1
	Benches or pedestrian scale lighting			0	0	0	0
	Shade trees			0	0		0
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes			0	0	0	0
	D and <6 travel lanes						
	A, B, or C and <6 travel lanes						
Maintenance (max 2)	Major or frequent problems						
	Minor or infrequent problems			0	0	0	
	No problems						
TDM/Multi Modal (max 1)	No support						
	Support exists			1	1	1	1
	Total Score	**0**	**0**	**8**	**8**	**7.5**	**11**
	Level of Service	**F**	**F**	**D**	**D**	**D**	**C**

Table 10. Segment 5 – I-515 to Tropicana Ave Scores

PPM Scores	Pedestrian LOS Inputs	Tropicana Ave. to Harmon Ave.		Harmon Ave. to Nellis Blvd.		Nellis Blvd to Flamingo Rd		Flamingo Rd to Indios Ave		Indios Ave to Lamb Blvd		Lamb Blvd to I-515		I-515 Int	
		E	W	E	W	E	W	E	W	E	W	E	W	E	W
Facility (max 10)	Not continuous or non-existent														
	Continuous	5	5	5	5	5	5	5	5	5	5	5	2.5	5	5
	Min. 5' wide and barrier free	2	2	2	2	2	2	2	2	2	2	1	1	2	2
	Sidewalk width > 5'	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Off-street/parallel alternative facility	0	0	0	0							0	0	0	0
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)	1	1	1	1	1	1	1	1	0	0	1	1	1	1
	Ped. Signal delay 40 seconds or less	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
	Reduced turn conflict implementation	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Crossing width 60' or less	0	0	0	0	0	0	0	0	0	0	0.5	0.5	0.5	0.5
	Posted speed <= 35mph	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Median present	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Amenities (max 2)	Buffer not less than 3'5"	1	1	1	1	0	0	1	1	1	1	0	1	0	1
	Benches or pedestrian scale lighting	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Shade trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D and <6 travel lanes														
	A, B, or C and <6 travel lanes														
Maintenance (max 2)	Major or frequent problems														
	Minor or infrequent problems														
	No problems														
TDM/Multi Modal (max 1)	No support														
	Support exists	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Total Score	**12**	**12**	**12**	**12**	**11**	**11**	**12**	**12**	11	**11**	11	**9.5**	**12**	**13**
	Level of Service	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**D**	**C**	**C**

Table 11. Segment 6 – Charleston Blvd to I-515 Scores

PPM Scores	Pedestrian LOS Inputs	I-515 to Sahara Ave		Sahara Ave to St Louis Ave		St Louis Ave to Mojave Rd		Mojave Rd to Lowes		Lowes to Charleston Blvd	
		East	West	East	West	East	West	East	West	East	West
Facility (max 10)	Not continuous or non-existent										
	Continuous	0	5	5	5	5	5	2.5	2.5	5	5
	Min. 5' wide and barrier free		0	2	1	2	1	1	1	1	0
	Sidewalk width > 5'		1	1	1	1	1	1	1	1	1
	Off-street/parallel alternative facility		0								
Conflicts (max 4)	<22 driveways and side streets/mile (dpm)		1	0	0	1	0	0	1	0	0
	Ped. Signal delay 40 seconds or less		0	0	0	0	0	0	0	0	0
	Reduced turn conflict implementation		0	0		0		0		0	0
	Crossing width 60' or less		0	0	0	0	0	0	0	0	0
	Posted speed <= 35mph		0	0	0	0	0		0	0	0
	Median present		1	1	1	1	1	1	1	1	1
Amenities (max 2)	Buffer not less than 3'5"		0	1	1	0	0	1	1	0	0
	Benches or pedestrian scale lighting		0		0	0	0	0	0	0	0
	Shade trees		0		0	0	0	0	0	0	0
Motor Vehicle LOS (max 2)	E or F OR 6 or more travel lanes		0	0	0	0	0	0	0	0	0
	D and <6 travel lanes										
	A, B, or C and <6 travel lanes										
Maintenance (max 2)	Major or frequent problems										
	Minor or infrequent problems										
	No problems										
TDM/Multi Modal (max 1)	No support										
	Support exists		1	1	1	1	1	1	1	1	1
	Total Score	**0**	**9**	**11**	**10**	**11**	**9**	**7.5**	**8.5**	**9**	**8**
	Level of Service	**F**	**D**	**C**	**D**	**C**	**D**	**D**	**D**	**D**	**D**

The highest-scoring pedestrian facilities are those located between Magic Way and Palo Verde Drive with several segments at a LOS B. In these segments the pedestrian facility is a continuous, separated multiuse path with few driveway crossings. The primary differentiator in best scoring of these sections is that the number of vehicle travel lanes is reduced and there are lower levels of vehicle congestion during the peak period. These segments provide a moderately comfortable walkway with reduced potential for conflicts with vehicles.

The worst scoring pedestrian facilities are from Warm Springs Road to Missouri Avenue, an approximately 4.3 mile stretch of corridor. This section scored LOS F as pedestrian facilities are either non-existent or have significant gaps. Some other segments dispersed along the corridor also scored LOS F. Some locations where pedestrian facilities are present scored lower because local conditions reduce the comfort level of the sidewalk. Examples of such conditions are poorly placed signs or fire hydrants which create barriers along the sidewalk and significantly reduce the usable space available to pedestrians. Other conditions that reduce the LOS include narrow sidewalks, lack of a buffer between the roadway and sidewalk, and a high concentration of driveways and vehicle entrances, defined by the PPM as greater than 22 per mile.

Pedestrian Analysis Summary

Sidewalks are generally present near the highest concentrations of pedestrian activity. The presence of sidewalks from Tropicana Avenue to Lamb Boulevard increase the pedestrian comfort and support these high-use areas. While pedestrian crossing control is generally in place at signalized intersections, long signal cycles and crossing distances impede pedestrian mobility. Additionally, due to long distances between intersections, there are limited opportunities for people to cross Boulder Highway under controlled conditions. The National Association of City Transportation Officials recommends a distance of 200 feet between crossings to support good pedestrian connectivity. Currently the average distance between crossings is 2,200 feet. The combination of increased potential for delay at intersections and the low crossing density increases the potential for illegal crossing behavior. Recommendations for improving pedestrian facilities should address this issue. While the PPM results show the lowest scores generally between Barrett Street and Tropicana Avenue, the current lack of sidewalk facilities is likely related to a lack of development along this stretch of the corridor. It could be assumed that there is a lower propensity for pedestrian activity at these locations.

D.2.2. Bicycle Traffic Operations Analysis

Methodology

Both Bicycle Level of Service (BLOS) and Level of Traffic Stress (LTS) were considered to assess bicycle comfort of the Boulder Highway, and each methodology had strengths and weaknesses. The BLOS does not include intersection analysis, which is a key factor when considering the function of low-stress bicycle networks. BLOS does not change based on facility type and is strongly influenced by ADT and width of dedicated bicycle facilities and does not directly consider the impact of traffic-calming interventions or diversions on low-stress roadway networks. In general, LTS is more easily interpreted by the public and specifically targets the greatest opportunities for improving bicycling facilities for population groups of bicyclists who may not be comfortable using the existing on-system network.

LTS was developed in part as a response to BLOS. It includes fewer inputs that are more widely available, it includes intersection conditions, and it is easily presented to the public. The LTS methodology has become a standard method of analysis for bicycle networks during the past four years. Roadways are ranked on a scale of one to four, where scores of two or lower are acceptable bicycle facilities to the average adult:

- LTS 1—Presents little traffic stress and demands little attention from bicyclists. Suitable for almost all bicyclists, including children who are trained to safely cross intersections. Traffic speeds are low and there is no more than one lane per direction. Intersections are easy to cross by children and adults. Typical street types include residential streets, local streets, and multi-use paths.
- LTS 2—Presents little traffic stress but requires more attention than children can handle. Suitable for teens and adult bicyclists with mainstream bicycle-handling skills. Traffic speeds are higher, but speed differentials are still low. Intersection crossings are not difficult for most teens or adults. Roadways are less than three lanes or additional separation/ dedicated space is provided between bicyclists and traffic. Typical street types include collector-level streets with bike lanes.
- LTS 3—Presents moderate traffic stress, is suitable for observant and confident adult bicyclists. Traffic speeds are moderate, or high where separation or exclusive riding space is provided. Intersection crossings are longer or higher speed than LTS 2, but still are considered acceptably safe by most adults. Typical locations include low-speed arterials with bike lanes.
- LTS 4—Represents high stress and is only suitable for experienced bicyclists. Traffic speeds are moderate or high and intersections can be complex, wide, or high volume. Intersections are difficult to cross and can be perceived as unsafe. Typical locations include high-speed and multi-lane roadways with no dedicated bicycling space or narrow shoulders.

Given the existing bicycle facilities on Boulder Highway, there are some factors of the traditional LTS analysis that are not necessary to consider. For example, bike lanes are impacted by the frequency of bike lane blockages. These blockages can include items such as transit stops and on-street parking. Bike lane blockages can force bicyclists into mixed-flow traffic lanes or require them to stop and wait for the blockage to clear. Because bike lanes are typically positioned on the inside of transit stops on Boulder Highway this criterion was not evaluated as part of the LTS analysis.

Analysis and Results

A majority of the study area on Boulder Highway includes a designated bicycle lane. This LTS facility analysis shows how well those facilities are performing in terms of bicyclist comfort. This analysis is meant to capture general characteristics of the corridor and to identify categorical issues that may degrade comfort for bicyclists traveling on the corridor. This analysis does not include crossings of Boulder Highway. Intersection analysis focuses on the performance of the intersection for travelers on Boulder Highway, including the intersection approach as determined by existing striping details. For example, where striping delineates a shift in alignment in advance of the intersection, that segment of the facility was considered as part of the intersection and excluded from the roadway segment score. It is assumed that any modifications to the design at intersections would change the approach configuration.

Mixed Traffic (Shared bus-bike lane)

In a typical LTS analysis, segments without bicycle lanes or shoulders are evaluated based on mixed-traffic criteria that include:

- Posted speed limit
- Number of travel lanes

For urban facilities without a dedicated bicycle lane, the LTS is heavily influenced by the number of lanes and the speed of a facility. For mixed-traffic conditions, roadways with a posted speed limit of 35 mph or higher are automatically scored as LTS 3 or greater. Roads with three or more lanes per direction are considered LTS 4. Because posted speeds on Boulder Highway are all greater than 35 mph, performing analysis on these types of roadway segment is not necessarily representative of the performance of a designated bicycle facility and skews other parts of the roadway were a facility is provided. For this analysis, where no bicycle lane is present, no score was given. Within the study area, there is no bicycle facility designated between Tropicana Blvd and Sunset Rd.

LTS considers the presence of a shared lane condition. In the context of Boulder Highway, this only applies to bicycle facilities that are shared with bus lanes. LTS was modified to consider whether the presence of the marking improves user comfort on the segment. A leading reference in this specific topic indicates that a shared bus-bike lane only provides comfort for roadway speeds of less than 20 miles per hour, or headways of more than four minutes (NACTO Transit Street Design Guide, 2016). While bus transit headways are typically 10 to 15 minutes on Boulder Highway, roadway speeds greater than 35 mph create discomfort for most users. The LTS analysis was modified to include a condition for shared bus-bike lanes. Segments with shared bus-bike lanes were given a score of LTS 3 due to the existence of a bike lane separate from general-purpose lanes and considering a potential for conflict with overtaking buses moving at a relatively high speed. Table 12 summarizes the specific scoring criteria for urban, mixed-traffic segments used in this analysis.

Table 12. Scoring for Urban, Mixed-Traffic Segments

Posted Speed Limit	1 Lane Per Direction	2 Lanes per Direction	3+ Lanes per Direction
≤ 25 mph	LTS 2	LTS 3	LTS 4
30 mph	LTS 3	LTS 4	LTS 4
≥ 35 mph	LTS 4	LTS 4	LTS 4
Shared Bus-Bike Lane			
≥ 35 mph	LTS 3		

Bike lanes

Bicycle lanes provide a designated space for bicyclists on a roadway. Although traffic maneuvers at intersections and access to parking may temporarily encroach on this space, a bicycle lane is otherwise assumed to be for sole use by bicyclists. While a designated bicycle lane is typically present, its positioning adjacent to general purpose and dedicated bus lanes varies.

The criteria for roadways with designated bike lanes include:

- Width of operating space
- Number of lanes
- Posted speed limit

The operating space for a bicycle lane is measured from either the face of the curb, the edge of pavement, or outside bicycle lane striping to the edge of the vehicle travel lane. Although speed and the number of lanes always play a role in LTS, these factors are mitigated when a wider bicycle lane (greater than seven feet) is present. For example, a roadway with a posted speed of 40 mph or greater is LTS 3 with a wide bicycle lane, while a bicycle lane narrower than seven feet drops the facility to LTS 4. For this analysis LTS was evaluated at the narrowest bicycle lane width along each roadway segment.

Multi use path

Bicycle facilities that are physically separated from vehicle traffic automatically are considered to be LTS 1. The original LTS methodology considers physical separation—such as curbs, raised medians, parking lanes, and bikeways—that removes stress caused by safety concerns, thereby offering the lowest level of traffic stress between intersections. For the purposes of this inventory, detached paths that are greater than or equal to eight feet in width were considered multi-use paths and automatically scored as LTS 1.

Intersection Approaches

Intersections were evaluated based on whether they are signalized or uncontrolled. The intersection LTS impacts the adjoining roadway segments and can negatively affect a segment score. However, an intersection will not improve a segment's score.

Signalized Intersections

Signalized intersections are evaluated in the same way, regardless of whether they have an urban or rural designation.

Approaches with right-turn lanes are evaluated on the number of lanes, type of lane, and length. Dual right-turn lanes are considered LTS 4 regardless of traffic speed. This condition does not exist on Boulder Highway. Type refers to the impact a right-turn lane has on the path of the bicycle lane. If the bicycle lane drops prior to the intersection, the approach is scored as LTS 4. Bicycle lanes also may continue straight through the intersection or may shift to the left of the right-turn lane. In these instances, the length of the right-turn lane is considered.

Longer right-turn lanes require bicyclists to travel with traffic on either side for a longer duration. Right-turn lanes less than 150 feet long result in a score of LTS 2 when the bicycle lane is aligned straight through the intersection. A bicycle lane where the alignment shifts left will score no better than LTS 3. Any other configuration of a single right-turn lane (dropped bicycle lane) results in a rating of LTS 4.

In locations that provided a dedicated bicycle lane or a right-turn lane, the LTS is lower than in locations that require bicyclists to mix with traffic. Table 13 shows CDOT's criteria for right-turn evaluation.

Table 13. Criteria for Right-Turn Evaluation, Urban Signalized*

Right-Turn Lane Configuration	Right-Turn Lane Length (ft)	Bike Lane Approach Alignment	LTS
Single	≤ 150	Straight	LTS 2
Single	> 150	Straight	LTS 3
Single	Any	Left	LTS 3
Single or Dual Exclusive/Shared**	Any	Any	LTS 4

* Assumes vehicles speeds at beginning of intersection approach are greater than 20 mph.
** A shared lane configuration allows both through and right turn movements.

Uncontrolled Intersections

The ELTS for uncontrolled intersections is not dependent upon whether the roadway is considered rural or urban. Table 14 is used to evaluate uncontrolled intersections, providing consideration for the number of lanes and traffic volumes. The number of lanes refers to the total number of lanes of the street being crossed, including turn lanes. Wider streets with more lanes of traffic are considered less comfortable to cross, and those with six lanes or more are LTS 4, regardless of speed.

Table 14. Uncontrolled Intersections

Daily Volume (vpd)	≤ 3 Lanes	4 to 5 Lanes	≥ 6 Lanes
< 400	LTS 2	LTS 3	n/a
400 to 1,500	LTS 2	LTS 3	n/a
1,500 to 7,000	LTS 2	LTS 3	n/a
> 7,000	LTS 3	LTS 4	LTS 4

Analysis of the Results

Results of the LTS analysis are shown in Table 15 through Table 20 for roadway segments. The LTS results for intersections are show in Table 21 through Table 26. Maps showing bicycle LTS in the Boulder Highway corridor are shown in Figure 24.

Table 15. Segment 1 – Wagonwheel Dr to Palo Verde Dr Highway LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
1	Wagonwheel Dr to Magic Way (0.7 miles)	N/A	N/A
2	Magic Way to Equestrian Dr (0.6 miles)	N/A	N/A
3	Equestrian Dr to Racetrack Rd (0.3 miles)	N/A	N/A
4	Racetrack Rd to Pueblo Blvd (0.67 miles)	N/A	N/A
5	Pueblo Blvd to Palo Verde Dr (0.3 miles)	1	1

* N/A LTS is for segments with no bicycle facilities present.

Table 16. Segment 2 – Palo Verde Dr to Water St Highway LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
6	Palo Verde Dr to Major Ave (0.5 miles)	4	1
7	Major Ave to Basic Rd (0.3 miles)	4	1
8	Basic Rd to Texas Ave (0.3 miles)	4	1
9	Texas Ave to Lake Mead Pkwy (0.25 miles)	4	1
10	Lake Mead Pkwy to Water St (0.58 miles)	4	1

* N/A LTS is for segments with no bicycle facilities present.

Table 17. Segment 3–Water St to Broadbent Rd Highway LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
11	Water St to Warm Springs Rd (0.46 miles)	4	4
12	Warm Springs Rd to Barrett Street (0.75 miles)	4	4
13	Barrett Street to Sunset Rd (0.66 miles)	4	4
14	Sunset Rd to Galleria Dr (0.5 miles)	N/A	N/A
15	Galleria Dr to Broadbent Blvd (0.44 miles)	N/A	N/A

* N/A LTS is for segments with no bicycle facilities present.

Table 18. Segment 4–Broadbent Rd to Tropicana Ave Highway LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
16	Broadbent Blvd to Russell Rd (0.85 miles)	N/A	N/A
17	Russell Rd to Missouri Ave (1.1 miles)	N/A	N/A
18	Missouri Ave to Tropicana Ave (0.4 miles)	N/A	N/A

* N/A LTS is for segments with no bicycle facilities present.

Table 19. Segment 5–Tropicana Ave to I-515 Highway LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
19	Tropicana Ave to Harmon Ave (0.67 miles)	3	3
20	Harmon Ave to Nellis Blvd (0.45 miles)	3	3
21	Nellis Blvd to Flamingo Rd (0.18 miles)	3	3
22	Flamingo Rd to Indios Ave (0.6 miles)	3	3
23	Indios Ave to Lamb Blvd (0.8 miles)	3	3
24	Lamb Blvd to I-515 Ramp (0.45 miles)	3	3

* N/A LTS is for segments with no bicycle facilities present.

Table 20. Segment 5–I-515 to Charleston Blvd Highway LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
25	I-515 Ramp to Ramp (0.16 miles)	3	3
26	I-515 Ramp to Sahara Ave (0.85 miles)	3	3
27	Sahara Ave to St Louis Ave (0.27 miles)	3	3
28	St Louis Ave to Mojave Rd (0.1 miles)	3	3
29	Mojave Rd to Lowes (0.55 miles)	3	3
30	Lowes to Charleston Blvd (0.32 miles)	4	3

* N/A LTS is for segments with no bicycle facilities present.

Table 21. Segment 1 – Wagonwheel Dr to Palo Verde Dr Intersection LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
1	Wagonwheel Drive	N/A	N/A
2	Magic Way	N/A	N/A
3	Equestrian Drive	N/A	N/A
4	Racetrack Road	N/A	N/A
5	Pueblo Boulevard/College Drive	N/A	N/A

* N/A LTS is for segments without bicycle facilities on at least one side.

Table 22. Segment 2 – Palo Verde Dr to Water St Intersection LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
6	Greenway Road/Palo Verde Drive	4	4
7	Major Avenue	4	4
8	Basic Road	3	3
9	Texas Avenue	4	4
10	Lake Mead Parkway	4	4

* N/A LTS is for segments without bicycle facilities on at least one side.

Table 23. Segment 3–Water St to Broadbent Rd Intersection LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
11	Water Street	N/A**	3
12	Warm Springs Road	4	4
13	Barrett Street	4	4
14	Sunset Road	N/A	N/A
15	Galleria Drive	N/A	N/A

* N/A LTS is for segments without bicycle facilities on at least one side.
** Water St intersection is a Florida-T.

Table 24. Segment 4–Broadbent Rd to Tropicana Ave Intersection LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
16	Gibson Road/Broadbent Boulevard	N/A	N/A

17	Russell Road	N/A	N/A
18	Missouri Avenue	N/A	N/A

* N/A LTS is for segments without bicycle facilities on at least one side.

Table 25. Segment 5–Tropicana Ave to I-515 Intersection LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
19	Tropicana Avenue	N/A	N/A
20	Harmon Avenue	4	4
21	Nellis Boulevard	4	3
22	Flamingo Road	3	4
23	Indios Avenue	4	3
24	Desert Inn Road/Lamb Boulevard	3	4

* N/A LTS is for segments without bicycle facilities on at least one side.

Table 26. Segment 5–I-515 to Charleston Blvd Intersection LTS

ID	Segment Description (Length)	East Side LTS	West Side LTS
25	Northbound I-515 Ramps	3	4
26	Southbound I-515 Ramps	4	3
27	Sahara Avenue	3	4
28	St. Louis Avenue	4	4
29	Mojave Street	3	4
30	Lowes Driveway	4	4

* N/A LTS is for segments without bicycle facilities on at least one side.

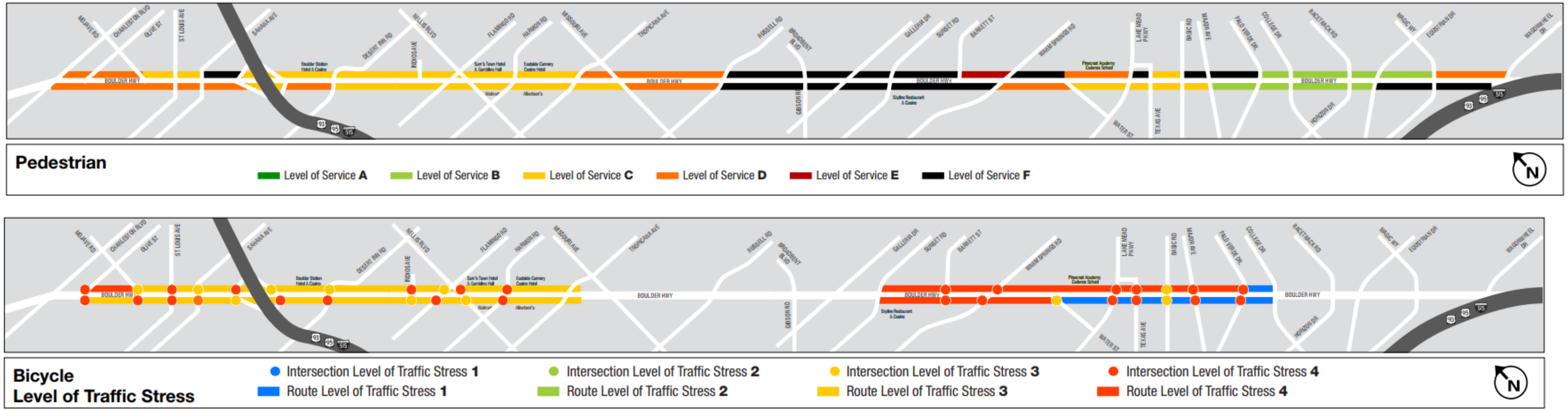

Figure 24. Pedestrian and Bicycle Existing LOS

D.2.3. Transit Operations Analysis

Route BHX is approximately 17 miles long. With an average weekday running time of 79 minutes in the early morning/late evening and 87 minutes in the PM peak period, the estimated average bus speed for Route BHX along Boulder Highway is approximately 12-13 miles per hour throughout the day. BHX stops along Boulder Highway are spaced between 0.35 to 0.4 miles apart, on average, which represents an optimal pattern for an enhanced, frequent bus without an underlying local route. Routes BHX and HDX share most stops within their overlapping portions in Henderson.

During March 2017, Route BHX reported a monthly average on-time performance of 79.1 percent (i.e. 79.1 percent of buses arrived at timepoints not more than 5 minutes after their scheduled arrival time), with less than 1 percent arriving early (Source: March 2017 RTC Fixed Route Monthly Service Report). This value is well below the RTC monthly average on-time performance of 85.2 percent systemwide and represents an opportunity for improvement. Route BHX on-time performance is substantially lower on Saturdays and Sundays (76.4 and 57.8 percent, respectively) than weekdays (82.7 percent), suggesting either greater unpredictability or inaccurate running times on weekends. More detailed review would be required to identify causes of on-time performance issues. Route HDX also reported on-time performance below system averages, with 78.2 percent, 66.1 percent, and 69.5 percent of buses arriving on time on weekdays, Saturdays, and Sundays, respectively.

The high ridership and productivity on route BHX suggest that speed and efficiency improvements along Boulder Highway, such as transit signal priority, curbside lane enhancements, or stop improvements would benefit a substantial number of riders and may further boost transit productivity and effectiveness.

D.2.4. Traffic Operations Analysis

Methodology

Existing performance of the Boulder Highway corridor was modeled using TransModeler microsimulation software. To develop the model, the corridor was coded into the model using aerial imagery and field observation to match existing geometric features. Signal timing plans were obtained from the RTC Freeway and Arterial System of Transportation (FAST) to ensure that the model used accurate signal timing information when replicating traffic conditions. Modeled volumes were developed using the turning movement counts collected on the corridor. Turning movement counts were used as direct inputs to the model. To estimate existing LOS and Delay the HCM analysis tool of TransModeler was used.

Analysis and Results

Traffic counts were collected at all major intersections on Boulder Highway in the study area. Additionally, vehicle classification counts were collected at several locations throughout the study area to capture vehicle traffic conditions. Appendix C shows the locations where turning movement counts and classification counts were collected.

Level of Service and Delay

Existing LOS and delay by intersection and approach for each intersection in the study area are shown in Table 27 through Table 32. Highway Capacity Manual (HCM) analysis was used to determine LOS and delay.

Table 27. Existing Intersection LOS and Delay Segment 1

Number	Intersection	Delay (sec)		Level of Service	
		AM	PM	AM	PM
1	Boulder Highway at Wagonwheel Drive	21.5	14.0	C	B
2	Boulder Highway at Magic Way	16.5	19.3	B	B
3	Boulder Highway at Equestrian Drive	16.8	17.4	B	B
4	Boulder Highway at Racetrack Road	40.9	37.9	D	D
5	Boulder Highway at Pueblo Boulevard/College Drive	28.0	20.6	C	C
6	Boulder Highway at Greenway Road/Palo Verde Drive	25.2	26.6	C	C

Table 28. Existing Intersection LOS and Delay Segment 2

Number	Intersection	Delay (sec)		Level of Service	
		AM	PM	AM	PM
7	Boulder Highway at Major Avenue	33.8	26.2	C	C
8	Boulder Highway at Basic Road	19.1	14.5	B	B
9	Boulder Highway at Texas Avenue	14.3	19.8	B	B
10	Boulder Highway at Lake Mead Parkway	36.2	40.3	D	D
11	Boulder Highway at Water Street	8.1	9.6	A	A

Table 29. Existing Intersection LOS and Delay Segment 3

Number	Intersection	Delay (sec)		Level of Service	
		AM	PM	AM	PM
12	Boulder Highway at Warm Springs Road	38.1	30.4	D	C
13	Boulder Highway at Barrett Street	5.7	6.6	A	A
14	Boulder Highway at Sunset Road	39.3	35.3	D	D
15	Boulder Highway at Galleria Drive	37.1	39.7	D	D
16	Boulder Highway at Gibson Road/Broadbent Boulevard	34.3	48.5	C	D

Table 30. Existing Intersection LOS and Delay Segment 3

Number	Intersection	Delay (sec)		Level of Service	
		AM	PM	AM	PM
17	Boulder Highway at Russell Road	41.3	47.9	D	D
18	Boulder Highway at Missouri Avenue	55.0	30.3	E	C

19	Boulder Highway at Tropicana Avenue	30.5	30.9	C	C

Table 31. Existing Intersection LOS and Delay Segment 5

Number	Intersection	Delay (sec)		Level of Service	
		AM	PM	AM	PM
20	Boulder Highway at Harmon Avenue	26.0	27.1	C	C
21	Boulder Highway at Nellis Boulevard	42.6	33.7	D	C
22	Boulder Highway at Flamingo Road	34.2	36.7	C	D
23	Boulder Highway at Indios Avenue	52.6	37.9	D	D
24	Boulder Highway at Desert Inn Road/Lamb Boulevard	45.7	112.9	D	F
25	Boulder Highway at Northbound I-515 Ramps	11.4	22.0	B	C
26	Boulder Highway at Southbound I-515 Ramps	12.5	26.6	B	C

Table 32. Existing Intersection LOS and Delay Segment 6

Number	Intersection	Delay (sec)		Level of Service	
		AM	PM	AM	PM
27	Fremont Street/Boulder Highway at Sahara Avenue	44.8	38.1	D	D
28	Fremont Street at St. Louis Avenue	37.7	43.1	D	D
29	Fremont Street at Mojave Street	17.3	13.3	B	B
30	Fremont Street at Lowes Driveway	28.5	31.7	C	C
31	Fremont Street at Charleston Boulevard	33.0	39.9	C	D

During the morning peak, most intersections operate at an overall LOS D or better. The exception to this is at the intersection of Boulder Highway and Missouri Avenue. Here, the intersection operates at an overall LOS E with the westbound approach operating at LOS F. The poor LOS at this intersection is a result of the signal phasing. This is the only intersection on the corridor using split phasing. This means that the eastbound and westbound side street traffic move consecutively rather than concurrently. This reduces the amount of green time for each of these phases and thus reduces the overall LOS.

Although all other intersections operate at and overall LOS D or better during the morning peak hour, some individual approaches operate at LOS E or LOS F. Figure 25 through Figure 28 show the existing LOS per approach and Turning Movement Counts along the corridor. Operating at LOS E or LOS F is significant because this means the approach is operating at or over capacity. This means that future traffic growth or reductions to vehicle operations at the intersection would result in negative and potentially severe impacts to vehicle delay. Intersection approaches operating at such levels of service include:

- The westbound approach at St. Louis Avenue
- The eastbound approach at Desert Inn Road
- The westbound approach at Indios Avenue

- Both the eastbound and westbound approaches at Nellis Boulevard
- Both the eastbound and westbound approaches at Russell Road
- Both the eastbound and westbound approaches at Gibson Road

All of these approaches are in the northern half of the corridor—north of Galleria Drive—where traffic volumes are generally higher. Additionally, these approaches are on side streets rather than on Boulder Highway. This result is a combination of the long signal cycle lengths coupled with the signal coordination along Boulder Highway. In general, during the morning peak period signals along the norther portion of the corridor operate on a 140 second cycle length and are coordinated for north-south traffic traveling along Boulder Highway. This means that side street traffic may have to wait more than two minutes before proceeding through an intersection.

Similar to the morning peak operations, during the evening peak hour most intersections along the corridor operate at LOS D or better. The only exception to this is the intersection of Boulder Highway and Desert Inn Road/Lamb Boulevard which operates at LOS F. This is a result of the combination of the high traffic volumes and the intersection configuration. On the eastbound and westbound approaches, there are no dedicated right-turn lanes. This results in right turning vehicles, which often must wait for pedestrians to clear the crosswalk before moving through the intersection, to block through traffic. Furthermore, there are heavy left-turn movements from Boulder Highway onto Lamb Boulevard which are sometimes not served in a single signal cycle.

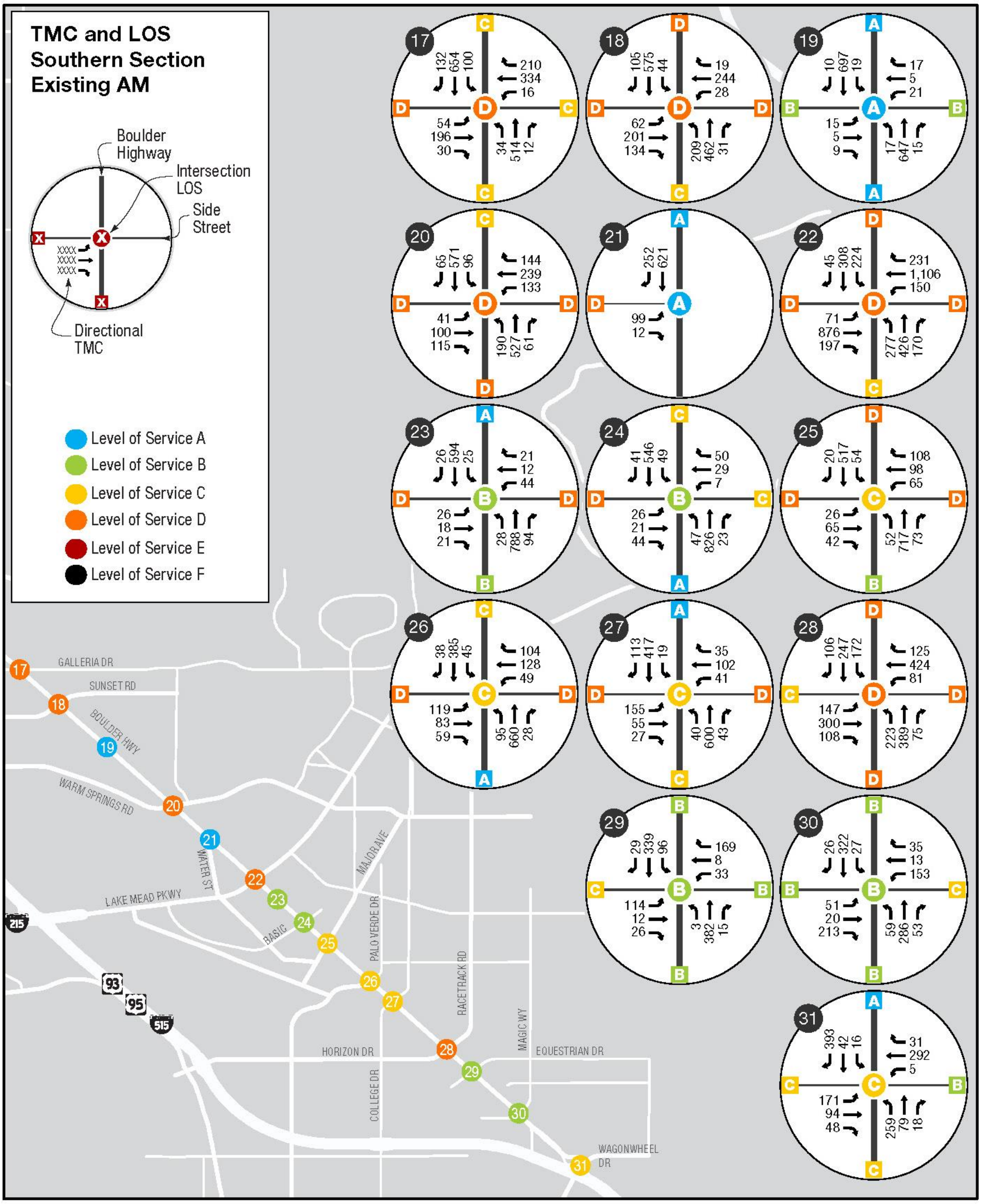

Figure 25. Existing Turning Movement Counts and Level of Service – Southern Section AM

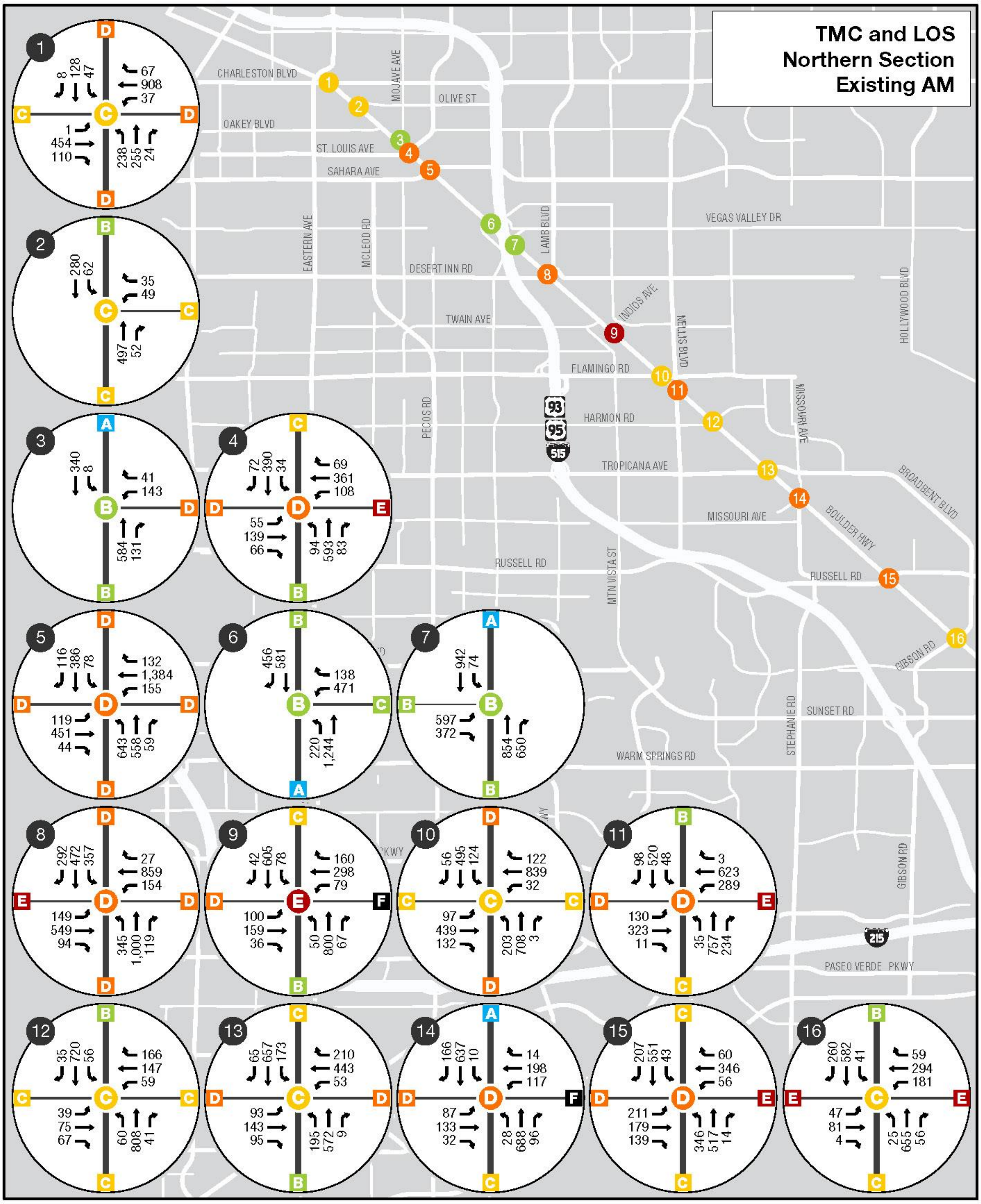

Figure 26. **Existing Turning Movement Counts and Level of Service – Northern Section AM**

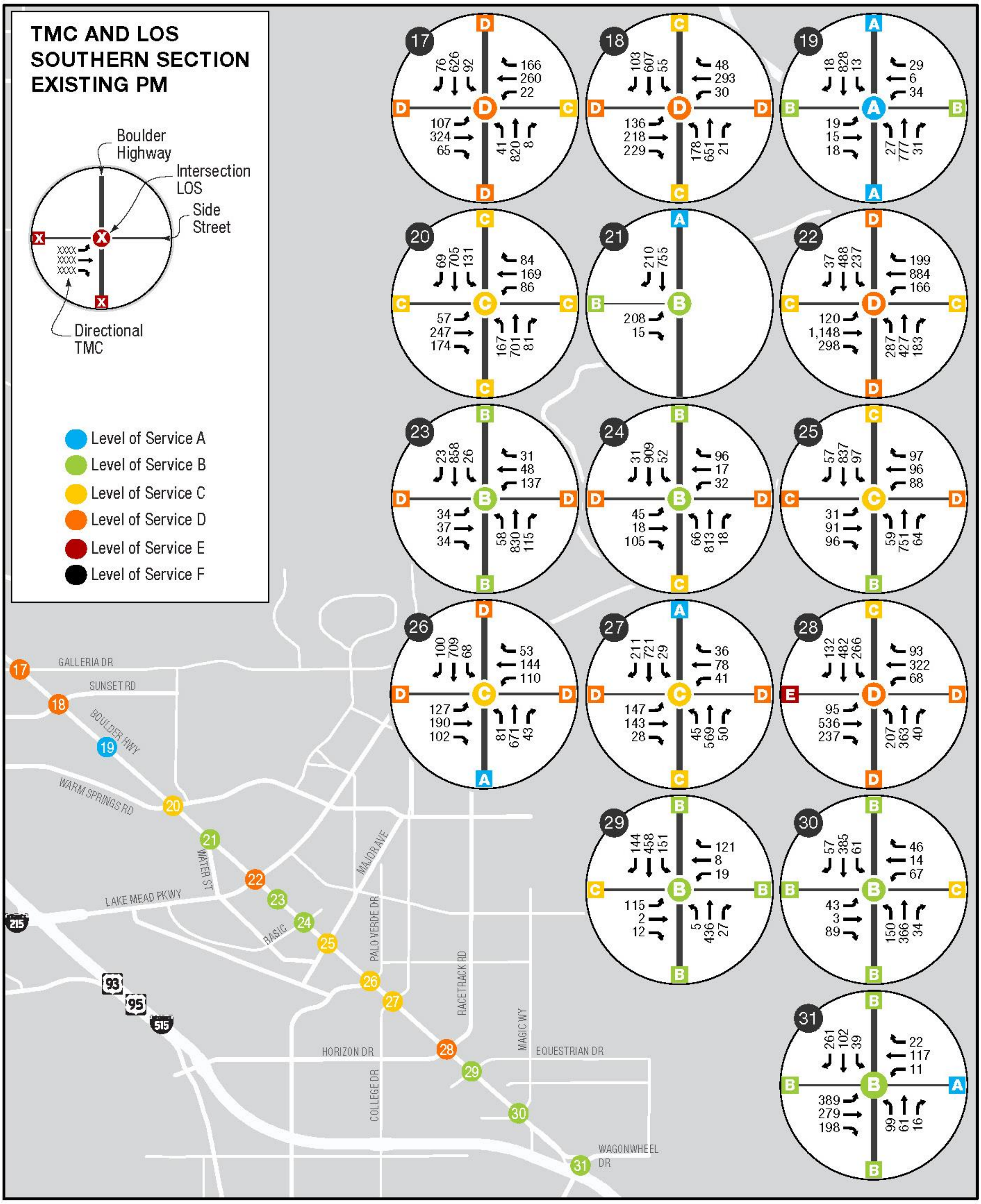

Figure 27. Existing Turning Movement Counts and Level of Service – Southern Section PM

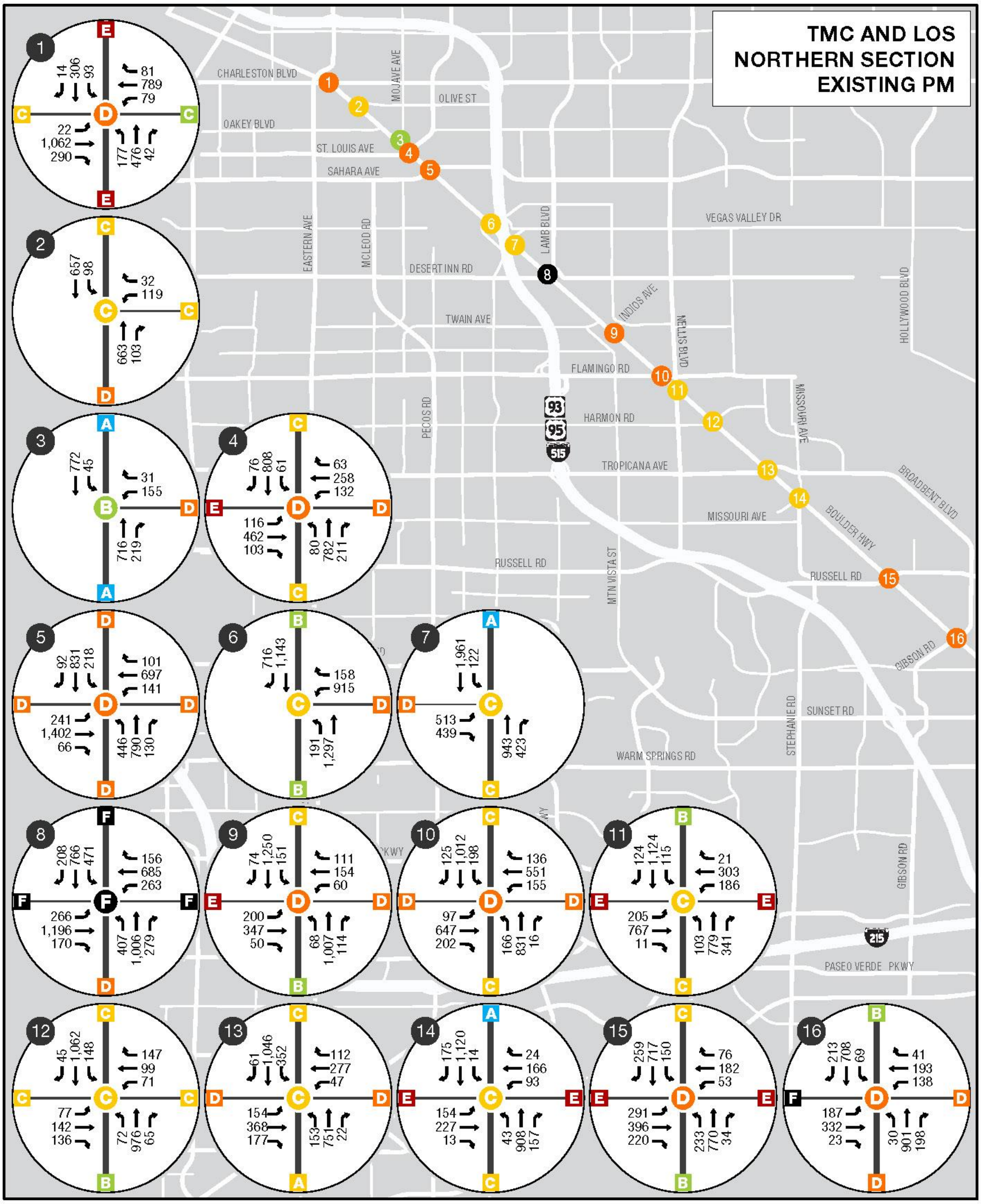

Figure 28. **Existing Turning Movement Counts and Level of Service – Northern Section PM**

Speeds Analysis

Speed data on Boulder Highway were collected from RTC. Maps showing measured speed on Boulder Highway and the ratio of measured speed to the average free flow speed are shown in Figure 29 and Figure 30. Northbound speeds are lowest between Desert Inn Road and northbound I-515 ramps. Southbound speeds are lowest between Flamingo Road and Harmon Avenue. Comparing average speed to the free flow speed, the biggest disparity occurs on northbound Boulder Highway between Desert Inn Road and northbound I-515 ramps. Speed in this area was less than half of the average free flow speed, indicating that this segment of the corridor experiences substantial congestion.

Travel Time Reliability Analysis

To understand travel time reliability on the corridor, data were collected for travel time on Boulder Highway through the study area: from Wagonwheel Dr. to Charleston Blvd. Travel time reliability is described by the travel time index (TTI), defined as the ratio of travel time during peak times to the travel time at free flow conditions. Travel time data for all of 2018 and weekdays in 2018 were analyzed to determine the corridor TTI. Table 33 shows TTI for both groups of data by direction. Northbound travel times are less reliable, with higher TTI than southbound. Weekday travel times are less reliable than average, with higher average TTI and 95th percentile TTI than the average across all days.

Table 33. Boulder Highway Travel Time Index

Days	Direction	Peak Hour	5^{th} % TTI	Average TTI	95^{th} % TTI
2018 All Days	Northbound	4 to 6 PM	0.76	1.05	1.57
	Southbound	4 to 6 PM	0.78	1.07	1.52
2018 Weekdays	Northbound	4 to 6 PM	0.76	1.06	1.54
	Southbound	4 to 6 PM	0.79	1.07	1.51

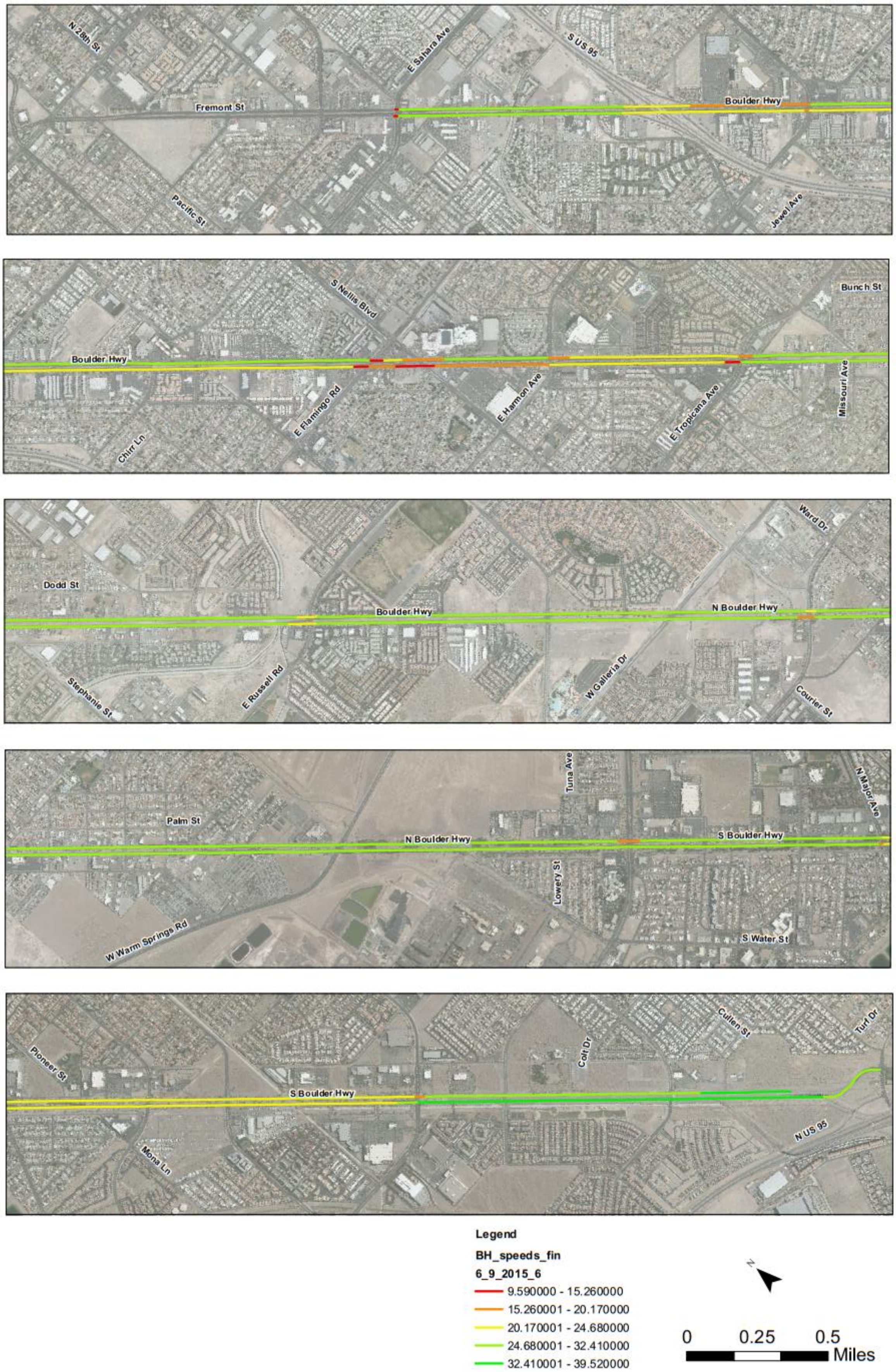

Figure 29. Average Speed in Miles per Hour

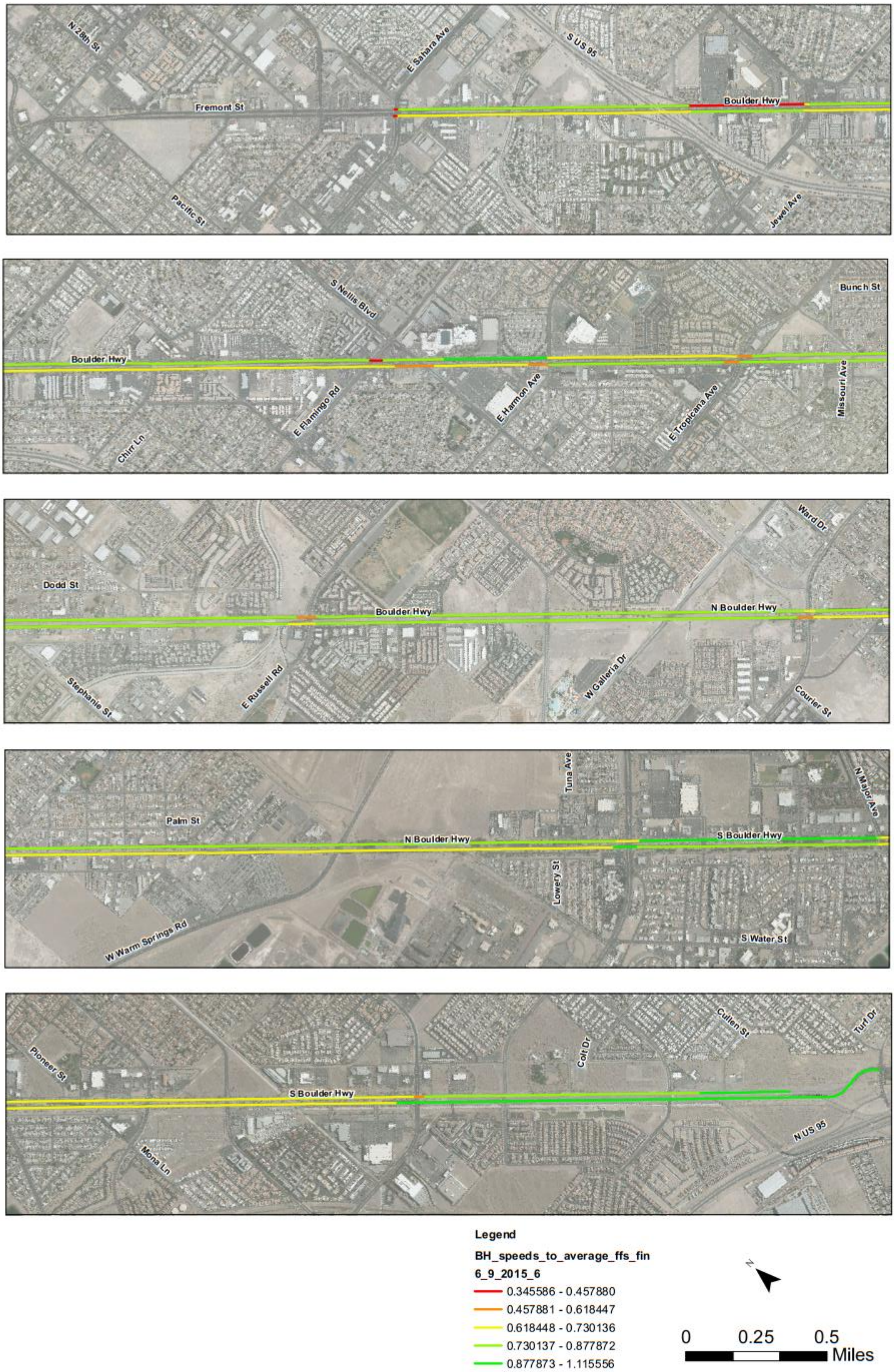

Figure 30. Ratio of Average Speed to Free Flow Speed Along the Corridor

APPENDIX E—

EXISTING SAFETY AND LIGHTING ANALYSIS

Appendix E. Safety Evaluation

Safety performance is a key component of assessing the existing conditions of Boulder Highway, and guide the process of identifying problems and selection of preferred solutions. The study area stretching from Charleston Blvd. (SH 159) to Wagonwheel Dr. (SH 582) is approximately 15.1 miles long and contains 65 intersections, of which 31 are signalized. Speed limits along the corridor, at the time the safety data was collected, range from 45 mph to 55 mph, where 45 mph is most prevalent, particularly along the north-western end of the corridor. Two-way AADTs along the corridor range from 11,000 to 39,000 vehicles per day. For the assessment, five years of crash data were obtained from the Nevada Department of Transportation (NDOT) for the time period of July 2011 to June 2016, where 53 fatal and 1,321 injury crashes were observed. In addition to conventional safety analysis techniques, methodologies outlined in the AASHTO's 2010 Highway Safety Manual (HSM) and International Road Assessment Programme (iRAP) Star Rating Demonstration tool were utilized to assess existing corridor safety performance for all modes. Further, this report qualitatively assesses how the proposed solutions will impact corridor safety in the future.

E.1. Traditional Safety Evaluation

In order to perform analysis, crashes were allocated spatially to highway segments or intersections based upon the coordinates associated with each record. A summary of the crash data, including fatal and injury (FI), property damage only (PDO), and non-motorized crashes specific to the Boulder Highway corridor are provided in Table 1 below.

Table 1. Summary of Boulder Highway Traffic Crash Data (7/2011 to 6/2016)

Location	Fatal	Injury	PDO	Total	Pedestrian	Bicycle
Intersections	42	1,100	1,075	2,217	98	35
Segments	11	168	130	309	27	6
Total Corridor	53	1,268	1,205	2,526	125	41

As shown above, a total of 2,526 crashes occurred along the project corridor, where 1,268 included an injured occupant and 53 resulted in a fatality. More information related to each specific intersection and segment location as identified in this analysis is provided in Attachment B.

E.1.1. Intersections

Intersections are planned locations where vehicles traveling on different highways may come into conflict with each other, along with other non-motorized road users. Understanding the type, frequency and severity of crashes is important for determining which countermeasures are most appropriate for improving safety[1]. , Table 2 and Table 3 and the accompanying Figure 1 and Figure 2 contain descriptive statistics for crash type and severity associated with the intersections along the project corridor.

[1] https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa10005/brief_2.cfm

Table 2. Intersection Crashes by Type (7/2011 to 6/2016)

Crash Type	Count	Percentage
Angle	766	34.6%
Backing	30	1.4%
Head-On	23	1.0%
Non-Collision	181	8.2%
Rear-End	1,045	47.1%
Rear-To-Rear	4	0.2%
Sideswipe, Meeting	51	2.3%
Sideswipe, Overtaking	112	5.1%
Unknown	5	0.2%
Total	2,217	100.0%

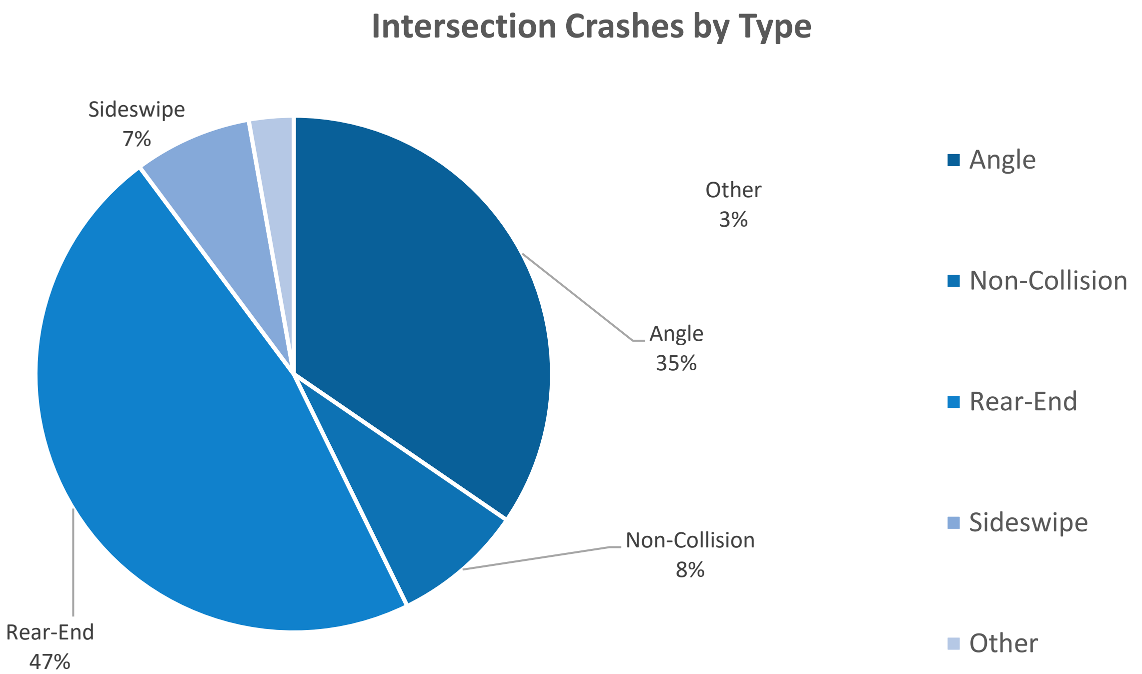

Figure 1. Intersection Crashes by Type

In general, rear-end and angle crashes represent the majority of crash types observed. The non-collision crash type which represents 8.2 percent of all crashes observed, typically includes pedestrian, bicycle or single-vehicle crashes. In this assessment, angle crashes were found to contribute to 13 fatalities (24.5 percent) and 415 injury crashes (32.7 percent).

Table 3. Fatal and Injury Crashes by Severity at Intersections (7/2011 to 6/2016)

Severity	Count	Percentage
K – Fatal	**42**	**3.8%**
A – Incapacitating Injury	**63**	**5.8%**
B – Non-Incapacitating Injury	**249**	**22.8%**
C – Possible Injury	**740**	**67.6%**
Total	**1,094**	**100.0%**

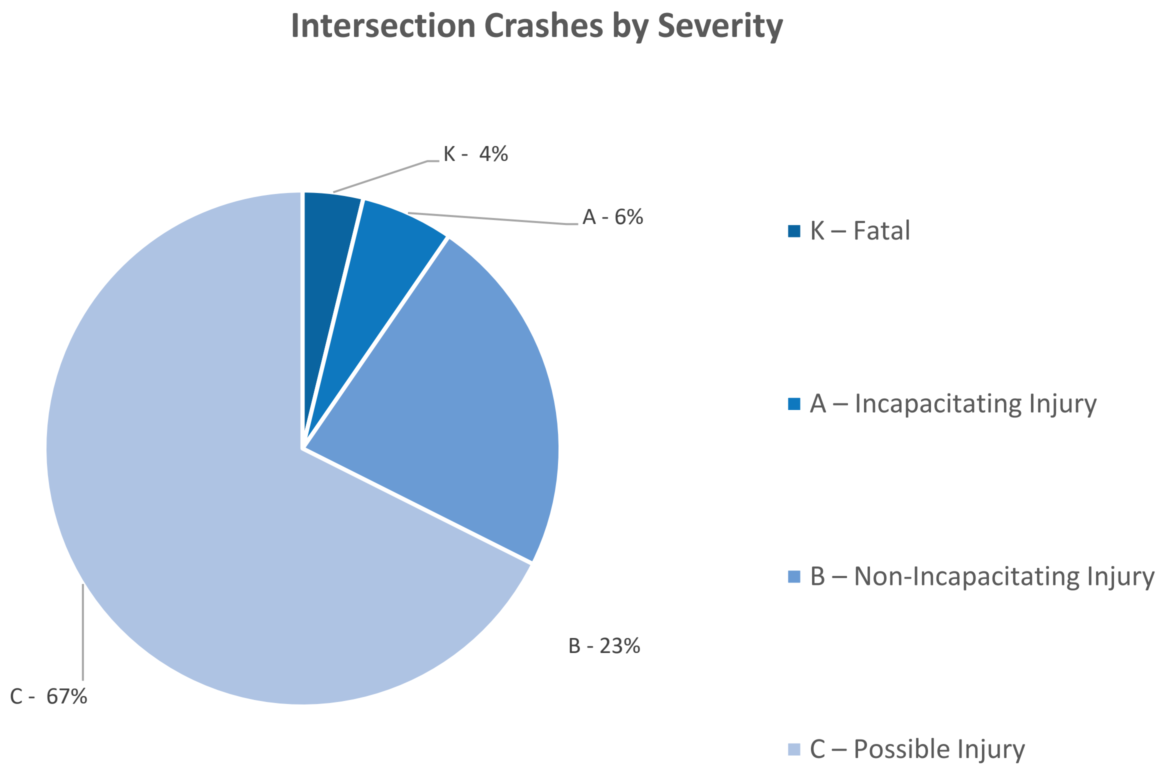

Figure 2. Intersection Crashes by Severity

As shown above, 42 of the 53 fatalities observed in the study occurred within the influence area of an intersection. Table 4 provides a ranking of the top five locations based on observed fatal and injury crashes during the study period.

Table 4. Top Five Intersections by Total Fatal and Injury Crashes

Rank	Intersection	Fatal and Injury	Fatal
1	**E Desert Inn Rd./S Lamb Blvd.**	**105**	**2**
2	**S Nellis Blvd.**	**87**	**3**
3	**E Flamingo Blvd.**	**80**	**1**
4	**E Sun Valley Dr.**	**68**	**3**
5	**E Sahara Ave.**	**62**	**2**

In addition to these five locations, the intersection of E Russell Road had the greatest number of fatalities, where four were observed during the five-year period.

Pedestrian and Bicycle Intersection Safety Assessment

As indicated in Table 1, 98 pedestrian crashes and 35 bicycle crashes were recorded at the intersections along the corridor during the five-year period. These crashes account for approximately six (6) percent of all intersection crashes in the corridor. There were 25 pedestrian related fatalities, which represent approximately 59.5% of all fatalities occurring at intersections during the 5-year time span. The disproportionate occurrence of crashes of this severity is indicative of the risks that pedestrians face along this corridor. Figure 3 and Figure 4 found in Attachment A illustrates intersections with high pedestrian and bicycle crashes along the corridor. Of particular interest is the area between I-515 and E Tropicana Avenue, where approximately 56 pedestrian and 18 bicycle related crashes occurred in 5-years.

E.1.2. Segments

Similar to intersections, segments also exhibited a large proportion of angle and rear-end crashes as shown in Table 5 and 0 below. The analysis indicates that these crashes were mostly associated with the many driveways that exist along the corridor. Vehicles either slowing down suddenly or pulling out into traffic in front of others generally contributes to these types of crashes. From a design perspective, this is characteristic of drivers presented with sudden decision making (e.g. poor primacy, visual clutter, high workload, etc.) or could also result from poor sight distance for drivers entering the corridor. Table 5, Table 6, Figure 5, and Figure 6 provide the breakdown of segment crashes by type and severity.

Table 5. Segment Crashes by Type (7/2011 to 6/2016)

Crash Type	Count	Percentage
Angle	132	42.7%
Backing	3	1.0%
Head-On	5	1.6%
Non-Collision	44	14.2%
Rear-End	103	33.3%
Rear-To-Rear	0	0.0%
Sideswipe, Meeting	11	3.6%
Sideswipe, Overtaking	10	3.2%
Unknown	1	0.3%
Total	309	100.0%

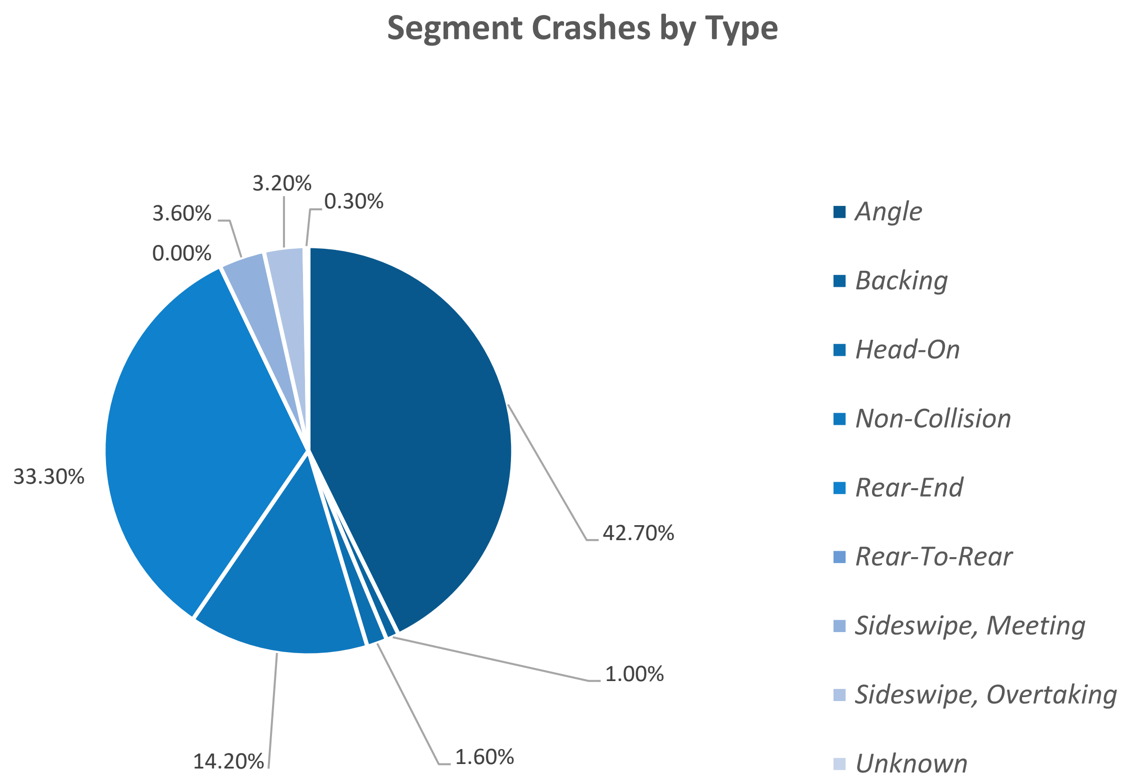

Figure 5. Segment Crashes by Type

Table 6. Fatal and Injury Crashes by Severity on Segments (7/2011 to 6/2016)

Severity	Count	Percentage
K – Fatal	**11**	**6.2%**
A – Incapacitating Injury	**17**	**9.6%**
B – Non-Incapacitating Injury	**61**	**34.5%**
C – Possible Injury	**88**	**49.7%**
Total	**177**	**100.0%**

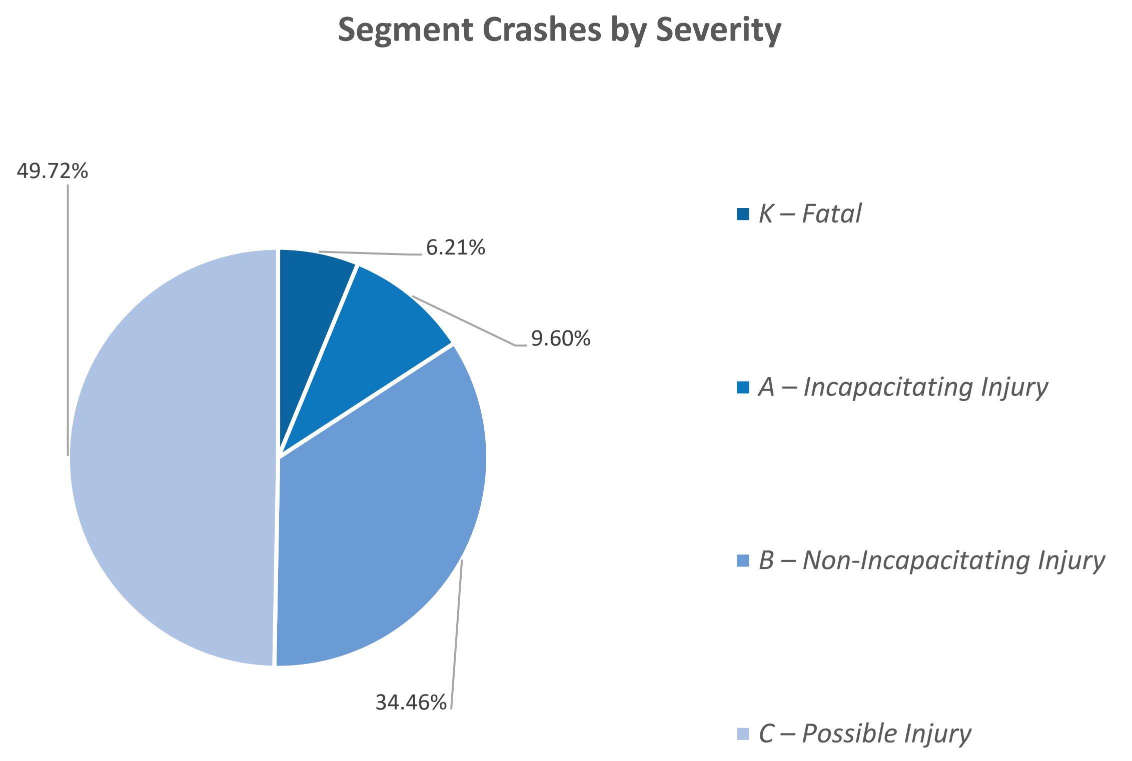

Figure 6. Segment Crashes by Severity

Segment Pedestrian and Bicycle Safety Assessment

A total of eight pedestrian fatalities occurred on segments, which represents approximately 72.7% of all segment fatalities on the corridor. Similar to intersections, pedestrian and bicycle fatalities are disproportionate when compared to vehicle crashes in terms of severity, and account for 10.7% of all crashes occurring on segments.

E.2. HSM Evaluation

To provide context to the crash data collected, the *Highway Safety Manual* (HSM) (AASHTO, 2010) methodology was applied to each intersection and segment throughout the corridor to determine if it experienced more or less crashes than would be expected.

Based on this methodology, once the observed crash frequency or number of crashes is summarized, the next step in this process is calculating the predicted average number of crashes using HSM safety models where appropriate. The predictive analysis is based on an examination of similar facilities from around the United States. This is useful because if there are elements/portions of the Boulder Highway that are experiencing more crashes than similar facilities, then this indicates there are likely improvements that could be made to this element/portion of Boulder Highway that would result in improved safety. An uncalibrated HSM analysis was performed since NDOT currently does not maintain Nevada-specific calibration factors. Where necessary, crash modification factors (CMF) were utilized for the segment models to account for the 6-lane cross section present along most of the corridor. For intersections, CMFs were used to model the safety effects of left turn lanes, signal phasing, right-turn-on-red restrictions, and right turn lane presence as observed.

To produce a more statistically reliable estimate of the corridor's expected average number of crashes, the EB method as defined by HSM was applied. This method combines the predicted number of crashes with the observed number of crashes to calculate the expected number of crashes in the corridor.

The difference between the expected number of crashes and predicted number of crashes, known as the "excess expected", demonstrates the relative safety of that facility. A negative number is indicative of better performance, as the facility is expected to have less crashes than other similar facilities as predicted by the SPF. Conversely, a positive number indicates there is a need for improvement relative to similar facilities (i.e. we are expecting more crashes than predicted) and suggests significant opportunity for improvement along the study corridor with appropriate safety treatments.

0 and Table 7 below show the results of this analysis for the entire corridor.

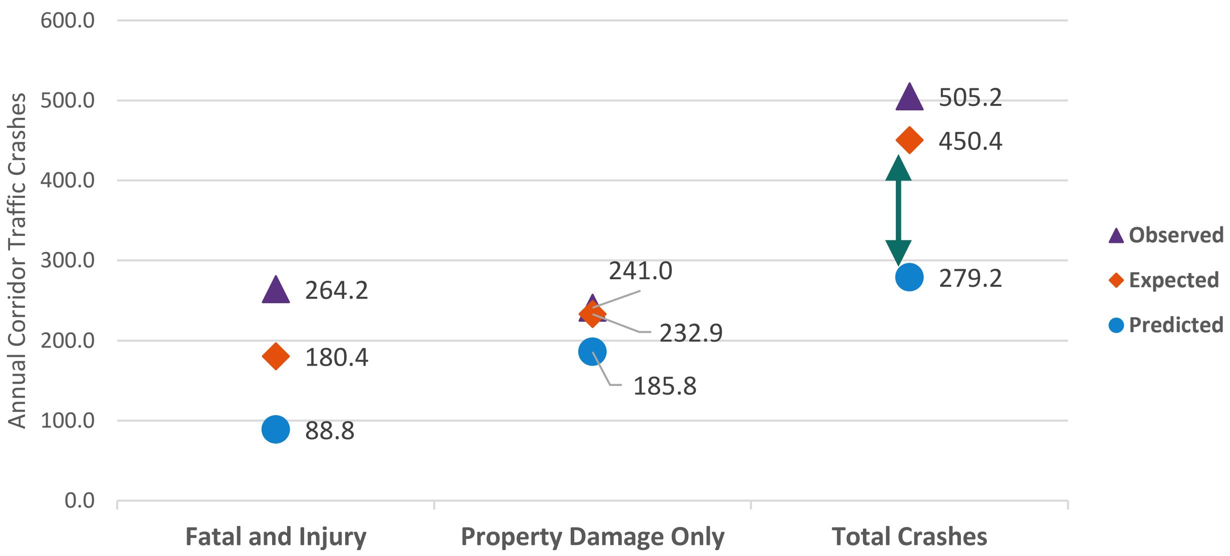

Figure 7. Summary of HSM Analysis Results

Table 7. Summary of EB- Method Analysis

Crash Severity	Observed Number of Crashes (per year)	Expected Number of Crashes (per year)	Predicted Crashes based on Similar Facilities (per year)	Difference between number of crashes on Boulder Highway and similar facilities
PDO	**241.0**	**232.9**	**185.8**	**47.1**
Fatal and Injury	**264.2**	**180.4**	**88.8**	**91.6**
Total	**505.2**	**450.4**	**279.2**	**171.3**

This analysis indicates that Boulder Highway is experiencing a larger overall number of crashes, and especially fatalities and injuries, than similar facilities.

Table 8 below shows the number of crashes that are predicted and expected to occur at each facility type.

Table 8. HSM Crashes per Year by Crash Severity

Roadway Component	Crash Severity	Number of Crashes (per year)2	Predicted Crashes based on Similar Facilities (per year)	Difference between number of crashes on Boulder Highway and similar facilities
Intersection	PDO1	204.0	134.3	69.8
	Fatal and Injury1	159.7	70.4	89.3
	Total	**397.9**	**212.1**	**185.8**
Segment	PDO	28.9	51.5	-22.6
	Fatal and Injury	20.7	18.5	2.3
	Total	**52.5**	**67.1**	**-14.6**

As demonstrated in Table 8 above, Boulder Highway intersection facilities experience 185.8 more total crashes than similar facilities. For segments, performance is better than expected with approximately 14.6 less total crashes on average when compared with similar facilities. However, as shown Figure 8 in Attachment A, there are some segments that have excess crashes and have a greater potential for improvement. More specifically, the section between Indios Ave. and Flamingo Rd. has over three excess crashes per year.

For intersections, the poorest performance was observed at the north-western end of the corridor, which also corresponds with the areas of greatest development and activity. Most notably, the worst location was the Desert Inn Rd/S Lamb Blvd intersection with an excess expected of nearly 33.6 crashes per year. This finding is consistent with the traditional methods, where the Desert Inn intersection demonstrated the highest number of fatal and injury crashes in the group. Table 9 below shows the top five worst performing intersections according to the excess expected crash output from the HSM models.

Table 9. Intersection Ranking by Excess Expected Crashes

Rank	Intersection	Observed Number of Crashes			Predicted Crashes based on Similar Facilities (per year)	Difference between number of crashes on Boulder Highway and similar facilities
		Total	Fatal and Injury	PDO		
1	E Desert Inn Rd	46.4	21.0	25.4	7.9	33.6
2	S Nellis Blvd	30.8	17.4	13.4	6.4	20.1
3	E Flamingo Rd	28.4	16.0	12.4	6.0	19.3
4	I-515 NB Ent/Ext	30.4	11.4	19.0	8.9	19.2
5	E Sahara Ave	24.8	12.4	12.4	6.5	16.1

With the exception of the E Sahara Avenue intersection, the top four intersections shown in Table 9 above are located in the same area as the pedestrian and bicycle crash hot spots. This section, from I-515 to E

Tropicana, is the primary contributor of poor crash performance along the corridor and would stand to benefit most from countermeasure implementation and improvement. Figure 9 found in Attachment A shows the excess expected crashes at all intersections along the corridor.

E.3. iRAP Risk Analysis

The International Road Assessment Programme (iRAP) is a registered charity dedicated to saving lives through safer roads and has developed tools and training to provide star rates and risk assessments for roadway systems. For this assessment, the Atkins team utilized the Star Rating Demonstrator tool to provide risk-based scoring at defined intervals of every 100 meters along the project corridor.

More specifically, the following data were collected for each section:

- Pedestrian, bicycle and vehicle flows;
- Pedestrian and bicycle facility information (crossing type, quality, signals, etc.);
- Intersection characteristics (access control, channelization, signalization, etc.);
- Geometrics (median type, no. of lanes, grade changes, delineation, etc.); and
- Roadside obstacles

As a result, star rating scores were generated using the model for the following four categories: vehicle, motorcycle, pedestrian and bicycle.Figure 10 and Figure 11 below show the pedestrian scores along the corridor. For amore discernible presentation of the data, the corridor was divided into two equal halves: Figure 10 shows scores from Charleston Blvd. to Broadbent Blvd., and Figure 11 shows the area from Broadbent Blvd. to Wagonwheel Dr.

Figure 10 shows that the risk rating approaches one star (worst case) for the intersections of Charleston, Atlantic,Sahara and Sun Valley. This finding correlates with the pedestrian hot spots as indicated by the crash data. These intersections and the areas surrounding them present a greater risk to pedestrians as higher vehiclevolumes and development increase the potential for accidents through greater exposure. In addition to pedestrian scores, model outputs that were generated for bicycle risk ratings are shown in Figure 12 and Figure 13 below.

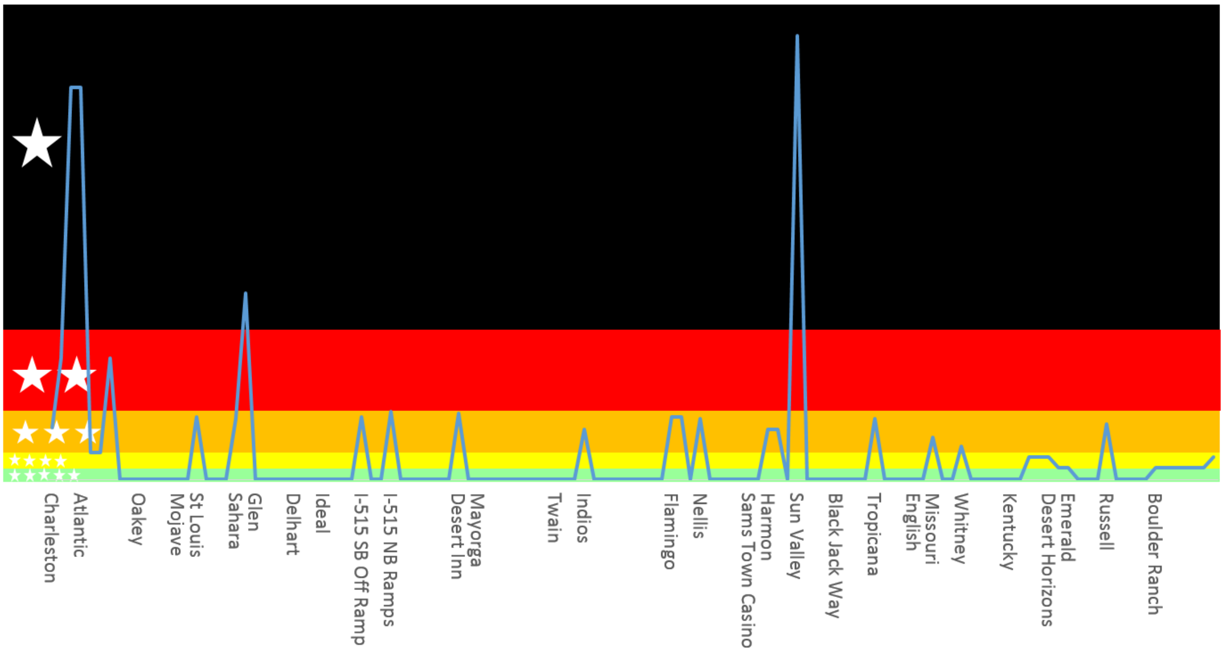

Figure 10. **Pedestrian iRAP Scoring (Charleston Blvd. to Broadbent Blvd.)**

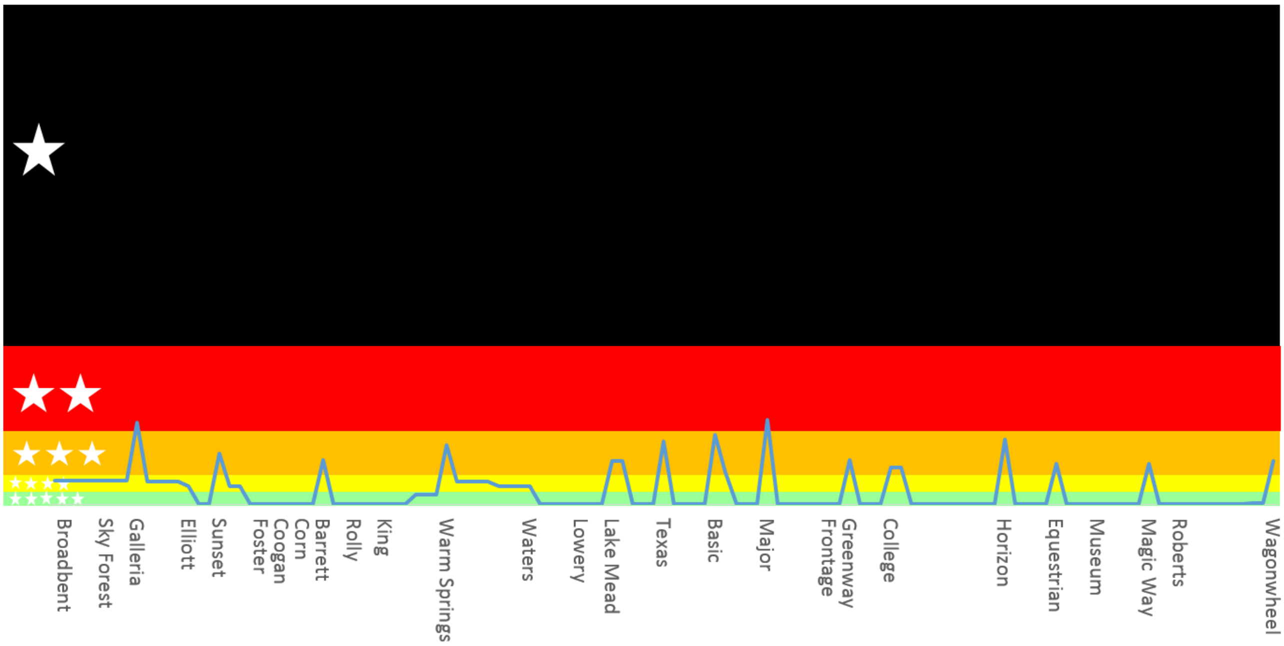

Figure 11. **Pedestrian iRAP Scoring (Broadbent Blvd. to Wagonwheel Dr.)**

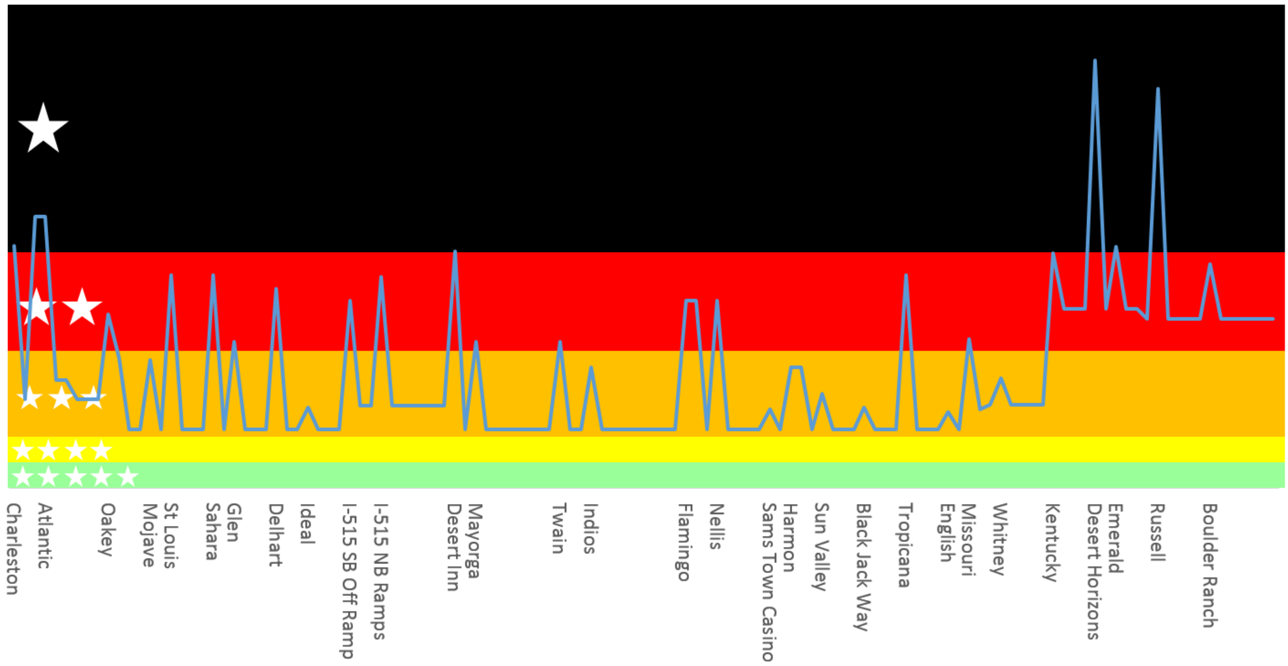

Figure 12. Bicycle iRAP Scoring (Charleston Blvd. to Broadbent Blvd.)

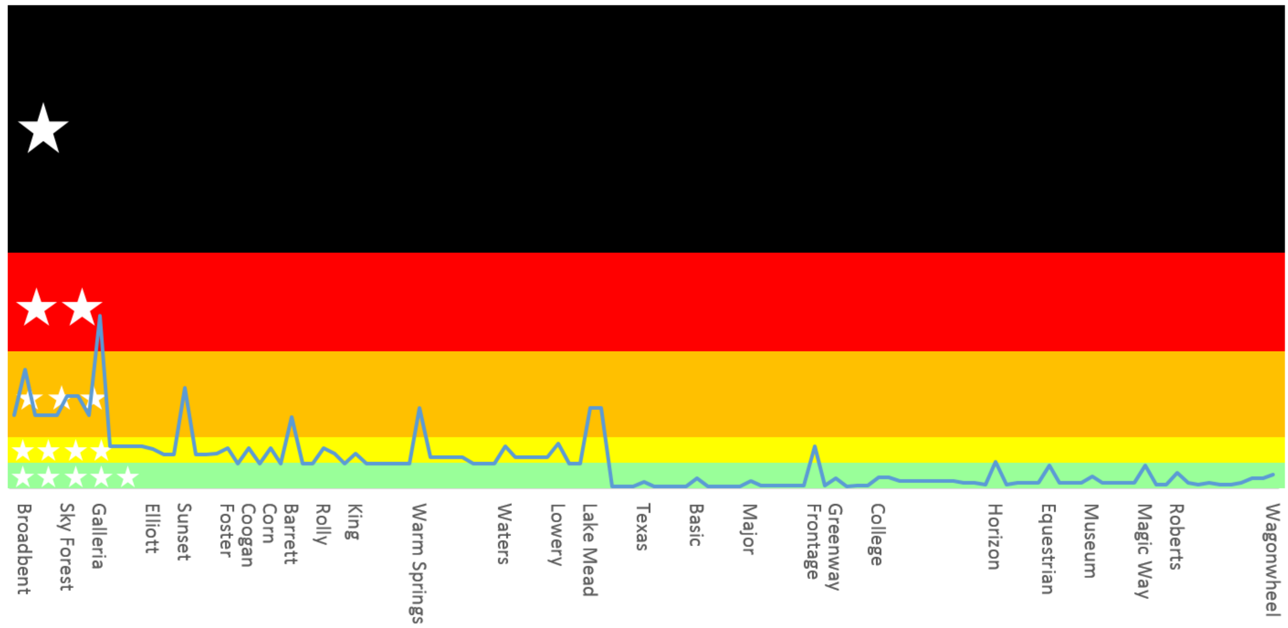

Figure 13. Bicycle iRAP Scoring (Broadbent Blvd. to Wagonwheel Dr.)

Similar to the pedestrian scores, more development leads to greater risk along the northwestern end of the corridor. Of particular interest is the section from Kentucky Ave. to Broadbent Blvd. where speeds are higher relative to the rest of the corridor, and no exclusive bicycle facilities are provided. The section southeast of Lake Mead Pkwy. and moving towards Wagonwheel Dr. exhibits the most consistent and safe performance according to the model for this corridor. In this section of the corridor bicycles are accommodated on a multimodal trail that is separated from the vehicular traffic.

E.4. Summary of Identified Issues

Major issues that lead to safety concerns along the corridor are identified based on the above crash data analysis combined with the corridor observations, conversations with road users and stakeholders, and analysis of roadway and traffic conditions.

E.4.1. Managing Walking Distances

Pedestrians cross the street outside of marked or controlled crosswalks due to the following issues:

- Crosswalks do not follow pedestrian desire lines
- Long distances between controlled crossings

E.4.2. Infrastructure Continuity, ADA Accessibility, and Sidewalk Design

Travelers back track to get to an acceptable facility or take risks to get to a destination because:

- Sidewalk is incomplete or bike lane simply ends
- Street furniture and infrastructure sometimes blocks a sidewalk
- Ramps or other accessible features are absent or poorly placed
- Many pedestrian and bicycle infrastructure predate ADA and present challenges for pedestrians with disabilities
- Entire corridor lacks facilities that accommodate sight impaired pedestrians
- Frequent driveways creating uneven pedestrian paths

E.4.3. Ease of Street Crossing

Pedestrians have difficulty negotiating large complex intersections and crossing the street at controlled and uncontrolled locations due to:

- Insufficient information about expectations, such as two-stage crossing at large, complex signalized intersections
- Long traffic signal cycles
- Lack of proper mid-block signals that notify them to stop walking
- Lack of crosswalks (or protected crosswalks) near necessary busy mid-block transit stops
- Long crossing distances
- Physical barriers, such as flood control facilities
- Lack of protected midblock pedestrian refuge

E.4.4. Lack of Pedestrian Scale

Lack of pedestrian scale design is observed along the entire corridor and is more critical in areas with high pedestrian activity. The ample right of way promotes high vehicular speed and low reaction time which has resulted in higher fatal and/or serious injuries.

E.4.5. Inconsistent lighting and insufficient visibility

Lighting is not consistent along the corridor. While many signalized intersections have sufficient lighting, this is not the case away from these locations. This situation places alternative modes at a disadvantage compared to vehicular traffic. The following is observed along the corridor.

- There are areas along the corridor where lighting is non-existent
- Distance between lights varies along the corridor
- Lighting is non-existent in the proximity of some transit stations

E.4.6. Access Management and Driveways

Closely spaced driveways increase the number of conflict points for vehicles, pedestrians, and bicycles.

E.5. Proposed Improvements Safety Assessment

A toolbox of improvements along Boulder Highway is proposed to improve safety for all modes of transportation along the corridor. The following is a summary of research documenting how the proposed concept improves vehicle, pedestrian and bicycle safety along the corridor.

E.5.1. Center Running Transit

National Association of City Transportation Officials (NACTO) recommends that safe crossings are installed per their Urban Street Design Guide[2]. Safety benefits of center running transit include:

- Pedestrian Crossing distance is shorter than side running transit since pedestrians are only required to only cross half of the roadway.
- Pedestrians waiting at the bus stop are less exposed to fast running vehicular traffic than side running transit stations, where in many instances the pedestrians are struck by cars at the station.
- Drivers do not get stalled behind buses, and buses do not have to wait for right turning vehicles. Similar concepts as illustrated here: https://betterbrt.growingeastcounty.com/portfolio/median-stations/.

E.5.2. Pedestrian midblock crossing with RRFB every ¼ - 1/8 miles and sensors

A study commissioned by the Transportation Research Board's (TRB) National Cooperative Research Program (NCHRP) was conducted by Zegeer et al. to develop crash modification factors for uncontrolled pedestrian crossing treatments[3]. Through the course of their research, they found that the installation of a rectangular rapid flashing beacon (RRFB) reduced pedestrian-vehicle crashes by 47.4 percent. They also suggest that RRFB's "…produce higher levels of yielding, particularly at night, when installed on the median or refuge island on roads with multiple lanes in each direction that are separate by a median or refuge

[2] https://nacto.org/publication/transit-street-design-guide/transit-lanes-transitways/transitways/center-transitway/
[3] http://www.trb.org/Main/Blurbs/175381.aspx

island at the crosswalk."[4] This is echoed by the Oregon Department of Transportation (ODOT), who found that installing median islands increased the performance of pedestrian activated flashing beacons, where driver stopping compliance increased as much as 50 percent.[5]

E.5.3. Corridor lighting

According to Frank Markowitz and Adam Smith of the San Francisco Municipal Transportation Agency, several studies have found that pedestrian injuries at night time are typically reduced roughly in half by illumination (Schwab et al., 1982, Elvik, 1995, Commission Internationale de L'Eclairage, 1992).[6] This assertion is echoed by the International Road Assessment Programme (iRAP) Road Safety Toolkit, which states lighting can reduce pedestrian crashes by approximately 50 percent.[7] Moreover, the toolkit recommends installation of lighting for midblock areas including: service roads, merge, diverge and weave locations, locations with high levels of background lighting, or high night time traffic volumes.

E.5.4. Cycle Track

Installation of a physically-separate, two-way cycle track was found to reduce injury risk for bicyclists by 28 percent according to information presented at the 91st Annual Meeting of the Transportation Research Board by Nosal and Miranda-Moreno.[8] These findings were derived from the study of six high bicycle volume corridors, totaling approximately 9.5 miles in length with two-way tracks on one side of the street.

E.5.5. Wider sidewalks

Improved pedestrian facilities increase compliance and promote walking. Therefore, if sidewalks were deficient previously, introducing a wider or improved facility would improve compliance and help direct pedestrians to the marked crossings.

E.5.6. Early Action Median Barrier or Fencing

The FHWA provides information and statistics with publication number FHWA-HRT-12-003, titled "Proven Countermeasures for Pedestrian Safety", that suggest crash reductions up to 46 percent are found by providing marked crosswalks with raised medians or refuge areas along a corridor.[9] Moreover, Florida DOT found that raised medians provide additional benefits beyond reducing pedestrian crashes, including:

- Reducing motor vehicle crashes by 15 percent
- Decreasing delays (>30 percent) for motorists by minimizing unpredictable interruptions in traffic flow
- Increasing capacity (>30 percent) of roadways by minimizing unpredictable interruptions in traffic flow
- Reducing vehicle speeds on the roadway
- Providing space for landscaping within the right-of-way
- Providing space to install additional roadway lighting, further improving the safety of the roadway

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[4] http://www.trb.org/Main/Blurbs/175381.aspx, page 50
[5] https://www.fhwa.dot.gov/publications/publicroads/12marapr/04.cfm
[6] https://www.westernite.org/annualmeetings/17_San_Diego/Papers/2D-Markowitz.pdf
[7] http://toolkit.irap.org/default.asp?page=treatment&id=58
[8] https://www.researchgate.net/publication/49822835_Risk_of_injury_for_bicycling_on_cycle_tracks_versus_in_the_street
[9] https://www.fhwa.dot.gov/publications/publicroads/12marapr/04.cfm

- Providing space to provide supplemental signage on multilane roadways
- Costing less to build and maintain than paved medians because the inclusion of a median leaves less asphalt for resurfacing and restriping

One study by Zhang et. al. sought to quantify the impacts of median treatments and found a reduction in the total number of crashes by 14 percent, with a reduction in fatal crashes of 86 percent.[10] Treatments considered as part of this study included concrete lane dividers, brick with landscaping, jersey barrier, and median planters.

E.5.7. Signal Timing

Leading pedestrian intervals may be useful along the corridor as they allow the pedestrian phase to start before the vehicle phase which facilitates bicyclists and pedestrians in clearing the intersection before conflicting right-turning vehicles move through the intersection.

[10] https://www.roads.maryland.gov/OPR_Research/MD-17-SHA-UM-4-28_Median-Fencing_Report.pdf

APPENDIX E— Attachment A

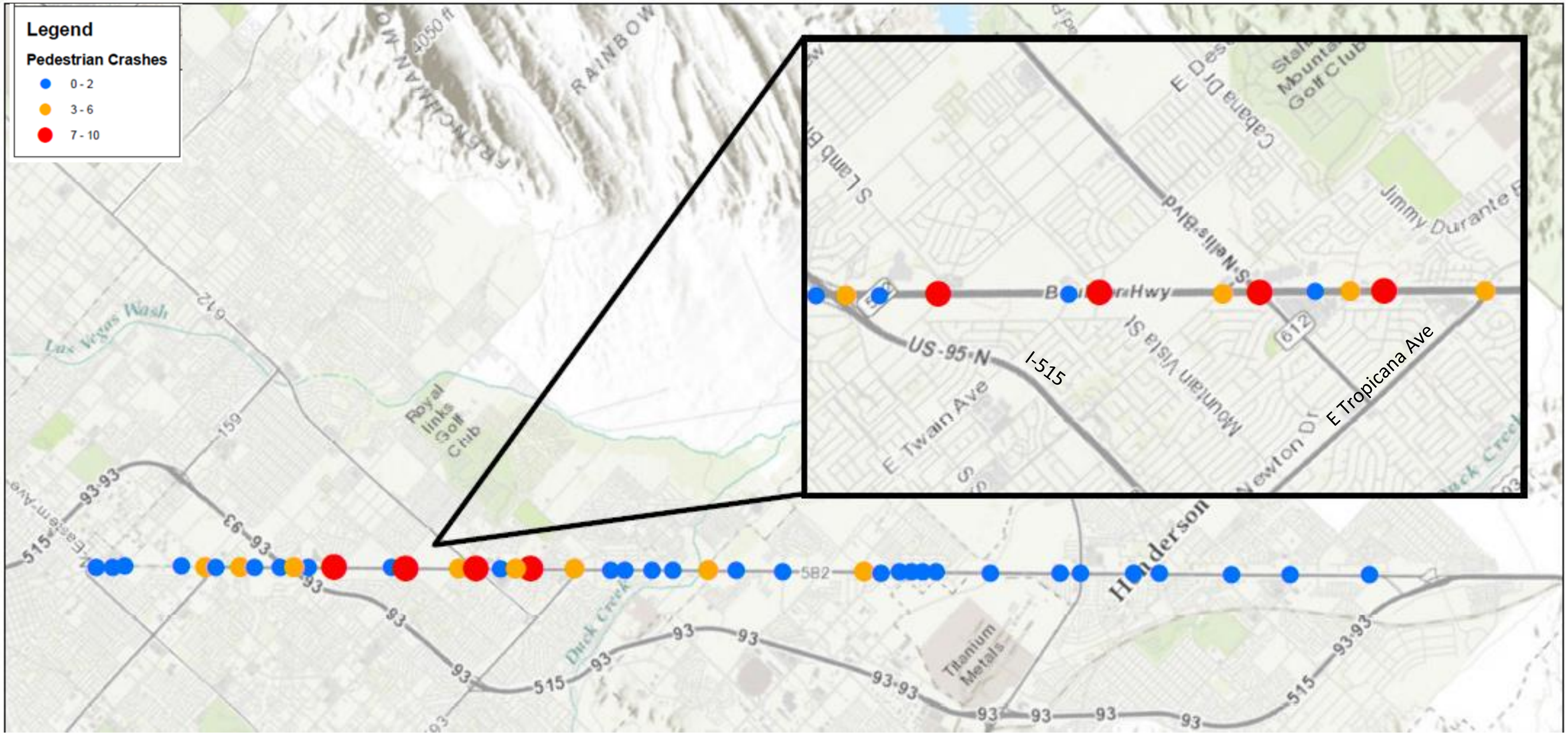

Figure 3. **Pedestrian Crashes at Intersections**

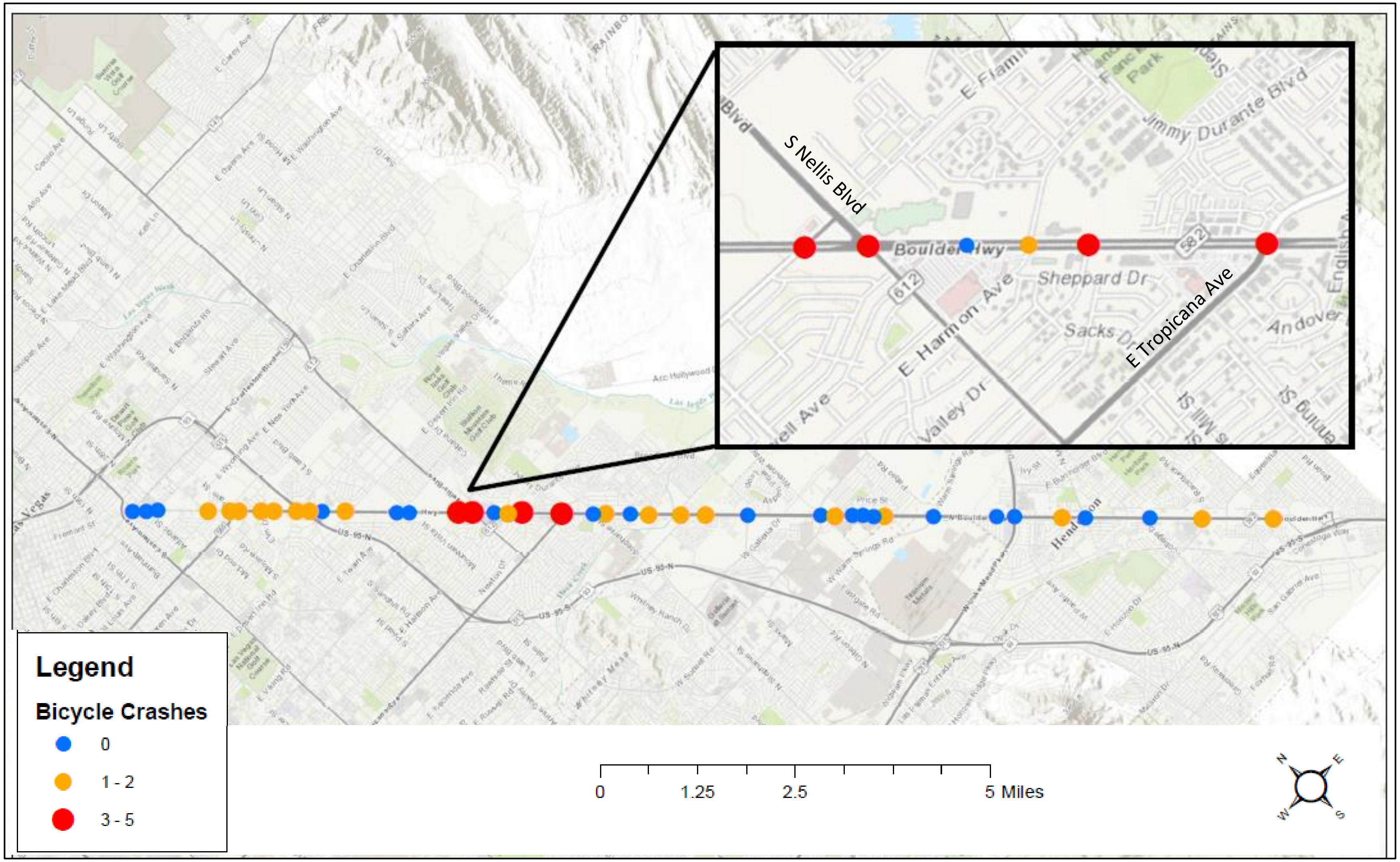

Figure 4. **Bicycle Crashes**

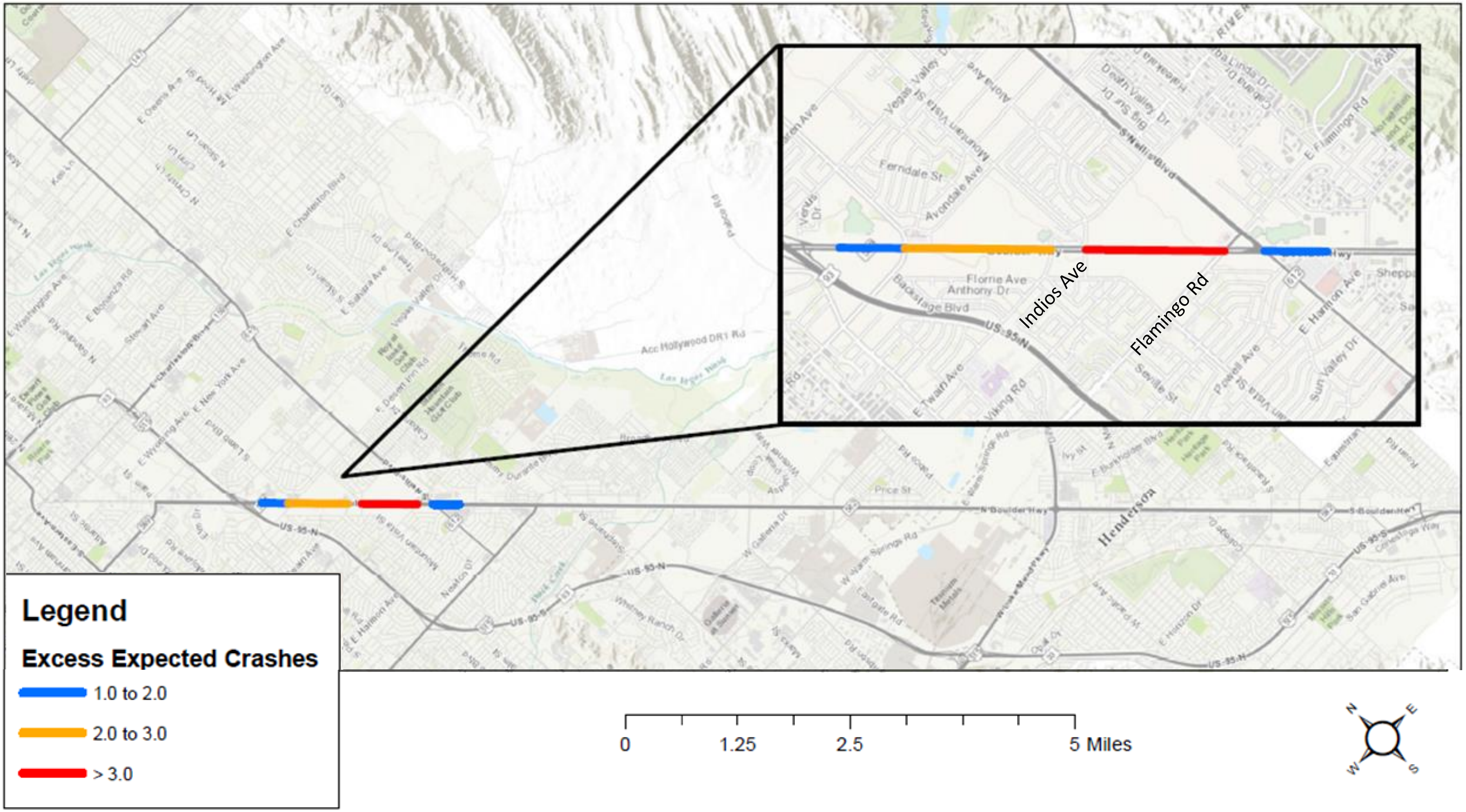

Figure 8. Excess Crashes on Boulder Highway from Flamingo Road to Indios Avenue

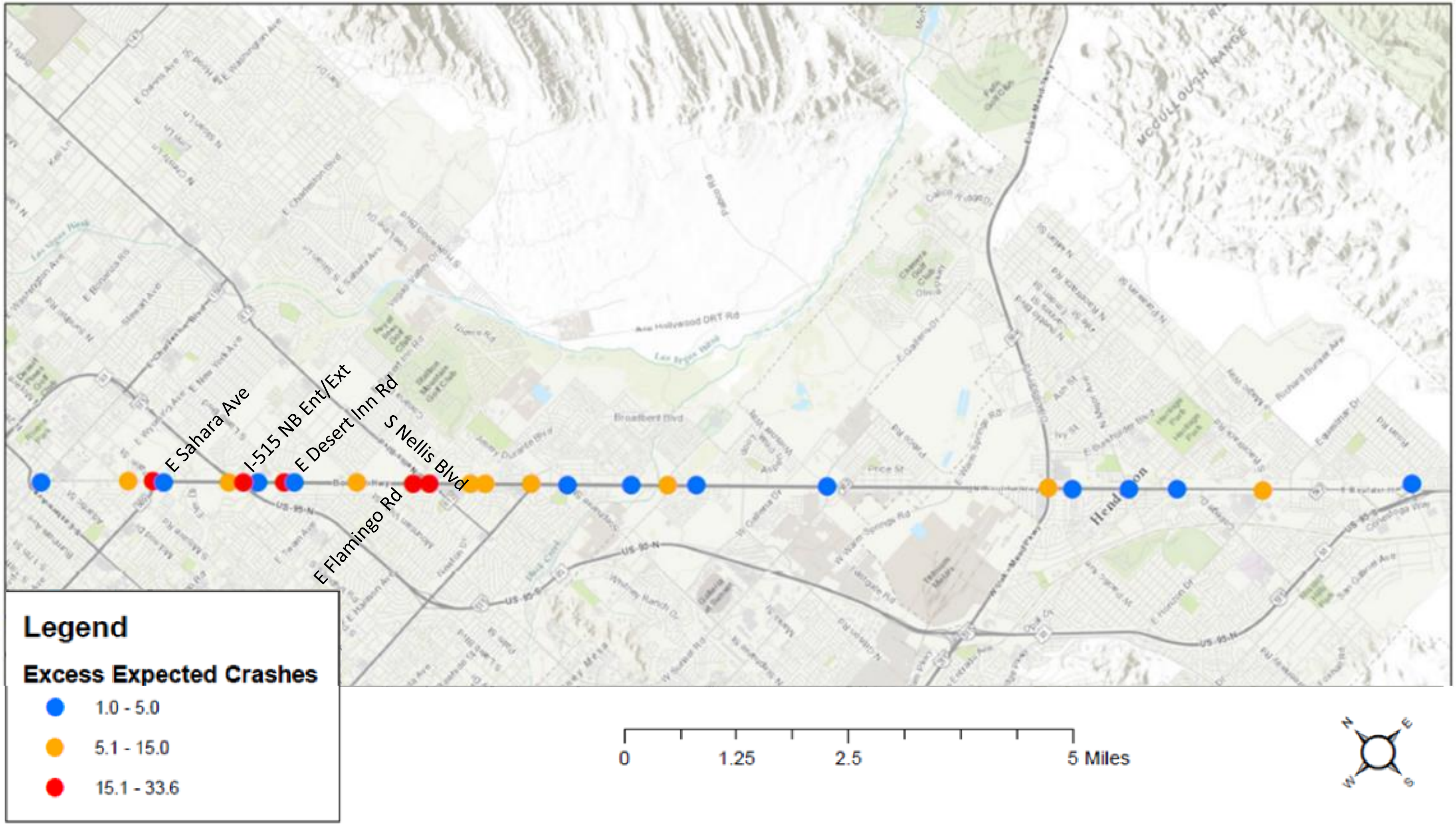

Figure 9. **Excess Crashes at Intersection Compared to Similar Facilities**

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APPENDIX E— Attachment B

Basic Information		Observed Crashes per Year			Predicted Crashes per Year			Expected Crashes per Year			Excess
Intersection Name	Configuration	Total	FI	PDO	Total	FI	PDO	Total	FI	PDO	
E Charleston Blvd	Four Leg Signal	5.8	2.4	3.4	3.4	1.0	2.1	5.2	1.5	3.2	1.8
Altlantic St	Three Leg Minor Stop	0.4	0.4	0.0	2.4	0.8	1.7	0.6	0.4	0.3	-1.8
Atlantic St	Three Leg Minor Stop	0.8	0.6	0.2	2.4	0.8	1.7	0.9	0.5	0.4	-1.5
Olive St	Three Leg Signalized	2.2	1.6	0.6	2.6	0.9	1.6	2.0	1.0	0.9	-0.6
E Oakey Blvd	Three Leg Stop	0.8	0.4	0.4	1.3	0.5	0.8	0.8	0.4	0.5	-0.4
S Mojave Rd	Three Leg Signalized	3.4	1.4	2.0	2.3	0.8	1.4	3.0	1.1	1.7	0.7
E St Louis Ave	Four Leg Signalized	13.0	7.8	5.2	3.4	1.0	2.1	11.3	5.0	4.6	8.0
E Sahara Ave	Four Leg Signalized	24.8	12.4	12.4	6.5	2.0	4.0	22.5	8.8	11.5	16.1
Glen Ave	Three Leg Minor Stop	2.6	0.8	1.8	3.7	1.3	2.7	2.8	0.9	2.0	-0.9
Glen Ave	Three Leg Minor Stop	6.2	2.6	3.6	3.7	1.3	2.7	5.9	2.2	3.5	2.2
Dalhart St	Four Leg Minor Stop	3.8	2.4	1.4	2.6	1.0	1.5	3.1	1.6	1.3	0.5
Ideal Dr	Three Leg Minor Stop	3.0	2.2	0.8	3.5	1.2	2.2	2.7	1.6	1.0	-0.8
S Sandhill Rd	Three Leg Minor Stop	3.2	2.0	1.2	3.7	1.3	2.7	3.1	1.5	1.4	-0.6
I-515 SB Ent/Ext	Four Leg Signalized	21.4	8.8	12.6	7.6	2.5	4.9	19.6	6.5	11.7	11.9
I-515 NB Ent/Ext	Four Leg Signalized	30.4	11.4	19.0	8.9	2.9	5.7	28.1	9.0	17.4	19.2
Boulder Station Casino	Three Leg Minor Stop	5.4	3.2	2.2	2.3	0.9	1.6	4.8	2.5	2.0	2.5
E Desert Inn Rd/S Lamb Blvd	Four Leg Signalized	46.4	21.0	25.4	7.9	2.5	4.9	41.5	15.0	22.7	33.6
E Twain Ave	Three Leg Minor Stop	2.2	1.2	1.0	3.5	1.2	2.6	2.3	1.1	1.2	-1.2
Indios Ave	Four Leg Signalized	12.4	7.8	4.6	4.3	1.4	2.7	10.4	4.5	4.4	6.1
E Flamingo Rd	Four Leg Signalized	28.4	16.0	12.4	6.0	1.9	3.8	25.4	10.9	11.4	19.3
S Nellis Blvd	Four Leg Signalized	30.8	17.4	13.4	6.4	2.0	4.0	26.5	11.0	12.1	20.1
Perry St	Four Leg Minor Stop	2.0	1.4	0.6	2.8	1.1	1.6	1.8	1.0	0.8	-0.9
E Harmon Ave	Four Leg Signalized	15.0	8.8	6.2	4.3	1.3	2.6	13.3	5.9	5.6	9.0
E Sun Valley Dr	Four Leg Minor Stop	21.0	13.6	7.4	2.4	0.9	1.4	16.2	8.3	5.4	13.7

Basic Information		Observed Crashes per Year			Predicted Crashes per Year			Expected Crashes per Year			Excess
Intersection Name	Configuration	Total	FI	PDO	Total	FI	PDO	Total	FI	PDO	
Black Jack Way	Three Leg Minor Stop	0.6	0.4	0.2	2.6	1.0	1.7	0.9	0.6	0.5	-1.7
E Tropicana Ave	Four Leg Signalized	17.2	9.0	8.2	5.1	1.6	3.1	14.6	5.4	7.4	9.5
English Ave	Four Leg Minor Stop	1.6	1.2	0.4	2.1	0.8	1.1	1.5	0.8	0.7	-0.6
Missouri Ave	Four Leg Signalized	8.8	5.0	3.8	3.7	1.1	2.3	7.7	3.2	3.6	4.0
Whitney Ave	Three Leg Minor Stop	2.6	1.2	1.4	2.3	0.9	1.6	2.4	1.0	1.3	0.0
Kentucky Ave	Three Leg Minor Stop	2.6	2.0	0.6	2.3	0.9	1.6	2.6	1.7	0.8	0.2
Desert Horizons Dr	Four Leg Minor Stop	4.2	2.6	1.6	2.3	0.9	1.3	3.4	1.7	1.3	1.0
Emerald Ave	Four Leg Minor Stop	2.4	1.8	0.6	2.3	0.9	1.3	2.3	1.4	0.8	-0.1
E Russell Rd	Four Leg Signalized	16.8	11.0	5.8	3.9	1.2	2.4	14.1	6.5	5.2	10.2
Boulder Ranch Ave	Three Leg Minor Stop	3.0	2.0	1.0	1.6	0.6	1.1	2.7	1.5	1.0	1.0
Tulip Falls Dr	Three Leg Minor Stop	0.6	0.4	0.2	2.3	0.9	1.6	0.9	0.6	0.5	-1.5
Gibson Rd	Four Leg Signalized	4.6	2.0	2.6	4.2	1.3	2.6	4.3	1.5	2.6	0.1
Sky Forest Dr	Three Leg Minor Stop	2.2	1.4	0.8	1.6	0.6	1.1	2.2	1.2	0.9	0.5
Galleria Dr	Four Leg Signalized	2.0	0.4	1.6	3.8	1.2	2.4	2.2	0.6	1.8	-1.6
Elliott Rd	Four Leg Minor Stop	0.0	0.0	0.0	1.8	0.6	1.0	0.5	0.3	0.4	-1.3
W Sunset Rd	Four Leg Signalized	7.0	3.0	4.0	3.9	1.2	2.4	5.9	1.9	3.5	2.0
E Merlayne Dr	Three Leg Minor Stop	0.4	0.2	0.2	2.9	1.0	2.0	0.7	0.4	0.5	-2.2
E Merlayne Dr	Three Leg Minor Stop	0.2	0.2	0.0	2.9	1.0	2.0	0.5	0.4	0.3	-2.4
Foster Ave	Four Leg Minor Stop	1.0	0.6	0.4	2.2	0.8	1.3	1.3	0.7	0.7	-0.9
Coogan Dr	Four Leg Minor Stop	1.0	0.8	0.2	2.2	0.8	1.3	1.1	0.6	0.6	-1.1
E Corn St	Four Leg Minor Stop	1.6	0.4	1.2	2.2	0.8	1.3	1.6	0.4	1.3	-0.6
Barrett St	Four Leg Signalized	3.0	1.4	1.6	4.2	1.3	2.7	3.0	1.2	1.9	-1.2
Rolly St	Four Leg Minor Stop	2.6	1.6	1.0	2.2	0.8	1.3	2.3	1.0	1.1	0.1
Wells St	Three Leg Minor Stop	0.2	0.2	0.0	2.1	0.8	1.4	0.4	0.3	0.3	-1.7
King St	Three Leg Minor Stop	0.2	0.0	0.2	1.5	0.6	1.0	0.4	0.2	0.3	-1.1

Basic Information		Observed Crashes per Year			Predicted Crashes per Year			Expected Crashes per Year			Excess
Intersection Name	Configuration	Total	FI	PDO	Total	FI	PDO	Total	FI	PDO	
Warm Springs Rd	Four Leg Signalized	5.0	2.6	2.4	3.7	1.1	2.3	4.3	1.7	2.2	0.7
N Water St	Three Leg Minor Stop	2.4	1.4	1.0	3.8	1.3	2.9	2.4	1.2	1.2	-1.4
Sturm St	Four Leg Minor Stop	1.0	0.6	0.4	1.9	0.7	1.1	1.2	0.6	0.7	-0.7
Lowery St	Four Leg Minor Stop	1.2	0.4	0.8	2.2	0.8	1.3	1.4	0.5	1.0	-0.8
E Lake Mead Pkwy	Four Leg Signalized	14.4	4.8	9.6	6.9	2.1	4.2	13.6	3.8	9.1	6.7
E Texas Ave	Four Leg Signalized	4.8	1.4	3.4	3.3	1.0	2.0	4.5	1.1	3.2	1.3
Basic Rd	Four Leg Signalized	4.6	3.0	1.6	3.8	1.2	2.3	4.4	2.1	1.8	0.6
Major Ave	Four Leg Signalized	5.4	2.2	3.2	3.7	1.1	2.3	5.2	1.7	3.1	1.5
Greenway Rd/Palo Verde Dr	Four Leg Signalized	5.2	2.4	2.8	3.0	0.9	1.9	4.8	1.8	2.6	1.8
College Dr	Four Leg Signalized	4.0	2.4	1.6	2.3	0.7	1.5	3.1	1.1	1.6	0.8
S Racetrack Dr/E Horizon Dr	Four Leg Signalized	10.0	3.4	6.6	2.9	0.8	1.8	8.4	2.0	5.6	5.5
Equestrian Dr	Four Leg Signalized	2.6	1.4	1.2	1.4	0.4	0.9	2.1	0.8	0.9	0.6
Magic Way	Four Leg Signalized	2.8	1.6	1.2	1.9	0.5	1.2	2.0	0.7	1.0	0.1
Roberts Rd	Three Leg Minor Stop	0.0	0.0	0.0	0.7	0.2	0.4	0.2	0.1	0.2	-0.5
Wagonwheel Dr	Four Leg Signalized	3.6	1.8	1.8	2.1	0.6	1.3	3.1	1.1	1.6	1.0
Mayorga St	Thre Leg Minor Stop	4.6	2.6	2.0	2.3	0.9	1.5	4.3	2.1	1.9	2.0

Basic Information				Observed Crashes per Year			Predicted Crashes per Year			Expected Crashes per Year			Excess
From	To	Length	HSM Type	Total	FI	PDO	Total	FI	PDO	Total	FI	PDO	
Charleston	Atlantic	0.17	4D	0.2	0.2	0.0	0.7	0.2	0.5	0.3	0.1	0.3	-0.4
Atlantic	Olive	0.15	4D	0.0	0.0	0.0	0.6	0.2	0.4	0.2	0.1	0.2	-0.3
Olive	Oakey	0.31	4D	0.6	0.4	0.2	1.2	0.3	0.9	0.7	0.3	0.5	-0.5
Oakey	Mojave	0.24	4D	0.2	0.0	0.2	1.0	0.3	0.8	0.4	0.2	0.3	-0.6
Mojave	St. Louis	0.09	4D	0.0	0.0	0.0	0.4	0.1	0.3	0.2	0.1	0.2	-0.2
St. Louis	Sahara	0.27	4D	0.2	0.2	0.0	1.1	0.3	0.9	0.4	0.2	0.3	-0.7
Sahara	Glen	0.12	4D	0.4	0.2	0.2	0.7	0.2	0.5	0.3	0.1	0.2	-0.4
Glen	Dalhart	0.27	4D	2.0	0.8	1.2	1.6	0.4	1.2	1.7	0.6	1.0	0.1
Dalhart	Ideal	0.16	4D	0.2	0.2	0.0	0.9	0.2	0.7	0.3	0.1	0.3	-0.6
Ideal	Sandhill	0.15	4D	2.2	1.0	1.2	0.8	0.2	0.6	1.4	0.5	0.8	0.5
Sandhill	Veterans SB Ramps	0.14	4D	0.2	0.2	0.0	0.7	0.2	0.5	0.2	0.1	0.2	-0.5
Veterans SB Ramps	Veterans NB Ramps	0.15	4D	1.0	0.6	0.4	1.1	0.3	0.9	0.8	0.4	0.4	-0.3
Veterans NB Ramps	Boulder Station Casino	0.16	4D	0.0	0.0	0.0	1.2	0.3	1.0	0.3	0.1	0.2	-1.0
Boulder Station Casino	Desert Inn	0.30	4D	6.6	2.8	3.8	2.6	0.7	2.0	4.0	0.9	2.5	1.4
Desert Inn	Twain	0.65	4D	8.4	5.2	3.2	3.9	1.1	2.9	6.7	2.6	2.7	2.9
Twain	Indios	0.15	4D	0.6	0.4	0.2	0.7	0.2	0.6	0.5	0.1	0.4	-0.3
Indios	Flamingo	0.61	4D	8.0	6.6	1.4	3.3	0.9	2.6	6.4	3.9	1.4	3.0
Flamingo	Neills	0.18	4D	0.4	0.4	0.0	1.2	0.3	0.9	0.5	0.2	0.3	-0.7
Neills	Perry	0.28	4D	4.8	3.2	1.6	1.6	0.4	1.2	3.3	1.0	1.5	1.7
Perry	Harmon	0.18	4D	0.8	0.4	0.4	1.0	0.3	0.8	0.8	0.4	0.4	-0.2
Harmon	Sun Valley	0.17	4D	1.0	0.8	0.2	1.0	0.3	0.8	0.8	0.4	0.3	-0.2
Sun Valley	Black Jack Way	0.25	4D	0.2	0.2	0.0	1.5	0.4	1.2	0.5	0.2	0.4	-1.0
Black Jack Way	Tropicana	0.25	4D	1.2	0.4	0.8	1.4	0.4	1.1	0.8	0.3	0.5	-0.6
Tropicana	English	0.22	4D	0.8	0.2	0.6	1.0	0.3	0.7	0.5	0.1	0.4	-0.5
English	Missouri	0.18	4D	0.8	0.6	0.2	0.9	0.2	0.7	0.5	0.2	0.4	-0.4

Basic Information				Observed Crashes per Year			Predicted Crashes per Year			Expected Crashes per Year			Excess
From	To	Length	HSM Type	Total	FI	PDO	Total	FI	PDO	Total	FI	PDO	
Missouri	Whitney	0.16	4D	0.4	0.4	0.0	0.8	0.2	0.6	0.5	0.2	0.3	-0.3
Whitney	Kentucky	0.3	4D	2.8	1.6	1.2	1.4	0.4	1.0	2.1	1.0	0.9	0.8
Kentucky	Desert Horizons	0.24	4D	0.4	0.4	0.0	1.1	0.3	0.8	0.5	0.3	0.3	-0.6
Desert Horizons	Emerald	0.16	4D	0.0	0.0	0.0	0.6	0.2	0.5	0.2	0.1	0.2	-0.5
Emerald	Russell	0.25	4D	0.0	0.0	0.0	1.0	0.3	0.8	0.3	0.1	0.2	-0.8
Russell	Boulder Ranch	0.31	4D	1.6	1.0	0.6	1.4	0.4	1.1	1.0	0.3	0.5	-0.5
Boulder Ranch	Tulip Falls	0.37	4D	3.4	2.0	1.4	1.6	0.4	1.2	2.0	0.8	0.8	0.5
Tulip Falls	Gibson	0.15	4D	0.0	0.0	0.0	0.6	0.2	0.5	0.2	0.1	0.2	-0.4
Gibson	Sky Forest	0.27	4D	0.6	0.2	0.4	1.1	0.3	0.8	0.4	0.3	0.2	-0.7
Sky Forest	Galleria	0.17	4D	0.0	0.0	0.0	0.7	0.2	0.5	0.2	0.1	0.2	-0.5
Galleria	Elliot	0.32	4D	0.4	0.4	0.0	1.3	0.4	1.0	0.5	0.3	0.2	-0.8
Elliot	Sunset	0.16	4D	0.0	0.0	0.0	0.7	0.2	0.5	0.2	0.1	0.2	-0.5
Sunset	Merlayne	0.16	4D	0.0	0.0	0.0	0.6	0.2	0.5	0.2	0.1	0.2	-0.4
Merylane	Foster	0.07	4D	0.0	0.0	0.0	0.3	0.1	0.2	0.2	0.1	0.1	-0.1
Foster	Coogan	0.13	4D	0.6	0.4	0.2	0.6	0.2	0.4	0.5	0.1	0.3	-0.1
Coogan	Corn	0.14	4D	0.2	0.0	0.2	0.6	0.2	0.5	0.4	0.1	0.4	-0.2
Corn	Barrett	0.13	4D	0.0	0.0	0.0	0.5	0.1	0.4	0.2	0.1	0.2	-0.3
Barrett	Rolly	0.14	4D	0.0	0.0	0.0	0.6	0.2	0.5	0.3	0.1	0.2	-0.3
Rolly	Wells	0.09	4D	0.0	0.0	0.0	0.4	0.1	0.3	0.2	0.1	0.2	-0.2
Wells	King	0.11	4D	0.0	0.0	0.0	0.5	0.1	0.4	0.2	0.1	0.2	-0.2
King	Warm Springs	0.42	4D	1.0	0.8	0.2	1.7	0.5	1.3	0.8	0.2	0.5	-0.9
Warm Springs	Water	0.46	4D	0.2	0.2	0.0	1.7	0.5	1.3	0.4	0.2	0.2	-1.3
Water	Sturm	0.13	4D	0.0	0.0	0.0	0.5	0.1	0.4	0.2	0.1	0.2	-0.3
Sturm	Lowery	0.21	4D	0.0	0.0	0.0	0.8	0.2	0.6	0.2	0.1	0.2	-0.6
Lowery	Lake Mead	0.23	4D	0.2	0.0	0.2	0.9	0.2	0.7	0.4	0.1	0.4	-0.5
Lake Mead	Texas	0.26	4D	0.6	0.2	0.4	1.1	0.3	0.9	0.8	0.3	0.5	-0.4
Texas	Basic	0.34	4D	0.4	0.2	0.2	1.3	0.4	1.0	0.6	0.3	0.4	-0.7

Basic Information				Observed Crashes per Year			Predicted Crashes per Year			Expected Crashes per Year			Excess
From	To	Length	HSM Type	Total	FI	PDO	Total	FI	PDO	Total	FI	PDO	
Basic	Major	0.29	4D	0.2	0.0	0.2	1.1	0.3	0.9	0.4	0.1	0.3	-0.8
Major	Greenway	0.53	4D	3.4	1.8	1.6	2.4	0.7	1.9	1.5	0.6	0.8	-0.9
Greenway	College	0.28	4D	0.0	0.0	0.0	1.1	0.3	0.8	0.3	0.1	0.2	-0.8
College	Racetrack	0.68	4D	2.0	0.6	1.4	2.8	0.8	2.2	1.6	0.4	1.2	-1.2
Racetrack	Equestrian	0.31	4D	0.2	0.0	0.2	0.6	0.2	0.5	0.3	0.1	0.3	-0.3
Equestrian	Magic Way	0.58	4D	0.2	0.0	0.2	1.1	0.3	0.9	0.4	0.1	0.4	-0.7
Magic Way	Roberts	0.19	4D	1.0	0.4	0.6	0.4	0.1	0.3	0.5	0.1	0.4	0.2
Roberts	Wagonwheel	0.58	4D	1.2	0.2	1.0	1.1	0.3	0.8	1.2	0.1	1.0	0.1

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APPENDIX F—

ROADWAY CONDITIONS

Appendix F. Roadway Conditions

Boulder Highway was built in 1931 to connect the Five Points (today Charleston Boulevard) intersection to the railroad pass with the purpose of transporting people and materials for the construction of Hoover Dam. This road was the only highway in the valley carrying State Route 5 and later serving as U.S. Routes 93, 95 and 466. Although many components of this roadway have been reconstructed over the years, considering the age of this facility many roadway components may lack compliance with the current local, state, and national standards. The purpose of this summary is to document current roadway configuration and evaluate compliance with some of the standards based on visual field observations. A more detailed evaluation of specific locations and components will be required in the future as improvements are proposed.

F.1. Roadway Functional Classification

Boulder Highway is a state highway based on the NDOT Access Management Systems and Standards (AMSS) (2017) and is classified as a "Roadway Class Three - Principal Arterial" for the entire approximately 15-mile length of the corridor from Wagonwheel Drive to Charleston Boulevard. Based on the NDOT's AMSS, roadways included in this class "are intended for the movement of high volumes of traffic at high speeds over long intercity and intracity distances". Additionally, "this class of roadway carries the major portion of trips entering and leaving the urban area and interconnects major areas of development within the urbanized area".

The history of this highway indicates that the area surrounding Boulder Highway started developing in the early 1980s, and for a long time this highway served as US Route 95 until the construction of I-515 in the early 1990s. The construction of I-515 and the expansion of the urbanized area has gradually impacted the function of Boulder Highway as a Class Three - Principal Arterial facility. Some of the changes in character of this roadway are outlined below:

Shorter Trips. While this highway can still be used as an alternative route to I-515, high speed and long-distance trips connecting Boulder City, City of Henderson, and City of Las Vegas, take place on I-515. A review of Travel Demand origin-destination data indicates that the average trip length on Boulder Highway is 2 miles. A more detailed analysis of Travel Patterns is provided in Appendix D.

Increased Number of Access Points. The number of access points has increased over the years, increasing the number of conflict points and potential for crashes. An analysis of the access point density as compared to the NDOT AMSS is provided in Section F.6 below.

Speed Limit. The urbanization of land surrounding Boulder Highway and increased pedestrian activity in the corridor necessitated the lowering of the speed limit from 55mph to 45 mph along the entire corridor.

F.2. Roadway Configuration

Boulder Highway is a divided highway with two (2) to four (4) general purpose lanes in each direction as the roadway transitions from the undeveloped areas in the south to the developed areas to the north. Median breaks are typically rare, with only the largest attractions and cross-streets having median breaks for access. The median width varies from 15' to 65' and is used to accommodate the left turn lanes at the major intersections. There are 31 signalized intersections with added left and right turn lanes. A dedicated transit lane in each direction from Tropicana Avenue to just South of Charleston Boulevard accommodates the Boulder Highway Express (BHX) route. As described in Appendix B, six primary segments were identified along Boulder Highway that have similar context and characteristics. The roadway lane configuration components for each of these segments are summarized in Table 1 below.

Table 1. Roadway Configuration and Components

	Segment	Length (miles)	General Purpose Lanes	Transit Lanes	Lane width (feet)	Speed Limit (mph)
1	Wagonwheel Dr. to Palo Verde Dr.	2.5	4	0	12	45
2	Palo Verde Dr. to Water St.	2.0	6	0	12	45
3	Water St. to Tulip Falls Dr.	3.0	6		12	45
4	Tulip Falls Dr. to Tropicana Ave.	2.25	6	0	12	45
5	Tropicana Ave. to I-515	3.25	6	2	12	45
6	I-515 to Charleston Blvd.	2.25	6	2	12	45

F.3. Pedestrian Facilities

A review of conditions for all pedestrian facilities was performed utilizing field observations, aerial maps from Google, and construction plans where available. The analysis included a review of conditions of sidewalks, pedestrian ramps, driveways interrupting the sidewalks, and mid-block crossings.

F.3.1. Sidewalks

The type of pedestrian facilities on Boulder Highway varies along the length of the corridor. For the purposes of this analysis, sidewalk condition was categorized into three primary types: “sidewalk”, “multi-use trail”, and “no facilities present”. A “non-continuous” subcategory was created for sidewalks and multi-use trails to highlight areas where a sidewalk or trail is present, but a moderate gap exists (between 100 and 200 feet) or where the facility stops short of the intersection. Figure 1 through Figure 6 show examples from the corridor of the various categories of pedestrian facilities along Boulder Highway.

Figure 1. Segment 1- Multi-use Trail: East side of Boulder Highway at Racetrack Road, looking north

Figure 2. Segment 1 - Multi-use trail with gaps: East side of Boulder Highway between Wagonwheel Drive and Magic Way, looking east

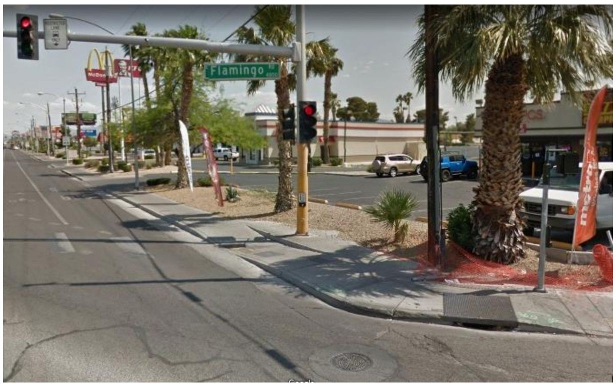

Figure 3. Segment 5 – Sidewalk: West side of Boulder Highway at Flamingo Road, looking south

Figure 4. Segment 6 - Sidewalk with gaps: East side of Boulder Highway between Mojave Road and Olive Street, looking north

Figure 5. Segment 3 - No pedestrian facilities present: West side of Boulder Highway between Sunset Road and Galleria Drive, looking south

Figure 6. Segment 4 - Sporadic pedestrian facilities present: West side of Boulder Highway between Russell Road and Whitney Avenue, looking south

The existing sidewalks are typically five to six-foot attached concrete with directional curb ramps at intersections. At several locations in the study area, the sidewalk is interrupted by driveway access curb-cuts, which in some sections of the corridor have a frequency of over 50 driveways per mile.

In the southern portion of corridor Segments 1-3, south of Water Street there are no or limited sidewalks; however, there is multi-use trail present between Wagonwheel Drive and Palo Verde Drive on the east side, and from Equestrian Drive to Water Street on the west side. Between Water Street and Missouri Avenue, on both sides of the corridor, there is either no pedestrian facilities present or sections with sporadic pedestrian facilities which render the facility non-continuous. Segments 5 and 6 north of Tropicana Avenue have continuous or non-continuous sidewalks in relatively good condition. From Tropicana Avenue to Desert Inn Road, sidewalks are present on both sides of the corridor. Between Desert Inn Road and the end of the study area at Charleston Boulevard, sidewalk facilities are mostly present and continuous. The exception to this is the section between Desert Inn Road and NB I-515 Ramps, on the west side, and between Mojave Road and Olive Street, on both sides of the corridor, where gaps exist in the sidewalk facility. On the east side, between SB I-515 and Sahara Avenue the pedestrian facility is sporadic, non-continuous sidewalk.

0 shows the type and state of pedestrian facilities along Boulder Highway.

Figure 7. Pedestrian Facilities Along Boulder Highway

F.3.2. Pedestrian Ramps

Meeting ADA requirements is important not just legally, but for fostering the multimodal-inclusive, community-focused corridor as envisioned for Boulder Highway. Ensuring accessibility makes multimodal travel safer and more attractive for all, fulfilling the vision of Boulder Highway as a welcoming and vibrant community asset.

Pedestrian ramps throughout the corridor were checked for Americans with Disabilities Act (ADA) compliance. The ADA compliance for sidewalk ramps necessitate certain requirements such as 2% cross slopes and a tactile warning panel.

A total of 203 sidewalk ramps were reviewed, of which 31 were found to violate ADA standards. The noncompliant ramps are concentrated at specific intersections throughout the corridor: College Drive, Major Avenue, Texas Avenue, Warm Springs Road, Barrett Street, Broadbent Boulevard, Missouri Avenue, and Nellis Boulevard. At some intersections along Boulder Highway, such as College Drive and Texas Avenue, the sidewalk ramps do not have a tactile warning panel, creating issues for pedestrians with visual disabilities. The full inventory of sidewalk ramps and ADA compliance can be found in Appendix C.

F.3.3. Pedestrian Crossings

There are 31 signalized intersections in the study area and three mid-block crossings that provide some designated roadway crossings for pedestrians. NDOT is in the process of constructing eight additional crossings at the locations shown in Figure 8, which will bring the total number of mid-block crossings to 11. This creates an average density of 2.8 crossings per mile.

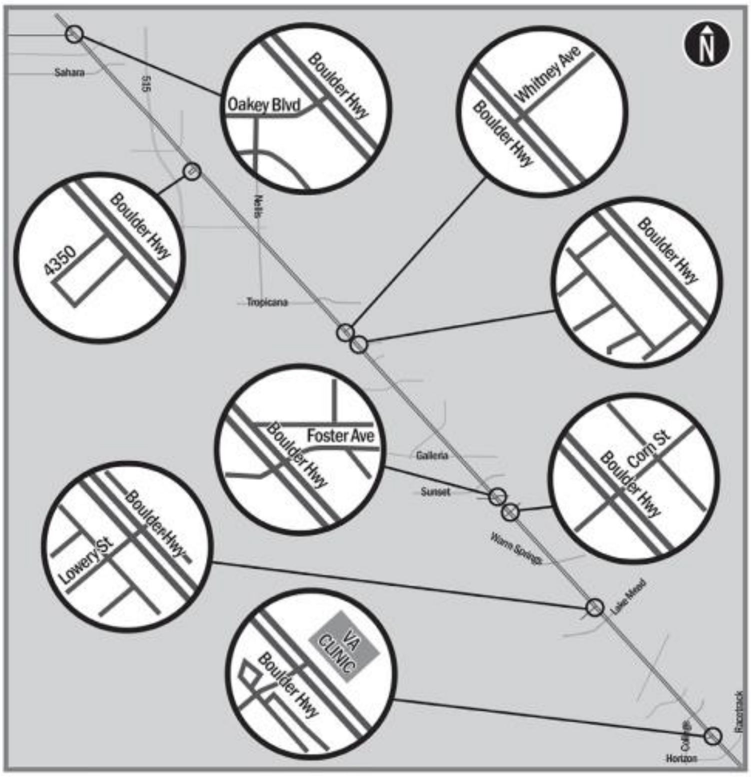

Figure 8. New Mid-Block Crossing Locations (Source: NDOT)

The new mid-block crossings include overhead rapid flashing beacons, median enhancements, advance pedestrian crossing warning signs, and new crosswalks. Project improvements include the following:

- Oakey Boulevard –overhead rapid flashing beacons in both directions, with pedestrian crossing warning signs and lights, and a new crosswalk.
- Boulder Palms Senior Apartment Community, 4350 Boulder Highway – overhead rapid flashing beacons in both directions, with pedestrian crossing warning signs and lights, a new Danish offset median and a new crosswalk.
- Whitney Avenue – overhead rapid flashing beacons in both directions, with pedestrian crossing warning signs and lights, a new Danish offset, median reconfiguration, and a new crosswalk.
- Hamilton Avenue – overhead rapid flashing beacons in both directions, pedestrian crossing warning signs and lights, a new Danish offset, median upgrades, and a new crosswalk.
- Corn Street – overhead rapid flashing beacons in both directions, pedestrian crossing warning signs and lights, a new Danish offset, median upgrades and a new crosswalk.
- Foster Avenue – overhead rapid flashing beacons in both directions, pedestrian crossing warning signs and lights, a new Danish offset, median upgrades, and a new crosswalk.

- Lowery Street – overhead rapid flashing beacons in both directions, pedestrian crossing warning signs and lights, a new Danish offset, median upgrades, and a new crosswalk.
- Veterans Affairs Southeast Clinic, 1020 S. Boulder Highway – overhead rapid flashing beacons in both directions, pedestrian crossing warning signs and lights, a new Danish offset, median upgrades, and a new crosswalk.

Where signalized crossings exist, intersections are generally equipped with push-button plates and count-down timers with audible locator tones during the crossing phase. Crosswalks are striped with typical “zebra” crossing symbols.

Because of the wide cross-section of the roadway and the skewed crossing with east-west arterials, pedestrian crossing distances are extremely high varying from 110 feet to 250 feet with the Nellis Boulevard Intersection having the longest crossing distance. Due to these distances, signal crossing times are reduced at many intersections enabling people to cross only one side of the roadway, wait a complete signal cycle, and cross the second half of the roadway. Refuge islands in the median create some separation for pedestrians while waiting to cross the second half of the corridor. An example of the existing pedestrian islands on the corridor is shown in Figure 9. This operational pattern causes additional delay for people walking and could encourage non-compliance with the pedestrian crossing phase.

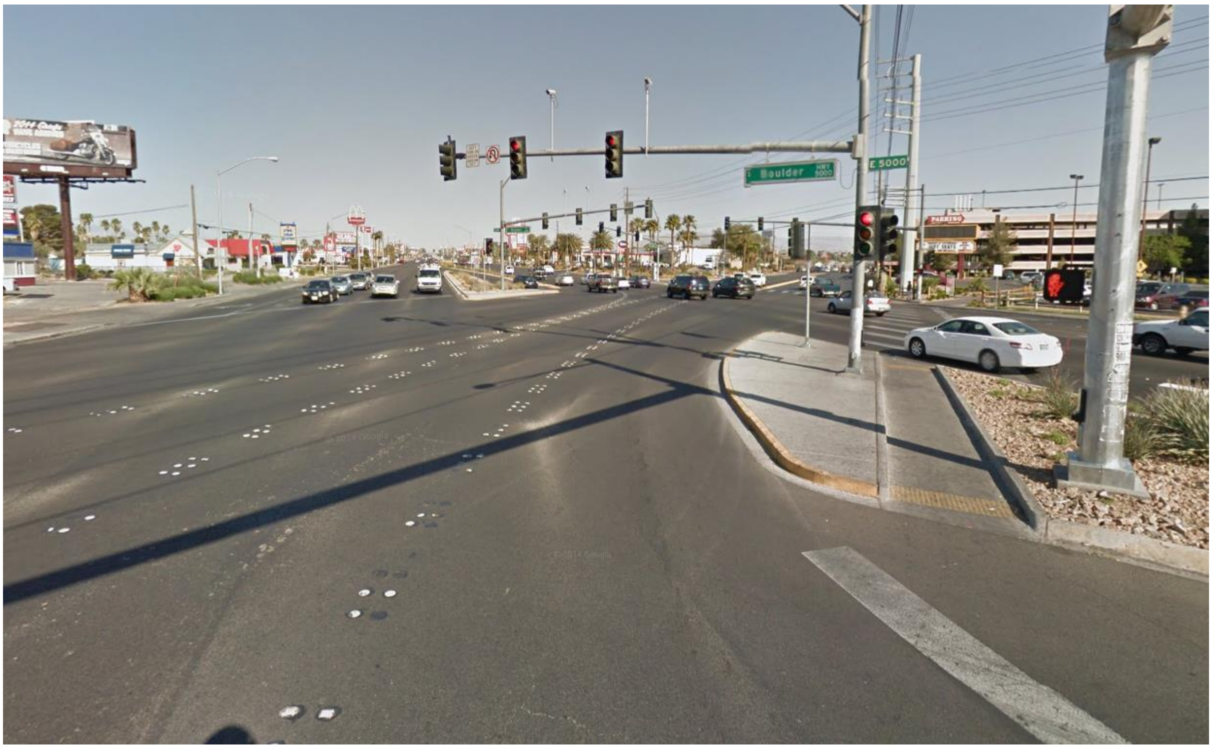

Figure 9. Pedestrian Refuge Island at S. Nellis Boulevard

The mid-block crossing locations use two different traffic control devices. The newest of these devices, located at all new crossings installed recently by NDOT, and the one on Harmon Avenue is a rectangular rapid-flashing beacon (RRFB) with push-button actuation on both sides of the roadway and at the center refuge island. The mid-block crossings, located at Whitney Avenue and Sun Valley Drive, are continuous overhead flashing beacons. A refuge island exists at the Sun Valley Drive intersection.

There is one grade-separated bridge crossing accommodating the Flamingo Arroyo Trail that crosses Boulder Highway. This structure is over 800 feet from ramp to ramp at the street grade, requiring a person walking to travel nearly 1,375 linear feet or over a quarter mile to complete the crossing using the bridge, including out of direction travel to get to the beginning of the bridge ramps. The roadway curb-to-curb distance is 160 feet at that location.

F.4. Bicycle Facilities

Various types of bicycle facilities exist along Boulder Highway in the study area. Conventional bike lanes are signed and marked from Tropicana Avenue to Olive Street just south of Charleston Boulevard. From Sunset Road to Tropicana Avenue no bicycle facilities are present. From Water Street to Sunset Road the bicycle lane is accommodated on an 8 to 10-foot paved shoulder. South of Water Street no bicycle lanes are available. However, the multi-use Boulder Highway Trail meanders along the west and east side of Boulder Highway from Water Street to Wagonwheel Drive.

F.5. Right of Way

Boulder Highway is entirely located on a public right of way (ROW) easement. The width of the ROW varies along the corridor. The ROW line is displayed on the GIS inventory maps included in Appendix C. Table 2 shows the range of ROW width along each segment.

Table 2. ROW width along Boulder Highway

Segment		Length (miles)	ROW (feet)	Average Roadway width* (feet)
1	Wagonwheel Dr. to Palo Verde Dr.	2.5	320 – 670	150
2	Palo Verde Dr. to Water St.	2.0	225 – 450	160
3	Water St. to Tulip Falls Dr.	3.0	200 – 400	170
4	Tulip Falls Dr. to Tropicana Ave.	2.25	190 – 210	180
5	Tropicana Ave. to I-515	3.25	200 – 210	170
6	I-515 to Charleston Blvd.	2.25	105 – 210	165

(*) roadway width is measured from the back of sidewalk to the other back of the sidewalk

In relation to the ROW, the current roadway facility is not located at the center of ROW. Therefore, this needs to be considered in developing any new roadway concept alternatives outside the current footprint.

Field observations indicate that at many locations along the corridor private properties have encroached into the public right of way. Landscaping and parking lots are primarily built adjacent to the sidewalk within the ROW.

F.6. Access Management Standards

The 2017 NDOT Access Management Systems and Standards (AMSS) were used to provide a comparison of existing spacing and access design with the new standards. A total of 505 access points along the corridor were inventoried into the GIS data base and were evaluated for compliance. Table 3 below provides a comparison of Boulder Highway average values or range of access spacing and corner clearance values to the current standards.

Table 3. Comparison of Boulder Highway Access Spacing to the 2017 AMSS

Criteria Description	Current Standard	Boulder Highway Existing Conditions
Full Access Spacing Signalized Unsignalized	 2640’ 1320’	Average 2,675’
Limited Access Spacing Left In /Right In/Right Out Right In/Right Out	 990’ 660’	 Average 809’ – 4448’ Average 120’ – 2566’
Upstream Corner Clearance	460”	Average 182’
Downstream Corner Clearance	360’	Average 243’

As indicated by Table 3 and field observations, there are many locations along Boulder Highway where driveways are spaced less than 660 feet apart and, in some cases, as close as 0 to 10 feet apart. Within some sections of the corridor, the sidewalk is crossed by more than 50 driveways per mile as shown in Figure 10. For example, there are 55 driveways per mile between Nellis Boulevard and Flamingo Road.. For Class Three Principal Arterial, the AMSS indicates that “Generally, only one access will be allowed per parcel or for contiguous parcels under one ownership. The driveway analysis indicated that only approximately 58% of access points along boulder highway belong to either a public road or dedicated to a single parcel as required by the AMSS. Many parcels have 2-7 driveway’s per parcel which make 42% of total access points along Boulder Highway. The analysis also indicates that many access points along the corridor lead to empty/undeveloped parcels. In some cases, there are lengths of sidewalk that used to front properties—which no longer exist—creating an uneven sidewalk for pedestrians. The implications of closely spaced driveways include:

- Increases conflict points and as a result increased potential for angle crashes
- Creates an uneven path for pedestrians and poor walking conditions

The AMSS identifies four types of access connections as shown in **Error! Reference source not found.** below:

Table 4. Types of Access Connections (Source: 2017 AMSS, NDOT, page 41)

Type of Connection	Use
Non-commercial	For access to single-family swellings Multiple family dwellings of three or fewer dwelling units Agricultural land and field access Emergency gated access
Minor Commercial	Medium volume generator (fewer than 500 vehicles per day)
Major Commercial	High volume generators (500 or more vehicles per day) Provides access to shopping centers, industrial parks, office parks, colleges, residential complexes, and subdivisions, etc.
Public or Private Roads	New public or private roads or streets

Figure 10. Driveway Frequency

The GIS database driveway inventory includes information on design components of each driveway and an assessment to design standard compliance, based on field observations. A sample of the driveway inventory data is shown in Table 5.

Table 5. Typical Driveway Component Summary

Driveway/Access	Driveway / Access Component	
	Entry width	50'
	One- or two-way operation	2
	Median opening (if there is one)	None
	Width of shoulder	10'
	Throat Length	85'
	Type of Access Connection	Public or Private Road
	Location of overhead lighting, if available	Yes
	Throat width	36'
	One- or two-way operation	2
	Median opening (if there is one)	None
	Width of shoulder	10'
	Throat Length	40'
	Type of Access Connection	Commercial
	Location of overhead lighting, if available	Yes
	Throat width	34'
	One- or two-way operation	2
	Median opening (if there is one)	None
	Width of shoulder	10'
	Throat Length	14'
	Type of Access Connection	Commercial
	Location of overhead lighting, if available	None
	Total throat width	22'
	One- or two-way operation	1
	Median opening (if there is one)	None
	Width of shoulder	10'
	Throat length	10'
	Type of Access Connection	Commercial

<table>
<tr><th>Driveway/Access</th><th colspan="2">Driveway / Access Component</th></tr>
<tr><td>
</td><td>Location of overhead lighting, if available</td><td>None</td></tr>
<tr><td rowspan="7">
</td><td>Throat width</td><td>100'</td></tr>
<tr><td>One- or two-way operation</td><td>2</td></tr>
<tr><td>Median opening (if there is one)</td><td>16'</td></tr>
<tr><td>Width of shoulder</td><td>10'</td></tr>
<tr><td>Throat length</td><td>12'</td></tr>
<tr><td>Some sense of heavy vehicle use (i.e. Warehouse, delivery docks, etc.)</td><td>Commercial</td></tr>
<tr><td>Location of overhead lighting, if available</td><td>Yes</td></tr>
<tr><td rowspan="7">
</td><td>Throat width</td><td>40'</td></tr>
<tr><td>One- or two-way operation</td><td>2</td></tr>
<tr><td>Median opening (if there is one)</td><td>None</td></tr>
<tr><td>Width of shoulder</td><td>0'</td></tr>
<tr><td>Throat length</td><td>100'</td></tr>
<tr><td>Type of Access Connection</td><td>Commercial</td></tr>
<tr><td>Location of overhead lighting, if available</td><td>Yes</td></tr>
<tr><td rowspan="7">
</td><td>Throat width</td><td>130'</td></tr>
<tr><td>One- or two-way operation</td><td>2</td></tr>
<tr><td>Median opening (if there is one)</td><td>None</td></tr>
<tr><td>Width of shoulder</td><td>0'</td></tr>
<tr><td>Throat Length</td><td>180'</td></tr>
<tr><td>Type of Access Connection</td><td>Public or Private Road</td></tr>
<tr><td>Location of overhead lighting, if available</td><td>Yes</td></tr>
</table>

The NDOT Design Standards according to NDOT STD. DWG. R-5-3-2, require a 1.5% driveway cross slope which is more stringent than the Uniform Standard Drawings for Clark County Area CCAUSE 223 and 224, that require the driveway cross slopes not to exceed a maximum 2 percent and transition slopes not to exceed a slope of 1:12. Visual field observations indicate that approximately 54% of driveways have slopes that are greater than these standards. This creates an uncomfortable walking experience for pedestrians and can lead to mobility concerns for pedestrians utilizing mobility devices as traversing excess slopes or uneven surfaces can be difficult and dangerous.

F.7. Lighting

F.7.1. Intersection Lighting Analysis

Analysis of lighting at intersections was conducted to determine if the existing lighting is adequate. Intersection lighting analysis measures the lighting level throughout an intersection to identify areas with deficient lighting.

Existing lighting plans were not available; therefore, a lighting analysis was conducted for a representative intersection. The intersection of Boulder Highway and St. Louis Avenue was selected because lighting at this intersection uses the same basic configuration that is found throughout the Boulder Highway corridor. Because no plans were available, lighting was assumed to be mounted on conventional poles and assumptions were made for the mounting height and luminaire wattage. Photometric lighting calculations were performed using the following parameters:

- Location of the light poles as indicated in Figure 11.
- A nominal luminaire mounting height of 35 ft was assumed.
- For signal poles, the luminaire type was assumed to be GE flat-lens cobra-head with 400-watt medium cut-off type 3 photometric distribution Curve No. 1002.
- For standard conventional poles, the luminaire type was assumed to be GE flat-lens cobra-head with 250-watt medium cut-off type 3 photometric distribution Curve No. 1002.

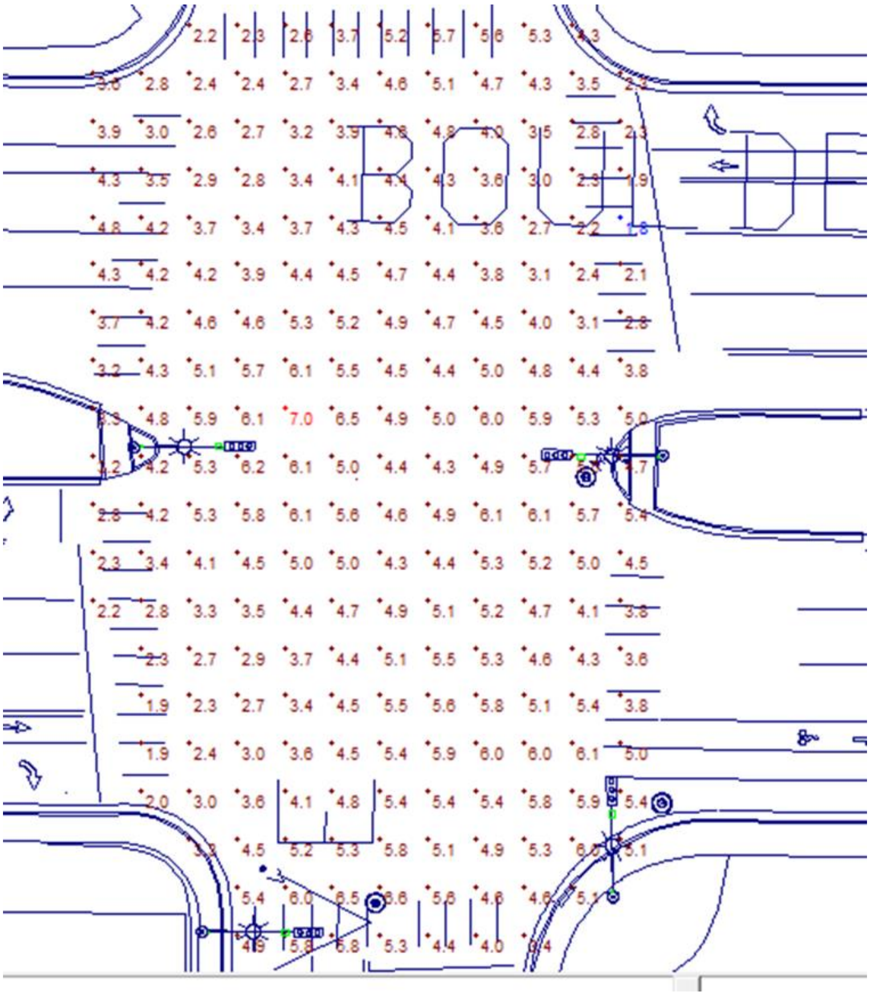

Figure 11. Lighting Analysis Results and Luminaire Analysis Results

The lighting analysis results indicate that existing lighting meets the requirements of RTC Standard Drawing 300.S3 Table 2 for signalized intersections. Lighting analysis results are summarized in Table 6 below.

Table 6. Boulder Highway and St. Louis Avenue Lighting Analysis Results

Location	Average	Maximum	Minimum	Max/Min	Avg/Min
Boulder Highway at St. Louis Ave	4.4 foot-candles	7.0 foot-candles	1.8 foot-candles	3.9:1	2.4:1

In addition to this analysis, field observations and a geospatial analysis of lighting availability was performed for the entire corridor. A summary of lighting conditions by segment is provided below. The graphical representation of lighting availability is shown in Appendix C – Data Collection and Spatial Analysis of Data.

Segment 1 – Wagonwheel Drive to Palo Verde Drive

Lighting throughout segment 1 is concentrated at the intersections. Lighting throughout the segment is inconsistent. From Wagonwheel Drive to Equestrian Drive, lighting is placed about 800 feet apart along the median. From Equestrian Drive to Palo Verde Drive, lighting is placed about 100 feet apart along the median, northbound lanes, and southbound lanes.

Segment 2 – Palo Verde Drive to Water Street

Lighting throughout segment 2 is concentrated at the intersections. Lighting is consistent throughout the segment, placed about 100 feet apart. Placement of lighting is consistent from intersection to intersection (ie median, northbound, southbound. There is a lack of lighting between Major Avenue and Basic Road.

Segment 3 – Water Street to Tulip Falls Drive

Lighting throughout segment 3 is concentrated at the intersections. Lighting is inconsistent throughout the segment. Lighting is placed about 100 feet apart with the exception of Water Street to Warm Springs Road, Sunset Road to Galleria Drive, and Galleria Drive to Broadbent Boulevard/Gibson Road where lighting is sparse.

Segment 4 – Tulip Falls Drive to Tropicana Avenue

Lighting throughout segment 4 is concentrated at the intersections. Lighting is consistently placed about 150’ apart along developed parcels northbound and southbound. There is a lack of lighting in front of undeveloped parcels.

Segment 5 – Tropicana Avenue to I-515

Lighting throughout segment 5 is concentrated at the intersections. Lighting is consistently placed about 100’ apart along developed parcels northbound and southbound. There is a lack of lighting in front of undeveloped parcels.

Segment 6 – I-515 to Charleston Boulevard

Lighting throughout segment 6 is concentrated at the intersections. Lighting is consistently placed about 100’ apart northbound and southbound. There are a few cases in which driveways are too wide to allow for spacing to be 100’ apart.

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APPENDIX G—
UTILITY INVENTORY

Appendix G. Utilities Inventory

Existing utility plans were requested from multiple providers including NV Energy, Southwest Gas (SWG), City of Henderson (COH), Century Link, COX, Clark County Water Reclamation District (CCWRD), and Las Vegas Valley Water District (LVVWD).

The obtained plans were utilized to identify utility locations and evaluate the utility infrastructure that would be affected by the implementation of the proposed plan. The type and quantity in total linear feet of affected utilities by ownership is presented in Table 1 and Figure 1.

Table 1. Utilities by item and owner

OWNER	Item	Length (feet)	Percentage
COX	Cable TV	5,978	2.01%
SWG	Gas Under 14 inch	27,893	9.37%
SWG	Gas Under 14 inch Abandoned	25,049	8.41%
SWG	Gas 14 inch - 24 inch	8,214	2.76%
SWG	Gas Over 24 inch	4,884	1.64%
SWG	Gas High Pressure 10 inch	8,803	2.96%
SWG	Gas High Pressure 12 inch	1,001	0.34%
NVE	Power Buried	7,052	2.37%
NVE	Power Overhead	84,783	28.47%
CCWRD	Sanitary Sewer Under 12 inch	8,569	2.88%
CCWRD	Sanitary Sewer 12 inch - 24 inch	4,962	1.67%
CCWRD	Sanitary Sewer Over 24 inch	2,470	0.83%
COH	Sanitary Sewer Under 12 inch	12,483	4.19%
COH	Sanitary Sewer 12 inch - 24 inch	26,769	8.99%
COH	Sanitary Sewer Over 24 inch	1,410	0.47%
CENTURYLINK	Telephone	11,409	3.83%
LVVWD	Water Line Under 12 inch	8,766	2.94%
LVVWD	Water Line Under 12 inch Abandoned	738	0.25%
LVVWD	Water Line 12 inch - 24 inch	9,496	3.19%
LVVWD	Water Line Over 24 inch	984	0.33%
LVVWD	Water Line Over 24 inch Abandoned	1,005	0.34%
COH	Water Line Under 12 inch	16,034	5.38%
COH	Water Line 12 inch - 24 inch	18,537	6.22%
COH	Water Line Over 24 inch	552	0.19%

As shown in Table 1, the overhead power lines represent the highest percentage, 28.47%, of the total utilities impacted, followed by underground 14 inch gas lines with 9.37%. Relocation of these utilities tends to be expensive and requires extensive coordination.

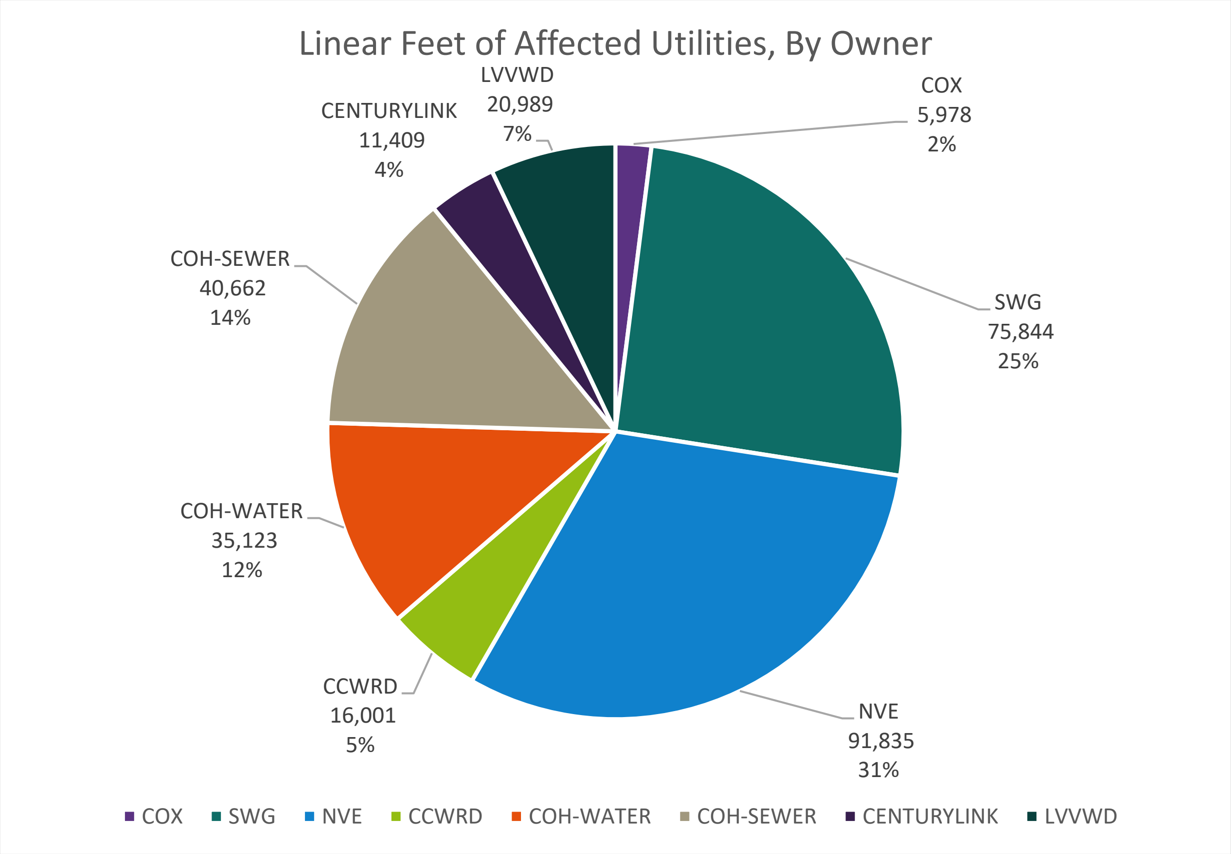

Figure 1. Impacted utilities by owner

A total of 31% of the utilities along Boulder Highway belong to NV Energy and 25% of utilities belong to Southwest Gas. Establishing who has prior rights along the corridor is key to estimating the impact of utility relocation to the overall project cost.

To better understand the concentration of utilities impacted along the corridor an analysis of total utilities length by segment is performed and shown in Figure 2.

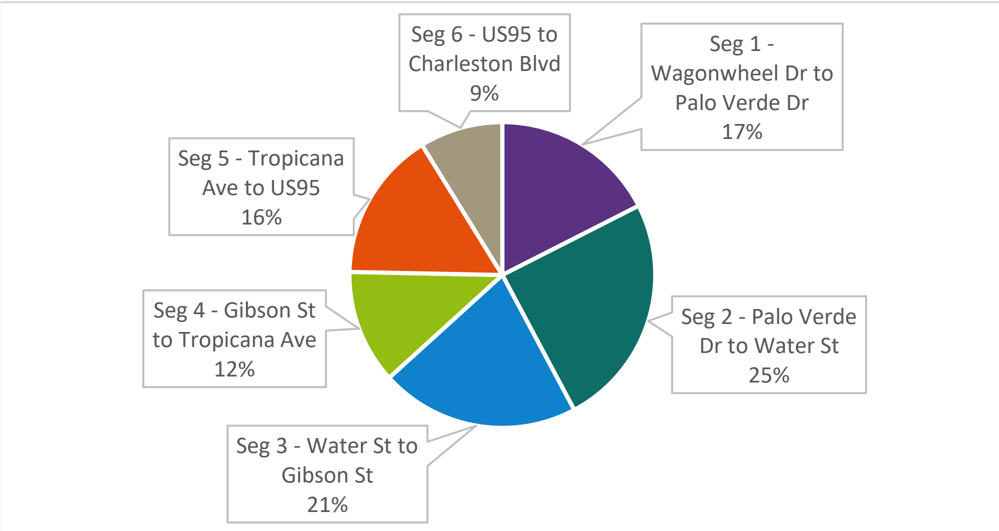

Figure 2. Total utilities length by segment

Affected utility types by owner for each segment of the corridor are summarized in Tables 2-7 below.

Table 2. Affected utility types by owner - Segment 1 (Wagonwheel Dr. to Palo Verde Dr.)

No.	Owner	Item	Quantity Linear Feet	Percentage
1	COX	Cable TV	1,820	3.5%
2	SWG	Gas Under 14 inch	6,950	13.3%
3	SWG	Gas Under 14 inch Abandoned	14,371	27.5%
4	SWG	Gas 14 inch - 24 inch	562	1.1%
5	NVE	Electric Buried	1,575	3.0%
6	NVE	Electric Overhead	6,935	13.3%
7	COH	Sanitary Sewer Under 12 inch	3,387	6.5%
8	COH	Sanitary Sewer 12 inch - 24 inch	8,367	16.0%
9	CENTURYLINK	Telephone	623	1.2%
10	COH	Water Line Under 12 inch	5,052	9.7%
11	COH	Water Line 12 inch - 24 inch	2,542	4.9%

Table 3. Affected utility types by owner - Segment 2 (Palo Verde Dr to Water St)

No.	Owner	Item	Quantity Linear Feet	Percentage
1	COX	Cable TV	2,065	2.8%
2	SWG	Gas Under 14 inch Abandoned	10,334	14.1%
3	SWG	Gas 14 inch - 24 inch	7,272	9.9%
4	SWG	Gas High Pressure 10 inch	8,803	12.0%
5	SWG	Gas High Pressure 12 inch	579	0.8%
6	NVE	Electric Buried	266	0.4%
7	NVE	Electric Overhead	12,163	16.5%
8	COH	Sanitary Sewer Under 12 inch	918	1.2%
9	COH	Sanitary Sewer 12 inch - 24 inch	9,223	12.5%
10	CENTURYLINK	Telephone	3,209	4.4%
11	COH	Water Line Under 12 inch	6,887	9.4%
12	COH	Water Line 12 inch - 24 inch	11,247	15.3%
13	COH	Water Line Over 24 inch	552	0.8%

Table 4. Affected utility types by owner - Segment 3 (Water St to Tulip Falls Ave)

No.	Owner	Item	Quantity Linear Feet	Percentage
1	COX	Cable TV	538	0.9%
2	SWG	Gas Under 14 inch	11,461	18.3%
3	SWG	Gas Under 14 inch Abandoned	156	0.2%
4	SWG	Gas 14 inch - 24 inch	380	0.6%
5	NVE	Electric Buried	953	1.5%
6	NVE	Electric Overhead	18,504	29.5%
7	COH	Sanitary Sewer Under 12 inch	8,178	13.0%
8	COH	Sanitary Sewer 12 inch - 24 inch	9,179	14.6%
9	COH	Sanitary Sewer Over 24 inch	1,410	2.2%
10	CENTURYLINK	Telephone	3,124	5.0%
11	COH	Water Line Under 12 inch	4,095	6.5%
12	COH	Water Line 12 inch - 24 inch	4,748	7.6%

Table 5. Affected utility types by owner - Segment 4 (Tulip Falls Ave. to Tropicana Ave.)

No.	Owner	Item	Quantity Linear Feet	Percentage
1	SWG	Gas Under 14 inch	1,256	3.5%
2	SWG	Gas High Pressure 24 inch	4,884	13.6%
3	NVE	Electric Buried	4,136	11.5%
4	NVE	Electric Overhead	13,270	37.0%
5	CCWRD	Sanitary Sewer Under 12 inch	2,358	6.6%
6	CCWRD	Sanitary Sewer 12 inch - 24 inch	219	0.6%
7	CENTURYLINK	Telephone	2,293	6.4%
8	LVVWD	Water Line Under 12 inch	5,518	15.4%
9	LVVWD	Water Line Under 12 inch Abandoned	738	2.1%
10	LVVWD	Water Line 12 inch - 24 inch	234	0.7%
11	LVVWD	Water Line Over 24 inch Abandoned	1,005	2.8%

Table 6. Affected utility types by owner – Segment 5 (Tropicana Ave to I-515)

No.	Owner	Item	Quantity Linear Feet	Percentage
1	COX	Cable TV	1,370	2.9%
2	SWG	Gas Under 14 inch	3,721	7.9%
3	SWG	Gas Under 14 inch Abandoned	188	0.4%
4	NVE	Electric Overhead	22,595	47.8%
5	CCWRD	Sanitary Sewer Under 12 inch	2,989	6.3%
6	CCWRD	Sanitary Sewer 12 inch - 24 inch	307	0.6%
7	CCWRD	Sanitary Sewer Over 24 inch	2,181	4.6%
8	CENTURYLINK	Telephone	1,394	2.9%
9	LVVWD	Water Line Under 12 inch	3,061	6.5%
10	LVVWD	Water Line 12 inch - 24 inch	9,262	19.6%
11	LVVWD	Water Line Over 24 inch	200	0.4%

Table 7. Affected utility types by owner - Segment 6 (I-515 to Charleston Blvd)

No.	Owner	Item	Quantity Linear Feet	Percentage
1	COX	Cable TV	185	0.7%
2	SWG	Gas Under 14 inch	4,505	17.2%
3	SWG	Gas High Pressure 12 inch	422	1.6%
4	NVE	Electric Buried	122	0.5%
5	NVE	Electric Overhead	11,316	43.1%
6	CCWRD	Sanitary Sewer Under 12 inch	3,222	12.3%
7	CCWRD	Sanitary Sewer 12 inch - 24 inch	4,436	16.9%
8	CCWRD	Sanitary Sewer Over 24 inch	289	1.1%
9	CENTURYLINK	Telephone	766	2.9%
10	LVVWD	Water Line Under 12 inch	187	0.7%
11	LVVWD	Water Line Over 24 inch	784	3.0%

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APPENDIX H—
FUTURE CONDITIONS ANALYSIS

Appendix H. Future Capacity Analysis

This appendix presents the future travel patterns and traffic volumes forecast development methodology. The capacity and Level of Service (LOS) analysis for the intersections and segments along the Boulder Highway corridor is also presented. In addition, limitations of the methodology and recommendations are included.

H.1. Future 2040 Traffic Volume Forecasting

The year 2040 traffic volume forecasts were developed using TransCAD and the Travel Demand Model (TDM) released by the Regional Transportation Commission of Southern Nevada (RTC) on February 7, 2017. The forecasting methodology followed the guidelines described in the Nevada Department of Transportation (NDOT) Traffic Forecasting Guidelines of August 2012.

The future 2040 travel forecasting was developed for two scenarios.

- Scenario 1 – 2017 No-Build
- Scenario 2 – Build

Scenario 1 – 2040 No-Build. The baseline TDM was developed for year 2015. A review of the baseline TDM inputs was performed to ensure that the 2017 land use and network geometry are included in the baseline model. The TDM network was reviewed and changes were made to reflect any approved projects that are under construction and not included in the 2040 Regional Transportation Plan (RTP).

Scenario 2 – 2040 Build. This scenario includes anticipated improvements through the implementation of the proposed concept. During the alternative development process, stakeholders determined that the proposed concept will be further developed by agencies during the design process based on context and needs of specific areas along the corridor. However, there was general agreement that for most areas in the City of Henderson within Segments 1 through 3 two lanes of traffic on each direction would be preferred. Segments 4 through 5 exhibit a higher demand with a high percentage of traffic utilizing the right through lane to access current businesses. To guide the future more detailed development of the proposed concept, the analysis assumed two (2) travel lanes in each direction for Segments 1 through 3 and three (3) lanes in each direction for Segments 4 through 6.

The corridor is expected to maintain a 45mph speed limit to a lower transit vehicle travel time and increased ridership. However, the proposed concept, in the future, is expected to reduce the effective travel speed due to narrower lanes and an increased number of mid-block pedestrian crossings approximately every 1/8th of a mile.

The model developed for the purpose of this analysis does not include these mid-block pedestrian crossings and no predictions can be made at this time on the number of pedestrians crossing at these locations. Therefore, to better replicate travel conditions with increased stops at these crossings, an average travel speed of 40 mph was assumed in the model for the entire length of the corridor.

Speed and lane configuration for each scenario is summarized in Table 1 below.

Table 1. Analysis Scenarios

Segment	No-Build		Build	
	Speed (mph)	Number of Lanes (WB/EB)	Speed (mph)	Number of Lanes
Segment 1 – Wagonwheel Dr. to Greenway Rd.	45/55	2/2	40	2/2
Segment 2 – Greenway Rd. to Water St.	45/55	3/2 3/3	40	2/2
Segment 3 – Water St. to Tulip Falls Dr.	45	3/3	40	2/2
Segment 4 – Tulip Falls Dr. to Tropicana Ave.	45	3/3	40	3/3
Segment 5 – Tropicana Ave. to I-515	45	3/3	40	3/3
Segment 6 – I-515 to Charleston Blvd.	45	3/3	40	3/3

The National Cooperative Highway Research Program 255 (NCHRP) difference method was used to adjust the TDM output. The TDM outputs for the 2040 No-Build and Build scenarios were then compared to determine potential trip diversion due to the implementation of the proposed concept. The TDM output comparison for the No-Build and Build scenario did not indicate a trip diversion under the 2040 Build scenario. The main reasons why a diversion was not observed include:

- A volume increase was primarily observed on the east to west movements toward I-515. This might result in increased delay at intersections, but it is not captured by the TDM.
- The only parallel alternative route is I-515, which for most of the length is quite far from Boulder Highway, making trip diversion longer in time and distance.

Considering that the future volumes under the No-Build and Build alternatives have insignificant differences, only one set of future volumes was forecasted and utilized for further analysis.

Table 2 shows the existing and forecasted Annual Average Daily Traffic (AADT) values along Boulder Highway. This table also includes the 2017 K Factor and peak volumes on both directions along the corridor. The forecasted AADT values were estimated using the average existing K factor (0.09) and the estimated future peak hour volumes.

Table 2. AADT Values

Location	AADT	K Factor	Peak Volume both directions	Forecasted AADT
Charleston Blvd. to I-515 (0030410)	24,400	0.10	2,860	31,800
I-515 to Tropicana Ave. (0030271)	30,000	0.07	2,883	32,000
Tropicana Ave to Tulip Falls Dr. (0030733)	25,000	0.09	2,546	28,300
Tulip Falls Dr to Water St. (0030467)	21,000	0.08	2,695	29,900
Water St. to Palo Verde Dr. (0030243)	23,000	0.08	2,060	22,900
Palo Verde Dr. to Wagonwheel Dr. (0030893)	19,000	0.09	1,689	18,800

The forecasted turning movement volumes are shown in Figure 1 through Figure 4. Traffic patterns in the southern portion of the corridor between Wagonwheel Dr. and Texas Ave. did not change. The trips generated from the growth in the areas surrounding Wagon Wheel Dr. are absorbed by I-515. It was observed that traffic patterns primarily change between Lake Mead Blvd. and Russell Rd., due to the construction of the new Cadence Development on the east side of Boulder Highway. The Traffic Analysis Zones between Missouri Ave. and Charleston Blvd. show low population and employment changes which result in minor changes in volumes on the cross streets. The increase in through volume along Boulder Highway north of I-515 is attributed to the change in the external through volume. The reasons for this increase were not further investigated as they were outside of the scope area.

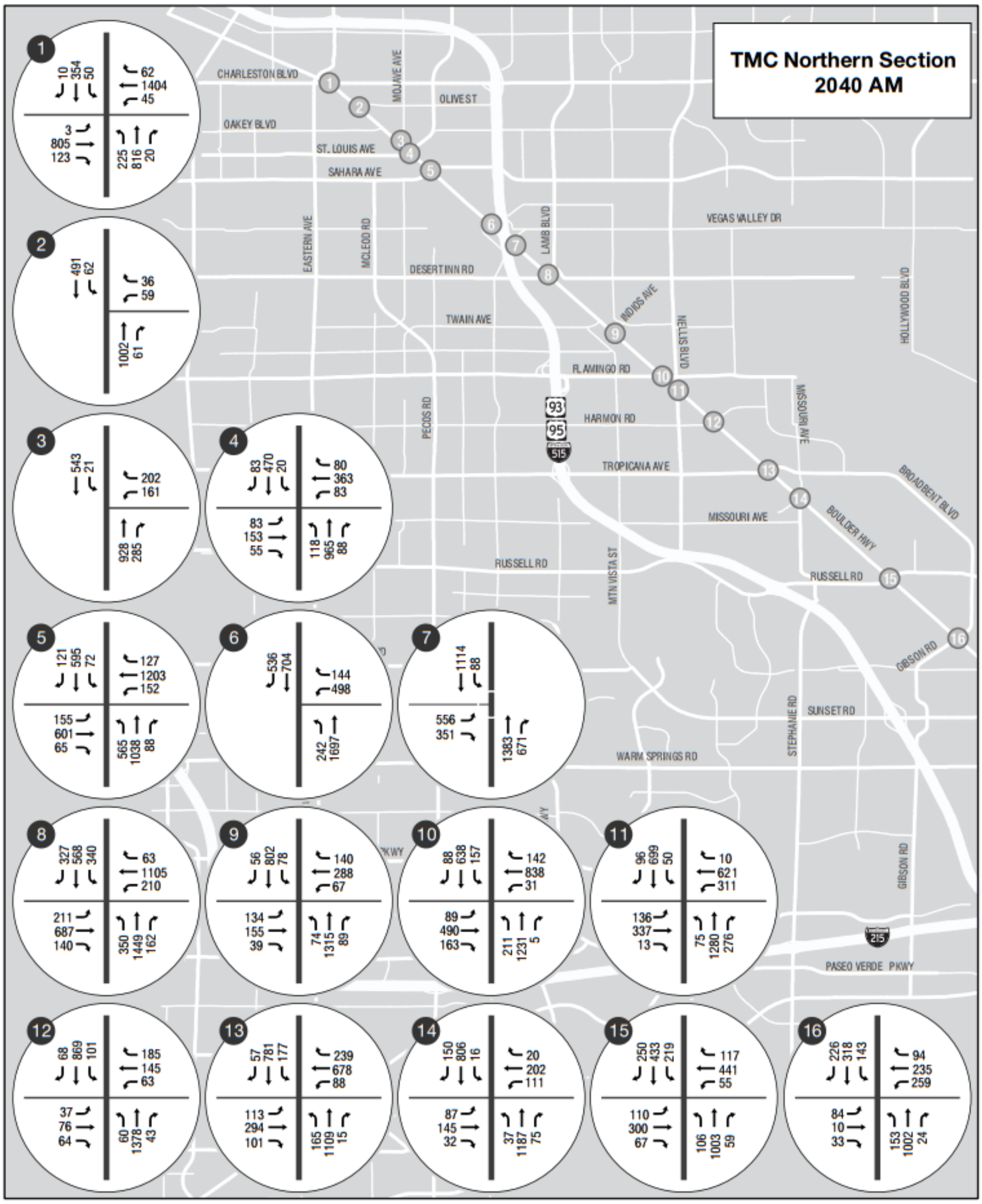

Figure 1. **Forecasted Turning Movement Volumes 2040 AM Northern Section**

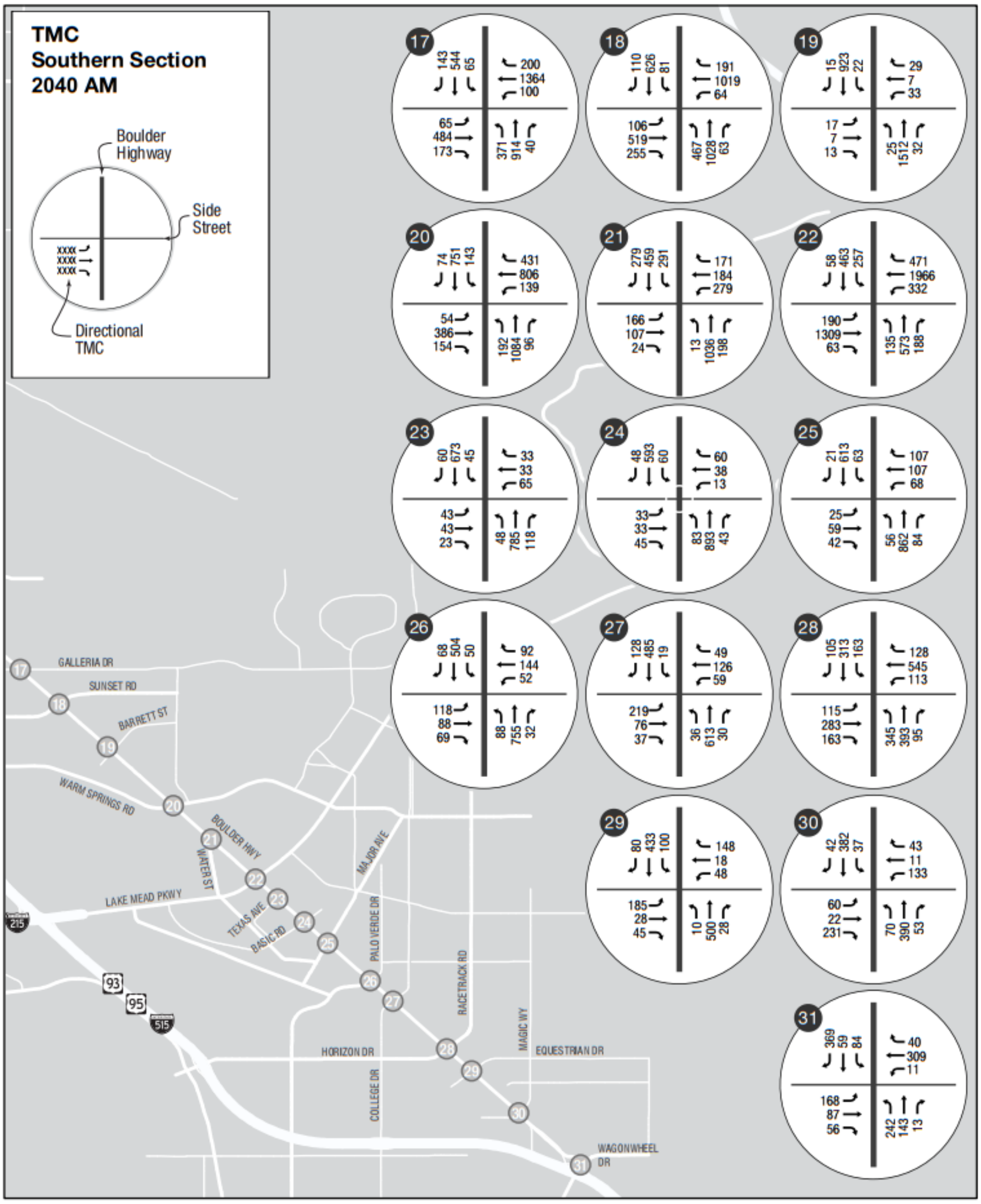

Figure 2. **Forecasted Turning Movement Volumes 2040 AM Southern Section**

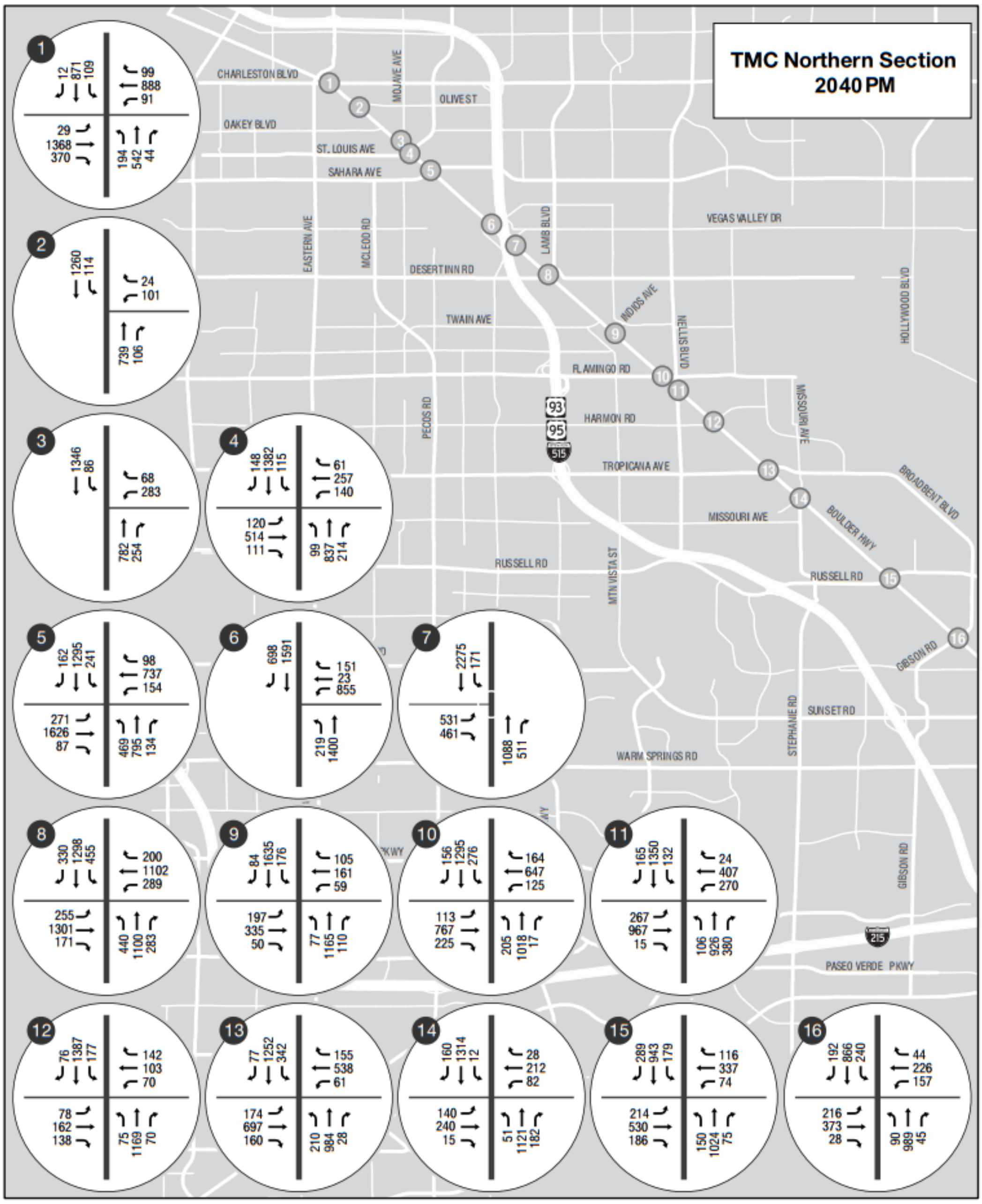

Figure 3. Forecasted Turning Movement Volumes 2040 PM Northern Section

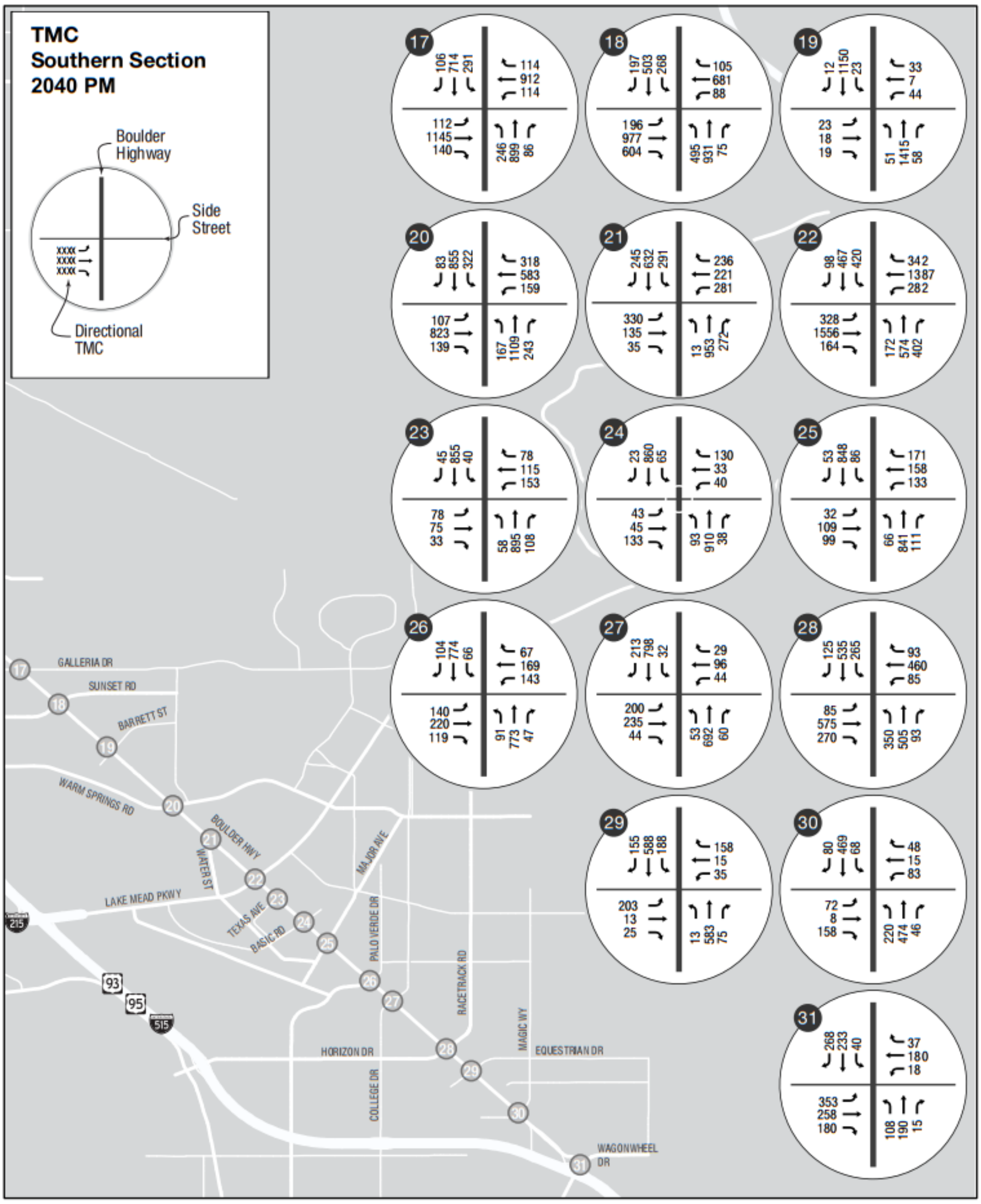

Figure 4. **Forecasted Turning Movement Volumes 2040 PM Southern Section**

H.2. Future Capacity Analysis for Boulder Highway

To evaluate the future traffic operations, a peak-hour segment capacity analysis was performed using the traffic volumes forecasted using the TDM. The segment Level of Service (LOS) and Volume over Capacity (VOC) values were used as indicators for the traffic operations performance along Boulder Highway. Table 3 shows the Transportation Research Board, Highway Capacity Manual, Special Report 209 (Washington, D.C., 1994) criteria used in this analysis.

Table 3. LOS Criteria for Arterials Based on VOC

Level of Service	Description	VOC
A	Free-flow conditions with unimpeded maneuverability. Stopped delay at signalized intersection is minimal.	0.00 to 0.60
B	Reasonably unimpeded operations with slightly restricted maneuverability. Stopped delays are not bothersome.	0.61 to 0.70
C	Stable operations with somewhat more restrictions in making mid-block lane changes than LOS B. Motorists will experience appreciable tension while driving.	0.71 to 0.80
D	Approaching unstable operations where small increases in volume produce substantial increases in delay and decreases in speed.	0.81 to 0.90
E	Operations with significant intersection approach delays and low average speeds.	0.91 to 1.00
F	Operations with extremely low speeds caused by intersection congestion, high delay, and adverse signal progression.	Greater Than 1.00

http://ccag.ca.gov/wp-content/uploads/2014/07/cmp_2005_Appendix_B.pdf

The analysis of the No-Build scenario maintains the assumptions of the 2040 TDM in terms of roadway classification, capacity value, number of lanes, and speed. The Build scenario updates the speed to 40 mph throughout the corridor and number of lanes as shown in Table 1. The results of the analysis for the No-Build and Build scenarios during AM and PM Peak are shown in Figure 5 through Figure 10 below.

Segment 1 – Wagonwheel Dr to Greenway Rd

The analysis for this segment shows that the proposed concept provides sufficient capacity for the 2040 forecasted volumes with a LOS B or better throughout the segment for the No-Build and Build scenarios. Figure 5 shows the capacity analysis results for this segment.

Segment 2 – Greenway Rd to Water St

The analysis for this segment shows that the proposed concept provides sufficient capacity for the 2040 forecasted traffic volumes. Limited capacity is observed in the northbound direction just north of Water Street. Figure 6 shows the capacity analysis results for this segment.

Segment 3 – Water St to Tulip Falls Dr

The analysis for this segment shows that the proposed concept provides limited capacity especially in the northbound direction from Water St to Gibson Rd The decrease in LOS is attributed to the reduction in capacity due to the change in speeds and the removal of one travel lane in the westbound direction for the Build scenario. Figure 7 shows the capacity analysis results for this segment.

Segment 4 – Tulip Falls Dr to Tropicana Ave

The analysis for this segment shows that proposed concept provides sufficient capacity for the 2040 forecasted volumes with a LOS B or better throughout the segment for the No-Build and Build scenarios. Figure 8 shows the capacity analysis results for this segment.

Segment 5 – Tropicana Ave to I-515

The analysis for Segment 5 shows limited capacity on the southbound direction south of the I-515 interchange in the Build scenario. The low LOS for southbound is attributed to the reduction in capacity due to the speed reduction from 45 mph to 40 mph. In addition, it was observed that the segments between the I-515 interchange and Desert Inn Rd are currently operating at near capacity as shown in Appendix D. Figure 9 shows the capacity analysis results for this segment.

Segment 6 – I-515 to Charleston Blvd

The analysis for this segment shows sufficient capacity for the 2040 forecasted volumes for the segments north of Sahara Ave Similar to Segment 5, the southbound direction north of the I-515 interchange has limited capacity. This is consistent with the existing operational conditions in this section. Figure 10 shows the capacity analysis results for this segment.

H.2.1. Methodology limitations

The methodology used to evaluate the LOS and VOC ratios for Boulder Highway corridor provides an estimate of the future conditions along the corridor using the forecasted turning volumes and the capacity from the TDM. Limitations of this methodology include:

1. Current TDM does not anticipate an increase in transit share along the corridor that might contribute to the reduction of vehicular trips.
2. Current TDM does not account for any changes to land use due to the anticipated economic development.
3. The capacity analysis methodology does not consider the effect of traffic control at the intersections. Microsimulation or HCM procedures are recommended to be utilized during the design phase to determine the most appropriate configuration for congested segments of the corridor.

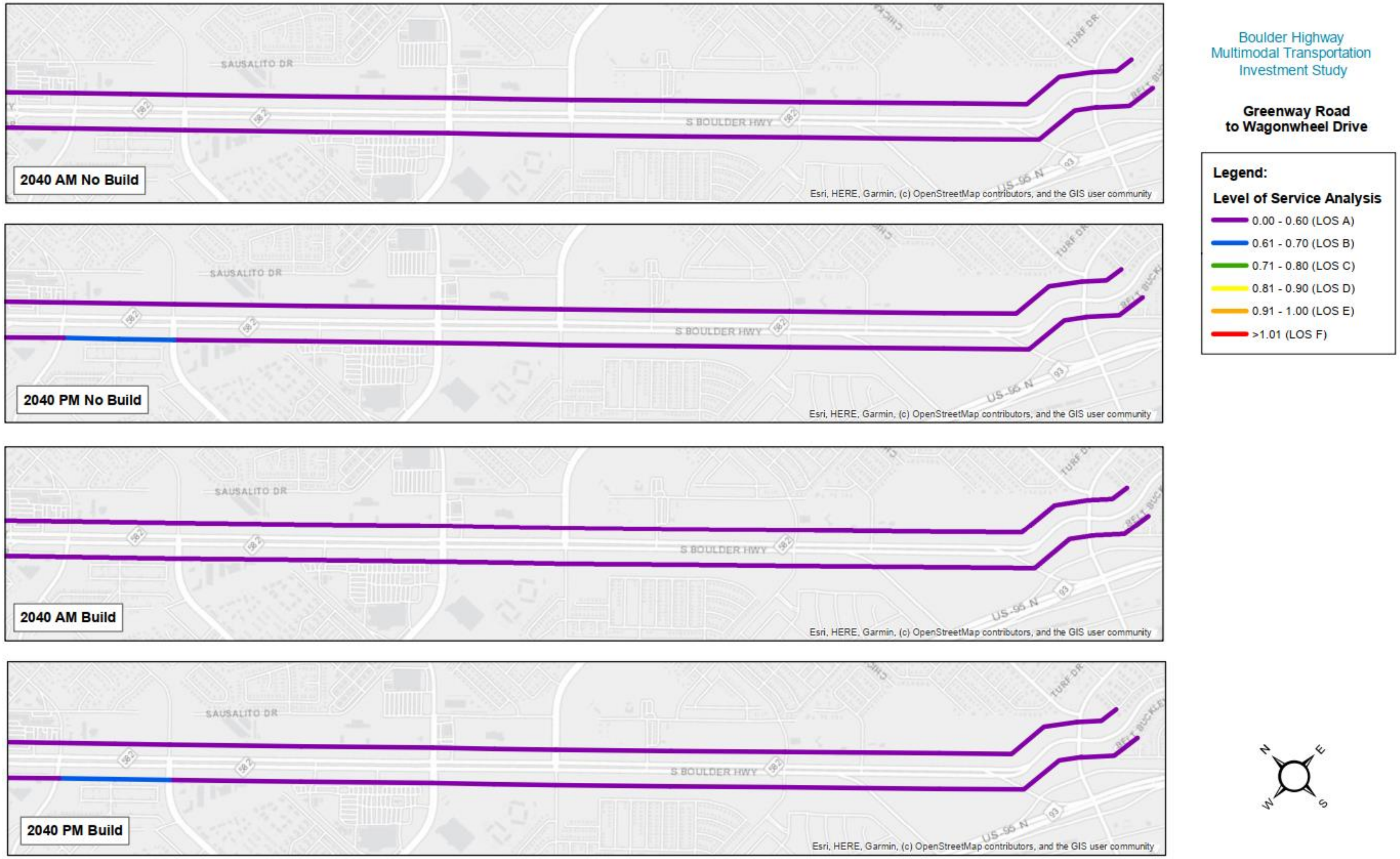

Figure 5. **Segment 1 VOC for No-Build vs Build Scenarios**

Figure 6. Segment 2 VOC for No-Build vs Build Scenarios

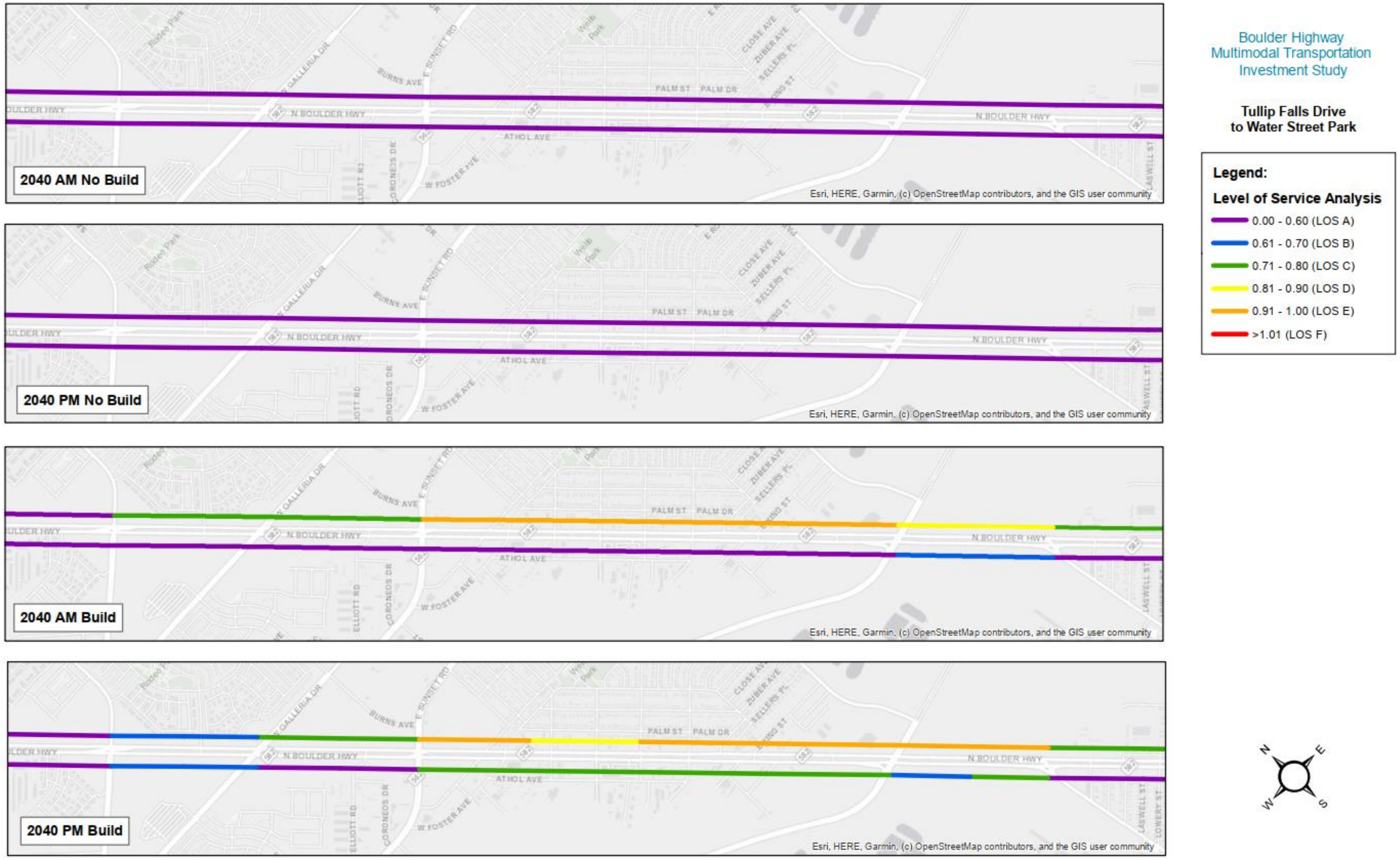

Figure 7. Segment 3 VOC for No-Build vs Build Scenarios

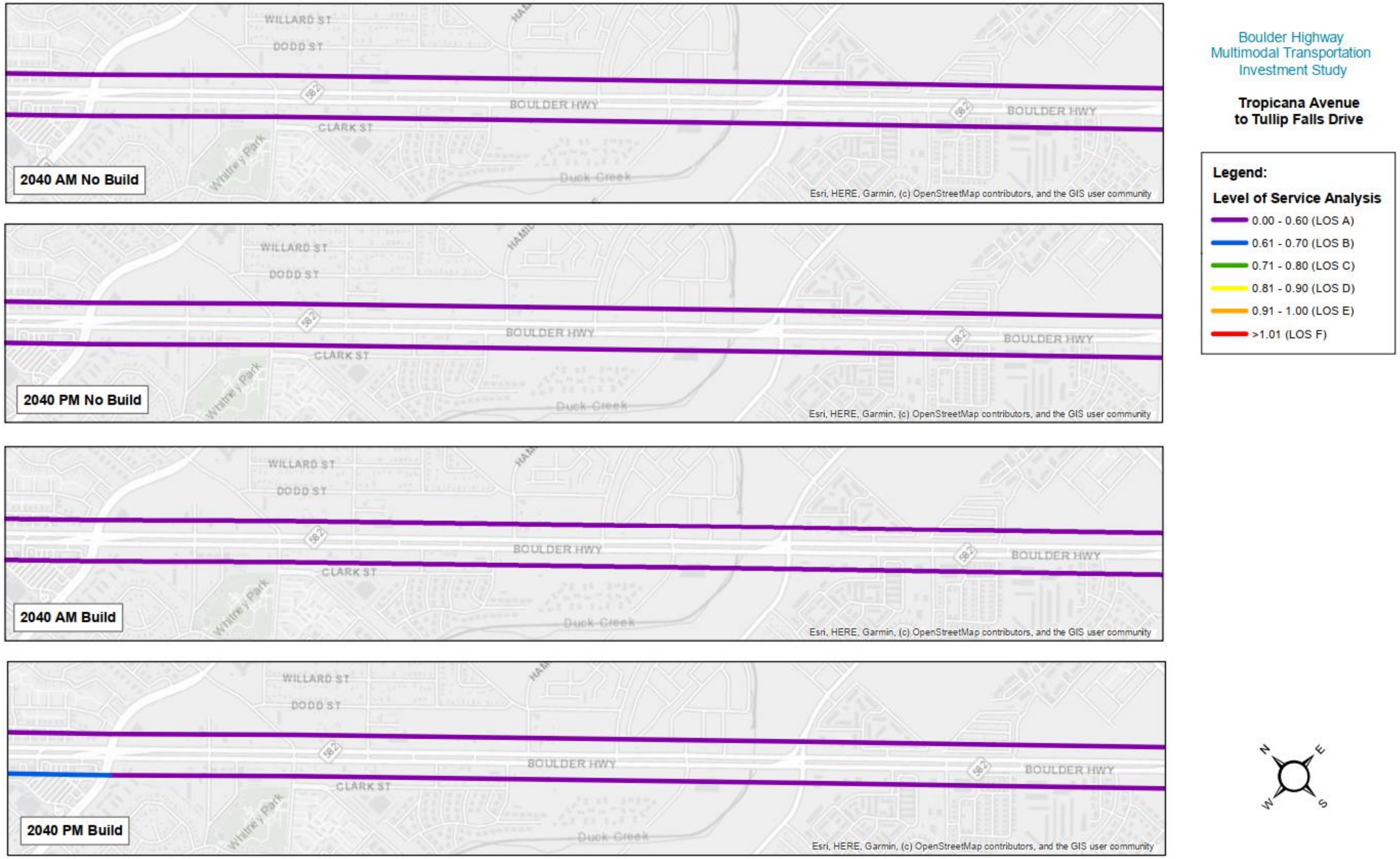

Figure 8. Segment 4 VOC for No-Build vs Build Scenarios

Figure 9. Segment 5 VOC for No-Build vs Build Scenarios

Figure 10. Segment 6 VOC for No-Build vs Build Scenarios

H.3. Future Capacity Analysis for Intersections

Using the initial recommendations for alternative intersection designs discussed in Appendix I – Alternative Analysis, additional traffic analysis was performed using the Federal Highway Administration's (FHWA's) Capacity Analysis for Planning of Junctions (CAP-X) tool. Cap-X is a tool used to perform planning level analyses for multiple types of intersections, and it is based on HCM methodologies. This tool has the capability to simultaneously evaluate different types of intersection designs at a specific location based on the turning movements, heavy vehicle percentages, and other high-level traffic information. It is important to note that this tool is intended to be a planning-level analysis tool. Therefore, the results of this analysis should not be used to determine final intersection layouts and operations. Rather, the outcomes of the CAP-X analysis provide guidance on intersection layouts that are likely to provide some benefit and, therefore, warrant additional, more detailed analysis in future studies.

For the purposes of this analysis, the forecasted 2040 turning movement and existing heavy vehicle percentages were used as an input to the CAP-X analysis. The future vehicle make-up on Boulder Highway is anticipated to remain similar to existing conditions. The result of the CAP-X analysis is the VOC ratio for the intersection. A VOC ratio greater than one indicates that the intersection is likely to operate over capacity. A value less than one indicates the intersection configuration is likely to operate under capacity. Overall, a lower value generally indicates the specific intersection configuration will likely operate better.

Table 4 shows the Transportation Research Board, Highway Capacity Manual, Special Report 209 (Washington, D.C., 1994) criteria used in this analysis to estimate LOS.

Table 4. LOS Criteria for Intersections Based on VOC

Level of Service	Description	VOC
A	Uncongested operations; all queues clear in a single signal cycle	Less Than 0.60
B	Very light congestion; an occasional approach phase is fully utilized.	0.60 to 0.69
C	Light congestion; occasional backups on critical approaches.	0.70 to 0.79
D	Significant congestion on critical approaches, but intersection functional. Cars required to wait through more than one cycle during short peaks. No long-standing queues formed.	0.80 to 0.89
E	Severe congestion with some long-standing queues on critical approaches. Blockage of intersection may occur if traffic signal does not provide for protected turning movements. Traffic queue may block nearby intersections(s) upstream of critical approach(es).	0.90 to 0.99
F	Total breakdown, stop-and-go operation.	1.00 and Greater

The CAP-X analysis is performed on the types of alternative intersections as recommended in Appendix I. These types were selected based on impacts to traffic operations, safety and land use and urban form. The results from the CAP-X analysis are shown in Table 5.

Table 5. CAP-X Analysis VOC Results

Time	Intersection	LOS	Critical VOC Ratio				
			Signalized	MUT N-S	MUT E-W	2NS x 1EW Roundabout	2 Lane Roundabout
AM Peak Hour	Olive St	A	0.30			0.55	0.54
	Mojave Rd	A	0.35			0.70	0.69
	St Louis Ave	A	0.39	0.36	0.35		
	Desert Inn Rd	C	0.75	0.79	0.80		
	Harmon Ave	A	0.49			1.06	0.81
	Tropicana Ave	B	0.60	0.53	0.51		
	Russell Rd	A	0.56	0.52	0.53		
	Barrett St	A	0.37			0.77	0.76
	Water St	D	0.81			1.44	1.01
	Lake Mead Pkwy	C	0.78	0.96	0.87		
	Texas Ave	A	0.36			0.54	0.52
	Basic Rd	A	0.29			0.56	0.54
	Horizon Dr	B	0.61	0.57	0.64		
	Magic Rd	A	0.40			0.44	0.34
	Wagonwheel Dr	A	0.56			0.67	0.56
PM Peak Hour	Olive St	A	0.34			0.75	0.73
	Mojave Rd	A	0.48			0.93	0.86
	St Louis Ave	A	0.58	0.54	0.50		
	Desert Inn Rd	D	0.82	0.96	0.95		
	Harmon Ave	A	0.53			1.14	0.97
	Tropicana Ave	B	0.64	0.60	0.60		
	Russell Rd	A	0.55	0.64	0.61		
	Barrett St	A	0.37			0.76	0.75
	Water St	D	0.81			1.78	1.21
	Lake Mead Pkwy	D	0.80	1.12	0.96		
	Texas Ave	A	0.48			0.69	0.59
	Basic Rd	A	0.34			0.60	0.57
	Horizon Dr	B	0.65	0.66	0.62		
	Magic Rd	A	0.38			0.50	0.48
	Wagonwheel Dr	A	0.46			0.91	0.56

* Slash – Intersection type not recommended

Based on the CAP-X analysis, the alternative intersection configurations considered are not expected to operate notably better than a traditional signalized intersection. Therefore, no alternative intersection designs are recommended for implementation at this time. However, it should be noted that as segments of the corridor are moved into additional phases of analysis and design, alternative intersection configurations should be reevaluated based on the most current information available.

H.4. Future Model Development Considerations

The existing conditions model described in Appendix D developed using the TransModeler was utilized to develop a future No-Build and a future Build model to further evaluate the traffic operations of the proposed concept. The objective of developing this model was to provide stakeholders a tool that can be further enhanced during the more advanced alternative design evaluation. The development of the Build alternative model revealed limitations that need to be considered in future phases:

- At this stage of the study there is no clear definition of the future intersection types. A more detailed design is required to fully evaluate future conditions.
- The locations of access lanes have not been determined at this stage of the study.
- A transit signal priority (TSP) study needs to be conducted to properly evaluate operations and impact on signal timing.
- New signal clearance intervals and signal retiming need to be developed based on the new configuration. The pedestrian crossing time calculations need to follow guidelines provided by the Manual on Uniform Traffic Control Devices, 2009 Edition (MUTCD) and Freeway and Arterial Systems of Transportation (FAST). To reduce pedestrian crossing times, strategies for reducing the intersection footprint are recommended to be evaluated. Strategies might include utilization of transit lanes to accommodate left turn lanes.
- Signal timing needs to incorporate, in addition to TSP, the cycle track green time. Right Turn on Red (RTOR) needs to be evaluated on a location basis. If dual lane cycle tracks are implemented, then the RTOR should not be allowed.
- TransModeler might not be able to integrate access lanes on the traffic operations calculations. Intervention from developer of the software might be needed to integrate this feature and aggregate results into one intersection level performance measure.

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APPENDIX I—
ALTERNATIVE ANALYSIS

Appendix I. Alternative Analysis

To best meet the project's stated purpose, goals, and objectives, a multi-stepped alternatives evaluation process was used. This process consisted of:

- Identifying specific problems to be addressed;
- Identifying potential design elements for each mode of travel;
- Evaluating the appropriateness and benefit of each design element for each mode of travel;
- Packaging the most beneficial design elements into wholistic alternatives;
- Evaluating and refining the wholistic alternatives;
- And then identifying a recommended alternative.

Each of these steps is discussed in further detail in the following chapter.

I.1. Problem Statements

Problem statements represent core issues identified through technical analysis, site observations, and collaboratively by project stakeholders. These statements formed the starting point for the generation of alternatives. In total, 11 unique problem statements were identified. Each of these statements and a discussion about their relevant topic and recommended toolbox of solutions are discussed below.

I.1.1. Managing Walking Distances

Throughout the Boulder Highway corridor, there are long distances between marked crosswalks on Boulder Highway. This results in many people crossing at unmarked locations which is contributing to a lack of pedestrian safety and comfort. Furthermore, existing crossings do not match up with pedestrian desire lines which represent the shortest path (usually in a straight line) between where a pedestrian trip on the corridor begins and where it wishes to go.

Tool Box of Solutions:

- Appropriately spaced pedestrian crossings that follow desire lines

I.1.2. Infrastructure Continuity, ADA Accessibility, and Sidewalk Design

As discussed in previous appendices, infrastructure, particularly bicycle and pedestrian infrastructure, is inconsistent and/or deficient throughout the study area. For pedestrians, this means that sidewalks end abruptly and without warning; not every crossing has Americans with Disabilities Act (ADA) compliant ramps; street furniture, utility poles, and other obstructions are routinely placed within the pedestrian area sometimes blocking sidewalks; and the corridor lacks adequate accommodations for pedestrians with sight impairments. These deficiencies result in pedestrians having to back-track or find alternate ways to traverse the corridor. This issue is also true for bicyclists. Although some portions of the corridor have bicycle facilities, they are inconsistent and sometimes end abruptly. This results in bicyclists either riding along the sidewalks or sharing space with high-speed vehicular traffic.

Tool Box of Solutions:

- Protected, wide and connected sidewalks
- ADA and Public Rights-of-Way Accessibility Guidelines (PROWAG) compliant sidewalks and ramps
- Consistent and protected bicycle facilities

I.1.3. Ease of Street Crossing

Existing pedestrian crossing locations at signalized intersections, non-signalized intersections, and mid-block crossings have been identified as having inadequate pedestrian and bicyclist crossing amenities. At signalized intersections, complex intersection layouts, long crossing distances, long traffic signal cycles, and insufficient information about required two-stage crossings result in pedestrian and bicyclist safety and comfort issues. Additionally, at unsignalized intersections and mid-block crossing locations, a lack of median refuges is resulting in people becoming trapped in the middle of the active traffic way as they attempt to cross Boulder Highway. Furthermore, large physical barriers, such as flood control facilities, prohibit pedestrians from crossing the roadway for long distances.

Tool Box of Solutions:

- Clearly marked and signed crosswalks,
- Accessible crossing equipment such as appropriately placed pedestrian push buttons and easily visible and legible crossing signals
- Median refuges to help break-up crossing distances
- Adaptive lighting at midblock crossings

I.1.4. Lack of Pedestrian Scale Design

Lack of pedestrian scale design is observed along the entire corridor and is more critical in areas with high pedestrian activity. This results in the vehicles on Boulder Highway driving at high speeds and pedestrians being poorly visible, creating an uncomfortable and less safe environment for Boulder Highway users not in a vehicle.

Tool Box of Solutions:

- Pedestrian scaled design including:
  - Pedestrian scale lighting
  - Narrower crossing distances
  - Tree lined sidewalks
  - Wide pedestrian space
  - Zero setback buildings

I.1.5. Transit Trip Reliability

People count on reliable transit timing to get where they need to be within an expected period. As discussed previously, transit service on Boulder Higher provides a major regional link for transit users with a high frequency of service in the corridor. Several factors have been identified to have a significant impact on transit trip reliability along Boulder Highway, but the most significant ones identified by stakeholders relate to the ease of transfers between routes on Boulder Highway and those that cross it. Conditions which are negatively affecting transit trips are insufficient time provided to transfer between routes and a lack of major transfer locations between regional routes.

Issues related to transit transfer times include insufficient amounts of time provided in transit schedules to accommodate transfers, long crossing distances across Boulder Highway and cross streets, and long traffic signal cycle lengths. Both issues increase the time required to transfer between transit routes and are resulting in some riders missing transit transfers on Boulder Highway.

In addition to transit transfer times, a lack of major transfer locations between regional routes was also identified as a major issue by stakeholders. Although many crossing transit routes do provide transfer opportunities, these locations are often no more than a simple curb-side bus stop with limited or no amenities. Because these are not major transit stations—stations with shelters, bus layover spaces, signage, etc.—they do not provide clear, easy to navigate transfers. This reduces the transit experience along Boulder Highway and increases barriers for users who may not be familiar with the transit system.

Tool Box of Solutions:

- Optimize transit transfer time to account for realistic times between stations
- Minimize walking distances between transfer points

I.1.6. Limited Transit Stop Amenities

Transit stop amenities improve the transit user's experience and can help facilitate an easy, safe, and comfortable transit system. Currently along Boulder Highway, many transit stops lack amenities which could encourage increased transit usage. These amenities include complete and equitable traveler information, enhanced personal security and comfort, adequate seating, adequate lighting, and access to water and restroom facilities.

Tool Box of Solutions:

- Basic features such as benches and lighting at all transit stops
- Enhanced features such as water and restrooms at major transfer facilities

I.1.7. Exposure to Climate Events

Climate events along the corridor negatively affect all users. On Boulder Highway these events primarily include extreme heat and flooding. Extreme heat events primarily impact bicyclists and pedestrians. Along Boulder Highway, there is currently little shade or protection from the sun. Furthermore, the lack of vegetation or other breaks in the paved and built environment results in an urban heat island effect which exacerbates extreme heat events.

In addition to heat, heavy rains also result in regular flooding along Boulder Highway. This flooding reduces safety for all users and can result in an increase in crashes, slower/delayed transit travel, often making the roadway difficult or impossible to navigate safety by walking or bicycling.

Tool Box of Solutions:

- Ways to address climate events in a manner that ensures consistent and safe travel for all users regardless of weather conditions

I.1.8. Access to Desired Uses

Throughout the Boulder Highway corridor there are numerous cultural, medical, recreational, business, and service-related destinations that are travelled to by all modes of travel. However, stakeholders have identified that accessing these destinations can be difficult, especially for people not traveling by vehicle. The primary challenges affecting access to destinations along the corridor for non-vehicle travel include long-distances between transit stations and destinations, a lack of consistent bicycle and pedestrian facilities, and inadequate crossing opportunities.

Tool Box of Solutions:

- Opportunities to better locate transit stations and improve bicycle and pedestrian facilities and connections to these desired destinations
- Consider future desired destinations which may be constructed in the future

- Protected bicycle facilities
- Connected and comfortable pedestrian facilities

I.1.9. Inconsistent Lighting and Insufficient Visibility

Lighting along the corridor is inconsistent and, in some locations, non-existent. Lighting as shown in Appendix G, is usually best at signalized intersections and diminishes between them. This creates safety and comfort issues for Boulder Highway users, especially those not traveling in a vehicle.

Tool Box of Solutions:

- Pedestrian scale lighting
- Roadway lighting
- Adaptive Lighting and pedestrian sensors

I.1.10. Access Management and Driveways

Driveways create additional conflict points between all modes of travel. This issue is exacerbated where driveways are closely spaced together.

Tool Box of Solutions:

- Access Road – this will manage driveway access to Boulder Highway to avoid conflicts where possible
- Reduce speeds for through traffic by:
    - Narrowing lanes
    - Reducing number of lanes where excess capacity exists
    - Horizontal traffic calming measures
    - Create visual design elements that influence driver behavior

I.1.11. Side Street Access

Data collected as part of the existing conditions reporting for this project indicate that the predominant movements on Boulder Highway are actually trips crossing the roadway or turning onto/off of the roadway from side streets. However, the traffic signal timing favors progression along Boulder Highway for through trips. Additionally, the skewed layout of many intersections makes turns from or to Boulder Highway, especially those without a protected green phase such as right-turns, both operationally challenging and uncomfortable for corridor users.

- Shorter pedestrian crossings to achieve reduced pedestrian minimums
- Adaptive signal timing

I.2. Range of Potential Design Elements

Based on the identified problem statements and recommended toolbox of solutions, a range of potential design elements was created which could potentially improve conditions on Boulder Highway. The range of potential design elements includes a comprehensive list of different infrastructure and technology options which can improve the travel conditions for at least one mode of travel on Boulder Highway. For analysis purposes, these different design elements were divided into six groups which include general roadway characteristics, transit improvements, bicycle facilities, intersections, pedestrian improvements, and lighting improvements. Each of these groups and the design and technology options within them are discussed below.

I.2.1. General Roadway Characteristics

General roadway elements include the number of general-purpose lanes, the width of those general-purpose lanes, access to and from the roadway, and the roadway's overall speed limit. Different configurations evaluated as part of this project's alternative's analysis process are shown in Table 1.

Table 1. General Roadway Characteristics Considered

Design Element	Options Considered
Number of general-purpose lanes	Two general-purpose lanes in each direction
	Three general-purpose lanes in each direction
General-purpose travel lane width	10-foot wide general-purpose lanes
	11-foot wide general-purpose lanes
	12-foot wide general-purpose lanes
Access management	Access road
Roadway speed limit	Speed limit increases from existing conditions
	Speed limit remains unchanged from existing conditions
	Speed limit decreases from existing conditions
	Speed limit significantly decreases from existing conditions

I.2.2. Transit Improvements

The general transit travel way options were evaluated as part of the alternative's evaluation process (Table 2). Additional elements which contribute to the transit experience, such as wayfinding signage, benches, etc., were evaluated as part of the pedestrian improvements and are discussed in the pedestrian improvements section below.

Table 2. Transit Improvements Considered

Design Element	Options Considered
Transit lane configuration	Center running transit
	Side running transit
	Transit on one side, general traffic on the other

I.2.3. Bicycling Improvements

Bicycling improvements considered during the alternative's evaluation process include different configurations of bicycling facilities, such as convention, buffered, protected, and off-street bicycle lanes/facilities, as well as the placement of such facilities, such as providing a facility on one or both sides of the street. Table 3 lists the different bicycle facility and configuration option evaluated.

Table 3. Bicycling Improvements Considered

Design Element	Options Considered
Bicycle infrastructure configurations	One-way protected bicycle lanes
	One-way buffered bicycle lanes
	One-way conventional bicycle lanes
	Two-way protected bicycle lanes on one side of the roadway
	Two-way protected bicycle lanes on both sides of the roadway
	Shared bicycle and transit lanes
	Off-street trail on one side of the roadway
	Off-street trails on both sides of the roadway

I.2.4. Pedestrian Improvements

Numerous types of pedestrian improvements were considered during the alternative's analysis process. These included intersection crossing treatments, mid-block crossing treatments, crossing frequencies, pedestrian fences, crossing at transit stations, sidewalk configurations, and streetscaping amenities. Specific treatments/configurations/elements for each of these categories are shown in Table 4.

Table 4. Pedestrian Improvements Considered

Design Element	Options Considered
Intersection Crossing Types	Two-stage unsignalized intersection crossing
	Two-stage signalized intersection crossing
	One-stage signalized intersection crossing with central refuge island
	One-state signalized intersection crossing
Mic-block Crossing Types	Grade separated mid-block crossing
	Signalized mid-block crossing
	Rapid flashing beacon mid-block crossing
	Unsignalized or yield controlled mid-block crossing
Spacing Between Crossings	Low crossing frequencies
	Moderate crossing frequencies
	High crossing frequencies
Pedestrian Fencing	Provide pedestrian fencing
	Do not provide pedestrian fencing
At-grade Midblock Crossings at Transit Stations	Provide at-grade crossings at or near transit stations
	Do not provide at-grade crossing at or near transit stations
Sidewalk types	6-foot wide, attached sidewalk
	6-foot wide, detached sidewalk
	8- to 10-foot wide, attached sidewalk
	8- to 10-foot wide, detached sidewalk
	>10-foot wide sidewalk

Design Element	Options Considered
Streetscaping Amenities	Moderate activity level amenities (benches, bicycle racks, wayfinding signage, etc.)
	High activity level amenities (parklets, play spaces, gathering zones, etc.)

I.2.5. Intersection Configurations

Due to the number of intersections along the Boulder Highway corridor, general intersection classifications were created based on volume of traffic served. The purpose of this grouping was to evaluate the appropriateness of implementing alternative intersection designs throughout the corridor at a qualitative level without examining the specific conditions at any one location. For this analysis, three types of intersections were defined:

- **Type A** – Major intersection (high turning movements, high cross street volumes, arterial street)
- **Type B** – Intermediate intersection (medium turning movements, medium cross street volumes, low volume arterial or collector)
- **Type C** – Minor intersection (low turning movements, low cross street volumes, local access)

For each type of intersection, three different intersection configurations were evaluated. These included roundabouts, traditional traffic signals, and Michigan U-turns. These three intersection configurations were identified by the project team and stakeholders to be appropriate and most likely desired by local agencies. Table 5 summarizes the types of intersections and the different intersection configurations evaluated.

Table 5. Intersection Configurations Considered

Intersection Type	Intersection Configuration Considered
Type A	Roundabout
	Traditional traffic signal
	Michigan U-turn
Type B	Roundabout
	Traditional traffic signal
	Michigan U-turn
Type C	Roundabout
	Traditional traffic signal
	Michigan U-turn

I.2.6. Lighting

Two different lighting configurations were considered as part of the alternative's analysis process. This included both roadway lighting—lighting primarily designed to illuminate the vehicular travel lanes—and pedestrian scale lighting—lighting primarily designed to illuminate the sidewalks and crosswalks. Consideration for each of these was given individually, but was not mutually exclusive.

I.3. Level 1 Analysis: Design Element Evaluation

Due to the number of design elements identified, it was necessary to complete an initial level of evaluation prior to developing corridor alternatives. This process allowed the project team to identify those design elements that best met the project's stated goals while minimizing the number of potential corridor alternatives to be evaluated in the future.

Each individual design element was evaluated independently using a tool called Criterium DecisionPlus. This tool takes multiple numerical values, normalizes those values based on groupings, and then applies a user defined weight to each group to derive a final score. For the purpose of this project, this tool was utilized by identifying individual scoring criteria for each of the project's goal areas, scoring each design element for each criterion, weighting the criteria and goals, and finally ranking the individual design elements based on the resulting scores.

The following sections describe the individual steps and inputs used as part of the Criterium DecisionPlus evaluation process.

I.3.1. Evaluation Criteria

Based on the identified project goals, multiple criteria were created for each goal. These criteria represent specific, well defined indicators that contribute to achieving a specific goal. Furthermore, for each criteria a set of measures of effectiveness were defined. For each measure of effectiveness, a value between zero and two or sometimes three was also defined. The purpose of creating these criteria and measures of effectiveness was to be able to apply a numerical value to each design element for each criterion which could then be input into the Criterium DecisionPlus tool.

Due to the length and land-use diversity of the project corridor, it was necessary to account for the idea that there is likely not one ideal corridor alternative that is appropriate for every section of Boulder Highway. To accommodate this, the study corridor was divided into six segments. Each of these segments was then analyzed and a character zone profile was created to ensure that design elements, and ultimately the corridor alternatives, reflected the individual needs of different sections of the roadway. Within the evaluation criteria, character zones/segment needs were captured through the creation of additional criteria and measures of effectiveness unique to each character zone.

Design elements were evaluated for both the general criteria—those criteria derived from the overall project goals—and the character zone criteria—those derived from the segment's specific needs. Discussion of both criteria and their measures of effectiveness is provided below. Each design element was evaluated for each of these criteria.

Criteria Related to Overall Project Goals

As discussed in previous chapters, there are five project goals. These include:

1. Provide safe non-motorized travel environment
2. Improve vehicle safety (i.e. provide safe motorized travel environment)
3. Support transit culture
4. Reliability movement of people in the corridor
5. Support economic redevelopment

Table 6 shows the individual criteria and associated measures of effectiveness for each goal area. It is important to note that having some measures of effectiveness score from zero to three while others score from zero to two is considered acceptable because all values are normalized at the criteria level.

Table 6. Criteria and Measures of Effectiveness Related to Overall Project Goals

Goal: Provide safe non-motorized travel environment	
Criteria: Improve visibility of bicyclists and pedestrians	
Does the design option create/improve visibility of pedestrians?	0 = Provides no benefits or opportunity for benefits to visibility of pedestrians 1 = Provides some benefits or opportunity for benefits to visibility of pedestrians 2 = Provides large benefits or opportunity for benefits to visibility of pedestrians
Does the design option create/improve visibility of bicyclists?	0 = Provides no benefits or opportunity for benefits to visibility of bicyclists 1 = Provides some benefits or opportunity for benefits to visibility of bicyclists 2= Provides large benefits or opportunity for benefits to visibility of bicyclists
Criteria: Increase the comfort for bicyclists on the corridor	
Does the design option increase comfort for bicyclists?	0 = Does not provide a comfortable bicycling experience for any user group 1 = Provides a comfortable experience for the most experienced/fearless bicyclists 2 = Provides a comfortable experience for average bicyclists 3 = Provides a comfortable experience for all ages and abilities
What level of separation does the design option provide between bicyclists and vehicles?	0 = No separation created between bicyclists and vehicles 1 = Some separation created between bicyclists and vehicles, but no physical separation 2= Physical separation between bicyclists and vehicles
What level of separation does the design option provide between bicyclists and pedestrians?	0 = No separation created between pedestrians and vehicles 1 = Some separation created between pedestrians and vehicles, but no physical separation 2 = Physical separation between pedestrians and vehicles
Criteria: Increase comfort for pedestrians on the corridor	
Does the design option provide comfortable separation between pedestrians and other modes of travel?	0 = Sidewalks are attached to the roadway curbs and have no physical barrier 1 = Sidewalks are attached to curbs but have physical barrier from traffic (e.g. pedestrian fences) 2 = Sidewalks are detached from curbs and have no physical barrier (e.g. low landscaping) 3 = Sidewalks are detached from curbs and have physical barrier (e.g. trees)
Does the design option provide the opportunity to include human scale/oriented amenities?	0 = Provides no or very little opportunity to include human-scaled amenities 1 = Provides some opportunity to include human-scaled amenities 2 = Provides ample opportunity to include human-scaled amenities 3 = Provides lots of opportunity to include pedestrian amenities and create human-scaled nodes/activity centers
Does the design option create a comfortable crossing experience for pedestrians?	0 = Design option creates an adequate crossing experience for pedestrians 1 = Design option creates a satisfactory crossing experience for pedestrians 2 = Design option creates a comfortable crossing experience for pedestrians
Criteria: Create safe access to transit stations	
Does the design option create/improve bicycle access to transit stations?	0 = Provides little or no benefit to bicyclists accessing transit stations 1 = Provides some benefit to bicyclists accessing transit stations 2 = Provides large benefits to bicyclists accessing transit stations

Does the design option create/improve pedestrian access to transit stations?	0 = Provides little or no benefit to pedestrians accessing transit stations 1 = Provides some benefit to pedestrians accessing transit stations 2 = Provides large benefits to pedestrians accessing transit stations
Criteria: Address known safety issues	
Does the design improve a condition for which there has been a recorded crash involving a bicyclist?	0 = Does not contribute to addressing an observed bicyclist safety issue 1 = Does contribute to addressing an observed bicyclist safety issue.
Does the design improve a condition for which there has been a recorded crash involving a pedestrian?	0 = Does not contribute to addressing an observed pedestrian safety issue 1 = Does contribute to addressing an observed pedestrian safety issue.
Does the design improve a condition for which there has been a recorded crash involving a vehicle?	0 = Does not contribute to addressing an observed vehicle safety issue. 1 = Does contribute to addressing an observed vehicle safety issue.
Criteria: Reduce conflicts between users	
Does the option reduce the potential for conflicts at driveways/accesses?	0 = no reduction in conflict potential at driveways 1 = Some reduction in potential for conflicts at driveways 2 = Large reduction in potential for conflict at driveways
Does the design option promote predictable pedestrian behavior?	0 = Does not promote predictable pedestrian behavior 1 = Promotes somewhat predictable pedestrian behavior 2 = Promotes very predictable pedestrian behavior
Does the design option promote predictable bicyclist behavior?	0 = Does not promote predictable bicyclist behavior 1= Promotes somewhat predictable bicyclist behavior 2 = Promotes very predictable bicyclist behavior
Does the option reduce pedestrian/vehicle interactions?	0 = Interactions are not reduced 1 = Interactions are slightly reduced 2 = Interactions are greatly reduced
Does the option reduce pedestrian/bicycle interactions?	0 = Interactions are not reduced 1 = Interactions are slightly reduced 2 = Interactions are greatly reduced
Does the option reduce bicyclists/vehicle interactions?	0 = Interactions are not reduced 1 = Interactions are slightly reduced 2 = Interactions are greatly reduced
Goal: Improve vehicle safety (i.e. Provide Safe Motorized Travel Environment)	
Criteria: Enhanced access management	
Does the design option create the opportunity to control access onto Boulder Highway?	0 = No opportunity to control access 1 = Some opportunity to control access 2 = Great opportunity to control access
Goal: Support Transit Culture	
Criteria: Facilitate convenient and consistent transfers	
Does the design option create convenient transfers between transit routes?	0 = Does not enhance transfer experience 1 = Transfers are slightly more convenient 2 = Transfers are significantly more convenient

Criteria: Provide comfortable waiting environment for transit riders	
Does the design option provide separation between transit riders and through traffic?	0 = Transit riders have no buffer from vehicle traffic 1 = Transit riders have spatial buffer from vehicle traffic 2 = Physical barrier between vehicle traffic and waiting transit riders
Goal: Reliable Movement of People in the Corridor	
Criteria: Provide vehicle trip reliability	
Does the design option support vehicle travel demand?	0 = Would likely negatively affect vehicle travel times 1 = Would likely have no effect on vehicle travel times 2 = Would likely positively affect travel times
Criteria: Provide transit trip reliability	
Does the design option support transit travel demand?	0 = Design option does not support consistent transit speeds or reliability 1 = Design somewhat supports consistent transit speeds and reliability 2 = Design strongly supports consistent transit speeds and reliability
Goal: Support Economic Redevelopment	
Criteria: Destination and placemaking	
Does the design option encourage people to spend time on the corridor?	0 = Design option discourages people to spend time on the corridor 1 = Design option does not encourage or discourage people to spend time on the corridor 2 = Design option encourages people to spend time on the corridor
Criteria: Flexibility in development	
Does the design option provide flexibility to accommodate multiple land-use types?	0 = Design decreases the flexibility in the right-of-way to accommodate all development types 1 = Design does not impact the flexibility in the right-of-way too accommodate all development types

Criteria Related to Character Zones

As discussed previously, the study corridor was divided into six segments in order to ensure that alternatives reflected the diverse needs along Boulder Highway. Based on the land-uses within each segment, both current and planned, each segment was assigned a character zone profile. These character zone profiles were constructed based on the mixing/weighting of four base character types including urban mixed-use, urban light industrial, suburban, and parks and open space. The criteria and measures of effectiveness related to each base character zone type is shown in Table 7. A discussion of the mixing/weighting of character zone types to create character zone profiles for each segment of Boulder Highway is discussed as part of the criteria weighting section of this report, Section 1.3.2.

Table 7. Criteria and Measures of Effectiveness Related to Character Zones

Urban Mixed-Use	
Does the design option create a walkable urban environment?	0 = Design option does not facilitate walkability 1 = Design option has some benefits to walkability 2 = Design option promotes walkability
Does the design option support local trip connectivity?	0 = Short trips are hindered by lack of connectivity 1 = Short trips are not impacted by the design 2 = Short trip connectivity is somewhat supported 3 = Short trip connectivity is well-supported with design option

Does the design option support adjacent placemaking opportunities?	0 = Design option hinders placemaking adjacent to the corridor 1 = Design option does not impact placemaking adjacent to the corridor 2 = Design option supports placemaking adjacent to the corridor 3 = Design option encourages placemaking adjacent to the corridor
Urban Light Industrial	
Does the design option support heavy vehicle/commercial vehicle use?	0 = Design option hinders use of heavy vehicles 1 = Design option does not impact the use of heavy vehicles 2 = Design option supports the use of heavy vehicles
Does the design option support through vehicle movements (connections to regional delivery/transport routes)?	0 = Design option hinders through-vehicle movements 1 = Design option does not impact through vehicle movements 2 = Design option supports through vehicle movements
Urban Light Industrial	
Does the design option support fast connections to regional arterials/transport routes?	0 = Design option impedes connections to regional routes 1 = Design option does not impact connections to regional routes 2 = Design option enhances connections to regional routes
Does the design alternative support access to large scale retail?	0 = Design option impedes access to large scale retail 1 = Design option does not impact access to large scale retail 2 = Design option enhances access to large scale retail
Parks and Open Space	
Does the design option support connections to regional recreational opportunities?	0 = Design option impedes connections to regional recreational opportunities 1 = Design option does not impact connections to regional recreational opportunities 2 = Design option enhances connections to regional recreational opportunities

I.3.2. Evaluation Criteria Weighting

Based on input from project stakeholders, individual weights for each goal were identified. This weighting reflects the idea that not every goal area is equally important. Furthermore, weights were also applied to criteria related to character zones. Weights for character zones reflect the segments along Boulder Highway that may not be considered fully one character zone type or another. Blending the character zone criteria together via weights allows each segment to be a mix of character zones. The weighting values used as part of the alternative's analysis process are shown in Table 8. Character zone weighting by segment is shown in Table 9.

Table 8. Evaluation Criteria Weighting

Goal Area	Weighting
Provide safe non-motorized travel environment	20%
Improve vehicle safety (i.e. Provide Safe Motorized Travel Environment)	5%
Support transit culture	12%
Reliable movement of people in the corridor	8%
Support economic redevelopment	5%
Character zones	50% (See Table 9)

Table 9. Evaluation Criteria Character Zone Weighting (see Table 8)

Segment	Weighting
Segment 1	Urban Mixed-Use – 40% Parks & Open Space – 60%
Segment 2	Urban Mixed-Use – 52% Parks & Open Space – 48%
Segment 3	Urban Mixed-Use – 50% Urban Light Industrial – 5% Suburban – 10% Parks & Open Space – 20%
Segment 4	Urban Mixed-Use – 90% Parks & Open Space – 10%
Segment 5	Urban Mixed-Use – 85% Parks & Open Space – 15%
Segment 6	Urban Mixed-Use – 75% Parks & Open Space – 25%

I.3.3. Design Element Evaluation Results

After evaluating each design element for each measure of effectiveness and applying the different weights, a final ranking of design elements was obtained for each segment of the corridor. These results were reviewed to identify the design elements for each mode of travel that would best meet the project's overall goals and enhance the individual segment's character. A summary of the design elements recommended for additional evaluation, by travel mode and segment, are shown in Table 10.

The recommended design element for each mode of travel was not always the design element which received the highest numeric score in the evaluation results. Rather, design element selection was done considering not only the individual scores, but also how well specific design elements work together within the context of a segment and equally meet the goals. In some cases, the identification of a single design element for a particular mode of travel was not appropriate. This was generally the case when multiple design elements for one particular mode of travel were considered to meet the project's goals equally well. In these cases, multiple design elements were recommended for further consideration in future phases of the alternative's analysis process.

Table 10. Design Elements Recommended for Further Evaluation by Segment

Segment	Travel Mode	Recommended Design Elements
1	Vehicle	Two 12-foot wide general-purpose lanes
	Transit	Transit all on one side
	Bicycle	Two-way or one-way protected bicycle lane
	Pedestrian	Moderate to high intensity street scaping, frequent crossings using RFBs or grade separation, 8- to 10-foot wide sidewalks, pedestrian scale lighting
2	Vehicle	Two 12-foot wide general-purpose lanes with frontage roads
	Transit	Transit all on one side or center running transit (likely transitioning between center running and all on one on side within this segment)
	Bicycle	Two-way protected bicycle lane or one-way protected bicycle lanes
	Pedestrian	Moderate to high intensity street scaping; frequent crossings using RFBs, mid-block traffic signals, or grade separation; 8- to 10-foot wide sidewalks, pedestrian scale lighting
3	Vehicle	Two or three 12-foot wide general-purpose lanes with frontage roads and street lighting
	Transit	Center running transit lanes
	Bicycle	One-way protected bicycle lanes or off-street trail
	Pedestrian	Moderate to high intensity street scaping; frequent crossings using RFBs, mid-block traffic signals, or grade separation; 8- to 10-foot wide sidewalks; pedestrian scale lighting
4	Vehicle	Two 10- to 12-foot wide general-purpose lanes with frontage roads and street lighting
	Transit	Center running transit lanes
	Bicycle	Two-way protected bicycle lane or one-way protected bicycle lanes
	Pedestrian	Moderate to high intensity street scaping; frequent crossings using RFBs or mid-block traffic signals; 8- to 10-foot wide sidewalks; pedestrian scale lighting
5	Vehicle	Two 10- to 12-foot wide general-purpose lanes with frontage roads and street lighting
	Transit	Center running transit lanes
	Bicycle	Two-way protected bicycle lane or one-way protected bicycle lanes
	Pedestrian	Moderate to high intensity street scaping; frequent crossings using RFBs or mid-block traffic signals; 8- to 10-foot wide sidewalks; pedestrian scale lighting
6	Vehicle	Two 10- to 12-foot wide general-purpose lanes with frontage roads and street lighting
	Transit	Center running transit lanes
	Bicycle	Two-way protected bicycle lane
	Pedestrian	Moderate to high intensity street scaping; frequent crossings using RFBs or mid-block traffic signals; 8- to 10-foot wide sidewalks; pedestrian scale lighting

1. Pedestrian scale lighting includes additional lighting for all walkways and crossings. It is assumed that adequate lighting will always be provided at transit stations and intersections with crosswalks regardless of if pedestrian scale lighting is recommended or not.
2. The inclusion of signalized mid-block crossings would be dependent on meeting the required MUTCD signal warrants.
3. Specific grade separated crossings, where not recommended. However, this type of crossing might be considered during more advanced phases of design or in the future in areas of special concern, for example near hospitals or other areas that may have a large number of people crossing who have additional needs. It is intended that grade separated crossings would be paired with other crossing types, such as RFBs or mid-block traffic signals, to achieve the overall crossing density recommended for each segment.
4. High frequency crossings mean a crossing frequency of between 300-500 feet. (about 13 crossings per mile. This is about the density of crossings in downtown Las Vegas and the surrounding older neighborhoods). Moderate crossing frequency means a crossing frequency of 500-1,000 feet. (about 7 crossing per mile). Low frequency crossings mean a crossing frequency of more than 1,000 feet.

I.4. Level 2 Analysis: Alternative Cross Section and Intersection Evaluation

The purpose of this level of analysis was to determine the most appropriate cross section for each segment and recommended intersection types along the corridor. The following sections describe the processes and results of the alternative cross section analysis as well as the process and results of the intersection analysis.

I.4.1. Alternative Cross Sections

The Level 1 design element evaluation process ensured that elements included within the alternative cross sections met the corridor goals. Therefore, the primary focus of this level of analysis is to arrange these elements into a combination that best reflected the options developed by stakeholders during the visioning activity described in Chapter 3 of the report. The evaluation of cross sections was done in a qualitative manner based on stakeholder input.

Alternative Cross Sections Considered

In total, seven different cross sections were evaluated (Table 11). Each of these cross sections is discussed in further detail in the following sections. The figures presented within this section of the report are intended to represent a typical section of roadway. For transit, rail vehicles are shown to represent the widest necessary cross section. Additional analysis will need to be completed before any final high-capacity transit facility type—such as light rail or bus rapid transit—is determined. The biggest disagreement among stakeholders was one of the vehicle design elements. Many stakeholders were supportive of two travel lanes and narrower lanes, while others were very determined on maintaining three lanes of traffic. For comparative purposes, all options are shown with three general-purpose lanes. The final number of recommended lanes could be less depending on the specific characteristics of each corridor segment.

Table 11. Alternative Cross Sections Considered

Alternative Cross Section	Pedestrian Element	Bicycle Element	Transit Element	Vehicle Element
Option 1	Detached sidewalks, both sides of the street	Buffered bicycle lanes	Center running transit with two outside transit stations	Three general-purpose travel lanes each direction
Option 2	Detached sidewalks, both sides of the street	Buffered bicycle lanes	Center running transit with one inside transit station	Three general-purpose travel lanes each direction
Option 3	Detached sidewalks, both sides of the street	Two-way cycle tracks, both sides of the street	Center running transit with one inside transit station	Three general-purpose travel lanes each direction
Option 4	Detached sidewalks, both sides of the street	Two-way cycle tracks, both sides of the street	Center running transit with two outside transit stations	Two - three general-purpose travel lanes each direction
Option 5	Detached sidewalks, both sides of the street	Two-way cycle tracks, both sides of the street	Center running transit with one inside transit station	Two - three general-purpose travel lanes each direction
Option 6	Detached sidewalks, both sides of the street	Two-way cycle track, one side of the street	Transit all on one side of the roadway	Three general-purpose travel lanes each direction

Alternative Cross Section	Pedestrian Element	Bicycle Element	Transit Element	Vehicle Element
Option 7	Detached sidewalks, both sides of the street	Traditional bicycle lanes	Side running transit	Three general-purpose travel lanes each direction

Option 1

Option 1 includes detached sidewalks, buffered bicycle lanes, center running transit, and three general-purpose travel lanes in each direction. Key features identified as part of this option are listed below and shown in Figure 1 and Figure 2.

- 10-foot wide detached sidewalks on both sides of the street
- Mid-block pedestrian crossings to/from transit stations
- Buffered bicycle lanes
- Three general-purpose travel lanes in each direction
- Center running transit lanes separated from general-purpose lanes with amenity zones
- Transit stations on the outside of the dedicated transit lanes
- Continuous center median

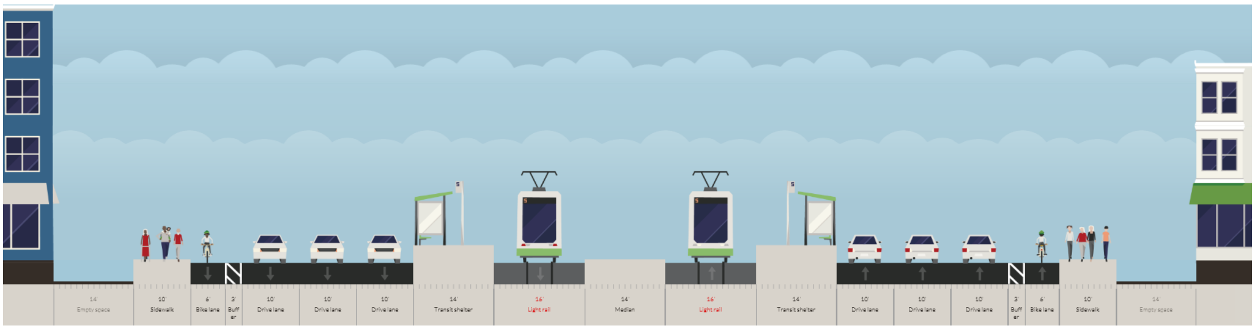


Figure 1. **Option 1 Cross Section**

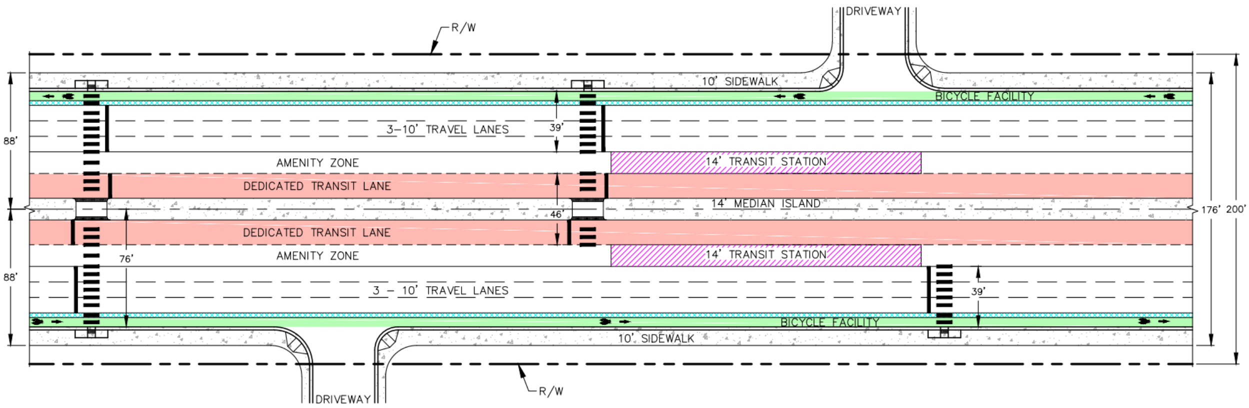


Figure 2. **Option 1 Plan View**

Option 2

Option 2 includes detached sidewalks, buffered bicycle lanes, center running transit, and three general-purpose travel lanes in each direction. The key difference between Option 1 and Option 2 is the placement of transit stations. In this option, there is a single, center platform serving both directions of transit travel. Key details of this option are listed below and shown in Figure 3 and Figure 4.

- 10-foot wide detached sidewalks on both sides of the street
- Mid-block pedestrian crossings to/from transit stations
- Buffered bicycle lanes
- Three general-purpose travel lanes in each direction
- Center running transit lanes separated from general-purpose lanes with buffer space
- Single transit platform located between the two transit lanes
- Continuous center median

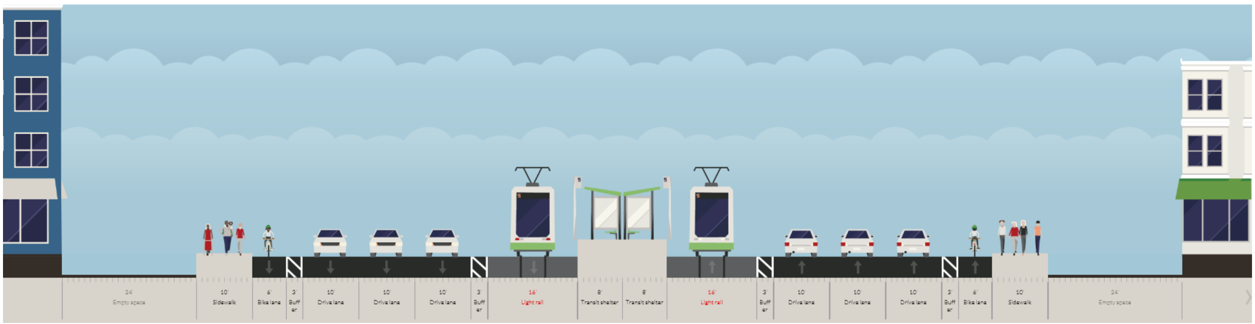


Figure 3. Option 2 Cross Section

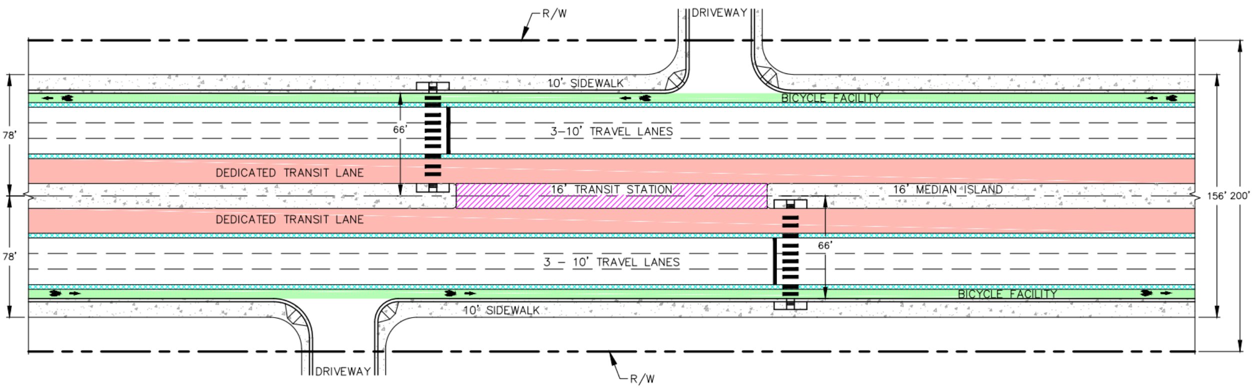


Figure 4. Option 2 Plan View

Option 3

Option 3 includes detached sidewalks, two-way cycle tracks on both sides of the roadway, center running transit, and three general-purpose lanes in both directions. Key details of this alternative are listed below and shown in Figure 5 and Figure 6.

- 10-foot wide detached sidewalks on both sides of the street

- Mid-block pedestrian crossings to/from transit stations
- Two-way cycle tracks on both sides of the street, separated from traffic with buffer space
- Three general-purpose travel lanes in each direction
- Center running transit lanes separated from general-purpose lanes with buffer space
- Single transit platform located between the two transit lanes
- Continuous center median

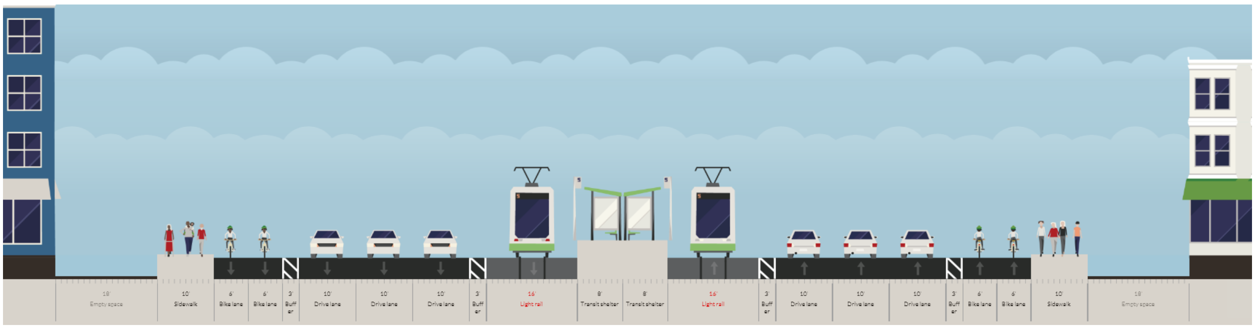


Figure 5. Option 3 Cross Section

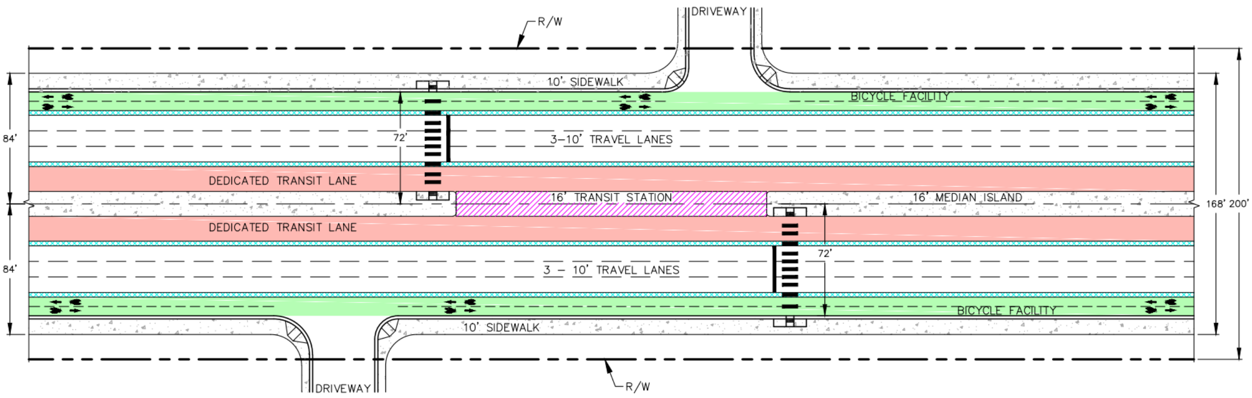


Figure 6. Option 3 Plan View

Option 4

Option 4 includes detached sidewalks, two-way cycle tracks on both sides of the roadway, center running transit, and three general-purpose lanes in both directions. The major differences between Options 3 and 4 is that in Option 4 the two-way cycle tracks are vertically separated from the general-purpose travel lanes and the transit station platforms are located on the outside of the transit lanes. Key details of this alternative are listed below and shown in Figure 7 and Figure 8.

- 6-foot wide detached sidewalks on both sides of the street
- Mid-block pedestrian crossings to/from transit stations
- Two-way cycle tracks on both sides of the street, separated from vehicle traffic both vertically and physically with amenity zones
- Three general-purpose travel lanes in each direction
- Center running transit lanes separated from general-purpose lanes with amenity zones

- Transit stations on the outside of the dedicated transit lanes
- Continuous center median

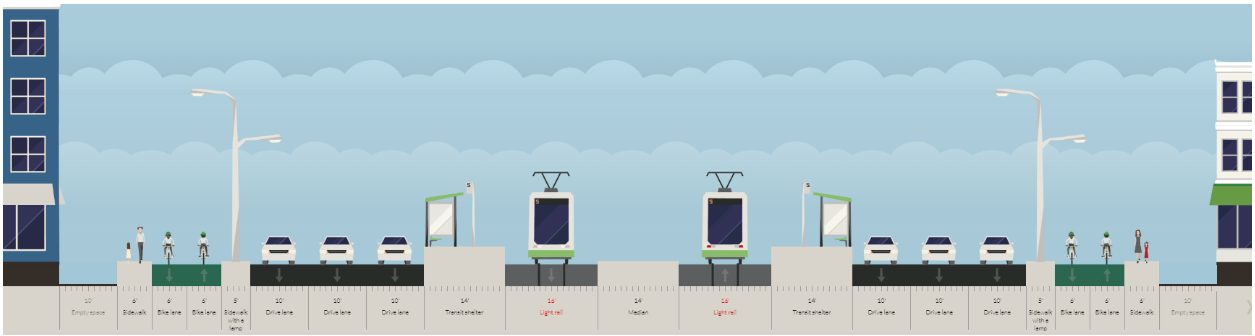


Figure 7. Option 4 Cross Section

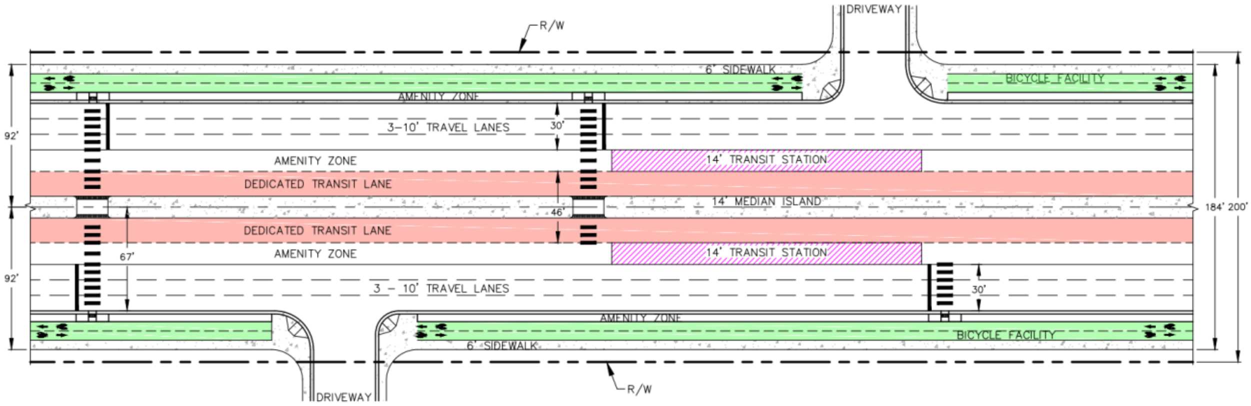


Figure 8. Option 4 Plan View

Option 5

Option 5 includes detached sidewalks, two-way cycle tracks on both sides of the roadway, center running transit, and three general-purpose lanes in both directions. The major difference between Options 4 and 5 is that in Option 5 there is only a single, center transit platform serving both direction of transit travel. Key details of this alternative are listed below and shown in Figure 9 and Figure 10.

- 6-foot wide detached sidewalks on both sides of the street
- Mid-block pedestrian crossings to/from transit stations
- Two-way cycle tracks on both sides of the street, separated from vehicle traffic both vertically and physically with amenity zones
- Three general-purpose travel lanes in each direction
- Center running transit lanes separated from general-purpose lanes with buffer space
- Single transit platform located between the two transit lanes
- Continuous center median

Figure 9. Option 5 Cross Section

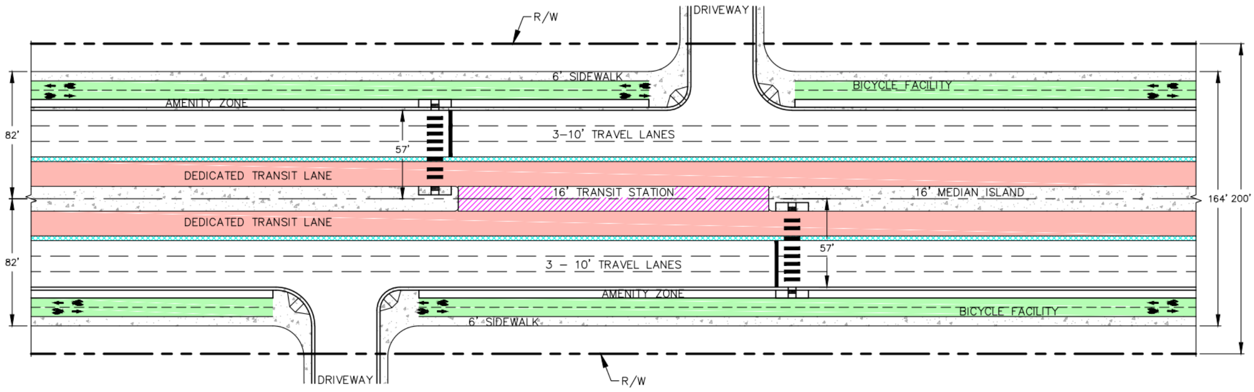


Figure 10. Option 5 Plan View

Option 6

Option 6 includes detached sidewalks, a single two-way cycle track, transit all on one side, and three general-purpose lanes in both directions. Key details of this alternative are listed below and shown in Figure 11 and Figure 12.

- 10-foot wide detached sidewalks on both sides of the street
- Mid-block pedestrian crossings to/from transit stations
- A two-way cycle track separated from vehicle traffic with buffer space
- Three general-purpose travel lanes in each direction
- A dedicated transit-way on one side of the street separated from other modes of travel via an amenity zone
- Transit stations on the outside of the dedicated transit lanes
- Continuous center median

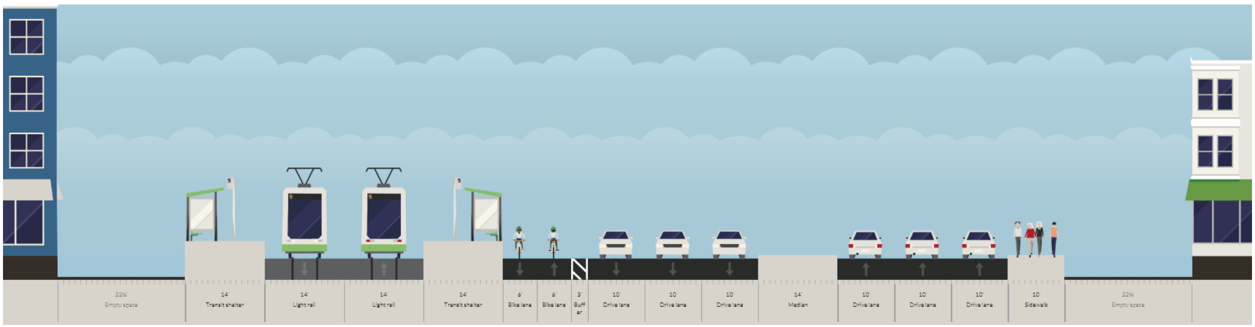


Figure 11. Option 6 Cross Section

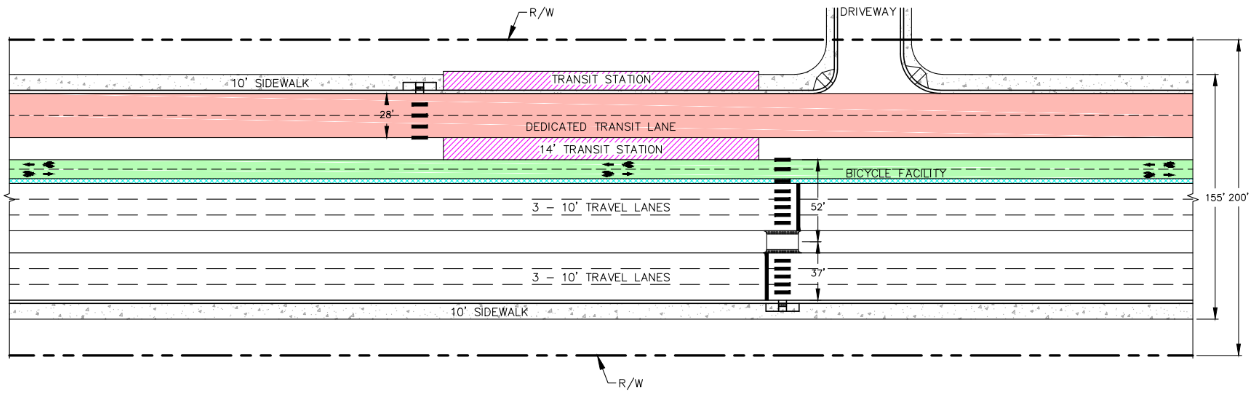


Figure 12. Option 6 Plan View

Option 7

Option 7 includes attached sidewalks, buffered bicycle lanes, side running transit, and three general-purpose lanes in both directions. Key details of this alternative are listed below and shown in Figure 11 and Figure 12.

- 10-foot wide detached sidewalks on both sides of the street
- Mid-block pedestrian crossings to/from transit stations
- Bicycle lanes separated from general-purpose traffic via buffer space and the transit lanes
- Three general-purpose travel lanes in each direction
- Side running transit lanes
- Continuous center median

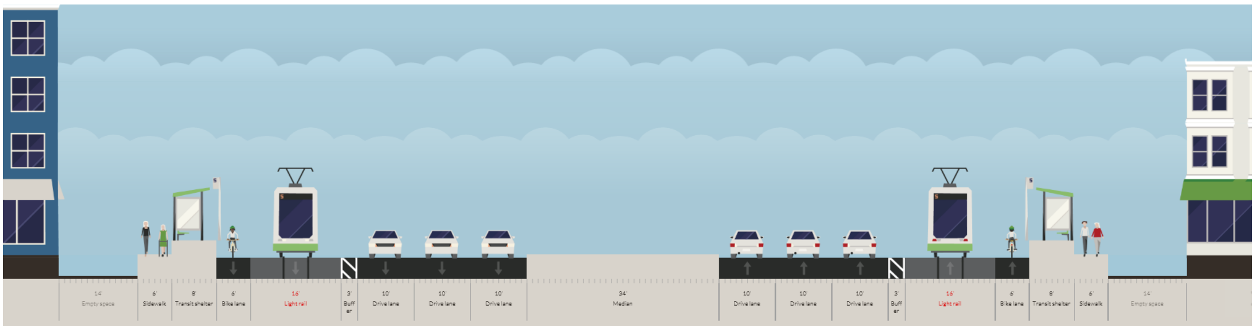


Figure 13. **Option 7 Cross Section**

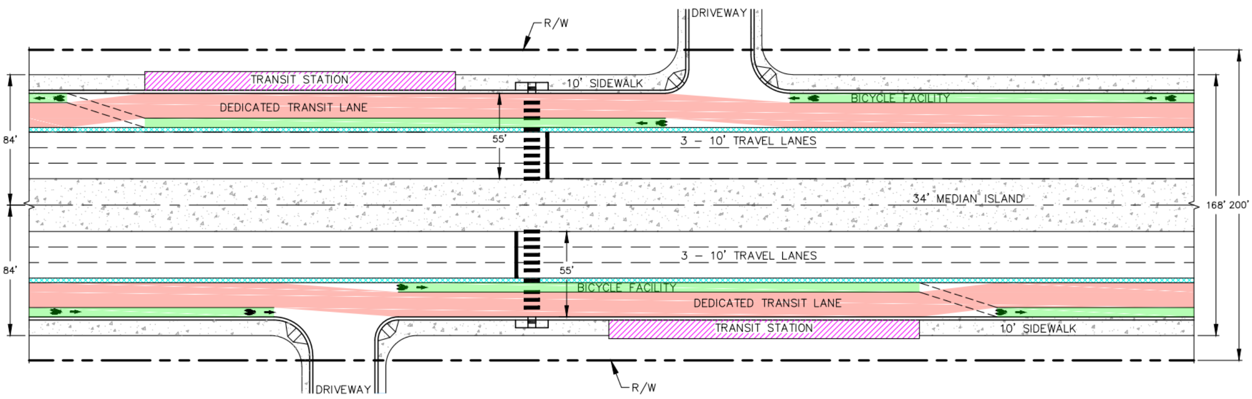


Figure 14. **Option 7 Plan View**

Alternative Cross Section Evaluation

The evaluation of the alternative cross sections was based on the qualitative feedback received from project stakeholders. For the purposes of this report, the qualitative feedback and resulting outcomes are presented by mode of travel.

Pedestrian Infrastructure

The primary pedestrian considerations identified during the evaluation of the alternative cross section was the desire to have physical separation between pedestrians and vehicular traffic and the need for additional mid-block crossings. This could be accomplished through the placement of amenity zones and/or bicycle facilities between the sidewalks and vehicular travel lanes. Stakeholders were also in agreement to provide pedestrian scale lighting on the sidewalk in addition to roadway lighting, along the entire length of the corridor.

I.4.2. Bicycling Infrastructure

Based on the feedback received on the alternative cross sections, there was a strong desire to have physically separated, two-way cycle tracks on both sides of the highway. There were two primary reasons for this. First, a majority of stakeholders noted they preferred physically separated cycle tracks due to safety and comfort concerns. Secondly, stakeholders wanted two-way cycle tracks on both sides of the roadway to limit the numbers of times a bicyclist would need to cross Boulder Highway. Even though additional crossing opportunities are recommended, it was noted that reducing the need to cross Boulder Highway would improve the comfort, safety, and convenience of bicycling.

I.4.3. Transit Infrastructure

There was an overall strong desire to have center running transit on Boulder Highway. The primary reasoning for this was to provide the best transit experience. With center running transit, transit vehicles are fully separated from general vehicle traffic, including right-turning vehicles. Although constructing a transit way on one side of the road would also provide a dedicated space for transit without any general-purpose traffic, it was noted that this configuration would create complex intersections and limit access to local businesses along the corridor. Regarding transit station layout there was agreement among the stakeholders to have one station in the center for both directions of travel.

I.4.4. General Vehicle Infrastructure

There was a strong desire among stakeholders to reduce the vehicle centric nature of the corridor where possible and create a boulevard feel. However, the length of the corridor, varying travel demand, context, and specific stakeholder needs were key components of concern. The conversations with stakeholders concluded with the following items being agreed upon:

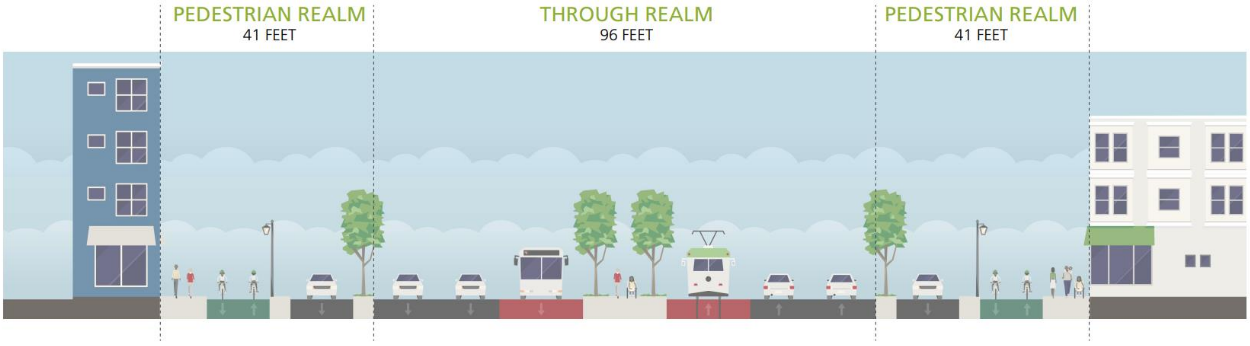
- Create a configuration that would establish corridor consistency throughout the entire length.
- Two lanes of traffic in each direction will be sufficient in most areas of the corridor.
- A third lane of traffic is needed in existing and congested areas of the corridor.
- The concepts need to address access management.
- Narrower lanes along the entire corridor. Lane width to be determined during the design process.
- Roadway lighting for the entire length of corridor.

With this input from stakeholders the technical team revisited the proposed concept alternatives and developed the proposed alternative described below.

I.5. Recommended Alternative

The overall corridor vision of the stakeholders during the planning process was to develop a boulevard concept that is consistent through the entire length of the corridor but also addresses the needs of each community. To ensure this, the proposed concept shown in Figure 15 is based on maintaining the existing minimum 178-foot-right-of-way and defining the space allocated to two separate realms: through realm and pedestrian realm. These distinct realms create a high degree of flexibility, offering local agency stakeholders the opportunity to configure the spaces within the realms in a manner that is best suited for their uses while maintaining a level of consistency throughout the corridor. Furthermore, this design ensures that the corridor goals are achieved now and into the future as the corridor develops and re-develops.

Figure 15. Proposed Concept



The through realm is located in the center of the roadway and includes two travel lanes in each direction along the entire length of the corridor as well as two dedicated lanes for high capacity transit. This space allows Boulder Highway to continue to accommodate regional travel while maintaining the multimodal and local placemaking elements critical to a safe and vibrant corridor. Transit lanes can be configured in different ways to accommodate vehicle type, pedestrian promenades or provide additional capacity in case of emergency. This realm is recommended to maintain a speed that will make transit attractive to users. More detailed transit studies are needed to determine what speed threshold will negatively impact the ridership.

The pedestrian realm is a slower speed zone on either or both sides of the roadway. This zone accommodates segregated pedestrian and bicycle facilities, linear parks, parking, or a local-access road for vehicles. Physically separated from through traffic, this realm can be configured in multiple ways depending on the desires of local agency stakeholders while still maintaining a consistent character throughout the corridor. A local access road can be implemented as needed to primarily serve three purposes:

1. Eliminate conflict between fast moving through traffic and high frequency business access along the corridor
2. Ensure that NDOT access management standards are met
3. Provide additional capacity in sections of Boulder Highway where an additional travel lane is needed

Pedestrian scale and roadway lighting will also be provided along the entire length of the corridor.

I.5.1. Alternative Non-Cross-Sectional Elements

In addition to evaluating alternative cross sections, additional analysis was performed to better refine non-cross-sectional elements. This include two things: alternative intersection recommendations and mid-block crossings.

Alternative Intersection Analysis

All intersections along Boulder Highway are currently signalized. The stakeholders, early in the process identified the need to evaluate whether alternative configurations would provide operational and safety benefits to the corridor.

The traffic operations evaluation was performed using the Federal Highway Administration's (FHWA) Capacity Analysis for Planning of Junctions (CAP-X) tool. This planning-level analysis tool takes turning movement counts, heavy vehicle percentages, and other high-level traffic information and simultaneously evaluates the operations of different intersection designs. The outcomes of the CAP-X analysis provide guidance on intersection layouts that are likely to provide some benefit and therefore warrant additional, more detailed analysis in future studies. This existing conditions CAP-X analysis, as shown in Appendix J, indicates that there are three types of intersections that are more appropriate along Boulder Highway: signalized intersection, roundabout, and Michigan U-turn.

Once the future configuration of Boulder Highway was agreed among stakeholders, another CAP-X analysis was performed utilizing the forecasted 2040 volumes as shown in Appendix J. Based on the future conditions CAP-X analysis, no alternative intersection configurations are expected to operate notably better than a traditional signalized intersection. Therefore, no alternative intersection designs are recommended for implementation at this time. However, as segments of the corridor are moved into additional phases of analysis and design, alternative intersection configurations need to be re-evaluated based on the community needs and context.

Considering that the operations are not the only deterministic variable on intersection type, a qualitative assessment of intersection types was performed once the design element evaluation for the future configuration of each segment of Boulder Highway was complete. Intersections were grouped into three generic types—major intersections (Type A), intermediate intersections (Type B) and minor intersections (Type C). The qualitative assessment focused on additional traffic operations, safety, and character zone impacts. The results of this assessment are presented in Table 12. Information about additional traffic, safety, and character zone considerations used to determine the final recommended intersection types for each location on the corridor are provided in Appendix J.

The intersection recommendations presented in Table 12 only reflect a preliminary, planning-level analysis. These recommendations imply that these intersection types may be further considered during future phases of this study. Additional analysis is required before any final recommendations for implementation are made.

Table 12: Intersection Types Recommended for Further Evaluation

Intersection	Designated Intersection Type	Intersection Configurations Recommended for Further Evaluation
Charleston Blvd	Major (Type A)	Traditional signal
Olive St/Lowes Driveway	Minor (Type C)	Traditional signal or roundabout
Mojave Rd	Minor (Type C)	Traditional signal or roundabout
St Louis Ave	Intermediate (Type B)	Traditional signal or Michigan U-turn
Sahara Ave	Major (Type A)	Traditional signal
I-515 SB Ramps	Major (Type A)	Traditional signal
I-515 NB Ramps	Major (Type A)	Traditional signal
Desert Inn Rd/Lamb Blvd	Major (Type A)	Traditional signal or Michigan U-turn
Indios Ave	Intermediate (Type B)	Traditional signal
Flamingo Rd	Major (Type A)	Traditional signal
Nellis Blvd	Major (Type A)	Traditional signal
Harmon Ave	Intermediate (Type B)	Traditional signal or roundabout
Tropicana Ave	Major (Type A)	Traditional signal or Michigan U-turn
Missouri Ave	Intermediate (Type B)	Traditional signal
Russell Rd	Intermediate (Type B)	Traditional signal or Michigan U-turn
Gibson Rd/Broadbent Blvd	Intermediate (Type B)	Traditional signal

Intersection	Designated Intersection Type	Intersection Configurations Recommended for Further Evaluation
Galleria Dr	Intermediate (Type B)	Traditional signal
Sunset Rd	Intermediate (Type B)	Traditional signal
Barrett St	Minor (Type C)	Roundabout
Warm Springs Rd	Intermediate (Type B)	Traditional signal
Water St	Minor (Type C)	Traditional signal or Roundabout
Lake Mead Pkwy	Major (Type A)	Traditional signal or Michigan U-turn
Texas Ave	Minor (Type C)	Traditional signal or roundabout
Basic Rd	Minor (Type C)	Roundabout
Major Ave	Minor (Type C)	Traditional signal
Greenway Rd/Palo Verde Dr	Intermediate (Type B)	Traditional signal
College Dr/Pueblo Blvd	Intermediate (Type B)	Traditional signal
Horizon Dr/Racetrack Rd	Major (Type A)	Traditional signal or Michigan U-turn
Equestrian Dr	Minor (Type C)	Traditional signal
Magic Way	Minor (Type C)	Traditional signal or roundabout
Wagonwheel Dr	Intermediate (Type B)	Traditional signal or roundabout

Mid-Block Crossings

The initial evaluation of design elements considered three crossing frequencies: high-frequency, moderate-frequency, and low-frequency of mid-block crossings. High-frequency of crossings were considered to be one-crossing approximately every 300 to 500 feet, moderate-frequency crossings were considered to be a crossing approximately every 500 to 1,000 feet, and low-frequency crossings would have crossings spaced more than 1,000 feet apart. Additional analysis was completed to further refine the initial recommendations to allow them to be implemented into the final recommended alternative.

Mid-Block Crossing Analysis Methodology

Level 1 evaluation of all six segments of Boulder Highway showed that high-frequency of mid-block crossings ranks better than the other two options. The Level 1 evaluation was based on the identified need to improve safety for pedestrians and reduce out of direction travel for bicyclists, pedestrians, and transit users. To further refine these recommendations, two additional factors were considered as part of the Level 2 evaluation.

The first consideration was the potential future land uses along the corridor. New development is expected to occur along the corridor; however, it is unlikely that the entire corridor will develop into a high-density, urban environment for which mid-block crossings every 300 to 500 feet is necessary.

The second consideration was the balancing of trade-offs between the needs of mid-block cross users—bicyclists and pedestrians—and people moving along Boulder Highway—vehicle drivers and transit riders. Although increasing the frequency of mid-block crossings would improve the experience for pedestrians and bicyclists, it would also slow down drivers and transit riders as they would have to stop more frequently to accommodate people crossing the street. This impact would be exacerbated by the type of mid-block crossing. It is envisioned that a majority of mid-block crossings would be some form of yield-controlled crossing, such as a RRFB, HWAK, etc. These types of crossings reduce the efficiency of coordinated traffic signals for vehicles and can result in longer travel times and an increase in congestion.

Mid-Block Crossing Recommendations

To balance the needs of all users, crossing frequency recommendations were refined to better match the needs of specific sections of the corridor with the recommendations. In areas where higher-density more urban environments are envisioned, it is recommended to implement high-frequency crossings. However, where this type of development is not envisioned, it is recommended to have moderate-frequency (between 500 and 1,000 feet apart) crossings.

Based on existing planning documents, higher-density, mixed-use, pedestrian oriented environments—for which high-frequency mid-block crossings are recommended—are expected to occur near future high-capacity transit stations along Boulder Highway as tentatively identified by the ongoing High Capacity Transit Plan. The locations of these stations are:

- Boulder Highway and Wagon Wheel (Segment 1)
- Boulder Highway and Magic Way (Segment 1)
- Boulder Highway and Horizon Drive/Racetrack Road (Segment 1)
- Boulder Highway and Lake Mead Parkway (Segment 2)
- Boulder Highway and Warm Springs Road (Segment 3)
- Boulder Highway and Barrett Street (Segment 3)
- Boulder Highway and Sunset Road (Segment 3)
- Boulder Highway and Gibson Road (Segment 3)
- Boulder Highway and Russell Road (Segment 4)
- Boulder Highway and Tropicana Avenue (Segment 5)
- Boulder Highway and Nellis Boulevard (Segment 5)
- Boulder Highway and Desert Inn Road (Segment 5)
- Boulder Highway and Charleston Boulevard (Segment 6)

It is recommended that a high-frequency of mid-block crossings is provided within one-quarter mile of each station. Further than one-quarter mile of each station, it is recommended that a moderate-frequency of mid-block crossings is provided.

The pedestrian crossing type will be determined based on the 2009 Manual on Uniform Traffic Control Devices (MUTCD) at the time of project implementation. However, for locations where pedestrian signals are not warranted, Rectangular Rapid Flashing Beacons (RRFB) are proven to provide significant safety benefits. Pedestrian sensors and adaptive lighting are recommended to be implemented at these crossing locations to improve pedestrian visibility and alert drivers of crossing pedestrians.

APPENDIX J—

COST ESTIMATE

Appendix J. Cost Estimate

This appendix summarizes the assumptions made for each implementation phase on each segment of the corridor and the respective cost estimate.

J.1. Cost Estimate Assumptions

The final configuration of the corridor will be further advanced during the design process. To develop a reasonable range of the cost estimate two options were estimated:

Option 1 – Two general purpose lanes in each direction. This option was only estimated for segments 1 through 3.

Option 2- Two general purpose lanes and one access lane in each direction. This option was only estimated for segments 2 through 6.

The following are the improvements for each segment and implementation phase of the project.

Segment 1

Early Action: Early action items include:

a. Adding a third lane in both directions between Palo Verde Dr. and College Dr. to accommodate the multimodal lane
b. Two new mid-block crossings
c. Fence along both sides of the median
d. Restriping to accommodate the additional lane and transitioning back to the two lanes in each direction
e. Improving lighting at existing bus stops

Phase 1 (Complete Street Improvements): The ultimate section will be centered along the existing median island and all the Phase 1 improvements are aligned to accommodate the ultimate improvements. The following are the items included in Phase 1:

a. Addition of cycle track that will be used as the multimodal lane in each direction to complement the two general purpose lanes between College Dr. and Wagon Wheel Dr.
b. Curb, gutter, and sidewalk in the ultimate location
c. Utility relocations assumed to be 50% of total relocations identified.
d. Addition of street lighting and pedestrian level lighting for the entire length of the segment
e. Signalizing five major intersections identified

Ultimate Improvements: Ultimate improvements include completing the improvements in the proposed cross section. For segment 1 it means the following improvements:

a. Adding the dedicated transit lane in the middle of the corridor
b. Addition of the transit stations

Segment 2

Early Action: Early action items include:

a. Adding a third lane in both directions between Major Ave. and Palo Verde Dr. to accommodate the multimodal lane
b. One new mid-block crossing
c. Fence along both sides of the median
d. Two additional bus shelters
e. Restriping to accommodate the additional lane and transitioning back to the two lanes in each direction
f. Improving lighting at existing bus stops

Phase 1 (Complete Street Improvements): The ultimate section will be centered along the existing median island and all the Phase 1 improvements are aligned to accommodate the ultimate improvements. The ultimate improvements in this segment are estimated with and without the frontage road for a range of cost.

a. Addition of cycle track that will be used as the multimodal lane in each direction to complement the two general purpose lanes between College Dr. and Wagon Wheel Dr.
b. Curb, gutter and sidewalk in the ultimate location
c. Utility Relocations assumed to be 50% of total relocations identified
d. Addition of street lighting and pedestrian level lighting for the entire length of the segment
e. Signalizing five major intersections identified

Ultimate Improvements: Ultimate improvements include completing the improvements in the proposed cross section. For segment 1 it means the following improvements:

a. Adding the dedicated transit lane in the middle of the corridor
b. Addition of the transit stations

Segment 3

Early Action: Early action items include

a. Four new mid-block crossing
b. Fence along both sides of the median
c. Two additional bus shelters
d. Restriping to accommodate the additional lane and transitioning back to the two lanes in each direction
e. Improving lighting at existing bus stops

Phase 1 (Complete Street Improvements): The ultimate section will be centered along the existing median island and all the Phase 1 improvements are aligned to accommodate the ultimate improvements. The ultimate improvements in this segment are estimated with and without the frontage road for a range of cost.

a. Addition of cycle track that will be used as the multimodal lane in each direction to complement the two general purpose lanes between College Dr. and Wagon Wheel Dr.

b. Curb, gutter, and sidewalk in the ultimate location
c. Utility relocations assumed to be 50% of total relocations identified
d. Addition of street lighting and pedestrian level lighting for the entire length of the segment
e. Signalizing five major intersections identified

Ultimate Improvements: Ultimate improvements include completing the improvements in the proposed cross section. For segment 1 it means the following improvements.

a. Adding the dedicated transit lane in the middle of the corridor.
b. Addition of the transit stations

Segment 4

Early Action: Early action items include

a. No roadway work is proposed for this segment as the existing three lanes in each direction and the BRT lane will be enough width to accommodate the proposed multimodal lane, frontage road and two travel lanes
b. Three new mid-block crossings
c. Fence along both sides of the median

J.2. Summary of Cost Estimate

Table 1 summarizes the cost estimate of the corridor by roadway feature or item for both options and each implementation phase. This cost estimate does not include the cost of transit vehicles.

Table 1. Summary of Cost Estimate by Item

Boulder Hwy - Wagonwheel Dr. to Charleston Blvd. Length of the Segment per Exhibits in Miles: 15.4 Total Number of Intersections (including Palo Verde Dr.): 31		
Item	**Option 1**	**Option 2**
EARLY ACTION IMPROVEMENTS		
Additional Lane for Transit	$560,000	
Mid-Block Crossings	$3,500,000	
Bus Stop Lighting	$960,000	
Bus Shelter	$200,000	
Striping	$3,416,542	
Median Fence	$2,395,008	
SUB TOTAL	**$11,031,550**	
Mobilization (10% of Improvements)	$1,103,155	
Contingency (20% of Improvements)	$2,206,310	
Preliminary Engineering, Design, and Construction	$1,654,733	
SUB TOTAL	**$4,964,198**	
EARLY ACTION IMPROVEMENTS TOTAL	**$15,995,748**	
COMPLETE STREETS IMPROVEMENTS (PHASE 1)		
Roadway Costs	$28,263,714	$35,645,913

Boulder Hwy - Wagonwheel Dr. to Charleston Blvd. Length of the Segment per Exhibits in Miles: 15.4 Total Number of Intersections (including Palo Verde Dr.): 31		
Item	**Option 1**	**Option 2**
Utility Costs	$20,200,000	$20,200,000
Street Lighting and Pedestrian Lighting and ITS	$19,169,487	$19,169,487
Traffic Signals	$10,850,000	$10,850,000
SUB TOTAL	**$78,483,201**	**$85,865,400**
Preliminary Engineering, Design, and Construction	$3,829,043	$4,936,373
SUB TOTAL	**$3,829,043**	**$4,936,373**
PHASE 1 IMPROVEMENTS TOTAL =	**$82,312,244**	**$90,801,773**
ULTIMATE IMPROVEMENTS TOTAL		
Transit Lane	$26,104,855	
Transit Stations	$7,529,167	
SUB TOTAL	**$33,634,022**	
Preliminary Engineering, Design, and Construction	$4,570,103	
SUB TOTAL	**$4,570,103**	
ULTIMATE IMPROVEMENTS TOTAL	**$38,204,125**	
TOTAL	**$136,512,117**	**$145,001,646**

A summary of the cost estimate by segment for each option is shown in Table 2.

Table 2. Cost Estimate by Segment

Boulder Hwy - Wagonwheel Dr, to Charleston Blvd, Length of the Segment per Exhibits: 15.4 Total Number of Intersections (including Palo Verde Dr): 31						
Item	**Early Action**	**Phase 1 Option 1**	**Phase 1 Option 2**	**Ultimate**	**Total Option 1 By Segment**	**Total Option 2 By Segment**
Segment 1	$1,940,086	$14,749,829	Not Applicable	$6,334,163	$23,024,078	Not Applicable
Segment 2	$2,356,842	$12,590,910	$16,021,023	$4,929,310	$19,877,062	$23,307,175
Segment 3	$3,595,423	$14,627,843	$19,687,259	$8,684,274	$26,907,539	$31,966,956
Segment 4	$2,275,701	Not Applicable	$11,133,691	$5,284,741	Not Applicable	$18,694,133
Segment 5	$3,248,961	Not Applicable	$17,413,408	$7,807,004	Not Applicable	$28,469,373
Segment 6	$2,578,736	Not Applicable	$11,796,562	$5,164,633	Not Applicable	$19,539,931
Total Cost	**$15,995,748**	**$82,312,244***	**$90,801,773***	**$38,204,125**	**$136,512,117***	**$145,001,646***

(*) Total based on applicable cost per segment

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APPENDIX K—
STAKEHOLDER ENGAGEMENT SUMMARY

BOULDER HIGHWAY CORRIDOR STUDY PUBLIC ENGAGEMENT RESULTS

OVERVIEW:

The Boulder Highway Multimodal Transportation Investment Study encompasses the 15-mile corridor between Wagon Wheel Drive and Charleston Boulevard. The goal of this study is to develop recommendations for improved pedestrian, bicycle, transit, and automobile movement as well as overall safety and increased economic development.

December 2017 – February 2019 Engagement Summary

The purpose of the initial public outreach efforts was to understand the community's biggest concerns within the corridor. A survey was developed to have members of the community identify challenges along the corridor, and then rank potential solutions to those challenges.

ENGAGEMENT ACTIVITIES:

- Community events & transit outreaches
- Making News story shared with jurisdictions & elected officials
- New project website with background information, NDOT short-term projects, contact form and direct link to survey
- Email blast to TAC members, jurisdictions, stakeholders. Stakeholders also shared the eblast with business community and neighborhoods.
- Press release to local transportation reporters
- Social media organic posts
- Digital geo-targeted ads

RESULTS:

- Captured 1,700 surveys
- Collected approximately 200 additional emails
- Attended 10 community events and 11 bus stop activations

REIMAGINE BOULDER HIGHWAY

December 2018 – January 2019

The purpose of the second phase of public outreach efforts was to share a draft concept plan and gage public approval and proposed solutions. Stakeholders, property owners and members of the community were asked to rate each solution with a thumbs up, thumbs down or neutral response. Results would be used to move the plan forward into cost and phasing, or to make necessary adjustments.

ENGAGEMENT ACTIVITIES:

- Community events & transit outreaches
- Making News story shared with all jurisdictions & elected officials
- Updated project website with direct link to survey
- Email campaign to TAC members, jurisdictions, stakeholders and public who have shared email to date
- Press release and media pitch
- Social media organic posts
- Social media geo-targeted digital ads

RESULTS:

- Captured 1,922 surveys
- Collected 975 emails
- Attended 12 events
- Shared in RTC Making News & Commissioner Gibson December newsletters
- Covered on five media channels:
  - LVRJ - https://www.reviewjournal.com/news/news-columns/road-warrior/deadly-stretch-of-boulder-highway-in-las-vegas-being-reimagined-1557732/
  - Channel 13 - https://www.ktnv.com/news/making-boulder-highway-safer
  - Channel 8 – https://www.8newsnow.com/news/local-news/rtc-shares-ideas-to-make-boulder-highway-safer/
  - Las Vegas Sun - https://lasvegassun.com/news/2018/dec/26/rtc-seeking-public-input-on-boulder-highway-projec/
  - US News - https://lasvegassun.com/news/2018/dec/26/rtc-seeking-public-input-on-boulder-highway-projec/

Sept/Oct 2019 Final Public Meetings & Community Engagement

The purpose of the final phase of public outreach efforts was to share the final concept plan that includes costs and phasing for public feedback. While the final plan did not change from the draft, stakeholders, property owners and members of the community were asked to review the plan with included costs and phasing and provide general feedback. Results will be included in the final plan and contacts will be used in the design and engineering of the corridor.

ENGAGEMENT ACTIVITIES:

- Two community events/public meetings
- Blog story & press release shared with local transportation reporters, jurisdictions & elected officials
- New interactive project website with concept elements, costs and phasing as well as a feedback form.
- Email blast to TAC members, jurisdictions, stakeholders and approximately 900 community members who shared their contact information previously.
- Social media organic posts
- Digital geo-targeted ads

RESULTS:

- Captured 504 comments
- Collected 504 emails
- Attended two community events and pushed heavy digital ads and website engagement
- Media coverage:
  - LVRJ - https://www.reviewjournal.com/traffic/boulder-highway-to-get-major-makeover-in-southern-nevada-1677516/
  - KNPR -

    RTC Wants Public Input On Boulder Highway Plans

    September 25, 2019
    https://knpr.org/headline/2019-09/rtc-wants-public-input-boulder-highway-plans

    KNPR
    Boulder Highway
    September 24, 2019
    https://mms.tveyes.com/Transcript.asp?StationID=6780&DateTime=9%2F24%2F2019+5%3A35%3A44+PM&Term=RTC&PlayClip=TRUE

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RE IMAGINE BOULDER HIGHWAY

BOULDER HIGHWAY

Multimodal Transportation Investment Study

JANUARY 2020