APPENDIX A EXISTING FREEWAY CONDITIONS REPORT

Existing Freeway Conditions Report

As part of the Environmental Review Process for

I-80/I-580/US 395
Spaghetti Bowl Interchange Reconstruction
Washoe County, Nevada

Prepared for

Federal Highway Administration, Nevada Division

Nevada Department of Transportation

NDOT Project Number 74020
FHWA Project Number NHFP-080-1(172)

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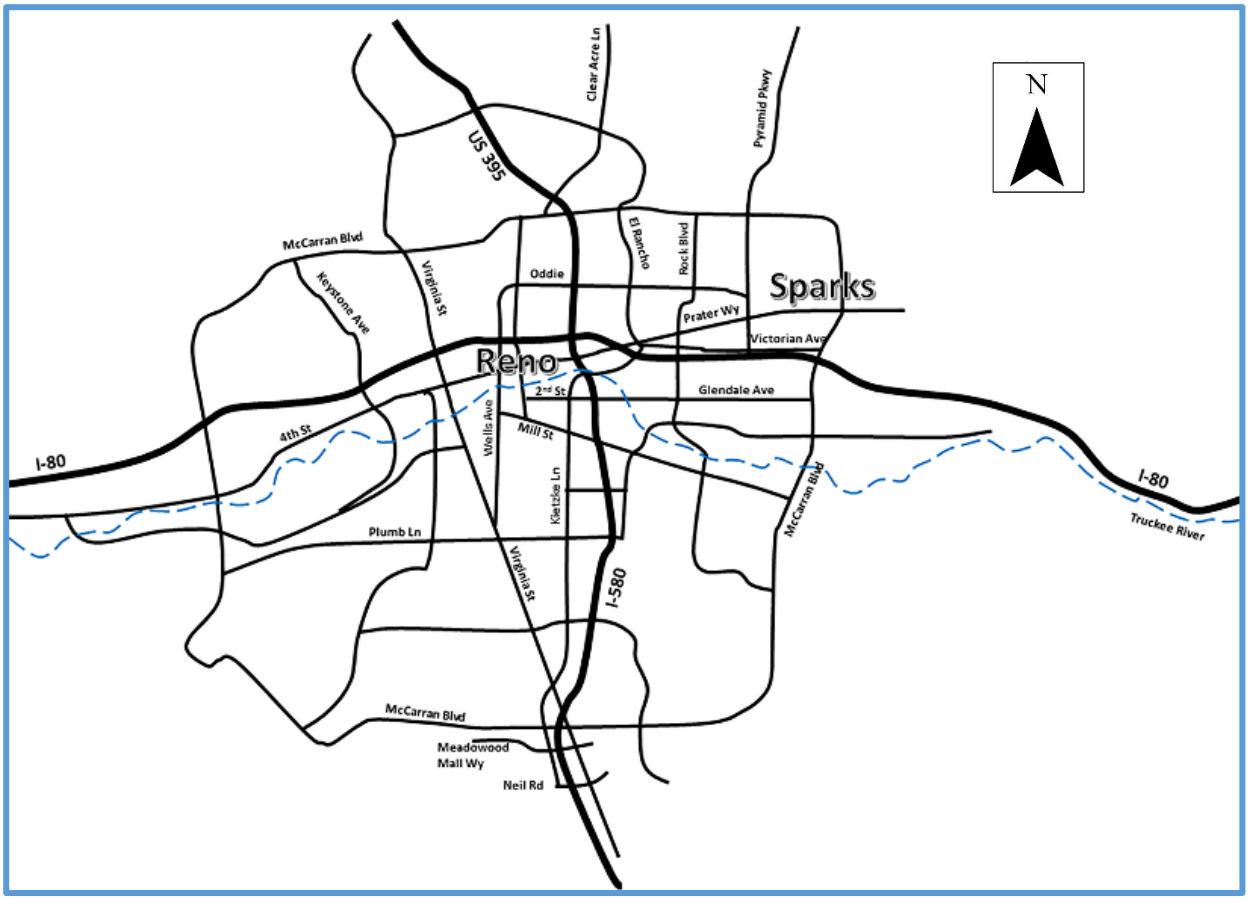
ACRONYMS AND ABBREVIATIONS

EN	east to north (ramp direction)
ES	east to south (ramp direction)
FHWA	Federal Highway Administration
FO	functionally obsolete
I-	Interstate
mph	miles per hour
NDOT	Nevada Department of Transportation
NE	north to east (ramp direction); northeast
NW	north to west (ramp direction); northwest
S/V/C	Sierra Street/Virginia Street/Center Street
SD	structurally deficient
Spaghetti Bowl Project	I-80/I-580/US 395 System Interchange Project
SR	sufficiency rating
US 395	U.S. Highway 395
WN	west to north (ramp direction)
WS	west to south (ramp direction)

1.0 INTRODUCTION

As the existing Interstate 80/Interstate 580/U.S. Highway 395 (I-80/I-580/US 395) System Interchange (Spaghetti Bowl) nears its design capacity, the Nevada Department of Transportation (NDOT) desires to complete the necessary National Environmental Policy Act of 1969 and design studies to determine appropriate measures to reconstruct the system (freeway-to-freeway) interchange and the associated connecting freeway systems to accommodate future travel demands. The proposed project would improve the operations, capacity, and safety of the freeways, system interchange, and service interchanges that comprise the transportation system in the project area.

The Spaghetti Bowl is located in the heart of the City of Reno and extends into the City of Sparks to the west, all of which are located in Washoe County. The Spaghetti Bowl was originally constructed between 1996 and 1971 to serve a metropolitan population of about 130,000 people. The current population of Washoe County has increased to approximately 420,000 people, with a forecasted growth rate exceeding state and national averages. This growth has translated into addition demand on the aging infrastructure, affecting the operations of the existing systems. Prior improvement projects along both freeway corridors have been implemented to add arterial street access and improve traffic operations of the system and service interchanges. However, NDOT continues to identify traffic congestion and safety



Vicinity Map

conditions throughout the system interchange and all directions on the approach freeways. The extents of these conditions have established the limits of the project, as follows:

- I-80 Western Limits: Keystone Avenue Interchange
- I-80 Eastern Limits: McCarran Boulevard Interchange
- I-580/US 395 Northern Limits: Parr Boulevard/Dandini Boulevard Interchange
- I-580/US 395 Southern Limits: Meadowood Mall Way Interchange
- 16 service interchanges, 1 system (freeway-to-freeway) interchange and braided ramps
- Connecting arterial streets and ramp intersections at the service interchanges

This existing freeway conditions report identifies problem areas due to the existing roadway conditions, bridge structure conditions, areas of know traffic congestion, and high traffic accident locations within the project limits.

2.0 PROJECT DESCRIPTION

2.1 I-80

I-80 is the east-west freeway system serving interstate travel through Reno. Within the project limits, this 5-mile segment varies between two and five lanes in the eastbound direction and between two and four lanes in the westbound direction. Its horizontal alignment gently curves toward the south, following the Truckee River, which is located south of the corridor. It is a gradually curving alignment to traverse the adjacent development and site constraints. The vertical alignment is generally level to rolling terrain and transitions from an elevated roadway on the west to a depressed roadway through downtown Reno, at-grade through the system interchange, to an elevated roadway to the east.

Local street frontage roads, a UPRR railroad network, commercial and residential developments, local parks, and a transit center constrain the existing roadway along its corridor. These constraints include:

- The 1.3-mile segment between Keystone Avenue and Wells Avenue. This is the downtown Reno and University of Nevada Reno access. The parallel frontage roads serving the interchange access at Sierra/Virginia/Center are built on the old street patterns adjacent to the right-of-way. Commercial and residential properties border this segment. This area includes a structural cap over the freeway, supporting a commercial development (Walgreens).

- Eight over-crossing structures west of US 395, including local roads, a pedestrian crossing and a railroad crossing.

- The I-80/I-580/US 395 crossing structure and four ramp structures within the core of the system interchange.

Project Location Map

- The 1.4-mile segment between Prater Way and Pyramid Parkway. This is the downtown Sparks area with commercial and residential development lining both sides of the right-of-way. This area includes the Nugget Casino, with building facilities underneath and adjacent to both sides of the existing viaduct structures. There is also a UPRR corridor located immediately south of the freeway.

- The 1-mile segment between Pyramid Parkway and McCarran Boulevard. This area is bordered by parallel frontage roads on both sides, residential properties to the north, and the "Tank Farm" on the south.

2.2 I-580/US 395 FREEWAY

I-580/US 395 is the north-south freeway system through Reno. Within the project limits, this 6.5-mile segment varies between three and seven lanes in the northbound direction and between two and five lanes in the southbound direction. The horizontal alignment meanders throughout its length, traversing the adjacent development and site constraints. The vertical alignment follows level to rolling terrain and is almost entirely elevated, except at the northern limit where the terrain begins to climb out of the valley and the freeway depresses for the McCarran Boulevard/Clear Acre interchange.

Commercial and residential developments, river and railroad crossings, tribal lands, and Regional Transit Commission facilities constrain the existing roadway along its corridor. These constraints include:

- At the Plumb Land/Villanova Drive interchange. The RTC facilities are located under the I-580 viaduct structure. There are also direct connector ramps accessing the Reno/Tahoe International Airport.
- The 1.3-mile segment south of I-80. The corridor crosses the UPRR right-of-way and the Truckee River. It is also bordered by tribal lands on the east and west side in the vicinity of Glendale Avenue.
- The 2-mile segment north of I-80. Residential properties backing up to the freeway, a large storage development north of Oddie Boulevard, and a commercial development at Clear Acre Lane border the right-of-way.

2.3 I-80/I-580/US 395 System (Freeway-to-Freeway) Interchange (Spaghetti Bowl)

The Spaghetti Bowl is an aging system interchange that, when originally built, provided access between the developing I-80 and US 395 corridors. It is a fully directional interchange that uses a combination of direct, semi direct, and loop ramps. These ramps are designed using speeds varying between 25 miles per hour (mph) and 50 mph. As travel demand has grown in the valley, this compact, lower-speed ramp configuration has affected the ability of the interchange to serve growing traffic volumes.

The areas bordering the interchange are developed:

- The southeast quadrant is an older commercial/industrial area with access roads, parking, and yard areas bordering the right-of-way. Most buildings are set back.
- The southwest quadrant is predominantly the Governors Bowl Park and parking area. There is also a commercial/industrial area with access roads, parking, and yard areas bordering the right-of-way. All buildings are set back.
- The northeast and northwest quadrants are residential areas with circulation roadways and homes adjacent to the right-of-way.

2.4 Service Interchanges and Local Streets

Service interchanges provide connectivity between the local street system and the freeway system. On the I-80 corridor, service interchanges are located at Keystone Avenue, Sierra Street/Virginia Street/Center Street (S/V/C), Wells Avenue, Prater Way/Kietzke Lane, Rock Boulevard, Pyramid Parkway, and McCarran Boulevard (East). On the I-580/US 395 corridor, the service interchanges are located at Meadowood Mall Way, S Virginia Street, Moana Lane, Plumb Lane/Villanova Drive, Mill Street, Glendale Avenue, Oddie Boulevard, and Clear Acre

Lane/N McCarran Boulevard. The local streets at these interchange locations comprise the major streets through the valley that provide north-south and east-west connectivity.

Most of the service interchanges are in a diamond-type configuration, while some use combinations of diamond, loop, and braided ramp configurations. The interchanges are spaced between 0.5 and 1.0 mile apart, including the separation distances from the system interchange. The older sections of the three freeways have interchange spacing closer together than the newer sections.

The areas surrounding the interchanges are mostly developed with residential, commercial, and industrial properties. Only the US 395/Clear Acre Lane/N McCarran Boulevard interchange has somewhat open space surrounding it, due to the nature of the terrain at the beginning of the foothills in the northern valley areas.

Most streets are well developed corridors and are improved beyond the limits of the freeway system. However, due to the proximity of the railroad along the south side of I-80, Kietzke Lane and Rock Boulevard are restricted by the existing railroad structures and Pyramid Parkway is blocked, ending at the Nugget Avenue frontage road.

3.0 DESIGN CRITERIA

Design guidelines based on the current NDOT and Federal Highway Administration (FHWA) guidelines have been established for this project. The design of all roadways shall be in accordance with the 2011 “Green Book” and shall be supplemented with the other standards listed. The 2005 AASHTO Policy on Design Standard - Interstate System is only applicable to improvements to I-80 and I-580. The following design guidelines apply to the project:

- *A Policy on Geometric Design of Highways and Streets (Green Book)*, AASHTO, 2011
- *Roadside Design Guide*, AASHTO, 2011
- *A Policy on Design Standards - Interstate System 5th Edition*, AASHTO, 2005
- *Road Design Guide,* NDOT, 2010

The project geometric design criteria are included in Attachment A of this report.

4.0 EXISTING ROADWAY CONDITIONS

The overall condition of the freeway system is consistent with an aged facility that has been upgraded over time. The north leg of US-395 and the east and west legs of the I-80 freeway systems, including the Spaghetti Bowl, are the older portions of the corridors and are constrained by the smaller interchange footprints, surrounding development, the older structures supporting or spanning the roadways, and closer interchange spacing. The south leg of I-580 in the area from Mill Street to the north is also a part of the older segment of the freeway. The remainder of the freeway to the south is recently improved.

A review of the project geometric conditions was performed based on the project criteria to encompass mainline and ramp alignments, cross section widths, and speeds. This review is based on the project aerial topographic mapping, available aerial imagery, and available as-built plan information. Based on this review, the following conditions warranting discussion were identified:

- Mainline and ramp lane discontinuities
- Outdated and inefficient interchange configurations
- Interchanges and ramps that are too close together
- Reduced weaving/merging lengths
- Speeds that are not consistent with the traffic needs
- Reduced ramp lengths with poor accelerations/deceleration conditions
- Reduced lane and shoulder widths
- Stopping sight distance restrictions
- Narrow bridges
- Substandard vertical clearances

The full results of these investigations are included in the following attachments:

- Attachment B – Existing Geometric Summary
- Attachment C – Existing Geometric Review
- Attachment D - Bridges
- Attachment E – Preliminary Traffic Evaluation

Where deficient conditions have been identified, the findings are summarized below and shown on Figure 1 (located in a separate attachment at the conclusion of this report).

4.1 MAINLINE AND RAMP LANES

The freeway and system ramps have been reviewed for consistency in the number of lanes provided on the facility and the way in which lanes are added or dropped at ramp connections. This is known as lane balance and involves two components: the basic number of lanes provided for a freeway corridor and the methodology of adding and dropping lanes through the system at the ramps. There are inconsistencies in the number of mainline lanes through the study area. There are also lane discontinuities along some of the Spaghetti Bowl interchange ramps.

4.1.1 Basic Number of Lanes

According to AASHTO (Green Book), the “designation of the basic number of lanes is fundamental to establishing the number and arrangement of lanes on a freeway. Consistency should be maintained in the number of lanes provided along any route of arterial character. Thus, the basic number of lanes is defined as a minimum number of lanes designated and maintained over a significant length of a route, irrespective of changes in traffic volume and lane balance needs.”

Through the project limits, the basic number of lanes is inconsistent. Roadways leading into the project limits have three basic lanes in each direction. This number drops to two lanes in various location through the project limits. The following locations of lane drops have been identified. See Figure 1 (located in attachments).

1. There are two lanes through the Spaghetti Bowl for the eastbound, westbound, and southbound directions. This creates bottlenecks in the core of the interchange for three of the four travel directions and contributes to traffic congestion. This restriction is a result of the older system interchange configuration and the lack of space to widen the mainline in the existing footprint.
2. At the east project limits, the westbound lanes between McCarran Boulevard (East) and Pyramid Parkway, there are only two lanes. This should be considered to be increase to three lanes to maintain consistency.
3. There are additional lanes planned as part of the Pyramid Parkway Connector Project, north of the US 395/Clear Acre Lane/N McCarran Boulevard interchange. The number of basic lanes for the project is anticipated to increase to a minimum of three in each direction to maintain consistency between the projects.

This lane assessment is based on the existing facility. The number of basic lanes required through the project limits for the proposed project will be determined during the traffic investigations.

4.1.2 Lane Balance

According to AASHTO (Green Book):

> *The balance in the number of lanes should be confirmed on the basis of the following principles:*
>
> 1. *At entrances, the number of lanes beyond the merging of two traffic streams should not be less than the sum of all traffic lanes on the merging roadways minus one, but may be equal to the sum of all traffic lanes on the merging roadways*
> 2. *At exits, the number of approach lanes on the highway should be equal to the number of lanes on the highway beyond the exit, plus the number of lanes on the exit, minus one.*
> 3. *The traveled way of the highway should be reduced by not more than one traffic lane at a time.*

Within the project limits there are several areas that do not comply with these principles. The result is lane reductions that create additional bottlenecks with the freeway system and contribute to traffic congestion. The following locations have been identified. See Figure 1 (located in attachments).

- **Eastbound I-80 at Keystone Avenue.** The facility expands from two to five lanes and then drops to four lanes after the Sierra Street/Virginia Street/Center Street exit. A total of three lanes are added within the core of the Keystone interchange. Although a portion of this

interchange is outside the project limits, consideration should be given to improving the lane balance by extending the third mainline lane to the west.

- **Eastbound I-80 at the I-580 Southbound/US 395 Northbound (East to South/East to North [ES/EN]) System Ramp Exit.** The facility drops from five lanes to three lanes following the exit. For continuity, the fourth lane should be carried through the system interchange, where there are four lanes on the east side of US 395.

- **Eastbound I-80 at Rock Boulevard to Pyramid Parkway.** The lanes drop from five to three to two. One lane should be added from the Rock Boulevard off-ramp to the Pyramid Parkway off-ramp and one lane should be added between the Pyramid Parkway off-ramp and on-ramp, resulting a drop of five to four to three lanes.

- **Southbound I-580 at Mill Street.** The lanes drop from five to three and then increase back to four lanes between the off- and on-ramps. The fourth lane has been dropped to avoid widening the structure. This fourth lane should be extended to connect south of the southbound Mill Street on-ramp.

- **Northbound I-580/US 395, from Glendale Avenue to the 580N-80E (North to East [NE]) and 580N-80W (North to West [NW]) System Ramp Exits.** The lanes drop from seven to three lanes between the Glendale northbound loop on-ramp and northbound US 395. This has been configured to improve operations of the existing system ramps to eastbound I-80 and westbound I-80. These ramps are constrained in the I-80 corridor by low speeds and poor merging conditions. The four auxiliary lanes serve the two ramps as storage lanes, effectively blocking the northbound Glendale loop on-ramp and making weaving movements between the three ramps and the northbound US 395 traffic difficult. Reconfiguration of the ramp connections is necessary to correct lane balance and remove the storage lane condition of the existing roadway.

Basic Lane Deficiencies

- *I-80 Eastbound – third lane missing at the system interchange*
- *I-80 Westbound – third lane missing at the system interchange*
- *US 395 Southbound – third lane missing at the system interchange*
- *US 395 Southbound and Northbound – missing lanes at the Clear Acre/N McCarran Boulevard for the future Pyramid Connector*

4.1.3 Other Lane Discontinuities

Three other locations have been identified within the system ramps where lanes have not been provided but are known areas of congestion:

- **ES Ramp.** This is a two-lane system ramp that narrows to one lane prior to merging with I-580 S. The ramp is currently over capacity for a single-lane ramp. The resulting congestion backs up on I-80 and blocks the EN ramp exit, the I-80/Wells on-ramp and extends to the I-80/S/V/C eastbound on-ramp.

- **80 W to 580 S/395N (WS/WN) Ramp.** This is a low-speed, two-lane system ramp that is joined by the westbound Kietzke Lane on-ramp prior to splitting to two one-lane ramps heading north to US 395 and south to I-580. The WS ramp is currently over capacity for a low-speed, one-lane ramp. The resulting congestion backs up on the ramp, blocks the westbound Kietzke Lane on-ramp and backs up onto I-80, affecting operations at the Rock Boulevard westbound on-ramp and Prater Way westbound off-ramp. At the Kietzke Lane entrance, the three lanes should continue to the WS/WN split as two two-lane ramps. The WS should continue as two lanes and the WN could drop to one lane if demand does not require two lanes.

- **NE Ramp.** This is a two-lane system ramp that narrows to one lane prior to merging with I-80. The ramp is currently over capacity for a one-lane ramp. The resulting congestion backs up onto I-580 and affects operations on the mainline and the NW ramp exit, as well as blocking the Glendale northbound on-ramp.

Lane Balance and Other Lane Discontinuity Deficiencies:

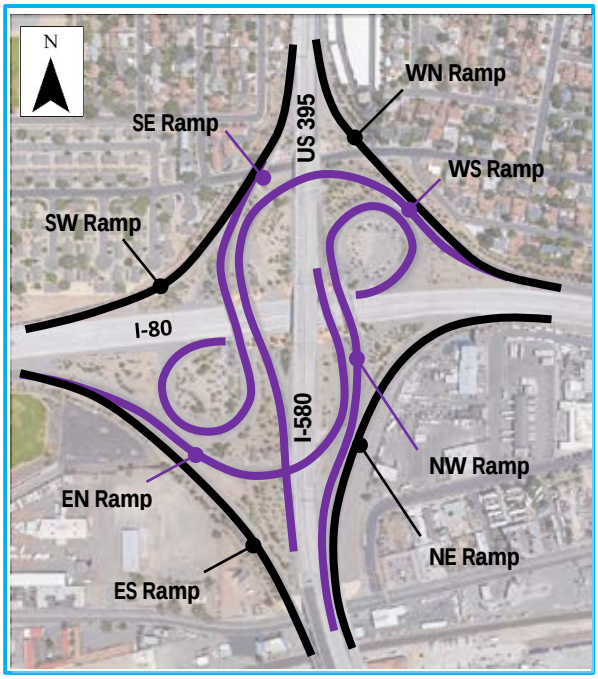
- *I-80 Eastbound at Keystone Interchange – two-lane to five-lane imbalance*
- *I-80 Eastbound at the ES/EN Exit – five-lane to three-lane imbalance*
- *I-80 Eastbound at the Rock Boulevard to Pyramid Parkway Interchanges – five-lane to three-lane to two-lane imbalance*
- *I-580 Southbound at Mill Street Interchange – five-lane to three-lane to four-lane imbalance*
- *NB I-580 from Glendale Interchange to the NW and NE Ramp Exits – seven-lane to three-lane imbalance*
- *ES Ramp at the I-580 Entrance – two-lane to one-lane drop*
- *WS/WN/Kietzke Lane Ramp – three-lane to two-lane to two-lane to one-lane ramps*
- *NE Ramp at the I-80 Entrance – two-lane to one-lane drop*

4.2 INTERCHANGES

4.2.1 System Interchange

The Spaghetti Bowl is a fully grade-separated interchange that uses a combination of direct, semi-direct, and semi-direct loop ramps to provide access between the freeway systems. These ramps are designed using speeds varying between 25 mph and 50 mph. Four of the eight system ramps are low speed:

- SE Ramp – 25 mph loop, posted 25 mph
- NW Ramp – 25 mph, posted 20 mph
- EN Ramp – 35 mph, posted 30 mph
- WS Ramp – 35 mph, posted 30 mph



Existing Spaghetti Bowl

The eight system interchange ramp connections to the freeways have been condensed. Of the maximum 16 entrances and exits possible, 6 connections are used on I-80 and 7 connections are used on I-580/US 395. This has allowed the system interchange to maintain a smaller right-of-way footprint and a lower vertical profile, using two levels.

Previous construction projects to improve the interchange have maintained the original ramp configurations and made localized improvements to enhance their operations. However, because of the lower design speeds, the ramps have maintained their lower capacities and have not been able to accommodate the traffic volumes currently using the interchange. These low-speed ramps have become bottlenecks for the system interchange and are regularly congested during peak-hour operations. These low-speed ramps will need additional capacity added in the form of additional lanes or higher design speeds. However, in the case of the NW loop ramp it is already a two-lane loop ramp built using the smaller radius of a one-lane loop ramp, making the radius undersized for the design. It also cannot be widened, because three-lane loops are not used due to safety and operational considerations. The NW loop ramp will need to be replaced with a higher speed ramp design.

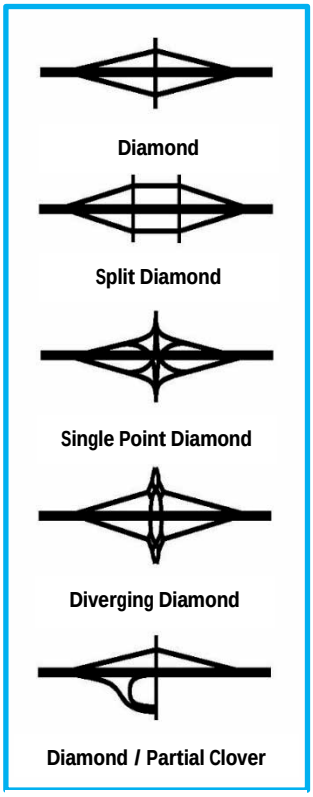
System Interchange Deficiencies:

- *SE Ramp – 25 mph ramp speed with low capacity*
- *NW Ramp –20 mph posted ramp speed with low capacity and less than desirable radius for a two-lane loop ramp*
- *EN Ramp – 30 mph posted ramp speed with low capacity*
- *WS Ramp – 30 mph posted ramp speed with low capacity*

4.2.1.1 Local Interchange Types

The local street interchanges within the project limits are consistent with the needs of the freeway traveler. The diamond configuration provides for a consistent entrance and exit pattern that meets a driver's expectations. All 16 service interchanges are a form of the diamond interchange.

Table 1 lists the interchange locations and types within the project limits.



Interchange Types

Table 1. Local Street Interchange Location and Type

Location	Interchange Type(s)[a]
I-80	
Keystone Ave	Single Point Diamond
Sierra Ave/Virginia St/ Center St (S/V/C)	Split Diamond
Wells Ave	Diamond
Prater Way/Kietzke Ln	Diamond serving I-80; Isolated from Kietzke Ln to I-580/US 395
Rock Blvd	Diamond
Pyramid Parkway	Single Point Diamond
McCarran Blvd	Diamond (eastbound); Partial cloverleaf (westbound)
I-580/US 395	
Meadowood Mall Way	Split Diamond with the Neal Road
S Virginia St	½ Diamond
Moana Ln	Diverging Diamond
Plumb Ln/ Villanova Dr	Split Diamond; Added airport access ramps
Mill St	Diamond (southbound); Partial cloverleaf (northbound)
Glendale Ave	Diamond (southbound); Partial cloverleaf (northbound)
Oddie Blvd	Partial Cloverleaf (southbound); Diamond (northbound)
Clear Acre Ln/ N McCarran Blvd	Split Diamond (southbound): Diamond incorporating braided ramps (northbound)

[a] See inset to the left of this table or schematics of typical interchange types.

The ramp designs for the diamond-type interchanges typically require between 800 and 1,200 feet of distance along the mainline to make the horizontal and vertical alignment connections and to provide proper ramp metering, intersection storage lengths, and acceleration/deceleration lengths. All of the older interchanges have ramp lengths well short of this distance. In accordance with the NDOT Design Guide, the preferred ramp exit is a tapered configuration, and the preferred ramp entrance is a parallel configuration. For these interchanges, all exits are tapered designs. However, for the entrance ramps, only 18 of 29 connections are parallel. In the cases where the entrances are tapered, several of the entrance angles were at or below the minimum entrance angle of 2 degrees. In some cases, the exit tapers were also at or below the minimum angle. The effect of small merge/diverge angles is a lengthening of the ramp beyond the gore and a corresponding shortening of the ramp separation distances, including shortening auxiliary lanes where they are present. This is compounded by the distance a ramp needs to connect in a diamond-type configuration and the closeness of the interchanges along the corridors.

Local Interchange Type Deficiencies:

- *Inconsistent use of the parallel ramp entrance design*
- *Shallow entrance/exit angles of tapered ramp designs*
- *Ramp connections inconsistent with the length of auxiliary lane needed*

4.2.1.2 Multi-Street Interchanges

The local street systems at the interchange connections are developed and provide access from the surrounding neighborhoods. These east-west and north-south streets create a grid system that is interconnected, and most of these streets also intersect away from the freeways. This grid serves not only to distribute traffic to an interchange but also to redistribute traffic demand to other areas along the freeway when congestion is encountered. Table 2 lists the local streets serving the interchanges.

Figures 2 and 3 show the travel speeds on the freeway network in the AM and PM peak periods. The slowing of traffic shown on the figures is indicative of congestion and the varying degrees each roadway and freeway-to-freeway ramp experiences during the morning and afternoon commutes.

The AM and PM peak period, congestion levels differ significantly. During the AM period along the I-80 corridor and north of the system interchange, there are points of congestion on the local streets and the ramps at the interchanges. In the S/V/C, Clear Acre/N McCarran, and Pyramid to McCarran (East) interchange areas, the congestion extends beyond the interchanges on both the local streets and freeways.

In the PM period along all corridors and interchanges, congestion is widespread. The local street system is congested around the freeway system and well beyond. The freeway congestion extends across all interchanges except in the S/V/C and Plumb/Villanova interchange areas.

Table 2. Local Streets at Interchanges

Street Name	No. of Lanes	Raised Median	Bike Lanes	Sidewalk	Remarks
I-80 Corridor					
Keystone Ave	5	Yes	No	Yes	
Sierra St	4	No	No	Yes	Bike Lanes north of freeway
Virginia St	5/6	Yes	No	Yes	
Center St	3/4	No	No	Yes	
Maple St	3	No	No	Yes	Part of ramp – one way – eastbound
E 8th St	3	No	No	Yes	Part of ramp – one way - westbound
Wells Ave	5	Yes	No	Yes	7 lanes south of the freeway Bike lanes north of the freeway
Prater Way (4th St)	5/6	Yes	No	Yes	
Kietzke Ln	4/6	Yes	No	Yes	
Victoria Ave	3/5	Yes	Yes	Yes	Prater/Kietzke connection
Rock Blvd	4/6	Yes	No	Yes	Sidewalk on west side only
Pyramid Pkwy	6	Yes	No	Yes	
McCarran Blvd	7	Yes	No	Yes	
I-580/US 395 Corridor					
Meadowood Mall Way	5/6	Yes	Yes	Yes	
S Virginia St	6/9	Yes	No	Yes	Bike lanes north/west of freeway
Moana Ln	5/8	Yes	Yes	Yes	
Plumb Ln	7	Yes	Yes	Yes	
Villanova Dr	3/5	Yes	No	Yes	
Matley Ln	3	No	No	Yes	Part of ramp – one way – southbound
Frontage Rd	3	No	No	No	Part of ramp – one way – northbound
Mill St	5	Yes	Yes	Yes	
Glendale (2nd St)	5/6	Yes	No	Yes	
Oddie Blvd	5/7	Yes	No	No	Graded paths and access ramps in lieu of sidewalks
McCarran Blvd	6/8	Yes	Yes	Yes	
Clear Acre Ln	5/7	Yes	Yes	Yes	

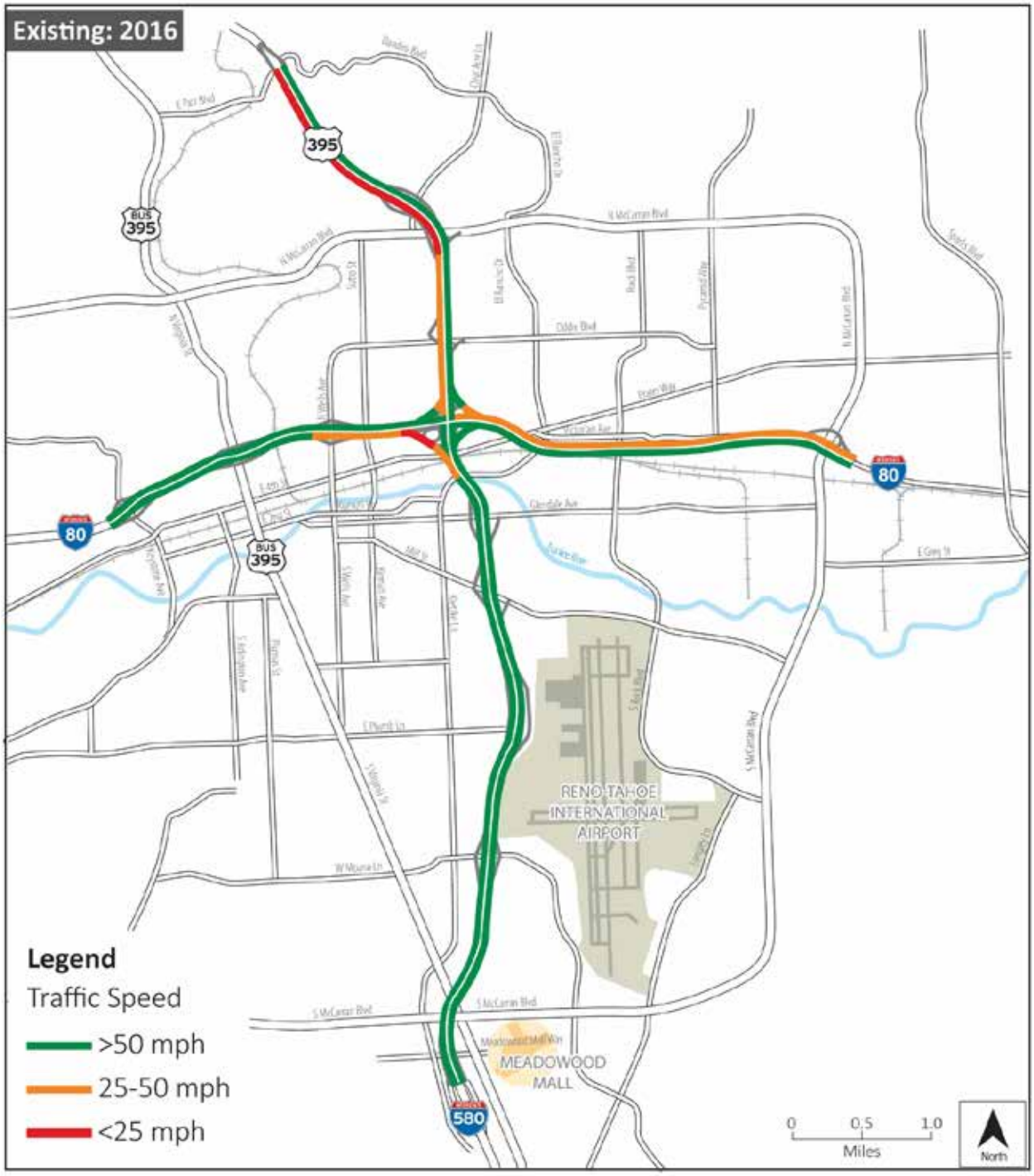


Figure 2. Typical Weekday Traffic Patterns (Speed) – AM Peak

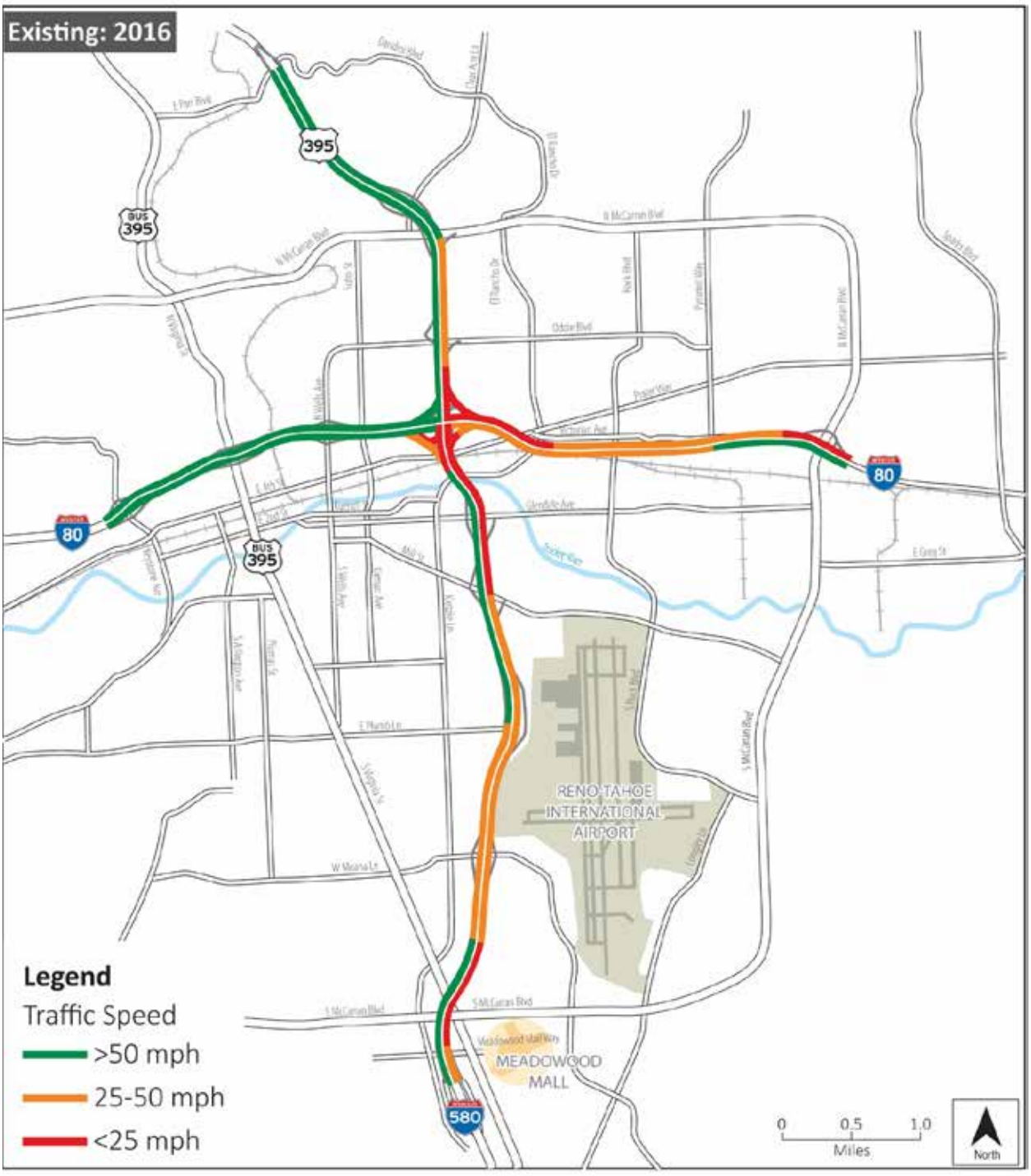


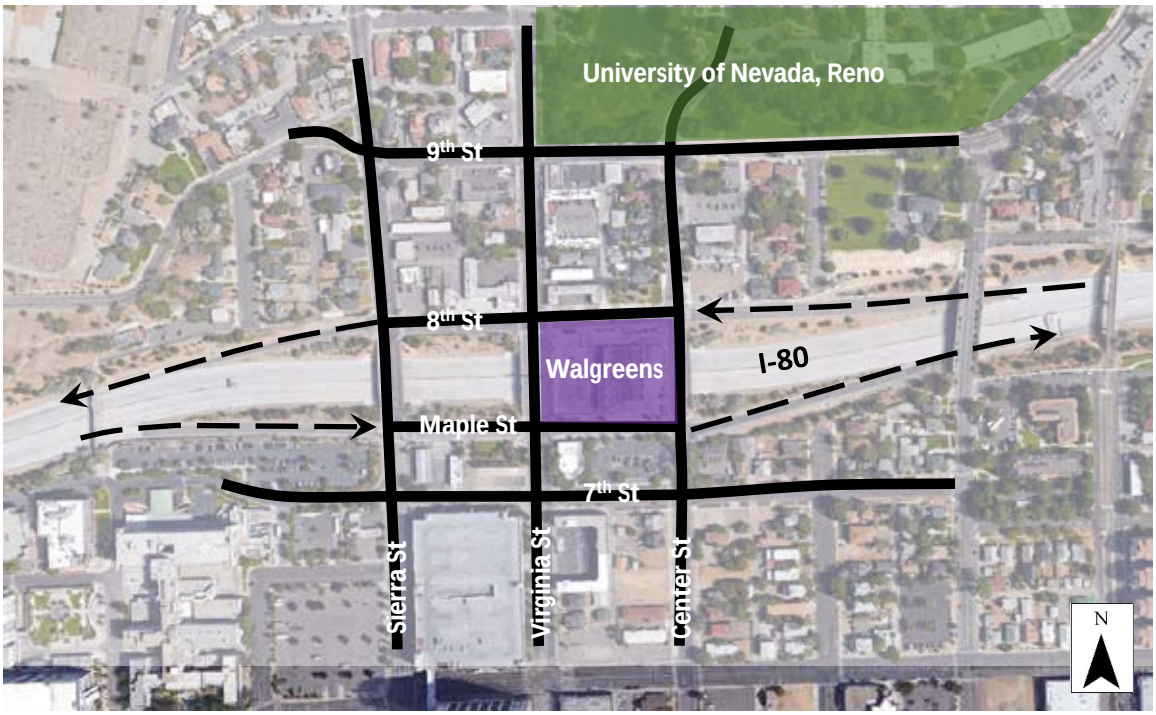
Figure 3. Typical Weekday Traffic Patterns (Speed) – PM Peak

All of these streets experience some form of congestion. The interchange type, ramps, and the ramp terminal intersections will need to be investigated for the best ways to accommodate traffic demand and improve the functions of the interchanges.

There are three interchange locations that serve multiple local streets. Each of these interchanges has been developed in a unique manner to maintain local street continuity and still provide the connectivity to the freeways. However, with the areas showing the extensive congestion, these interchanges need to be investigated for additional solutions to improve the function of the interchanges and freeways and to alleviate congestion. The three interchanges locations are:

- I-80/S/V/C Interchange
- I-80/Prater Way/Kietzke Lane Interchange
- I-80/Pyramid Parkway Interchange

I-80/S/V/C Interchange



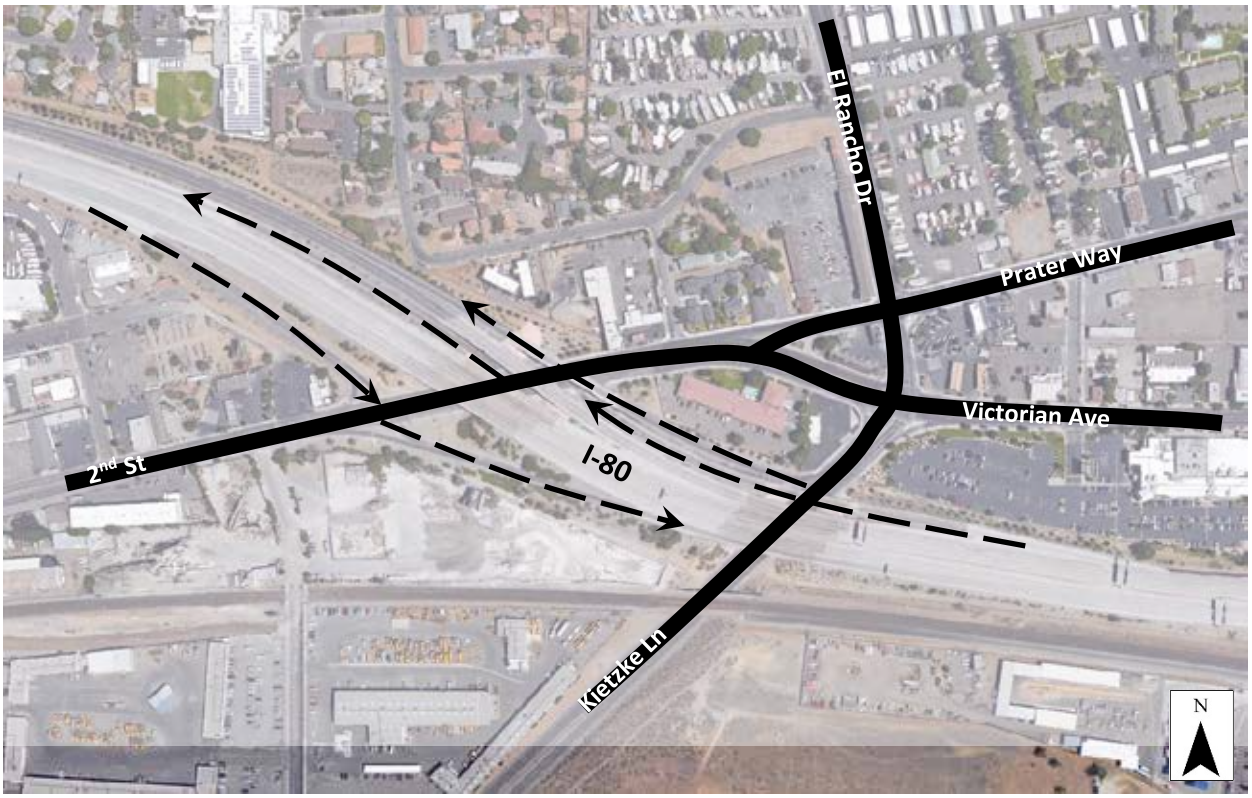
This interchange is located in the downtown Reno area and provides access to the University of Nevada Reno, casinos, businesses, and the Truckee River. The street grid is older and closely spaced. Because of the need to maintain street network continuity, the interchange at this location connects the three cross streets in a split diamond configuration, using Maple Street and East Eighth Street as one-way frontage roads and part of the eastbound and westbound ramps. In order to fit this interchange into the street network, both West Street and Lake Street were severed by the freeway and interchange ramps. Both streets now dead-end at the freeway. This configuration includes six traffic signals to maintain cross-street and ramp circulation. Other interchanges typically have two signals. Additionally, because Maple Street

was added between Seventh Street and Eighth Street for the eastbound ramp access, Seventh Street is unusually close to the freeway and the three additional stop-controlled intersections within the influence of the interchange. The combined nine intersections create congestion issues for all directions of travel, including periodic queueing of vehicles onto I-80. This location is further complicated with a commercial development (Walgreens) located over the freeway between the ramp frontage roads, Virginia Street, and Center Street. Driveways are located on all of the adjacent streets.

Multi-Street Interchange Deficiencies: I-80/S/V/C Interchange

- *Narrow local street system*
- *Multiple signals and intersections within the interchange's influence*
- *Abundance of driveway access points within the interchange's influence*
- *Loss of local access on West Street and Lake Street*
- *Commercial development over the freeway mainlines and within the interchange.*

I-80/Prater Way/Kietzke Lane Interchange



This interchange is located at the west edge of downtown Sparks and provides local street connectivity through the interchange from downtown Reno via Fourth Street, from the portions of Reno that are immediately south of the Truckee River via Kietzke Lane, and from Sparks via El Rancho Drive, Prater Way, and Victorian Avenue. These streets interconnect immediately north of I-80 to serve the interchange. These streets combine in six separate intersections that are separated from each other by 200 to 500 feet. E Fourth Street provides the eastbound ramp access and the combination of E Fourth Street/Prater Way/Victorian Avenue/El Rancho

Drive/Kietzke Lane are channelized together to provide the westbound I-80 ramp access and the I-580 S and US 395 N ramp access. Five of the six intersections are signalized. Cross-freeway flow has been channelized as E Fourth Street (five lanes), Prater Way (five lanes), and Victorian Avenue (three lanes) with turning movements to the other streets. Victorian Avenue is the through movement. E Fourth Street traffic must make a left turn to continue onto Prater Way. The residential and commercial property access also affect circulation on the north side of the freeway. There are driveways on all sides of the streets. This configuration creates congestion issues at the interchange connections and into the adjacent neighborhoods.

Multi-Street Interchange Deficiencies: I-80/Prater Way/Kietzke Lane Interchange

- *All streets converge at the interchange and serve different areas of Reno and Sparks*
- *Multiple signals and intersections within the interchange's influence*
- *Abundance of driveway access points within the interchange's influence*
- *Isolated ramp at Kietzke Lane*

I-80/Pyramid Parkway Interchange

This interchange is located adjacent to downtown Sparks and its historic district, the Nugget Casino, and the UPRR railroad yard. From the interchange, Pyramid Parkway is Route 445, a continuous north-running street that extends out of town to Spanish Springs and Pyramid Lake. At I-80, Pyramid Parkway is blocked by the railroad yard and ends at Nugget Avenue, south of the freeway. This street serves eastbound I-80 exiting traffic, the Nugget Casino, and the downtown Sparks areas north of the freeway via Victorian Plaza Circle. The street starts at the eastbound exit from I-80 and has no connectivity to Rock Boulevard. It becomes a frontage road

extending to McCarran Boulevard (East). Nugget Avenue is close to the single point diamond interchange intersection, located 200 feet south.

Victorian Avenue is the first street along the north side of the freeway. Because of the downtown development patterns, the street is within 300 feet of I-80 and only 100 feet north of the single point diamond intersection. It becomes the northern frontage road of I-80 between Pyramid Parkway and McCarran Boulevard (East). West of Pyramid Parkway, Victorian Avenue connects Prater Way, Rock Boulevard, and Pyramid Parkway and is one of the main streets serving this area of the city, including a transit station, multiple casinos, and Victorian Square. Properties adjacent to the interchange and Pyramid Parkway access the interchange via the Victorian Avenue and Nugget Avenue intersections. There are no driveway accesses between the two intersections along Pyramid Parkway. However due to the proximity of the three intersections and the expansive nature of interchange footprint, they influence each other creating channelization and lane-storage deficiencies that cause congestion at the interchange and into the adjacent neighborhoods.

Multi-Street Interchange Deficiencies: I-80/Pyramid Parkway Interchange

- *Route 445 connection to I-80 and is congested*
- *Proximity of Victorian and Nugget Avenue to the interchange; congestion of these roadways*
- *Multiple signals within the interchange's influence*
- *Multiple casinos and downtown Sparks located adjacent to the interchange*
- *Bus transit station access point*
- *UPRR facilities and the petroleum storage tanks located immediately south of the freeway*

4.3 INTERCHANGE AND RAMP TERMINAL SEPARATION

Interchange and ramp spacing are key components of a freeway system, which enable efficient access and safe and effective traffic operations. According to AASHTO guidelines (Green Book), a general rule of thumb for minimum interchange spacing is 1 mile in urban areas and 2 miles in rural areas. Within the project limits, the valley is an urban environment and spacing should be approximately 1 mile to accommodate lane maneuvers and signage. However, the existing development has placed interchanges much closer together. In these cases, adding grade-separated ramps or collector-distributor roads should be considered. In addition, interchange ramp spacing distances should generally comply with AASHTO Green Book (as shown in Figure 10-68 Recommended Minimum Ramp Terminal Spacing of the Green Book). This ensures the intent of the ramp and interchange spacing guidance.

These interchange and ramp spacing distances are provided as guidance. The adequacy of the existing ramp separation distances/weaving sections depends on the actual volumes and physical configuration at each intersection. The necessary separation distances to provide acceptable operations for the proposed project will be determined during the traffic investigations. Figure 1 (see attachments) shows the locations of the interchange spacing and ramp spacing that was found to be deficient.

Table 3 lists of the interchanges within the project limits and the separation distances between them. Of the 16 local interchanges and the system interchange, 9 are considered too closely spaced.

Ramp spacing on I-80 and I-580/US 395 was found to be consistent with the findings of the interchange spacing. Where the interchanges were considered too close, the ramp separation distances were less than the guidance suggested, with some providing less than half the recommended distance.

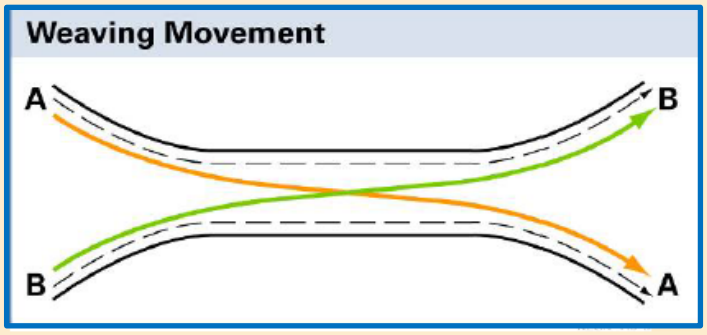
Table 3. Interchange Spacing

Interchange Location	Interchange Location	Separation Distance (miles)	Spacing Met?	Remarks
I-80 Corridor				
Keystone Ave	Sierra St/Virginia St/ Center St	0.9	No	
Sierra St/Virginia St/Center St	Wells Ave	0.6	No	
Wells Ave	I-80/I-580/US 395	0.8	No	Insufficient for the system ramps.
I-80/I-580/US 395	Prater Way	0.6	No	
Prater Way	Rock Blvd	0.7	No	
Rock Blvd	Pyramid Pkwy	0.7	No	
Pyramid Pkwy	McCarran Blvd (East)	0.8	No	
I-580/US 395 Corridor				
Meadowood Mall Way	Moana Ln	1.4	Yes	S Virginia is a half-diamond connection that does not interfere with Meadowood Mall Way.
S Virginia St	Moana Ln	1.0	Yes	
Moana Ln	Plumb Ln/Villanova Dr	0.9	No	
Plumb Ln/Villanova Dr	Mill St	0.9	No	
Mill St	Glendale Ave	0.6	No	
Glendale Ave	I-80/I-580/US 395	0.7	No	
I-80/I-580/US 395	Oddie Blvd	0.6	No	
Oddie Blvd	Clear Acre Ln/ N McCarran Blvd	0.8	No	
Clear Acre Ln/ N McCarran Blvd	Sutro St (Future)	0.5	N/A	Sutro interchange is planned as a braided ramp configuration with the adjacent interchanges.
Clear Acre Ln/ N McCarran Blvd	Parr/Pyramid Pkwy Connector (Future)	1.5	Yes	

4.4 SHORT MERGE\WEAVINGS SECTIONS

The areas affected by the short ramp and interchange spacing extend on I-80 from Center Street to Pyramid Parkway, a distance of 3.4 miles, and it includes six interchanges. On I-580/US 395, it extends from Mill Street to Oddie Boulevard, a distance of 1.8 miles that includes four interchanges. On average the spacing between the interchanges is 0.7 mile, leaving each interchange approximately 1,500 feet short of the distance needed to provide effective weaving sections.

Weaving is the crossing of two or more traffic streams traveling in the same direction. For example, weaving occurs when an interchange entrance ramp is followed by an exit ramp. The most critical aspect of operations within a weaving segment is lane changing. The configuration of the weaving segment (i.e., the relative placement of entry and exit lanes) has a major effect on the number of lane changes required of weaving vehicles to successfully complete their maneuver.



Closely spaced on- and off-ramps create bottlenecks when merging traffic attempts to enter a freeway and traffic in the right lane is either unable to move over because of traffic volume or reluctant to move over because it is exiting at the next off-ramp. As the freeway and ramp volumes increase, the problem is exacerbated, leading to congestion and crashes. Short merge/weave sections in the study area include the following:

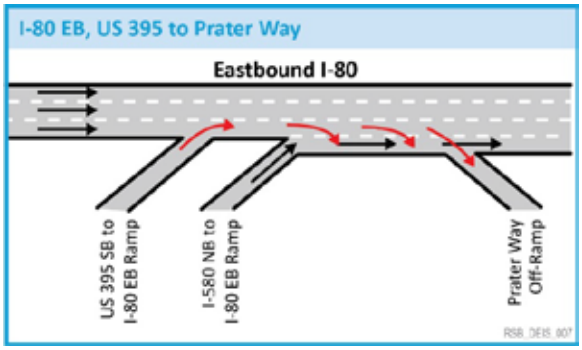
- Standard weaving conditions on I-80 and I-580/US 395
- The SE loop ramp to Prater Way off-ramp
- The Rock Boulevard on-ramp to I-80 W
- The Glendale loop on-ramp to US 395 N
- The WS ramp to Glendale off-ramp
- The EN ramp to Oddie off-ramp

4.4.1 Standard Weaving Conditions on I-80 and I-580/US 395

These weaving sections are not complex but are short, creating slow traffic conditions and backups on the arterial streets, ramps, and mainline.

- I-80/S/V/C to Wells – eastbound and westbound auxiliary lanes
- I-80/Wells to Spaghetti Bowl – eastbound and westbound auxiliary lanes
- I-80/Prater to Rock – eastbound auxiliary lane
- I-80/Rock to Pyramid – eastbound and westbound auxiliary lanes
- I-80/Pyramid to McCarran (East) – eastbound and westbound auxiliary lanes
- I-580/Plumb/Villanova to Mill – northbound and southbound auxiliary lanes
- I-580/Mill to Glendale – southbound auxiliary lane
- US 395/Oddie to N McCarran – northbound and southbound auxiliary lanes

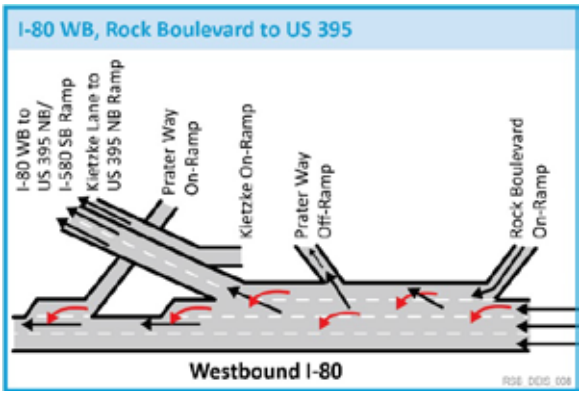
4.4.2 The SE Loop Ramp to Prater Way Off-Ramp



This weaving section combines I-80 E with the SE loop on-ramp, the I-580 N to 80 E (NE) on-ramp, and the Prater Way off-ramp. The SE ramp joins I-80 in a 600-foot merge before the NE ramp enters and the I-80 traffic begins to weave to take the Prater Way off-ramp. This weave distance is less than 600 feet.

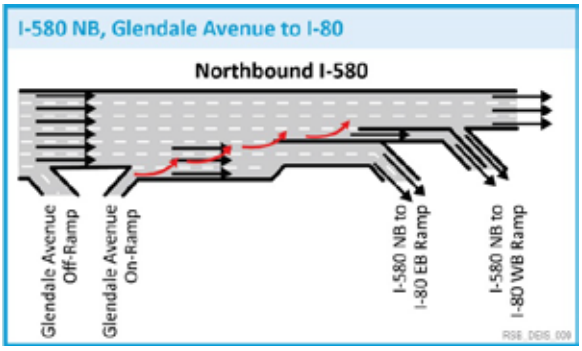
The short merge of the loop ramp affects I-80 traffic flows at the point where vehicles are preparing to weave with the NE ramp and exit the freeway at Prater Way. This configuration of three traffic flows combining to split to two destinations in extremely short distances forces the drivers to slow and struggle for space to weave. Heavy traffic volumes in the three through lanes exacerbate the problem, allowing fewer gaps for merging/weaving vehicles. The result is traffic backups onto I-80 eastbound, the SE ramp, and the NE ramp, and access to the Prater Way eastbound off-ramp becomes partially blocked by the backed-up traffic.

4.4.3 The Rock On-Ramp to I-80 W



This weaving section combines I-80 W with the Rock Boulevard on-ramp, the Prater Way off-ramp, the system ramps to US 395 N and I-580 S, and a mainline lane drop. The Rock Boulevard on-ramp joins an auxiliary lane that becomes the US 395 N ramp. Traffic heading to I-580 S must weave with the I-80 traffic heading to US 395 N and the Prater Way off-ramp traffic. Traffic heading to I-80 W must move across an additional lane that is predominantly I-580 S exiting traffic. This is complicated by the loss of a mainline lane just west of the system ramp exit. Heavy traffic volumes in the three through lanes merging to two lanes exacerbate the problem, allowing fewer gaps for merging/weaving vehicles. The result is traffic backups on I-80 westbound and Rock Boulevard, the WS ramp, and the WN ramp, and the Prater Way westbound off-ramp becomes partially blocked by the backed-up traffic.

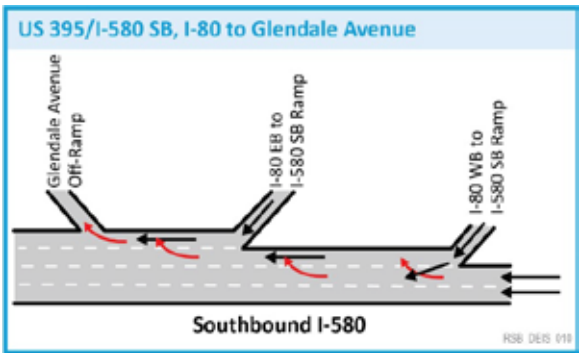
4.4.4 The Glendale Loop On-Ramp to US 395 N



This weaving section combines I-580 N with the Glendale loop on-ramp, the NE ramp, and the NW ramp. The Glendale on-ramp joins I-580 as a parallel entrance from a 25-mph loop. This is generally in the same location as the NE ramp auxiliary lanes and exit and the NW ramp auxiliary lanes. Glendale traffic

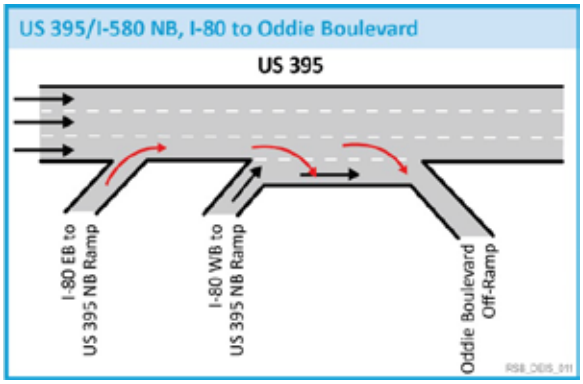
heading north must accelerate to freeway speeds and weave across the two NE ramp auxiliary lanes and the two NW ramp auxiliary lanes to reach 395 N. This is a distance of 1,900 feet. With the heavy traffic using the NE and NW ramps, the loop ramp is mostly blocked to the NE or NW ramps within that distance. The congestion created by the interaction between the one entering ramp, two exiting ramps, and the 395 N traffic allows few gaps for merging/weaving vehicles. The result is traffic backups on Glendale and the on-ramp, in addition to added congestion on the mainline.

4.4.5 The WS Ramp to Glendale Off-Ramp



This weaving section combines US 395 S with the WS ramp, the ES ramp, and the Glendale southbound off-ramp. The WS ramp joins US 395 S in its own lane and is joined by the ES ramp, also in its own lane. Traffic on 395 S exiting to Glendale must weave across two lanes of the entering system ramps over a distance of 2,100 feet to exit, including a 1,000-foot weave section between the ES ramp and the Glendale off-ramp. This weave is complicated by the need for the ES ramp to merge to the left to continue south due to a mainline lane drop at Mill Street. The result is there are few gaps for merging/diverging traffic and traffic backs up on 395 S, the WS ramp, and the ES ramp. The Glendale off-ramp becomes partially blocked too.

4.4.6 The EN Ramp to Oddie Off-Ramp



This weaving section combines 395 N with the EN ramp, the WN ramp, and the Oddie off-ramp. The EN ramp joins US 395 in a short 800-foot merge prior to the WN ramp joining in an auxiliary that ends in the Oddie off-ramp. Traffic on the EN ramp must merge with US 395 and then weave with the WN traffic

Interchange and Ramp Spacing Deficiencies:

- *Interchange separation – 9 of 16 are too close together*
- *Standard entrance/exit ramp – 14 are too close together*
- *SE loop ramp to the Prater Way off-ramp – multiple-movement weave in short distances*
- *Rock Boulevard westbound on-ramp to westbound I-80 – multi-lane weave in a short distance*
- *Glendale loop on-ramp to northbound US 395 – multiple-movement weave and multi-lane in a short distance*
- *WS ramp to I-580 – multiple-movement weave in short distances*
- *EN ramp to US 395 – multiple-movement weave in short distances*
- *Bus transit station access point*

heading north and the Oddie off-ramp traffic. The combined length of this weaving section is approximately 1,500 feet. The result is there are few gaps for merging/diverging traffic and traffic backs up on US 395N, the EN ramp, and the WN ramp and there partial blocking of the Oddie off-ramp.

4.5 SPEEDS

Design speed is a function of the type of facility being served. For the freeway system, the controlling *minimum* design speeds are:

- Freeway mainline – 70 mph
- Direct connector system ramp – 40 mph
- Semi-direct connector system ramp – 35 mph
- System loop ramp – 25 mph
- Local interchange ramp – 35 mph
- Local interchange loop ramp – 25 mph

The Spaghetti Bowl and the I-80 and I-580/US 395 corridors generally follow these design speed criteria. However, there are key areas where these criteria are not met and where there are effects on the freeways and ramps.

4.5.1 Speed Reductions

4.5.1.1 I-80, US 395 and I-580 Freeways

With the age of the freeway facilities ranging back to 1960s, design criteria have progressed to the higher speeds and larger vehicles of today. This is evident on both I-80 and US 395/I-580, where the mainline alignment has been preserved. The freeways have been widened with the original geometrics to squeeze economic capacity improvements from the original facilities. The freeways are now a mix of geometric conditions that are consistent with lower design speeds. As these elements of design are improved to meet today's design standards, a combination of horizontal and vertical freeway realignment can be expected. Table 4 lists these changes

Table 4. Freeway Mainline Speeds

Freeway	Location	Posted Speed (mph)	Range of Speeds[a] (mph)	Remarks
I-80 West	Keystone to Spaghetti Bowl	65	50 - 70	8 horizontal curves
I-80 East	Spaghetti Bowl to McCarran (East)	65	(30) 60 - 70	5 horizontal curves. The reversing curves at Pyramid are 30 mph as built design speeds.
I-580 South	Meadowood Mall Way to Spaghetti Bowl	65	30 - 70	5 horizontal curves. Meadowood Mall Way curve is 30 mph. Plumb-Villanova curve is 40 mph.
US 395 North	Spaghetti Bowl to Clear Acre Lane	65	60 - 65	2 horizontal curves. Split alignment at Clear Acre Lane.

[a] Existing Design Speed based on existing geometric conditions and as-built information.

The geometric conditions that affect design speeds are prevalent throughout the project limits. The key areas where the curves create obvious slowdowns follow:

- I-80 at Pyramid Parkway – reversing 30-mph curves with short tangent
- I-580 at Meadowood Mall Way – 30-mph curve with approximately 60 degree turn
- I-580 at the Truckee River – reversing 55-mph curves with short tangent and short super-elevation transitions

These existing geometric conditions are consistent with the use of minimum radius design methods (comfort speeds). Under these conditions, the original freeway is consistent with a 65- to 70-mph speed.

Even with this in mind, a fully reconstructed interstate freeway needs to comply with current state and federal design standards.

4.5.1.2 Ramps

Portions of the project area have posted speed reductions at the exit ramps. The nature of the ramp geometrics has required these restrictions to be added to accommodate other constraints in the area. Older ramps tend to be short and are not able accommodate the combined vehicle storage and deceleration lengths needed today. Where ramps have required reconstruction, most have been done on existing alignment due to restrictions from existing bridges or roadside features. These restrictions are located where the standard 50 mph speed cannot be met and an advanced warning restriction has been incorporated. Table 5 lists these speed-reduction locations, which are also shown on Figure 1 (located in attachments).

Table 5. Ramp Speed Reductions

Location	Posted Speed	Remarks
ES Ramp Exit	35 mph	Sight distance restrictions at the right shoulder due to the sound wall and barrier.
NE Ramp Exit	35 mph	Sight distance restrictions at the bridge/barrier railing of the NW structure over UPRR and E 4th St.
NW Ramp Exit	35 mph	Sight distance restrictions at the bridge/barrier railing of the NW structure over UPRR and E 4th St.
I-80/S/V/C Eastbound Off-Ramp	25 mph	Geometric restrictions from a structure pier and an adjacent retaining wall and from ramp and deceleration length restrictions.
I-80/S/V/C Westbound Off-Ramp	25 mph	Ramp and deceleration length restrictions.
I-80/Wells Eastbound Off-Ramp	35 mph	Sight distance restrictions at the exit from a structure pier.
I-80/Prater Eastbound Off-Ramp	30 mph	Deceleration distance to the intersection is restricted.

Table 5. Ramp Speed Reductions

Location	Posted Speed	Remarks
I-80/Prater Westbound Off-Ramp	35 mph	Narrow shoulders and proximity of structures restricts sight distance on the ramp approaching the intersection.
I-580/Moana Northbound Off-Ramp	35 mph	Ramp and deceleration length restrictions.
I-580/Mill Southbound Off-Ramp	35 mph	Sight restrictions at the right shoulder and sound wall and from ramp and deceleration length restrictions.
I-580/Airport Southbound Off-Ramp	35 mph	Deceleration restrictions at the approach to the first curve at the ramp gore.
I-580/Glendale Southbound Off-Ramp	35 mph	Sight restrictions at the right shoulder and sound wall and from ramp and deceleration length restrictions.
US 395/Oddie Southbound Off-Ramp	35 mph	Sight restrictions at the right shoulder for a sound wall and for the horizontal alignment.

4.5.2 Speed Differential

The speed difference between ramp and mainline lanes is preferred to be limited to a 5 to 10 mph difference prior to a ramp joining the mainline. Most cases provide adequate acceleration length in advance of the ramp gore (or ramp meter stop bar if present) to comply. Where an auxiliary lane is present, the ramp will use a portion of the auxiliary lane to accelerate, but the lanes need to remain separate from the mainline until the proper speed is reached. In the case of the I-80, I-580, and US 395, the facilities are closely spaced in many locations and the lengths of the ramp and auxiliary lanes has been compromised. At these locations, the acceleration or deceleration occurs adjacent to higher-speed traffic flows, creating a high/low speed interaction that affects traffic flows and interaction between movements. Disruptions like these affect the capacity of both facilities and may contribute to a deterioration in safety. The following areas with deficiencies have been identified:

- **I-80/Keystone Eastbound On-Ramp.** Short acceleration distance from the ramp meter stop bar onto I-80; short auxiliary lane and weaving distance to Wells Avenue.
- **I-80/S/V/C Eastbound Off-Ramp.** Traffic backs up from the intersection signal onto I-80, creating a stopped condition adjacent to the high-speed through traffic.
- **I-80/S/V/C Westbound Off-Ramp.** Traffic backs up from the intersection signal onto I-80, creating a stopped condition adjacent to the high-speed through traffic.
- **NW Ramp.** This ramp is a two-lane, 25 mph loop on-ramp that connects immediately to I-80 into two auxiliary lanes. No separation from the mainline is provided. This location is also a short merge/weave area previously discussed.

- **NE Ramp Exit.** This is a two-lane ramp exit that is designed to provide substantial auxiliary lane storage on the I-580 northbound mainline to support the poor ramp capacity that is available onto I-80. This area queues traffic as far back as Mill Street, creating stopped conditions on the mainline. This location is also a short weave/merge area discussed in Section 4.3, Interchange and Ramp Terminal Separation.

- **NW Ramp Exit.** This is a two-lane ramp exit that is designed to provide substantial auxiliary lane storage on the I-580 northbound mainline to support the poor ramp capacity of the low-speed loop configuration. This area interacts with the NE ramp to queue traffic as far back as Mill Street, creating stopped conditions on the mainline. This location is also a short weave/merge area discussed in Section 4.3, Interchange and Ramp Terminal Separation.

Speed Deficiencies:

- *Interchange ramps – 13 exit ramps with exit speed warnings at 35 mph or less*
- *Speed differential – six locations at ramp entrances/exits where the speed difference between the ramp and the mainline is large*

4.6 OTHER GEOMETRIC CONSIDERATIONS

The following sections describe other existing roadway conditions that have been reviewed as part of this report. The results of the reviews have been included in Attachment C, and the substandard conditions found are included in Figure 1 (as an attachment to this report).

4.6.1 Acceleration and Deceleration Distance

The acceleration and deceleration distances have been mentioned in the other discussions. Generally, when the interchanges and ramps are close together, the loss of ramp length and the shortness of the auxiliary lanes coincide with a loss of acceleration or deceleration length and a loss of speed, which results in a facility that is less safe. This has been the case for most locations between the S/V/C and Pyramid interchanges on I-80 and from Mill Street to Oddie Boulevard on I-580/US 395. In all cases where this length has been compromised, the proposed designs must accommodate ramp lengths and separation distances to ensure minimum distances are exceeded. This is done either by changing the interchange type, braiding ramps, adding collector distributor ramps, or removing an interchange or ramp connection.

4.6.2 Lanes and Shoulder Widths

Lane and shoulder widths within the project limits are less than standard in the older freeway segments and in several newer areas. There are several reasons for this:

- Constrained area where an older structure limited the available width for widening, so lanes and shoulders were reduced. Locations include the I-80 mainline lanes, ramp lanes, and shoulder widths at the S/V/C interchange

- Constrained area where development blocked widening. I-80 mainline lanes and shoulders between Rock Boulevard and Pyramid Parkway across the Nugget Viaduct.

- Conversion between English and metric measurements. Many 11.5-foot lanes were identified.

- Any locations where the lane and shoulder widths have been reduced that are revised as part of this project will be improved to meet the minimum width requirements.

4.6.3 Stopping Sight Distances

There are multiple locations of substandard stopping sight distances along the mainline. These locations are shown on Figure 1 and detailed in Attachment B. Most of these locations are due to the narrowing of the shoulders at median barriers, bridge piers, bridge abutments, or slope paving.

At locations where stopping sight distance is insufficient for the design speeds, the shoulders and other geometrics will be improved to exceed minimum standards.

Other Geometric Deficiencies:

- *Acceleration distances – multiple locations of substandard lengths*
- *Deceleration distances – multiple locations of substandard lengths*
- *Lane and shoulder widths – multiple locations of substandard widths*
- *Stopping sight distances – multiple locations of substandard length*

4.7 STRUCTURES

4.7.1 Bridge Condition

The condition of bridges in the study area freeway corridors is a factor in the need for the proposed action. The majority of the bridges in the I-80 corridor were constructed in the late 1960s and early 1970s. In aggregate, the I-580/US 395 corridor bridges are not quite as old, with many constructed in the late 1970s and early 1980s. However, the I-580/US 395 corridor includes its share of older bridges constructed in the late 1960s and early 1970s.

When the study area bridges were built, it was common practice to assume a 50-year useful service life. With that in mind, many of study area bridges, especially those constructed in the 1960s, may be candidates for rehabilitation or replacement in conjunction with corridor improvements. In general, the need for rehabilitation and/or replacement is evaluated based on existing structural (load carrying capacity) and functional (geometric and operations) conditions. To summarize, bridges that cannot reliably support the load of current design vehicles may be considered structurally deficient (SD); bridges with substandard geometry (e.g., roadway alignment, horizontal and vertical clearance) are deemed functionally obsolete (FO). Reported deterioration (e.g., spalled concrete, corroded steel, damage from vehicle impacts) can lead to a reduction in load-carrying capacity and may result in a structurally deficient condition assessment. None of the bridges in the study area freeway corridors are presently considered to be structurally deficient.

4.7.2 Bridge Types

The highway bridges in the study area are either concrete or steel girder bridges. Concrete bridges include cast-in-place box girders, cast-in-place T-beams, and precast girders. Cast-in-place concrete box girder bridges comprise a top deck slab carrying traffic, multiple vertical webs (girders) supporting the deck, and a bottom slab between girders. The Victorian Plaza Circle Viaduct (H-866E/W) on the east leg of the I-80 corridor is an example of a cast-in-place box girder. Cast-in-place T-beam bridges are similar to cast-in-place box girders, except they do not have a bottom slab between girders (i.e., girders are exposed beneath the structure). The bridge carrying US 395 over Wedekind Road (H-1090) is an example of a cast-in-place T-beam bridge.

Precast concrete girder bridges comprise a deck slab carrying traffic supported on multiple girders. Precast concrete girders come in various shapes including box beams, I-beams, and U-girders. The bridge carrying N McCarran Boulevard over US 395 (I-1305) is an example of a precast concrete U-girder bridge. The widening constructed on the southbound side of the bridge carrying US 395 over Oddie Boulevard (I-1089) utilized precast concrete box girders.

Similar to precast concrete girders, steel girder bridges comprise a deck slab carrying traffic supported on multiple girders. Steel girder bridges in the study area include those constructed of built-up steel-plate I-girders (single vertical web plate, top and bottom horizontal flanges) and tub sections (dual web plates with connecting bottom flange and top flanges in the shape of a tub). The I-580 bridge over Mill Street (I-1252) is an example of a steel tub girder bridge. The bridge carrying the I-580 southbound off-ramp over Plumb Lane to the airport (I-1773) is an example of a steel I-girder bridge.

4.7.3 Existing Bridge Condition Ratings

4.7.3.1 Sufficiency Rating

In accordance with FHWA requirements, highway bridges are inspected biennially to visually assess the condition of the structure. Each element or component of a bridge (the deck, for example) is assigned a numeric rating from 9 (excellent condition) to 0 (failed condition). Condition ratings for individual elements are compiled into an overall Sufficiency Rating (SR) which provides an overall measure of condition. The SR accounts for structural and functional conditions and is a measure of the overall "health" of the structure.

The SR is one indicator in determining the need for bridge rehabilitation or replacement. The maximum SR for a bridge in theoretically perfect condition is 100.0. In determining funding eligibility for bridge improvements, FHWA uses an SR less than 80.0 as the threshold where federal funding may be available for rehabilitation. FHWA uses a SR less than 50.0 at the threshold where federal funding may be available for replacement.

In the study area corridors, none of the bridges are eligible for federal bridge replacement funds. The 14 bridges listed in Table 6 could be considered eligible for federal bridge rehabilitation funding.

Table 6. Bridges Potentially Eligible for Federal Rehabilitation Funding

Bridge No.	Facility Carried	Facility Crossed	Structure Rating
B-1349	I-80	Overflow relief culvert	70.0
I-992	Sierra Street	I-80	75.1
H-993	Virginia Street (SR 661)	I-80	70.8
I-994	Center Street	I-80	77.2
H-997	Valley Road	I-80	79.2
I-998	I-80	Wells Avenue	70.0
H-999	I-80	Sutro Street (SR 666)	68.6
H-866E/W	I-80	Victoria Plaza Circle Viaduct	64.2
H-1090	US 395	Wedekind Road	76.7
I-1172	US 395	E 9th Street and WS Ramp	72.6
H-1234	I-580	Kietzke Lane and Truckee River	78.2
I-1250	I-580	Plumb Lane	61.3
I-1799	I-580	S Virginia Street	74.4
H-1798	I-580	S McCarran Boulevard	74.4

4.7.3.2 Condition Assessment

When certain individual element rating factors fall below a given threshold (less than 4 on a scale from 0 to 9), a bridge is considered FO. In the study area corridors, 25 bridges have an FO condition assessment, 5 of those for deck geometry and the remainder for underclearance. An FO designation for deck geometry is an indication the bridge deck width is inadequate to meet current standards for traffic lanes and shoulders. An FO designation for underclearance means the vertical or horizontal clearance is significantly less than current standards.

Table 7 lists the bridges within the study area corridors deemed FO. The individual element rating factor is shown in parentheses. For all bridges deemed FO for underclearance, it is the horizontal clearance that is significantly less than current standards.

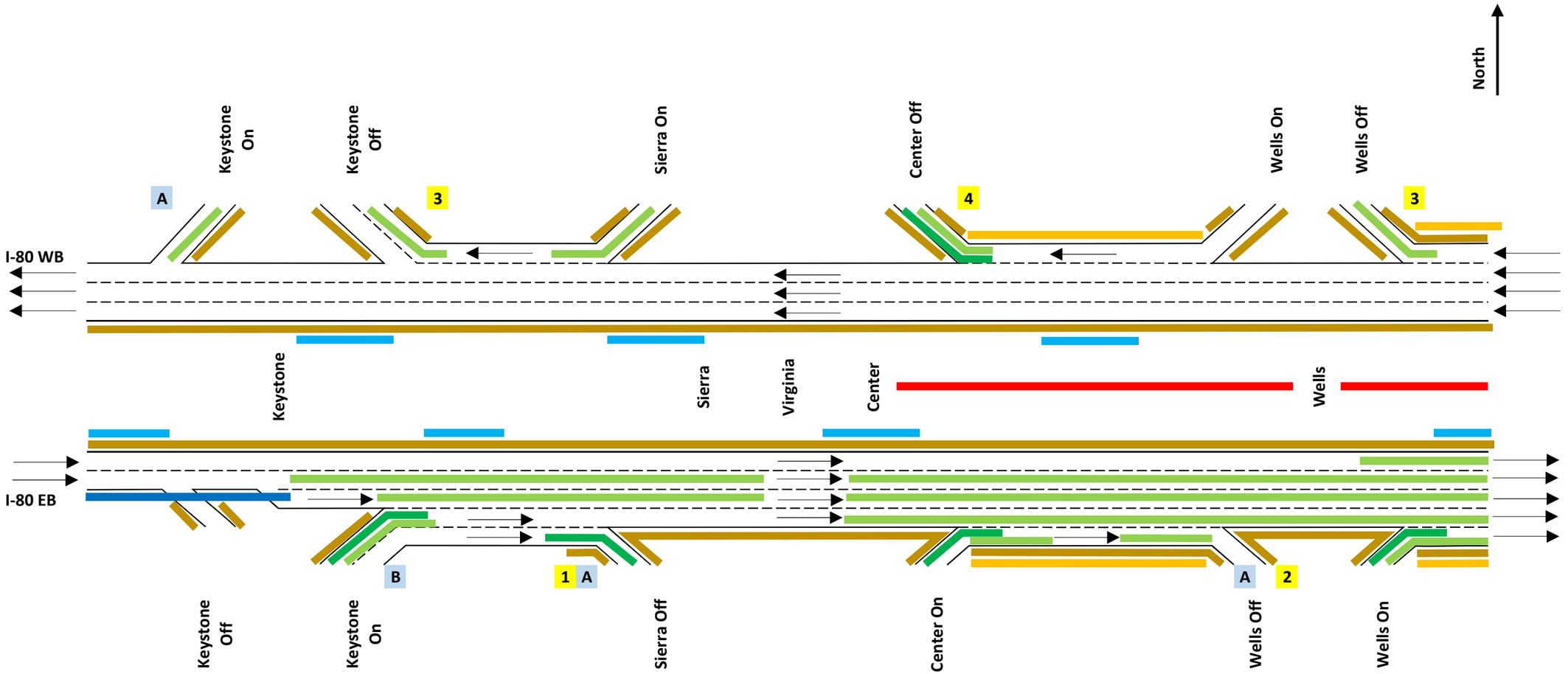
A complete listing of existing bridges within the study area corridors is included in Attachment D. The attachment also includes aerial exhibits with bridge locations shown together with sufficiency threshold information, an indication of FO rated elements, and minimum vertical clearance where clearance is less than the NDOT's standard of 16.50 feet.

Table 7. Functionally Obsolete Bridges in the Study Area

Bridge No.	Facility Carried	Facility Crossed	Functionally Obsolete Element (Rating)
H-993	Virginia Street (SR 661)	I-80	Deck Geometry (2)
H-997	Valley Road	I-80	Underclearance (2)
I-998	I-80	Wells Avenue	Underclearance (2)
H-999	I-80	Sutro Street (SR 666)	Underclearance (2)
I-1000	SE Ramp	I-80	Underclearance (3)
I-1001	WS Ramp	I-80	Underclearance (2)
I-1086	I-580/US 395	I-80	Underclearance (2)
I-1087	EN Ramp	I-80	Underclearance (3)
I-1088	NW Ramp	I-80	Underclearance (3)
I-1002	I-80	4th Street/Prater Way (SR 647)	Underclearance (3)
I-1005E/W	Rock Boulevard (SR 668)	I-80	Underclearance (3)
I-1007E/W	E McCarran Boulevard	I-80	Underclearance (3)
I-1305	N McCarran Boulevard	US 395	Underclearance (3)
H-1090	US 395	Wedekind Road	Underclearance (3)
I-1172	US 395	E 9th Street and WS Ramp	Underclearance (3)
G-1233	I-580	E 4th Street and UPRR	Underclearance (2)
H-1251	I-580	Vassar Street	Underclearance (3)
I-1774	I-580 southbound off-ramp	I-580 and Terminal Way	Underclearance (3)
I-1248	I-580	Moana Lane	Underclearance (3)
I-1799	I-580	S Virginia Street	Deck Geometry (2)
H-1798	I-580	S McCarran Boulevard	Deck Geometry (2)
H-2654	Kietzke westbound on-ramp	Prater Way	Deck Geometry (3)
H-1171	SW/SE Ramps	E 9th Street	Deck Geometry (3)
G-1233R	NE Ramp	E 4th Street and UPRR	Underclearance (2)
G-1233L	ES Ramp	E 4th Street and UPRR	Underclearance (3)

FIGURE 1
EXISTING CONDITIONS DEFICIENCIES

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

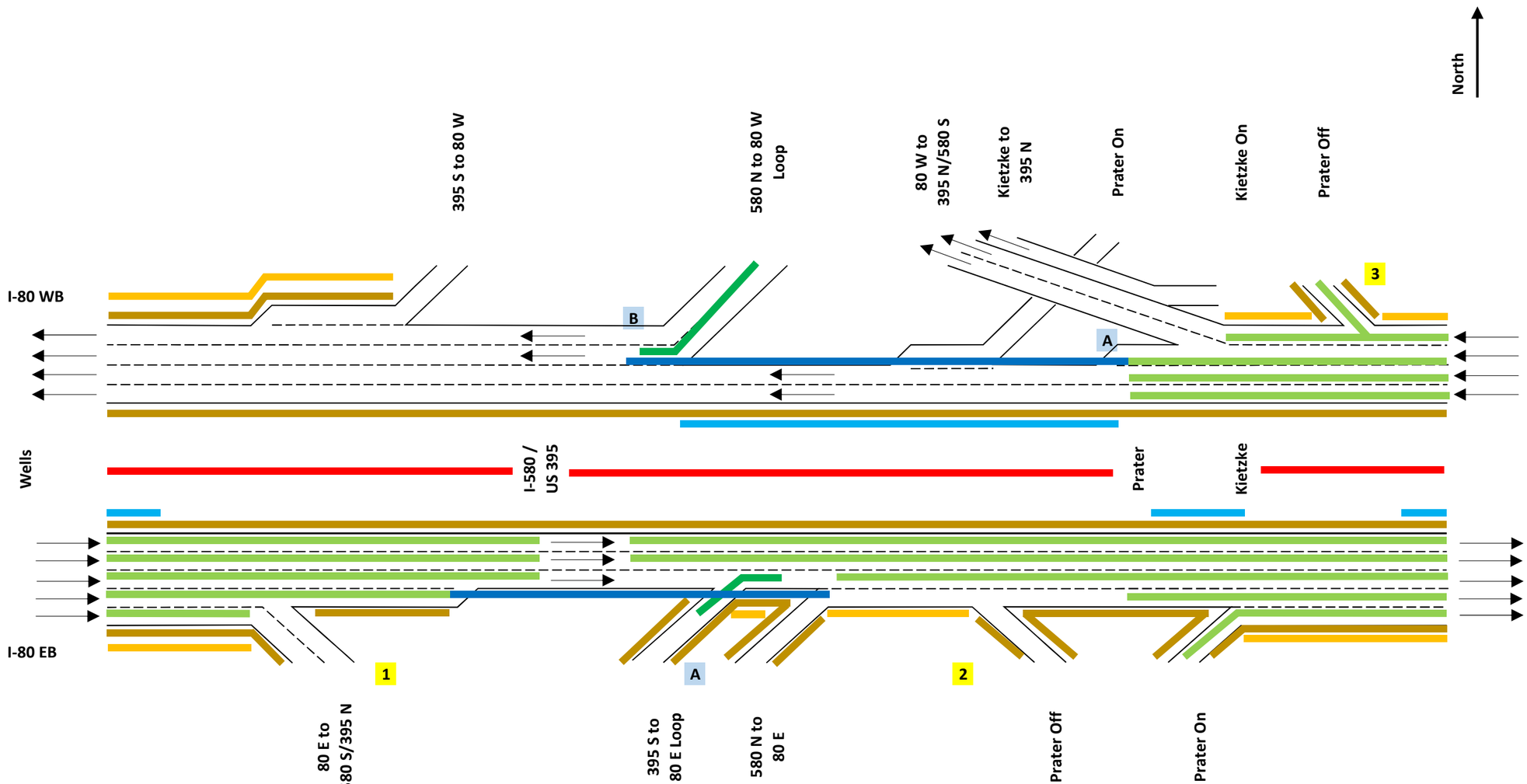
Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1	Exit posted 25 MPH due to geometric restrictions
2	Exit posted 35 MPH due to sight distance restrictions
3	Exit posted 40 MPH
4	Exit posted 25 MPH due to ramp storage/deceleration length restrictions

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
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- Stopping Sight Distance

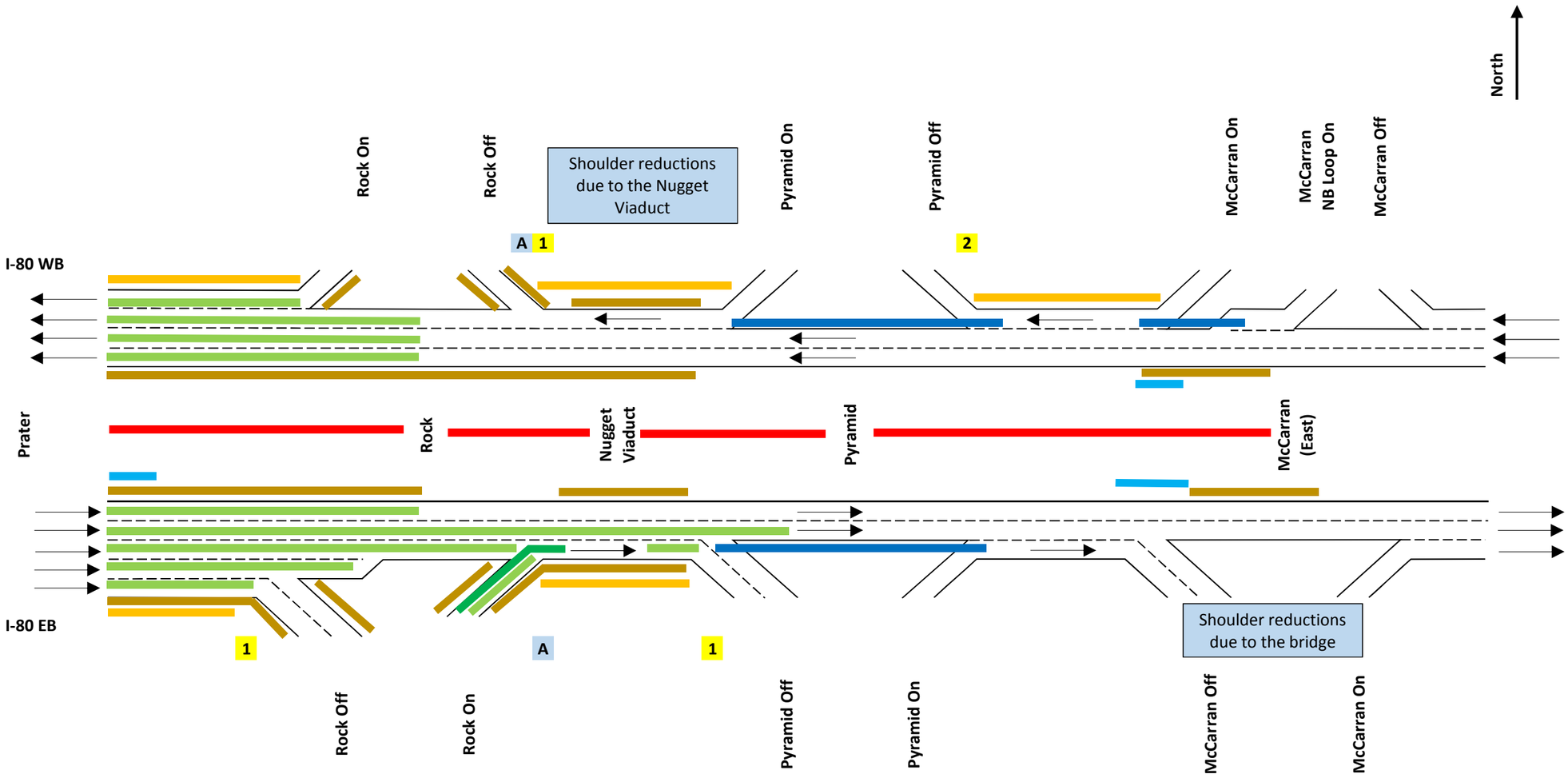
Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1	Exit posted 35 MPH - sight distance is restricted due to soundwall
2	Exit posted 30 MPH – deceleration distance to the intersection.
3	Exit posted 35 MPH - sight distance restricted from narrow shoulders and structures

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

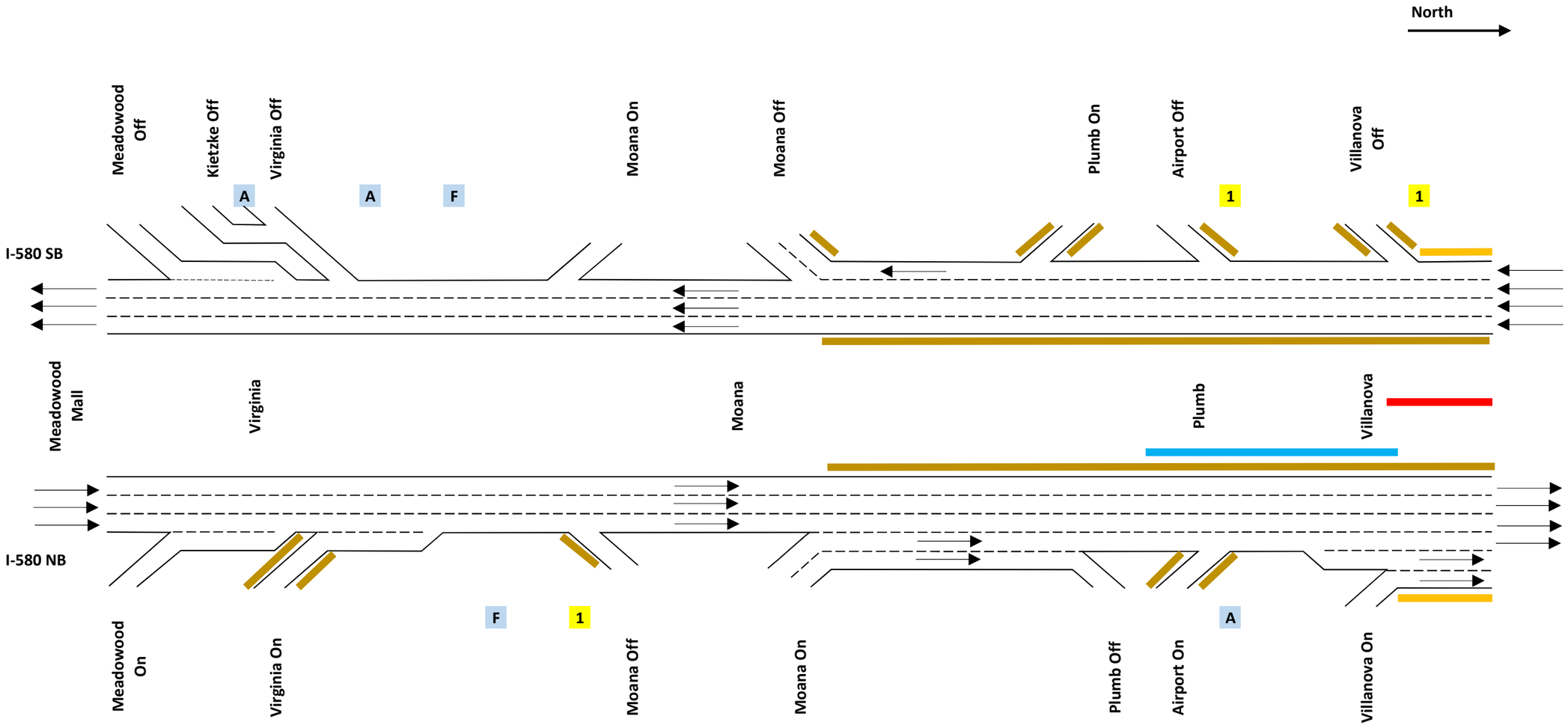
Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1	Exit posted 45 MPH
2	Exit posted 40 MPH

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

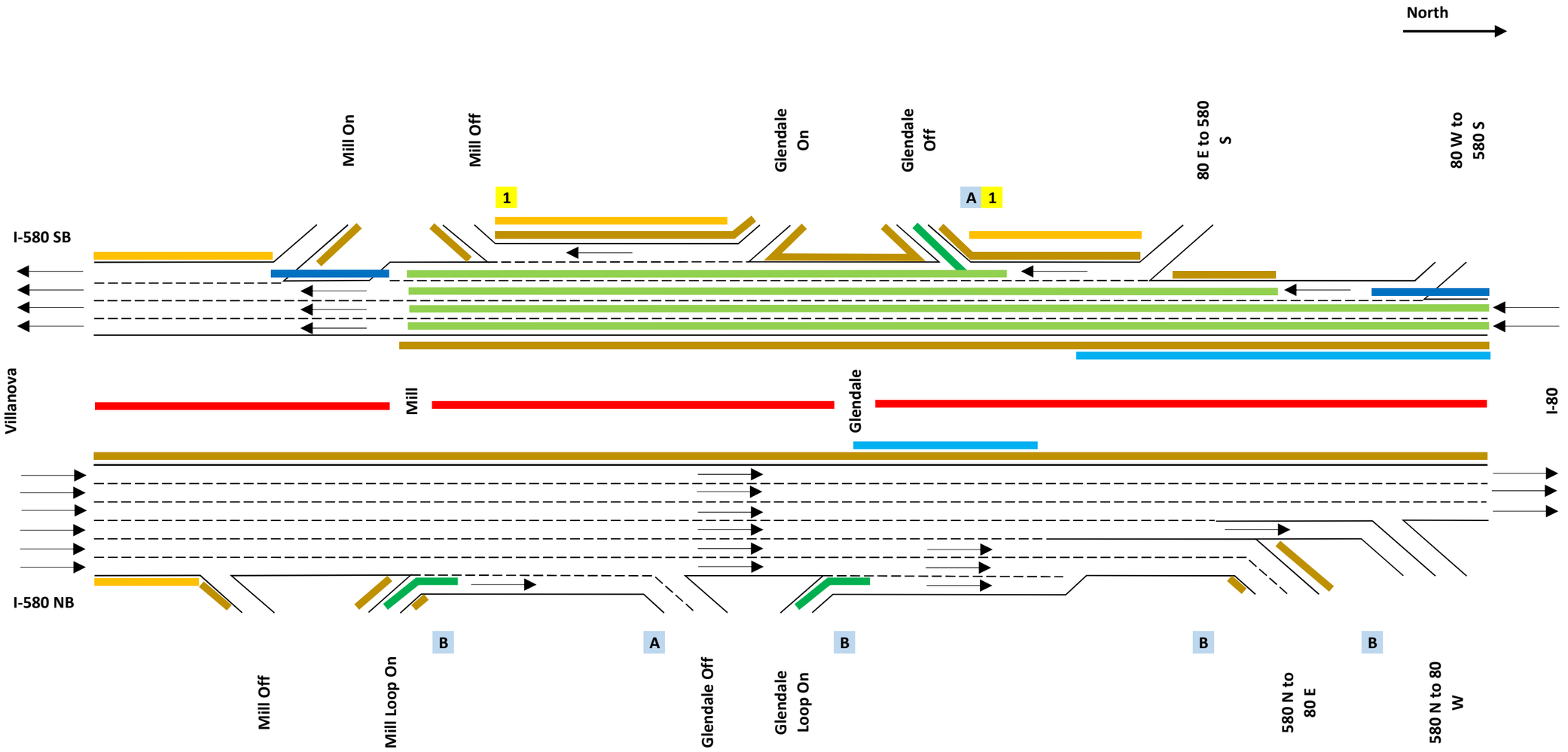
Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1	Exit posted 35 MPH

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

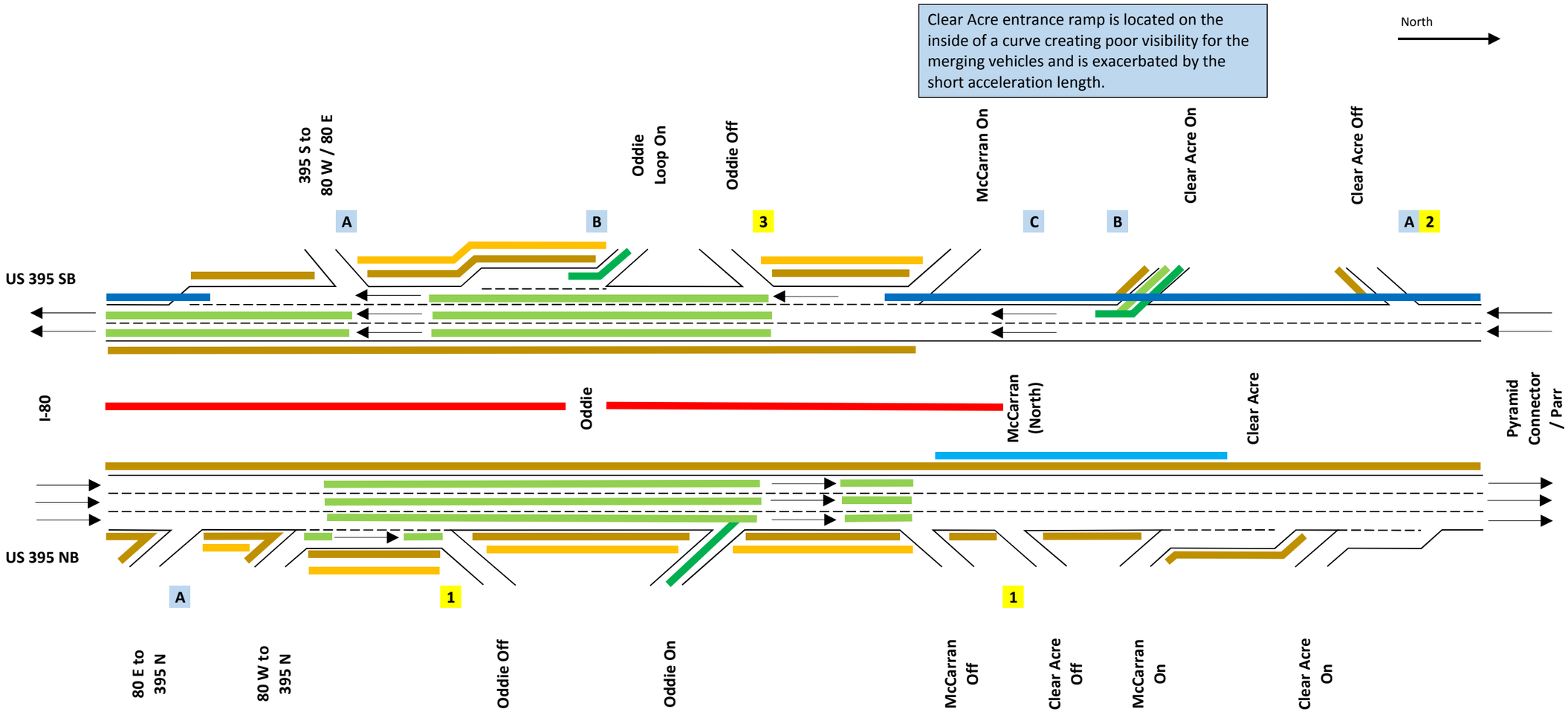
Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1 Exit posted 35 MPH - due to sight restrictions at the right shoulder and soundwall and from ramp and deceleration length restrictions

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

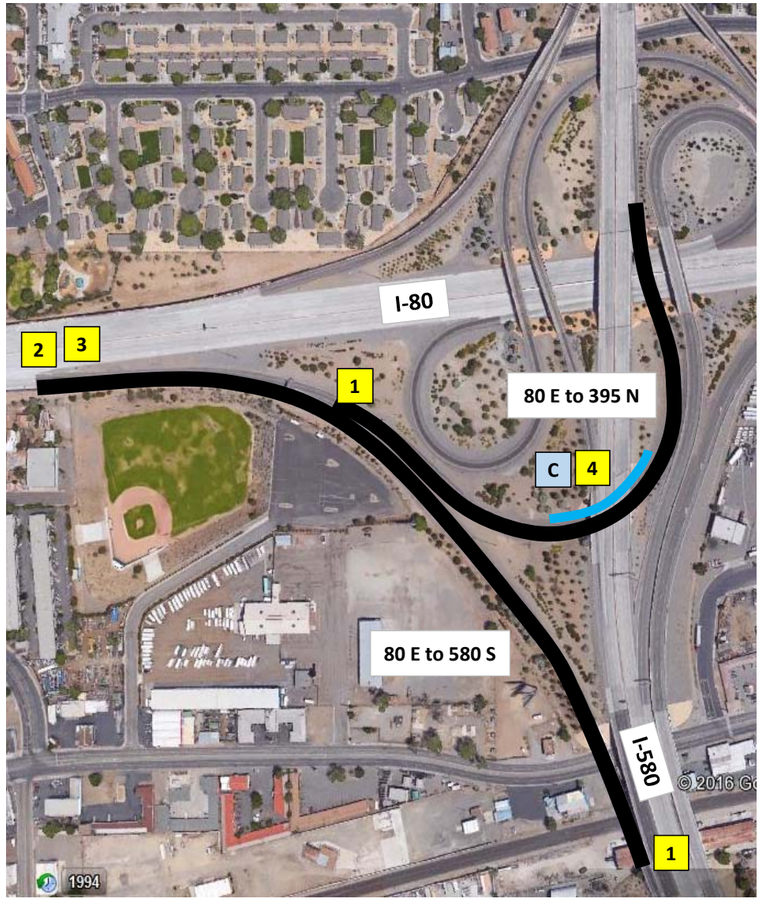
Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1	Exit posted 45 MPH
2	Ramp body posted 45 MPH
3	Exit posted 35 MPH - sight restrictions due to shoulder and soundwall

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

North

Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1 Single lane ramp is at or near capacity at the SB 580 entrance to 580 south. The ramp backs up blocking the exit to 395 north.

2 The combined 395 N and 580 S traffic backs up onto 80 east mainline.

3 Congestion at the ramp exit blocks the Wells EB on ramp and auxiliary lane to the exit

4 Sight distance restricts the speed, posted 30 MPH

5 2016 Traffic Demand, VPH

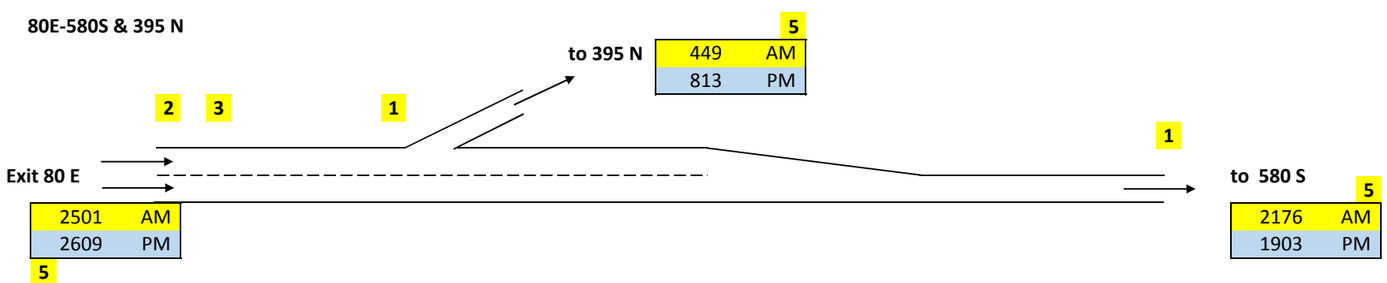


FIGURE 1
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Substandard Features identified:

- Basic Lanes/Lane Balance
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- Acceleration/Deceleration Length
- Stopping Sight Distance

North

Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

Additional Notes:

1 Ramp split to 580 S is near or at capacity in the current year. Merge/weave movements to SB 580 impact operations and back up traffic onto westbound 80.

2 Sight distance restricts the speed, posted 30 MPH

3 For local traffic headed south, the Kietzke WB on ramp requires 2-lane changes in approx. 1500 ft. This merge/weave movement impacts both lanes of the exit ramp onto 80 west.

4 Exit from westbound 80 is also the auxiliary lane for the EN-EX weave between the Rock WB on and the Prater WB off. This impacts the entering traffic when congested.

5 2016 Traffic Demand, VPH

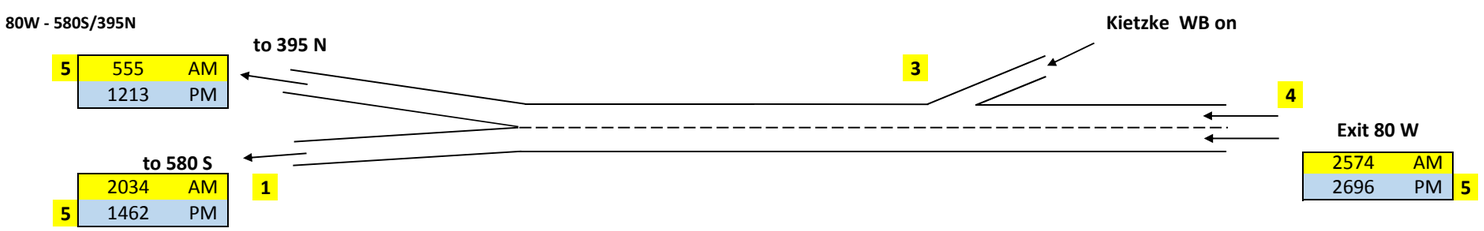
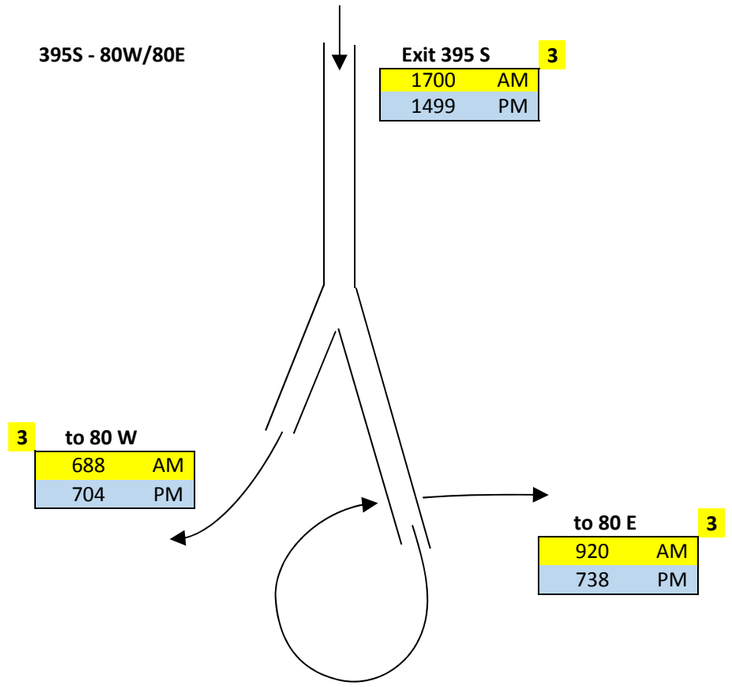


FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES



Substandard Features identified:

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- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

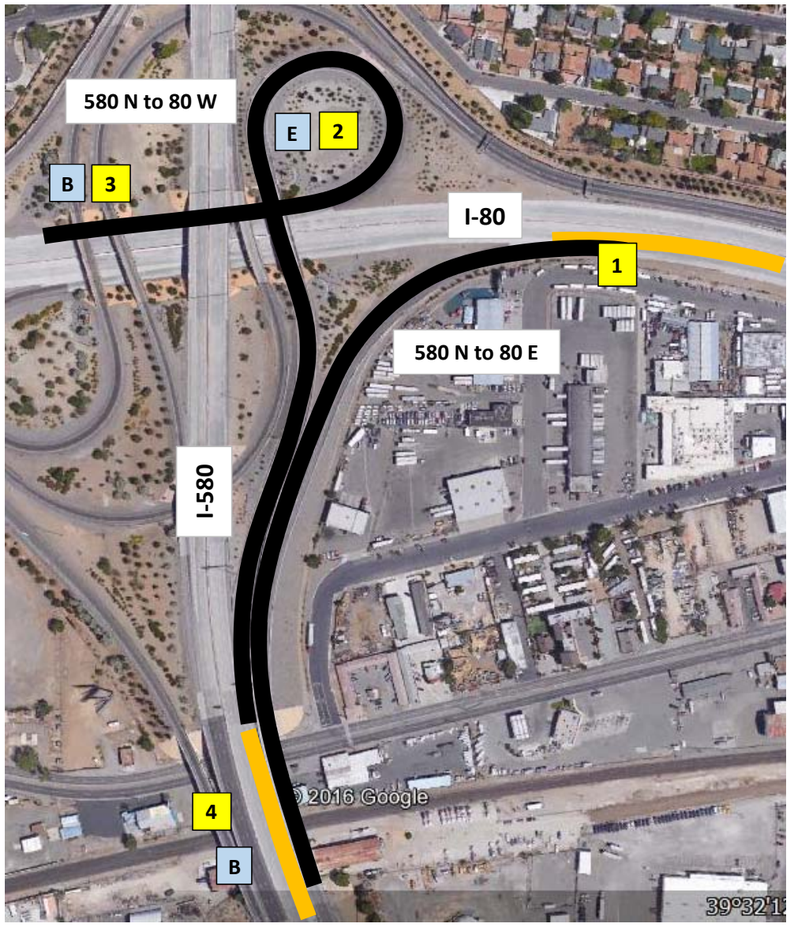
Additional Notes:

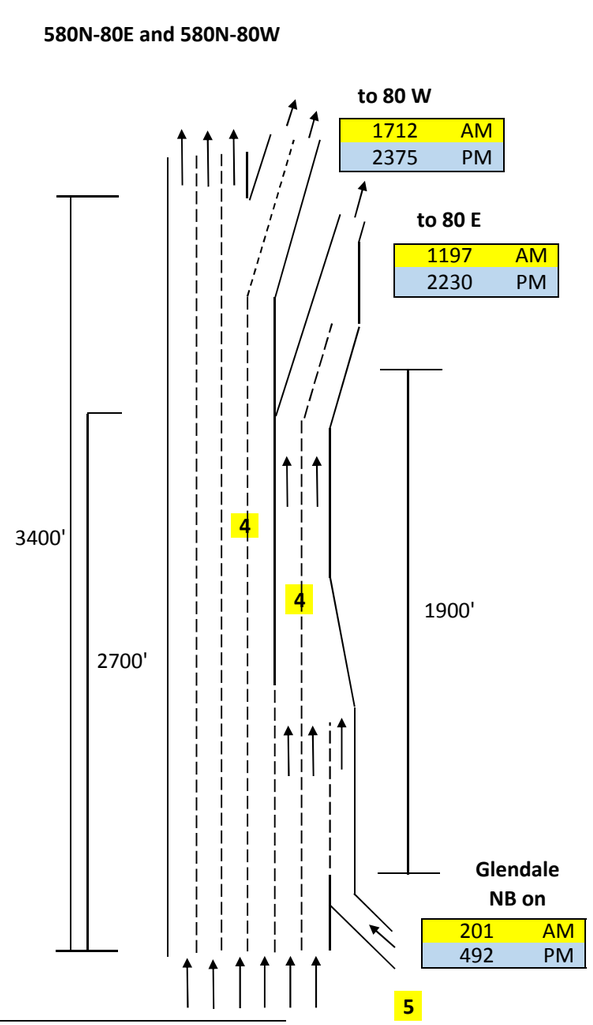
1 Entrance to 80 East is impacted by a substandard merge and no auxiliary lane, congesting the low speed loop.

2 Ramp is a reversing curvilinear alignment with a low speed 25 MPH loop ramp with limited capacity.

3 2016 Traffic Demand, VPH

FIGURE 1
EXISTING CONDITIONS-DEFICIENCIES





North

Additional Notes:

1 The NE ramp entrance to I-80 east is impacted by a substandard 580' weave with the EB Prater off ramp, congesting the ramp entrance.

2 NW ramp is a 2-lane reversing curvilinear alignment with a low speed 25 MPH loop ramp. The ramp is over capacity.

3 The NW ramp entrance onto I-80 west is a 2-lane loop ramp into dual auxiliary lanes. It is low speed and requires the 1500+ feet to accelerate to mainline speeds. It conflicts with the SW ramp and the Wells Ave off ramp from 80 west.

4 The NW and NE ramps are congested and the resultant backup of traffic is accommodated by providing long storage lanes. This storage blocks access from the Glendale IC and has a large speed differential with the mainline lanes.

5 Glendale NB loop on ramp enters within the auxiliary/storage lanes for the NE and NW ramps. Vehicles using the ramp require 4 lane changes in 1900 feet to go north on 395.

6 2016 Traffic Demand, VPH

Substandard Features identified:

- Basic Lanes/Lane Balance
- System/Service IC Spacing
- Ramp Separation/Weaving Distance
- Shoulders Widths
- Lane Widths (less than 12 ft)
- Acceleration/Deceleration Length
- Stopping Sight Distance

Issues:

A	Entrance/exit taper rate
B	High Speed Low Speed Mix
C	Restricted sight distance due to object or merging condition
D	Inadequate separaton between horizontal curves
E	Low speed loop ramps
F	Lack auxiliary lanes

ATTACHMENT A

ROADWAY DESIGN GUIDELINES

ROADWAY DESIGN CRITERIA

I-80/I-580/US 395
Reno Spaghetti Bowl Interchange Reconstruction
Washoe County, Nevada

Prepared for

Nevada Department of Transportation

Prepared by
CH2M
2485 Village View Drive, Suite 350
Las Vegas, NV 89074

March 2017

TABLE OF CONTENTS

Section Page

1.0 INTRODUCTION AND PURPOSE

Project CONNECT consists of the planning and construction of improvements to the Interstate 80/U.S. Highway 395/Interstate 580 (I-80/US 395/I-580) system interchange, on I-80 between Keystone Avenue and Pyramid Way, and on US 395/I-580 from Parr Boulevard to Meadowood Mall Way.

The project also includes improvements to the service interchanges and their connecting arterial streets within the project limits. These service interchanges include the following:

- I-80/Keystone Avenue Interchange (IC)
- I-80/Sierra/Virginia/Center Street IC
- I-80/Wells Avenue IC
- I-80/4th Street/Prater Way/Kietzke Lane IC
- I-80/Rock Boulevard IC
- I-80/Pyramid Way IC
- I-80/N. McCarran Boulevard IC
- US395/Future Pyramid Connector Project IC (Existing US395/Parr Boulevard IC)
- US 395/Clear Acre Ln/N McCarran Boulevard IC
- US 395/Oddie Boulevard IC
- I-580/2nd Street/Glendale Avenue IC
- I-580/Mill Street IC
- I-580/Villanova Drive/E Plumb Lane IC
- I-580/Reno-Tahoe International Airport Access Ramps
- I-580/Moana Lane IC
- I-580/S Virginia Street IC
- I-580/Meadowood Mall Way IC

The purpose of this document is to provide a guide to the design criteria for roadways within the project limits. The specific criteria listed herein are intended to establish uniform design criteria of common geometric elements. Information in this roadway design criteria document does not negate any requirements set forth in the applicable roadway design criteria publications listed in Section 2.1. These referenced documents represent the most current and appropriate standards for geometric design of the project's roadway features and should be reviewed when detail or insight not provided herein is required to resolve design issues.

2.0 BASIS OF CRITERIA

2.1 APPLICABLE STANDARDS

The design of all roadways shall be in accordance with the Nevada Department of Transportation's (NDOT's) Road Design Guide, 2010 Edition – Revised May 25, 2011, and AASHTO's A Policy on Geometric Design of Highways and Streets (AASHTO 2011) (referred to as the Green Book) and shall be supplemented with the following standards.

- Standard Specifications for Road and Bridge Construction, NDOT, 2014
- Roadside Design Guide, AASHTO, 2011
- A Policy on Design Standards - Interstate System 5th Edition, AASHTO, 2005 (applicable to improvements to I-80 and I-580)
- Access Management System and Standards, NDOT, 1999
- Managed Lanes and Ramp Meter Manual, NDOT, 2013
- Guidelines for Railroad Grade Separation Projects, UPRR, 2007
- Structures Manual, NDOT, 2008
- Standard Plans for Road and Bridge Construction, latest edition, NDOT, 2017)
- Highway Capacity Manual, Transportation Research Board, 2010
- A Guide for the Development of Bicycle Facilities, 4th Edition, AASHTO, 2012
- A Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition, AASHTO 2004
- Roadway Functional Classification Map, Washoe County, Urbanized Area Loop, NDOT (http://www.nevadadot.com/About_NDOT/NDOT_Divisions/Planning/Roadway_Systems/FCMGS_Clark.aspx)

2.2 CRITERIA UPDATES

This Roadway Design Criteria report is intended to be a living document. It will be updated as the project progresses and more information becomes available. Updates will be prepared as needed.

3.0 DESIGN CRITERIA

3.1 ROADWAY DESIGN CRITERIA

The project's roadway design criteria are listed in Attachment A.

3.2 OTHER DESIGN CRITERIA

3.2.1 Local Roadways and Connections

Local roadways shall be designed in accordance with the criteria listed in Attachment A and the following standards and guidelines. Each local street proposed as part of the project shall be established in cross section and alignment based on the local entity's design guidelines as follows:

- City of Reno Design Manual
  - http://www.reno.gov/government/departments/public-works/forms-publications
- City of Sparks Design Manual
- Regional Transportation Commission (RTC)
  - http://www.rtcwashoe.com/engineering-construction-99
- RTC Long-Range Plan (includes a list of future identified projects, street access management plans, and a list of all the streets and classifications for design)
  - http://www.rtcwashoe.com/RTC2030/documents/Website_Full_Appendices_042516.pdf

If no guidelines are available, NDOT standards will be followed.

In addition, access management for streets within NDOT right-of-way and for connections to the freeway system and local street network shall comply with the requirements of NDOT's Access Management System and Standards for the type of facility and connection being considered.

3.2.2 Barrier Railing

Type F bridge rail shall be used in critical areas, such as when separating high-volume/high-speed traffic along the outside curve of bridge structures and along retaining walls, per NDOT's Road Design Guide 2010, page 16:

- All mainline facilities on I-80, US 395, and I-580 are considered high-speed and shall use Type F railing in the median and on the roadside, where applicable.
- Provide concrete barrier rail, Type FA through Type FD as appropriate, for all roadside obstacles.
- In locations of stopping sight distance restrictions, the lower Type A through Type D railing may be considered.

3.2.3 Pedestrian Facilities

Pedestrian facilities shall be designed in accordance with the following documents:

- ADA Standards for Accessible Design, Department of Justice, 2010
- Public Right-of-Way Accessibility Guidelines (PROWAG), U.S. Access Board, 2011

3.2.4 Right-of-Way and Maintenance Access

Control of access fencing and maintenance roads and access shall be provided at all new and existing right-of-way lines.

- 6-foot chain-link fencing shall be placed at access control lines. In areas of unwanted high-pedestrian access, the fencing type is to be confirmed with NDOT.
- Maintenance access roads adjacent to fill slopes, bridges, and retaining walls shall be 15 feet in width and surfaced with 4 inches of aggregate base material.
- Drainage and utility access needs are to be determined separately (see NDOT Road Design Guide, Section 3.21).

3.2.5 Ramp Metering

Space to provide ramp metering facilities shall be included regardless if operations require the meter to be installed or not:

- Ramp meter design shall comply with NDOT Managed Lanes and Ramp Meter Manual (2013).
- Provide for a minimum two-lane ramp body to accommodate storage.
- Provide Nevada Highway Patrol enforcement pullout.
- Provide standard acceleration distances and taper rate beyond the stop bar.

3.2.6 High-Occupancy Vehicle Future Compatibility

Compatibility for a future high-occupancy vehicle (HOV) system shall be incorporated into all new bridge structures. Horizontal width for providing future HOV facilities at bridges includes the following:

- HOV lanes shall comply with NDOT Managed Lanes and Ramp Meter Manual (2013).
- No accommodation for HOV direct connect structures will be included.
- The facility shall accommodate one lane in each direction with continuous enforcement area on the inside shoulder and a buffer to allow for limited access:
  - One 12-foot-wide lane for each direction of travel
  - One 14-foot-wide left shoulder for continuous enforcement for each direction of travel
  - One 4-foot-wide buffer for each direction of travel
  - Total additional horizontal width (one direction) to accommodate a future HOV lane: 20 feet (14 feet - 10 feet + 12 feet + 4 feet)
- The additional horizontal width shall be applied to the outside horizontal clearances on all bridges.
- Minimum vertical clearance for bridge crossings shall be established considering the future widening, including accommodation of cross slope and superelevation.

Retaining walls and sound walls shall be considered for placement outside this clearance area but must also consider right-of-way impacts and noise attenuation.

3.2.7 Other Criteria and Standards

The following design criteria and standards will be provided under separate cover and appended to this document once available:

- Traffic design
- Drainage design
- Structures design

4.0 DESIGN EXCEPTIONS

4.1 CRITERIA REQUIRING A DESIGN EXCEPTION

The Green Book presents numerous geometric design elements and dimensional criteria. In accordance with the Federal Highway Administration (FHWA) memorandum, *Revisions to the Controlling Criteria for Design and Documentation for Design Exceptions* (May 5, 2016), which identifies specific design criteria for high-speed facilities that require formal written design exceptions, subject to approval by FHWA, when the established criteria are not met. There are 10 controlling criteria:

1. Design speed
2. Lane width
3. Shoulder width
4. Horizontal curve radius
5. Superelevation rate
6. Maximum grade
7. Stopping sight distance (both horizontal and vertical alignments except for sag vertical curves)
8. Cross slope
9. Vertical clearance
10. Structural capacity

If exceptions are required, mitigation strategies shall consider FHWA guidance: *Mitigation Strategies for Design Exceptions*, Publication No. FHWA-SA-01-011 (July 2007).

ATTACHMENT A

PROJECT CONNECT - DESIGN CRITERIA

DESIGN STANDARDS	INTERSTATE	SERVICE IC RAMP	SYSTEM IC DIRECT CONNECTOR RAMP	SYSTEM IC SEMI-DIRECT RAMP	SYSTEM IC LOOP RAMP	LOCAL STREET	CRITERIA BASIS
Functional Classification	Interstate	Ramp	System Connector	System Semi-Direct Connector	System Loop	Varies	
Ownership	NDOT	NDOT	NDOT	NDOT	NDOT	Varies	
Access	Full	Full	Full	Full	Full		
Design Speed (DS) (mph) (Upper/Middle/Lower Ranges, where applicable) for Ramps	70	60/50/35	60/50/40	60/50/35	60/50/25	Varies	AASHTO 2011 Table 2-1b NDOT Road Design Guide, Pg. 3
Posted Speed (mph)	65	Varies	Varies	Varies	Varies	Varies	
Design Vehicle	WB-67	WB-67	WB-67	WB-67	WB-67	Varies	
Minimum Stopping Sight Distance (feet)	730	570/425/250	570/425/305	570/425/250	570/425/155	Varies	AASHTO 2011 Table 3-1
Stopping Sight Distance Adjustments for Grades	AASHTO 2011 Table 3-2	AASHTO 2011 Table 3-2	AASHTO 2011 Table 3-2	AASHTO 2011 Table 3-2	AASHTO 2011 Table 3-2	AASHTO 2011 Table 3-2	AASHTO 2011 Table 3-2
GEOMETRY							
Horizontal							
Minimum Horizontal Radius Curve (feet)	1,810	1,330/833/340	1,330/833/485	1,330/833/340	1,330/833/144	Varies	AASHTO 2011 Table 3-9, 3-10b
Minimum Length of Curve (feet)	2,100	100 feet / 1 degree of central angle	100 feet / 1 degree of central angle	100 feet / 1 degree of central angle	100 feet / 1 degree of central angle	N/A	AASHTO 2011 Section 3.3.13, Pg. 3-111
Maximum Superelevation (%)	8	6	6	6	6	4	NDOT Road Design Guide Pg. 3, 5 City of Reno Design Manual Pg. 103
Design Superelevation Rate	AASHTO 2011 Table 3-10b	AASHTO 2011 Table 3-9	AASHTO 2011 Table 3-9	AASHTO 2011 Table 3-9	AASHTO 2011 Table 3-9	Varies	City of Reno Design Manual Pg. 103
Minimum Length of Runoff	AASHTO 2011 Table 3-17b AASHTO 2011 Equation 3-23	AASHTO 2011 Table 3-17b AASHTO 2011 Equation 3-23	AASHTO 2011 Table 3-17b AASHTO 2011 Equation 3-23	AASHTO 2011 Table 3-17b AASHTO 2011 Equation 3-23	AASHTO 2011 Table 3-17b AASHTO 2011 Equation 3-23	100 ft	City of Reno Design Manual Pg. 105
Minimum Length of Runout	AASHTO 2011 Equation 3-24	AASHTO 2011 Equation 3-24	AASHTO 2011 Equation 3-24	AASHTO 2011 Equation 3-24	AASHTO 2011 Equation 3-24	-	
% of Runoff on Tangent	AASHTO 2011 Table 3-18	AASHTO 2011 Table 3-18	AASHTO 2011 Table 3-18	AASHTO 2011 Table 3-18	AASHTO 2011 Table 3-18	-	
Vertical							
Terrain classification	Level	Level	Level	Level	Level	Level	
Maximum Grade (%)	3	6	6	6	6	6	NDOT Road Design Guide, AASHTO 2011 Pg. 10-92 & 10-93 City of Reno Design Manual, Pg. 102
Minimum Grade (%)	0.50	0.50	0.50	0.50	0.50	0.60	NDOT Road Design Guide, City of Reno Design Manual, Pg. 102
Minimum Rate of Vertical Curvature (Ksag – Design)	181	136/96/49	136/96/64	136/96/49	136/96/26	Varies	AASHTO 2011 Table 3-36
Minimum Rate of Vertical Curvature (Kcrest – Design)	247	151/84/29	151/84/44	151/84/29	151/84/12	Varies	AASHTO 2011 Table 3-34
Minimum Length of Vertical Curve (feet)	3 x Design Speed	3 x Design Speed	3 x Design Speed	3 x Design Speed	3 x Design Speed	3 x Design Speed	AASHTO 2011 Pg. 3-153
Maximum Allowable Rollover (Longitudinal Grade Break) (%)	5	5	5	5	5	5	
Minimum Vertical Clearance - New Roadway Structures	16 feet-6 inches	16 feet-6 inches	16 feet-6 inches	16 feet-6 inches	16 feet-6 inches	16 feet-6 inches	NDOT Road Design Guide Pg. 14 NDOT Structures Manual

ATTACHMENT A

PROJECT CONNECT - DESIGN CRITERIA

DESIGN STANDARDS	INTERSTATE	SERVICE IC RAMP	SYSTEM IC DIRECT CONNECTOR RAMP	SYSTEM IC SEMI-DIRECT RAMP	SYSTEM IC LOOP RAMP	LOCAL STREET	CRITERIA BASIS
CROSS SECTION							
Minimum Lane Width (feet)	12	12	12	12	12	11	NDOT Road Design Guide Local City Standards
Minimum Turn Lane Width (feet)	N/A	14	14	14	14	11	NDOT Road Design Guide Local City Standards
Minimum Shoulder Width – Left/Inside (feet)	8 (10 when number of lanes in a direction exceeds 2)	4	4	4	4	Varies	NDOT Road Design Guide, Local City Standards
Minimum Shoulder Width – Right/Outside (feet)	12	8	8	8	8	Varies	NDOT Road Design Guide Local City Standards
Cut and Fill Slopes	Table 2.20	Table 2.20	Table 2.20	Table 2.20	Table 2.20	Table 2.20	NDOT Road Design Guide
Normal Crown (%)	2	2	2	2	2	2	NDOT Road Design Guide City of Reno Design Manual
Clear Zone (feet)	30	Table 3-1	Table 3-1	Table 3-1	Table 3-1	Back of walk or Table 3-1	AASHTO 2011 Roadside Design Guide Table 3-1
Lateral Offset to Obstruction (feet)	N/A	N/A	N/A	N/A	N/A	1.5 min	AASHTO 2011 Roadside Design Guide Page 10-1
Curb, Curb and Gutter	N/A	N/A	N/A	N/A	N/A	Type 1 and Type A	NDOT Standard Plan R-5.1.1
Sidewalk Width (feet)	N/A	N/A	N/A	N/A	N/A	6	Match width if the existing local street is wider
Bike Lane Width (feet)	N/A	N/A	N/A	N/A	N/A	5 min.	4-foot minimum uninterrupted surface required
Shy Distance, EP to face of barrier (feet)	2	2	2	2	2	N/A	Shy distance not required for shoulders meeting the 12-foot preferred width
Bridge Width	Match Approach Roadway; Accommodate Future HOV Lane	Match Approach Roadway	Match Approach Roadway	Match Approach Roadway	Match Approach Roadway	Match Approach Roadway	NDOT Road Design Guide

Notes:

AASHTO = American Association of State Highway and Transportation Officials
DS = design speed
Kcrest = The horizontal distance along which a 1% change in grade occurs along a crest vertical curve
Ksag = The horizontal distance along which a 1% change in grade occurs along a sag vertical curve

mph = miles per hour
N/A = not applicable
NDOT = Nevada Department of Transportation

ATTACHMENT B

EXISTING GEOMETRICS SUMMARY

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

CROSS SECTION

I 80

Number of roadways	2
Number of lanes	2 to 4 lanes in the WB direction, 2 to 5 lanes in the EB direction
Median width	Barrier Separated
Lane width	10.5 to 12 feet
Shoulder width	1.5'-11' inside shoulders. 1' to 15' outside shoulders.
Bicycle Facility Type	None
Sidewalk and curb ramps	None
Cross slope	2%
Super-elevation.	Varies from 2% to 7.6%
Clear Zone	TBD
Vertical clearance	TBD
Side-slopes and Ditch sections	TBD

I 580 / US 395

Number of roadways	2
Number of lanes	2 to 5 lanes in the SB direction, 3 to 7 lanes in the NB direction
Median width	Barrier Separated
Lane width	12 feet
Shoulder width	1' to 18' inside shoulders. 2' to 11' outside shoulders.
Bicycle Facility Type	None
Sidewalk and curb ramps	None
Cross slope	2%
Super-elevation.	Varies from 2% to 7.8%
Clear Zone	TBD
Vertical clearance	TBD
Side-slopes and Ditch sections	TBD

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

RAMP SPACING

Location	Min Spacing Req (ft)	Exist Spacing Between Ramps (ft)	Comments
I-80 eastbound entrance from Keystone Ave to N Sierra St/N Virginia St/ N Center St exit	1,600	1,950	*OK*
I-80 eastbound entrance from N Sierra St/N Virginia St/ N Center St to N Wells Ave exit	1,600	1,200	*Substandard*
I-80 eastbound entrance from N Wells Ave to I-580 exit	2,000	1,350	*Substandard*
I-80 eastbound exit to I-580 to I-580 loop entrance	500	2,300	*OK*
I-80 eastbound I-580 loop entrance to I-80 eastbound entrance from I-580	1,000	600	*Substandard, although it does meet the suggested 300' requirement between the end of the first entrance taper to the painted nose of the second entrance.*
I-80 eastbound entrance from I-580 to Prater Way / Kietzke Ln exit	2,000	550	*Substandard*
I-80 eastbound entrance from Prater Way / Kietzke Ln to Rock Blvd exit	1,600	1,350	*Substandard*
I-80 eastbound entrance from Rock Blvd t to Pyramid Pkway exit	1,600	1,500	*Substandard*
I-80 westbound entrance from Pyramid Pkway to Rock Blvd exit	1,600	1,450	*Substandard*
I-80 westbound entrance from Rock Blvd to Prater Way / Kietzke Ln exit	1,600	1,200	*Substandard*
I-80 westbound exit to Prater Way / Kietzke Ln to I-580 exit	1,000	900	*Substandard*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Min Spacing Req (ft)	Exist Spacing Between Ramps (ft)	Comments
I-80 westbound exit to I-580 to entrance from Prater Way / Kietzke Ln	500	1,800	*OK*
I-80 westbound entrance from Prater Way / Kietzke Ln to entrance from I-580 loop	1,000	1,500	*OK*
I-80 westbound entrance from I-580 loop to entrance from I-580	1,000	1,450	*OK*
I-80 westbound entrance from I-580 to N Wells Ave exit	2,000	1,500	*Substandard*
I-80 westbound entrance from N Wells Ave to N Sierra St/N Virginia St/ N Center St exit	1,600	900	*Substandard*
I-80 westbound entrance from N Sierra St/N Virginia St/ N Center St to Keystone Ave exit	1,600	1,950	*OK*
I-580/US 395 northbound entrance from S Virginia St/Kietzke Ln to E Moana Exit	1,600	2,500	*OK*
I-580/US 395 northbound entrance from E Moana Exit to E Plumb Ln	1,600	2,200	*OK*
I-580/US 395 northbound entrance from Airport to entrance from E Plumb Ln/Villanova Dr	1,000	2,150	*OK*
I-580/US 395 northbound entrance from E Plumb Ln/Villanova Dr to Mill St exit	1,600	1,150	*Substandard*
I-580/US 395 northbound entrance from Mill St exit to entrance from Mill St	500	1,200	*OK*
I-580/US 395 northbound entrance from Mill St exit to Glendale Ave entrance	1,600	1,950	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Min Spacing Req (ft)	Exist Spacing Between Ramps (ft)	Comments
I-580/US 395 northbound entrance from Glendale Ave to entrance from Glendale Ave	500	1,150	*OK*
I-580/US 395 northbound entrance from Glendale Ave to I-80 exit	2,000	2,100	*OK*
I-580/US 395 northbound exit to I-80 to I-80 exit loop	1,000	1,100	*OK*
I-580/US 395 northbound exit loop to I-80 to entrance from I-80	500	1,500	*OK*
I-580/US 395 northbound entrance from I-80 eastbound to entrance from I-80 westbound	1,000	800	*Substandard, although it does meet the suggested 300' requirement between the end of the first entrance taper to the painted nose of the second entrance.*
I-580/US 395 northbound entrance from I-80 to Oddie Blvd exit	2,000	700	*Substandard*
I-580/US 395 northbound entrance from Oddie Blvd to N McCarran Blvd/Clear Acre Ln exit	1,600	1,200	*Substandard*
I-580/US 395 southbound entrance from N McCarran Blvd/Clear Acre Ln to Oddie Blvd exit	1,600	1,300	*Substandard*
I-580/US 395 southbound exit to Oddie Blvd to entrance from Oddie Blvd	500	950	*OK*
I-580/US 395 southbound entrance from Oddie Blvd to I-80 exit	2,000	1,950	*Substandard*
I-580/US 395 southbound exit to I-80 to entrance from I-80 westbound	500	2,000	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Min Spacing Req (ft)	Exist Spacing Between Ramps (ft)	Comments
I-580/US 395 southbound entrance from I-80 westbound to entrance from I-80 eastbound	1,000	1,100	*OK*
I-580/US 395 southbound entrance from I-80 to Glendale Ave exit	2,000	1,000	*Substandard*
I-580/US 395 southbound entrance from Glendale Ave to Mill St exit	1,600	500	*Substandard*
I-580/US 395 southbound entrance from Mill St to E Plumb Ln/Villanova Dr exit	1,600	1,400	*Substandard*
I-580/US 395 southbound exit to E Plumb Ln/Villanova Dr to Airport exit	1,000	2,100	*OK*
I-580/US 395 southbound entrance from E Plumb Ln/Villanova Dr entrance to E Moana Ln exit	1,600	2,100	*OK*
I-580/US 395 southbound entrance from E Moana Ln to S Virginia St/Kietzke Ln exit	1,600	1,650	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Ramp Taper Rates

According to AASHTO standards, the taper rate for a freeway entrance ramp should be 50:1, which means the merge lane becomes one foot narrower every 50 feet. Alternatively, a parallel entrance ramp should have a taper length of 300' minimum. The taper rate for a freeway exit ramp should be between 2 degrees and 5 degrees.

RAMP TAPER RATES

Location	Minimum Taper Rate Criteria	Existing Taper Rate	Comments
I-80 eastbound exit to Keystone Ave	2° - 5°	4° 7'	*OK*
I-80 eastbound entrance from Keystone Ave	50:1	Aux Lane	*OK*
I-80 westbound exit to Keystone Ave	2° - 5°	4° 28'	*OK*
I-80 westbound entrance from Keystone Ave	50:1	38:1	*Substandard*
I-80 eastbound exit to N Sierrra St/N Virginia St/N Centre St	2° - 5°	5° 11'	*Substandard*
I-80 eastbound entrance from N Sierrra St/N Virginia St/N Centre St	50:1	Aux Lane	*OK*
I-80 westbound exit to N Sierrra St/N Virginia St/N Centre St	2° - 5°	4° 59'	*OK*
I-80 westbound entrance from N Sierrra St/N Virginia St/N Centre St	50:1	Aux Lane	*OK*
I-80 eastbound exit to N Wells Ave	2° - 5°	1° 37'	*Substandard*
I-80 eastbound entrance from N Wells Ave	50:1	Aux lane	*OK*
I-80 westbound exit to N Wells Ave	2° - 5°	2° 28'	*OK*
I-80 westbound entrance from N Wells Ave	50:1	Aux lane	*OK*
I-80 eastbound exit to I-580	2° - 5°	4° 17'	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Minimum Taper Rate Criteria	Existing Taper Rate	Comments
I-80 eastbound I-580 Exit to 1-580 Split	2° - 5°	5° 49’	*Substandard*
I-580 southbound entrance from I-80 eastbound	50:1	Aux Lane	*OK*
I-580 northbound entrance from I-80 eastbound	50:1	27:1	*Substandard*
I-80 westbound exit to I-580	2° - 5°	1° 33’	*Substandard*
I-80 westbound I-580 Exit to 1-580 Split	2° - 5°	NA	*OK, Two lane divergence*
I-580 southbound entrance from I-80 westbound	50:1	Aux Lane	*OK*
I-580 northbound exit to I-80 eastbound	N/A	Branch	*OK*
I-580 northbound exit to I-80 westbound	2° - 5°	3° 50’	*OK*
I-580 northbound entrance from I-80 westbound	50:1	Aux Lane	*OK*
I-580 southbound exit to I-80 split	2° - 5°	1° 55’	*Substandard*
I-580 southbound / I-80 EB-WB split	N/A	Branch	*OK*
I-80 eastbound entrance from I-580 southbound	50:1	28:1	*Substandard*
I-80 eastbound entrance from I-580 northbound	50:1	Aux Lane	*OK*
I-80 westbound entrance from I-580 southbound	50:1	Parallel entrance/300’taper	*OK*
I-80 westbound entrance from I-580 northbound	50:1	Aux Lane	*OK*
I-80 eastbound exit to Prater Way / Kietzke Ln	2° - 5°	4° 15’	*OK*
I-80 eastbound entrance from Prater Way / Kietzke Ln	50:1	Aux lane	*OK*
I-80 westbound exit to Prater Way / Kietzke Ln	2° - 5°	3° 57’	*OK*
I-80 westbound entrance from Prater Way / Kietzke Ln	50:1	Parallel entrance/300’taper	*OK*
I-80 eastbound exit to Rock Blvd	2° - 5°	3° 49’	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Minimum Taper Rate Criteria	Existing Taper Rate	Comments
I-80 eastbound entrance from Rock Blvd	50:1	Parallel entrance/280'taper	*Substandard*
I-80 westbound exit to Rock Blvd	2° - 5°	5° 8'	*Substandard*
I-80 westbound entrance from Rock Blvd	50:1	Aux lane	*OK*
I-80 eastbound exit to Pyramid Pkway	2° - 5°	2° 8'	
I-80 eastbound entrance from Pyramid Pkway	50:1	Aux lane	*OK*
I-80 westbound exit to Pyramid Pkway	2° - 5°	2° 29'	
I-80 westbound entrance from Pyramid Pkway	50:1	Aux lane	*OK*
I-580/US 395 northbound entrance from S Virginia St/Kietzke Ln	50:1	Parallel entrance/300'taper	*OK*
I-580/US 395 southbound exit to S Virginia St/Kietzke Ln	2° - 5°	1° 19'	*Substandard*
I-580/US 395 southbound exit to Kietzke Ln	2° - 5°	1° 51'	*Substandard*
I-580/US 395 northbound exit to E Moana Ln	2° - 5°	4° 34'	*OK*
I-580/US 395 northbound entrance from E Moana Ln	50:1	50:1	*OK*
I-580/US 395 southbound exit to E Moana Ln	2° - 5°	2° 54'	*OK*
I-580/US 395 southbound entrance from E Moana Ln	50:1	Parallel entrance/300'taper	*OK*
I-580/US 395 northbound exit to E Plumb Ln/Villanova Ln	2° - 5°	5° 0'	*OK*
I-580/US 395 northbound entrance from Airport	50:1	30:1	*Substandard*
I-580/US 395 northbound entrance from E Plumb Ln/Villanova Ln	50:1	Aux lane	*OK*
I-580/US 395 southbound exit to E Plumb Ln/Villanova Ln	2° - 5°	3° 58'	*OK*
I-580/US 395 southbound exit to Airport	2° - 5°	4° 54'	*OK*

ATTACHMENT– B

EXISTING GEOMETRICS SUMMARY

Location	Minimum Taper Rate Criteria	Existing Taper Rate	Comments
I-580/US 395 southbound entrance from E Plumb Ln/Villanova Ln	50:1	60:1	*OK*
I-580/US 395 northbound exit to Mill St	2° - 5°	3° 20’	*OK*
I-580/US 395 northbound entrance from Mill St	50:1	Aux lane	*OK*
I-580/US 395 southbound exit to Mill St	2° - 5°	3° 36’	*OK*
I-580/US 395 southbound entrance from Mill St	50:1	Aux lane	*OK*
I-580/US 395 northbound exit to Glendale Ave	2° - 5°	3° 43’	*OK*
I-580/US 395 northbound entrance from Glendale Ave	50:1	Aux lane	*OK*
I-580/US 395 southbound exit to Glendale Ave	2° - 5°	5° 42’	*Substandard*
I-580/US 395 southbound entrance from Glendale Ave	50:1	Aux lane	*OK*
I-580/US 395 northbound exit to Oddie Blvd	2° - 5°	2° 53’	*OK*
I-580/US 395 northbound entrance from Oddie Blvd	50:1	55:1	*OK*
I-580/US 395 southbound exit to Oddie Blvd	2° - 5°	3° 56’	*OK*
I-580/US 395 southbound entrance from Oddie Blvd	50:1	Aux lane	*OK*
I-580/US 395 northbound exit to McCarren Blvd	2° - 5°	4° 50’	*OK*
I-580/US 395 northbound exit to Clear Acre Ln	2° - 5°	3° 53’	*OK*
I-580/US 395 northbound entrance from McCarren Blvd	50:1	Parallel entrance/300’taper	*OK*
I-580/US 395 northbound entrance from Clear Acre Ln	50:1	Parallel entrance/300’taper	*OK*
I-580/US 395 southbound exit to Clear Acre Ln	2° - 5°	5° 10’	*Substandard*
I-580/US 395 southbound entrance from Clear Acre Ln	50:1	Parallel entrance/300’taper	*OK*

ATTACHMENT– B

EXISTING GEOMETRICS SUMMARY

Location	Minimum Taper Rate Criteria	Existing Taper Rate	Comments
I-580/US 395 southbound entrance from McCarren Blvd	50:1	Aux lane	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Ramp Acceleration and Deceleration Data.

Location	Minimum Lane Length Needed (feet)	Actual Acceleration/ Deceleration Lane Length (feet)	Comments
I-80 eastbound entrance from Keystone Ave	1620	440	*Accel length limited by metering bar. When metering is not in use, accel length is OK*
I-80 eastbound entrance from N Sierra St/N VirginiaSt/N Centre St	1620	380	*Accel length limited by metering bar. When metering is not in use, accel length is OK*
I-80 eastbound entrance from N Wells Ave	1620	380	*Accel length limited by metering bar. When metering is not in use, accel length is OK*
I-80 eastbound entrance from I-580 loop ramp	1350	800	*Assuming 25 mph Vd on loop ramp*
I-80 westbound entrance from I-580 loop ramp	960	0	*Although the loop ramp lanes are perpetuated onto the mainline, there is no accel length from the end of the loop to the painted nose, resulting in a high speed/low speed mix.*
I-580/US 395 northbound entrance from I-80 eastbound	580	300	*OK*
I-580/US 395 southbound exit from I-80 split	290	160	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Minimum Lane Length Needed (feet)	Actual Acceleration/ Deceleration Lane Length (feet)	Comments
I-80 eastbound entrance from Rock Blvd	1620	1230	*Constricted by viaduct*
I-580/US 395 northbound entrance from Mill St	1420	0	*Although the loop ramp lane is perpetuated onto the mainline, there is no accel length from the end of the loop to the painted nose, resulting in a high speed/low speed mix.*
I-580/US 395 northbound entrance from Glendale Ave	1420	0	*Although the loop ramp lane is perpetuated onto the mainline, there is no accel length from the end of the loop to the painted nose, resulting in a high speed/low speed mix.*
I-580/US 395 southbound entrance from Odie Blvd	1420	0	*Although the loop ramp lane is perpetuated onto the mainline, there is no accel length from the end of the loop to the painted nose, resulting in a high speed/low speed mix.*
I-580/US 395 southbound entrance from Clear Acre Ln	1620	1350	

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

LANE WIDTH

Per the NDOT Road Design Guide, and the AASHTO 2011 Green Book, lane widths on interstates should be 12' minimum. The existing I-80 and I-580/US 395 lanes vary in width from 10.5 feet to 12 ft.

Lane widths were measured in CAD using topographic mapping.

I-80 Substandard Lane Widths

Location	Minimum Lane Width	Comments
Keystone Ave to N Sierra St/N Virginia St/N Centre St	EB: 11'	*2 of 5 lanes measure at 11'*
N Sierra St/N Virginia St/N Centre St to N Wells Ave	EB: 10.5'	*Outside lane measures at 10.5'*
N Wells Ave to I-580/US 395	EB: 11.5	*All EB lanes measure at 11.5'*
Within the I-580 / US 395 IC	EB: 11.5	*Inside and middle EB lanes measure at 11.5'.*
I-580/US 395 to Prater Way / Kietzke Ln	EB: 11.5'	*Only the outside lane measures at 12'*
Prater Way / Kietzke Ln to Rock Blvd	EB: 11'/11.5' WB: 10.75'/11'	*EB: Inside lane measures 11.5', all others 11'* *WB: Inside two lanes measure at 10.75', all others measure at 11'*
Rock Blvd to Pyramid Pkway	EB: 11'/11.5'	*EB: Middle lane measures at 11', outside lane at 11.5'.*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

I-580/US 395 Substandard Lane Widths

Location	Minimum Lane Width	Comments
Mill St to Glendale Ave	SB: 11’	*All SB lanes measure at 11’*
Glendale Ave to I-80	SB: 11’	*All SB lanes measure at 11’*
Within the I-80 Interchange	SB: 11’	*SB lanes measure at 11’*
I-80 to Oddie Blvd	NB: 11’ SB: 11’	*All NB lanes measure at 11’* *Inside and outside SB lanes measure 11.5’, middle lane measures 11’.*
Oddie Blvd to McCarran Blvd / Clear Acre Ln	NB 11’	*NB inside and outside lanes measure 11’, middle lane measures 11.5’.*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Interchange Ramp Lane Widths

According to the NDOT Road Design Guide, single lane freeway ramps should have a 24-foot width. Lane width should be 12 feet. A number of ramps within the project area do not conform to these requirements, predominantly along the I-80 corridor.

Location	Minimum Lane Width	Comments
I-80 eastbound exit to Keystone Ave	12’	*OK*
I-80 eastbound entrance from Keystone Ave	11’	*Substandard Inside lane*
I-80 westbound exit to Keystone Ave	11’	*Substandard outside lane*
I-80 westbound entrance from Keystone Ave	11’	*Substandard outside*
I-80 eastbound exit to N Sierra St/N Virginia St/N Centre St	12’	*OK*
I-80 eastbound entrance from N Sierra St/N Virginia St/N Centre St	12’	*OK*
I-80 westbound exit to N Sierra St/N Virginia St/N Centre St	10.5’/11’	*Substandard outside lane/lanes at cross st intersection*
I-80 westbound entrance from N Sierra St/N Virginia St/N Centre St	11’	*Substandard lane*
I-80 eastbound exit to N Wells Ave	12	*OK*
I-80 eastbound entrance from N Wells Ave	11.5’	*Substandard inside lane at cross st intersection*
I-80 westbound exit to N Wells Ave	11’	*Substandard lanes at cross st intersection*
I-80 westbound entrance from N Wells Ave	12’	*OK*
I-80 eastbound to I-580	12’	*OK*

ATTACHMENT – B

EXISTING GEOMETRICS SUMMARY

Location	Minimum Lane Width	Comments
I-80 eastbound to I-580 southbound	12’	*OK*
I-80 eastbound to I-580 northbound	12’	*OK*
I-80 westbound exit to I-580	12’	*OK*
I-80 westbound to I-580 southbound	12’	*OK*
I-80 westbound to I-580 northbound	12’	*OK*
I-580 northbound to I-80 eastbound	12’	*OK*
I-580 northbound to I-80 westbound	12’	*OK*
I-580 southbound to I-80	12’	*OK*
I-580 southbound to I-80 eastbound	12’	*OK*
I-580 southbound to I-80 westbound	12’	*OK*
I-80 eastbound exit to Prater Way / Kietzke Ln	12’	*OK*
I-80 eastbound entrance from Prater Way / Kietzke Ln	11’	*Substandard at single lane*
I-80 westbound exit to Prater Way / Kietzke Ln	11’	*Substandard lanes at cross st intersection*
I-80 westbound entrance from Prater Way / Kietzke Ln	12’	*OK*
I-80 eastbound exit to Rock Blvd	12’	*OK*
I-80 eastbound entrance from Rock Blvd	11’	*Substandard inside lane at cross st intersection*
I-80 westbound exit to Rock Blvd	12’	*OK*
I-80 westbound entrance from Rock Blvd	12’	*OK*
I-80 eastbound exit to Pyramid Pkway	12’	*OK*

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EXISTING GEOMETRICS SUMMARY

Location	Minimum Lane Width	Comments
I-80 eastbound entrance from Pyramid Pkway	12’	*OK*
I-80 westbound exit to Pyramid Pkway	12’	*OK*
I-80 westbound entrance from Pyramid Pkway	12’	*OK*
I-580/US 395 northbound entrance from S Virginia St/Kietzke Ln	12’	*OK*
I-580/US 395 southbound exit to S Virginia St/Kietzke Ln	12’	*OK*
I-580/US 395 southbound exit to Kietzke Ln	12’	*OK*
I-580/US 395 northbound exit to E Moana Ln	12’	*OK*
I-580/US 395 northbound entrance from E Moana Ln	12’	*OK*
I-580/US 395 southbound exit to E Moana Ln	12’	*OK*
I-580/US 395 southbound entrance from E Moana Ln	12’	*OK*
I-580/US 395 northbound exit to E Plumb Ln/Villanova Ln	12’	*OK*
I-580/US 395 northbound entrance from Airport	14’	*OK*
I-580/US 395 northbound entrance from E Plumb Ln/Villanova Ln	12’	*OK*
I-580/US 395 southbound exit to E Plumb Ln/Villanova Ln	12’	*OK*

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EXISTING GEOMETRICS SUMMARY

Location	Minimum Lane Width	Comments
I-580/US 395 southbound exit to Airport	14’	*OK*
I-580/US 395 southbound entrance from E Plumb Ln/Villanova Ln	12’	*OK*
I-580/US 395 northbound exit to Mill St	12’	*OK*
I-580/US 395 northbound entrance from Mill St	12’	*OK*
I-580/US 395 southbound exit to Mill St	12’	*OK*
I-580/US 395 southbound entrance from Mill St	12’	*OK*
I-580/US 395 northbound exit to Glendale Ave	12’	*OK*
I-580/US 395 northbound entrance from Glendale Ave	12’	*OK*
I-580/US 395 southbound exit to Glendale Ave	12’	*OK*
I-580/US 395 southbound entrance from Glendale Ave	12’	*OK*
I-580/US 395 northbound exit to Oddie Blvd	12’	*OK*
I-580/US 395 northbound entrance from Oddie Blvd	12’	*OK*
I-580/US 395 southbound exit to Oddie Blvd	12’	*OK*
I-580/US 395 southbound entrance from Oddie Blvd	12’	*OK*

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EXISTING GEOMETRICS SUMMARY

Location	Minimum Lane Width	Comments
I-580/US 395 northbound exit to McCarren Blvd	12’	*OK*
I-580/US 395 northbound exit to Clear Acre Ln	12’	*OK*
I-580/US 395 northbound entrance from McCarren Blvd	12’	*OK*
I-580/US 395 northbound entrance from Clear Acre Ln	12’	*OK*
I-580/US 395 southbound exit to Clear Acre Ln	12’	*OK*
I-580/US 395 southbound entrance from Clear Acre Ln	10’/11’	*Substandard inside/outside lane at cross st intersection*
I-580/US 395 southbound entrance from McCarren Blvd	12’	*OK*

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EXISTING GEOMETRICS SUMMARY

SHOULDER WIDTH

Per the NDOT Road Design Guide and the AASHTO 2011 Green Book, the outside shoulders of interstates should be 10 foot minimum. Inside shoulders of interstates with three or more lanes in a direction should be 10 foot minimum in that direction. Inside shoulders of interstates with two lanes in a direction should be 4' minimum in that direction.

From	To	Minimum Inside Shoulder	Minimum Outside Shoulder	Comments
I-80 Eastbound				
Keystone Ave	N Sierra St/N Virginia St/N Centre St	3'	10'	*Substandard* *3' measured to face of median barrier*
N Sierra St/N Virginia St/N Centre St	N Wells Ave	1.75'	2.5'	*Substandard* *Both measured to face of barrier*
N Wells Ave	I-580/US 395	2.75'	1'	*Substandard* *Both measured to face of barrier*
Within I-580 / US 395 IC		1'	3.75'	*Substandard* *Inside shoulder measured to face of median barrier* *Outside shoulder measured in EB direction after EB off ramp to I-580 / US 395.*
I-580/US 395	Prater Way / Kietzke Ln	2'	14'	*Substandard* *Inside shoulder measured to face of median barrier*
Prater Way / Kietzke Ln	Rock Blvd	1.25'	6'	*Substandard* *Both measured to face of barrier*
Rock Blvd	Pyramid Pkway	2'	4'	*Substandard*

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EXISTING GEOMETRICS SUMMARY

From	To	Minimum Inside Shoulder	Minimum Outside Shoulder	Comments
				Both measured to face of barrier
I-80 Westbound				
Keystone Ave	N Sierra St/N Virginia St/N Centre St	3.5’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
N Sierra St/N Virginia St/N Centre St	N Wells Ave	2.3’	10.5’	*Substandard* *Inside shoulder measured to face of median barrier*
N Wells Ave	I-580/US 395	3.5’	8’	*Substandard* *Both measured to face of barrier*
Within Spaghetti Bowl		1.5’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
I-580/US 395	Prater Way / Kietzke Ln	3’	8’	*Substandard* *Both measured to face of barrier*
Prater Way / Kietzke Ln	Rock Blvd	4.5’	8.5’	*Substandard* *Both measured to face of barrier*
Rock Blvd	Pyramid Pkway	4’	3’	*Substandard* *Both measured to face of barrier*
I-580/US 395 Northbound				
S Virginia St/Kietzke Ln	E Moana Ln	10’	11’	*OK*

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EXISTING GEOMETRICS SUMMARY

From	To	Minimum Inside Shoulder	Minimum Outside Shoulder	Comments
E Moana Ln	E Plumb Ln/Villanova Ln	8’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
E Plumb Ln/Villanova Ln	Mill St	4’	10’	*Substandard* *Inside shoulder measured to face of median barrier within E Plumb Ln / Villanova Ln IC*
Mill St	Glendale Ave	5’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
Glendale Ave	I-80	5’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
Within Spaghetti Bowl		1.5’	6’	*Substandard* *Both measured to face of barrier*
I-80	Oddie Blvd	3.3’	4.3’	*Substandard* *Inside shoulder measured to face of barrier flare at overhead sign structure.* *Outside shoulder measured to face of barrier*
Oddie Blvd	McCarren Blvd/Clear Acre Ln	2’	5.5’	*Substandard* *Inside shoulder measured to face of barrier flare at overhead sign structure.*

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EXISTING GEOMETRICS SUMMARY

From	To	Minimum Inside Shoulder	Minimum Outside Shoulder	Comments
				Outside shoulder measured to face of barrier
I-580/US 395 Southbound				
S Virginia St/Kietzke Ln	E Moana Ln	10’	11’	*OK*
E Moana Ln	E Plumb Ln/Villanova Ln	8’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
E Plumb Ln/Villanova Ln	Mill St	8’	10’	*Substandard* *Inside shoulder measured to face of median barrier*
Mill St	Glendale Ave	1’	7’	*Substandard* *Inside shoulder measured to face of barrier flare at overhead sign structure.* *Outside shoulder measured to face of barrier*
Glendale Ave	I-80	1’	7’	*Substandard* *Inside shoulder measured to face of barrier flare at overhead sign structure.* *Outside shoulder measured to face of barrier*
Within Spaghetti Bowl		3’	7.5’	*Substandard* *Both measured to face of barrier*

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EXISTING GEOMETRICS SUMMARY

From	To	Minimum Inside Shoulder	Minimum Outside Shoulder	Comments
I-80	Oddie Blvd	1’	8’	*Substandard* *Inside shoulder measured to face of barrier flare at overhead sign structure.* *Outside shoulder measured to face of barrier*
Oddie Blvd	McCarren Blvd/Clear Acre Ln	1’	8’	*Substandard* *Inside shoulder measured to face of barrier flare at overhead sign structure.* *Outside shoulder measured to face of barrier*

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EXISTING GEOMETRICS SUMMARY

Interchange Ramp Shoulder Widths

Per AASHTO's Green Book, when paved shoulders are provided on ramps, they should have a uniform width for the full length of ramp. For one-way operation, the sum of the right and left shoulder widths are typically between 10 to 14 ft. A paved shoulder width of 2 to 4 ft is desirable on the left with the remaining width of 8 to 10 ft used for the paved right shoulder. Shoulder widths in table were measured using CAD. Shoulder measurements followed by (gutter) were measured to lip of gutter. Shoulder measurements followed by (FOB) were measured to the face of barrier.

Location	Minimum Inside Shoulder Width	Minimum Outside Shoulder Width	Comments
I-80 eastbound exit to Keystone Ave	0' (gutter)	0' (gutter)	*Substandard*
I-80 eastbound entrance from Keystone Ave	0' (gutter)	6' (gutter)	*Substandard*
I-80 westbound exit to Keystone Ave	0' (gutter)	6' (gutter)	*Substandard*
I-80 westbound entrance from Keystone Ave	0' (gutter)	6' (gutter)	*Substandard*
I-80 eastbound exit to N Sierra St/N Virginia St/N Centre St	0' (gutter)	1.25	*Substandard*
I-80 eastbound entrance from N Sierra St/N Virginia St/N Centre St	0' (gutter)	6' (gutter)	*Substandard*
I-80 westbound exit to N Sierra St/N Virginia St/N Centre St	0' (gutter)	2' (FOB)	*Substandard*
I-80 westbound entrance from N Sierra St/N Virginia St/N Centre St	0' (gutter)	0' (gutter)	*Substandard*
I-80 eastbound exit to N Wells Ave	0' (gutter)	0' (gutter)	*Substandard*
I-80 eastbound entrance from N Wells Ave	0' (gutter)	6' (gutter)	*Substandard*
I-80 westbound exit to N Wells Ave	0' (gutter)	0' (gutter)	*Substandard*
I-80 westbound entrance from N Wells Ave	0' (gutter)	0' (gutter)	*Substandard*
I-80 eastbound to I-580	4' (gutter)	7' (FOB)	*OK*
I-80 eastbound to I-580 southbound	1 (FOG)	8' (FOB)	*Substandard*

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EXISTING GEOMETRICS SUMMARY

Location	Minimum Inside Shoulder Width	Minimum Outside Shoulder Width	Comments
I-80 eastbound to I-580 northbound	2.5’ (FOB)	8’ (FOB)	*OK*
I-80 westbound exit to I-580	5’ (FOB)	8’ (FOB)	*OK*
I-80 westbound to I-580 southbound	4’	5.5’ (FOB)	*Substandard*
I-80 westbound to I-580 northbound	2’ (FOB)	9.5’ (FOB)	*Substandard*
I-580 northbound to I-80 eastbound	3.5’	5’ (FOB)	*Substandard*
I-580 northbound to I-80 westbound	4’ (FOB)	8’ (FOB)	*OK*
I-580 southbound to I-80	6.5’ (FOB)	10’ (FOB)	*OK*
I-580 southbound to I-80 eastbound	2’ (FOB)	7.5’ (FOB)	*OK*
I-580 southbound to I-80 westbound	4’	8’ (FOB)	*OK*
I-80 eastbound exit to Prater Way / Kietzke Ln	0’ (gutter)	3.3’	*Substandard*
I-80 eastbound entrance from Prater Way / Kietzke Ln	0’ (gutter)	4.4’ (FOB)	*Substandard*
I-80 westbound exit to Prater Way / Kietzke Ln	0.5’ (gutter)	0.5’ (gutter)	*Substandard*
I-80 westbound entrance from Prater Way / Kietzke Ln	5’ (FOB)	9’ (FOB)	*OK*
I-80 eastbound exit to Rock Blvd	1.5’ (gutter)	3’	*Substandard*
I-80 eastbound entrance from Rock Blvd	0’ (gutter)	6.5’ (FOB)	*Substandard*
I-80 westbound exit to Rock Blvd	0.5’ (gutter)	2’ (FOB)	*Substandard*
I-80 westbound entrance from Rock Blvd	3’	8.5’ (FOB)	*Substandard*
I-80 eastbound exit to Pyramid Pkway	2’ (gutter)	4.5’ (FOB)	*Substandard*
I-80 eastbound entrance from Pyramid Pkway	2’	2’ (gutter)	*Substandard*
I-80 westbound exit to Pyramid Pkway	2’ (gutter)	2’ (gutter)	*Substandard*
I-80 westbound entrance from Pyramid Pkway	3’	2’ (gutter)	*Substandard*

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EXISTING GEOMETRICS SUMMARY

Location	Minimum Inside Shoulder Width	Minimum Outside Shoulder Width	Comments
I-580/US 395 northbound entrance from S Virginia St/Kietzke Ln	1.5’	6’ (FOB)	*Substandard*
I-580/US 395 southbound exit to S Virginia St/Kietzke Ln	4’	9.5’	*OK*
I-580/US 395 southbound exit to Kietzke Ln	5’ (FOB)	9’ (FOB)	*OK*
I-580/US 395 northbound exit to E Moana Ln	4’	6’	*OK*
I-580/US 395 northbound entrance from E Moana Ln	4’	8’	*OK*
I-580/US 395 southbound exit to E Moana Ln	4’	4’	*Substandard*
I-580/US 395 southbound entrance from E Moana Ln	4’	8’	*OK*
I-580/US 395 northbound exit to E Plumb Ln/Villanova Ln	4’ (FOB)	8’ (FOB)	*OK*
I-580/US 395 northbound entrance from Airport	3.5’ (FOB)	5.5’ (FOB)	*Substandard*
I-580/US 395 northbound entrance from E Plumb Ln/Villanova Ln	4’ (gutter)	8’ (FOB)	*OK*
I-580/US 395 southbound exit to E Plumb Ln/Villanova Ln	1’ (gutter)	2’ (gutter)	*Substandard*
I-580/US 395 southbound exit to Airport	5.5’ (FOB)	5.5’ (FOB)	*Substandard*
I-580/US 395 southbound entrance from E Plumb Ln/Villanova Ln	2’ (FOB)	6’ (FOB)	*Substandard*
I-580/US 395 northbound exit to Mill St	0’ (gutter)	8’	*Substandard*
I-580/US 395 northbound entrance from Mill St	2’	6.5’	*Substandard*
I-580/US 395 southbound exit to Mill St	0’ (gutter)	10’	*Substandard*
I-580/US 395 southbound entrance from Mill St	0’ (gutter)	8’	*Substandard*
I-580/US 395 northbound exit to Glendale Ave	2.5’ (gutter)	8’	*OK*
I-580/US 395 northbound entrance from Glendale Ave	2’ (gutter)	8’ (gutter)	*OK*

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EXISTING GEOMETRICS SUMMARY

Location	Minimum Inside Shoulder Width	Minimum Outside Shoulder Width	Comments
I-580/US 395 southbound exit to Glendale Ave	0’ (gutter)	0’ (gutter)	*Substandard*
I-580/US 395 southbound entrance from Glendale Ave	0’ (gutter)	6’ (FOB)	*Substandard*
I-580/US 395 northbound exit to Oddie Blvd	4’	8’ (FOB)	*OK*
I-580/US 395 northbound entrance from Oddie Blvd	4’ (FOB)	8’ (FOB)	*OK*
I-580/US 395 southbound exit to Oddie Blvd	4’	8’ (FOB)	*OK*
I-580/US 395 southbound entrance from Oddie Blvd	2.5’ (gutter)	8’ (FOB)	*OK*
I-580/US 395 northbound exit to McCarren Blvd	5’	10’ (FOB	*OK*
I-580/US 395 northbound exit to Clear Acre Ln	5’ (FOB)	10’ (FOB	*OK*
I-580/US 395 northbound entrance from McCarren Blvd	5.5’ (FOB)	4’ (FOB)	*Shoulders swap through curve to provide sight distance, ramp shoulders are OK.*
I-580/US 395 northbound entrance from Clear Acre Ln	4’	8’	*OK*
I-580/US 395 southbound exit to Clear Acre Ln	3.5’	6.5’ (gutter)	*Substandard*
I-580/US 395 southbound entrance from Clear Acre Ln	4’ (FOB)	4’ (FOB)	*Substandard*
I-580/US 395 southbound entrance from McCarren Blvd	8’ (FOB)	10’ (FOB)	*OK*

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EXISTING GEOMETRICS SUMMARY

STOPPING SIGHT DISTANCE

Per the AASHTO 2011 Green Book, stopping sight distance for a facility designed for 65 mph should be 645 feet. A number of locations along I-80 and I-580/US 395 do not provide this stopping sight distance in the inside lane due to the median barrier within a curve. These locations are provided below.

From	To	Measured SSD	Comments
I-80			
Keystone Ave	N Sierra St/N Virginia St/N Centre St	WB: 400' EB: 460'	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
Within the N Sierra St/N Virginia St/N Centre St Interchange		WB: 350' EB: 480'	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
N Sierra St/N Virginia St/N Centre St	N Wells Ave	WB: 400'	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
N Wells Ave	I-580/US 395	EB: 550	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
I-580/US 395	Prater Way / Kietzke Ln	WB: 460'	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
Prater Way / Kietzke Ln	Rock Blvd	EB: 310'/550'	*Substandard in the inside lane due to median barrier rail within the curve*
Pyramid Pkway	McCarran Blvd	EB: 475	*Substandard in the inside WB lane due to median barrier rail*

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EXISTING GEOMETRICS SUMMARY

From	To	Measured SSD	Comments
		WB: 650	*Substandard in the outside EB lane due to guardrail within the curve..*
I-580/US 395			
E Plumb Ln/Villanove Dr	Mill St	NB: 570	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
Glendale Ave	I-80	NB: 425' SB: 425'	*Substandard in the inside lane.* *Due to median barrier rail within the curve*
Within McCarran Blvd/Clear Acre Ln Interchange		NB: 380'	*Substandard in the inside lane.* *Due to median barrier rail within the curve*

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EXISTING GEOMETRICS SUMMARY

I-80 / I-580/US395 Interchange Horizontal Alignments:

The Spaghetti Bowl ramp horizontal alignments were reviewed to determine if substandard superelevation runoff conditions existed. Existing ground digital terrain models were used to understand the existing superelevation conditions, and the runoff guidelines provided in the AASHTO 2011 Green Book were used as a criteria to determine if substandard conditions exist. The existing ground terrain models did not provide exact superelevation data, but rather presented a range of approximately 2%. Two substandard conditions were found, listed below. The runoff values were assumed to be 1/3 in the curve, and 2/3 in the tangent, but using 1/2; in the curve and 1/2 in the tangent was also reviewed.

Ramp	Assumed Vd	Assumed Superelevation	Required Space From PT to PC	Provided Space	Comments
I-80 EB to I-580 NB	40 mph	Curve 1: 8.7% Curve 2: 9.1%	240 ft (1/3 & 2/3) 180 ft (1/2 & 1/2)	165 ft	*Substandard*
I-80 EB to I-580 NB	40 mph	Curve 1: 9.1% Curve 2: 5.8%	200 ft (1/3 & 2/3) 150 ft (1/2 & 1/2)	92 ft	*Substandard*

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ATTACHMENT C

EXISTING GEOMETRIC REVIEW

ATTACHMENT C

EXISTING GEOMETRICS REVIEW

I-80 & I-580 / US 395 Corridor Geometry Summary

	Criteria										
Segment/Interchange/Ramp	**System / Service IC Spacing (ramp to ramp)**	**No. of Lanes**	**Lane Width (inside lane to outside lane)**	**Inside Shoulder Width**	**Outside Shoulder Width**	**Departure Angle**	**Taper Rate**	**Accel Length**	**Decel Length**	**Stopping Sight Distance**	**Comments**
I-80											
Keystone Ave IC											
EB Off Ramp		1 to 3	16 12, 12, 16	0 + gutter typ	8 0 + gutter	4° 7'			1200	515 155	Assumes the controlling curve is supered for 65 mph
EB On Ramp		3 to 2	12, 12, 12 11, 12	0 + gutter typ	6 + gutter typ		na	na		191 425	During ramp metering, not enough accel length to avoid low speed/high speed mix in aux lane
WB Off Ramp		2 to 4	12, 11 12, 11.5, 12, 11.5	0 + gutter typ	6 to FOB typ	4° 28'			400	425 155	
WB On Ramp		2 to 1	11, 11 13.5	0 + gutter typ	6 + gutter 9		38:1	1220		155 535	Accel length assumes beginning speed of 25 mph
Within Keyston Ave IC		EB 3 : WB 3	EB - 12 typ WB - 12 typ	EB - 9 to FOB WB - 3 to FOB	EB - 10 to FOB WB - 10 to FOB					EB - 460	
I-80 From Keystone Ave to Sierrra/Virginia/Center St's	EB - 1950 en-ex WB - 1900 en-ex	EB 5 : WB 4	EB - 12, 11, 11, 12, 12 WB - 12 typ	EB - 3 to FOB WB - 3.5 to FOB	EB - 10 to FOB WB - 10 to FOB					WB - 400	
Sierrra/Virginia/Center St's IC											
EB Off Ramp		2	12 typ	0 + gutter typ	1.25	5° 11'			75	370	Assumes the controlling curve is supered for 65 mph
EB On Ramp		2 to 1	12 typ	0 + gutter typ	6 + gutter		na	na		na	During ramp metering, not enough accel length to avoid low speed/high speed mix in aux lane
WB Off Ramp		2 to 3	12, 12 10.5, 11, 11	2 to FOB 0 + gutter	6 to FOB 2 to FOB, 5 + gutter	4° 59'			1130	na	
WB On Ramp		2 to 1	12, 12 11	0 + gutter typ	0 + gutter 6 + gutter		na	na		na	
Within Sierrra/Virginia/Center St IC		EB 4 : WB 3	EB -11', 11.75', 11.5', 11.75' WB - 12' typ	EB - 3 to FOB WB - 3.5 to FOB	EB - 4.5 to FOB WB -14.5 to FOB					EB - 480 WB - 350	
I-80 From Sierrra/Virginia/Center St's to Wells Ave	EB - 1200 en-ex WB - 900 en-ex	EB 5 : WB 4	EB - 12, 11.5, 11.5, 11.5, 10.5 WB - 12 typ	EB - 1.75 to FOB WB - 2.3 to FOB	EB - 2.5 to FOB WB - 10.5 to FOB					WB - 400	
Wells Ave IC											
EB Off Ramp		1 to 2	12 typ	0 + gutter typ	8 0 + gutter	1° 37'			1100	350	Assumes the controlling curve is supered for 65 mph
EB On Ramp		2 to 1	11.5, 12 12	0 + gutter typ	6 + gutter 8 to FOB		na	na		na	During ramp metering, not enough accel length to avoid low speed/high speed mix in aux lane
WB Off Ramp		1 to 3	12 11, 11.5, 11	0 + gutter typ	8 to FOB 2 to FOB, 0 + gutter	2° 28'			1400	na	
WB On Ramp		2 to 1	12 typ	0 + gutter typ	0 + gutter 8		na	na		na	
Within Wells Ave IC		EB 4 : WB 3	EB - 11.5 typ WB - 12 typ	EB - 1.5 to FOB WB - 2 to FOB	EB - 2 + gutter WB - 15 to FOB					na	
I-80 From Wells Ave to I-580 / US395	EB - 1350 en-ex : 600 en-en : 2300 ex-en WB - 1500 en-ex : 1450 en-en : 1500 ex-en	EB 5 : WB 4	EB - 11.5 typ WB - 12 typ	EB - 2.75 to FOB WB - 3.5 to FOB	EB - 1' to FOB WB - 8 to FOB					EB - 550	
I-580/US395 IC											
EB Off Ramp		2	12 typ	4 + gutter	7 to FOB	4° 17'				300	Guardrail obstructs SSD
EB to SB Ramp		2 to 1	12 typ	1 to FOG	8 to FOG	na	na	na	na	385	
EB to NB Ramp		1	12	2.5	8 to FOB	5° 49	27:1	260	na	250	Superelevation runoff lengths too short to comply with standard runoff lengths between S curves.
WB Off Ramp		2	12 typ	5 to FOB	8 to FOB	1° 33'		na	na	510	
WB to SB Ramp		1	12	4	5.5 to FOB	na	na	na	na	200	
WB to NB Ramp		1	12	2 to FOB	9.5 FOB	na	na	na	na	305	
NB to EB Ramp		2 to 1	12 typ	3.5	5 to FOB	na	na	na	na	305	Becomes aux lane on I80, but potential for low speed/high speed mix
NB to WB Ramp		2	12 typ	4 to (FOB)	8 to FOB	na	na	na (see comment)	na	155	no accel length after loop, low speed high speed mix
SB Off Ramp		1	12	6.5 to FOB	10 to FOB	1° 55'		220	na	305	
SB to EB Ramp		1	12	2 to FOB	7.5 to FOB	na	28:1	800	na	155	
SB to WB Ramp		1	12	4	8 to FOB	na	300 ft aux lane taper	1000	na	260	Noise wall obstructs SSD. SSD ok if speed is reduced, but geometry doesn' t limit the speed well.
Within the I-580 / US 395 IC		EB 4 to 3 : WB 2 to 4	EB - 11.5, 11.5, 12 WB - 12 typ	EB - 1 WB - 1.5	EB - 3.75 WB - 10					WB - 465	
I-80 From I-580 / US395 to Prater Way / Kietzke Ln	EB - 550 en-ex WB - 1500 en-en : 900 ex-ex : 1800 ex-en	EB 4 : WB 2	EB - 11.5, 11.5, 11.5, 12 WB - 12 typ	EB - 2 to FOB WB - 3 to FOB	EB - 14 to FOB WB - 8 to FOB					WB - 465	

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EXISTING GEOMETRICS REVIEW

	Criteria										
Segment/Interchange/Ramp	System / Service IC Spacing (ramp to ramp)	No. of Lanes	Lane Width (inside lane to outside lane)	Inside Shoulder Width	Outside Shoulder Width	Departure Angle	Taper Rate	Accel Length	Decel Length	Stopping Sight Distance	Comments
Prater Way / Kietzke Ln IC											
EB Off Ramp		1 to 2	15.5 13, 14.5	0 + gutter typ	3.3 4.5	4° 15'			900	485	Assumes entry curve is same speed as mainline
EB On Ramp		2 to 1	14, 12 11	0 + gutter typ	5.5 4.4 to FOB		na	na		na	
WB Off Ramp		1 to 2	12 11, 11	0.5 + gutter typ	3.5 to FOB 0.5 + gutter	3° 57'			1450	335	Assumes entry curve is same speed as mainline
WB On Ramp		1	12	5 to FOB	9 to FOB		300 ft aux lane taper	1640		540	
Kietzke Ln to US 395 N		1	12	4 to FOB	10 to FOB		>300 ft aux lane taper	1700		450	
Within the Prater Way / Kietzke Ln IC		EB 4 : WB 2	EB - 11.5 typ WB - 12 typ	EB - 2.5 to FOB WB - 3.3 to FOB	EB - 4 to FOB WB - 10 to FOB					EB - 310 WB - 465	
I-80 From Prater Way / Kietzke Ln to Rock Blvd	EB - 1350 en-ex WB - 1200 en-ex	EB 5 : WB 4	EB - 11.5, 11, 11, 11, 11 WB - 10.75, 10.75, 11, 11	EB - 1.25 to FOB WB - 4.5 to FOB	EB - 6.5 to FOB WB - 8.5 to FOB					EB - 550	
Rock Blvd IC											
EB Off Ramp		2	12 typ	1.5 to FOB, 2 + gutter	6, 3	3° 49'			1400	na	
EB On Ramp		2 to 1	11, 12 12	0 + gutter typ	9 + gutter 6.5 to FOB		280 taper on aux ramp	1150		720	
WB Off Ramp		1 to 2	12 typ	0.5 + gutter typ	6 to FOB 2 to FOB	5° 8'			970	na	
WB On Ramp		1	12	3	8.5 to FOB		na	na		815	
Within the Rock Blvd IC		EB 3 : WB 3	EB - 11 typ WB - 11 typ	EB - 11 to FOB WB - 11 to FOB	EB - 8.5 to FOB WB - 9 to FOB					na	
I-80 From Rock Blvd to Pyramid Way	EB - 1500 en-ex WB - 1450 en-ex	EB 3 : WB 3	EB - 12, 11, 11.5 WB 12 typ	EB - 2 to FOB WB - 4 to FOB	EB - 4 to FOB WB - 3 to FOB					na	
Pyramid Pkway IC											
EB Off Ramp		2 to 3	12 typ	2.5 + gutter 2 + gutter	4.5 to FOB 6 to FOB	2° 08'			800	650 145	
EB On Ramp		2 to 1	12, 14 12	2 + gutter 2	2 + gutter 4 to FOB		na	na		160 425	
WB Off Ramp		1 to 3	12 13, 13, 12	2 + gutter typ	4.5 to FOB 2 + gutter	2° 29'			450	500 130	
WB On Ramp		3 to 1	12, 12, 12 12.5	2 + gutter 3	2 + gutter 3.5 to FOB		na	na		145 655	
Within the Pyramid Pkway IC		EB 2 : WB 2	EB - 12 typ WB - 12 typ	EB - 20.5 to FOB WB - 19.5 to FOB	EB - 11.5 to FOB WB - 10.5 to FOB					EB & WB - 760	
Pyramid Pkway IC to McCarran Blvd IC	EB - 1850 en-ex WB - 970 en-ex	EB 3 to 2 : WB 3 to 2	EB - 12 typ WB - 12 typ	EB - 18 to FOB WB - 18 to FOB	EB - 10 to FOB WB - 10 to FOB					EB - 475 WB - 650	
I-580 / US395											
Virginia St IC											
NB On Ramp		1	12	1.5	6 to FOB		300 ft aux lane taper	1620		650	
SB Off Ramp		1 to 2	12 12, 12	4 typ	9.5 typ	1° 19'			2000	na	
SB Off Ramp to Kietzke Ln		1	12	5 to FOB	9 to FOB	1° 51'			2000	265	
Within the Virginia St IC		NB 3 : SB 3	NB - 12 typ SB - 12 typ	NB - 10 to FOB SB - 10 to FOB	NB - 11 to FOB SB - 11 to FOB					880	
I-580 / US 395 From Virginia St to Moana Ln	NB - 2500 en-ex SB - 1650 en-ex	NB 3 : SB 3	NB - 12 typ SB - 12 typ	NB - 10 to FOB SB - 10 to FOB	NB - 11 to FOB SB - 11 to FOB					na	
Moana Ln IC											
NB Off Ramp		1 to 3	12 typ	4 typ	8 to FOB 6	4° 34'			620	550	
NB On Ramp		3 to 2	12 typ	4 typ	8 typ		50:1	na		650	
SB Off Ramp		2 to 4	12 typ	4 typ	8 4	2° 54'			620	650	
SB On Ramp		2 to 1	12 typ	4 typ	8 typ		>300 aux lane taper	1660		650	
Within the Moana Ln IC		NB 3 : SB 3	NB - 12 typ SB - 12 typ	NB - 10 to FOB SB - 10 to FOB	NB - 10 to FOB SB - 10 to FOB						
I-580 / US 395 From Moana Ln to E Plumb Ln / Villanova Dr	NB - 2200 en-ex : 2150 en-en SB - 2100 en-ex : 2100 ex-ex	NB 4 : SB 5	NB - 12 typ SB - 12 typ	NB - 8 to FOB SB - 8 to FOB	NB - 10 to FOB SB - 10 to FOB					750	

ATTACHMENT C

EXISTING GEOMETRICS REVIEW

	Criteria										
Segment/Interchange/Ramp	System / Service IC Spacing (ramp to ramp)	No. of Lanes	Lane Width (inside lane to outside lane)	Inside Shoulder Width	Outside Shoulder Width	Departure Angle	Taper Rate	Accel Length	Decel Length	Stopping Sight Distance	Comments
E Plumb Ln/Villanova Dr IC											
NB Off Ramp		2 to 3	12 typ	4 to FOB 6	8 to FOG 8	5° 0'			1450	650	
NB On Ramp		2 to 1	12 typ	4 + gutter 4	8 to FOB 10 to FOB		na	na		360 570	
SB Off Ramp		1 to 3	14 12, 12, 12	2 + gutter 1 + gutter	2 + gutter 7.5 + gutter	3° 58'			950	na	
SB On Ramp		2 to 1	12 typ	2 to FOB 3	6 to FOB 8		60:1	1620		na	
Airport Ramps											
NB On Ramp		1	14	3.5 to FOB	5.5 to FOB		30:1	1190		225	
SB Off Ramp		1	14	5.5 to FOB	5.5 to FOB	4° 54'			370	255	
Within E Plumb Ln / Villanova Dr IC		NB 4 to 5 : SB 4	NB - 12 typ SB - 12 typ	NB - 4 to FOB SB - 8 to FOB	NB - 10 to FOB SB - 11 to FOB					NB - 600	
I-580 / US 395 From E Plumb Ln / Villanova Dr to Mill St	NB - 1150 en-ex : 1150 en-en : 1150 ex-en SB - 1400 en-ex : 2100 ex-ex : 1850 ex-en	NB 6 : SB 4	NB - 12 typ SB - 12 typ	NB - 4 to FOB SB - 8 to FOB	NB - 10 to FOB SB - 10 to FOB					NB - 570	
Mill St IC											
NB Off Ramp		1 to 3	12 typ	4 0 + gutter	8 to FOG 8	3° 20'			380	360	
NB On Ramp		3 to 1	14, 15.5, 17 12	0+ gutter 2	6.5 8		na	na (see comment)		na	no accel length after loop, low speed high speed mix
SB Off Ramp		1 to 3	12 typ	0 + gutter typ	10 to FOB typ	3° 36'			1200	na	
SB On Ramp		2 to 1	15	0 + gutter typ	8 typ		na	na		na	
Within the Mill St IC		NB 6 : SB 3	NB - 12 typ SB - 12 typ	NB - 7 to FOB SB - 7 to FOB	NB - 10 to FOB SB - 10 to FOB					na	
I-580 / US 395 From Mill St to Glendale Ave	NB - 1950 en-ex : 1150 en-en SB - 500 en-ex	NB 7 : SB 5	NB - 12 typ SB - 11 typ	NB - 5 to FOB SB - 1 to FOB	NB - 10 to FOB SB - 7 to FOB					SB - 650	
Glendale Ave IC											
NB Off Ramp		2 to 3	12 typ	4 2.5 + gutter	8 to FOG 8	3° 43'			420	360	
NB On Ramp		3 to 1	16, 16, 16 12	2 + gutter 4	8 + gutter 10 to FOG		na	na (see comment)		220	no accel length after loop, low speed high speed mix
SB Off Ramp		1 to 3	12 typ	4 0	7 to FOB 0 + gutter	5° 42'			0 (see comment)	380	not enough decel length to enter assumed 50 mph curve.
SB On Ramp		2 to 1	13, 13 12	0 + gutter typ	6 to FOB 8 to FOB		na	na		500	
Within the Glendale Ave IC		NB 6 : SB 4	NB - 12 typ SB - 11 typ	NB - 7 to FOB SB - 4 to FOB	NB - 10 to FOG SB - 7					na	
I-580 / US 395 From Glendale Ave to I-80	NB - 2100 en-ex : 1100 ex-ex : 1500 ex-en : 800 en-en SB - 1000 en-ex : 2000 ex-en : 1100 en-en	NB 7 : SB 5	NB - 12 typ SB - 11 typ	NB - 5 to FOB SB - 1 to FOB	NB - 10 to FOB SB - 7 to FOB					NB - 425 SB - 425	
Within the I-580 / US 395 IC		NB 3 : SB 2	NB - 12 typ SB - 11 typ	NB - 1.5 to FOB SB - 3 to FOB	NB - 6 to FOB SB - 7.5 to FOB					SB - 425	
I-580 / US 395 From I-80 to Oddie Blvd	NB - 700 en-ex SB - 1950 en-ex	NB 4 : SB 3	NB - 11 typ SB - 11.5, 11, 11.5	NB - 3.3 to FOB SB - 1 to FOB	NB - 4.3 to FOB SB - 8 to FOB					na	
Oddie Blvd IC											
NB Off Ramp		1	12	4	8 to FOB	2° 53'			930	na	
NB On Ramp		1	12	4 to FOB	8 to FOB		55:1	830		na	no accel length after loop, low speed high speed mix
SB Off Ramp		1 to 2	12 typ	4 typ	8 to FOB typ	3° 56'			1380	285 170	accel length adequate for 65 mph, not 70 mph design speed.
SB On Ramp		1	12	2.5 + gutter	8		na	300		155	
Within the Oddie Blvd IC		NB 3 : SB 3	NB - 11 typ SB - 12 typ	NB - 6 to FOB SB - 4 to FOB	NB - 10 to FOG SB - 10					na	
US 395 From Oddie Blvd to N McCarran Blvd/Clear Acre	NB - 1200 en-ex SB - 1300 en-ex : 950 ex-en	NB 3 : SB 3	NB - 11, 11.5, 11 SB - 12 typ	NB - 2 to FOB SB - 1 to FOB	NB - 5.5 to FOB SB - 8 to FOB					na	

ATTACHMENT C

EXISTING GEOMETRICS REVIEW

	Criteria										
Segment/Interchange/Ramp	System / Service IC Spacing (ramp to ramp)	No. of Lanes	Lane Width (inside lane to outside lane)	Inside Shoulder Width	Outside Shoulder Width	Departure Angle	Taper Rate	Accel Length	Decel Length	Stopping Sight Distance	Comments
N McCarran Blvd/Clear Acre Ln IC											
NB Off Ramp to McCarren Blvd		1 to 4	12 typ	5 6 to FOB	17 10 to FOB	4° 50'			760	260	
NB Off Ramp to Clear Acr Ln		1	12	5 to FOB	10 to FOB	3° 53'			450	310 160	
NB On Ramp from McCarren Blvd		1	12	5.5 to FOB	4 to FOB		300 ft aux lane taper	830		360	
NB On Ramp from Clear Acre Lne		1	12	4	8		300 ft aux lane taper	2300		380	
SB Off Ramp to Clear Acre Ln		1 to 3	12 typ	5 3.5 to FOB	8 6.5 + gutter	5° 10'			400	370	
SB On Ramp from Clear Acre Ln		2 to 1	10, 11 12	4 to FOB 6 to FOB	4 to FOB 7.5 to FOB		300 ft aux lane taper	1400		450	
SB On Ramp From McCarren Blvd		2 to 1	12 typ	8 to FOB typ	10 to FOB typ		na	na		280 390	
Within the McCarren Blvd / Clear Acre Ln IC		NB 3 : SB 2	NB - 12 typ SB - 12 typ	NB - 4 to FOB SB - 9 to FOB	NB - 2 to FOB SB - 10					NB - 380	

Legend: FOB = Face of Barrier; FOG = Face of Guardrail; na = not applicable

ATTACHMENT C

EXISTING SYSTEM IC RAMP GEOMETRICS

Segment/Interchange		No. of Lanes	Lane Width (inside lane to outside lane)	Inside Shoulder Width	Outside Shoulder Width	Departure Angle	Taper Rate	Accel Length	Decel Length	Stopping Sight Distance	Assumed Vd (mph)	Curve Radii	Supers From DTM	Runoff Between Reverse Curves	Comments
Spaghetti Bowl (I-580/US395)															
EB Off Ramp		2	12 typ	4 + gutter	7 to FOB	4° 17'				300	40	C1: 3888 LT, C2:820 RT,	C2: 7.0%		
EB to SB Ramp		2 to 1	12 typ	1 to FOG	8 to FOG	na	na	na	na	385	50	C1: 1432 RT, C2: 2329.39 LT	C1: 8.0%		
EB to NB Ramp		1	12	2.5	8 to FOB	5° 49	27:1	260	na	250	35	C1: 832 RT, C2: 382 LT, C3: 955 RT, C4: 1910 R	C1: 8.2%, C2: 8.0%, C3: na	165, 92	
WB Off Ramp		2	12 typ	5 to FOB	8 to FOB	1° 33'		na	na	510	50	C1: 1650 RT, C2: 3500 LT, C3: 650 RT	C1: 4.8%, C2: na, C3: 7.0%		
WB to SB Ramp		1	12	4	5.5 to FOB	na	na	na	na	200	30	C1: 370 LT, C2: 1000 RT, C3: 2400 LT	C1: 10.0%, C2: 5.0%	330, 325	
WB to NB Ramp		1	12	2 to FOB	9.5 FOB	na	na	na	na	305	40	C1: 550 RT	C1: 7.0%		
NB to EB Ramp		2 to 1	12 typ	3.5	5 to FOB	na	na	na	na	305	40	C1: 1206 RT, C2: 520 RT	C1: 8.0%, C2: 8.2%		
NB to WB Ramp		2	12 typ	3.5	5 to FOB	na	na	na (see comment)	na	155	25	C1: 1126 RT, C2: 591 LT, C3: 164 RT, C4: 656 R	C1: 4.8%, C2: 6.0%, C3: 8.5%	128, 340	128 is OK
SB Off Ramp		1	12	8 to FOB	10 to FOB	1° 55'		220	na	305	40	C1: 754 RT	C1: 4.6%		
SB to EB Ramp		1	12	3 to FOB	7.5 to FOB	na	28:1	800	na	155	25	C1: 520 LT, C2: 180 RT	C1: 7.8%, C2: 9.0%	260, 300	
SB to WB Ramp		1	12	4	7.5 to FOB	na	300 ft aux lane taper	1000	na	260	45	C1: 639.76 RT, C2: 2624.67 RT	C1: 4.7%,		

ATTACHMENT C

EXISTING CONDITIONS - MAINLINE LANES

Existing I-80 Mainline Lanes	WB Direction (Looking East)					EB Direction (Looking East)				
	Ramp	Auxiliary	Mainline	Descriptions	Issues/Remarks	Mainline	Auxiliary	Ramp	Descriptions	Issues/Remarks
S. McCarran Blvd		0	3			2	0			
EB on ramp (from McCarran)								1	Parallel entrance	
WB off ramp (to McCarran)	2			Parallel exit developed to 2 lanes						
McCarran to Keystone		0	3			2	0			Not within the study limits: Consider adding a 3rd EB mainline lane further west to McCarran.
EB off Ramp (to Keystone)								1	Tapered exit	
WB on Ramp (from Keystone)	1			Tapered entrance						
Keystone Ave		0	3			2(3)	0		3rd lane added after the exit	Not within the study limits: Consider adding a 3rd EB mainline lane further west to McCarran.
EB on ramp								2	Parallel entrance to 2 auxiliary lanes	
WB off ramp	2			Tapered exit - trap/choice						
Keystone to Sierra		1	3			3	2			
EB off Ramp								2	Tapered exit - trap/choice	
WB on Ramp	1			Tapered entrance						
Sierra/Virginia/Center St		0	3			3	1			
EB on ramp								1	Parallel entrance	
WB off ramp	2			Tapered exit - trap/choice						
Center to Wells		1	3			3	2			
EB off Ramp								1	Tapered exit	
WB on Ramp	1			Tapered entrance						
N Wells Ave		0	3			3	1			
EB on ramp								1	Parallel entrance	
WB off ramp	1			Tapered exit						
Wells to System IC		1	3			3	2			
80E-395N (& ES) exit ramp								2	Tapered exit - trap/choice	
395S-80W on ramp	1			Parallel entrance						
		1	3			3	1(0)		4th EB lane dropped after the exit	
395S-80E Loop on ramp								1	tapered entrance merge	
580N-80W Loop on ramp	2			Parallel entrance to 2 auxiliary lanes						
		0	2		Consider adding (3rd) through lane	3	0			Consider EB auxiliary lane
580N-80E on ramp								1	Parallel entrance	
System to Prater		0	2		Consider adding (3rd) through lane	3	1			

EXISTING CONDITIONS - MAINLINE LANES

EB off Ramp									1	Tapered exit	
WB on Ramp		1			Parallel entrance	Consider WB auxiliary lane					
4th/Prater/Kietzke Ln			0	2(3)	3rd lane drops at the WS & WN exit	Consider adding (3rd) through lane		3	1		
EB on ramp									1	Parallel entrance	
WN & WS exit ramp - 395/580		2			Tapered exit						
			2	2		Consider adding (3rd) through lane		3	2		
WB off ramp (to 4th/Prater/Kietzke)		1			Tapered exit						
Prater to Rock			2	2		Consider adding (3rd) through lane		3	2		
EB off Ramp									2	Tapered exit - trap/choice	
WB on Ramp		1			Parallel entrance						
Rock Blvd			1	2		Consider adding (3rd) through lane		3(2)	1(0)	Auxiliary lane to Pyramid drops west of Rock 3rd through lane drops at the EB Rock on ramp	Consider adding (3rd) through lane Consider EB auxiliary lane
EB on ramp									1	Parallel entrance	
WB off ramp		1			Tapered exit						
Rock to Pyramid			1	2		Consider adding (3rd) through lane		2	1		Consider adding (3rd) through lane
EB off Ramp									2	Tapered exit - trap/choice	
WB on Ramp		1			Parallel entrance						
Pyramid Wy			0	2		Consider adding (3rd) through lane		2	0		Consider adding (3rd) through lane
EB on ramp									1	Parallel entrance	
WB off ramp		1			Tapered exit						
Pyramid to McCarran			1	2		Consider adding (3rd) through lane		2	1		Consider adding (3rd) through lane
EB off Ramp									2	Tapered exit - trap/choice	
WB on Ramp		1			Parallel entrance						
S. McCarran Blvd			0	2		Between Sparks and McCarran, 3 one lane ramps enter and 1 single lane exit the mainline. Consider adding (3rd) through lane		2	0		Consider adding (3rd) through lane
WB loop on Ramp		1			Parallel entrance						
			0	2				2	0		
EB on ramp									1	Parallel entrance	
WB off ramp		1			Tapered exit						
Sparks Blvd			1	2				2	1		

ATTACHMENT C

EXISTING CONDITIONS - MAINLINE LANES

Existing US 395/I-580 Mainline Lanes	SB Direction (Looking North)					NB Direction (Looking North)				
	Ramp	Auxiliary	Mainline	Descriptions	Issues/Remarks	Mainline	Auxiliary	Ramp	Descriptions	Issues/Remarks
South of E Parr Blvd IC		0	2			3	0			
SB off ramp (to Clear Acre)	1			Tapered exit						
NB on ramp (from Clear Acre)								1	Parallel entrance	
Clear Acre Ln		0	2			3	0			
SB on ramp (from Clear Acre)	1			Parallel entrance						
NB on ramp (from McCarran)								1	Parallel entrance	
N. McCarran Blvd		0	2		Consider beginning (3rd) through lane	3	0			
NB off ramp (to Clear Acre)								1	Tapered exit	
SB on ramp (from McCarran)	1			Tapered entrance						
NB off ramp (to McCarran)								1	Tapered exit	
McCarran to Oddie		0	3		Consider SB auxiliary lane	3	0			Consider NB auxiliary lane
SB off ramp	1			Tapered exit						
NB on ramp								1	Tapered entrance	
Oddie Blvd		0	3			3	0			
SB Loop on ramp	1			Parallel entrance - long parallel lane drop just before the next exit						
NB off ramp									Tapered entrance	
Oddie to System IC		0	3		Consider SB auxiliary lane	3	1			
80W-395N on ramp								1	Tapered entrance	
395S-80W (& SE) off ramp	1			Tapered exit						
		0	2(3)	Lane drops just south of the SW-SE ramp exit	Consider adding (3rd) through lane	3	0			
80E-395N on ramp								1	Tapered entrance	
		0	2		Consider adding (3rd) through lane	3	0			
80W-580S on ramp	1			Tapered entrance						
		0	3			3	0			
580N-80W off ramp								2	Parallel exit-trap/choice	
80E-580S on ramp	1			Tapered entrance						
		0	4			3	1			
580N-80E off ramp								2	Parallel exit	
System IC to E 2nd/Glendale		0	4			3	3			
SB off ramp	1			Tapered exit						
E 2nd St/Glendale Ave		0	4			3	3			

ATTACHMENT C

EXISTING CONDITIONS - MAINLINE LANES

NB Loop on ramp											1	Parallel entrance - long parallel lane drop overlaps at the next exit	Consider other methods of connecting. Ramp does not end until it is within the next ext gore. Requires 3 lane changes in 1700 ft to the I-80 west exit and 4 lane changes in 2700 ft to exit to NB 395.
E 2nd to Mill			0	4				3	3		4 lane turns into an aux lane	
SB on ramp		1			Parallel entrance								
NB off ramp										2	Tapered exit - trap/choice		
			1	4				3	4				
SB off ramp		1			Tapered exit								
Mill St			0	3 (4)	4th lane dropped after the SB off, north of Mill			3	4				
NB Loop on ramp										1	Parallel entrance		
			0	3		Consider extending 4th lane		3	3				
SB on ramp		1			Tapered entrance								
NB off ramp										1	Tapered exit		
Mill to Villanova			1	3		Consider extending 4th lane		3	3				
SB off ramp		1			Tapered exit								
NB on ramp										1	Parallel entrance		
Villanova Dr			1	3		Consider extending 4th lane		3	1(2)		2nd aux lane added north of Villanova		
SB off to Airport		1			Tapered exit								
NB on from Airport										1	Tapered entrance		
E. Plumb Ln			1	3				3	1				
SB on ramp		1			Tapered entrance								
NB off ramp										2	Tapered exit - trap/choice		
Plumb to Moana			1	3				3	2				
SB off ramp		2			Tapered exit-trap/choice								
NB on ramp										2	Tapered entrance		
E. Moana Ln			0	3				3	0				
SB on ramp		1			Tapered entrance								
NB off ramp										1	Tapered exit		
Moana to Virginia			0	3		Consider SB auxiliary lane		3	0			Consider NB auxiliary lane	
SB off ramp (to Virginia/Kietzkie)		1			Tapered exit								
NB on ramp (from Virginia)										1	Parallel entrance		
S. Virginia St			0	3		Consider SB auxiliary lane		3	0			Consider NB auxiliary lane	
SB off ramp (to Meadowood)		1			Parallel exit								
NB on ramp (from Meadowood)										1	Parallel entrance		
Meadowood Mall Wy			0	3				3	0				

ATTACHMENT D

BRIDGES

Reno Spaghetti Bowl - Existing Bridge Inventory

I-80 Crossings - Structures		Bridge No.	Year Built	Condition			Min. Vert.
				SR	SD/FO	Deficiency	Clearance
Keystone Ave (SR 657)	UC	I-987	1991	98.0			16.4'
RCB - Overflow Relief Culvert	UC	B-1349	1971	70.0			--
Vine St	OC	H-1199	1973	94.7			17.3'
Washington St	OC	H-990	1970	84.7			16.8'
Ralston St	OC	H-991	1969	86.3			17.0'
Arlington Pedestrian	OC	P-1177	1970	--	--	--	17.7'
Sierra St	OC	I-992	1968	75.1			16.4'
Virginia St (SR 661)	OC	H-993	1970	70.8	FO	Deck Geometry	15.3'
Center St	OC	I-994	1969	77.2			16.2'
Evans Ave	OC	H-995	1969	95.5			16.2'
UPRR	OC	G-996	1969	--	--	--	18.5'
Valley Rd	OC	H-997	1970	79.2	FO	Underclearance	16.8'
Wells Ave	UC	I-998	1970	70.0	FO	Underclearance	16.0'
Sutro St (SR 666)	UC	H-999	1970	68.6	FO	Underclearance	16.0'
SE Ramp	OC	I-1000	1969	92.5	FO	Underclearance	16.4'
WS Ramp	OC	I-1001	1969	90.8	FO	Underclearance	16.3'
US395/I-580	OC	I-1086	1969	80.0	FO	Underclearance	21.0'
EN Ramp	OC	I-1087	1969	91.4	FO	Underclearance	17.0'
NW Ramp	OC	I-1088	1969	92.7	FO	Underclearance	16.7'
4th St/Prater Way (SR 647)	UC	I-1002	1969	81.0	FO	Underclearance	16.5'
Kietzke Ln (SR 667)	UC	H-1003	1969	83.0			15.4'
Rock Blvd (SR 668)	UC	I-1005E/W	1968	91.6	FO	Underclearance	15.3'
Victorian Plaza Circle Viaduct	UC	H-866E/W	1966	64.2			15.0'
Pyramid Way (SR 669)	UC	I-1006	1999	96.0			17.0'
E McCarran Blvd	UC	I-1007E/W	1964	87.3	FO	Underclearance	15.9'

US395/I-580 Crossings - Structures		Bridge No.	Year Built	Condition			Min. Vert.
				SR	SD/FO	Deficiency	Clearance
Clear Acre Ln	UC	I-1091N/S	2006	99.0			16.1'
N McCarran Blvd	OC	I-1305	2006	90.2	FO	Underclearance	17.3'
Wedekind Rd	UC	H-1090	1967	76.7	FO	Underclearance	16.5'
Oddie Blvd	UC	I-1089	1967	86.6			14.7'
E 9th St & WS Ramp	UC	I-1172	1969	72.6	FO	Underclearance	14.6'
I-80	UC	I-1086	<=======	*See I-80 Crossings List*		=======	>
EN Ramp	UC	I-1149	1969	82.8			16.4'
E 4th St & UPRR	UC	G-1233	1971	88.6	FO	Underclearance	16.0'
Kietzke Ln & Truckee River	UC	H-1234	1971	78.2			18.1'
E 2nd St/Glendale Ave	UC	I-1253	1977	93.5			16.8'
Mill St	UC	I-1252	1977	92.5			16.0'
Vassar St	UC	H-1251	1977	89.1	FO	Underclearance	16.0'
Plumb Ln	UC	I-1250	1980	61.3			16.6'

Reno Spaghetti Bowl - Existing Bridge Inventory

US395/I-580 Crossings - Structures (cont.)		Bridge No.	Year Built	Condition			Min. Vert.
				SR	SD/FO	Deficiency	Clearance
RTO Flyover	OC	I-1774	1988	95.7	FO	Underclearance	16.8'
Moana Ln	UC	I-1248	1980	90.5	FO	Underclearance	16.2'
Peckham Ln	UC	H-1247	1980	83.0			17.5'
S Virginia St	UC	I-1799	1986	74.4	FO	Deck Geometry	16.3'
S McCarran Blvd	UC	H-1798	1986	74.4	FO	Deck Geometry	16.3'
Meadowood Mall Way	UC	I-2936	2012	96.4			16.7'

Adjacent Crossings - Structures	Bridge No.	Year Built	Condition			Min. Vert.
			SR	SD/FO	Deficiency	Clearance
I-80W to 395N/I-580S over Prater	I-1002R	2004	94.6			16.4'
Kietzke WB On-Ramp over Prater	H-2654	2004	93.7	FO	Deck Geometry	16.6'
I-80W to Prater over Kietzke	I-1010	1969	95.7			15.8'
I-80E to Nugget over Rock	H-1840	1987	95.9			16.6'
SW/SE over E 9th	I-1171	1969	92.1	FO	Deck Geometry	15.3'
WN over E 9th	I-1173	1969	86.2			14.8'
NE over E 4th/UPRR	G-1233R	1971	80.5	FO	Underclearance	16.0'
ES over E 4th/UPRR	G-1233L	1971	92.0	FO	Underclearance	16.0'
I-580S to RTO over Plumb Ramp	I-1773	1988	90.6			16.5'
RTO to I-580N over Plumb Ramp	I-1772	1988	96.3			16.7'
McCarran to US395N over Clearacre Ramp	I-1305R	1999	99.5			17.1'
I-580S to Kietzke over Virginia	I-1799R	1997	98.7			16.3'

Abbreviations

FO = Functionally Obsolete

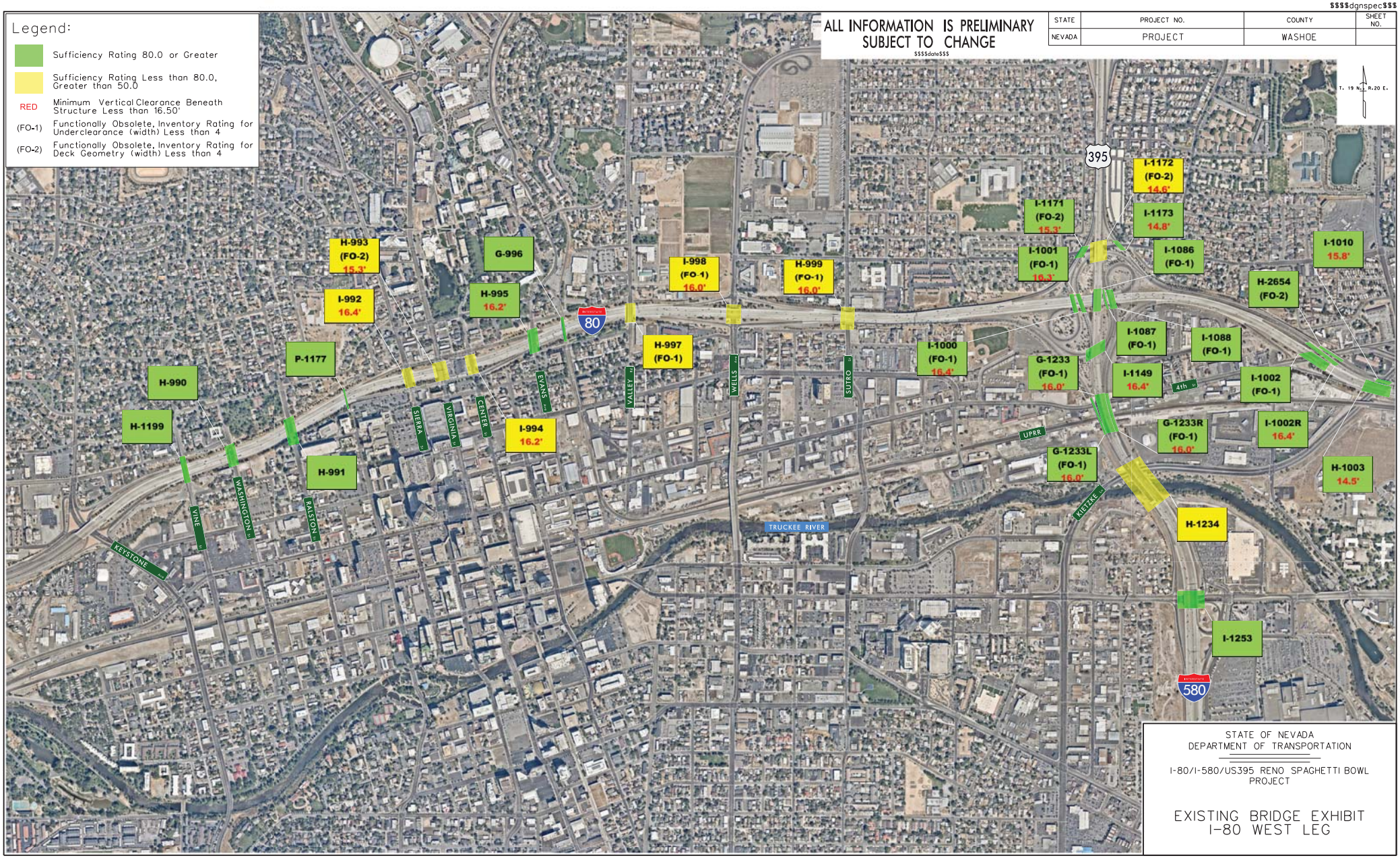
OC = Overcrossing

SD = Structurally Deficient

SR = Sufficiency Rating

UC = Undercrossing

$$$$dgnspec$$$



STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA	PROJECT	WASHOE	

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

I-80/I-580/US395 RENO SPAGHETTI BOWL PROJECT

EXISTING BRIDGE EXHIBIT I-80 WEST LEG

$$$$scale$$$ PLOT SCALE $$$$username$$$

$$$$dgnspec$$$

ALL INFORMATION IS PRELIMINARY
SUBJECT TO CHANGE
$$$$date$$$

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA	PROJECT	WASHOE	

T. 19 N., R.20 E.

Legend:

- Sufficiency Rating 80.0 or Greater
- Sufficiency Rating Less than 80.0, Greater than 50.0
- RED — Minimum Vertical Clearance Beneath Structure Less than 16.50'
- (FO-1) — Functionally Obsolete, Inventory Rating for Underclearance (width) Less than 4
- (FO-2) — Functionally Obsolete, Inventory Rating for Deck Geometry (width) Less than 4

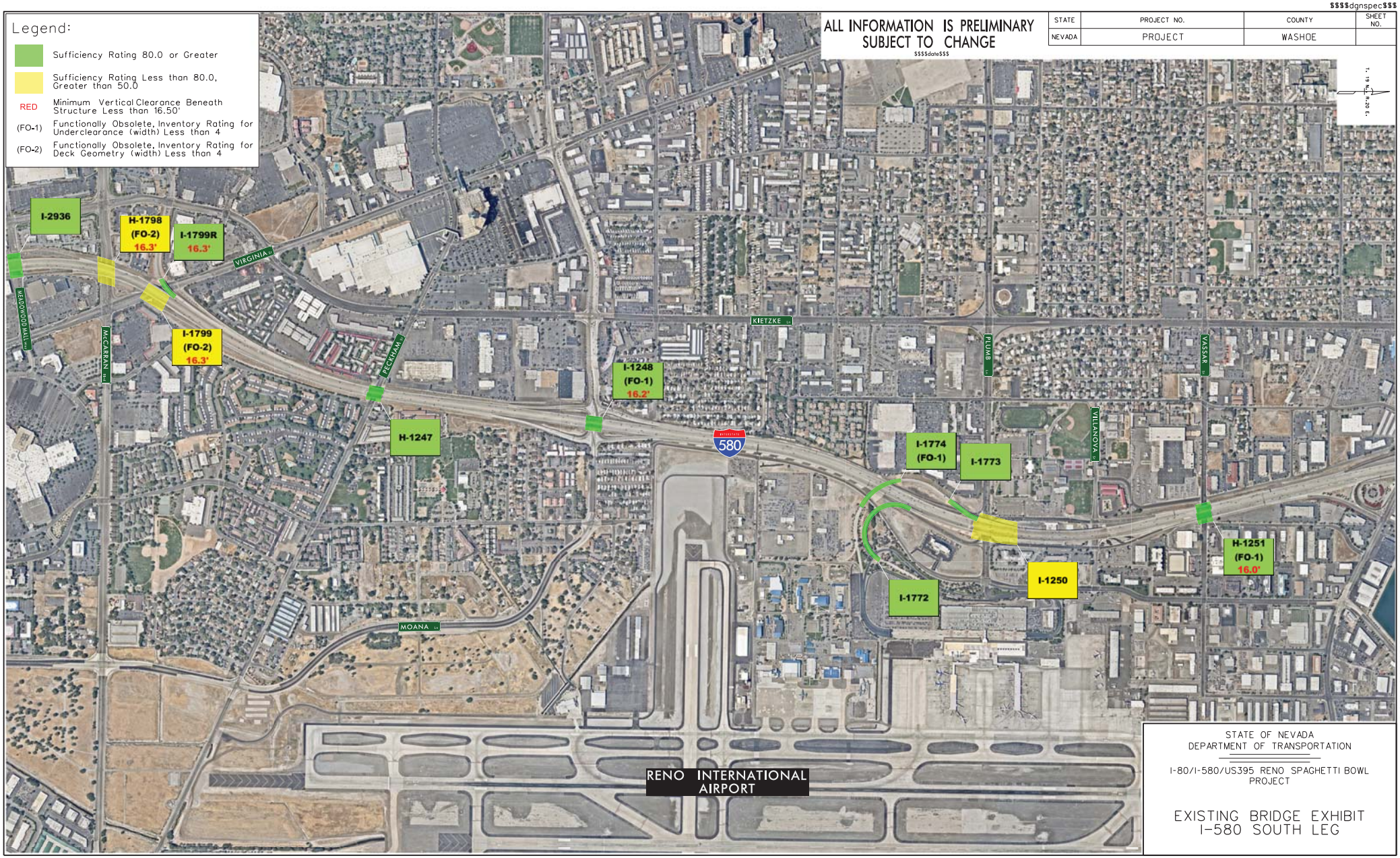
STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

I-80/I-580/US395 RENO SPAGHETTI BOWL PROJECT

EXISTING BRIDGE EXHIBIT
I-80 EAST LEG

$$$$scale$$$ PLOT SCALE $$$$username$$$

$$$$dgnspec$$$



STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA	PROJECT	WASHOE	

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

I-80/I-580/US395 RENO SPAGHETTI BOWL PROJECT

EXISTING BRIDGE EXHIBIT I-580 SOUTH LEG

$$$$scale$$$ PLOT SCALE $$$$username$$$

Existing_Bridge_Exhibit_04.dgn

ALL INFORMATION IS PRELIMINARY
SUBJECT TO CHANGE
01-MAR-2017

STATE	PROJECT NO.	COUNTY	SHEET NO.
NEVADA	PROJECT	WASHOE	

T. 19 N., R. 20 E.

ODDIE BLVD

I-1089
14.7'

H-1090
(FO-1)

I-1305
(FO-1)

I-1305R

McCARRAN BLVD

I-1091NS
16.1'

CLEAR ACRE LN

395

PARR BLVD

Legend:

- Sufficiency Rating 80.0 or Greater
- Sufficiency Rating Less than 80.0, Greater than 50.0
- RED — Minimum Vertical Clearance Beneath Structure Less than 16.50'
- (FO-1) — Functionally Obsolete, Inventory Rating for Underclearance (width) Less than 4
- (FO-2) — Functionally Obsolete, Inventory Rating for Deck Geometry (width) Less than 4

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION

I-80/I-580/US395 RENO SPAGHETTI BOWL PROJECT

EXISTING BRIDGE EXHIBIT
US395 NORTH LEG

1000.000000:1.000000 PLOT SCALE

pwsvc

ATTACHMENT E

PRELIMINARY TRAFFIC EVALUATION

This attachment summarizes the existing and future traffic volumes in the study corridor. The 2040 forecast traffic volumes are based on the 2035 Regional Transportation Commission of Washoe County (RTC) Regional Transportation Plan Travel Demand Forecast Model. Existing and future average daily traffic volumes along the study corridor are shown in Table E-1. This attachment also analyzes existing and future travel delay in the study corridor caused by the physical bottlenecks described in Chapter 1 of the Spaghetti Bowl Draft EIS. The assessment of existing and future travel delay used a VISSIM traffic model developed for the Reno-Sparks Freeway Traffic Study (expected 2017). The analysis relies on this traffic forecast model to estimate delay on the freeway system under the current (2016) conditions and future (2040) conditions if no improvements are made to the freeway system (no-build condition).

The traffic model evaluated:

- System metrics such as vehicle miles traveled (VMT), vehicle hours traveled (VHT), average speed, and average delay.
- Traffic movements that travel from one end of the study network to the other end through the Spaghetti Bowl. This evaluation calculated the average speed, travel time, and delay for these movements.

Table E-1. Existing and Future Traffic Comparison in the Study Area

Roadway Segment	Existing Traffic Volume (2016) (vehicles per day)	2040 Traffic Volume (vehicles per day)	% Increase (2016 to 2040)
I-80 Corridor			
McCarran Boulevard to Pyramid Way	90,000	113,000	25.6
Pyramid Way to Rock Boulevard	103,000	116,000	12.6
Rock Boulevard to 4th Street	111,000	126,000	13.5
4th Street to Spaghetti Bowl	113,000	129,000	14.2
Spaghetti Bowl to Wells Avenue	120,000	141,000	17.5
Wells Avenue to Center Street/Sierra Street	115,000	134,000	16.5
Center Street/Sierra Street to Keystone Avenue	103,000	121,000	17.5
I-580/US 395 Corridor			
Parr Boulevard to Clear Acre Lane	74,000	150,000	102.7*
Clear Acre Lane to Oddie Boulevard	94,000	142,000	51.1*
Oddie Boulevard to Spaghetti Bowl	105,000	159,000	51.4*
Spaghetti Bowl to 2nd Street	150,000	183,000	22.0
2nd Street to Mill Street	156,000	186,000	19.2
Mill Street to Villanova Drive/Plumb Lane	146,000	171,000	17.1
Villanova Drive/Plumb Lane to Moana Lane	145,000	167,000	15.2
Moana Lane to Virginia Street	124,000	141,000	13.7
Virginia Street to Meadowood Mall Way	81,000	93,000	14.8

*Increase north of the Spaghetti Bowl is due in part to the addition of the Pyramid Highway interchange at US-395, north of the Spaghetti Bowl

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Existing Travel Delay

Segments of the freeway system that experience congestion during the existing morning (7 AM to 9 AM) and evening (4 PM to 6 PM) peak periods:

- AM Peak (see Figure E-1)
  - Southbound US 395 at Clear Acre Lane on-ramp: traffic demand at this location (4,330 vph) is greater than the capacity for two lanes. At this location, average speeds are reduced to 50 miles per hour (mph) during the morning peak period.
  - Southbound US 395 at I-80 interchange: traffic demand at this location (4,350 vph) is greater than the capacity of the two through lanes. At this location, average speeds are reduced to 30 mph during the morning peak period.
  - Eastbound I-80 ramps to southbound I-580: traffic demand at this location (1,980 vph) is greater than the capacity for the one lane eastbound-to-southbound ramp. The average speeds on the ramp are reduced to 8 mph during the morning peak period.
  - Westbound I-80 ramps to Southbound I-580: traffic demand at this location (1,950 vph) is greater than the capacity for the one lane westbound-to-southbound ramp.
- PM Peak (See Figure E-2)
  - Northbound I-580 at Virginia Street on-ramp: traffic demand at this location (6,350 vph) is greater than the capacity for three lanes. At this location, average speeds are reduced to 55 mph during the evening peak period.
  - Northbound I-580 to eastbound I-80 ramp: traffic demand at this location (2,470 vph) is greater than the capacity for the one lane northbound-to-eastbound ramp. The average speeds on the ramp are reduced to 6 mph during the evening peak period.
  - Northbound US 395, between I-80 and Oddie Boulevard: short weaving distance between Spaghetti Bowl and Oddie Boulevard leads to reductions in speed. At this location, average speeds are reduced to 45 mph during the evening peak period.
  - Northbound US 395, between Oddie Boulevard and McCarran Boulevard: traffic demand at this location (6,160 vph) is greater than the capacity for three lanes. At this location, average speeds are reduced to 40 mph during the evening peak period.
  - I-80 eastbound and westbound ramps to northbound US 395: poor operations on US 395 between the Spaghetti Bowl and Oddie Boulevard lead to reduced speeds (45 mph) and congestion on both the I-80 eastbound and westbound ramps to northbound US 395.
  - Eastbound I-80, between Spaghetti Bowl and Pyramid Way: poor lane balance and weaving conditions between closely spaced interchanges lead to reduced speeds (30 to 55 mph).

Tables E-2 and E-3 show the travel times and peak hour delays under existing conditions. Figure E-3 shows the existing AM and PM peak hour demands, demand-to-capacity ratios, and associated speeds.

Figure E-1. Existing Conditions Traffic Observations: Morning Peak

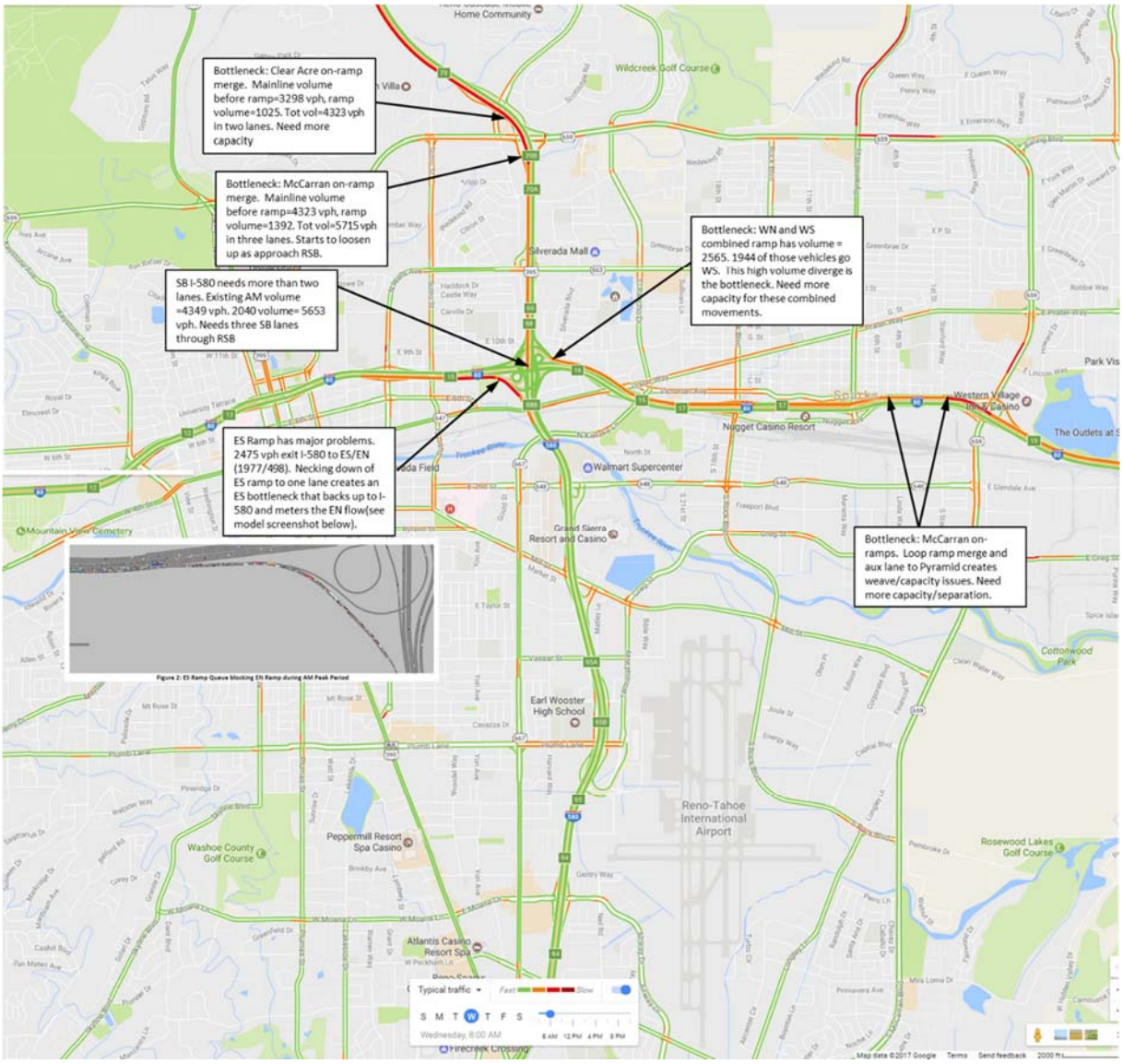

Figure E-2. Existing Conditions Traffic Observations: Evening Peak

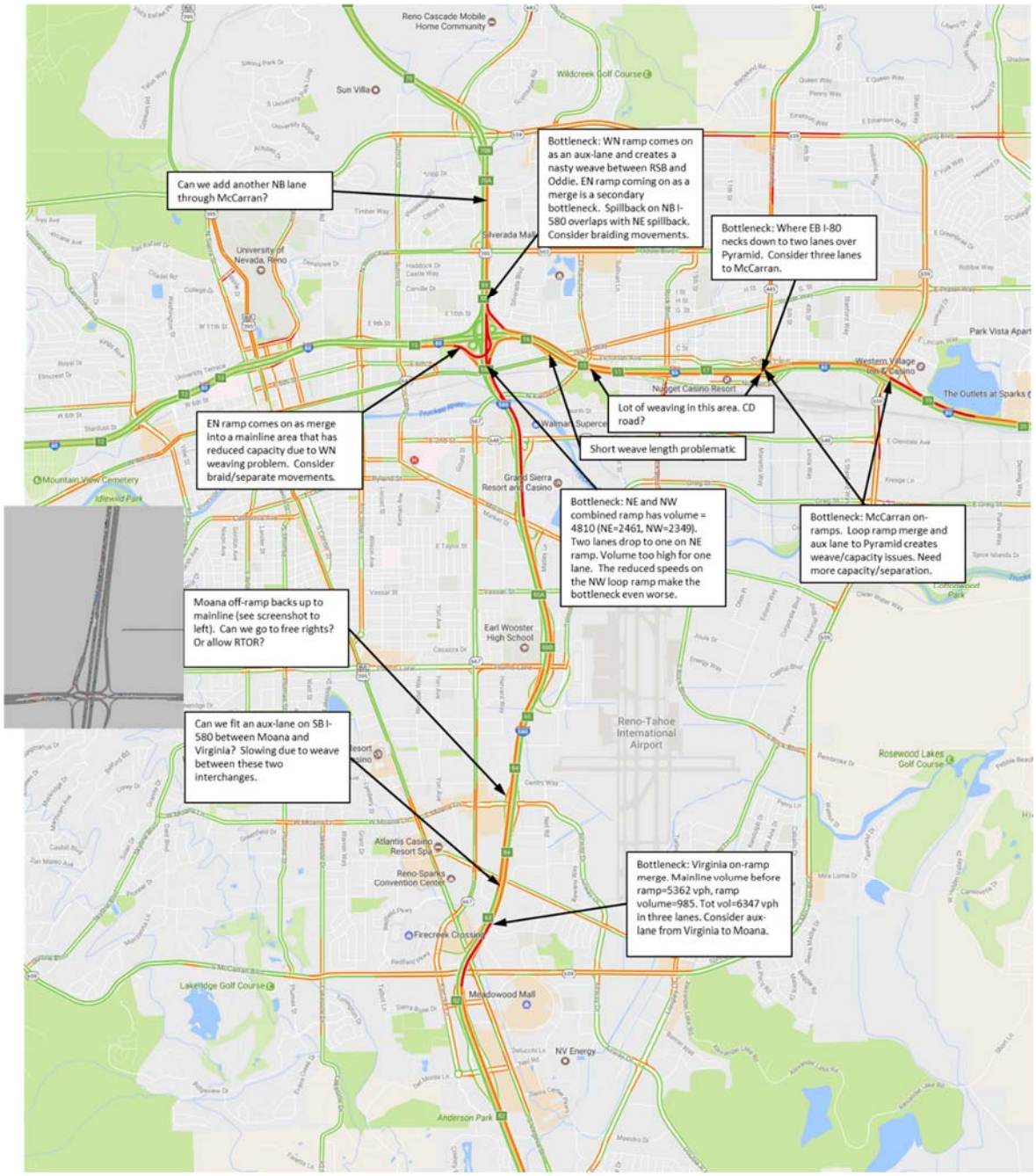

Table E-2. Existing (2016) Peak Hour Travel Times

Movement	Distance (miles)	Freeflow travel time (mins)	Travel Time (minutes)							
			7:00 - 7:30	7:30-8:00	8:00-8:30	8:30-9:00	4:00-4:30	4:30-5:00	5:00-5:30	5:30-6:00
EB to EB (From west of Keystone Blvd to the east of Pyramid Way)	5.4	4.58	4.58	4.68	5.19	5.07	5.04	5.97	7.78	9.77
WB-WB (From east of Pyramid Way to the west of Keystone Blvd)	5.4	4.57	4.63	4.70	4.62	4.57	4.78	4.89	4.83	4.82
NB-NB (From south Moana Ln to the north of Clear Acre Ln)	6.0	5.11	5.12	5.24	5.21	5.12	5.67	5.94	6.82	9.53
SB-SB (From north of Clear Acre Ln to the south of Moana Ln)	6.0	5.11	5.62	5.96	6.29	5.59	5.67	5.73	5.67	5.59
EB-NB (From west of Keystone Blvd to the north of Clear Acre Ln)	5.5	4.72	5.10	5.79	9.01	8.96	5.65	6.30	6.43	8.40
EB-SB (From west of Keystone Blvd to the south of Moana Ln)	6.5	5.59	6.49	7.93	12.18	11.99	6.49	7.13	7.22	9.11
WB-NB (From east of Pyramid Way to the north of Clear Acre Ln)	4.6	3.92	4.39	4.55	4.36	4.30	4.62	4.86	4.74	4.65
WB-SB (From east of Pyramid Way to the south of Moana Ln)	6.2	5.30	6.28	6.66	6.97	6.43	6.16	6.40	6.33	6.26
NB-WB (From south Moana Ln to the west of Keystone Blvd)	7.0	5.97	6.09	6.22	6.21	6.08	6.57	6.74	7.71	10.47
NB-EB (From south Moana Ln to the east of Pyramid Way)	5.9	5.10	5.24	5.38	5.38	5.24	6.70	9.80	14.68	20.05
SB-WB (From north of Clear Acre Ln to the west of Keystone Blvd)	5.2	4.46	4.94	5.20	5.04	4.60	5.01	5.11	5.02	4.92
SB-EB (From north of Clear Acre Ln to the east of Pyramid Way)	4.9	4.24	5.00	5.26	5.07	4.62	5.26	6.19	7.93	9.47

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Table E-3. Existing (2016) Peak Hour Travel Delay Times

Movement	Travel Delay Times (minutes)							
	7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00	4:00-4:30	4:30-5:00	5:00-5:30	5:30-6:00
EB to EB (From west of Keystone Blvd to the east of Pyramid Way)	0.01	0.10	0.61	0.49	0.46	1.39	3.20	5.19
WB-WB (From east of Pyramid Way to the west of Keystone Blvd)	0.06	0.13	0.05	0.00	0.21	0.32	0.26	0.25
NB-NB (From south Moana Ln to the north of Clear Acre Ln)	0.01	0.13	0.10	0.01	0.56	0.83	1.71	4.42
SB-SB (From north of Clear Acre Ln to the south of Moana Ln)	0.52	0.86	1.19	0.49	0.56	0.63	0.56	0.48
EB-NB (From west of Keystone Blvd to the north of Clear Acre Ln)	0.38	1.07	4.29	4.24	0.93	1.59	1.72	3.69
EB-SB (From west of Keystone Blvd to the south of Moana Ln)	0.89	2.34	6.59	6.40	0.90	1.54	1.62	3.51
WB-NB (From east of Pyramid Way to the north of Clear Acre Ln)	0.47	0.63	0.44	0.38	0.70	0.94	0.82	0.73
WB-SB (From east of Pyramid Way to the south of Moana Ln)	0.98	1.36	1.67	1.13	0.86	1.10	1.03	0.96
NB-WB (From south Moana Ln to the west of Keystone Blvd)	0.12	0.26	0.24	0.11	0.61	0.78	1.75	4.50
NB-EB (From south Moana Ln to the east of Pyramid Way)	0.14	0.29	0.28	0.15	1.60	4.70	9.58	14.95
SB-WB (From north of Clear Acre Ln to the west of Keystone Blvd)	0.48	0.74	0.58	0.14	0.55	0.65	0.56	0.46
SB-EB (From north of Clear Acre Ln to the east of Pyramid Way)	0.76	1.02	0.82	0.38	1.02	1.95	3.69	5.23

Future (2040) Travel Delay: No-Build Alternative

- Peak period traffic demand is forecasted to grow by 16 percent between 2016 and 2040.
- Average delay for drivers in the study area will increase by 49 percent between 2016 and 2040 if no improvements are made to the Spaghetti Bowl interchange.
- Total travel time for all vehicles in the study area (vehicle hours traveled) will increase by 35 percent between 2016 and 2040 if no improvements are made to the Spaghetti Bowl interchange.
- Peak period congestion: movements/segments identified as areas of congestion in existing conditions will continue to worsen in the 2040 no-build condition.

Figure E-4 shows the 2040 no-build AM and PM peak hour demands, demand-to-capacity ratios, and associated speeds. Tables E-4 and E-5 show the travel times and peak hour delays in 2040 under the no-build conditions.

Table E-4. Future (2040) Travel Times, No Build Conditions

Movement	Distance (miles)	Freeflow travel time (mins)	Travel Time (minutes)							
			7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00	4:00-4:30	4:30-5:00	5:00-5:30	5:30-6:00
EB to EB (From west of Keystone Blvd to the east of Pyramid Way)	5.4	4.58	4.71	4.83	5.48	5.74	5.00	5.18	5.57	6.70
WB-WB (From east of Pyramid Way to the west of Keystone Blvd)	5.4	4.57	4.96	5.22	5.33	5.16	4.95	5.15	6.15	8.53
NB-NB (From south Moana Ln to the north of Clear Acre Ln)	6.0	5.11	5.35	5.57	5.51	5.45	6.55	9.92	14.37	19.08
SB-SB (From north of Clear Acre Ln to the south of Moana Ln)	6.0	5.11	5.86	6.26	6.19	5.85	5.98	6.18	6.28	6.23
EB-NB (From west of Keystone Blvd to the north of Clear Acre Ln)	5.5	4.72	5.18	5.68	8.65	8.85	6.33	8.65	10.25	12.70
EB-SB (From west of Keystone Blvd to the south of Moana Ln)	6.5	5.59	6.28	7.59	10.91	11.29	6.57	7.15	8.07	9.98
WB-NB (From east of Pyramid Way to the north of Clear Acre Ln)	4.6	3.92	4.61	5.51	5.93	5.50	5.43	7.83	11.19	13.52
WB-SB (From east of Pyramid Way to the south of Moana Ln)	6.2	5.30	6.42	7.81	8.22	7.23	6.34	7.02	9.28	11.19
NB-WB (From south Moana Ln to the west of Keystone Blvd)	7.0	5.97	6.59	6.85	6.81	6.70	6.93	8.88	12.82	17.73
NB-EB (From south Moana Ln to the east of Pyramid Way)	5.9	5.10	5.39	5.56	5.55	5.46	6.17	7.75	12.08	16.38
SB-WB (From north of Clear Acre Ln to the west of Keystone Blvd)	5.2	4.46	5.26	5.40	5.23	5.04	5.42	5.57	5.60	6.63
SB-EB (From north of Clear Acre Ln to the east of Pyramid Way)	4.9	4.24	5.11	5.32	5.34	5.06	5.34	5.55	5.58	5.55

Table E-5. Future (2040) Travel Delay Times, No Build Conditions

Movement	Travel Delay Times (minutes)							
	7:00-7:30	7:30-8:00	8:00-8:30	8:30-9:00	4:00-4:30	4:30-5:00	5:00-5:30	5:30-6:00
EB to EB (From west of Keystone Blvd to the east of Pyramid Way)	0.13	0.25	0.90	1.16	0.42	0.60	0.99	2.12
WB-WB (From east of Pyramid Way to the west of Keystone Blvd)	0.40	0.65	0.76	0.59	0.38	0.58	1.58	3.96
NB-NB (From south Moana Ln to the north of Clear Acre Ln)	0.24	0.46	0.40	0.34	1.44	4.81	9.26	13.96
SB-SB (From north of Clear Acre Ln to the south of Moana Ln)	0.76	1.16	1.08	0.75	0.87	1.08	1.18	1.12
EB-NB (From west of Keystone Blvd to the north of Clear Acre Ln)	0.46	0.96	3.93	4.13	1.62	3.94	5.54	7.99
EB-SB (From west of Keystone Blvd to the south of Moana Ln)	0.69	2.00	5.32	5.70	0.97	1.56	2.48	4.39
WB-NB (From east of Pyramid Way to the north of Clear Acre Ln)	0.69	1.59	2.01	1.58	1.51	3.91	7.27	9.60
WB-SB (From east of Pyramid Way to the south of Moana Ln)	1.12	2.51	2.92	1.93	1.04	1.72	3.98	5.89
NB-WB (From south Moana Ln to the west of Keystone Blvd)	0.63	0.88	0.84	0.73	0.97	2.91	6.85	11.76
NB-EB (From south Moana Ln to the east of Pyramid Way)	0.29	0.46	0.45	0.36	1.07	2.66	6.99	11.28
SB-WB (From north of Clear Acre Ln to the west of Keystone Blvd)	0.80	0.94	0.77	0.58	0.96	1.11	1.14	2.18
SB-EB (From north of Clear Acre Ln to the east of Pyramid Way)	0.87	1.08	1.10	0.82	1.10	1.31	1.34	1.31

The increase in delay for end-to-end travel times in the study area that travel through the Spaghetti Bowl (percent increase in travel time between 2016 and 2040) are summarized in Table E-6. The most notable increases are:

- EB to EB (from west of Keystone Blvd to the east of Pyramid Way): 90 percent
- WB-WB (from east of Pyramid Way to the west of Keystone Blvd): 1,138 percent
- NB-NB (From south Moana Ln to the north of Clear Acre Ln): 254 percent
- SB-SB (From north of Clear Acre Ln to the south of Moana Ln): 87 percent
- EB-NB (From west of Keystone Blvd to the north of Clear Acre Ln): 117 percent
- WB-NB (From east of Pyramid Way to the north of Clear Acre Ln): 921 percent
- WB-SB (From east of Pyramid Way to the south of Moana Ln): 435 percent
- NB-WB (From south Moana Ln to the west of Keystone Blvd): 239 percent
- SB-WB (From north of Clear Acre Ln to the west of Keystone Blvd): 236 percent

Table E-6. Maximum Travel Delay Times

Movement	2016 Max Delay AM (mins)	2016 Max Delay PM (mins)	2040 Max Delay AM (mins)	2040 Max Delay PM (mins)	2040 Maximum Increase in Travel Delay between 2016 and 2040
EB to EB (From west of Keystone Blvd to the east of Pyramid Way)	0.61	5.19	1.16	2.12	90%
WB-WB (From east of Pyramid Way to the west of Keystone Blvd)	0.13	0.32	0.76	3.96	1,138%
NB-NB (From south Moana Ln to the north of Clear Acre Ln)	0.13	4.42	0.46	13.96	254%
SB-SB (From north of Clear Acre Ln to the south of Moana Ln)	1.19	0.63	1.16	1.18	87%
EB-NB (From west of Keystone Blvd to the north of Clear Acre Ln)	4.29	3.69	4.13	7.99	117%
EB-SB (From west of Keystone Blvd to the south of Moana Ln)	6.59	3.51	5.70	4.39	25%
WB-NB (From east of Pyramid Way to the north of Clear Acre Ln)	0.63	0.94	2.01	9.60	921%
WB-SB (From east of Pyramid Way to the south of Moana Ln)	1.67	1.10	2.92	5.89	435%
NB-WB (From south Moana Ln to the west of Keystone Blvd)	0.26	4.50	0.88	11.76	239%
NB-EB (From south Moana Ln to the east of Pyramid Way)	0.29	14.95	0.46	11.28	59%
SB-WB (From north of Clear Acre Ln to the west of Keystone Blvd)	0.74	0.65	0.94	2.18	236%
SB-EB (From north of Clear Acre Ln to the east of Pyramid Way)	1.02	5.23	1.10	1.34	8%

1

2

FIGURE E-3. TRAVEL DEMAND MODEL OUTPUT, 2016 TRAFFIC

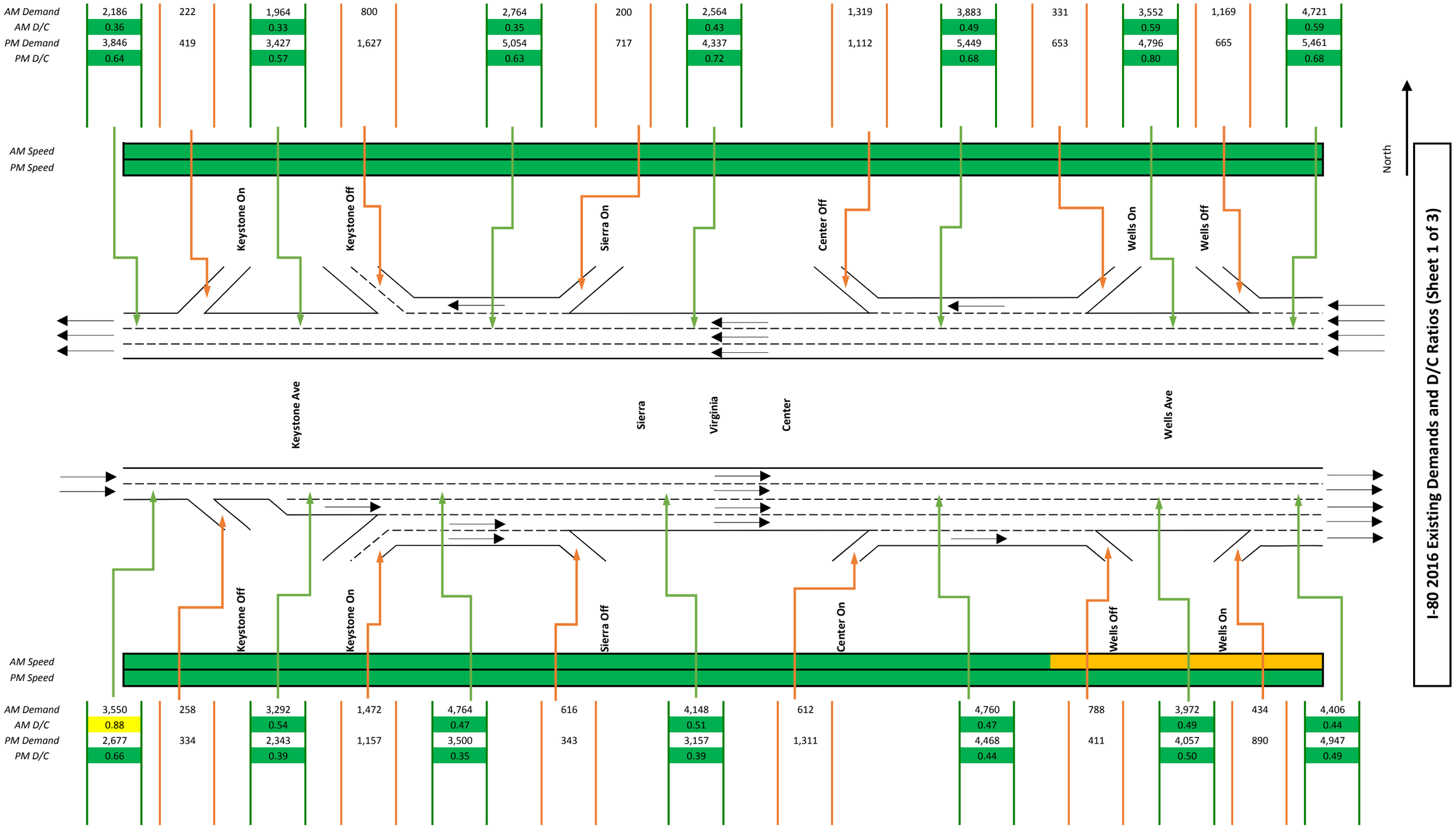


FIGURE E-3. TRAVEL DEMAND MODEL OUTPUT, 2016 TRAFFIC

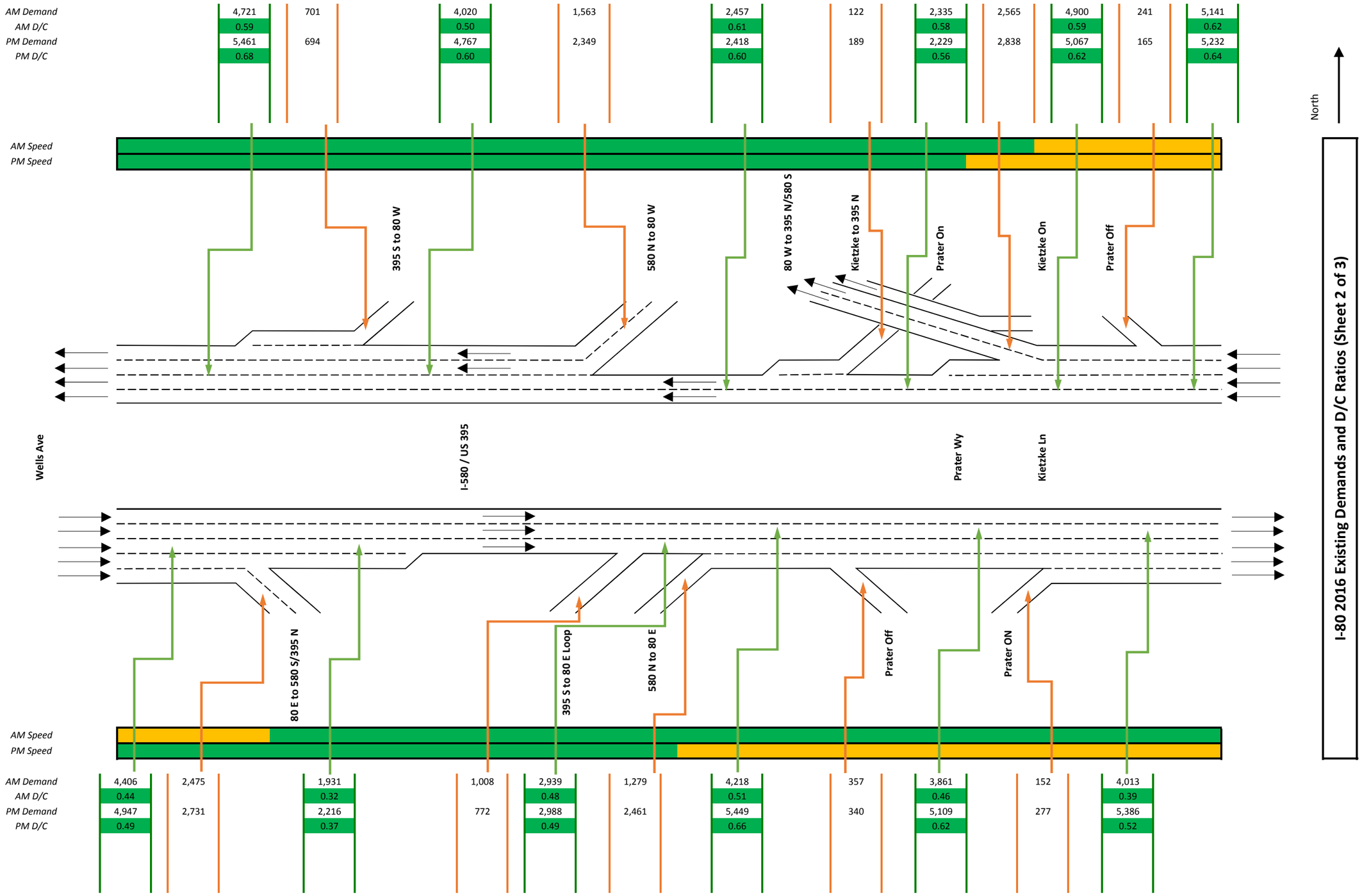


FIGURE E-3. TRAVEL DEMAND MODEL OUTPUT, 2016 TRAFFIC

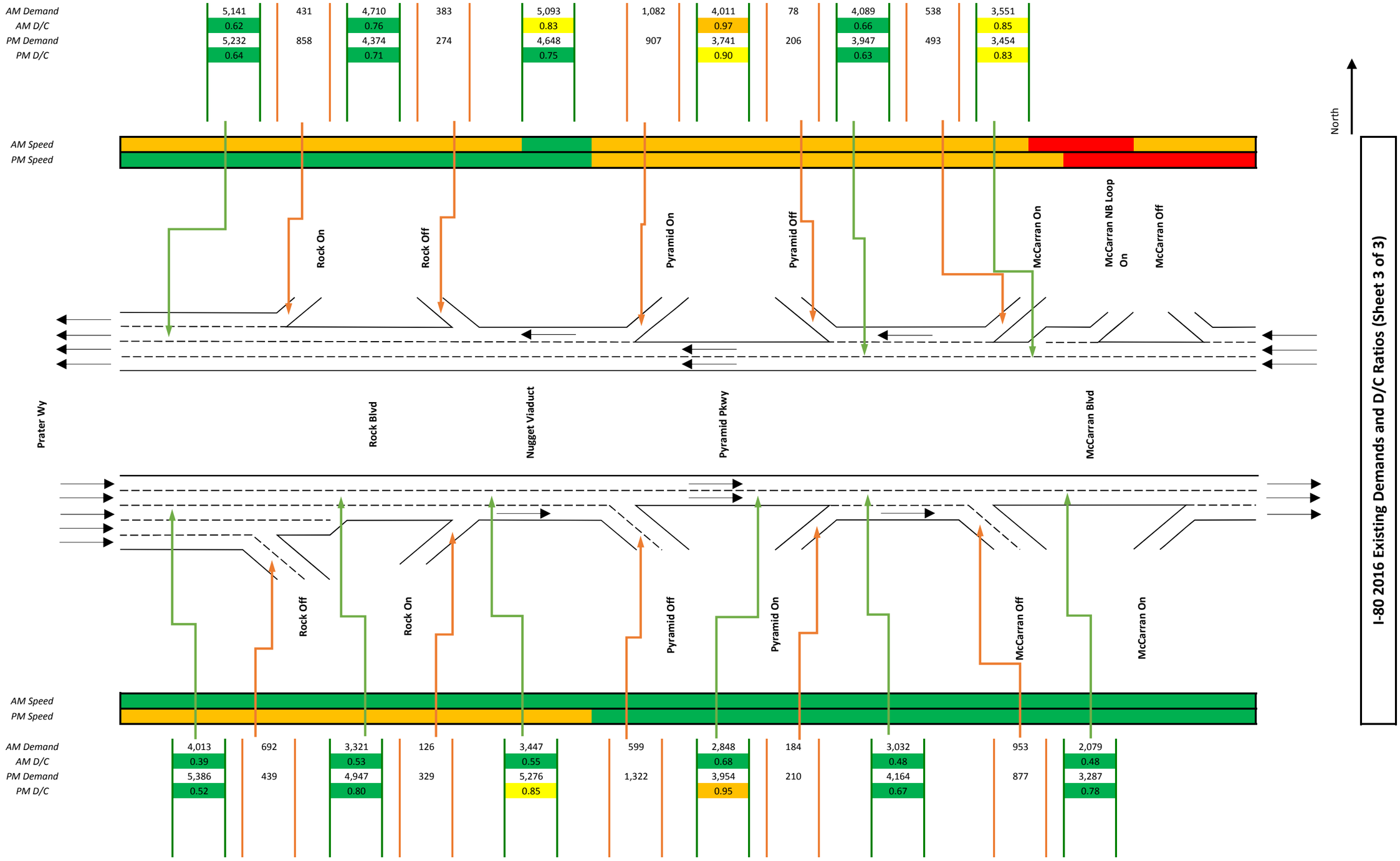
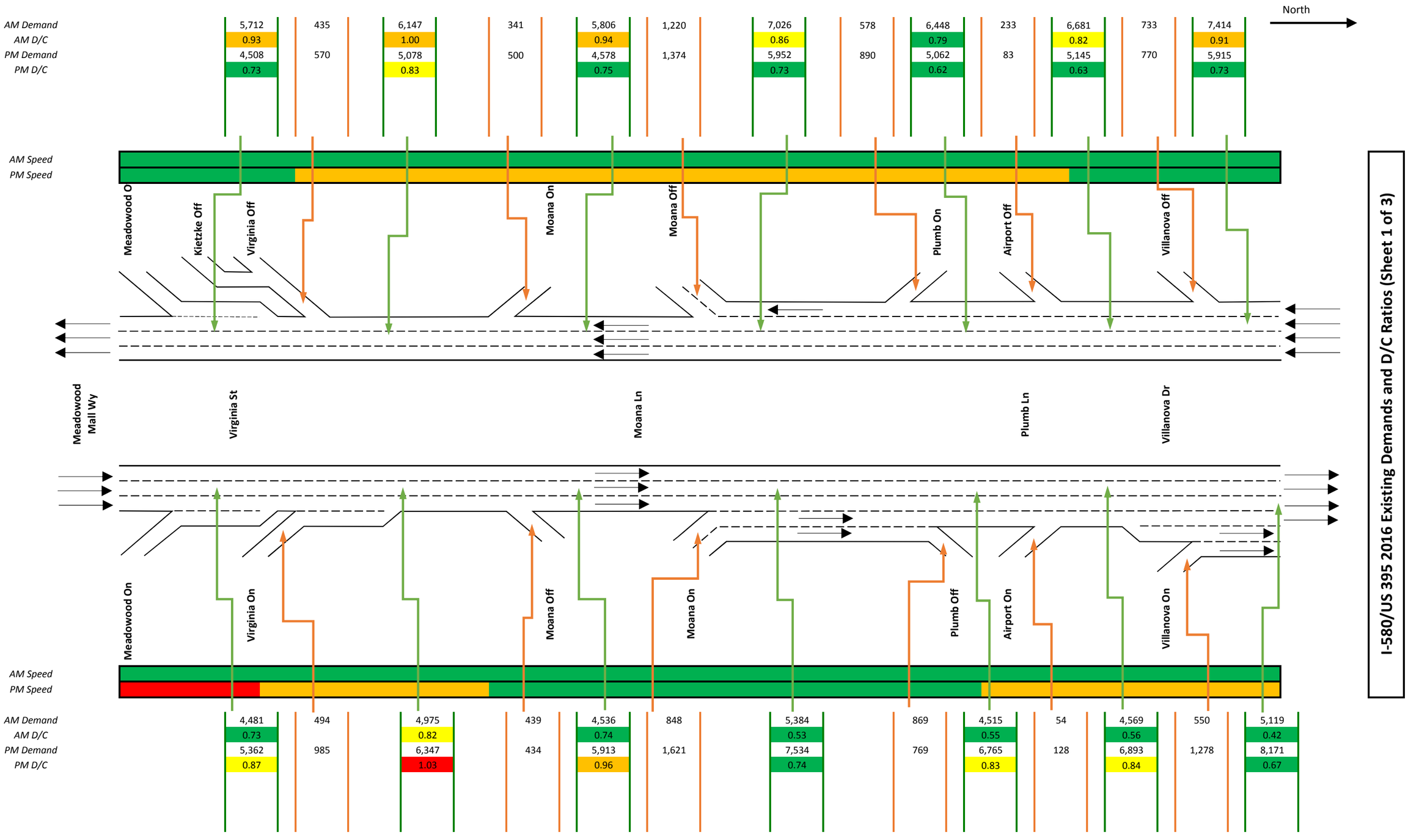
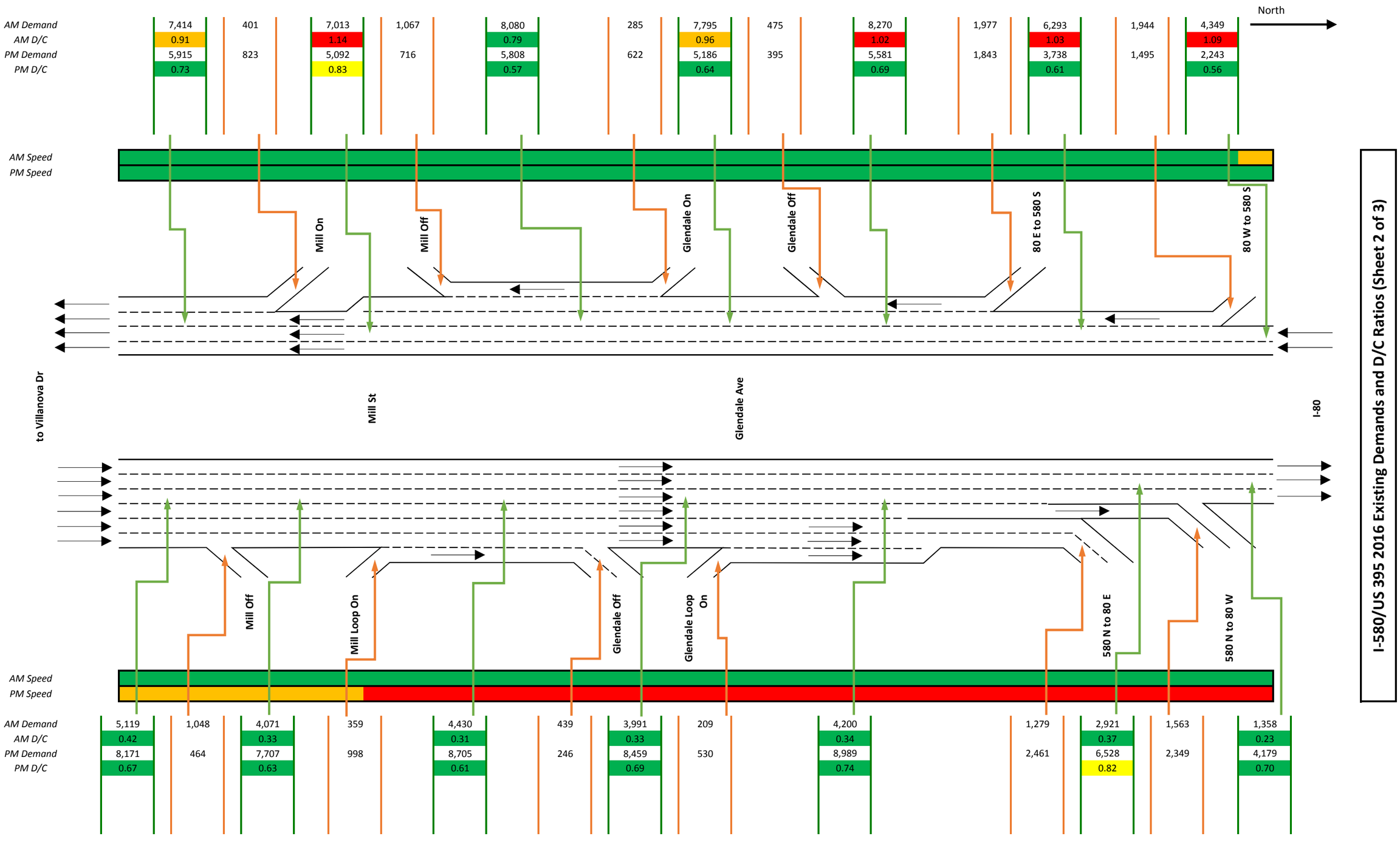


FIGURE E-3. TRAVEL DEMAND MODEL OUTPUT, 2016 TRAFFIC



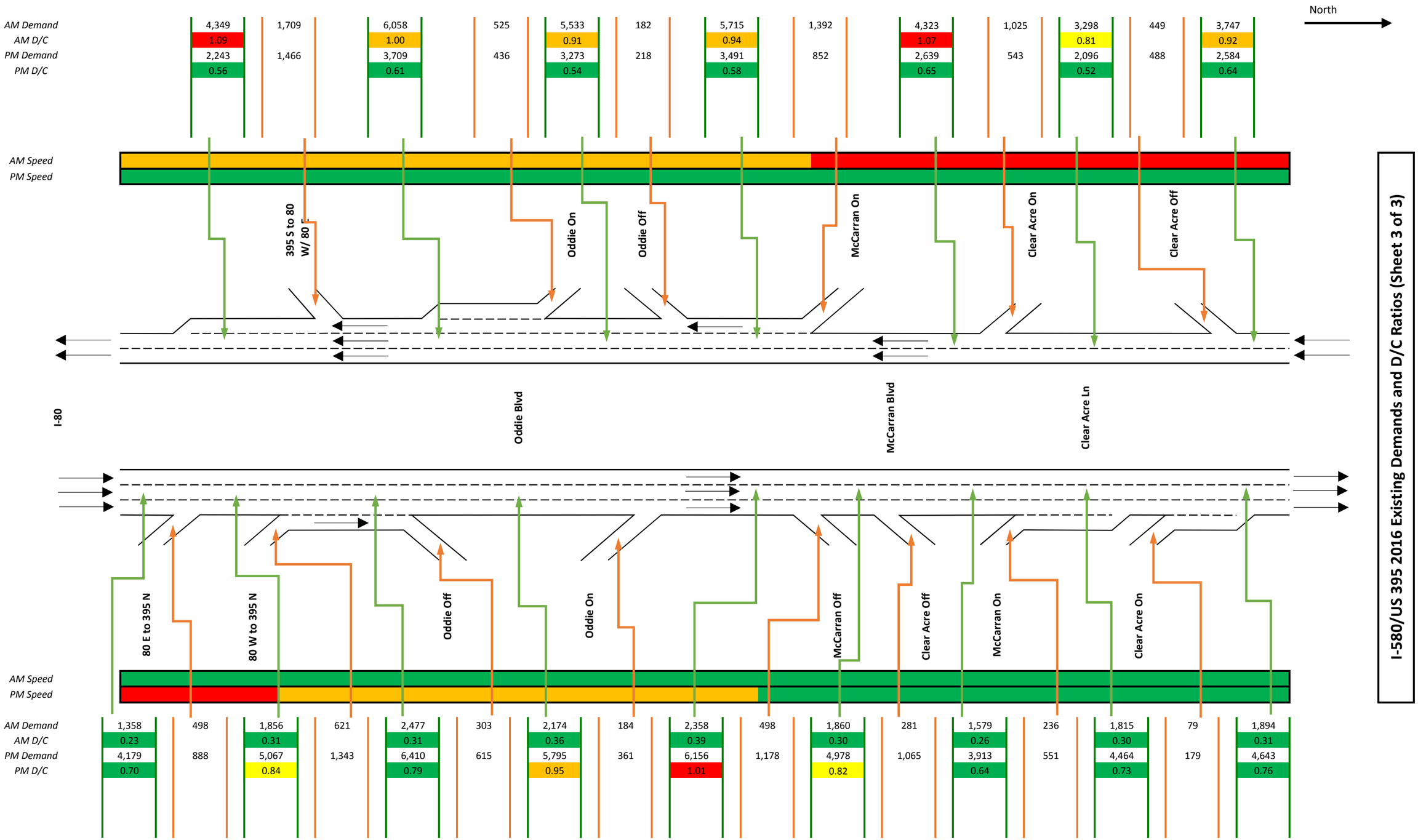
I-580/US 395 2016 Existing Demands and D/C Ratios (Sheet 1 of 3)

FIGURE E-3. TRAVEL DEMAND MODEL OUTPUT, 2016 TRAFFIC



I-580/US 395 2016 Existing Demands and D/C Ratios (Sheet 2 of 3)

FIGURE E-3. TRAVEL DEMAND MODEL OUTPUT, 2016 TRAFFIC



US 395-I80 to Clear Acre
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FIGURE E-4. TRAVEL DEMAND MODEL OUTPUT, 2040 TRAFFIC

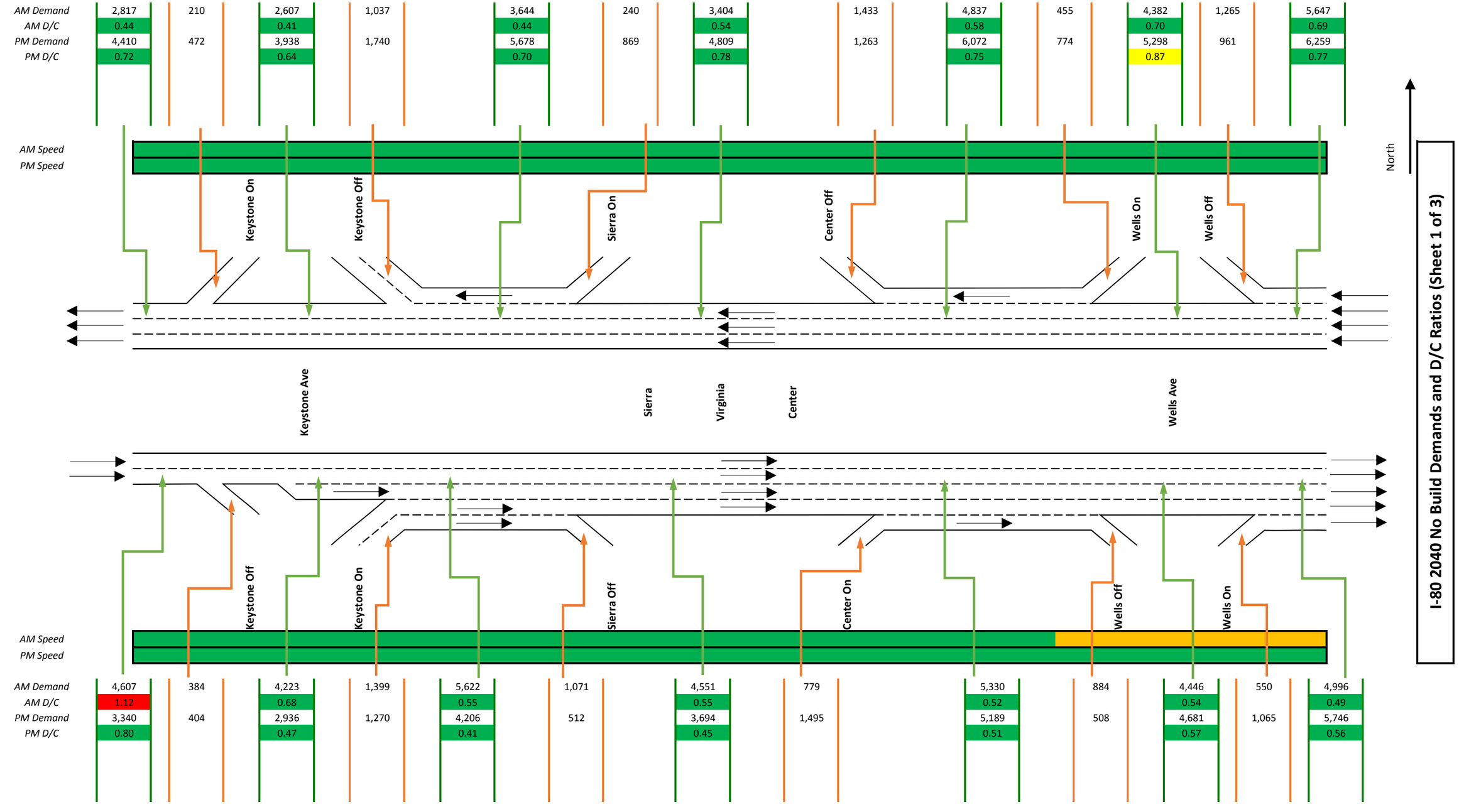


FIGURE E-4. TRAVEL DEMAND MODEL OUTPUT, 2040 TRAFFIC

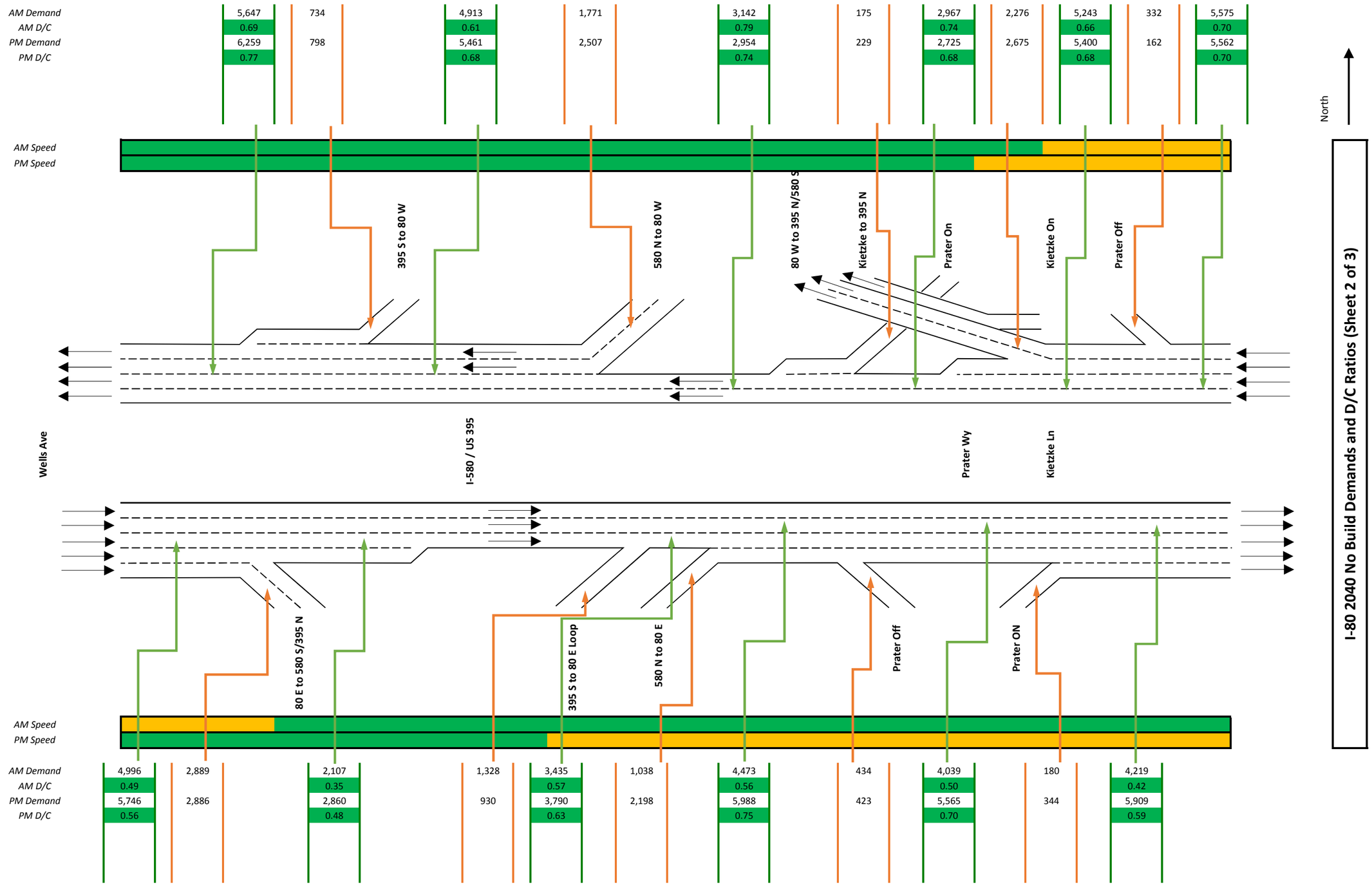
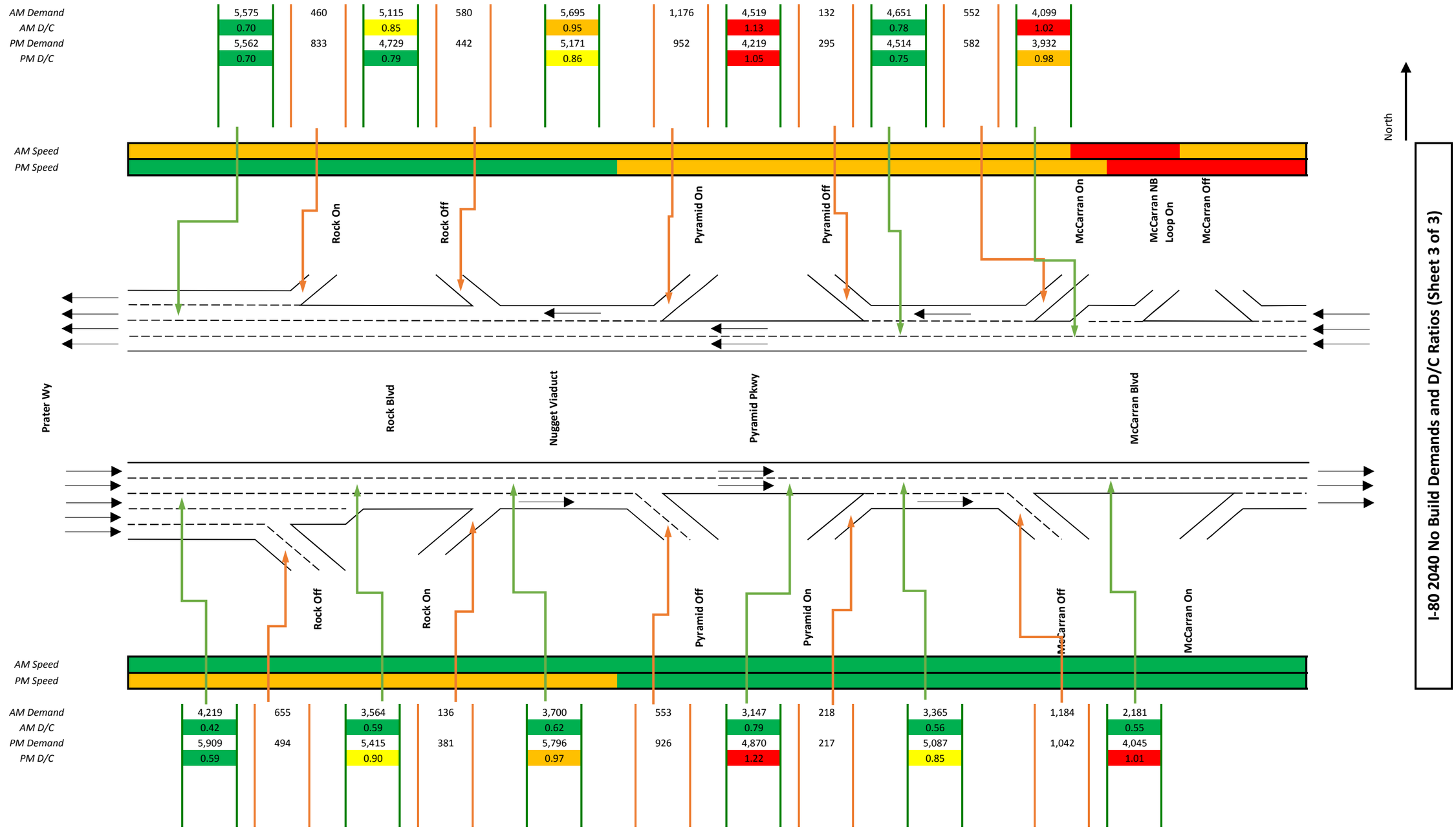


FIGURE E-4. TRAVEL DEMAND MODEL OUTPUT, 2040 TRAFFIC



I-80 2040 No Build Demands and D/C Ratios (Sheet 3 of 3)

FIGURE E-4. TRAVEL DEMAND MODEL OUTPUT, 2040 TRAFFIC

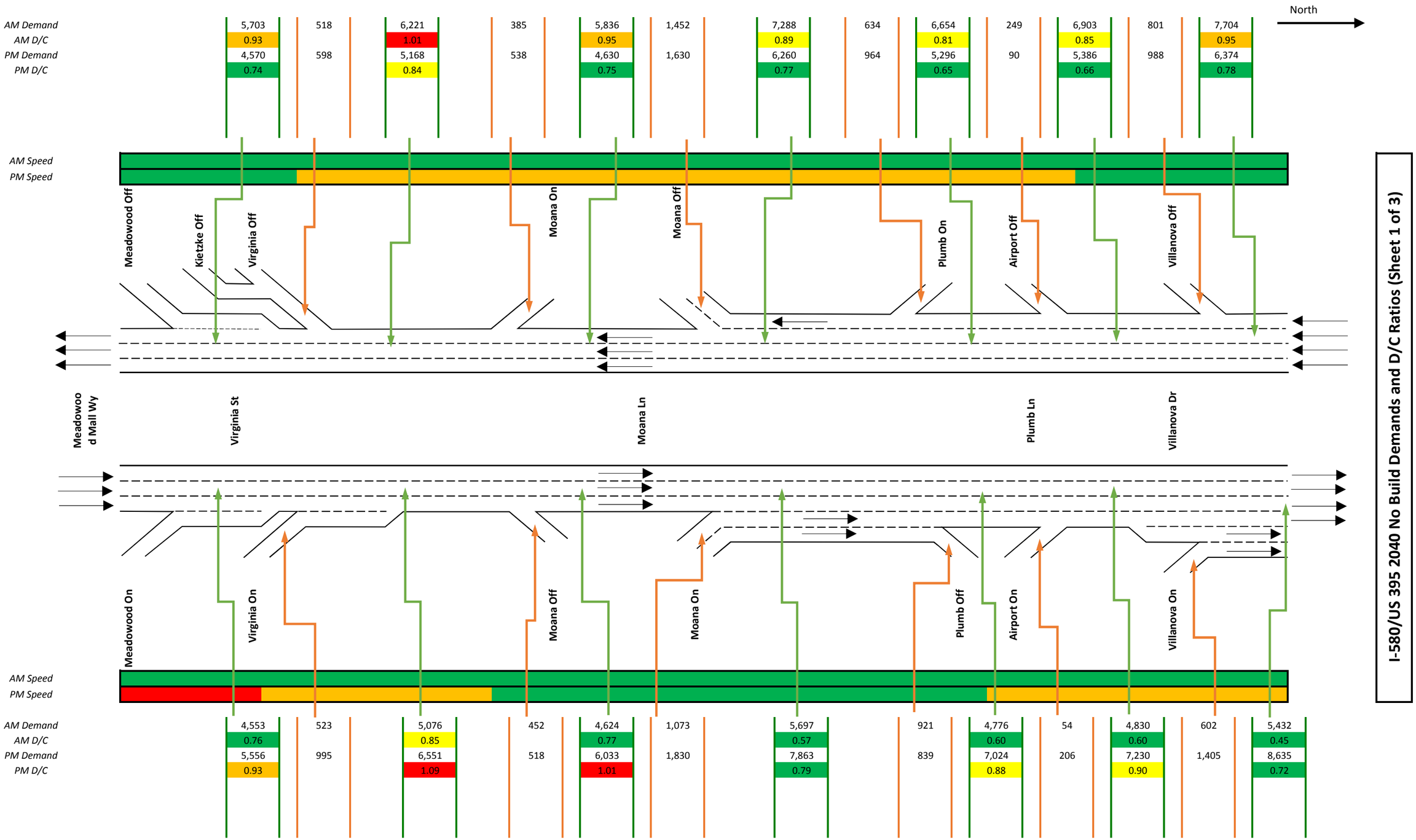


FIGURE E-4. TRAVEL DEMAND MODEL OUTPUT, 2040 TRAFFIC

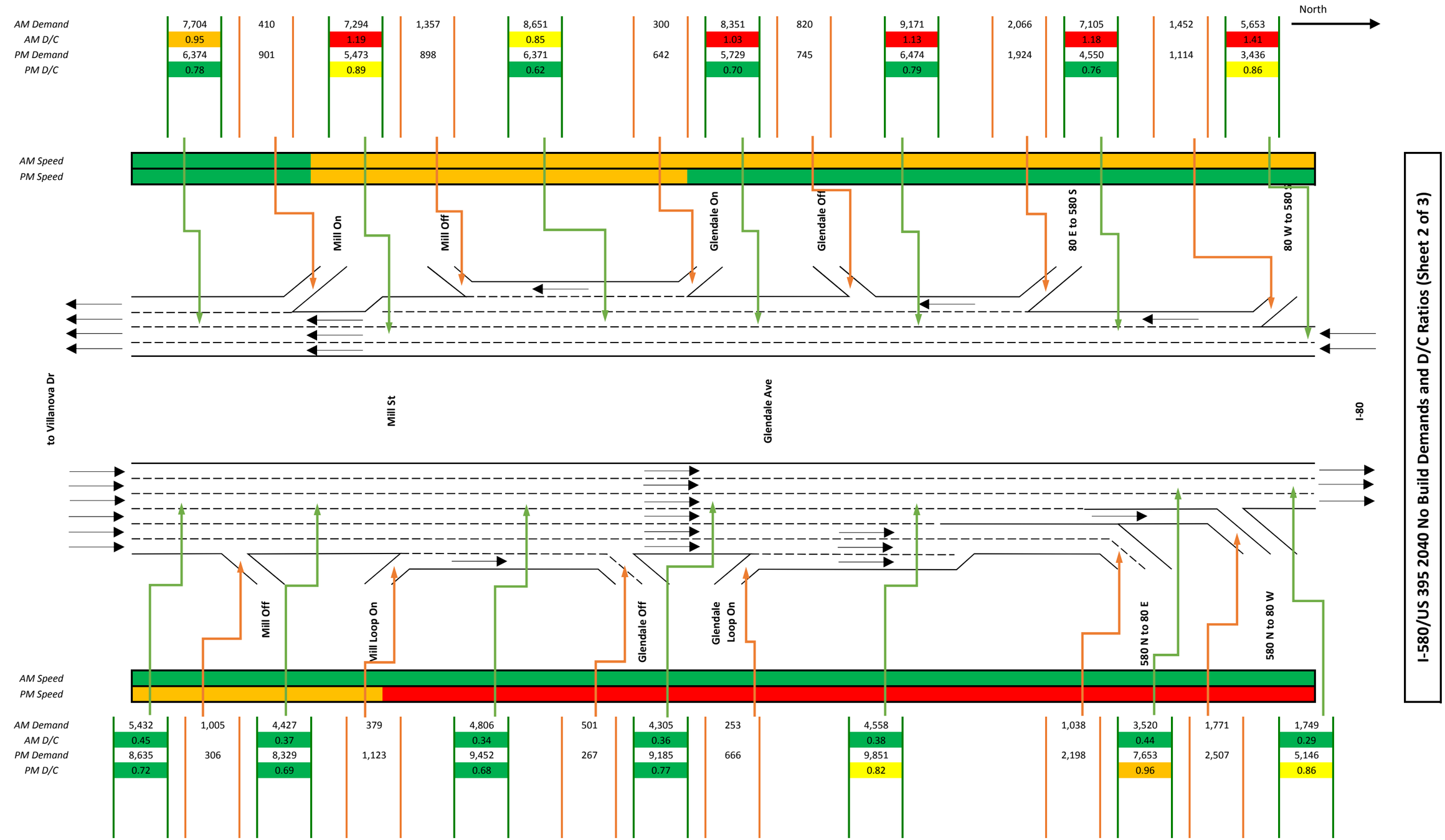
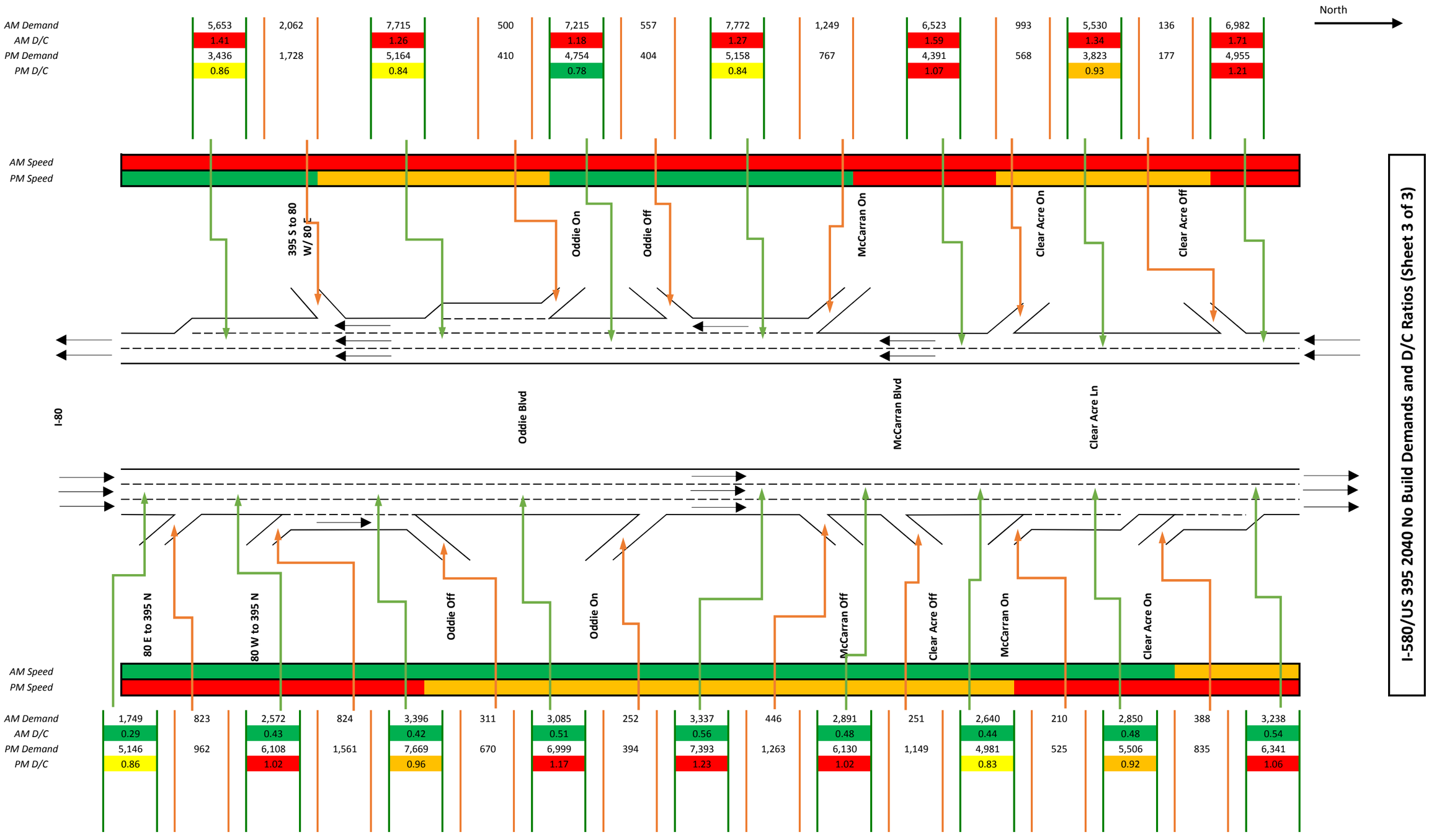


FIGURE E-4. TRAVEL DEMAND MODEL OUTPUT, 2040 TRAFFIC



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