FINAL REPORT

Southern Nevada HOV Plan

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Acronyms

CMP	Congestion Management Process (formerly Congestion Management System)
CC-215	Clark County Road 215 (the Beltway west of I-15)
FHWA	Federal Highway Administration
HOT	high occupancy toll
HOV	high occupancy vehicle
I-15	Interstate Highway 15
I-215	Interstate Highway 215
I-515	Interstate Highway 515
LOS	level of service
MLK	Martin Luther King Boulevard
mph	miles per hour
NDOT	Nevada Department of Transportation
NEPA	National Environmental Policy Act
pph	persons per hour
ROW	right-of-way
RTC	Regional Transportation Commission of Southern Nevada
RTP	Regional Transportation Plan
SOVs	single-occupant vehicles
SR	State Route
US-95	United States Highway 95
V/C	vehicle-to-capacity ratio
VORs	vehicle occupancy rates
vph	vehicles per hour

Executive Summary

The purpose of the Southern Nevada High Occupancy Vehicle (HOV) Plan is to determine the usefulness of implementing HOV lanes on freeways in the Las Vegas metropolitan area. Traffic forecasts for the year 2030 show substantial congestion on area freeways even if they are widened to include the number of lanes shown in the 2030 Regional Transportation Plan (RTP). Implementation of HOV lanes, or carpool lanes, is one method of maintaining mobility in congested freeway corridors.

With proper management an HOV lane can carry more vehicles than an adjacent general purpose lane that is congested. A freeway lane operating at capacity will handle approximately 2000 vehicles per hour. However, when demand exceeds that capacity and heavy congestion or jammed conditions ensue, a freeway lane handles as few as 900 vehicles per hour. Managed lanes, such as HOV lanes, manage or limit the number of vehicles in the lane so that demand is kept below capacity so that heavy congestion and jammed conditions are avoided. In that way the vehicular throughput of an HOV lane is managed so that it is higher than the throughput of an adjacent congested general purpose lane. The greater number of people in each vehicle in the HOV lane provides an added benefit of moving more people, as well as more vehicles.

Evaluation of All Freeway Corridors

An evaluation of the traffic forecasts and other information was completed to determine which freeway corridors in the metropolitan area meet criteria for consideration of HOV facilities. The criteria included:

- Presence of congestion in the general purpose lanes;
- Bottlenecks that HOV lanes could potentially bypass;
- Transit service potential in the HOV lanes;
- Sufficient HOV demand; and
- Availability of right-of-way (ROW).

Based on the results of the evaluation, the following corridors met criteria indicating good potential for successful HOV facility implementation:

- Interstate Highway 15 (I-15) from Sloan Road to Interstate Highway 215 (I-215);
- I-15 from I-215 to United States Highway 95 (US-95)/Interstate Highway 515 (I-515);
- I-15 from US-95/I-515 to Clarke County Road 215 (CC-215) North;
- I-215 from I-15 to I-515;
- CC-215 South from I-15 to Summerlin Parkway;
- US-95 from I-15 to North Durango Road just north of CC-215; and
- I-515 from I-215 to I-15.

For the segments of I-15 from I-215 to US-95/I-215, US-95 from I-15 to Summerlin Parkway, and I-215 from I-15 to the Airport Connector, future HOV demand warrants the provision of multiple HOV lanes. The Summerlin Parkway approach to US-95 as far west as

Rampart Boulevard meets the criteria to provide a bottleneck bypass at the Summerlin Parkway interchange with US-95. HOV demand on both US-95 and I-15 through their interchange (the Spaghetti Bowl) is sufficient to support a through HOV lane in each direction on each freeway.

Freeway HOV Lanes

Based on the evaluation results, a plan for HOV lanes in both directions along 84 miles of freeways in the metropolitan area was prepared. It is shown on Figure ES-1. The figure shows the peak hour traffic forecast for year 2030 for the HOV lanes included in the plan. The forecasts are based on limiting access to HOV lanes to vehicles with two or more occupants (2+). The success of HOV lanes requires a travel time advantage in the HOV lanes. Slow and congested general purpose lanes adjacent to faster, less congested HOV lanes are the incentive for motorists to rideshare and use the HOV lanes. As 2+ vehicles increase in numbers they could become so numerous that they congest the HOV lane. In that event, it could become necessary to impose a more stringent restriction (such as 3+) on access to the HOV lanes. More restrictive access is not considered in this report and would be evaluated long after HOV lanes are implemented if they begin to congest and lose their travel time advantage over the general purpose lanes.

A single HOV lane in each direction is included in the plan, except along I-15 between I-215 and US-95, along US-95 between I-15 and Summerlin Parkway, and along I-215 between I-15 and the Airport Connector Tunnel, where two lanes in each direction are included in the plan.

HOV lanes are one type of “managed lanes”. Dedicated freeway lanes, including HOV lanes, are collectively referred to as “managed lanes” by transportation professionals and local, state, and federal agencies. Managed lanes represent all forms of dedicated lane treatment that apply the mobility benefits associated with HOV lanes to a broader number of potential lane users, including trucks and general traffic. Managed lanes include high occupancy/toll (HOT) lanes as well as “value-priced” lanes. HOT lanes are lanes available free to HOVs and for a toll to vehicles with fewer occupants than required for free travel. Value-priced lanes are toll lanes in which tolls vary in order to maintain higher speeds than in the general purpose lanes. As the traffic volumes in the value-priced or HOT lanes increase to the point of congestion, the tolls are raised to reduce the traffic and maintain the higher speeds. The primary purpose of the tolls is to limit traffic; revenue generation is rarely sufficient to offset the costs of construction and operation.

Managed lanes were considered as part of this study. HOV lanes are recommended for the Las Vegas Valley’s first foray into the managed lanes environment for several reasons. The metropolitan area is already committed to the implementation of HOV lanes in the US-95 corridor. The traffic forecasts of HOV utilization on the freeway HOV lanes included in the HOV plan are substantial enough to provide good utilization of the lanes. The freeway HOV lanes included in the HOV plan are a sufficiently extensive system to noticeably improve travel times for the longer distance travel needed to encourage HOV lane use. Implementation of HOV lanes is generally simpler than the implementation of other types of managed lanes. Except for periodic monitoring to confirm the absence of congestion, little is needed in addition to the initial capital investment in the facilities. Toll lanes that provide real-time toll collection and remove toll collection delay require extensive electronic systems for toll collection, dissemination of electronic toll readers for motorists to place in their vehicles, and some type of physical

Figure ES-1. Year 2030 Forecast Peak Hour HOV Lane Volumes – AM(PM)

separation of traffic streams on the toll and non-toll portions of the roadway requiring additional land. High occupancy toll (HOT) lanes that provide access to HOV lanes by single occupant vehicles (SOVs) for a fee can be tolled through a sticker system which does not require the real-time electronic toll collection apparatus, but does require more extensive monitoring to assure that traffic volumes are not permitted to reach congested levels. Truck and express lane options require substantial through volumes of these vehicles, which would not address the largest component of traffic in the Las Vegas Valley focused on the resort corridor.

Generally, the HOV plan provides for implementation by constructing some new freeway lanes included in the 2030 RTP as HOV lanes. To meet the planned policy of implementing HOV lanes only on facilities with three or more general purpose lanes in each direction, an additional lane in each direction would be required to implement the HOV lanes included in the plan along I-215 and CC-215 south of Summerlin Parkway to I-515, along I-15 north of Alexander Road to CC-215 North, and along US-95 from I-15 to Summerlin Parkway.

HOV Direct Connectors

Access to the HOV lanes is assumed to be continuous. Generally, motorists entering and exiting the HOV lanes would merge across the general purpose lanes to enter and exit the freeway. However, at some locations, direct ramp connectors would provide access directly to the HOV lanes. At some freeway system interchanges, direct connector ramps exclusively for the use of HOVs would link HOV lanes on different freeways. In addition, a limited number of direct access connectors would provide direct access between arterial roadways and the HOV lanes.

The locations evaluated for HOV direct connectors are shown in Figure ES-2. Direct access arterial connectors to HOV lanes were evaluated only in the I-15 resort corridor because of strong HOV demand and the number of major activity centers served by the arterial system. Direct access arterial connectors to HOV lanes in other freeway corridors will be evaluated in conjunction with HOV lane implementation and arterial improvements.

The direct access HOV arterial connectors evaluated and shown in Figure ES-2 could occur at other nearby locations. For example, the I-15 arterial HOV direct access ramps serving the resort corridor to/from the south is shown at Hacienda Avenue. If that location is infeasible or impractical due to ROW or geometric issues, a potential alternate location would be Warm Springs Road. Providing direct access from arterials to freeway HOV lanes at locations without general purpose interchanges is preferred to reduce interchange complexity and disperse traffic demand more evenly over the arterial system.

Figure ES-2 shows the year 2030 forecast peak hour ramp volumes for the HOV direct connectors. The HOV direct connectors evaluated at system interchanges show strong demand forecasts. The HOV direct connectors to the arterial system in the resort corridor also show strong demand.

The Las Vegas Valley HOV freeway facilities included in the HOV plan are shown in Figures ES-1 and ES-2. Additional facilities not shown in the figures include:

Figure ES-2. Proposed HOV Direct Connectors with Year 2030 Peak Hour Traffic – AM(PM)

- An HOV lane in each direction on US-95 through the Spaghetti Bowl;
- An HOV lane in each direction on I-15 through the Spaghetti Bowl;
- Dual HOV lanes in each direction on I-15 between I-215 and US-95, on I-215 between I-15 and the Airport Connector, and on US-95 between I-15 and Summerlin Pkwy;
- HOV lanes on Summerlin Parkway from US-95 to Rampart Boulevard; and
- Arterial HOV direct connectors in addition to those shown in Figure ES-2 at locations to be determined during freeway and arterial design studies; and
- Park-and-ride, express bus, and other support facilities and services to be determined during future planning studies.

Cost

A planning-level cost estimate was developed for the HOV plan. Since the HOV plan provides for implementation by constructing some new freeway lanes included in the 2030 RTP as HOV lanes, only those components of the HOV plan not already included in the RTP are estimated as costs of the HOV plan.

For those locations where HOV lanes included in the plan are to be among the new freeway lanes included in the 2030 RTP, the additional cost to provide HOV lanes instead of a general purpose lane includes the cost of additional ROW and pavement width to provide a buffer between the HOV lanes and the general purpose lanes, as well as the cost to provide HOV signage and striping. Those costs are estimated at $47.9 million.

For those locations where HOV lanes included in the plan are in addition to those included in the 2030 RTP, the full cost of construction of the HOV lanes is included in the estimate. Those costs are estimated at $235.6 million plus an additional $100 million to provide continuous HOV lanes through the interchange of I-15 and US-95 in both directions on both freeways.

The HOV direct connectors linking HOV lanes on different freeways and linking HOV lanes to arterial roadways are estimated at $71.2 million. The total cost of the facilities in the HOV plan not included in the 2030 RTP is $454.7 million.

Implementation Phasing Plan

Phased implemention of the HOV freeway facilities included in the HOV plan for the Las Vegas Valley freeway system is recommended. The purpose of the phasing is to provide an HOV system that has the greatest chance for success by providing early implementation in the highest demand corridors, thereby ensuring a positive response to implementation and continued support for further implementation.

A single HOV lane in each direction along US-95 north of Rancho Drive to Summerlin Parkway is currently under construction. Since this is the first set of freeway HOV lanes introduced in the metropolitan area, future implementations should expand that initial system to ensure success. HOV lanes have already been constructed north of Summerlin Parkway approximately four miles to Craig Road and opened to general purpose traffic pending

completion of the HOV lanes from Rancho Drive to Summerlin Parkway. The HOV lanes would be extended north to North Durango Drive (approximately 4 miles north of Craig Road) by a project for which environmental and design work are currently ongoing. To increase the utilization of the initial HOV lanes on US-95, their extension is ranked as the highest priority after the ongoing US-95 construction. Provision of HOV facilities on Summerlin Parkway and HOV direct connectors directly linking the HOV lanes on Summerlin Parkway and US-95 are the next priorities, also to support the US-95 HOV lanes. The timing for the implementation of the second HOV lane in each direction on US-95 between I-15 and Summerlin Parkway included in the HOV Plan is more long term. Implementation should be coordinated with provision of continuous HOV lanes through the US-95/I-15 interchange on US-95/I-515.

Following completion of the HOV facilities in the US-95 North corridor, I-15 along the resort corridor from I-215 to I-515 should be the highest priority for implementation. Connections between the HOV lanes on US-95 and I-15 should be phased immediately after completion of the HOV lanes in the resort corridor to maximize the success of the HOV facilities in both freeway corridors. In the near term a single HOV lane in each direction on I-15 between I-215 and I-515 is recommended. The timing for implementation of the second HOV lane in each direction on I-15 between I-215 and I-515 included in the HOV Plan is more long term. Implementation of the second lane should be coordinated with implementation of HOV lanes on I-215, increased HOV demand in the I-15 corridor, and future I-15 improvement projects.

Extending the I-15 corridor HOV facilities south of I-215 to Sloan Road and north of I-515 to Alexander Road represent, respectively, the next highest priorities because they have strong demand and feed HOV traffic to I-15 in the resort corridor. Connections through the Spaghetti Bowl are critical to the success of the resort corridor HOV lanes. A gap in the HOV lanes through the interchange will impede their success and public perception of their value.

The facilities noted above, US-95 north of I-15 to CC-215 and I-15 from Sloan Road through the resort corridor and Spaghetti Bowl interchange with US-95 to Alexander Road, represent the near term priorities for implementation of an HOV system in the Las Vegas Valley. These facilities are shown in Figure ES-3. This set of freeway HOV facilities would provide an integrated HOV system with sufficient demand, travel distances, and sufficient congestion in the adjacent general purpose lanes to provide a successful HOV implementation. Many of the facilities in this initial, near term, system are currently under design for freeway widening. Inclusion of HOV facilities would require substantial design changes which should be undertaken before construction commitments preclude HOV facilities.

The incremental additional cost of this near term system above what is included in the 2030 RTP for freeway widening is $104 million. The near term system provides 37.0 miles of continuous integrated HOV freeway facilities. The near term HOV facilities include a freeway-to-freeway HOV direct connector in the Spaghetti Bowl linking HOV lanes on US-95 north of I-15 and I-15 south of US 95 and widening of I-15 through the Spaghetti Bowl to accommodate an HOV lane in each direction. The HOV direct connectors between US-95 and I-15 are vital to linking the HOV lanes currently under construction on US 95 to the region's major employment center in the resort corridor. The costs of the connectors are included in the latest Project Neon cost estimates. Widening I-15 through the Spaghetti Bowl to accommodate a continuous HOV

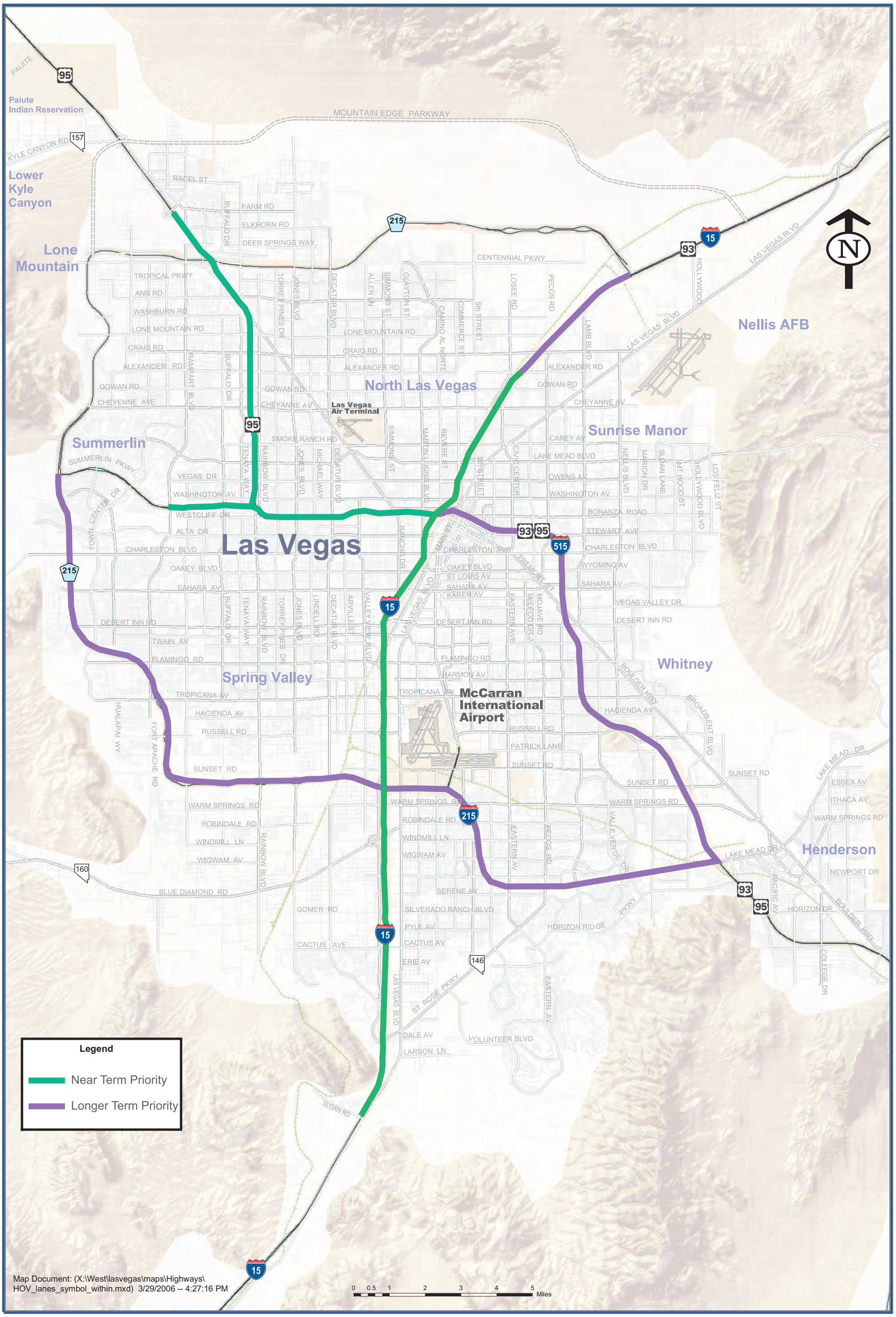


Figure ES-3. Near and Long Term Priorities for HOV Freeway Facility Implementation

lane in each direction is vital to a continuous HOV backbone on I-15. The planning estimate for that widening represents nearly 50 percent of the total near term costs, but the project is vital. The near term projects would provide 44 percent of the HOV freeway system lane miles included in the HOV plan at only 23 percent of the total expected cost.

The remaining facilities included in the HOV plan represent longer term priorities. These facilities include I-15 north of Alexander Road, I-215 for its entire length, CC-215 South from I-15 to Summerlin Parkway, and I-515 from I-215 to I-15.

Next Steps

A successful HOV program in the metropolitan area will require that ongoing design projects for freeways incorporate HOV facilities. Upcoming major investment and corridor studies where the HOV Plan recommends HOV facilities should actively include HOV facilities among corridor alternatives. NDOT should assume the role of coordinating integration of HOV facilities into all freeway and corridor projects regardless of jurisdiction of ownership.

Consideration should be given to full inclusion of the projects recommended by this HOV plan in the next round of RTP development currently scheduled for adoption in July 2008. Since NDOT sponsored the development of the HOV plan, NDOT should take the lead in recommending HOV facility inclusion in the next RTP. A financial strategy for implementation of the recommended HOV facilities will be required based on the constrained funding requirement for the RTP.

Once included in the RTP, NDOT should take the lead in the identification and inclusion of HOV projects in the RTC's Transportation Improvement Program (TIP) and NDOT's State Transportation Improvement Program (STIP). Federal funding can only be used for projects included in the TIP and/or STIP. Initially, priority should be given to projects that will support and expand HOV facilities currently under construction on US-95.

RTC should also pursue the adoption of a mode split component to its regional travel forecasting model. A mode split model is essential to HOV forecasting.

Fully achieving the long-term potential of HOV freeway facilities depends upon the implementation of a variety of support facilities and services. Critical among these are express transit, arterial HOV direct connectors, and park-and-ride facilities that act as staging grounds for carpool formation and transit services. A comprehensive planning effort covering the range of support facilities envisioned in the Las Vegas area should be undertaken under RTC's regional leadership. RTC's recent park-and-ride study (October 2006) should be expanded to incorporate facilities needed to enhance the potential success of the HOV system included in the plan.

The metropolitan area's Congestion Management Process (CMP) should be updated to reflect the HOV Plan and to focus resources on HOV planning, programming, implementation, and monitoring. As the lead CMP agency, RTC should take the lead in incorporating HOV facilities into the CMP. The facilities to be included in the CMP should include not only HOV lanes, but also arterial HOV direct connectors, park-and-ride facilities, and other support facilities and services including express bus.

To support the inclusion of HOV facilities in the next RTP, a public awareness campaign is needed. As the current leader in HOV planning, NDOT should initially take the leadership role in this activity. As HOV planning becomes more developed, it may be appropriate for that role to transfer to RTC based on their leadership in congestion management strategies. A component of the public awareness campaign should be targeted at related transportation, transit, and land use planning agencies. RTC should identify ongoing and planned projects and processes (such as park-and-ride facility planning and bridge widening projects over freeways recommended for HOV facilities) so that infrastructure improvements are advanced in a way that permits easy incorporation of potential HOV facilities.

Additional HOV planning will be required in support of the facilities included in the HOV plan. Terms of HOV lane eligibility should be defined for each HOV project. All projects should provide an Operation Plan which stipulates the operating periods for the HOV lane restrictions. Criteria should be identified for use in determining when reliability and reduced delay have deteriorated such that lane restrictions and operation periods require change.

Congestion pricing has the potential for improving the efficiency of freeway corridor operation in conjunction with HOV lane operation. A consideration of congestion pricing involves a number of topics including tolling techniques and technologies, pricing policies, enforcement mechanisms, physical design requirements, and management strategies that will promote an acceptable level of service in a dynamic mobility environment.

Enforcement of HOV lane restrictions needs consideration in terms of fine levels, grace periods following HOV lane implementation, and policing levels. State law should be reviewed to make certain that HOV enforcement and congestion pricing provisions in state law are supportive of implementing successful transportation projects.

Some of the operational issues identified above require a regional agency such as RTC to provide a consistent approach across the Las Vegas Valley. Others, such as enforcement, may vary with the operating agency or enforcement agency responsible for a specific roadway.

1.0 Introduction

The purpose of this report is to present a plan for high occupancy vehicle (HOV) freeway facilities in the Las Vegas Valley. The report documents the evaluation of freeway corridors in the Valley to determine if HOV facilities were warranted and the subsequent preparation of the plan for those freeway corridors where warranted. The report provides background information related to the need for HOV facilities in the Valley.

The background information is provided in this section of the report. Section 2 provides a complete description of the different types of managed lanes, including HOV freeway facilities and the conditions under which their implementation is beneficial. Section 3 provides a framework for the evaluation of whether HOV implementation is likely to be successful in individual corridors. Section 4 applies that evaluation framework to the freeway corridors in the Las Vegas Valley. Section 5 examines HOV direct connectors directly linking HOV freeway lanes with HOV lanes on different freeways and on arterial roadways. Section 6 presents the HOV plan for the Las Vegas Valley, and Section 7 indicates what the priority should be for corridor-by-corridor implementation of the plan.

1.1 Need for HOV Facilities

Many communities have experienced traffic growth far outstripping the growth in roadway capacity. Managed lanes, of which HOV lanes are one form, is a technique to increase mobility by managing the use of highways. The Las Vegas metropolitan area is expected to increase in population and employment in the coming years, with a consequential increase in traffic on the area's roadways.

The Regional Transportation Commission of Southern Nevada (RTC) has developed a 2030 Regional Transportation Plan (RTP) that identifies the number of lanes planned for each of the Valley's freeways. The plan calls for widening nearly every freeway in the Valley. That plan is shown in Figure 1. Traffic forecasts prepared for the HOV study show that, despite this extensive program of freeway expansion, substantial portions of the freeway system will be congested in the year 2030.

Figure 2 shows the volume-to-capacity (V/C) ratios forecast for area freeways in the year 2030 assuming complete implementation of the freeway widenings that are included in the 2030 RTP. V/C ratios in excess of 0.90 represent congested level of service (LOS) E conditions, and V/C ratios in excess of 1.00 represent LOS F conditions under which roadways operate over capacity with substantial congestion delay.

Figure 2 shows that Interstate Highway 15 (I-15) through the resort corridor, from south of Interstate Highway 215 (I-215) to north of United States Highway 95 (US-95), will experience periods of LOS F conditions in peak hours in the year 2030. LOS E conditions will extend somewhat further north and south. US-95 west of I-15 will experience LOS F conditions, as will County Road 215 (CC-215) South west of I-15.

HOV lanes are a method of enhancing mobility for a segment of travelers willing to carpool and use transit. The objective of HOV lanes is to provide facilities with higher speeds and less delay by limiting the volume of traffic and congestion that occurs within them. Unless there is a time savings associated with traveling in the HOV lanes, there is little incentive to use

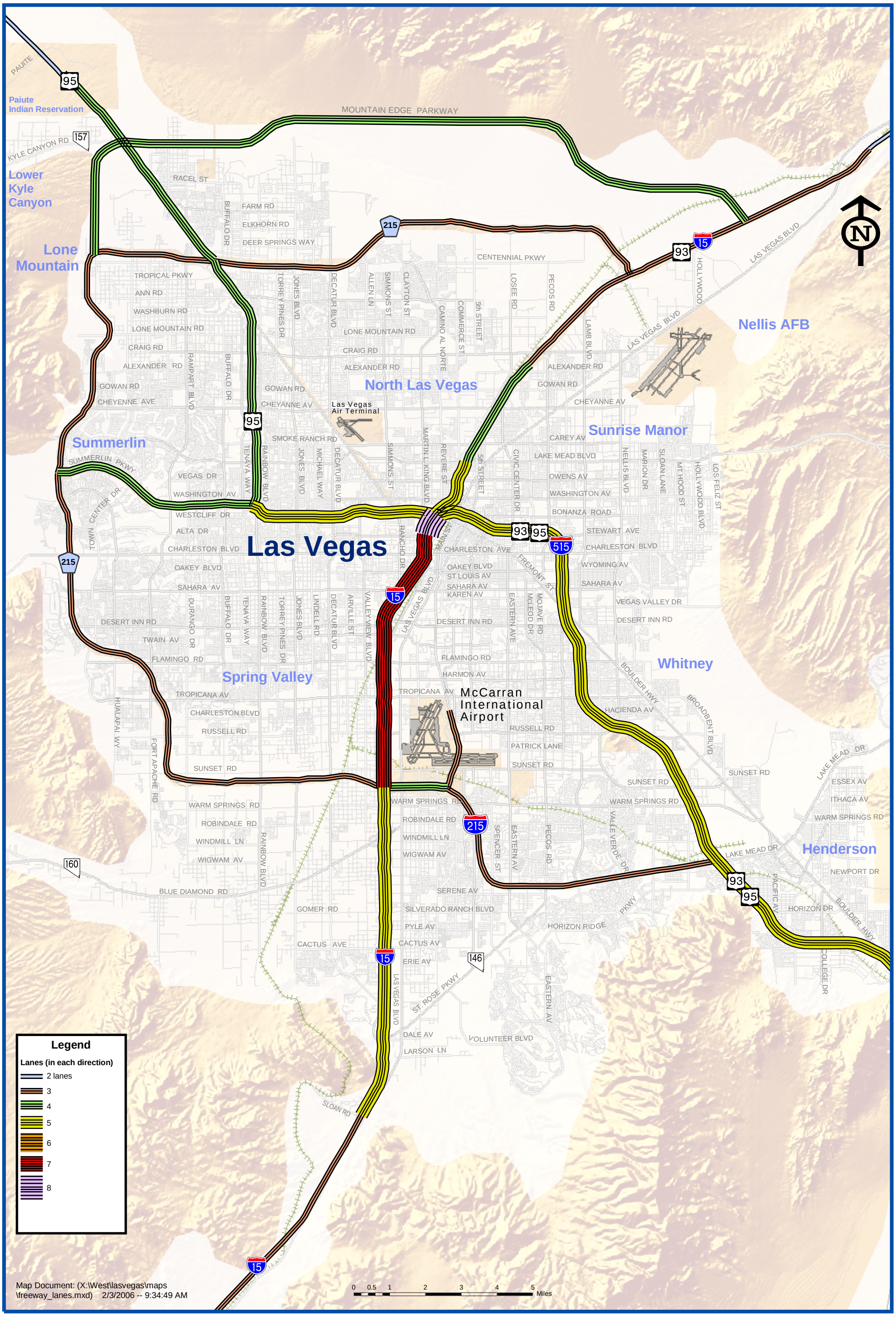


Figure 1. Freeway Lanes included in the Draft 2030 Regional Transportation Plan

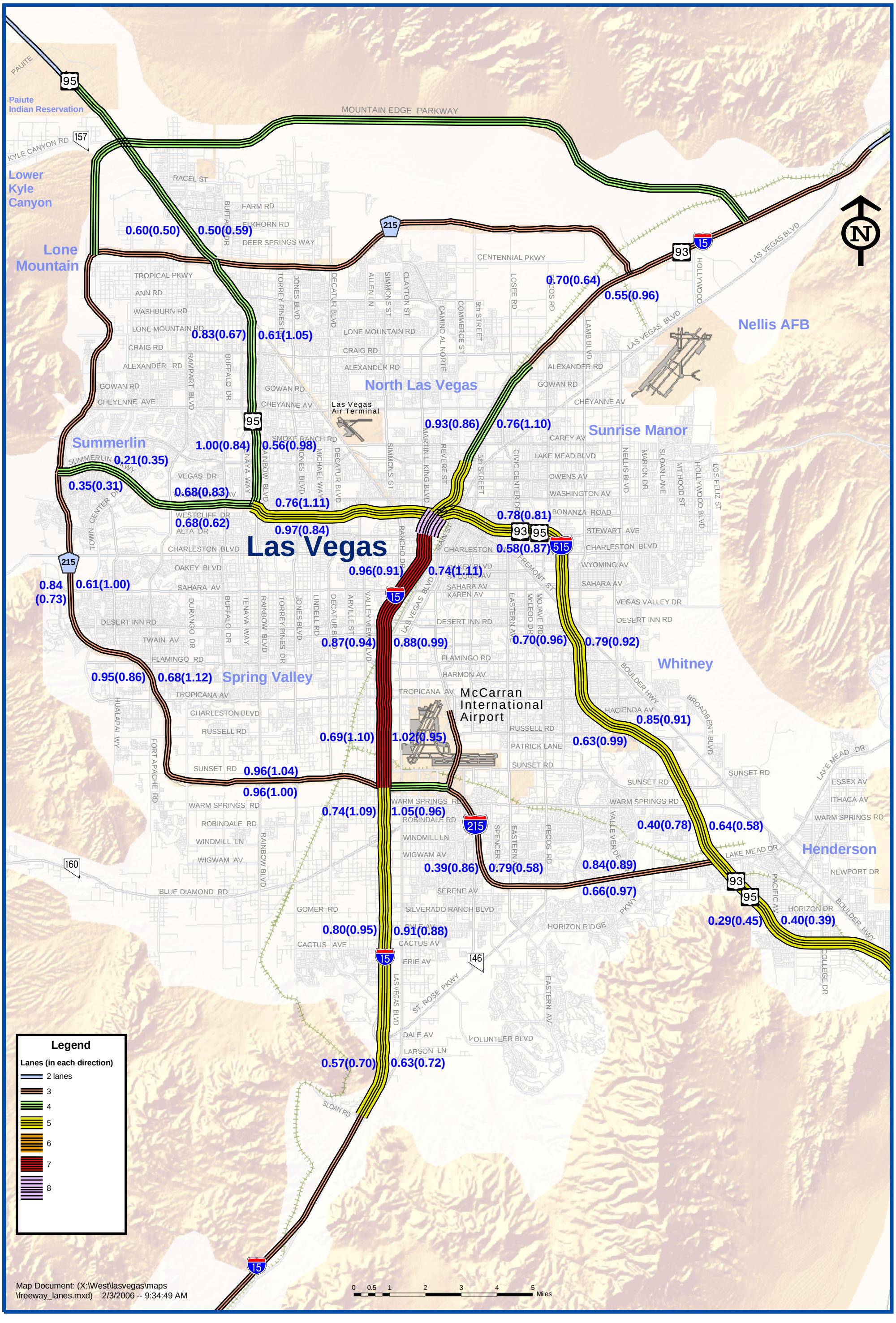


Figure 2. Year 2030 Forecast Peak Hour Volume-to-Capacity Ratios on draft RTP Freeway System – AM(PM)

them. Therefore, HOV lanes work best when they are relatively uncongested and the adjacent general purpose lanes are congested.

The forecasts for HOV lane traffic included in this report are based on full implementation of the freeway improvements included in the 2030 RTP. If the planned improvements are not fully implemented freeway congestion will be more extensive than shown in Figure 2. This will provide even more incentive to use, and a greater need to implement, HOV facilities.

The forecasts for HOV lane traffic included in this report are based on limiting access to HOV lanes to vehicles with two or more occupants (2+). As 2+ vehicles increase in numbers they could become so numerous that they congest the HOV lane. In that event, it could become necessary to impose a more stringent restriction (such as 3+) on access to the HOV lanes. More restrictive access is not considered in this report and would be evaluated long after HOV lanes are implemented if they begin to congest and lose their travel time advantage over the general purpose lanes.

1.2 Potential Benefits of HOV Lanes

There are two major potential benefits of HOV lanes. First, they increase the person "throughput" (the number of persons passing a fixed point along the freeway) on a congested freeway by increasing the number of persons in each vehicle in the HOV lane. Carpools form in response to the presence of an HOV lane and its faster travel times. The carpool members travel faster and more efficiently while removing some vehicles that would otherwise be in the general purpose lanes, thereby freeing up some capacity in those lanes for other vehicles.

Secondly, and perhaps more importantly, HOV lanes have a higher vehicle throughput than congested general purpose lanes. When properly managed, more vehicles can travel in an HOV lane than in a congested general purpose lane. A freeway lane operating at capacity will handle approximately 2000 vehicles per hour. However, when demand exceeds that capacity and heavy congestion or jammed conditions ensue, a freeway lane can handle as few as 900 vehicles per hour. Managed lanes, such as HOV lanes, manage or limit the number of vehicles in the lane so that demand is kept below capacity thereby avoiding heavy congestion and jammed conditions. In that way the vehicular throughput of an HOV lane is managed so that it is higher than the throughput of an adjacent congested general purpose lane.

The choice of HOV lanes over other forms of managed lanes for the Las Vegas area is based on a number of factors. The metropolitan area is already committed to the implementation of HOV lanes in the US-95 corridor. The traffic forecasts of HOV utilization on the freeway HOV lanes included in the HOV plan are substantial enough to provide both good utilization of the lanes and a sufficiently extensive system to noticeably improve travel times for the longer distance travel needed to encourage carpool formation. Implementation of HOV lanes is generally simpler than the implementation of other types of managed lanes. Except for periodic monitoring to confirm the absence of congestion, little is needed in addition the initial capital investment in the facilities. Toll lanes that remove toll collection delay require extensive electronic systems for toll collection, dissemination of electronic toll tags for motorists to place

in their vehicles, and some type of physical separation of traffic streams on the toll and non-toll portions of the roadway requiring additional land. High occupancy toll (HOT) lanes that provide access to HOV lanes by single occupant vehicles (SOVs) for a fee can be tolled through a sticker system which does not require the real-time electronic toll collection apparatus, but does require more extensive monitoring to assure that traffic volumes are not permitted to reach congested levels. Exclusive truck lanes and express lanes require substantial through volumes of these vehicles, which would not address the largest component of traffic in the Las Vegas Valley focused on the resort corridor.

1.3 Policy Changes Needed

To implement HOV lanes in the Las Vegas Valley, a number of policy changes will be needed. Among these is the freeway design standard of building freeways to provide uncongested operation at LOS D during the peak hour 20 years after the project is open to traffic. Based on the forecast congestion noted above, this design standard is unlikely to be achieved. The 2030 RTP, which this study uses as a basis for development of the HOV plan, does not meet the LOS D policy.

It will cost too much to construct freeways to meet the LOS D policy and require too much land acquisition to be politically acceptable. Attempts to maintain such a design standard will thwart the implementation of alternative mobility improvements, such as HOV lanes, which can be successfully implemented but depend upon recognition of levels of congestion for their design and implementation.

Lower freeway congestion design standards, coupled with HOV lanes, represent a more achievable alternative to the existing freeway design standard of uncongested freeway operations. Such alternative standards should be considered by the Nevada Department of Transportation (NDOT) and RTC. Standards for HOV lanes are included in the NDOT *HOV/Managed Lane Design Manual* (November 2005). The HOV plan provides NDOT and RTC with one component of an alternative plan for development of the freeway system in the Las Vegas Valley.

2.0 Managed Lanes and HOV Lanes

Dedicated freeway lanes, including HOV lanes, are collectively referred to as "managed lanes" by transportation professionals and local, state, and federal agencies. The term "managed lanes" evokes different meanings and connotations depending on the public agency or individual project. There is no universally recognized definition of managed lanes.

Managed lanes represent all forms of dedicated lane treatment that apply the mobility benefits associated with HOV lanes to a broader number of potential lane users, including trucks and general traffic. The definition of managed lanes varies from agency to agency. The Federal Highway Administration (FHWA) provides the following definition[1]:

> *Managed Lane Definition: Highway facilities or designated lanes in which operational strategies are implemented and managed (in real time) in response to changing conditions.*

Two states—Texas and Washington—have developed definitions as they embark on a number of managed lane projects. The Texas Department of Transportation has developed the following definition for managed lanes as part of its managed lanes research program:

> *A managed lane facility is one that increases freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals.*

As specific managed lane projects in Texas undergo the planning and design process, the definition is tailored to address specific project needs. For example, the following variation on the definition was developed for the I-635 (LBJ Freeway) Managed Lanes project in Dallas:

> *Managed lanes increase freeway efficiency by offering a predictable trip with little congestion for those who carpool, ride bus transit, vanpool, ride a motorcycle or if driving alone, are willing to pay a toll. Lane management operations and pricing structure may be adjusted at any time to better serve modal needs.*

This project definition specifically addresses priority user groups and the use of pricing as a means to achieve objectives for the project. The Washington State Department of Transportation also developed a definition of managed lanes through a workshop held in June 2001:

> *Managed Lane facilities include any roadway lane that can be managed to prevent congestion from occurring. In managed lanes, one or more of these techniques is used to control the number of vehicles using the lane or roadway:*

[1]Obenberger, Jon. Managing Lanes, FHWA Public Roads. November/December 2004.

- *Limiting access—providing infrequent on-ramps, as on the I-5 and I-90 express lanes*
- *User eligibility requirements—such as HOV-only, truck-only, permit-only, etc.*
- *Pricing—tolls can be varied by time of day to control traffic volumes.*

By considering these as different forms of traffic management, it is possible to plan the best combination of tools to keep a roadway from becoming congested over time, and to optimize traffic to achieve the best person and vehicle throughput.

A common element in the definitions is the inclusion of a broad range of potential strategies and user groups. There is also an emphasis on achieving an enhanced operational condition within the managed lanes, as either explicitly stated in the definitions (i.e., freeway efficiency, reduction of congestion, optimized throughput) or through implicit qualities, such as travel time savings, trip reliability, free-flow speeds, or higher speeds than adjacent general purpose lanes.

HOV lanes are one example of managed lane applications. Recently, an increasing number of multiple-lane treatments have been proposed to address user groups other than HOVs, including express lane traffic traveling long distances and large commercial vehicles. HOV lanes fit within the managed lane definitions described above, although HOV applications are only one of many managed lane approaches that currently exist. The following facilities could be considered managed lanes if they are designed and operated to enhance travel conditions:

- High occupancy/toll (HOT) lanes (I-15 in San Diego, California);
- Value-priced lanes (State Route [SR] 91 in Orange County, California);
- Express lanes offering limited access (Dan Ryan or Kennedy Expressways in Chicago, Illinois);
- Separation or bypass lanes, primarily for commercial vehicles (I-5 truck bypass lanes at SR 14 in Los Angeles, California);
- Dual roadways—physically separated inner and outer roadways in one or both directions where operation can be managed on at least one of the roadways (New Jersey Turnpike); and
- Separate tollways implemented within existing freeways that manage traffic in real-time (under construction on I-10 in Houston, Texas).

2.1 Management Strategies

Management strategies to regulate demand currently fall into one of three categories:

- Eligibility
- Pricing
- Access

While these strategies are applied in other traffic management applications and may offer benefits, definitions applied herein are only made in the context of currently operating HOV-related managed lane concepts and applications. A wide variety of emerging projects are likely

to expand the manner and context for how each strategy is applied. Each strategy can be operated and implemented individually or in combination, depending on the unique travel demand conditions associated with each project setting. The three managed lane strategies are defined in more detail below.

2.1.1 Eligibility

Restricting a dedicated lane to specific users will limit demand. HOV lanes are prime examples of managed-user lanes. Most commonly, user restrictions on HOV lanes have taken the form of eligibility requirements based on a minimum number of people traveling in a vehicle. Over the years, restrictions on HOV lanes have evolved to include various occupancy levels (e.g., HOV with a minimum of two, three, or four occupants) and types of occupancy-exempt vehicles (e.g., motorcycles, inherently low-emission vehicles, hybrids, emergency vehicles, deadheading buses, deadheading paratransit vehicles). Other examples include designated bus-only or truck/freight-only roadway facilities. Restrictions can be in effect 24 hours a day or vary by time of day or day of the week. A managed lane using a variable eligibility strategy may restrict use to HOVs with a minimum of three or more occupants during the peak commute hours and relax restrictions to include lower-occupancy vehicles and occupancy-exempt vehicles or other users during off-periods.

Figure 3. Eligibility Signing on an HOV Lane.

2.1.2 Pricing

The introduction of pricing on HOV lanes in the mid-1990s was tested as a means to address underutilization of HOV lanes, such as the I-15 project in San Diego, and overutilization of HOV lanes, as in the case of the I-10 Katy Freeway project in Houston. While prepaid sticker programs have been used to restrict and justify users in HOV programs, the growing likelihood of pricing as a means to readily manage demand is facilitated by the development of electronic toll collection technology as an increasingly practical and inexpensive tool. Pricing can help maximize the use of available pavement while continuing to prioritize operation for HOVs. The introduction of pricing is seen by some as an opportunity to further manage a dedicated lane facility by allowing other users into the lanes as capacity allows.

Photo courtesy of the San Diego Association of Governments

Figure 4. Pricing Sign on I-15 in San Diego

Management of dedicated lanes using congestion or demand-based pricing has evolved in recent years to be termed value pricing. Value pricing involves charging a fee or toll to travel on a lane or roadway, which varies according to the time of day (peak/off-peak) and day of week or by the level of congestion on a roadway or facility. While value pricing has potential in many different contexts, the primary purpose of value pricing a managed lane is to manage demand by varying the pricing so that the facility is not allowed to become congested. Higher tolls are usually charged when congestion is heaviest and delay is at its worst, while lower tolls or free access may be provided to some or all users during periods of lowest demand and free-flow conditions on all lanes. Pricing is applied to better balance demand-to-lane capacity, and it can encourage some peak period users to shift to lower demand periods. Pricing can give preference to selected user groups, as has been demonstrated on several HOV lanes, so that lower-occupancy vehicles pay a higher price than higher-occupancy vehicles. Pricing is implemented using electronic toll tag readers, and all vehicles are required to have a toll tag to use the managed lane facility.

Pricing has been implemented in a limited number of areas on existing HOV lanes. Value pricing may permit all vehicles to access the managed lanes or only a select user group. Revenue generated from value pricing in these situations typically covers the administrative costs associated with toll collection and may help partially cover other expenditures such as capital costs associated with construction or operation costs associated with providing enforcement or transit services. Enforcement of pricing may be automated if electronic toll tags are employed and all users are treated equally, or enforcement may be more complicated if pricing preferences are applied to selected users, thereby requiring increased onsite law enforcement.

Value pricing examples on previous HOV lanes can be found on I-15 in San Diego, I-10 and US-290 in Houston, and SR 91 in Orange County, California. The latter is an example of a managed roadway that provides access to all traffic for a toll and preferential or free pricing to HOVs. SR 91 connects HOV restricted lanes located on either end of the project as part of a systemwide dedicated lane system.

2.1.3 Access

Limiting access has traditionally been applied to HOV and express lanes as a means of regulating entry and exit movements. Restricting access by this means helps ensure that the lanes do not become overloaded regardless of the level of demand that they generate, and access restrictions may help alleviate specific bottlenecks where short distance trips cause a lane to exceed its capacity.

Figure 5. Access Gating Applied on I-5 in Seattle

HOV access restrictions are applied on most lane treatments in the Los Angeles area where system demand is high. Access is also restricted in various multi-lane facilities and on reversible facilities where positive separation between opposing flow is required. On some roadways, like the New Jersey Turnpike, access is managed or metered between separate, parallel roadways, thereby giving preferential service to one of the two roadways during incident conditions. Access can be restricted under normal conditions by:

1. metering demand at entrance ramps via the use of traffic signals or gates;
2. limiting access at specific ramps to selected users such as HOVs (e.g., I-5 Seattle downtown ramps); or
3. limiting the number of entrance and exit ramps so that free flow is ensured along restricted lanes (e.g., I-5N Seattle, I-94 Chicago, and I-15 San Diego).

In several areas, such as Chicago and Seattle, this latter application is sometimes referred to as *express lanes*, and the lanes are open to all traffic. Once traffic enters the express lanes, vehicles can typically travel at unimpeded speeds to downstream exits. Some restricted access lanes like those in Seattle and New Jersey include HOV priority ramps or HOV lanes, or they connect to HOV lanes on either end.

2.2 Goals and Objectives of Managed Lanes

The following HOV/managed lane goals and objectives were identified and developed with local Las Vegas stakeholders in workshops held in Spring 2005. Stakeholders discussed parameters and considerations for each:

- Optimize the movement of people and goods;
- Provide incentives to share the ride;
- Increase bus transit efficiency;
- Not unduly impact traffic operations or transit services;
- Have public support;
- Consider value pricing as a means to optimize system performance; and
- Promote goods movement by trucking if possible.

More details about the goals are provided in NDOT's *HOV/Managed Lanes and Ramp Metering Implementation Plan* (March 2006). The document details statewide HOV policy and provides the following objectives:

- Increasing person-moving capacity of the roadway;
- Promoting transit and ridesharing mode split;
- Optimizing vehicle-carrying capacity;
- Promoting travel time savings, reliability, or efficiency for selected travel modes;
- Promoting air quality by increasing ridesharing and transit as part of a conformity plan;
- Increasing funding opportunities for new mobility improvements;
- Enhancing existing transit investments and services in the region/corridor;
- Providing a greater choice in serving multi-modal needs (i.e., people, goods, services);
- Improving the movement of commerce (i.e., goods and services movements); and
- Supporting community land use and development goals, particularly to major areas of employment.

Fundamental to these goals and objectives is an implicit set of conditions that should exist for managed lanes to be considered a viable project. These conditions include the following:

- A recurring congestion problem at LOS D or worse within a corridor or region for a significant period of time each weekday.
- A significant backlog of unmet travel demand, and/or lack of available resources (i.e., right-of-way (ROW), funding, regional consensus. or environmental issues) to address capacity deficiencies in a more conventional means through adding roadway or transit capacity.
- An interest and ability to minimally increase roadway capacity by managing its use to specific dedicated purposes to ensure that a high level of service can be provided as an alternative to recurring congestion.

Ultimately, the goals and objectives that are set for a corridor improvement or managed lanes project should dictate the operational strategies employed.

There are certain cases where regional needs will justify the consideration of managed lanes, particularly where demand on specific links in a system is so severe that the system may not perform without a broadened user definition. This case is probably true for I-15 between

I-215 and Interstate Highway 515 (I-515) in Las Vegas, where reliance on this transportation link, both regionally and locally, carries greater emphasis in future years. The ability to address major capacity improvements in this link will become progressively more difficult over time.

2.3 Types of HOV Lanes

In meeting the unique challenges and opportunities associated with each corridor's needs, various types of HOV lanes have been developed. This section addresses the following HOV lane orientations that may be considered in corridor evaluations. Each is described in more detail in the following sections.

- Concurrent flow
- Reversible flow
- Contraflow
- Queue bypass

2.3.1 Concurrent-Flow Lanes

Two-way or concurrent-flow operation involves the dedication of at least one lane in each direction of travel next to the median barrier, either during the respective peak period or at all times. This operation is appropriate where directional distribution is rather even (less than 60/40), and demand and congestion is evident in both directions of travel. The geographic dispersion of trip patterns in many emerging sunbelt cities, such as Las Vegas, and suburban settings around the U.S. exhibit this characteristic. The use of two-way operation eliminates the need for directional traffic control features, allows for continuous use or part-time use, and is the most flexible to fit within an existing freeway, where bridge columns and other freeway furniture are located such that symmetrical widening is the only approach that is practicable. For these reasons, concurrent-flow lanes far surpass all other forms of freeway managed lane treatments and orientations, representing approximately 70 percent of all route-miles implemented.

The orientation of concurrent-flow lanes is typically next to the median to serve high volume, high speed traffic. Several outside "shoulder" bus lanes exist in various cities (e.g., Minneapolis, Toronto, Ottawa, and Vancouver), and they are primarily applied where both ramp volumes are low and bus volumes are low, thus alleviating any cross-over friction. Most HOV/ managed lanes carry a traffic volume that would preclude consideration of right-side lanes for safety reasons, and for the Las Vegas area, they are not recommended for consideration in this regional study.

Concurrent-flow lanes have many different forms of access and separation treatments. While most are separated by a narrow buffer from adjacent lanes, examples exist that are separated by concrete barriers and plastic traffic channelizers or pylons. Some lanes operate only part time, reverting to general use during off-peak periods, thus allowing for continuous access. Still others allow continuous access across a buffer-separated area using dash skip-striping.

Figure 6. Examples of Concurrent-Flow HOV Lanes, Single- and Dual-Lane Orientations with Continuous Access (above) and Limited Access (below)

Concurrent-flow lanes should be considered when:

- Corridors have balanced directional splits (less than 60/40);
- Substantial congestion exists in both directions; and
- Design makes this approach the most cost effective from a capital and operation and maintenance perspective.

Table 1 shows the major advantages and disadvantages of concurrent-flow HOV lanes.

2.3.2 Reversible-Flow Lanes

Reversible-flow operation can be appropriate when there is a substantially higher demand traveling in one direction than the other, and when the heavy travel demand reverses between the morning and afternoon peak periods. Unequal directional traffic distribution exists in urban areas where most of the residents who live in outlying suburbs commute to their places of employment in the morning peak period and return home in the evening peak period. The observed directional split, or lack thereof in some corridors, can depend on the number of available mixed-flow lanes, nature of commute trips, and dispersion characteristics of the commuters. Because of the need to safely separate oncoming freeway traffic and avoid confusion, reversible-flow operations are

Table 1
Concurrent-Flow HOV Lanes: Advantages and Disadvantages

Potential Advantages	Potential Disadvantages
Cost effectiveness, since fewer modifications are typically required and demand can be served in one or both directions for the same relative construction investment. Less ROW is required than with other treatments. Faster implementation, particularly if widening can occur within an existing median.	Lower performance (i.e., slower speeds and vehicle throughput than other treatments) due to side friction caused by stopped or slow- moving traffic. Greater likelihood that incidents on either managed or general purpose roadway will affect both traffic streams. Enforcement made more complicated by traffic able to enter and exit lane indiscriminately. Unless barrier separated, potential safety issues may arise. Some recent studies show a higher than average accident rate associated with speed differentials between parallel traffic streams. Users may have difficulty merging across the general purpose lanes to enter and exit the concurrent-flow lanes, although most projects report that ingress/egress movements, whether allowed continually or at designated locations, can operate well without adversely affecting performance.

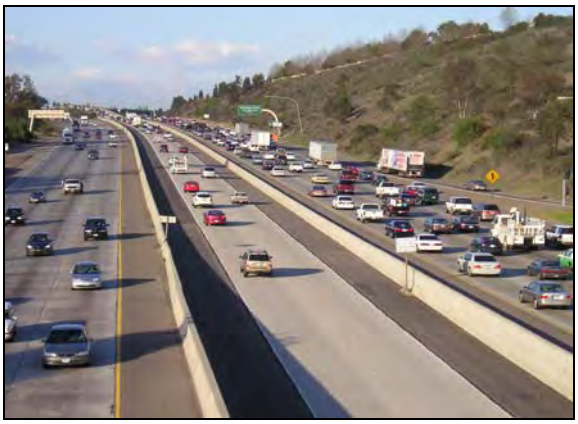


Figure 7. Examples of Reversible-Flow HOV Lanes, Single- and Dual-Lane Orientations

always barrier-separated, gated, and controlled through a combination of remote and onsite monitoring. Some limited onsite deployment personnel is needed, and this need should be mirrored in the estimated capital and operation and maintenance costs.

Reversible lanes should be considered when:

- Corridors have high directional splits (greater than 60/40) of the target market of travelers; and
- Substantial congestion will exist in one direction, and a low or tolerable level of congestion will exist in the other (off-peak) direction during the peak periods.

Table 2
Reversible-Flow HOV Lanes: Advantages and Disadvantages

Potential Advantages	Potential Disadvantages
Positive separation from adjacent traffic operations, thereby improving performance. **Better service in the only direction where congestion warrants a dedicated lane treatment.** **Easier enforcement.**	**Higher cost than other treatments, as widening may require replacement of median-oriented bridge columns, signs, and drainage structures.** **Greater need to monitor and quickly respond to incidents, and potential for wrong-way movements.** **Harder to respond to incidents due to infrequent access openings.** **Harder to sign and mark.** **Onsite personnel required to confirm proper deployment and closure, even if the traffic controls are automated.**

Table 2 shows the major advantages and disadvantages of reversible-flow HOV lanes.

2.3.3 Contraflow Lanes

Much like reversible-flow lanes, contraflow operation requires a select set of conditions in which demand is strong in a peak direction and unused roadway capacity exists in the off-peak direction. One or more off-peak lanes are borrowed for peak direction HOV use by the daily deployment (placement and removal) of moveable barriers or pylons to separate the opposing flows. Contraflow lanes are created only for the specified operating period and returned to general traffic lanes at other times. For example, a contraflow lane borrows an outbound lane in the AM peak and converts it to inbound HOV operation, or vice versa in the PM peak. This strategy requires unique conditions to exist, such as safe places for HOVs to cross over the median at each end of the project to enter the lane, space to place and store moveable barriers and barrier moving machinery next to the median, and a commitment to daily operations by a team of trained personnel to move and place barriers or pylons, and activate other traffic control devices.

Figure 8. Example of a Contraflow Lane Operation using Moveable Barriers

Contraflow lanes should be considered when:

- There is a high directional split (greater than 60/40) of the target market of travelers and where the remaining lanes for off-peak direction traffic will not be adversely affected by the loss of borrowing one or more lanes.
- There is little need for intermediate access (long-distance demand with common trip ends).

Table 3 shows the major advantages and disadvantages of contraflow HOV lanes.

Table 3
Contraflow HOV Lanes: Advantages and Disadvantages

Potential Advantages	Potential Disadvantages
Relatively low-cost way of adding capacity and addressing traffic congestion in some corridors where excess off-peak roadway capacity exists. **Easy to enforce and regulate at a single entrance point.** **Relatively safe, with a proven track record in a limited number of locales.**	**High operating and maintenance costs compared to other HOV lane treatments.** **Limited access, best when operating as a "pipeline" between an entrance and exit.** **Safety concerns may also be higher with contraflow facilities that are not barrier separated, requiring consideration of exclusive use by professional drivers.**

2.3.4 Queue Bypass Lanes

The nature of congestion may warrant a short-distance dedicated lane around an isolated bottleneck. This treatment is termed a queue bypass. Queue bypasses allow buses, HOVs, or trucks to save time by avoiding congestion associated with an isolated bottleneck. The bottleneck may be operationally induced by factors such as congestion bottleneck or may be artificially induced by factors such as a ramp meter, ferry dock, or toll plaza. Queue bypasses offer a dedicated lane for HOVs to bypass bottlenecks. If located at a ramp meter, the HOV lane may be metered at a more frequent rate or not metered at all.

Queue bypasses can be considered in conjunction with (or separate from) longer distance median HOV lane treatments on the same roadway. There are hundreds of HOV queue bypasses operating along freeway entrance ramps in a number of states, including Nevada. The largest number is located in California.

Queue bypasses can be considered when:

- Congestion is limited to a site-specific location.
- Modest HOV time-saving benefits can be provided for a relatively low cost.
- Demand for the bypass is low.

Table 4 shows the major advantages and disadvantages of queue bypass HOV lanes.

Figure 9. Examples of Freeway Ramp Meter Bypasses

Table 4
Queue Bypass HOV Lanes: Advantages and Disadvantages

Potential Advantages	Potential Disadvantages
Cost effectiveness, since only a limited amount of widening is required for a short distance. **Fast implementation, due to the modest nature of the improvement.** **Can be a "stand-alone" improvement not requiring full consideration of HOV lanes and supporting facilities in a corridor.**	**Modest benefits, not typically sufficient to generate mode shifts into transit or rideshare modes.** **Enforcement made more complicated by traffic able to enter and exit lane at will.** **Users may have difficulty merging into and out of the bypass lane.**

2.3.5 Access Connections

Access may be continuous or at designated locations along concurrent-flow HOV lanes. If access is designated, openings can be delineated through striping with the adjacent lanes or through direct access ramps, as shown on the next page. Direct access ramps reduce weaving across the general-use lanes and provide time savings for high HOV volumes. Such access ramps typically serve both directions, since the lanes are patterned similarly. Low-speed access ramps can service local streets and transit facilities. High speed ramps service major interchanges where one HOV lane accesses another.

Reversible and contraflow lanes require access only at designated locations that can be gated. The associated access connector can be reversible flow that serves only the peak direction. More information addressing the different HOV lane and access designs can be found in the NDOT *HOV/Managed Lane Design Manual* (November 2005).

Figure 10. Examples of Two-Way Connector Ramps

Figure 11. Examples of Reversible Connector Ramps

2.4 Operating Thresholds

The goal of an HOV/managed lane is to provide travel time savings and travel time reliability to eligible vehicles. Requirements must be established at an operating level that will sustain benefits to the largest number of users, without creating too much demand to make the lane congested. Accordingly, the lane cannot be allowed to reach capacity. This operational threshold for the minimum condition (opening year) is based on the perception of the HOV lane appearing adequately utilized. The threshold on the upper end is LOS C or better, based on the

eligible vehicle mix. For planning purposes, this value is approximately 1,650 vehicles per hour per lane for a single directional lane and 1,800 vehicles per hour per lane for multiple lane facilities.

The number of vehicles using an HOV/managed lane on opening day and during the initial phases of a project should be high enough to justify the restricted use of the facility and keep public perceptions acceptable. If the public perceives an HOV/managed lane to be underutilized during peak demand conditions, then pressure may be exerted to reduce or eliminate entry requirements. The level of public perception may be specific to the region or maturity of the system. The number of buses within the HOV traffic stream can also positively affect public acceptance. The minimum threshold for a specific project will depend on the specific corridor objectives, type of facility, vehicle eligibility requirements, level of congestion and local conditions, and public perceptions. Table 5 provides a set of thresholds for different freeway managed lanes.

Table 5
Vehicle Volume Operating Thresholds for HOV/Managed Lanes

Facility Type	Vehicle Volume Threshold (vehicles/lane/hour)		
	Minimum (opening year)	Minimum (design year)	Maximum
Barrier separated, one or two lanes each direction	700	1,000	1,650-1,800
Barrier separated, reversible flow, one or two lanes	700	1,000	1,650-1,800
Concurrent-flow (not physically separated), one or two lanes each direction	500	1,000	1,650-1,800
Contraflow (borrowed lane in off-peak direction separated by temporary barrier)	200	800	800-1,500
Bypass lane or direct access ramp at an interchange	250	1,000	depends on downstream merge volumes
Ramp meter bypass	Greater than 50	100-200	Not applicable

Source: NDOT *HOV/Managed Lanes and Ramp Metering Implementation Plan.*

A variety of managed lane alternatives was considered for the Las Vegas Valley. Toll lanes in the center of I-15 south of Las Vegas to the planned Ivanpah airport were discussed. HOT lanes were contemplated particularly in the early years of an HOV program when HOV demand may be low and substantial capacity available for other vehicles in the HOV lanes. Other managed lane concepts were considered during the course of this study. A system of HOV lanes is recommended for implementation with management of those lanes to be revisited as portions are planned and implemented.

3.0 Evaluation Criteria

A regional HOV planning process usually involves an initial screening of the potential for HOV lanes based on a review of existing and forecast travel conditions when compared to a set of baseline and forecast transportation improvements in the regional plan. The purpose of screening is to determine if specific conditions, including the presence of congestion, travel time benefits, and demand, are present to make HOV lanes appropriate. Screening is usually qualitative, involving input from a wide range of stakeholders.

The screening process involves identifying candidate corridors and testing present and future conditions. HOV lane strategies do not fit all congested settings, and even where the screening criteria are met, other factors, such as available space to add lanes, may be lacking. Criteria for regional planning screening tend to be more qualitative in nature, taking into account both the availability of data and the need to examine issues on a larger scale to fit variances in corridor characteristics and market needs. Criteria recommended for this study included:

- Congestion: The presence of severe and recurring congestion indicates that congestion management strategies, including HOV, managed lanes, and ramp metering, may be appropriate. A common measure is average travel speeds of 30 miles per hour (mph) or less for at least 2 hours during each peak commute period.

- Bottlenecks. Specific traffic bottlenecks or congestion points may cause significant delays. The existence of bottlenecks may point to the need for some kind of dedicated lane treatment, such as direct access ramps to provide a bypass.

- Transit Service. The level of transit service on a candidate roadway can provide an indication of the need for an HOV lane. Bus volumes may justify consideration of some type of HOV lane treatment, particularly at bottlenecks. Factors can include the number of buses, anticipated ridership levels, and bus operating time savings.

- Travel Patterns. Examining the travel patterns, including origins and destinations served by a potential HOV lane, is important to determining the viability of HOV or managed lanes. Trips need to be long enough on a given route to generate time savings that cause spatial and modal shifts into the HOV or managed lane. At the sketch-planning level, this analysis usually focuses on travel producers, such as residential areas and attractions, which include major employment and activity centers.

- HOV Demand. Existing and likely levels of transit, carpool, and vanpool demand in a corridor can be used to provide information on the potential use of an HOV lane. Vehicle occupancy counts and other available information on potential eligible vehicles in a corridor can be used to ascertain whether enough demand exists to justify a dedicated lane. Minimum demand is critical to determine whether an HOV lane can be a success in its opening year. Person throughput, generated from an assessment of demand, can determine if an HOV lane will move more people than a general purpose lane. However, the public's perception of success in the HOV lane is also dependent upon the number of vehicles using the lane.

- Available Space. Extra HOV or managed lanes can be provided either by widening the affected route or through modifying the existing roadway lanes and shoulders to provide for added capacity. Conversion of existing general-use lanes is not considered an acceptable means of accommodating HOV demand.

- Connectivity/Continuity. The success of an HOV/ managed lane system may be enhanced if it is part of a larger system of lanes. A specific link in a regional system may affect, or be affected by, other links. Consideration should be given at the regional screening level to those HOV lane segments that are critical to an overall network plan. Key links may be needed through interchanges or with major activity centers. For example, eligible vehicles may experience significant delays getting from one dedicated lane to another, or weaving into and out of the lane to reach ultimate destinations.

Thresholds for each criterion that indicate the potential success of an HOV application are identified in Table 6. Potential tools to evaluate whether each criterion is met in a regional screening process are provided in the table.

Not all of the criteria were used in the Las Vegas HOV screening process due to data limitations. The criteria used and the results of their application are described in Section 4.0. The criteria were applied at the corridor level and rated as having a high, moderate, or low potential for successful HOV implementation. The rankings may be used to prioritize corridors for further evaluation. These criteria may be used for both HOV freeway segment and HOV direct connector facilities.

Table 7 summarizes criteria identified and adopted for corridor screening in this study, along with thresholds used to assess each. Comparable values or qualitative measurements, as indicated, were applied to each of the criteria to measure the relative suitability of each analysis segment for HOV lanes.

For quantifiable measures (i.e., presence of congestion, bottlenecks, and HOV demand), data were derived from the results of the future year travel forecasting described in Section 4.0. Traffic volumes, travel speeds, and V/C ratios for the forecast year 2030 were obtained and compared for the purpose of the screening evaluation.

Travel patterns was the only criterion in which there was not adequate data to differentiate corridors. Overall average trip lengths of more than 8 miles reflected sufficiency to justify HOV lanes but not enough information from demand forecasts to differentiate findings by corridor.

Based on a qualitative and comparative ranking for the above criteria, each candidate corridor received an overall ranking that ranges from high to low in a scale of up to five (using a format similar to that utilized by *Consumer Reports*) for purposes of screening. This ranking can also be used to prioritize corridors for further evaluation. Corridor segments that lack sufficient demand and congestion in 2030, if not found to be critical in addressing a bottleneck or system connectivity, will be eliminated at this stage of the study.

Table 6
Regional Screening Criteria

Criteria	Threshold(s) to be Met	Input or Tool
Presence of Congestion	• Speeds below 30 mph for year of implementation and planning horizon (design) year, for at least 2 hours during each commute period.	• Speeds, vehicle/capacity from available traffic data (existing condition) and regional model (forecast condition).
Bottlenecks	• Speeds below 30 mph for potential opening year and planning horizon year, for at least 2 hours during each commute period.	• Speeds, vehicle/capacity from available traffic data (existing condition) and regional model (forecast condition).
Transit Service	• Minimum number of buses or ridership for existing and future transit services and plans, based on local policy. Generally at least 6 buses per hour are needed to justify a bottleneck bypass or direct-access ramp. • Bus operating time savings potential.	• Transit agency route system and service plan.
Travel Patterns	• Average trip distances on freeways of 5 miles or more. • Accrued travel time delay (comparison of peak to off-peak) on a given freeway route of 3 minutes minimum per trip, and 5 minutes per trip desirable. • Trip affinities for specific defined employment generators (High: Within 1-mile of existing industrial/commercial area. Moderate: Within 1-mile of planned industrial/ commercial area. Low: Neither of the above).	• Select link analysis from regional model or from origin/destination information. • Travel times based on comparison of HOV lane to general purpose lanes, assuming 55 mph for HOV lane.
Demand	• Meets minimum demand threshold for a specific implementation year (500 vehicles per hour [vph] or 1,000 persons per hour [pph] directionally) by 2010.* • Meets person-moving equivalency of approximately 1,000 vph or 2,000 pph directionally by planning horizon year (design year).* • Approximately half of these volumes are needed to justify a major HOV lane direct access connector between two intersecting freeways.	• HOV demand from regional model. • Sketch-planning output based on available occupancy and corridor speeds.
Available Space	• Ability to widen roadway based on cursory investigations, or • Ability to modify roadway through minor changes in geometrics or design exceptions, perhaps on an interim basis.	• As-built roadway plans or programmed plans and studies.
Connectivity/ Continuity	• Identification and validation of critical links in the system first. • Identification of key access links between segments of a system. • Part of a longer HOV/managed lane facility.	• Demand output from regional model and select link analysis for identified high volume movements between corridors.

** Note that this threshold holds true for a single concurrent-flow HOV lane on a freeway.*

Table 7
Criteria Thresholds for Screening HOV Lanes

Evaluation Matrix for Screening Las Vegas HOV Corridors					
Criteria Thresholds					
Criteria	***High*** ← 5	4	***Moderate*** 3	2	***Low*** → 1
Presence of Congestion	Many links with peak period travel speeds below 30 mph in peak direction and/or several links below 25 mph	Several links with peak period travel speeds below 30 mph in peak direction and/or isolated links below 25 mph	Several links with peak period travel speeds between 30 mph and 40 mph in peak direction and/or isolated links below 30 mph	Peak period link speeds generally between 40 mph and 55 mph	Peak period link speeds generally exceeding 55 mph
Bottlenecks	Many links with peak period V/C exceeding 1.00 in peak direction and/or several links exceeding 1.10	Several links with peak period V/C exceeding 1.00 in peak direction and/or isolated links exceeding 1.10	Several links with peak period V/C between 1.00 and 0.90 in peak direction and/or isolated links exceeding 1.00	Peak period link V/C generally between 0.90 and 0.70	Peak period link V/C generally below 0.70
Transit Service Potential	Qualitative assessment based on affinity for transit service to generate six (6) or more express bus trips per hour in the peak direction				
HOV Demand	Many links with peak hour HOV volumes exceeding 1,500 vph in peak direction and/or several links exceeding 1,700 vph	Many links with peak hour HOV volumes exceeding 1,000 vph in peak direction and/or several links exceeding 1,500 vph	Many links with peak hour HOV volumes between 900 vph and 1,000 vph in peak direction and/or several links exceeding 1,000 vph	Peak hour link HOV volumes generally between 500 vph and 900 vph	Peak hour link HOV volumes generally below 500 vph
Available Space	ROW acquisition has already cleared the National Environmental Policy Act (NEPA) procedures	Sufficient ROW generally available without substantial impacts	ROW proposed to be acquired for other freeway improvements (not including HOV)	Sufficient ROW generally <u>not</u> available without substantial impacts	
Connectivity Needs	Key access links between segments identified				

4.0 Screening for HOV System Potential

To evaluate the potential of HOV facilities in the Las Vegas Valley using the criteria explained in the previous section, a set of appropriate data were needed. Much of the data required the development of a travel forecasting model with a mode split component producing forecasts differentiating between travel in HOVs and single-occupant vehicles (SOVs).

The RTC travel forecasting model was upgraded with such a mode split model. To validate the mode split model, existing vehicle occupancy data were needed. This section describes the collection of existing vehicle occupancy data and provides a summary of current vehicle occupancy rates. The section also reviews the mode split model and the assumptions and methods used in forecasting HOV and SOV traffic volumes.

HOV freeway volumes output by the forecasting model for year 2030 are reviewed, along with year 2030 overall freeway V/C ratios as measures of congestion. These data are used in the screening of freeway corridors for HOV potential, which is presented at the end of the section.

4.1 Existing Vehicle Occupancy

Vehicle occupancy data were collected along each of the following seven corridors:

- I-515;
- Project NEON, I-15;
- I-15 South;
- I-15 North;
- US-95 NW;
- Summerlin Parkway; and
- Southern Beltway, I-215.

The vehicle occupancy information was manually collected between Tuesday, September 20, 2005, and Thursday, September 22, 2005. The data collection schedule for the study locations is provided in Table 8.

Table 8
Vehicle Occupancy Counts Schedule

Roadway	Count Location	Peak Hour Direction	Lanes	Day	Date
I-15	Carey	AM – Southbound PM – Northbound	5	Tuesday	09-20-05
I-15	Tropicana	AM – Southbound PM – Northbound	6	Tuesday	09-20-05
I-215	Gilespie	AM – Westbound PM – Eastbound	8	Tuesday	09-20-05
I-515	Harmon	AM – Northbound PM – Southbound	8	Wednesday	09-21-05
US-95	Smoke Ranch	AM – Southbound PM – Northbound	7	Wednesday	09-21-05
Summerlin Pkwy	Durango	AM – Eastbound PM – Westbound	4	Wednesday	09-21-05
I-15	Warm Springs	AM – Northbound PM – Southbound	6	Thursday	09-22-05

4.1.1 Occupancy Data Collection

For each of the study count locations, vehicle occupancy and classification data were collected for both directions of travel using the following approach. Mainline counts utilized a sampling procedure. Each lane of the freeway was sampled during four 30-minute time periods, based on the number of lanes at the count location as shown below:

- 2 lanes sampled for 12 minutes per lane and a 6-minute break in a 30-minute period (40 percent sample per lane);
- 3 lanes sampled for 8 minutes per lane and a 6-minute break in a 30-minute period (27 percent sample per lane);
- 4 lanes sampled for 6 minutes per lane and a 6-minute break in a 30-minute period (20 percent sample per lane).

For instance, a 4-lane freeway was counted at 6 minutes per lane, with 24 minutes worth of counts over the 4 lanes, and then there was a 6-minute break before starting the count over again. Consequently, all freeways were counted for 96 minutes out of a 120-minute time period.

Additionally, the study focused on collecting the occupancy rates for work trips, as the sampling was performed during the AM (6:30-8:30) and PM (4:00- 6:00) peak periods when most people commute to and from work. The occupancy counts were collected on a Tuesday, Wednesday, and Thursday, as these days are considered most representative of average weekday travel behavior and commute conditions.

Vehicle occupancy rates (VORs) were calculated by counting both passenger cars and the number of people at a given location. The number of people divided by the number of cars is the average vehicle occupancy for that location.

4.1.2 Occupancy Data Collection

Table 9
Auto Occupancy Rates and Truck Percentages

Count Locations	Occupancy Rates			Truck Percentages		
	AM	PM	Combined AM/PM	AM	PM	Combined AM/PM
I-15/Carey	1.24	1.22	1.23	15.5	9.1	12.5
I-15/Tropicana	1.30	1.38	1.34	9.0	7.4	8.1
I-15/Warm Springs	1.13	1.26	1.20	12.2	8.6	10.3
I-515/Harmon	1.14	1.19	1.17	5.3	2.4	3.8
Summerlin Parkway/Durango	1.11	1.18	1.15	1.4	0.5	0.9
I-215/Gilespie	1.09	1.14	1.12	3.4	1.4	2.3
US-95/Smoke Ranch	1.15	1.15	1.15	0.9	0.6	0.7

Table 9 lists the resulting VORs for the AM, PM, and combined AM/PM periods for the various study locations. Truck percentage information on each of the facilities is also included as a supplement to the occupancy rate information. A graphic representation of the VORs is presented in Figure 12.

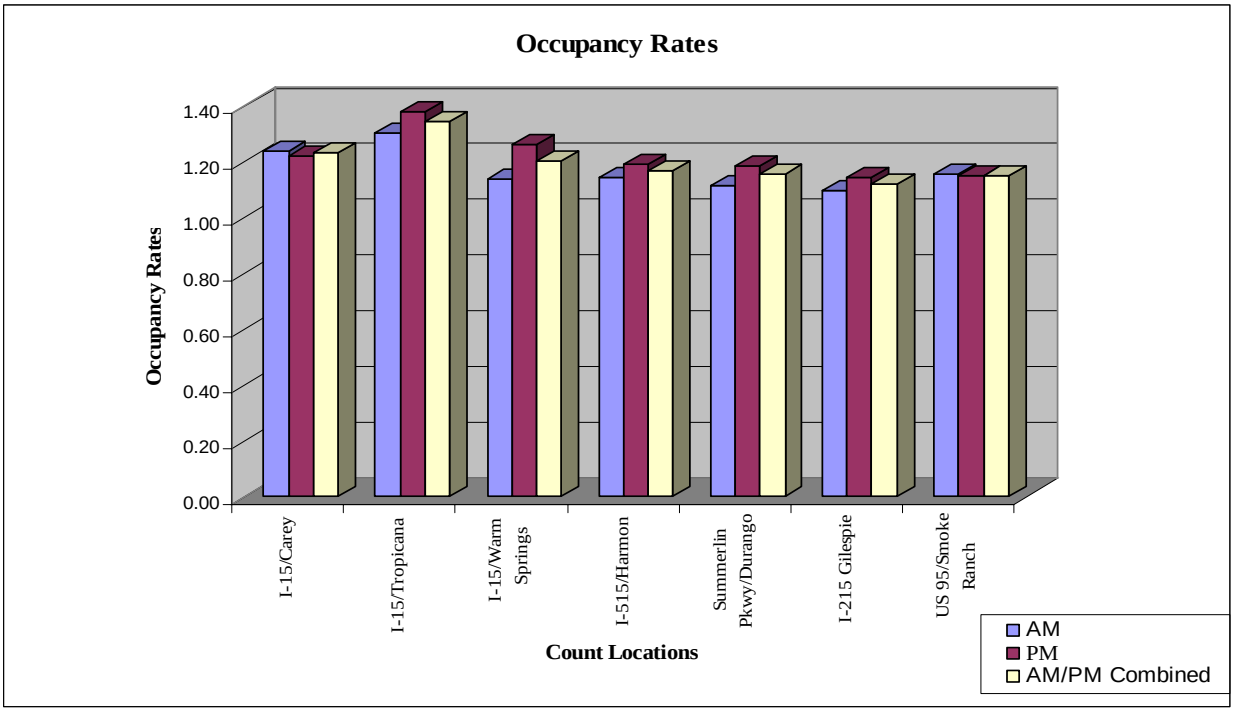


Figure 12. Auto Occupancy Rates Plot

The results follow typical trends in vehicle occupancy data. Generally, the PM VOR at each study location is higher than the AM VOR. Slightly higher VOR values in the PM peak hour may be attributable to the fact that people are more likely to make discretionary trips, such as shopping in the evening, as opposed to driving alone during the typical peak morning commute period.

Another interesting observation is that the VORs along I-15 are slightly higher than those observed on other freeway facilities in the Valley. I-15 runs parallel to the resort corridor along Las Vegas Boulevard and provides a number of convenient access points to the resorts for commuters and tourists alike. Tourist vehicles are likely to carry two or more people per vehicle. Additionally, the resort corridor, a very large and densely populated workplace, may have a higher volume of employee carpools or vanpools compared to other parts of the Valley.

4.2 HOV Forecasting Model

The RTC 2004 Regional Travel Demand Model has been updated to include optional transit processing and mode choice modeling capabilities. The modeling procedures were developed based on the transit system that existed in 2002, along with information from the on-board transit survey conducted in 2002. By design, the mode choice model includes the capability to estimate shared-ride auto use by group size.

Model constants were calibrated to reproduce observed two-person and three-or-more-person shared-ride auto use by trip purpose for 2002. The estimates of the observed two-person and three-or-more-person shared-ride auto use were based on 1996 household survey data.

The mode choice model includes coefficients for HOV travel time savings. The coefficients could not be rigorously calibrated since HOV lanes were nonexistent in the region in 1996 when the data were collected. As a result, the model coefficients were specified based on models developed in other regions. Because of the inability to calibrate the coefficients, sensitivity testing is an important consideration in forecasting HOV lane use. Table 10 from the May 5, 2006, revised draft of *Transit Processing and Mode Choice Modeling Capabilities for the RTC 2004 Regional Travel Demand Model, Model Methodology Technical Memorandum* (Chapters 10-12 of RTC 2004 Regional Travel Demand Model with Mode Choice) shows that the shared-ride modes increase by 0.2 percent of system-wide trips under an extensive HOV build alternative.

The amount of modal shift occurring in the model is reasonable and supports the use of the mode choice model HOV coefficients. The mode shift to the shared-ride modes under this sensitivity testing is an indicator of the reliability of the model when used to test specific alternatives with HOV facilities. The actual amount of mode shift will vary with the package of facilities being tested. Consequently, the number of shifted trips shown in Table 10 is not an indicator of the amount of modal shift taking place due to the HOV facilities evaluated for this study, but of the reliability of the model specification in forecasting that shift. Based on the amount of shift in the test as reported in Table 10, the model specification was deemed to be appropriate for HOV forecasting and was used in the forecasting for this study. Except for the mode shift model, which has not been formally endorsed by the RTC for regional travel forecasting, the forecasting for this study relied on the approved regional forecasting model and procedures.

Table 10
HOV Time Savings Coefficient Reliability Testing
Sensitivity Testing using Mode Shift of Year 2030 Daily Trips

Mode	No Build	Build	Difference	% Change
Drive Alone	5,197,452	5,197,383	(69)	0.0
Shared Ride 2	3,140,653	3,142,550	1,897	0.1
Shared Ride 3+	2,754,531	2,755,983	1,452	0.1
Walk to Local Transit	211,198	208,097	(3,100)	-1.5
Walk to Premium Transit	31,348	31,490	142	0.5
Drive to Transit	4,704	4,382	(322)	-6.8
Total	11,339,885	11,339,885	(0)	0

4.3 Year 2030 HOV Forecasts

Figure 13 presents the HOV volumes forecast for the year 2030 freeway network under the No Build condition. The No Build condition assumes that the freeways have the total number of lanes included in the 2030 RTP shown in Figure 1. No HOV lanes are assumed to exist in the No Build condition except for the single lane in each direction included in the US-95 project west of the Spaghetti Bowl to North Durango Drive, a portion of which is currently under construction. The No Build condition also includes a single HOV lane in each direction on Summerlin Parkway east of Rampart Boulevard. The HOV volumes shown in Figure 13 are the total forecast HOV volumes on the roads regardless of whether the vehicles are forecast in the HOV lanes or the general purpose lanes.

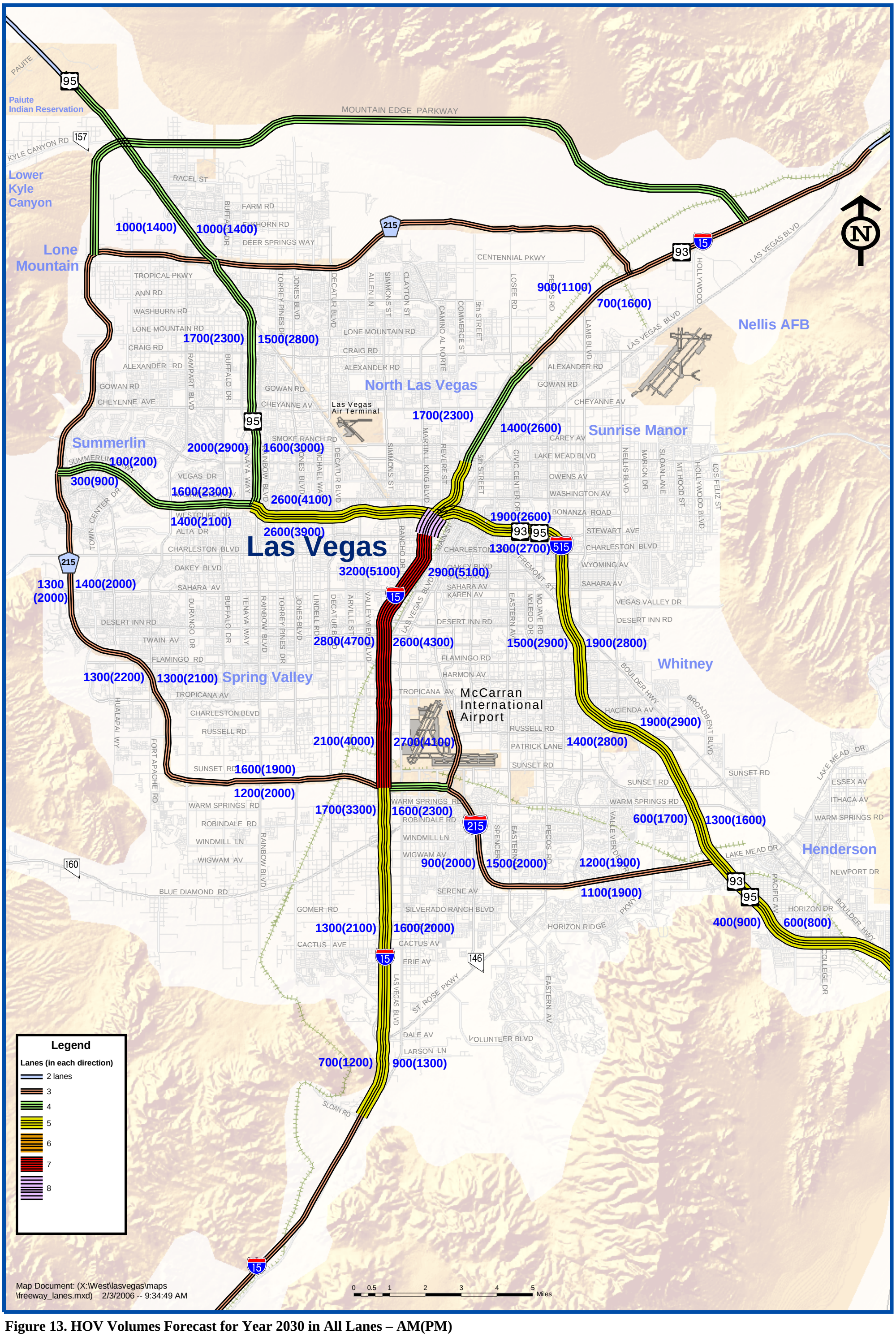


Figure 13. HOV Volumes Forecast for Year 2030 in All Lanes – AM(PM)

Figure 2 presents the V/C ratios forecast for the freeway system in year 2030. A V/C ratio of 0.90 or greater indicates LOS E or F conditions, indicative of the levels of congestion generally necessary for successful implementation of HOV lanes. The HOV volume and V/C ratio forecasts were used in the screening process to determine the potential for HOV facilities in the Las Vegas Valley and are more fully discussed in the next section.

4.4 Screening

Criteria presented in Table 11 cover six topics, including presence of congestion, HOV demand, bottlenecks, transit service potential, available space for ROW, and connectivity. These criteria were used to determine the potential for a successful HOV implementation. Quantitative information provided from regional demand forecasts were qualitatively ranked in the table on a scale comparable to the other factors. The presence of congestion and HOV demand are the most critical criteria to meet thresholds for potential HOV implementation.

The regional freeway system was evaluated on a corridor segment basis. Each criterion was applied to each segment and the results are presented below.

Table 11
Evaluation Matrix

Evaluation Matrix for Screening Las Vegas HOV Corridors — 5 4 3 2 1 (High — Moderate — Low)

Corridor	Segment	Presence of Congestion		Bottlenecks		Transit Service Potential	HOV Demand		Available Space	Connectivity needs	Segment Summary	Segment Rank
		AM	PM	AM	PM		AM	PM				
I-15	S. of I-215	3	4	5	5	3	5	5	4	-	4	5
I-15	I-215 to US 95/I-515	3	5	4	5	4	5	5	3	w/ I-215 & US 95	4	5
I-15	US 95/I-515 to CC-215N	3	4	4	5	3	5	5	4	-	4	4
I-15	N. of CC-215N	1	1	1	1	1	1	1	4	-	1	1
I-215	I-15S to I-515	4	5	4	5	3	4	5	2	w/ I-15	4	4
CC-215	I-15 to Summerlin	3	4	4	5	3	4	5	4	w/ I-15	4	4
CC-215	Summerlin to US 95	1	3	2	3	1	4	5	4	-	3	2
CC-215	US 95 to I-15N	1	2	1	2	1	4	5	4	-	3	2
US 95	I-15 to Summerlin*	3	5	3	5	4	5	5	5	w/ I-15 & Summerlin	4	5
US 95	Summerlin to CC-215*	2	3	3	5	3	4	5	5	-	4	3
US 95	N. of CC-215	1	1	1	1	2	2	2	4	-	2	1
I-515	S. of I-215	1	1	1	1	1	2	2	4	-	2	1
I-515	I-215 to Boulder Hwy	2	3	2	3	2	4	5	3	-	3	3
I-515	Boulder Hwy to I-15	3	4	3	4	3	4	5	2	-	4	3
Summerlin	US 95 to CC-215*	1	1	1	2	3	3	4	5	w/ Summerlin	3	2

Note: * = included in no-build

4.4.1 Presence of Congestion

Overall, I-15 and I-215 are forecast to be the most congested corridors by 2030, but almost all of the corridors are forecast to experience some congestion, particularly during the PM peak period. Segments on I-15, I-215/CC-215, US-95, and I-515 meet or exceed the threshold for

the presence of congestion by 2030, with peak period travel speeds in many locations falling below 35 mph.

Exceptions tend to be those segments on the periphery of the urbanized area where travel speeds are forecast to be close to free flow, with a limited number of links in the vicinity of freeway-to-freeway interchanges forecast to have congestion. In these peripheral segments, the time-savings benefits of HOV lanes would be minimized by the travel speeds on the freeway. Providing HOV lanes along the full lengths of these segments would not be necessary, although lanes serving to bypass isolated bottleneck locations (such as freeway-to-freeway interchanges) may be appropriate.

4.4.2 Bottlenecks

Similar to congestion, capacity constraints (bottlenecks) are observed in many corridors during the peak periods. Under 2030 forecast conditions, corridors experiencing substantial bottlenecks include I-15, I-215/CC-215, US-95, and I-515. Within these corridors, chronic bottlenecks are mostly observed on the approach to freeway-to-freeway interchanges. Critical bottleneck locations include I-15, US-95, and I-515 in the vicinity of the Spaghetti Bowl interchange, and I-15, I-215, and CC-215 in the vicinity of McCarran International Airport and Las Vegas Boulevard.

Isolated bottlenecks in other less-congested corridors may also support the development of HOV lanes primarily to serve the function of bypassing bottlenecks. One notable example is the Summerlin Parkway/US-95 interchange, which has links that exceed capacity during both the AM and PM peak periods. Although the forecasted lack of congestion along the full length of Summerlin Parkway may minimize the applicability of HOV lanes within this corridor, the presence of the bottleneck at US-95 indicates the suitability of providing HOV connectors through this interchange to effectively allow HOV users to bypass the bottleneck.

4.4.3 Transit Service Potential

Current RTC transit services use freeways for some conventional routings in a limited fashion, with the most recent service expansion improvements related to bus rapid transit operations along selected major arterial corridors. HOV lanes best serve express bus services in which large portions of the service routing takes place on the freeway network. The best markets for express bus service lie far enough away from major employment centers that travel savings can be gained to support mode shifts to transit. Express bus services rely on park-and-ride lots to aggregate enough demand to justify the service, typically of a sufficient size and critical demand service area to support fully loaded buses on a regular headway of no less than 15 to 20 minutes during the peak commute hours. This service level is not possible for many corridors today, but it could exist along some radial corridors. There is a greater likelihood in the future that employment centers will disaggregate into new developments, often termed exurban village centers. To the extent that this occurs, express bus opportunities may be difficult to serve on a point-to-point basis.

The best opportunity for express bus services exists in radial corridors, assuming that there is growth in the current travel markets to current employment centers that become denser over time. This prevalence appears most likely in downtown Las Vegas, along Las Vegas Boulevard, and around McCarran International Airport. Circumferential corridors are less likely

to provide a sufficient transit market to provide service frequent enough to warrant express buses. For these reasons, the radial and circumferential corridors under study were given different qualitative rankings in Table 11, commensurate with their potential distance from employment centers and forecast growth in the RTC regional model.

4.4.4 HOV Demand

HOV demand represents one of the most important criteria because demand ultimately drives lane justification and utilization. Based on the 2030 forecast model results and the assumptions presented, HOV demand exceeds the minimum thresholds in all of the study segments shown in Table 11, except for I-15 north of CC-215, US-95 north of CC-215, and I-515 south of I-215.

HOV demand is generally higher in the PM peak period than the AM peak period. In many locations, 2030 HOV demand during the PM peak period exceeds the optimal capacity for a single HOV lane.

The highest HOV demand is observed along I-15 between I-215 and US-95, on US-95 between I-15 and Summerlin Parkway, and on I-215 between I-15 and the Airport Connector. In these segments, HOV demand during the PM peak hour in 2030 is forecast to exceed 3,200 vph, which is double the optimal capacity of an HOV lane. At these levels, HOV demand in these segments is sufficient to justify two HOV lanes in each direction.

4.4.5 Available Space

The ability to add HOV lanes into the various corridors varies considerably. Availability is assumed to be easiest in yet-to-be-constructed roadway corridors and those undergoing planning studies that will result in ROW acquisition. Available space assumes the possibility to restripe inside shoulders and perhaps narrow some lanes to add HOV lanes in isolated pinch points as design deviations. Available space is much tougher in corridor segments where recent construction has been completed and fills up most of the current ROW. This condition is most apparent along I-15 between I-215 and US-95/I-515, along I-215 east of I-15, and along I-515 close to downtown. I-15 got a neutral ranking in Table 11 because of the large number of lanes and shoulders that might be able to be restriped to accommodate HOV lanes. Rankings provided reflect these characteristics.

4.4.6 Connectivity

Key movements in the system will likely require connectivity between corridors to serve high levels of HOV demand and to maximize the mobility benefits to HOV users transitioning between corridors. The following locations have been identified as critical for addressing high HOV demand for specific movements.

<u>I-15/US-95/I-515 and I-15/I-215/CC-215 Interchange Through Movements</u> – Through traffic movements at major interchanges are often subject to high levels of delay and can provide the potential to offer substantial time savings to HOV users who can avoid merging and diverging in the adjacent freeway lanes. In particular, through traffic movements at the I-15/US-95/I-515 interchange (i.e., north-south along I-15 and east-west along US-95/I-515) and the I-15/I-215/CC-215 interchange (i.e., north-south along I-15 and east-west along I-215/CC-215) represent sufficiently high demand to justify continuous HOV treatments. Although key

movements between intersecting freeways may represent higher HOV demand at these interchange locations, it is appropriate to serve the demand for through movements along the respective freeways to reduce the impact of merging as a result of HOV lane termination and to provide the maximum time savings benefits to HOV users.

US-95 North of I-15 to/from I-15 South of US-95 (Spaghetti Bowl Interchange) – At this interchange, travel between residential communities along US-95 to the northwest and employment opportunities in the resort corridor results in high HOV demand for these movements. To maximize time savings benefits to HOV users, a direct connection for these movements is necessary to bypass congestion at the Spaghetti Bowl interchange.

I-15 North of I-215 to/from I-215 East of I-15 – At this interchange, the two segments with the highest forecast HOV demand in the Valley converge. High travel demand between southeast metropolitan residential communities and McCarran International Airport and the employment and entertainment activities in the resort corridor make it appropriate to consider direct HOV connection for these movements.

Summerlin Parkway West of US-95 to/from US-95 South of Summerlin Parkway – Capacity limitations at this interchange will create a bottleneck situation for these movements. The provision of HOV direct connections will bypass this bottleneck, providing time savings for HOV users also utilizing HOV lanes on US-95. Construction of these HOV direct connectors is included in the environmental document for the current construction project on US-95, although construction of the connectors is only in the final design stage.

4.5 Corridor Screening Results

The evaluation of the regional freeway system on a segment-by-segment basis for HOV potential provides a set of findings with respect to the potential of each segment to provide benefits through implementation of HOV facilities. Those findings are summarized below and quantified in Table 11.

4.5.1 I-15 Corridor

I-15 is key to the regional freeway system, particularly from I-215 to I-515/US-95 adjacent to the Las Vegas Strip. I-15 represents the core of a regional HOV system.

South of CC-215 North, I-15 achieves the highest suitability ratings in most criteria, as shown in Table 11. In particular, HOV demand, the presence of congestion, bottlenecks, and transit service potential all emphasize the highest suitability of HOV lanes along I-15.

In the segment between I-215 and US-95/I-515, HOV demand and congestion are the highest in the region. In this segment, 2030 HOV demand is forecast to exceed 3,000 vph during the PM peak period, which is almost twice the optimal capacity for HOV lanes. At this level of demand, it will be necessary to have a multi-lane treatment in this section; otherwise, regional demand will be “metered.” However, physical limitations in this segment may preclude implementing sufficient HOV capacity to fully meet demand without utilizing elevated lanes.

As described previously, continuous HOV treatments along I-15 through the I-15/US-95/I-515 and I-15/I-215/CR-215 interchanges, and direct HOV connections between I-15 to/from the south and US-95 to/from the west and between I-15 to/from the north and I-215 to/from the east are appropriate to accommodate the high HOV demand for these movements. Furthermore, high levels of HOV demand to/from the Las Vegas Strip will necessitate the provision of HOV direct access to arterial streets at strategic locations to minimize the potential for congestion on the freeway as a result of HOV traffic weaving to/from the lanes to enter/exit the freeway.

CC-215 North represents the logical terminus for HOV lanes along I-15, with lanes extending south from this location. HOV demand and the presence of congestion are low north of CC-215.

4.5.2 I-215/CC-215

I-215, between I-15 and I-515, represents the next most critical link with a high presence of congestion, bottlenecks, and HOV demand and moderate transit potential. The highest HOV demand and congestion is observed between I-15 and the Airport Connector in the vicinity of McCarran International Airport, with 2030 demand sufficient to justify multiple HOV lanes in this location. However, physical limitations in this location may make it difficult to implement HOV lanes (along with direct connections to I-15) that provide sufficient capacity to meet demand.

The high HOV demand in the vicinity of McCarran International Airport also suggests that a direct connection between HOV lanes on I-215 and the Airport Connector would be beneficial. Combined with a direct connection between I-215 and I-15, and a direct connection between I-15 and arterial streets near the Las Vegas Strip, significant time savings could be afforded to HOV users, including transit service providers and private taxi and shuttle service providers traveling between the airport and the employment and entertainment opportunities along the Las Vegas Strip.

The segment of CC-215 from I-15 to Summerlin Parkway also ranks high overall for HOV suitability. In particular, the segment west of I-15 to Flamingo Road is forecast to have the highest levels of congestion, bottlenecks, and HOV demand. Furthermore, potential demand for through traffic movements along I-215/CC-215 at the I-15 interchange support the provision of continuous HOV treatments for this movement.

The remaining segments of CC-215 North from Summerlin Parkway to US-95 and from US-95 to I-15 rate low compared to the other segments analyzed. Despite high HOV demand, the low presence of congestion and few bottlenecks minimize the potential for time savings to attract HOV use of a dedicated lane, thereby minimizing the need for HOV lanes along these segments.

4.5.3 US-95 North and West of I-15

HOV lanes along US-95 are assumed in the RTP, and they are currently under construction in a segment of the corridor between I-15 and Summerlin Parkway. The results of the screening evaluation indicate highest suitability for HOV lanes in the segment from I-15 to Summerlin Parkway. In this segment, 2030 HOV demand exceeds 3,000 vph during the PM peak period, and the high presence of congestion and capacity bottlenecks highlights the suitability for

HOV facilities. At this level of demand, it will be necessary to provide a multi-lane HOV treatment.

The primary movement for HOV to/from US-95 at the I-15 interchange is I-15 south, necessitating the provision of HOV direct connectors to serve this demand. However, sufficient demand is also forecast for the through movements between US-95 and I-515 to justify the provision of continuous HOV treatments between these freeways.

Between Summerlin Parkway and CC-215 North, HOV demand along US-95 remains high, with bottlenecks observed in the vicinity of Summerlin Parkway. The reduced presence of congestion in this segment results in the moderate segment ranking for HOV suitability shown in Table 11. However, high demand and bottlenecks in the southern end of the segment are consistent with high suitability for HOV facilities in this location.

North of CC-215 North, HOV demand along US-95 is substantially reduced, and congestion is absent. Consistent with this forecast, the ongoing environmental and design project for improvements to US-95 north of Summerlin Parkway terminates the HOV lanes at the Durango Drive interchange, which is the first full interchange north of CC-215 North. A park-and-ride facility is planned for the Durango Drive interchange.

4.5.4 I-515

The segment of I-515 from Boulder Highway to I-15 is characterized by high forecast HOV demand, low to moderate presence of congestion, and moderate transit service potential. High levels of congestion are concentrated in the section of I-515 between I-15 and the downtown interchanges where V/C ratios are forecast as high as 0.98 in the morning peak hour and 1.06 in the evening peak hour. The results of the screening evaluation indicate a moderate ranking overall for the suitability of HOV lanes in this segment. This segment of I-515 provides a key link between I-15, US-95, and downtown Las Vegas. The provision of HOV lanes in this segment would provide a logical connection between the higher-ranked facilities described previously and the employment and transit service center of downtown Las Vegas. However, like the Las Vegas Strip and McCarran International Airport areas, development in downtown Las Vegas presents physical limitations to providing HOV lanes along this segment of the freeway.

Between I-215 and Boulder Highway, forecast HOV demand along I-515 remains high, although the presence of congestion and bottlenecks are moderate. Overall, this segment achieves a moderate rank. Contiguity with the previously described segment in the north and connectivity to I-215 in the south make this segment suitable for HOV lanes. However, this segment should represent a lower priority for implementation compared to other recommended HOV segments.

South of I-215, presence of congestion, bottlenecks, and HOV demand are low. This segment has low suitability for HOV lanes and should be eliminated from further consideration.

4.5.5 Summerlin Parkway

Overall, Summerlin Parkway achieves a low rank for HOV suitability as a segment. Despite moderate to high HOV demand in this segment, low presence of congestion and few

bottlenecks along the segment minimize the potential effectiveness of HOV lanes. However, the presence of a link bottleneck at the interchange from Summerlin Parkway to US-95 makes this location suitable for the provision of an HOV direct connection to/from Summerlin Parkway and HOV lanes on US-95. A direct connection at this location, and HOV lanes extending along Summerlin Parkway to provide transition, would enable a moderate to high volume of HOV users to bypass congestion at the interchange.

4.5.6 Summary of Findings

Based on the results of the screening evaluation, the following corridors ranked highest in suitability for HOV treatments and are recommended for more detailed consideration:

- I-15 South of I-215;
- I-15 from I-215 to US-95/I-515;
- I-15 from US-95/I-515 to CC-215;
- I-215 from I-15 to I-515;
- CC-215 South from I-15 to Summerlin Parkway; and
- US-95 from I-15 to Summerlin Parkway.

For the segment of I-15 from I-215 to US-95/I-215, US-95 from I-15 to Summerlin Parkway, and I-215 from I-15 to the Airport Connector, future HOV demand warrants the provision of multiple HOV lanes. Multiple HOV lanes in these locations should be evaluated in the context of the existing ROW limitations to determine if appropriate design, including the use of elevated lanes or parallel facilities, can be applied to achieve the necessary capacity to meet HOV demand.

In addition, the following segments, or portions of segments, ranked moderate in suitability for HOV treatments and are also recommended for further consideration:

- US-95 from Summerlin Parkway to North Durango Drive;
- I-515 from Boulder Highway to I-15;
- I-515 from I-215 to Boulder Highway; and
- Summerlin Parkway from US-95 to Rampart Boulevard as a bottleneck bypass.

Corridors ranked high and moderate in suitability for HOV facility implementation are shown in Figure 14. The following segments ranked low in suitability for corridor HOV treatments and are recommended for exclusion from further consideration:

- I-15 North of CC-215;
- CC-215 North from Summerlin Parkway to US-95;
- CC-215 North from US-95 to I-15;
- I-515 south of I-215; and
- Summerlin Parkway from Rampart Boulevard to CC-215.

Figure 14. Corridors Meeting Criteria for Potential HOV Facility Implementation

5.0 HOV Direct Connectors

In addition to the recommended segments for corridor HOV lane treatments, several specific bottleneck locations have been identified as requiring continuous HOV lane treatments in the form of HOV direct connections. Some of these locations link HOV lanes on different freeways at freeway-to-freeway interchanges. Others link freeway HOV lanes directly to the arterial roadway system. Each type is presented below.

5.1 Freeway-to-Freeway Connectors

Where HOV lanes are located on a freeway both upstream and downstream of a freeway-to-freeway system interchange, the lanes should generally be continuous through the interchange. If an HOV lane is planned to terminate at or near an interchange, whether it is ultimately carried through the interchange before being dropped or is directly connected to an HOV lane on an intersecting freeway will depend upon the traffic conditions forecast for the interchange.

At freeway system interchanges where HOV lanes are provided on intersecting freeways, consideration should be given to freeway-to-freeway HOV direct connectors. Where demand is sufficiently high and congestion delay in the general purpose sufficiently strong, HOV direct connectors can be used to reduce weaving by HOVs across the general purpose lanes from the median HOV lane to the outside general purpose lane in advance of an exit ramp. They can also provide time savings to HOVs by avoiding congestion and bottlenecks.

Freeway-to-freeway links forecast in 2030 to have strong HOV demand and congestion in the general purpose lanes include:

- I-15/US-95 (Spaghetti Bowl) interchange for movements I-15 south to/from US-95 north;
- I-15/I-215 interchange for movements I-15 north to/from I-215 east;
- Summerlin Parkway/US-95 interchange for movements Summerlin Parkway to/from US 95 east; and
- I-215/Airport Connector interchange for movements I-215 west to/from Airport Connector.

Year 2030 forecast demand for these freeway-to-freeway HOV direct connectors are shown in Figure 15. Table 6-2 of the NDOT *HOV/Managed Lanes and Ramp Metering Implementation Plan* (see Table 5 in this report) identifies minimum vehicle volume thresholds for the implementation of HOV direct connectors. The thresholds are 250 vph when a freeway-to-freeway HOV direct connector is initially opened and 1,000 vph forecast for the project design year. A threshold of 250 vph for HOV direct connectors to arterial roadways is generally recommended.

Figure 15. Year 2030 Peak Hour Traffic for HOV Direct Connectors – AM(PM)

The forecast volumes shown in Figure 15 generally exceed the 1,000 vph threshold. In some cases, such as at the I-215 interchange with the Airport Connector, the volumes meet the threshold in only one direction. In other cases, such as the Spaghetti Bowl link between US-95 North/I-15 South, the volumes meet the threshold in both directions during both morning and evening peak periods.

The HOV direct connector linking US-95 South with Summerlin Parkway provides a bypass to a bottleneck expected at the interchange. As it approaches US-95, the number of general purpose lanes on Summerlin Parkway is expected to be reduced. The HOV direct connector will provide a bypass of congestion expected as a result of the lane reduction. As noted in Section 4.5.5 above, Summerlin Parkway is not expected to have sufficient congestion for HOV lanes along its length to be effectively utilized. However, HOV lanes would be necessary for some distance west of the US-95 interchange to provide for a smooth transition into and out of the HOV direct connectors at the interchange.

Evaluation of the ROW requirements to provide freeway-to-freeway HOV direct connectors and lanes through freeway system interchanges should be completed as part of the design process as freeway projects are advanced in areas where HOV lanes are planned on freeways.

5.2 HOV Direct Access Connectors to the Arterial Roadway System

As noted in Section 4.5.1, direct access ramps between the HOV lanes and the arterial roadway system are beneficial at locations with high volumes of HOVs. They reduce weaving by HOVs across the general purpose lanes from the median HOV lane to the outside general purpose lane in advance of an arterial exit ramp. They reduce the opposite weaving move for HOVs entering the freeway, crossing the general purpose lanes, and entering the median HOV lane. Additionally, HOV direct access connectors linking freeway HOV lanes and arterial roadways can provide time savings to HOVs.

High volumes of HOVs are expected to concentrate in proximity to major employment and activity centers. In the Las Vegas Valley, the largest employment and activity center is the resort strip just east of I-15 between I-215 and I-515. Consideration of arterial HOV direct-access connector locations in this study was limited to this corridor. Consideration should be given to other locations as HOV freeway and arterial projects in other locations are advanced.

Locations generally considered best for HOV direct access connectors are arterial over (or under) crossings at which there are no general purpose interchanges. Providing arterial HOV direct access ramps at locations without general purpose interchanges is preferred to reduce interchange complexity and disperse traffic demand more evenly over the arterial system. Locations considered in this study for HOV direct access connectors to the arterial system included the following locations serving the noted movements:

- US-95 to/from the west and the planned MLK Connector providing access to Industrial Road and the resort corridor;
- I-15 to/from the north and Oakey Boulevard/Wyoming Avenue;
- I-15 in both directions and Industrial Road;

- I-15 in both directions and Desert Inn Road;
- I-15 in both directions and Harmon Avenue;
- I-15 in both directions and Hacienda Avenue;
- I-15 in both directions and Sunset Road; and
- I-15 in both directions and Warm Springs Road.

An initial evaluation of potential ROW impacts, construction costs, and HOV traffic demand led to the following observations. First, there is strong HOV demand in both directions between the resort corridor and the US-95 corridor north and west of the Spaghetti Bowl interchange. Utilizing the planned MLK Connector provides access to Industrial Road from which the entire resort corridor is readily accessible. Moreover, utilizing the MLK Connector removes this component of traffic from the Spaghetti Bowl interchange, where demand is expected to exceed capacity. However, the costs and right-of-way requirements to link US-95 with Industrial Road via the MLK Connector were considered too high for their inclusion in the HOV Plan. An HOV direct connector linking I-15 just south of US-95 to Oakey Boulevard and Wyoming Avenue was evaluated because it can also provide access to Industrial Road.

Second, there is strong HOV demand between I-15 in both directions and the resort corridor. Providing two different arterial locations for HOV direct access to I-15, one for traffic using I-15 to/from the south and one for traffic using I-15 to/from the north, will better serve traffic by dispersing demand more evenly over the arterial system.

Based on these observations, three locations were evaluated for HOV direct access connectors to the arterial system in the resort corridor in more detail. These locations are shown in Figure 15. The traffic volumes forecast for the HOV direct access connectors to the arterial system in the resort corridor indicate a level of demand exceeding the 250-vph threshold for implementation of HOV direct access connectors.

Figure 15 shows that the northbound evening peak hour volume on the HOV direct connector between Oakey/Wyoming and I-15 approaches the capacity of an HOV lane (approximately 1,650 vph, as indicated in Section 0 above). The corresponding southbound morning peak hour volume is somewhat less (1200) but sufficient to support the connector.

The volumes forecast to use an HOV direct access connector in the evening peak hour from Harmon Avenue to northbound I-15 (approximately 1,500 vehicles) approaches the capacity of the connector. The corresponding southbound volume in the morning peak hour is forecast to be 1,300, sufficient for consideration of an HOV direct access connector.

The volumes forecast to use an HOV direct access connector in the peak hours from Hacienda Avenue to and from I-15 south (approximately 900 vehicles) meet design criteria thresholds.

Direct access arterial connectors to HOV lanes in other freeway corridors should be evaluated in conjunction with freeway projects where HOV lanes are planned. They should also be considered as part of arterial projects near freeways on which HOV lanes are planned.

6.0 HOV System Plan

Based on the analysis presented above, an HOV system plan was developed for the Las Vegas Valley. Plan components include both HOV lanes on segments of area freeways and HOV direct connectors at selected locations. A total of 83.4 miles of freeway in the Las Vegas Valley are included in the plan with HOV lanes in each direction.

6.1 HOV Freeway Lanes

The mainline freeway plan is shown in Figure 16. The plan provides for HOV lanes along the following freeway segments:

- I-15 from Sloan Road to CC-215 North with a single HOV lane in each direction, except for the segment between I-215 and US-95, which is recommended for two HOV lanes in each direction;
- I-215 with a single HOV lane in each direction, except for the segment west of the Airport Connector, which is recommended for two HOV lanes in each direction;
- CC-215 South from I-15 to Summerlin Parkway, with a single HOV lane in each direction;
- US-95 from I-15 to Durango Drive (approximately 1.5 miles north of CC-215 North) with a single HOV lane in each direction except for the segment between I-15 and Summerlin Parkway, which is recommended for two HOV lanes in each direction; and
- Summerlin Parkway east of Rampart Boulevard to US-95, with a single HOV lane in each direction.

Figure 1 shows the freeways in the Las Vegas metropolitan area and the number of lanes included on each freeway in the 2030 RTP. Under the HOV plan, some new freeway lanes included in the 2030 RTP would be constructed as HOV lanes.

HOV lanes are generally not recommended unless there are a minimum of three general purpose lanes in each direction in addition to the HOV lanes. Three locations included in the HOV plan have a total of three freeway lanes in the 2030 RTP. An additional freeway lane is recommended for these locations to provide a minimum of three general purpose lanes and the HOV lane in each direction. These three locations are:

- CC-215 South from I-15 to Summerlin Parkway;
- I-15 from Alexander Road to CC-215 North; and
- I-215 from the Airport Connector to I-515.

On I-215 west of the Airport Connector to I-15, the 2030 RTP provides four lanes in each direction. The HOV plan calls for two HOV lanes in each direction. An additional freeway lane beyond what is included in the 2030 RTP is recommended for this location to provide a minimum of three general purpose lanes and the two HOV lanes in each direction.

Figure 16. HOV Plan showing HOV and General Purpose Lanes on Freeways

On US-95 between I-15 and Summerlin Parkway, the 2030 RTP provides five lanes in each direction. These lanes are currently under construction and will be opened in late 2007 with four general purpose lanes and one HOV lane. The HOV plan calls for six lanes in this segment with four general purpose lanes and two HOV lanes in each direction.

Figure 17 shows the year 2030 peak hour traffic forecast for the HOV lanes included in the plan. Figure 18 shows the forecast volumes for the general purpose lanes on the freeway system. Table 6-2 of the NDOT *HOV/Managed Lanes and Ramp Metering Implement Plan* (summarized in Table 5 in this report) identifies minimum vehicle volume thresholds for the implementation of HOV lanes forecast for the project design year. A minimum threshold of 1,000 vph per lane for HOV lanes and a maximum of 1,800 vph per lane are shown in the table. The volumes shown in Figure 17 generally fall within the 1,000 to 1,800 range. In some locations, the forecast volumes exceed the 1,800 maximum threshold. These locations may require access control or other management to maintain volumes consistent with a higher-speed facility.

Figure 19 shows the V/C ratios forecast for the year 2030 for the general purpose lanes of the freeway system where HOV facilities are included in the HOV plan. V/C ratios of 0.90 or more indicate substantial levels of congestion. All of the freeway segments where HOV lanes are included in the HOV plan have V/C ratios in excess of 0.90, indicating levels of congestion necessary to provide a time-savings incentive for HOVs. The highest levels of congestion, indicated by V/C ratios in excess of 1.00, are forecast along I-15 in the resort corridor extending south of I-215 and north of US-95. US-95 west of I-15 and CC-215 South west of I-15 are also forecast to exhibit these higher levels of congestion.

Figure 17 shows that at most locations in the HOV system plan year 2030 forecast volumes meet the minimum threshold volume in both directions in both the morning and evening peak periods. Since demand is generally strong in both directions, concurrent-flow HOV lanes are included in the HOV plan.

Full-time operation (during all hours of the day and night) is recommended for the HOV lanes. Volumes are sufficiently strong in the peak hour so that “shoulder” hours can also be expected to have substantial demand. In hours where demand is light, demand in the general purpose lanes will also be light, and congestion in the general purpose lanes would be insufficient to necessitate opening the HOV lane to SOV use. Furthermore, with the implementation of HOV direct connectors, signage is simplified with full-time operation.

Continuous access to the HOV lanes from the general purpose lanes is recommended as part of the HOV plan to increase HOV lane volumes. Because of its short distance, the initial implementation of HOV lanes on US-95 should have continuous access to maximize use. The forecast HOV lane volumes were developed with a model assuming continuous access. If volumes exceed capacity at some time in the future, consideration should be given to limiting the points of HOV ingress-egress to reduce HOV lane volume and maintain the speed benefit necessary to the successful operation of the HOV lanes. Even with continuous access a buffer between the HOV lanes and general purpose lanes, as shown in the upper photos of Figure 6, is recommended due to the potential speed differential.

Figure 17. Year 2030 Forecast Peak Hour HOV Lane Volumes – AM(PM)

Figure 18. Year 2030 Peak Hour General Purpose Lane Volumes – AM(PM)

Figure 19. Year 2030 Peak Hour General Purpose Lane V/C Ratios – AM(PM)

6.2 HOV Direct Connectors

In addition to continuous access to the HOV lanes from the general purpose lanes, HOV direct connectors are recommended at four freeway-to-freeway locations and at three arterial locations. As HOV freeway lanes are constructed, consideration should be given to additional HOV direct connectors. The HOV direct connectors recommended here are an initial set, the augmentation of which should be considered as components of the system are implemented.

The HOV direct connectors recommended for the Las Vegas Valley include connections for:

- US-95 to and from the south with Summerlin Parkway to and from the west;
- US-95 to and from the north with I-15 to and from the south;
- I-15 to and from the north with the Oakey Boulevard/Wyoming Avenue corridor;
- I-15 to and from the north with Harmon Avenue;
- I-15 to and from the south with Hacienda Avenue;
- I-15 to and from the north with I-215 to and from the east; and
- I-215 to and from the west with the Airport Connector to and from the north.

Year 2030 peak hour traffic forecasts for the HOV direct connectors are shown in Figure 15. As noted in Section 5.2, these HOV direct connectors meet the threshold criteria for HOV direct connector implementation. Locations for additional HOV direct connectors should be considered on a case-by-case basis as the HOV system is implemented.

6.3 Cost

Planning-level cost estimates to implement the HOV plan have been prepared for HOV lanes and HOV direct connectors. Cost estimates to implement the HOV lanes are shown in Table 12. The costs shown are the incremental costs of HOV lane implementation. As the table shows, most of the HOV lane implementation will be in the form of additional freeway lanes already included in the 2030 RTP. In those cases, one or two of the additional freeway lanes included in the RTP will be constructed as HOV lanes. Since the costs of the additional freeway lanes are already included in the RTP, the cost estimate for those lanes is limited to the increment of additional cost needed to construct HOV lanes rather than general purpose lanes. The increment of additional cost is largely attributable to additional width needed for a 2-foot buffer between the HOV and general purpose lanes and signage and striping needed for HOV facilities. The increment of additional cost, as shown in Table 12, is $47.9 million for the HOV plan.

As noted in Section 6.1 above, HOV lanes are not generally provided unless there are at least three general purpose lanes in each direction. In four segments construction of the additional freeway lanes included in the 2030 RTP along with implementation of the HOV plan, would result in freeways with only two general purpose lanes in each direction. In those four segments the HOV plan provides for construction of lanes in addition to those included in the 2030 RTP. The HOV plan provides for dual HOV lanes along US-95 between Summerlin Parkway and I-15. One HOV lane in each direction is currently under construction. The second lane in each direction would be a lane in addition to the lanes in the 2030 RTP. The cost of all these additional lanes is estimated at $235.6 million, as shown in Table 12.

Table 12 includes a cost for the widening of both US-95 and I-15 through their interchange (the Spaghetti Bowl) to provide continuous HOV through lanes. This cost is not included in any of the individual segment estimates, but it is part of the HOV plan. A planning cost estimate of $100 million is included in Table 12 for that widening.

Table 12
Incremental Cost of HOV Lane Implementation
Assuming Some Lanes Included in 2030 RTP Constructed as HOV Lanes
(costs in millions of 2006 dollars – number of lanes are in each direction)

		HOV Plan		Draft 2030 RTP		Additional Lanes in HOV Plan	
Segment	Miles	General Purpose Lanes	HOV Lanes	Lanes	Incremental Cost to Construct RTP Lanes as HOV Lanes[1]	Number of Lanes	Cost[2]
I-15: CR-215 to Alexander Road	5.2	3	1	3		1	$36.4
I-15: Alexander Road to Lake Mead Boulevard	3.0	3	1	4	$3.5		
I-15: Lake Mead Boulevard to US-95	1.8	4	1	5	2.1		
I-15: US-95 to I-215	7.8	5	2	7	10.1		
I-15: I-215 to Sloan Road	9.5	4	1	5	10.9		
US-95: CR-215 to Summerlin Parkway	7.3	3	1	4	0.0[3]		
US-95: Summerlin Parkway to I-15	5.3	4	2	5	0.0[4]	1	37.1
Summerlin Parkway: Rampart Boulevard to US-95	2.3	3	1	4	2.6		
I-515: I-15 to I-215	14.2	4	1	5	16.3		
CR-215: Summerlin Parkway to I-15	15.8	3	1	3		1	83.7
I-215: I-15 to Airport Connector	1.8	3	2	4	2.3	1	12.6
I-215: Airport Connector to US-95	9.4	3	1	3		1	65.8
Subtotal					47.9		235.6
I-15/US-95 Interchange HOV Through Lanes[5]							100.0
GRAND TOTAL	83.4				$383.5		

[1] *Incremental cost for a single HOV lane in each direction is $1 million per mile for the additional right-of-way and pavement to provide a 2 foot HOV buffer plus $150,000 per mile for HOV lane striping, signage, etc. For dual HOV lanes in each direction the cost for striping, signage, etc. is $300,000 per mile.*
[2] *Cost per lane mile for an additional HOV lane is $3.0 million.*
[3] *These lanes are included in the draft 2030 RTP so there is no additional incremental of cost.*
[4] *These lanes are currently under construction, so there is no additional increment of cost.*
[5] *This provides for HOV lanes through the I-15/US-95 interchange, which is not included in any of the individual segments.*

Preliminary planning-level cost estimates for the HOV direct connectors are shown in Table 13 for the HOV direct connectors shown in Figure 15. These are based on conceptual-level planning and design. The incremental total cost estimate for HOV direct connectors not included in the 2030 RTP is $71.2 million. The costs for the HOV direct connector linking US-95 and Summerlin Parkway are included in the 2030 RTP and are currently programmed. All of the costs for the HOV direct connector from US-95 west of the Spaghetti Bowl to and from I-15 south of the Spaghetti Bowl have been included in the latest cost estimates for Project Neon. Therefore, there is no additional incremental of cost for implementation of these projects.

Drawings included in Appendix A show the conceptual layout plans that form the basis for the cost estimates at the locations where HOV direct connectors are included in the HOV plan. The layouts are based on adding the connectors to projects currently in design or included in the 2030 RTP. For example, the HOV direct access connector linking I-215 east of I-15 to I-15 north of I-215 is based on ongoing design of the I-15 South project.

Table 13
Conceptual Planning-Level Cost Estimate of HOV Direct Connectors
Incremental Cost not Included in the 2030 RTP in Millions of 2006 Dollars

Location	Roadway	Construction	Contingency	ROW	Total
US-95 south of Summerlin Pkwy to/from Summerlin Parkway*	0.0	0.0	0.0	0.0	0.0
US-95 west of I-15 to/from I-15 south of US-95 and Oakey/Wyoming to from I-15N**	0.0	0.0	0.0	0.0	0.0
I-15 northbound to/from Harmon Avenue	0.5	4.8	1.6	8.1	14.9
I-15 southbound to/from Hacienda Avenue	0.5	2.5	0.9	6.4	10.3
I-15 north of I-215 to/from I-215 east	1.1	19.3	6.1	5.0**	31.5
I-215 west of Airport Connector to/from Airport Connector	0.9	8.7	2.9	2.0**	14.5
TOTAL					$71.2

* *All of these costs are in the 2030 RTP and have been programmed, so there is no incremental cost.*
** *Includes connections between US-95 to/from the west and I-15 to/from the south and between I-15 to/from the north and the Oakey/Wyoming arterials. All of this cost has been included in the most recent cost estimates for Project Neon, so there is no incremental cost.*

As Table 13 shows, four of the freeway-to-freeway HOV direct connectors are not included in the current RTP; neither is the freeway widening through the Spaghetti Bowl nor the additional lanes noted above that are required to provide a minimum of three general purpose lanes on freeways where an HOV lane is included in the HOV plan. The other HOV freeway facilities are included in the RTP as freeway lanes that would be constructed as HOV lanes rather than general purpose lanes.

The estimated incremental cost for the HOV freeway lanes above what is included in the RTP for freeway widening in the Las Vegas Valley is $383.5 million. The estimated cost of

HOV direct connectors is $71.2 million. Summing these amounts, the HOV plan has a total incremental cost in addition to the costs included in the 2030 RTP of $454.7 million. Because of the extent of that cost, a near term plan at a somewhat lower cost is included in the HOV plan. That plan is described in Section 7.0 and includes the HOV freeway facilities most important to the success of the US-95 HOV lanes currently under construction and to the region's largest employment center along the resort corridor.

7.0 Implementation Phasing Plan

This section presents a phasing plan for implementing the HOV freeway facilities included in the HOV plan for the Las Vegas Valley freeway system. The purpose of the phasing is to provide an HOV system that has the greatest chance for success by providing early implementation in the highest demand corridors, thereby ensuring a positive response to implementation and continued support for further implementation.

A single HOV lane in each direction along US-95 north of Rancho Drive to Summerlin Parkway is currently under construction. Since this is the first set of freeway HOV lanes introduced in the metropolitan area, future implementations should expand that initial system to ensure success. The lanes currently under construction extend west of Rancho Drive approximately four miles to the Summerlin Parkway interchange. The HOV lanes have already been constructed north of Summerlin Parkway approximately four miles to Craig Road and opened to general purpose traffic pending completion of the HOV lanes from Rancho Drive to Summerlin Parkway. Because of their short length, utilization of these initial lanes is likely to be limited. A substantial increase in time savings would be achieved with extension of the HOV lanes under construction through the US-95/I-15 interchange, since the interchange represents a substantial bottleneck to all traffic, including HOV traffic expected to use the HOV lanes currently under construction on US-95.

The HOV plan includes a second HOV lane in each direction on US-95 between I-15 and Summerlin Parkway. The timing for the implementation of the second HOV lane in each direction on US-95 between I-15 and Summerlin Parkway is more long term and should be coordinated with implementation of continuous HOV lanes through the US-95/I-15 interchange on US-95/I-515.

An environmental analysis and design are currently ongoing to extend the US-95 improvements north to Kyle Canyon Road. The HOV lanes would be extended north to North Durango Drive, approximately 4 miles north of Craig Road. To increase the utilization of the initial HOV lanes on US-95, their extension is ranked as the highest HOV freeway priority after the ongoing US-95 construction. Provision of HOV facilities on Summerlin Parkway and HOV direct connectors directly linking the HOV lanes on Summerlin Parkway and US-95 are the next priorities, also to support the US-95 HOV lanes. Priorities are shown by number in .

Following completion of the HOV freeway facilities in the US-95 North corridor, the analysis presented in Section 4.5.1 above indicates that I-15 along the resort corridor from I-215 to I-515 should be the highest priority for implementation. Connections to the HOV lanes on US-95 should be phased immediately after completion of HOV lanes in the resort corridor of I-15 to maximize the success of the HOV facilities on both freeways.

In the near term a single HOV lane in each direction on I-15 between I-215 and I-515 is recommended. The HOV plan includes a second HOV lane in each direction along this segment. The timing for implementation of the second HOV lane in each direction included in the HOV plan is more long term and should be coordinated with implementation of HOV lanes on I-215, increased HOV demand in the I-15 corridor, and future I-15 improvement projects.

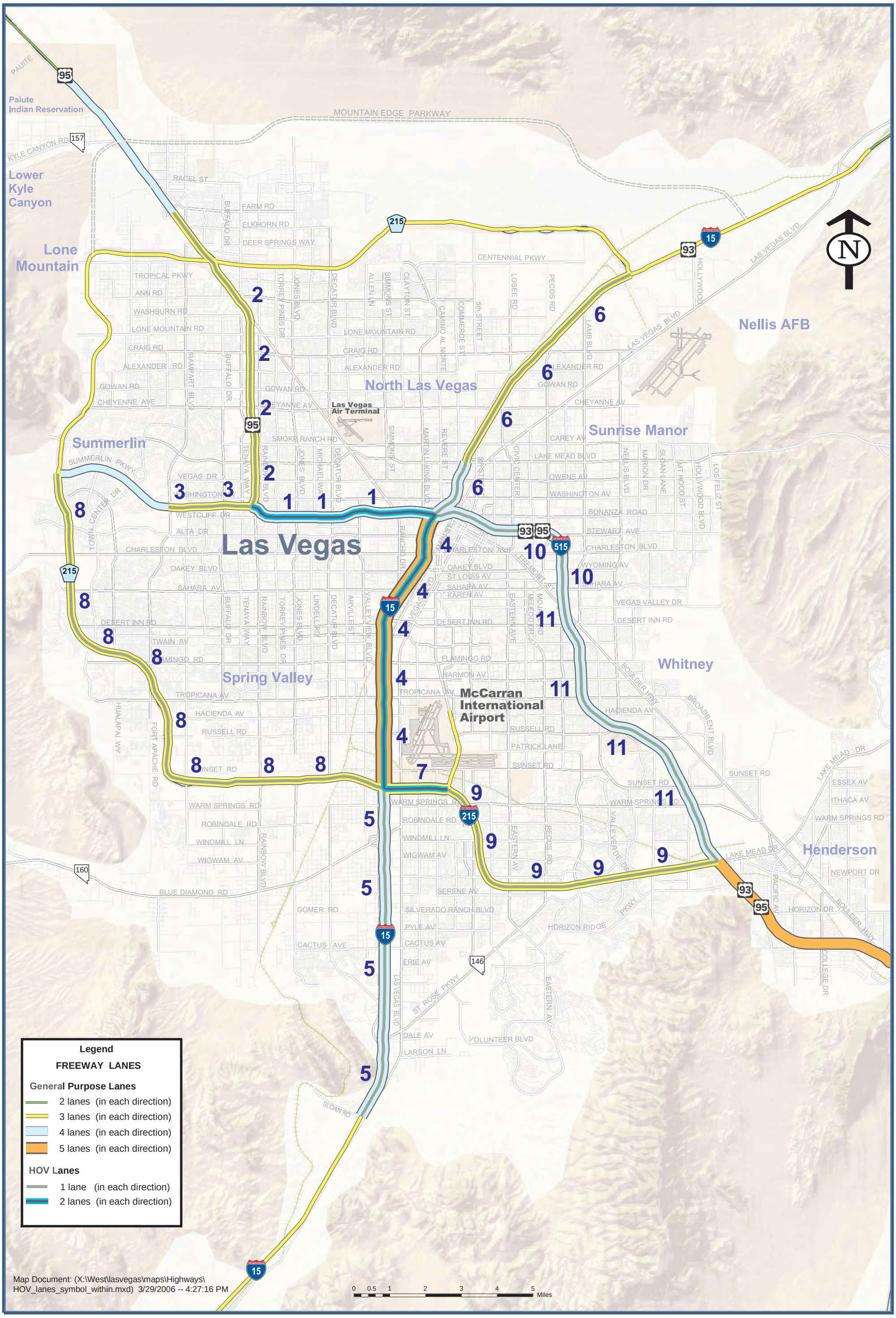


Figure 20. Phasing Plan Showing the Order of Implementation for HOV Lanes (lower numbers to be implemented first)

Extending the I-15 corridor HOV facilities south of I-215 to Sloan Road and north of I-515 to Alexander Road represent, respectively, the next highest priorities because they have strong demand and feed HOV traffic to I-15 in the resort corridor. Connections through the Spaghetti Bowl on I-15 are critical to the success of the resort corridor HOV lanes. A gap in the HOV lanes through the interchange would impede their success and public perception of their value.

The facilities noted above, US-95 north of I-15 to North Durango Drive, Summerlin Parkway, and I-15 from Sloan Road through the resort corridor and Spaghetti Bowl interchange with US-95 to Alexander Road, represent the near term priorities for implementation of an HOV system in the Las Vegas Valley. These facilities are shown Figure 21. This set of freeway HOV facilities would provide an integrated HOV system with sufficient demand, travel distances, and congestion in the adjacent general purpose lanes to provide a successful HOV implementation. Many of the facilities in this initial, near term, system are currently under design for freeway widening. Inclusion of HOV facilities would require substantial design changes, which should be undertaken before construction commitments preclude HOV facilities.

The incremental additional cost of this near term system above what is included in the 2030 RTP for freeway widening is summarized in Table 14. The individual facility costs are the same as those shown in Table 12 and Table 13 for mainline freeway and HOV direct connectors, except for the cost of HOV lane improvements needed for I-15 through the Spaghetti Bowl interchange. The Spaghetti Bowl through lane improvements included in Table 12 have components for both US-95 and I-15. Table 14 includes half of the interchange improvement cost since only the I-15 mainline would be affected.

Table 14 shows the near term projects in priority order based on . The near term projects have a total incremental cost not included in the 2030 RTP of $104.4 million and

Table 14
Incremental Cost of Near Term HOV Freeway Facilities not Included in the 2030 RTP in Millions of 2006 Dollars

Freeway HOV Project	Type	Mileage	Incremental Cost
US-95: I-15 to Summerlin Parkway	Lanes	5.3	0.0
US-95: Summerlin Parkway to Durango Boulevard	Lanes	7.3	0.0
Summerlin Parkway: Rampart Boulevard to US-95 including HOV direct connector to US-95	Lanes Connector	2.3	2.6
I-15: I-215 to US-95	Lanes	7.8	10.1
I-15 south of US-95 to/from US-95 west of I-15 and Oakey/Wyoming to from I-15N	Connectors	-	0.0
I-15 HOV Direct Connectors Hacienda and Harmon	Connectors	-	25.2
I-15: Sloan Road to I-215	Lanes	9.5	10.9
Spaghetti Bowl Interchange: I-15 HOV through Lanes*	Lanes	-	50.0*
I-15: US-95 to Alexander Road	Lanes	4.8	5.5
TOTAL		37.0	$104.4

* *Includes half of the planning estimate to improve the interchange to provide HOV lanes through the interchange on both US-95 and I-15, since the near term project would be limited to I-15 only.*

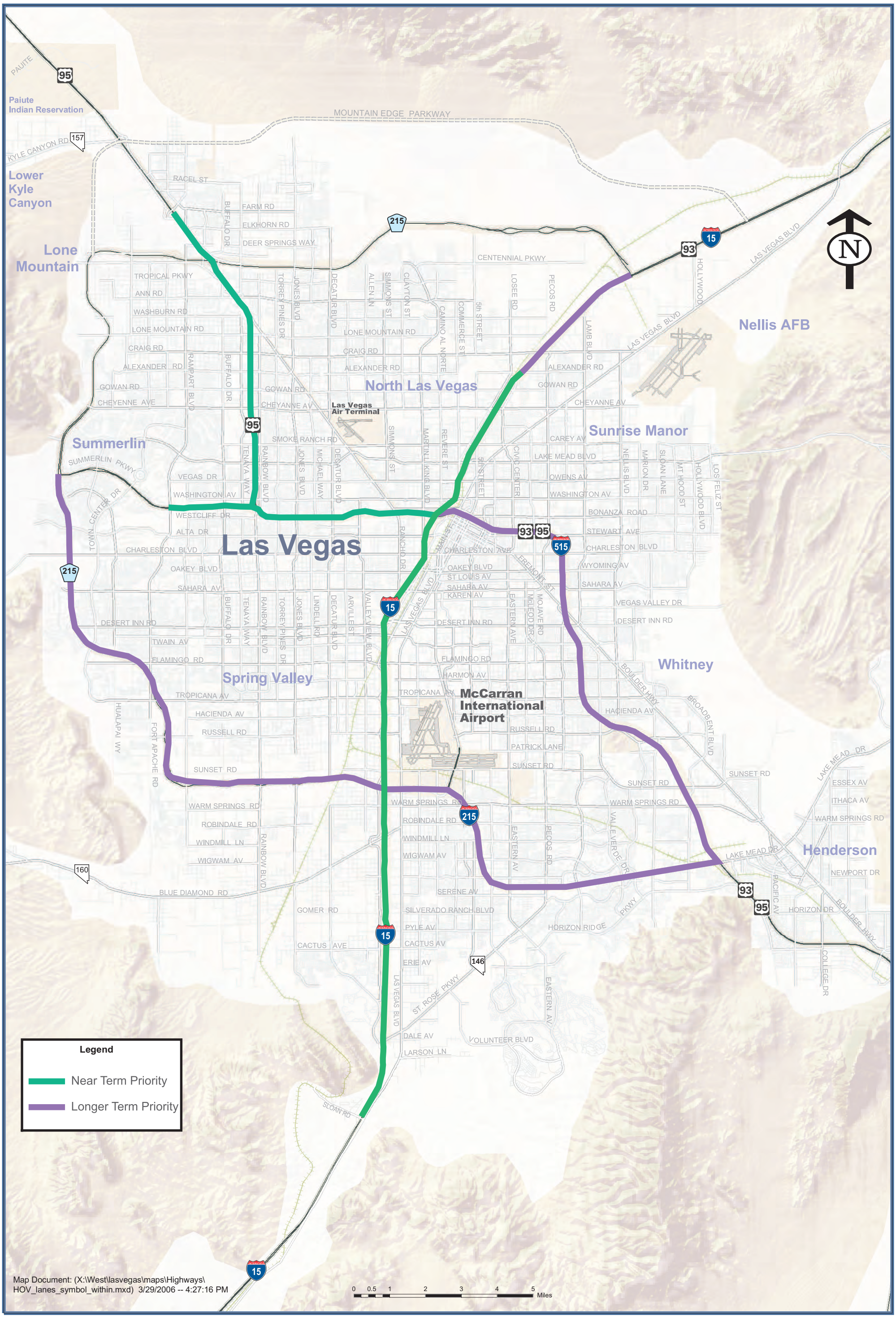


Figure 21. Near and Long Term Priorities for HOV Freeway Facility Implementation

provide 37.0 miles of continuous integrated HOV freeway facilities. The near term HOV facilities include a freeway-to-freeway HOV direct connector in the Spaghetti Bowl linking HOV lanes on US-95 north of I-15 with HOV lanes on I-15 south of US 95. The near term HOV facilities also include widening of I-15 through the Spaghetti Bowl to accommodate an HOV lane in each direction. The costs of the former project are included in project NEON. The costs of the latter represent 48 percent of the total near term costs. The former project is vital to linking the HOV lanes currently under construction on US 95 to the region's major employment center in the resort corridor. The latter project is vital to a continuous HOV backbone on I-15. Overall, the near term HOV projects would provide 42 percent of the HOV freeway system lane miles included in the HOV plan at only 23 percent of the total expected cost.

The remaining facilities included in the HOV plan represent longer term priorities. I-15 from Alexander Road to CC-215 North is the highest of the long term priorities and would complete the provision of HOV facilities on I-15. I-215 for its entire length and CC-215 South from I-15 to Summerlin Parkway are the next highest of the longer term priorities. I-215 east of I-15 to the Airport Connector would greatly enhance access to and demand for the HOV lanes in the resort corridor as traffic moves between the airport and the resorts. This should be the highest priority along I-215. The potential on CC-215 west of I-15 appears to be somewhat higher than along I-215 east of the Airport Connector, and it is prioritized ahead of completing the HOV lanes along I-215 east of the Airport Connector.

I-515 east of I-15 to Boulder Highway presents a number of difficulties, including provision for HOV lane connectivity through the Spaghetti Bowl and intense nearby development in the downtown. It has a somewhat lighter demand; therefore, it is prioritized for later implementation. The portion of I-515 south of Boulder Highway to I-215 represents the last priority for implementation.

8.0 Next Steps

This section presents recommendations for steps needed to advance the HOV plan. These steps include activities that would enhance the status of the plan itself as well as provide additional infrastructure that would support and enhance the implementation of a successful HOV program. An agency responsible for each activity is identified.

8.1 Integration with Freeway Corridor Planning and Design Projects

Corridors included in the HOV Plan are identified for further planning and design study of HOV alternatives. Major investment and other planning studies for corridors included in the HOV Plan should consider HOV alternatives. It is beyond the scope of this regional HOV Plan to examine in detail each of the corridors included in the RTP for increased transportation capacity.

There are four ongoing design projects encompassing major improvements along freeways included in the HOV plan. The projects include:

- US-95 North from Washington Avenue north to Kyle Canyon Road:
- I-15 North from the Spaghetti Bowl north to Craig Road;
- I-15 South from Sloan Road to Tropicana Avenue; and
- I-515 from Boulder Highway to I-15.

Each of these projects is at a different stage of design and at a different point in the environmental process. NDOT should review each to determine if any changes based on the HOV Plan are indicated.

The I-15 North project is imminent and contains no provisions for HOV facilities. The project would widen I-15 north of the Spaghetti Bowl Interchange for approximately five miles. NDOT should consider options to the current design which makes no provision for HOV facilities. However, the construction of an HOV facility as part of the project does not represent the best choice for ensuring the success of an HOV system in the Las Vegas area. Construction of an HOV lane as part of the I-15 North project would result in a short segment of HOV lane that would not connect to any other HOV facility, not traverse the Spaghetti Bowl Interchange, and probably lead to a poor public perception of HOV lanes. Other options that NDOT could consider include providing an HOV lane but striping it out until connecting facilities to the north or south provide connectivity and a meaningful HOV benefit. NDOT could also consider grading but not paving a median lane that could eventually become an HOV lane. At a minimum NDOT should assure that the imminent construction does not preclude future implementation of an HOV lane.

The I-15 South project includes the portion of I-15 used by traffic traveling between the resort corridor and McCarran International Airport. This traffic, including taxis, shuttle buses, and rental cars, is likely to have a larger HOV component than other traffic in the metropolitan area. Consequently, planning for the I-15 corridor north of I-215 and for I-215 between the Airport Connector Tunnel and I-15 should evaluate HOV potential by specifically including an examination of that component of HOV demand.

In addition to these Nevada DOT projects, Clark County is pursuing projects along the Beltway, at the Sunset Road interchange with the Airport Connector Tunnel, as well as through the tunnel itself. One of the projects would provide an additional lane in each direction on I-215 between the Airport Connector and Eastern Avenue. The City of Las Vegas is actively pursuing improvements to Summerlin Parkway. Many of these projects will not be constructed for a number of years. A successful HOV program in the metropolitan area will require that these projects incorporate HOV facilities. Project managers should be encouraged to advance these projects in such a way that HOV facilities can be incorporated into the projects with a minimum of redesign.

Since most of the projects noted above are under NDOT jurisdiction, NDOT should assume the role of coordinating integration of HOV facilities into the projects. NDOT should designate an HOV coordinator to participate in regular meetings with each of the project teams. The coordinator should keep project the teams aware of HOV planning, and its potential impacts on the projects, and encourage project designs that either incorporate or do not preclude HOV project implementation.

8.2 Regional Transportation Planning

Substantial funding for HOV facilities is more likely to occur with formal endorsement of an HOV plan as part of the next Regional Transportation Plan (RTP) adopted by the RTC, which is expected in 2009. The current RTP (adopted July 13, 2006) takes notice of the development of an HOV plan for the Las Vegas area and notes the HOV lanes under construction and included in the ongoing and planned US-95 projects and along Summerlin Parkway. Consideration should be given for full inclusion of the projects recommended by this HOV plan in the next round of RTP development currently scheduled for adoption in July 2008. Since NDOT sponsored the development of the HOV plan, NDOT should take the lead in recommending HOV facility inclusion in the next RTP by formally submitting to the RTC an application for such inclusion. NDOT should prepare that application immediately for submission to RTC based on RTC's current timetable for project submission.

In order to facilitate the incorporation into the next RTP of the projects identified in the HOV plan, a financial strategy for their implementation will be required based on the constrained funding requirement for the RTP. RTC and NDOT should agree on which agency will take the lead in developing that strategy because of the multiple jurisdictions and funding sources needed to fund successful HOV implementations. The lead agency should prepare the financial strategy consistent with the timing of preparation of the constrained funding component of the next RTP.

RTC should also pursue the adoption of a mode split component to its regional travel forecasting model. The mode split component enables travel forecasting broken down by mode, such as single occupant vehicle and multiple occupant vehicle. A mode split model is essential to HOV forecasting. Such a mode split component was developed for this HOV study but it needs formal adoption by the RTC and federal agencies for use in the air quality conformity process of RTP adoption and approval. Air quality conformity modeling is currently scheduled for the spring of 2008, so RTC should immediately begin the formal process of seeking approval for the mode split component.

Fully achieving the long-term potential of HOV freeway facilities depends upon the implementation of a variety of support facilities and services. Critical among these are express transit, arterial HOV direct connectors, and park-and-ride facilities that act as staging grounds for carpool formation and transit services,. Metropolitan planning in each of these functional areas and implementation of facilities as a result of those planning efforts will enhance the benefits derived from the HOV facilities included in the HOV Plan. A comprehensive planning effort covering the range of support facilities envisioned in the Las Vegas area should be undertaken under RTC's regional leadership. RTC completed an initial park-and-ride study to identify potential park-and-ride sites in October 2006. That study was completed in advance of the HOV plan so there was little coordination of the two plans. The park-and-ride plan should be expanded to incorporate facilities needed to enhance the potential success of the planned HOV system.

The metropolitan area's Congestion Management Process (CMP) provides a framework for identifying and addressing congested components of the transportation system. Since HOV facilities have not played a major role in the metropolitan area, they have not been fully included in the CMP. The CMP should be updated to reflect the HOV Plan and to focus resources on HOV planning, programming, implementation, and monitoring. As part of the CMP a review should be initiated of the current freeway design standard of building freeways to provide uncongested operation at LOS D during the peak hour 20 years after the project is open to traffic. Currently there are two separate components of the CMP for the Las Vegas area. One component addresses state highways and the other addresses local services and facilities including the arterial system and transit. HOV facilities overlap this division of the CMP and need to be coordinated across that division. As the lead CMP agency, RTC should take the lead in incorporating HOV facilities on and off the state highway system into the CMP. The facilities to be included in the CMP should include not only HOV lanes, but also arterial HOV direct connectors, park-and-ride facilities, and other support facilities and services including express bus.

8.3 RTC and State Transportation Improvement Programs

With inclusion of HOV facilities in the RTP, federal funding can be made available for HOV projects. Projects receiving federal funds must be included in the RTC's Transportation Improvement Program (TIP) and NDOT's State Transportation Improvement Program (STIP). The process of determining the projects to include in the TIP and STIP includes establishing funding priorities among the host of potential projects competing for limited transportation funding from all levels of government.

Each jurisdiction is responsible for pursuing the inclusion in the TIP of projects on highways owned by the jurisdiction. Since most of the facilities included in the HOV plan are freeway facilities owned by NDOT, NDOT should take the lead in identifying HOV projects for inclusion in the TIP and STIP. Priority should be given to projects that will support and expand HOV facilities currently under construction on US-95, including the higher priorities shown in and Figure 21. In order to provide a more extensive and connected system of HOV facilities, NDOT should encourage other jurisdictions to pursue inclusion in the TIP of both HOV roadway facilities and support facilities such as park-and-ride lots.

8.4 Public Awareness Campaign

To support the inclusion of HOV facilities in the next RTP, a public awareness campaign is needed. A campaign targeted at the general public is unlikely to reach a sufficiently large audience. Consequently, such a campaign should focus on providing information about the HOV concept and plan to decision makers and staff at the member agencies of the RTC. Presentations to municipal and county transportation boards and committees supplemented with printed materials should form the backbone of such an awareness campaign. Providing media outlets with printed materials can also assist in raising the awareness about HOV facilities and planning. As the current leader in HOV planning, NDOT should initially take the leadership role in this activity. As HOV planning becomes more developed, it may be appropriate for that role to transfer to RTC based on their leadership in congestion management strategies.

A component of the public awareness campaign should be targeted at related transportation, transit, and land use planning agencies. RTC should identify ongoing and planned projects and processes (such as park-and-ride facility planning and bridge widening projects over freeways recommended for HOV facilities) so that infrastructure improvements are advanced in a way that permits easy incorporation of potential HOV facilities. The public awareness campaign should target agencies and their staff to raise awareness of ongoing HOV planning activities and potential coordination opportunities.

8.5 HOV Operations Plans

Additional HOV planning will be required in support of the HOV plan. A variety of HOV operational issues need to be considered and resolved as the HOV program is implemented. Terms of HOV lane eligibility should be defined for each HOV project. The base HOV definition for this study is two or more persons per vehicle. State traffic regulations may require review and potential revision. Federal provisions of funding for HOV facilities allow some other vehicles, such as emergency vehicles on an emergency call, motorcycles, and buses either with or without passengers, to use HOV lanes.

Operation periods need consideration and definition including whether HOV restrictions are to apply 24 hours per day, seven days per week or only during peak hours Monday through Friday, or on some other basis. All projects should provide an Operation Plan which stipulates the operating periods for the HOV lane restrictions. Responsibility to periodically evaluate and recommend modifications to the operating period should be assigned.

Reliability of travel time and reduced delay are the key benefits afforded to HOV system users. Criteria should be identified for use in determining when reliability and reduced delay have deteriorated such that lane restrictions and operation periods require change.

Congestion pricing has the potential for improving the efficiency of freeway corridor operation in conjunction with HOV lane operation. Available unused HOV lane throughput could be priced and purchased for use by vehicles whose occupancy does not meet the HOV lane occupancy threshold. (This would reduce mixed flow lane demand and potentially improve its operation and tolls would be set high enough to preclude HOV lane congestion.) A consideration of congestion pricing involves a number of topics including tolling techniques and technologies,

pricing policies, enforcement mechanisms, physical design requirements, and management strategies that will promote an acceptable level of service in a dynamic mobility environment. Implementation of congestion pricing through electronic tolling would require a change to the regional ITS architecture. Additionally, state laws with respect to tolling should be thoroughly reviewed and updated to accommodate potential congestion pricing projects.

Enforcement of HOV lane restrictions needs consideration in terms of fine levels, grace periods following HOV lane implementation, and policing levels. Area-wide policies that balance enforcement costs and minimization of violations should recognize that enforcement demands upon the introduction of HOV lanes in the Las Vegas area may be substantially greater than required after HOV lanes have been in operation for an extended period.

Some of the operational issues identified above require a regional agency such as RTC to provide a consistent approach across the Las Vegas Valley. Others, such as enforcement, may vary with the operating agency or enforcement agency responsible for a specific roadway. Operational issues require attention in advance of HOV facility implementation by the appropriate agencies. Similarly, their timing is dependent upon the specific issue and whether it has localized or regional application.

APPENDIX A

HOV DIRECT CONNECTOR LAYOUT PLANS

The layout plans presented here represent design concepts that illustrate potential project feasibility. They are not final designs. They require further refinement and consistency with ongoing and future projects and designs.

HOV DIRECT CONNECTORS:

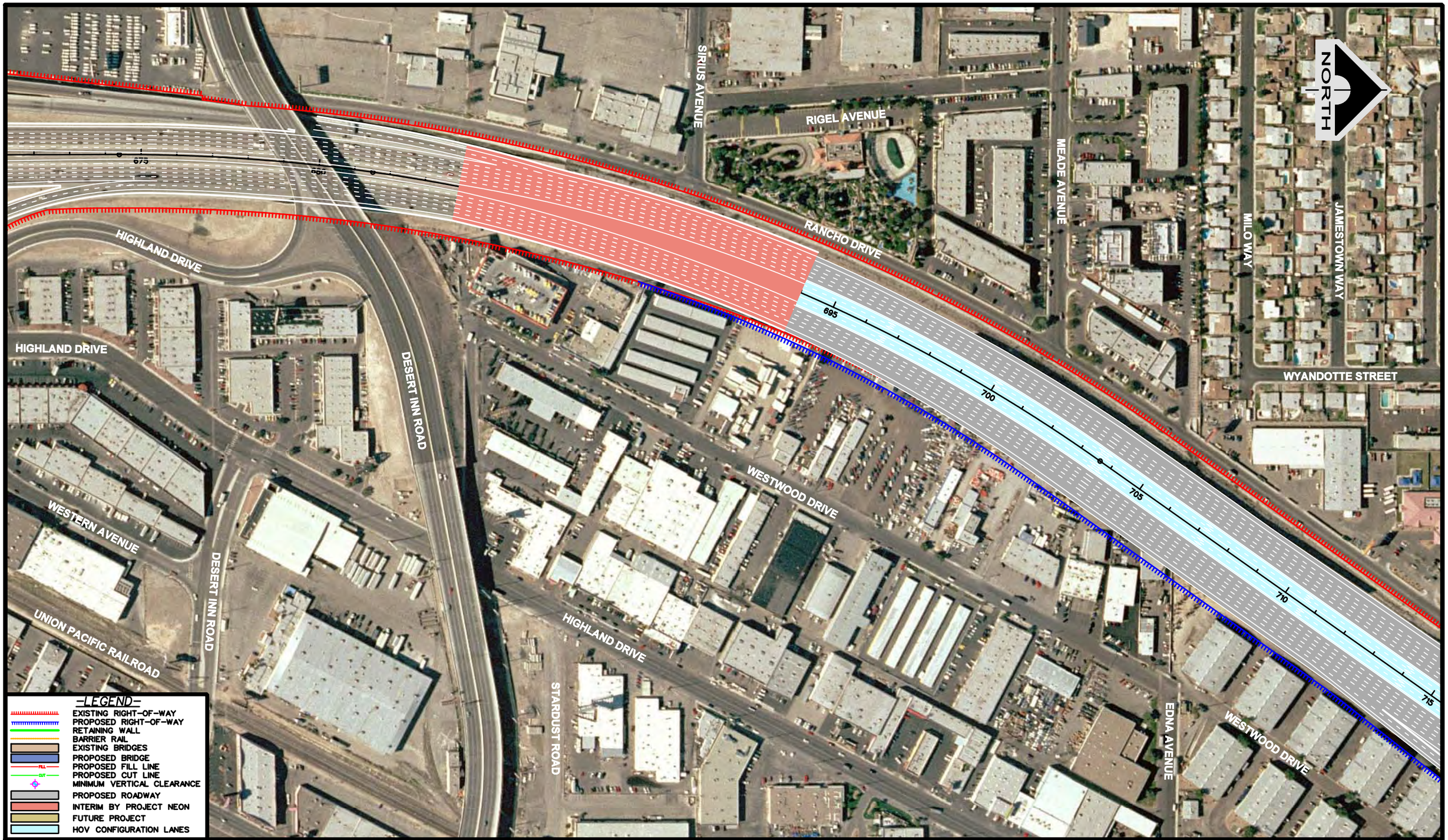
US 95 North of I-15

to

I-15 South of US 95

and

I-15 at Oakey Boulevard and Wyoming Avenue



NEVADA DOT

LEGEND

HOV DIRECT ACCESS
I-15 TO US95/RANCHO CONNECTOR

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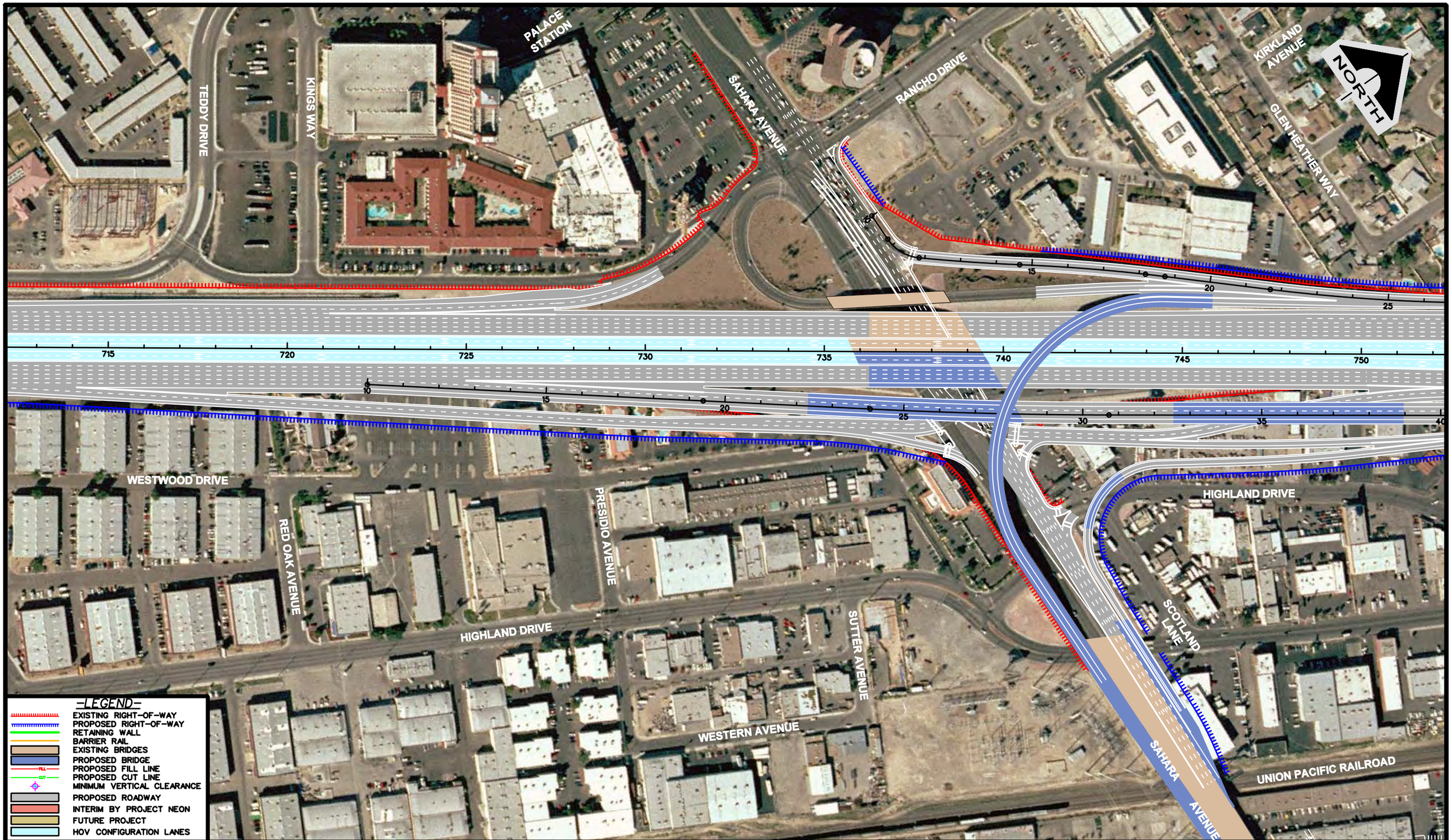

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HOV DIRECT ACCESS
I-15 TO US95/RANCHO CONNECTOR

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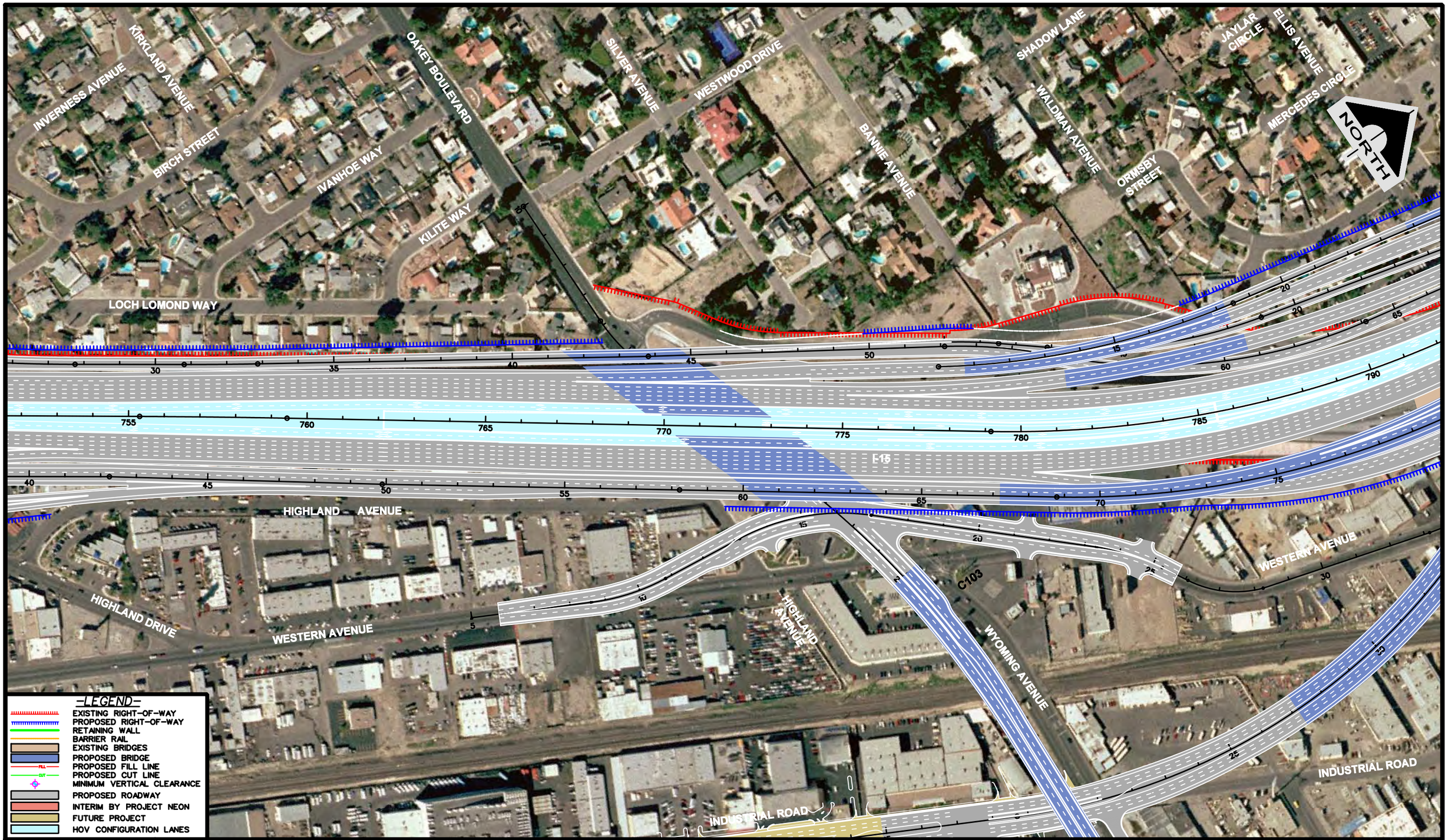

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I-15 TO US95/RANCHO CONNECTOR

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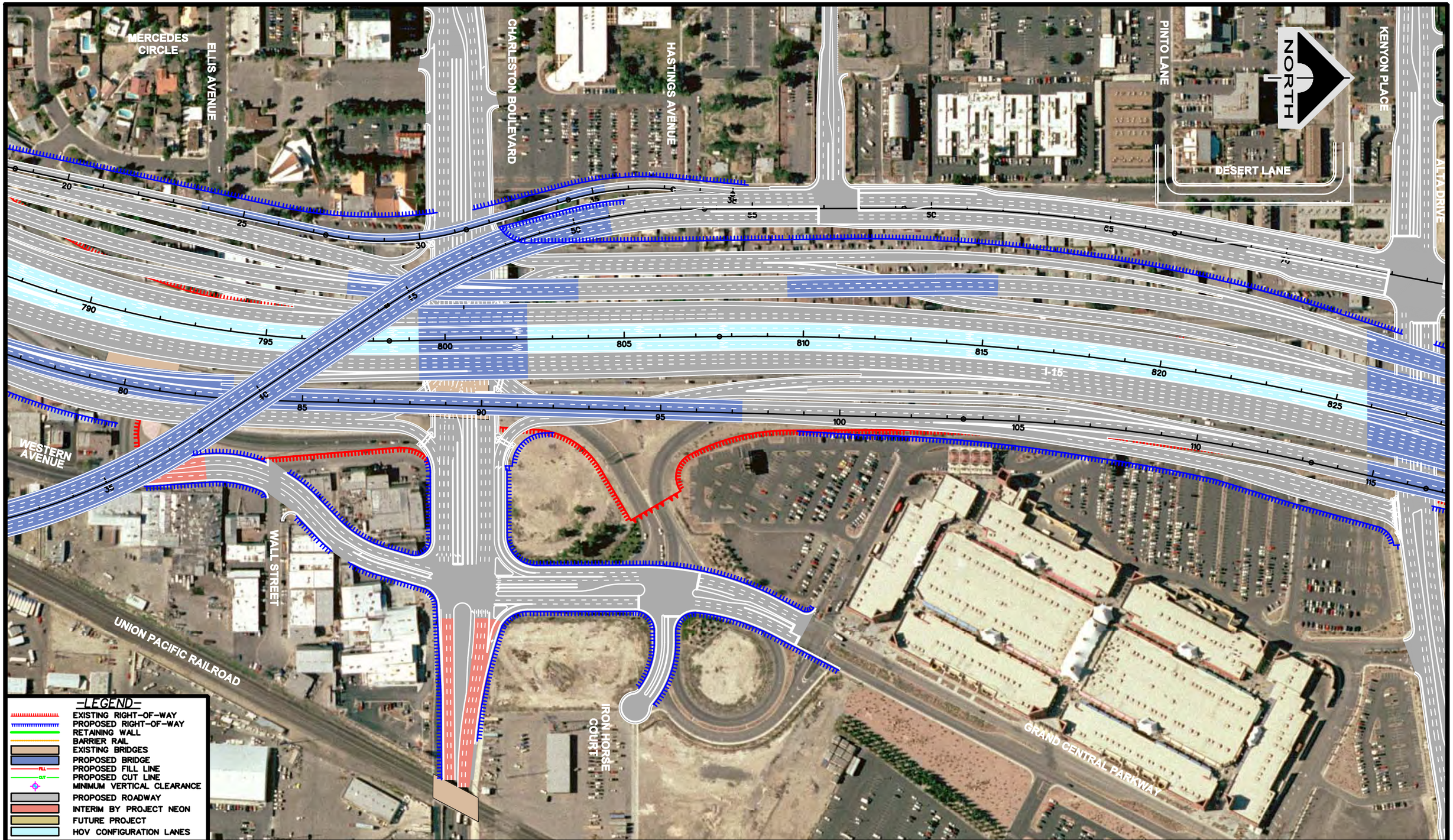

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HOV DIRECT ACCESS
I-15 TO US95/RANCHO CONNECTOR

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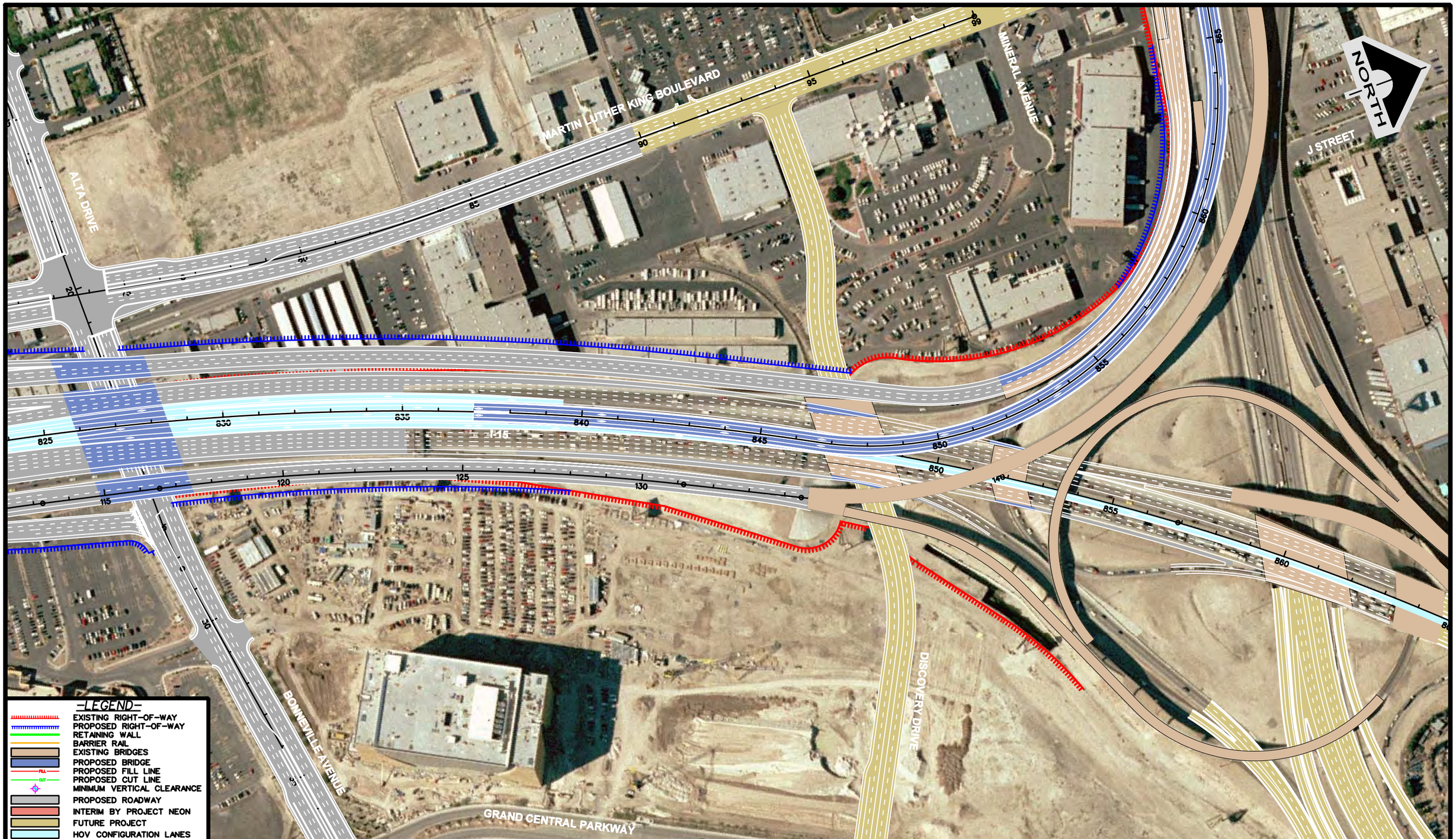

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HOV DIRECT ACCESS
I-15 TO US95/RANCHO CONNECTOR

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SHEET 5 OF 6

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HOV DIRECT ACCESS
I-15 TO US95/RANCHO CONNECTOR

PARSONS

SHEET 6 OF 6

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HOV DIRECT CONNECTORS:

I-15

at

Harmon Avenue and Hacienda Avenue

NEVADA DOT

LEGEND

HOV DIRECT ACCESS
I-15/HACIENDA CONNECTOR

PARSONS

SHEET 1 OF 3

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HOV DIRECT ACCESS
I-15/TROPICANA

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HOV DIRECT ACCESS
I-15/HARMON CONNECTOR

PARSONS

SHEET 3 OF 3

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HOV DIRECT CONNECTORS:

I-15 North of I-215

to

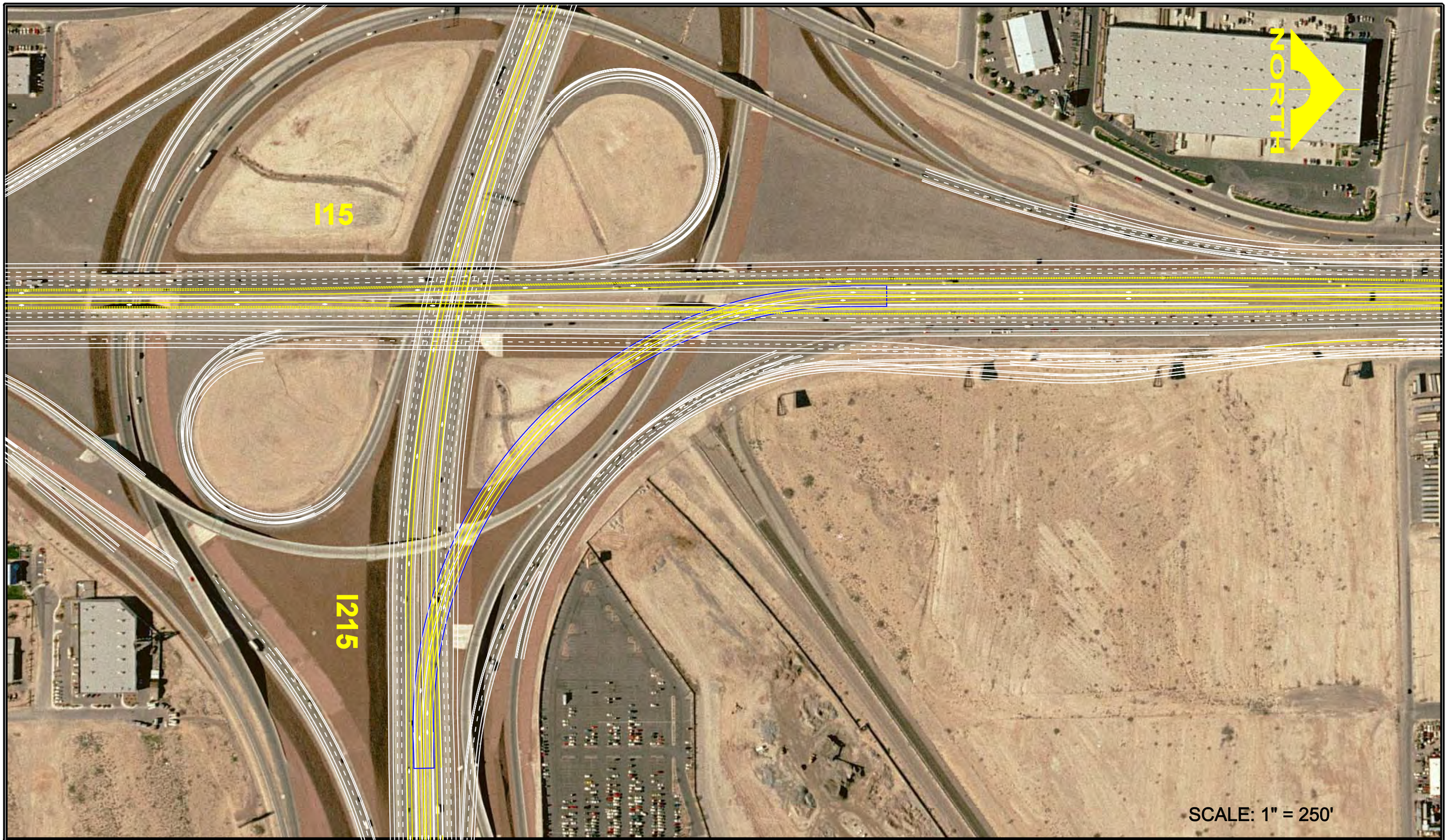
I-215 East of I-15

and

I-215 West of Airport Connector

to

Airport Connector



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HOV DIRECT ACCESS
I-15 TO I215/AIRPORT ROAD CONNECTOR

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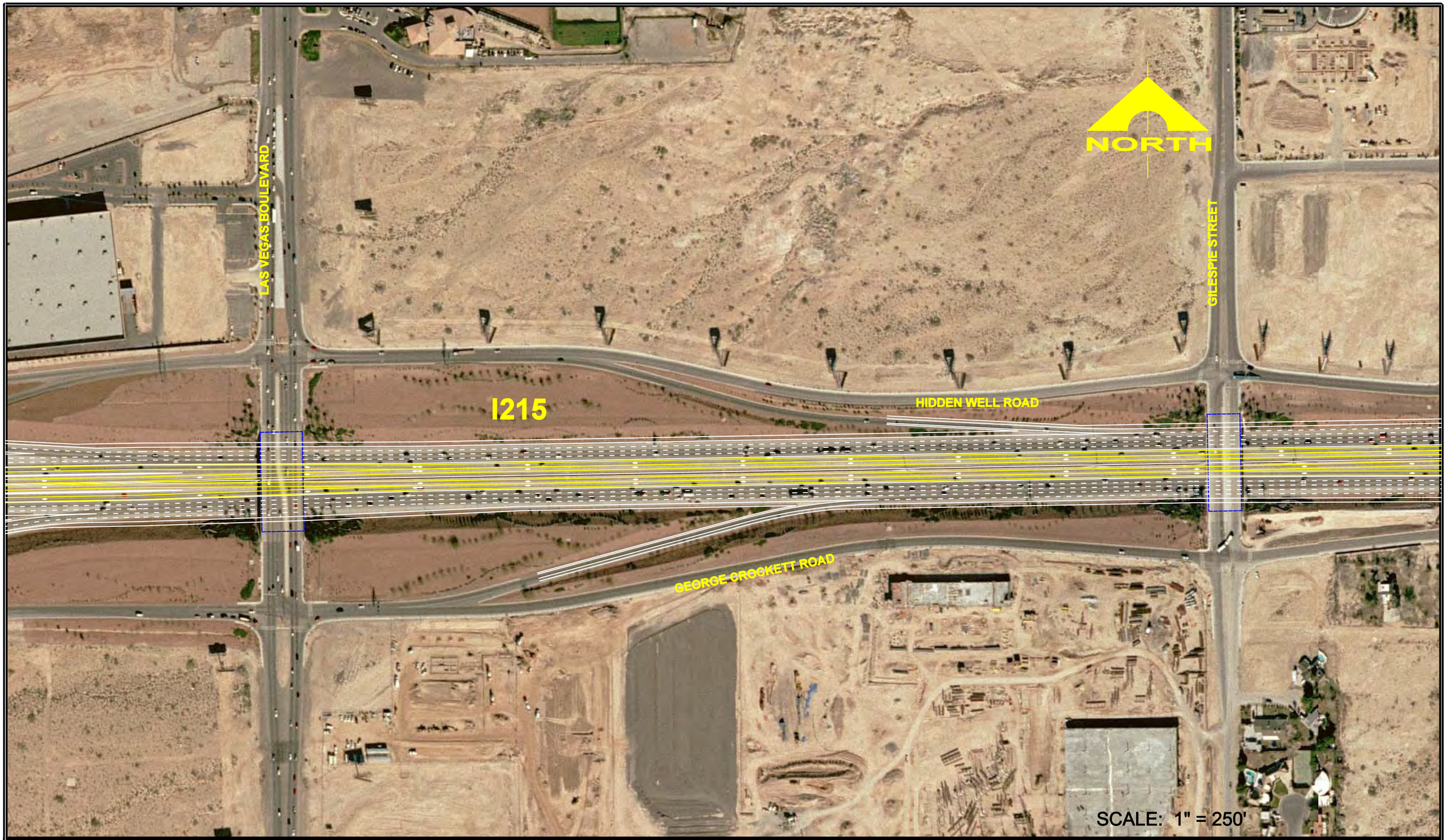

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HOV DIRECT ACCESS
I-15 TO I215/AIRPORT ROAD CONNECTOR

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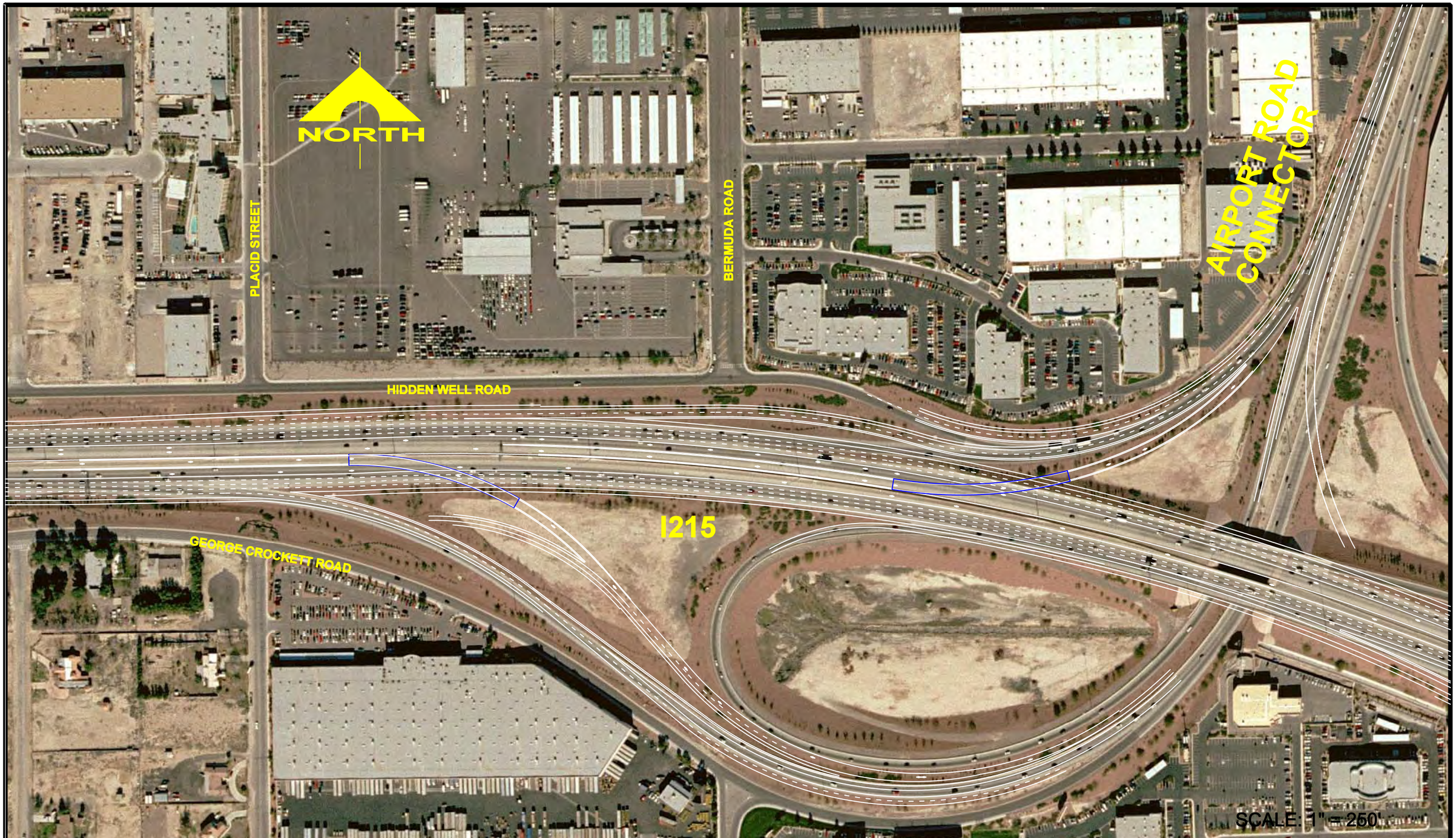

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HOV DIRECT ACCESS
I-15 TO I215/AIRPORT ROAD CONNECTOR

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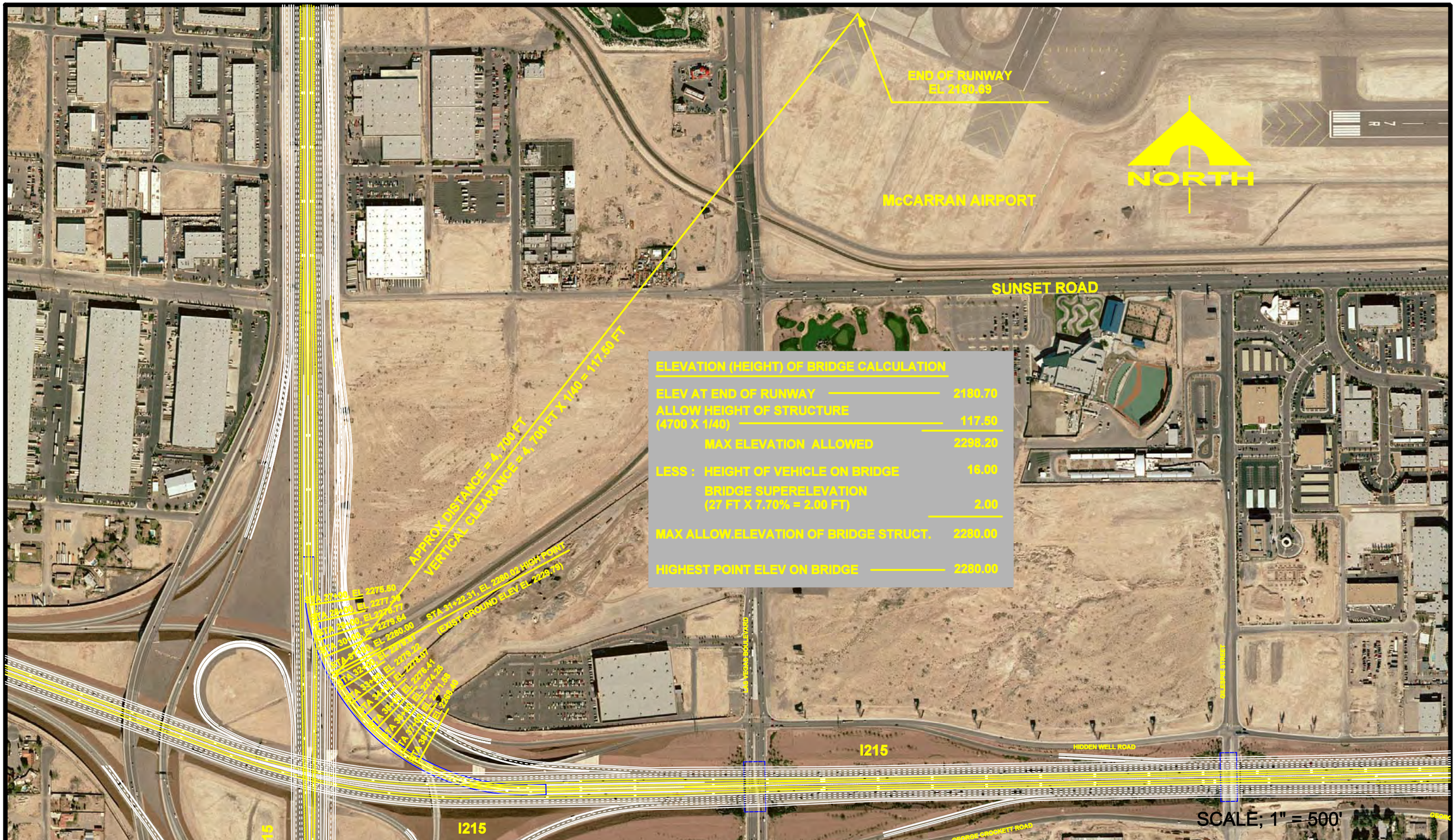

ELEVATION (HEIGHT) OF BRIDGE CALCULATION

ELEV AT END OF RUNWAY	2180.70
ALLOW HEIGHT OF STRUCTURE (4700 X 1/40)	117.50
MAX ELEVATION ALLOWED	2298.20
LESS : HEIGHT OF VEHICLE ON BRIDGE	16.00
BRIDGE SUPERELEVATION (27 FT X 7.70% = 2.00 FT)	2.00
MAX ALLOW.ELEVATION OF BRIDGE STRUCT.	2280.00
HIGHEST POINT ELEV ON BRIDGE	2280.00

NEVADA DOT

LEGEND

HOV DIRECT ACCESS
I-15 TO I215/AIRPORT ROAD CONNECTOR

PARSONS

SHEET 1 OF 1

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APPENDIX B

RESPONSE TO COMMENTS ON

DRAFT FINAL REPORT

and

FINAL REPORT REVIEW DRAFT

Comment Number	Draft Page # *Final*	Comment (page numbers refer to Draft)	Response (page numbers refer to Final Report – Review Draft)
Comments Received from John Terry, NDOT dated July 13, 2006			
1	4 *6* *16*	Somewhere in the Executive Summary we should indicate HOV = 2+	*The following language was added on to the Executive Summary on page 6 and to the main report on page 16:* "The forecasts for HOV lane traffic included in this report are based on limiting access to HOV lanes to vehicles with two or more occupants (2+). As 2+ vehicles increase in numbers they could become so numerous that they congest the HOV lane. In that event, it could become necessary to impose a more stringent restriction (such as 3+) on access to the HOV lanes. More restrictive access is not considered in this report and would be evaluated long after HOV lanes are implemented if they begin to congest and lose their travel time advantage over the general purpose lanes."
2	4 *6* *31*	Somewhere in the Executive Summary we should indicate that Managed lanes considered in the plan	*The following language was added to the Executive Summary on page 6:* "HOV lanes are one type of "managed lanes". Dedicated freeway lanes, including HOV lanes, are collectively referred to as "managed lanes" by transportation professionals and local, state, and federal agencies. Managed lanes represent all forms of dedicated lane treatment that apply the mobility benefits associated with HOV lanes to a broader number of potential lane users, including trucks and general traffic. Managed lanes include high occupancy/toll (HOT) lanes as well as "value-priced" lanes. HOT lanes are lanes available free to HOVs and for a toll to vehicles with fewer occupants than required for free travel. Value-priced lanes are toll lanes in which tolls vary in order to maintain higher speeds than in the general purpose lanes. As the traffic volumes in the value-priced or HOT lanes increase to the point of congestion, the tolls are raised to reduce the traffic and maintain the higher speeds. The

Comment Number	Draft Page # *Final*	Comment (page numbers refer to Draft)	Response (page numbers refer to Final Report – Review Draft)
			primary purpose of the tolls is to limit traffic; revenue generation is rarely sufficient to offset the costs of construction and operation. Managed lanes were considered as part of this study. HOV lanes are recommended for the Las Vegas Valley's first foray into the managed lanes environment for several reasons." *The following language was added to the report at the end of Section 2:* "A variety of managed lane alternatives was considered for the Las Vegas Valley. Toll lanes in the center of I-15 south of Las Vegas to the planned Ivanpah airport were discussed. HOT lanes were contemplated particularly in the early years of an HOV program when HOV demand may be low and substantial capacity available for other vehicles in the HOV lanes. Other managed lane concepts were considered during the course of this study. A system of HOV lanes is recommended for implementation with management of those lanes to be revisited as portions are planned and implemented."
3	4	For consistency NDOT roads go North or East (ie I-15 Sloan to I-215)	*Tables and text have generally been changed to reflect the south-to-north and west-to-east orientation except in cases where the sense of the text requires the opposite.*
4	4 *7* *55* *61* *and* *more*	4th para, US 95 HOV demand also warrants two lanes	*The paragraph was revised to include US 95 warranting multiple HOV lanes in each direction. The report was also revised in a number of other locations including Figures ES-1, Figure 16, Section 4.5.3, 4.5.6, 6.1, 7.0, and Table 12*
5	8 *10* *67*	Add a section to the end of Executive Summary on next steps; program projects, legislation, include HOV in corridor studies etc.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary.*
6	9 *16*	Discussion is for the need for HOV lanes assuming the 2030 network is built. Add a comment that HOV lanes	*The following language was added to draft page 16:* "The forecasts for HOV lane traffic included in this

Comment Number	Draft Page # *Final*	Comment (page numbers refer to Draft)	Response (page numbers refer to Final Report – Review Draft)
		more warranted if the full 2030 network cannot be completed.	report are based on full implementation of the freeway improvements included in the 2030 RTP. If the planned improvements are not implemented freeway congestion will be more extensive than shown in Figure 2. This will provide more incentive to use and a greater need to implement HOV facilities."
7	33 *40*	Table 10 is confusing. Are these numbers daily trips in 2030? Is this good or bad data for HOV?	*The sensitivity testing was conducted using 2030 forecast daily trips. The data are not an indication of the amount of shared ride travel to be expected under the recommended HOV plan, but an indicator of the reliability of the model specification in forecasting the mode shift. The title of the table was changed and the following language added to the text:* "The mode shift to the shared-ride modes under this sensitivity testing is an indicator of the reliability of the model when used to test specific alternatives with HOV facilities. The actual amount of mode shift will vary with the package of facilities being tested. Consequently, the number of shifted trips shown in Table 10 is not an indicator of the amount of modal shift taking place due to the HOV facilities evaluated for this study, but of the reliability of the model specification in forecasting that shift. Based on the amount of shift in the test as reported in Table 10, the model specification was deemed to be appropriate for HOV forecasting and was used in the forecasting for this study."
8	33 *40*	4.3 para 1, make it clear we used the approved 2030 model on the 2030 network with the mode choice the only change/refinement.	*The following language was added to the end of Section 4.3:* "Except for the mode shift model, which has not been formally endorsed by the RTC for regional travel forecasting, the forecasting for this study relied on the approved regional forecasting model and procedures."
9	37 *44*	4.4.4 para 3, mention US 95 demand warrants two lanes .	*The paragraph was revised to include US 95 between I-15 and Summerlin Parkway.*

Comment Number	Draft Page # *Final*	Comment (page numbers refer to Draft)	Response (page numbers refer to Final Report – Review Draft)
10	40 *47*	4.5.4 I-515 v/c (and LOS in EIS) do not show much congestion in 2030 yet we state 'moderate to high presence of congestion and bottlenecks'.	*The first sentence of the paragraph was revised and second clarifying sentence added. The two opening sentences of the paragraph now read:* "The segment of I-515 from Boulder Highway to I-15 is characterized by high forecast HOV demand, low to moderate presence of congestion, and moderate transit service potential. High levels of congestion are concentrated in the section of I-515 between I-15 and the downtown interchanges where V/C ratios are forecast as high as 0.98 in the morning peak hour and 1.06 in the evening peak hour."
11	49 *25* *56*	Para 4, we have modeled based upon continuous access but we should indicate that in design of HOV lanes buffers should be considered.	*Photos of continuous access buffering were added to Figure 6 and following language was added to paragraph 4 on draft page 49:* "The forecast HOV lane volumes assume continuous access. Even with continuous access a buffer between the HOV lanes and general purpose lanes, as shown in the upper photos of Figure 6, is recommended due to the potential speed differential."
12	56 *10* *67*	We end with the implementation plan. I think we need a next steps that indicates how the plan can begin to be implemented. Adding projects to the STIP, adding mode choice to the official regional model, adding HOV to corridor studies etc.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. Incorporating projects into the TIP and STIP is covered.*
	US 95- I-15- MLK dwgs *53* *App'x*	This concept appears to be way too expensive and includes additional ROW purchases beyond NEON. I believe a conceptual layout could be provided that is less expensive and within the ROW envelope.	*An alternative conceptual design has been developed. This alternative eliminates the direct MLK connection and provides arterial connection at Oakey/Wyoming. The design is integrated into the NEON design and requires considerably less right-of-way than the previous concept. The total price of the I-15 South/US 95 North connector plus the Oakey/Wyoming connector is about the same as the previous estimate. Drawings of this conceptual design are included in the Appendix and cost information in the cost section of the report.*

Comment Number	Draft Page # *Final*	Comment (page numbers refer to Draft)	Response (page numbers refer to Final Report – Review Draft)
Comments Received from Jeff Lerud, NDOT dated June 29, 2006			
1	p 17 *23*	2.2 Goals and Objectives of Managed Lanes – the "objectives" are identical to the "Objectives" in the HOV/Managed Lanes and Ramp Metering Manual, Implementation Plan page 6, but the "goals" are slightly different than the "goals" on page 8 of the Implementation Plan.	*Section 2.2 has been revised to reflect the language in NDOT's* HOV/Managed Lanes and Ramp Metering Implementation Plan (March 2006).
2	P 25, Table 5 *31*	The minimum opening year volume for "Bypass Lane or direct-access ramp at an interchange" is listed as 250 vph. This conflicts with the HOV/Ramp Manual, page 10 of the Policy Manual, which calls out 200 vph.	*The table is copied from NDOT's* HOV/Managed Lanes and Ramp Metering Implementation Plan (March 2006) *Table 6-2. The value recited in the comment is found in NDOT's* HOV/Managed Lanes and Ramp Metering Policy Manual (March 2006) *Table 2. The values are inconsistent in NDOT's documents. No change has been made in the text of the HOV Plan based on the sourcing of the value shown in the table.*
3	Throughout doc. *Many*	The labeling of County Road 215 (CR 215) is confusing to me. IS this the actual label of the road? We discussed this internally and could only find CC 215.	*The* "CC-215" *convention has been adopted and occurrences in the report revised.*
Comments Received from Gina Russo, City of Henderson dated June 29, 2006			
1	*70* *42*	General Comment: Please note that the County is currently studying the expansion of the southern Beltway between the Airport Connector to Eastern Avenue from 3-lanes to 4-lanes in each direction. The volumes and output of the Regional Traffic Model should serve as one of many factors in determining HOV / Express Transit lane need and not the sole source. The Model has typically underpredicted vehicle trips, particularly for "fringe" and newly developing areas of the valley. It appears that volumes on the beltway and other facilities in the	*The referenced section of the southern Beltway (I-215) is included in the HOV Plan. The following language has been included in a new "Next Steps" section of the report which includes a specific reference to the segment of I-215 referenced in the comment:* "Corridors included in the HOV Plan are identified for further planning and design study of HOV alternatives. Major investment and other planning studies for corridors included in the HOV Plan should consider HOV alternatives. It is beyond the scope of this regional HOV Plan to examine in detail each of the corridors included in the RTP for increased transportation capacity…. Clark County is pursuing projects along the Beltway and at the Sunset Road

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		outer areas have been underpredicted when compared to existing volumes.	interchange with the Airport Connector Tunnel. One of the projects would provide an additional lane in each direction on I-215 between the Airport Connector and Eastern Avenue." *Draft Table 11 shows that a number of factors in addition to forecast traffic volumes were used in development of the HOV plan and the identification of fys corridors where freeway HOV lanes are included in the plan.*
2	Figure ES-1	HOV lanes should extend south of I-515 to at least Wagonwheel or future Nevada State Drive ("Access Road"). Consider Nevada State College Boulder City Development of southeast Henderson Northern Arizona Possible development of western Eldorado Valley Need / Benefit of express transit service to these areas or to serve trips from these area once they enter the valley It appears shortsighted to extend the HOV / Transit lane on Summerlin Parkway to match into the HOV / Transit lane proposed on CC 215 Consider provisions for interstate truck traffic for express travel in dedicated lane(s) through the valley	*Draft Table 11 shows that there is moderate transit potential and more than moderate HOV demand in the I-515 corridor forecast for 2030. However, there is insufficient congestion forecast for the general purpose lanes included in the 2030 RTP to provide the incentive to use carpool lanes. As development increases in the service area I-515 and capacity increasing projects are evaluated for I-515 south of I-215, these conclusions should be revisited.* *The HOV Plan recommends HOV lanes on Summerlin Parkway only as far west as Rampart Boulevard. There is insufficient demand forecast for Summerlin Parkway to warrant HOV lanes. The principal purpose of the recommended HOV lanes is to provide access to the HOV direct connectors to US 95 south of Summerlin Parkway.* *Exclusive truck lanes were considered during the HOV Plan development. Exclusive truck lanes typically require a substantially greater truck volume than exists or is forecast on any of the metropolitan area freeways.*

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3	Figure ES-2	Consider direct HOV connectors for Henderson Interchange: N-W, E-S, E-N and S-W.	*HOV direct connectors were considered during the planning effort only along the I-15 resort corridor between I-215 and US 95 because this is the corridor with the most potential for HOV facilities and HOV direct connectors. The Airport Connector HOV direct connectors are a complementary component of the HOV direct connectors proposed for the I-15/I-215 interchange. The HOV direct connectors at the US 95 interchange with Summerlin Parkway are already in the design stage. Section 5.1 of the draft HOV Plan states that* "Evaluation of the ROW requirements to provide freeway-to-freeway HOV direct connectors and lanes through freeway system interchanges should be completed as part of the design process as freeway projects are advanced in areas where HOV lanes are planned on freeways."
4	Figure 1	Southern Beltway from I-15 to I-215 should reflect need for four lanes in each direction prior to 2030.	*The figure is based on the lanes in the current 2030 RTP.*
5	Figure 2	V/C ratios on southern Beltway currently exceed what is predicted for 2030 (with same number of lanes).	*The figure is based on forecasts using the RTC's adopted model. See response to comment #1 from this commenter.*
6	Page 45	City of Henderson arterials to consider for joint HOV / Express Transit: Lake Mead Parkway, St. Rose Parkway, Executive Airport / Via Inspirada / Starr, and Eastern	*The HOV Plan does not include recommendations for arterial HOV direct connectors outside the resort corridor. The draft plan states that* "Direct access arterial connectors to HOV lanes in other freeway corridors should be evaluated in conjunction with freeway projects where HOV lanes are planned. They should also be considered as part of arterial projects near freeways on which HOV lanes are planned."
Comments Received from Mike Janssen, City of Las Vegas dated June 29, 2006			
1	Figure	Should show 1 HOV lane in each direction to Durango	*Based on the current projects being considered for US 95*

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	ES-1 and Figure 14 *7* *49*	where HOV lane scheduled to begin/end in US95 EA. It's reasonable to expect the HOV lanes should continue some distance north of the 215/95 system interchange to improve operations at this major interchange.	*in this area the figures have been revised to show the HOV lanes extending north of CC-215 to North Durango Drive. The precise terminus of the lanes will be determined by project design.*
2	Figure ES-1	Summerlin Parkway will have 3 general purpose lanes in each direction between 215 and 95. This map appears to show 4 west of Rampart??	*The figure is based on the lanes included in the 2030 RTP.*
3	Page 45	Please add in section 5.2 at end of 2nd paragraph "For example, in the vicinity of the Elkhorn overpass at US95, a proposed regional mall, community college, hospital, and park and ride facility by the RTC might make an HOV direct connector at this overpass very desirable as it is expected to become a major employment and activity center.	*The HOV Plan does not include recommendations for specific arterial HOV direct connectors outside the resort corridor. The draft plan states that* "Direct access arterial connectors to HOV lanes in other freeway corridors should be evaluated in conjunction with freeway projects where HOV lanes are planned. They should also be considered as part of arterial projects near freeways on which HOV lanes are planned."
4	Figure 17 *7* *55* *61* *and* *more*	The segment of US95 west of the I-15/US95 interchange appears to be close to requiring more than just 1 hov lane in each direction. Evaluate the need for a sort of HOV Aux lane that might be needed to accommodate all of the movements in/out of the spag bowl at this location maybe requiring 2 HOV lanes in each direction up to maybe Decatur?	*The report has been revised to include US 95 warranting multiple HOV lanes in each direction between I-15 and Summerlin Parkway.*
5	Figure 19	I question the forecast 2030 v/c ratios on Summerlin Parkway at 215. We have well over 1000 vehicles in each direction today at a bottlenecked and constrained traffic signal operated "interim" 215/Sum Pkwy interchange. When the full system interchange is built and the expected 11,000 new homes are built in Summerlin west of 215 we anticipate they will use up way more than 25-29% of capacity. Was the calculation from an RTC model output? If so, I would like to see it so we can evaluate if RTC's	*The figure is based on forecasts using the RTC's adopted model augmented with a mode split model as described in draft Section 4.2.Intersection and freeway capacity are not closely related. Based on comment #2 from this commenter, V/C ratios would be higher if fewer lanes were implemented than were included in the model.*

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		land use codings to west were appropriate.	
6	ES-2 *53* *App'x*	The Warm Springs/I-15 and Oakey-Wyoming/I-15 direct connector concepts should be developed and added to the final plan	*The revised HOV Plan includes a detailed Oakey/Wyoming plan replacing the arterial HOV direct connector linking US 95 and Industrial Road via the planned MLK Connector. The Warm Springs HOV direct connector is an alternate for traffic to and from the south and was therefore not included in the report in detail.*
Comments Received from Greg Novak, Federal Highway Administration undated			
1	*10* *67*	The draft plan is for Freeway HOV only. It should mention what is planned for arterials, and must mention the Park and Ride tie-in. The draft shows that a regional HOV system will work, and adding those other parts should only strengthen the case for it. The US 95 ROD called for park and ride lots, and I am still waiting for those. They were to be part of the regional P&R look by RTC.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include the following language Section 8.2:* "Fully achieving the long-term potential of HOV freeway facilities depends upon the implementation of a variety of support facilities and services. Critical among these are park-and-ride facilities acting as staging grounds for carpool formation and transit services, express transit, and arterial HOV direct connectors. Metropolitan planning in each of these functional areas and implementation of facilities as a result of those planning efforts will enhance the benefits derived from the HOV facilities included in the HOV Plan. A comprehensive planning effort covering the range of support facilities envisioned in the Las Vegas area should be undertaken under RTC's regional leadership. RTC has already undertaken a park-and-ride study to identify potential park-and-ride sites."
2	*73*	The electronic toll option will require an update to the ITS regional architecture. That will require coordination with Mike Quintero, and Tom Moore – they need to know this may be coming. The link between HOV and HOT lanes is not clear – are we suggesting we can get this built quicker if we allow the HOT option? If we are talking tolls, be aware that Wayne Berman, the FHWA tolling contact,	*Neither HOT lanes nor tolled lanes are recommended in the HOV Plan. A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include the potential to consider congestion pricing and/or hot lanes in Section 8.5:* "Congestion pricing has the potential for improving the efficiency of freeway corridor operation in conjunction with HOV lane

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		will be in Las Vegas in September. Similar discussion are underway for the Boulder City Bypass, and we might be able to help NDOT with some briefings.	operation. Available unused HOV lane throughput could be priced and purchased for use by vehicles whose occupancy does not meet the HOV lane occupancy threshold. This would reduce mixed flow lane demand and potentially improve its operation and tolls would be set high enough to preclude HOV lane congestion. A consideration of congestion pricing involves a number of topics including tolling techniques and technologies, pricing policies, enforcement mechanisms, physical design requirements, and management strategies that will promote an acceptable level-of-service in a dynamic mobility environment. Implementation of congestion pricing through electronic tolling would require a change to the regional ITS architecture."
3	*10* *70* *71*	The $554M total cost is large, but not in comparison to what the current 2030 regional transportation plan calls for. I have not looked at the plan that was adopted last week, but the HOV draft should be amended into it as soon as possible (should everyone agree). My immediate concern is how the draft plan meshes with the I-15 North environmental assessment and design build RFP. HOV is not in there, but maybe it should be. At least consider allowing room for future HOV when the D/B contract moves forward. I told Terry to bring it up at this week's VE study.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include incorporating the HOV Plan elements into the next round of the RTP.* *The steps also include the following language in Section 8.1:* "The I-15 North project is imminent and contains no provisions for HOV facilities. The project would widen I-15 north of the Spaghetti Bowl Interchange for approximately three miles. NDOT should consider options to the current design which makes no provision for HOV facilities. However, the construction of an HOV facility as part of the project does not represent the best choice for ensuring the success of an HOV system in the Las Vegas area. Construction of an HOV lane as part of the I-15 North project would result in a short segment of HOV lane that would not connect to any other HOV facility, not traverse the Spaghetti Bowl Interchange, and probably lead to a poor public perception of HOV lanes.

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			Other options that NDOT could consider include providing an HOV lane but striping it out until connecting facilities to the north or south provide connectivity and a meaningful HOV benefit. NDOT could also consider grading but not paving a median lane that could eventually become an HOV lane. At a minimum NDOT should assure that the imminent construction does not preclude future implementation of an HOV lane."
4		The arterial/freeway median HOV lane connectors (shown in Figures ES-2 and 15) will require Interstate access approval (has to go to DC). Using the current grade separations instead of the existing interchanges makes good sense, and the scope of the HOV plan will help explain the regional approach. When you tie-in all the new and modified interchanges on I-15, I-215, I-515, and US 95, and new grade separations, you will have a freeway master plan that others can quickly understand. We don't need overly complicated graphics (I spoke to Jeff Hale about this). Keeping all the projects straight is complicated, but possible. I like the way you have sequenced the HOV work in Figure 20 (except for the I-15 N section that is priority 6).	*With respect to the priority ranking of the I-15 North project, see response to comment #3 from the same commenter.*
5	*10* *67* *68*	The sleeper item is 1.2, Policy Changes Needed (p12), that calls for dropping the LOS D target for peak hour traffic in 2030. LOS E may be more realistic for a metropolitan area pushing 3 M people and visitors. That will affect many Las Vegas projects, and should be tied to the Congestion Management Process (formerly System). The HOV plan needs to be coordinated with the corridor studies and NEPA documents, and I know you have spoken to others about that. I am glad to see our past comments/discussions have apparently had some effect	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include updating the Congestion Management Process (CMP) to incorporate HOV facilities and review the LOS D freeway design standard. See Section 8.2 of the revised HOV Plan.*

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		(not sure how much influence we really had, but I like this draft regardless of its genesis).	
6	*67*	You may want to give more attention to the number of taxis, vans pools and shuttle buses in the Las Vegas traffic mix. The may outnumber traditional HOV-2 or 3 commuters. The Las Vegas 24/7 tourism-based lifestyle is a bit different, and the draft notes that to a limited degree. Getting some political support will be critical to the draft becoming final, and eventuality a reality. We can take the US 95 HOV "pilot" and expand it throughout the valley.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include the following language in Section 8.1:* "The I-15 South project includes the portion of I-15 used by traffic traveling between the resort corridor and McCarran International Airport. This traffic, including taxis, shuttle buses, and rental cars, is likely to have a larger HOV component than other traffic in the metropolitan area. Consequently, planning for the I-15 corridor north of I-215 and for I-215 between the Airport Connector Tunnel and I-15 should evaluate HOV potential by specifically including an examination of that component of HOV demand."
Comments Received from Martyn James, Regional Transportation Commission dated July 19, 2006			
1	Fig.20 *64*	US.95. The HOV lanes currently under construction should be extended north of the Rainbow Curve as soon as possible. The southbound lanes in particular need to originate at or north of Lake Mead Blvd, preferably from the opening date in late 2007.	*The referenced figure shows the extension of US 95 HOV lanes north of Rainbow curve as the highest priority in the plan after the current construction of HOV lanes south of the Rainbow curve is completed. NDOT is currently investigating alternatives for implementation of HOV lanes north of the curve to Craig Road.*
2	Fig.20 *64*	US.95. Priority 2 should extend to Elkhorn Rd, in light of discussion regarding direct access ramps at that location.	*Based on the current projects being considered for US 95 in this area the figure has been revised to show the HOV lanes extending north of CC-215 to North Durango Drive. The precise terminus of the lanes will be determined by project design.*
3	Fig.20	Summerlin Pkwy. The Plan should include HOV lanes from the Western Beltway to Rampart as a potential long-term option.	*The HOV Plan recommends HOV lanes on Summerlin Parkway only as far west as Rampart Boulevard. There is insufficient demand forecast for Summerlin Parkway to warrant HOV lanes. The principal purpose of the recommended HOV lanes is to provide access to the HOV direct connectors to US 95 south of Summerlin*

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			Parkway.
4	Fig.20	Western Beltway. RTC is about to undertake a study of North-South facilities on the west side of the valley. HOV lanes could be an element of that study. The following segments should be shown as "Potential for HOV subject to further study": 1. CC.215 from Summerlin Pkwy to Mountain Edge Pkwy on-ramp Centennial 2. Mountain Edge Pkwy from CC.215 on-ramp Centennial to US.95 @ SR.157	*Draft Table 11 shows that there is more than moderate to strong HOV demand in the CC-215 corridor north of Summerlin Parkway forecast for 2030. However, there is insufficient congestion forecast for the general purpose lanes included in the 2030 RTP to provide the incentive to use carpool lanes. As development increases in the service area CC-215 North service area and capacity increasing projects are evaluated for CC-215 north of Summerlin Parkway, these conclusions should be revisited.*
Comments Received from Kevin Futch, Clark County DPW dated August 1, 2006			
1	*54*	At no time shall a HOV, exclusive, or special use lane(s) be provided on the mainline if there are 2 or less general-purpose lanes in each direction.	*Page 47 of the draft report states:* "HOV lanes are generally not recommended unless there are a minimum of three general purpose lanes in each direction in addition to the HOV lanes. Three locations included in the proposed HOV plan have a total of three freeway lanes proposed in the draft 2030 RTP. An additional freeway lane is recommended for these locations to provide a minimum of three general purpose lanes and the proposed HOV lane in each direction."
2	*73*	The use of managed lanes or High Occupancy Toll (HOT) lanes should be considered. Managed lanes could accomplish some of the following objectives: • Diverting some solo drivers from adjacent general-purpose lanes and reducing congestion in those lanes. • Generating revenue for highway and mass-transit improvements. • Giving motorists the option of traveling on less-congested lanes, if they are willing to pay for the privilege.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include the following language in Section 8.5:* "Congestion pricing has the potential for improving the efficiency of freeway corridor operation in conjunction with HOV lane operation. Available unused HOV lane throughput could be priced and purchased for use by vehicles whose occupancy does not meet the HOV lane occupancy threshold. (This would reduce mixed flow lane demand and potentially improve its operation and

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		• Relieving possible political pressure to convert HOV lanes to general use.	tolls would be set high enough to preclude HOV lane congestion.) A consideration of congestion pricing involves a number of topics including tolling techniques and technologies, pricing policies, enforcement mechanisms, physical design requirements, and management strategies that will promote an acceptable level-of-service in a dynamic mobility environment. Implementation of congestion pricing through electronic tolling would require a change to the regional ITS architecture. Additionally, state laws with respect to tolling should be thoroughly reviewed and updated to accommodate potential congestion pricing projects."
3		The managed lanes could also serve as HOV lanes.	*See response to the previous comment.*
4	*74*	With respect to enforcement, the state must pass laws that provide for stiff penalties and fines for violating the rules of HOV and Managed Lanes. Enabling legislation is an important factor in the enforcement of a facility. Laws should provide fines for both HOV lane violations as well as non-payment of tolls.	*A section on Next Steps has been added to the report and is summarized in the Executive Summary. The steps include the following language in Section 8.5:* "Enforcement of HOV lane restrictions needs consideration in terms of fine levels, grace periods following HOV lane implementation, and policing levels. Area wide policies that balance enforcement costs and minimization of violations should recognize that enforcement demands upon the introduction of HOV lanes in the Las Vegas area may be substantially greater than required after HOV lanes have been in operation for an extended period."
5		Legislation should be proposed that would use variable tolls in an effort to manage demand and tolls could finance the capital costs of the added capacity in order to provide possible revenue generation.	*See response to comment #2 from this same commenter. While revenue generation is a potential for tolls imposed on managed lanes, managing lane volumes to maintain high speed uncongested conditions is the principal purpose of congestion pricing.*
6		Using pricing, as a lane management strategy will require the need for legislative changes. Likewise, automated enforcement will also require enabling legislation.	*See response to comment #2 from this same commenter.*

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		Additionally, legislation may facilitate the cooperation between local agencies, state agencies, regional transportation authorities, and private developers.	

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Comments Received from John Terry, NDOT dated March 22, 2007			
1	6 *6*	Page 6, para 1, last sentence – Should be 'Fifth' not 'Fourth'. I am not sure we even need the numbering.	The numbering was removed from the Final Report.
2	10 *10*	Page 10, Cost, 4th para. - Check cost against later comments specifically what is already in NEON.	The costs of the HOV direct connectors linking I-15 to US-95 and I-15 to the Oakey/Wyoming arterials is fully included in the Neon Project cost estimate. Therefore these costs have been removed from the incremental cost of HOV facilities throughout the Final Report.
3	11 *13*	Page 11, 1st para – delete last sentence. Not sure if we or RTC should lead.	The statement was removed from the Final Report. Section 8.2, second paragraph was reworded to be consistent.
4	16 *18*	Page 16, 1.2, para 3 – numbering again. Not sure we need first, second…	The numbering was removed from the Final Report.
5	56 *57*	Page 56, para 5 – rewrite this paragraph. We need to make a few points. The system is modeled based upon continuous ingress-egress. We need to begin the limited US 95 system as continuous ingress-egress. Conversion to limited ingress-egress points should be considered later as the system is expanded and direct connectors are added. We recommend full time operation.	The referenced paragraph and the following paragraph referenced in the next comment were rewritten. As rewritten the paragraphs include language that states: - The traffic volumes result from a model that assumed continuous access to the HOV lanes. - The initial implementation of HOV lanes on US-95 should have continuous access due to the short length of the HOV lanes and the need to maximize their use. - Consideration should be given to limiting access to the HOV lanes in the future if HOV demand is sufficiently strong that the speed advantage to the lanes is lost. - Full time operation is recommended.
6	56 *57*	Page 56, para 6 – make consistent with para above. We may move to limited ingress as the system expands and volumes increase.	See response to comment 5.
7	61	Page 61, Table 12 - ? $16.3 million on US 95. Entire	The table was revised to show this as I-515 instead of

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	62	route is being constructed as HOV. What is this cost?	US-95.
8	62 *63*	Page 62, Table 13 – Verify NEON/direct connectors cost. If they are already in do we need to add $. There is a savings in not reconstructing the GP traffic connector ramp.	The costs of the HOV direct connectors linking I-15 to US-95 and I-15 to the Oakey/Wyoming arterials is fully included in the Neon Project cost estimate. Therefore these costs have been removed from the incremental cost of HOV facilities throughout the Final Report.
9	63	Page 63, 6.4 B/C seems low. Usually they are much higher. If it is what it is we need some disclaimer or added description. The corridor projects have higher B/C. We need to add some language that this is a modification/enhancement to corridor projects. We may need to discuss.	The benefit cost (B/C) section was removed from the report because the analysis is inconsistent with typical B/C analysis for roadway projects. Typically, a B/C compares a No-Build with a Build condition. In this case, neither the full costs nor benefits were included in the analysis. The comparison was the incremental benefits and costs of two build alternatives: the 2030 RTP Build alternative and the 2030 HOV Plan alternative. The results were therefore incremental and not a true representation of the B/C of the HOV Plan.
10	68 *67*	Page 68, Table 15 – The Summerlin HOV connector is $40 million. Perhaps since it is already programmed you are not adding the full cost.	The cost shown on the table for the Summerlin Parkway is the incremental cost of constructing one of the lanes as an HOV lane. The connector is included in the RTP and therefore its cost is not shown here as an additional cost to implement the HOV plan.
11	68 *67*	Page 68, Table 15 - Again check NEON connector cost.	The costs of the HOV direct connectors linking I-15 to US-95 and I-15 to the Oakey/Wyoming arterials is fully included in the Neon Project cost estimate. Therefore these costs have been removed from the incremental cost of HOV facilities throughout the Final Report.
12	68 *67*	Page 68, Table 15 – Do not include I-15 Alexander to CC-215. This does not need to be in the near term facilities. Revise Figure 21.	The referenced facility was removed from the near term facilities and the text rewritten. Cost tables and Figure 21 were updated. A section was added to the Executive Summary covering the phasing of HOV projects.
13		General comment. We may want to indicate that US 95	Section 7.0, 3rd paragraph, in the Final Report says, "The

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		Rainbow to I-15 is proposed for two HOV lanes each direction but the initial plan can/will be implemented with only one HOV each direction with the 2nd added when volumes justify another lane. Not sure where to put this in the report.	HOV plan includes a second HOV lane in each direction on US-95 between I-15 and Summerlin Parkway. The timing for the implementation of the second HOV lane in each direction on US-95 between I-15 and Summerlin Parkway is more long term and should be coordinated with implementation of continuous HOV lanes through the US-95/I-15 interchange on US-95/I-515." Similar language is also included in the section added to the Executive Summary covering the phasing of HOV projects. Section 7.0, 6th paragraph in the Final Report says, "In the near term a single HOV lane in each direction on I-15 between I-215 and I-515 is recommended. The HOV plan includes a second HOV lane in each direction along this segment. The timing for implementation of the second HOV lane in each direction included in the HOV plan is more long term and should be coordinated with implementation of HOV lanes on I-215, increased HOV demand in the I-15 corridor, and future I-15 improvement projects." Similar language is also included in the section added to the Executive Summary covering the phasing of HOV projects.