APPENDICES

Appendix A
Approved USA Parkway Traffic Forecast Memorandum

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
1263 S. Stewart Street
Carson City, Nevada 89712

BRIAN SANDOVAL
Governor

SUSAN MARTINOVICH, P.E., *Director*

August 1, 2012

In Reply Refer to:

PSD 4.00

Mr. John Karachepone, P.E.
Jacobs
319 Warm Springs Rd, Suite 200
Las Vegas, Nevada 89119

Subject: USA Parkway

Dear Mr. Karachepone:

The Nevada Department of Transportation (NDOT) Traffic Information Division reviewed the travel demand forecasts your firm provided in the Technical Memorandum: USA Parkway Traffic Forecast Memorandum dated July 11, 2012. Adequate documentation was provided on the source of the existing traffic conditions as well as the development of the forecasts.

This letter is acknowledgement that in accordance with NDOT policy memorandum 03-03, NDOT formally approves the use of the travel demand forecasts depicted in the Technical Memorandum for USA Parkway.

Sincerely,

Tracy Larkin-Thomason, P.E.
NDOT Assistant Director-Planning

TLT/RDT

CC: Randy Travis, NDOT Traffic Information
Hong Hoang, NDOT Operations
Pedro Rodriguez, NDOT Project Management
Andrew Soderborg, FHWA
Bryan Gant, Jacobs

Technical Memorandum

TO:	Randy Travis, Traffic Information, NDOT	**DATE:**	July 11, 2012
FROM:	John Karachepone, Jacobs		
SUBJECT:	USA Parkway - Traffic Forecasts		
COPIES:	Pedro Rodriguez, NDOT; Hoang Hong, NDOT; Bryan Gant, Jacobs		

1. INTRODUCTION AND BACKGROUND

USA Parkway (SR 439) begins at I-80 about 10 miles east of Reno at the USA Parkway Interchange. Currently, approximately six miles of the USA Parkway alignment within Storey County has been paved and the remaining is graded to the Lyon County line. The paved section is a four-lane divided arterial with open median. Extension of the USA Parkway southeast from Storey County into Lyon County to tie into US 50 in Silver Springs is proposed.

USA Parkway (SR 439) has been envisioned as an important link between US 50 and I-80. Currently, US 395 through Carson City, SR 341 through Virginia City and US 95A through Fernley are used to connect the Reno metro area with points south and east. A complete USA Parkway between US 50 and I-80 will improve that connectivity. In addition, the development of the Tahoe-Reno Industrial Center (TRIC) along USA Parkway continues to change the employment and transportation character of the region. The TRIC is planned to become a large industrial park. Figure 1-1 illustrates the proposed project in relation to surrounding roadways and land use.

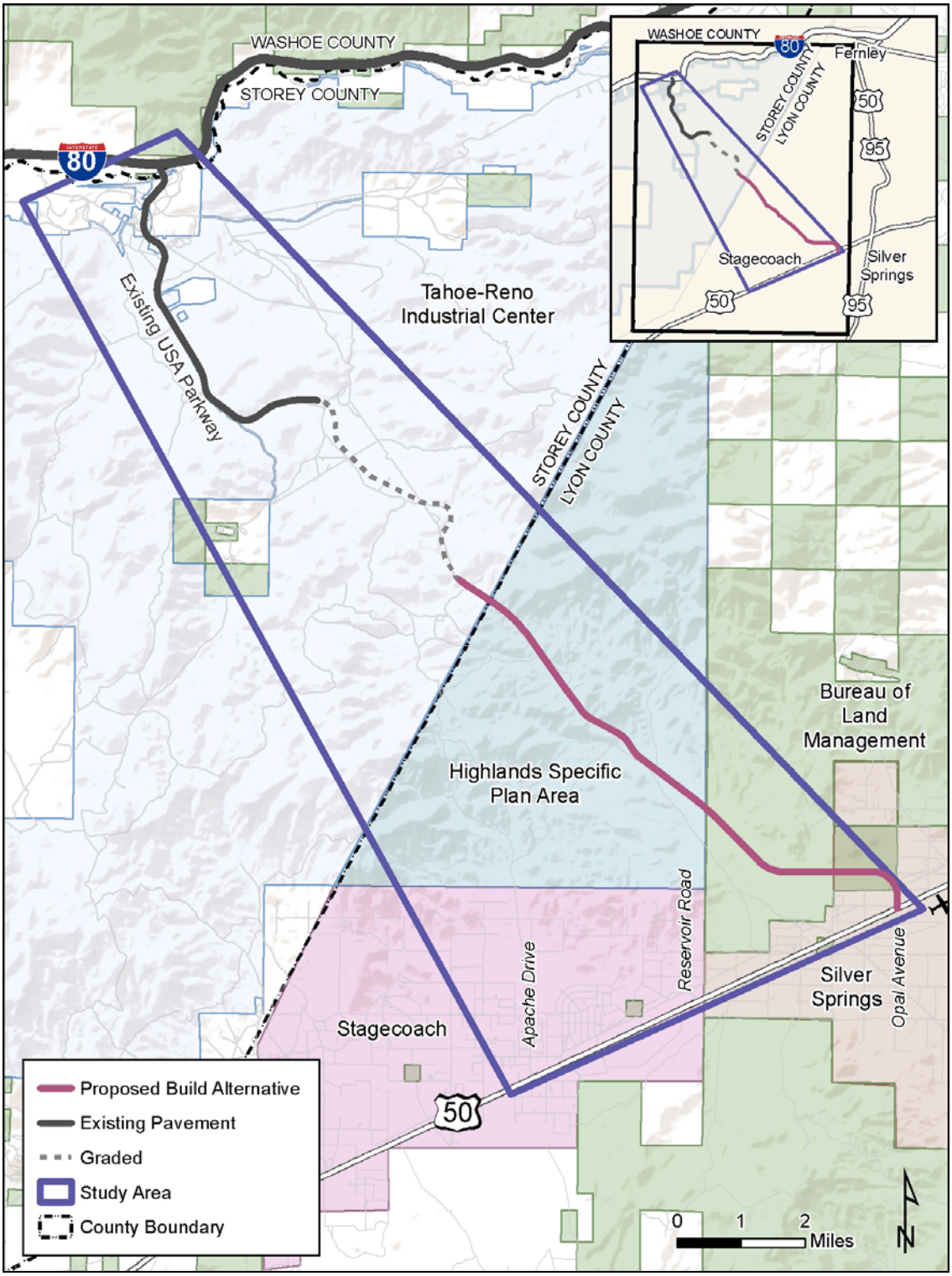
Jacobs is retained by the Nevada Department of Transportation (NDOT) to provide environmental and preliminary engineering services for the proposed project. At the present time, it appears that an Environmental Assessment (EA) will be the appropriate class of action for National Environmental Policy Act (NEPA) conformance. The lead agency is the Federal Highway Administration (FHWA) with joint NDOT and Bureau of Land Management (BLM) participation. The anticipated opening year for the proposed project is 2017. The design year is 2037, consistent with NDOT's and FHWA's 20 year beyond opening year policy.

To support the USA Parkway EA, a Traffic Study will be completed. The purpose of this memorandum is to present the design year 2037 traffic volumes that have been estimated for use in the Traffic Study. Additionally, opening year 2017 traffic volume estimates are presented.

Figure 1-1 shows an area called "Highlands Specific Plan Area" south of the county line along USA Parkway (referred to as Highlands herein). Highlands was originally proposed as a mixed-use development planned to open in year 2020. At the present time it is uncertain if the site would indeed be developed. Lyon County has not heard from the developer in several years. Concerns were expressed regarding the likelihood of the fruition of the Highlands development, especially due to economic uncertainties; and the question has arisen as to whether the Highlands development should be included in the traffic forecasts. The answer is not clear at this time; therefore the project team decided to develop traffic forecasts for two scenarios: 1) Highlands gets built ("with Highlands"); and 2) Highlands does not get built ("No-Highlands").

With this approach, forecasts will be ready for whichever development scenario is selected as the most likely scenario to go into the EA document.

Figure 1-1: Proposed Project



The basis of the traffic forecasts are the travel demand models developed specifically for the USA Parkway EA. The preparation of the traffic forecast, including travel demand model development, assumptions, data sources and refinements are documented. In all, the following travel demand models were developed specifically for the USA Parkway EA:

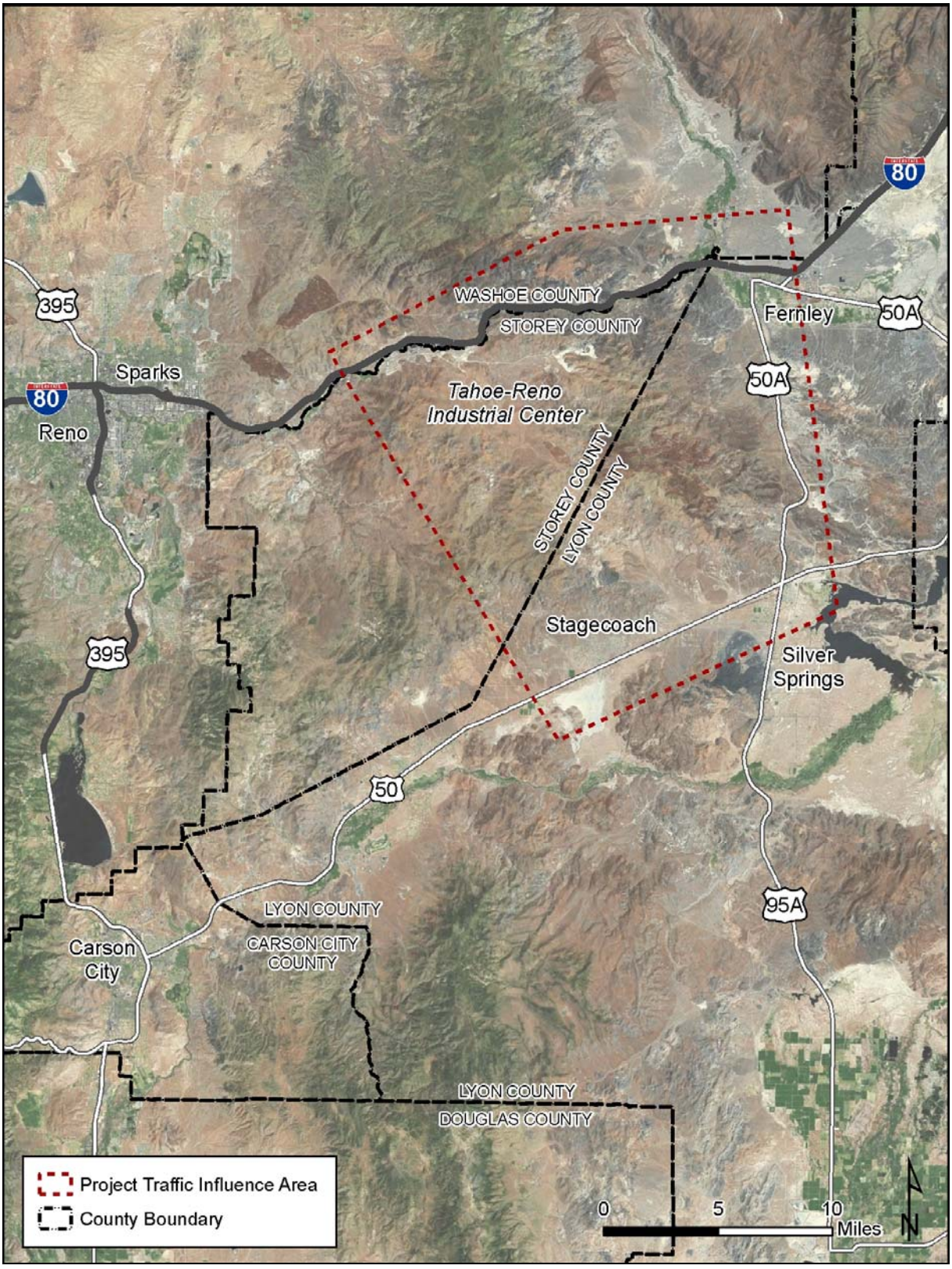
- Year 2010 Base Year Model
- Year 2035 No-Action Model (with-Highlands)
- Year 2035 Build Model (with-Highlands)
- Year 2035 No-Action Model (No-Highlands)
- Year 2035 Build Model (No-Highlands)
- Year 2017 No-Action Model
- Year 2017 Build Model

The methodologies used are consistent with the *Draft NDOT Traffic Forecasting Guidelines* and the previously approved USA Parkway Traffic Analysis Methodology, dated December 28, 2011. The Traffic Forecasting Guidelines Checklist was completed as explained in the *Draft NDOT Traffic Forecasting Guidelines* and is provided in Appendix A.

Figure 1-2 shows the general traffic study area within the regional context. This is the project traffic influence area; specifically the area bounded by I-80 to the north, US 50 to the south, US 95A to the east and USA Parkway to the west. Traffic operations analysis will be performed according to the design year development scenario identified by the project team. A traffic operations analysis of the existing USA Parkway with I-80 Interchange will also be completed for existing conditions.

This Traffic Forecast Memorandum is consistent with the *Approved USA Parkway Traffic Analysis Methodology* dated December 28, 2011, and included in Appendix B.

Figure 1-2: General Traffic Study Area



2. TRAVEL DEMAND MODEL

A travel demand modeling effort is needed to provide a regional understanding of the future traffic demand for the proposed USA Parkway.

A travel demand model does not exist for Storey County. For Lyon County, a TransCAD travel demand model was developed by Fehr & Peers in 2008 and calibrated and validated to year 2005 conditions. This model was initially developed for the US 50 Corridor Study and expanded to the rest of the County by Fehr & Peers, but was not formally adopted by the County. It had also not been maintained or updated since 2008, when Fehr & Peers turned over the network files and results to Lyon County. Fehr & Peers provided the most current version of the 2005 and 2030 travel model networks and input files to the project team. Appendix C contains the *Preliminary Modeling Report* from Fehr & Peers describing the original development and validation of the model.

It was recognized that the Lyon County model, by expanding it into Storey County, would be the best available planning tool to accomplish the forecasting needs for the USA Parkway EA. A travel demand model has the capability to demonstrate the change in travel patterns due to the addition of new capacity to a transportation network. The model modification and revalidation effort was focused on the USA Parkway area, and specifically was not an update of the entire regional model.

This section provides a description of the original Lyon County model, and documents the expansion of the original Lyon County model to cover the project area and the validation of its reasonableness in the project area.

2.1. Original Lyon County Model

The Lyon County Travel Demand Model was developed for a base year of 2005 and follows the four-step modeling procedure. Figure 2-1 displays the Lyon County Model in a regional context; the study area is in the northern half of the model, which is where the travel demand modeling effort was focused. Figure 2-2 displays the model Traffic Analysis Zone (TAZ) system,

Figure 2-3 displays the model roadway network and Figure 2-4 displays the location of the proposed USA Parkway within the model framework.

2.1.1. Model Structure and Operation

The original model is performed in TransCAD Version 4.8, Build 393 or higher. The model resource code (US50_2005.rsc) contains the GISDK code used to perform the model and was compiled using TransCAD's GISDK utility. This code utilizes the following input files:

- Trip Generation – a Microsoft Excel file consisting of worksheets to produce demographics, trip generation rates, productions and attractions, and through trips.
  - Demographics.dbf
  - Crossclasspa.bin (from "TO_CROSSCLASS" worksheet)
  - Through_trips.mtx

Figure 2-1: Lyon County Model in Regional Context

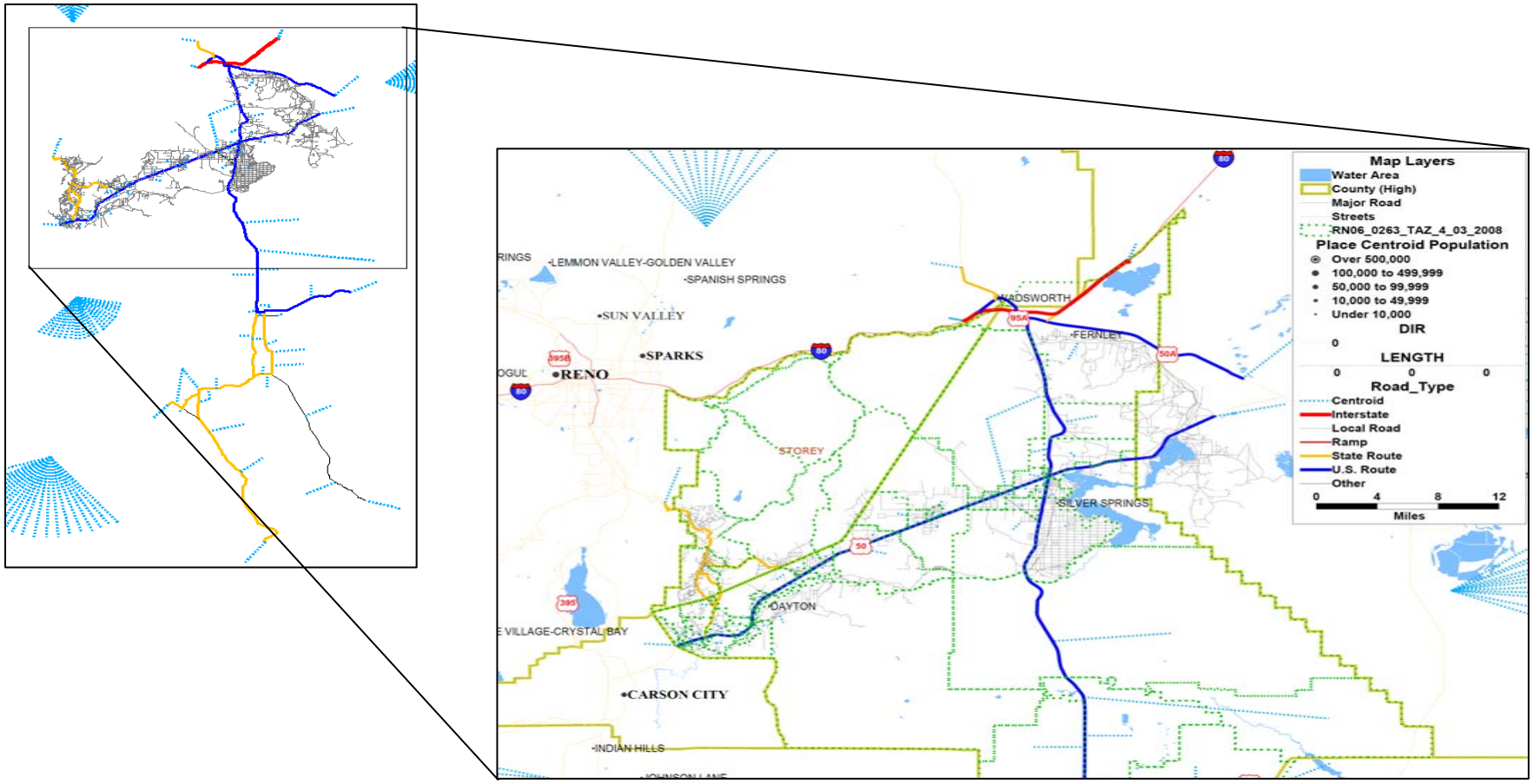
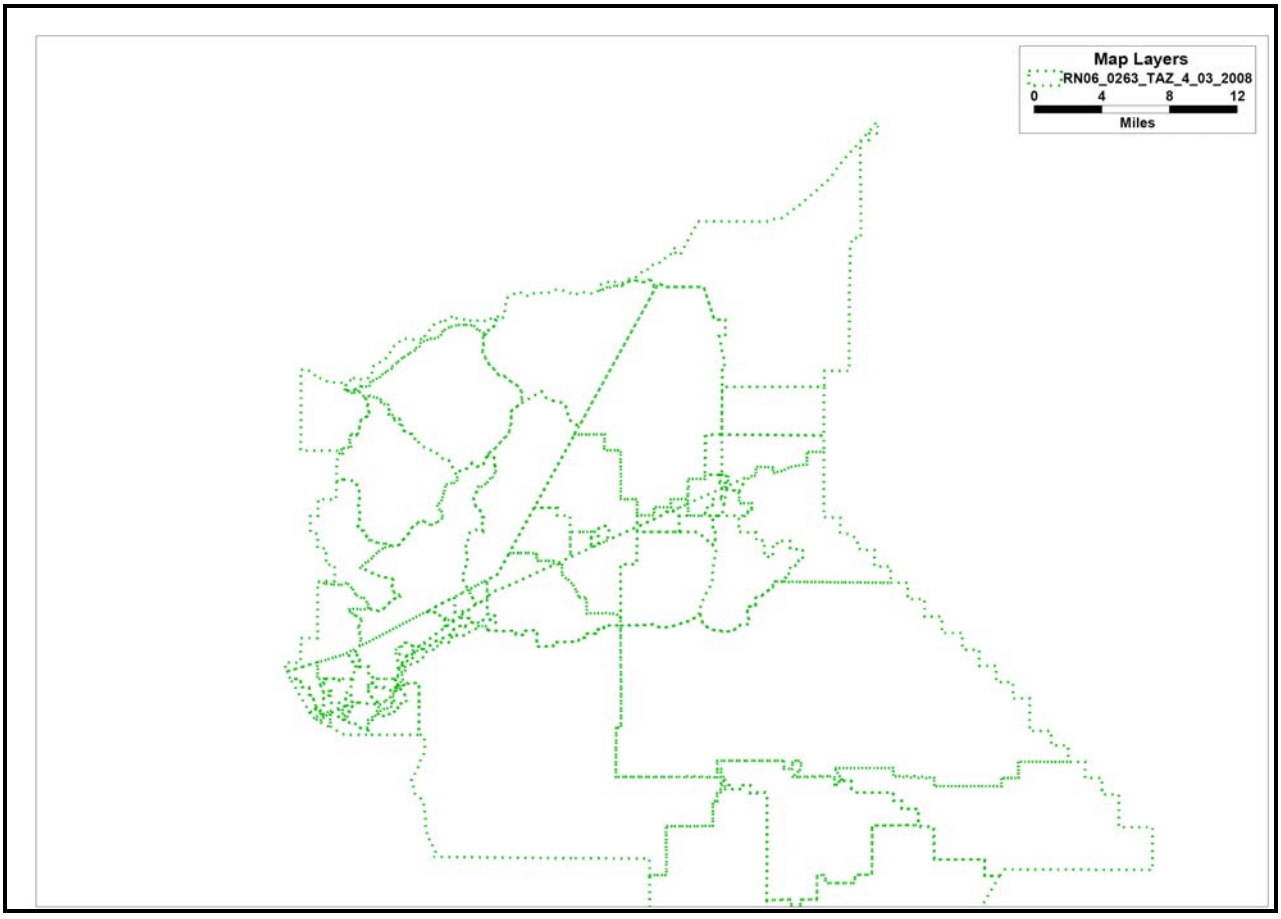
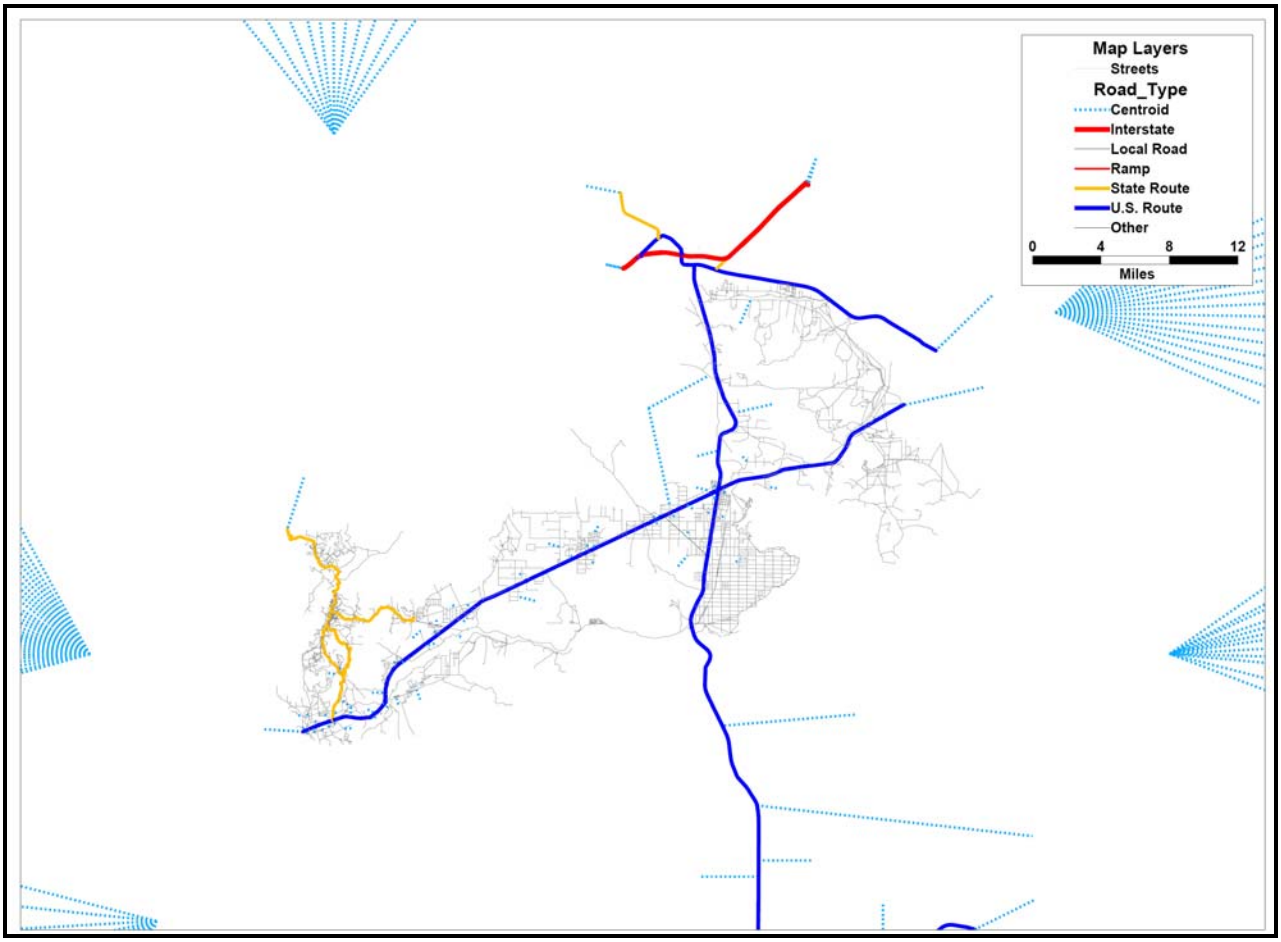


Figure 2-2: Lyon County Model TAZ System (North Area)



- Geographic File – the TransCAD network was provided for the 2005 base year. The model uses these parameters within the network:
  - Length (auto-filled)
  - Dir – direction of the link (0 = bi-directional, 1 and -1 = one-way)
  - AB_Speed, BA_Speed – free-flow or posted speed
  - AB_Lane, BA_Lane – number of lanes by direction
  - LANE_CAPACITY – hourly lane capacity
  - ALPHA, BETA – speed curve function parameters
- TAZ System – the model area was divided into 98 Traffic Analysis Zones (TAZs) and 10 External stations.
- Friction Factors – a dbf file containing friction factors is used for Trip Distribution.
- Hourly Assignment – a bin file depicting the traffic assignment values for peak hours and off-peak hours.

Figure 2-3: Lyon County Model Roadway Network (North Area)



2.1.2. Model Base and Future Years

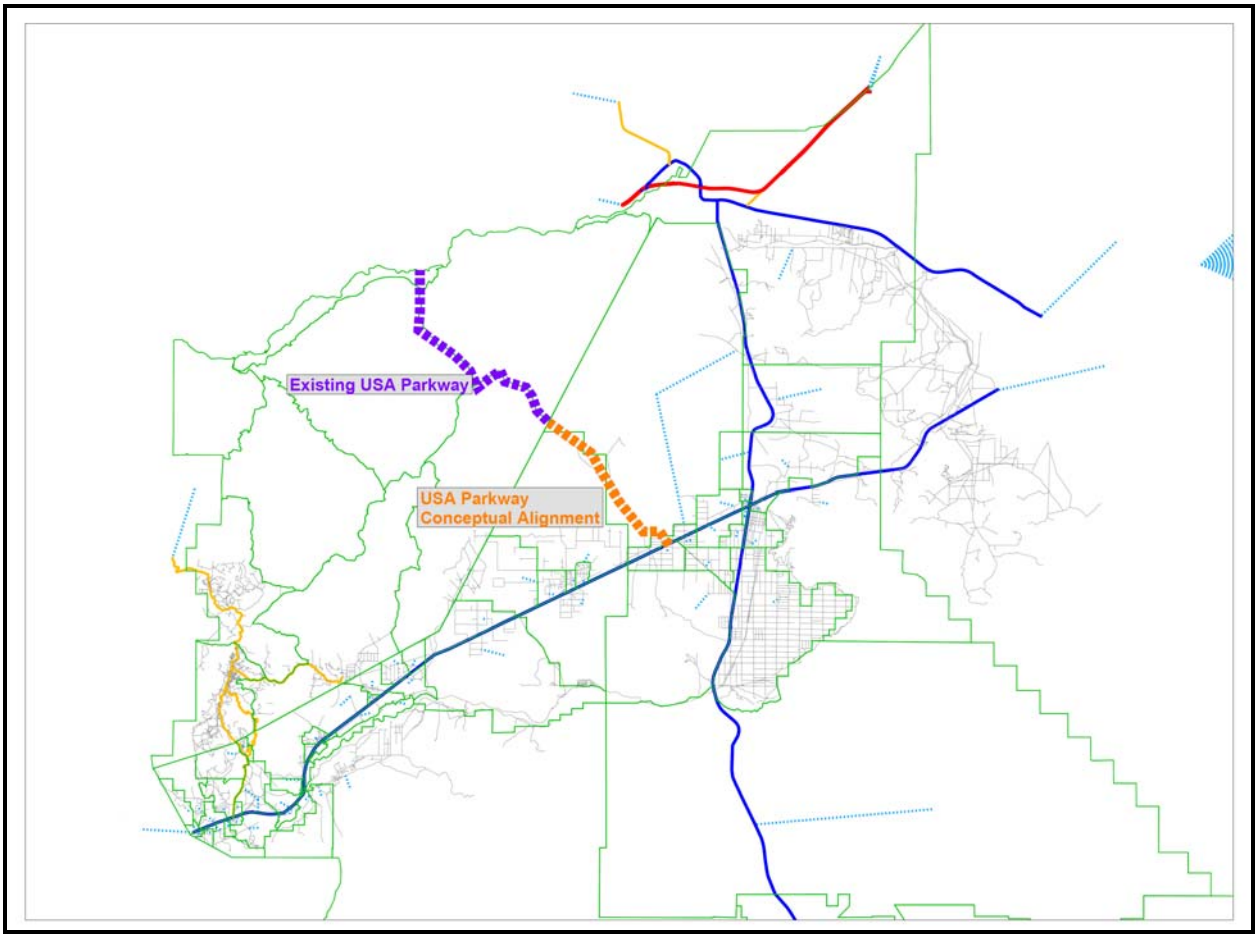
The original models provided by Fehr & Peers were calibrated and validated to a 2005 base year model and a 2030 future year.

2.1.3. Trip Purposes

There are four trip purposes in the original travel demand model:

- Home-based-work (HBW)
- Home-based other (HBO)
- Non-home-based (NHB)
- School

Figure 2-4: USA Parkway Location within Lyon County Model Network



2.1.4. Trip Generation

A primary input of the model is future estimates of population and employment socio-economic data, distributed geographically by TAZ. Table 2-1 displays the totals of population and employment in Lyon County for the base year 2005 and future year 2030. As noted in the Lyon County model *Preliminary Modeling Report* in Appendix C, the socio-economic data were not field-verified, and were last reviewed in 2008. Details can be found in Appendix C.

Table 2-1: Socio-economic Data from Lyon County Model

	Year 2005	Year 2030
Households	24,693	40,003
Employees	12,627	13,938

The Lyon County model utilizes trip generation rates compiled from a variety of sources:

- The Institute of Transportation Engineers (ITE) Trip Generation Manual
- The California Statewide Household Survey for Sierra Nevada Counties
- The Sacramento Area Council of Governments

These are shown in Table 2-2 for the different geographic areas of the model. These trip generation rates resulted in approximately five daily trips per household.

Table 2-2: Trip Generation Rates

Land Use Type	Unit	Lyon County	Dayton	Fernley	Silver Springs	Yerington	External
SFR	DU	2.56	6.40	3.84	4.22	3.20	6.40
MFR	DU	1.40	3.50	2.10	2.31	1.75	3.50
MH	DU	1.40	3.50	2.10	2.31	1.75	3.50
RURAL Residential	DU	2.56	6.40	3.84	3.20	3.20	6.40
ELEM	Students	1.29	1.29	1.29	1.29	1.29	1.29
HIGHSCH	Students	1.71	1.71	1.71	1.71	1.71	1.71
Retail	Jobs	12.20	24.40	12.20	18.30	18.30	24.40
Non-Retail	Jobs	2.00	4.00	2.00	3.00	3.00	4.00

2.1.5. External Stations

There are 11 external stations in the original model:

- Node 200: I-80 West of Fernley
- Node 201: CR 447 North of Wadsworth
- Node 202: I-80 East of Fernley
- Node 203: US 50 East of Fernley
- Node 204: SH 341 North of Dayton
- Node 205: US 50 East of Silver Springs
- Node 206: US 50 West of Dayton
- Node 207: US 95A East of Yerington
- Node 208: CR 208 West of Wellington
- Node 209: Pine Grove Road South of Yerington
- Node 800: CR 338 South of Wellington

2.1.6. Trip Distribution

The model utilizes a standard gravity model procedure to distribute trips. The friction factor table is used to determine impedances. The friction factors for the original model are shown in Figure 2-5.

The original model produced trips that were somewhat skewed toward very short trips, but otherwise reasonably-well distributed. Seventy percent of all trips were less than 30 minutes long and 40 percent of all trips were to locations within 10 minutes. Figure 2-6 displays the trip length distribution for the original 2005 base year model.

2.1.7. Auto Occupancy

A flat auto-occupancy rate of 1.5 people per vehicle is used for all trip types.

2.1.8. Traffic Assignment

The model performs traffic assignment for daily, AM peak hour, and PM peak hour. The hourly capacity and alpha and beta fields determine speed curves and the model performs a maximum of 10 speed-balancing iterations for each assignment period.

Figure 2-5: Friction Factors for the Original Model

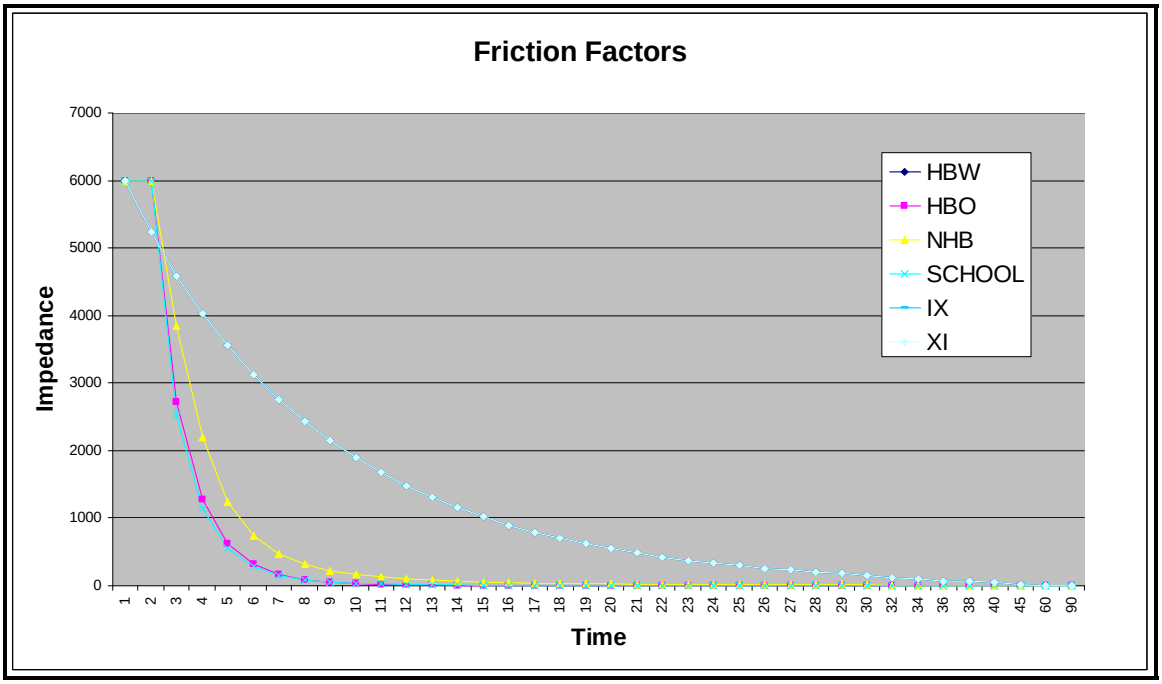
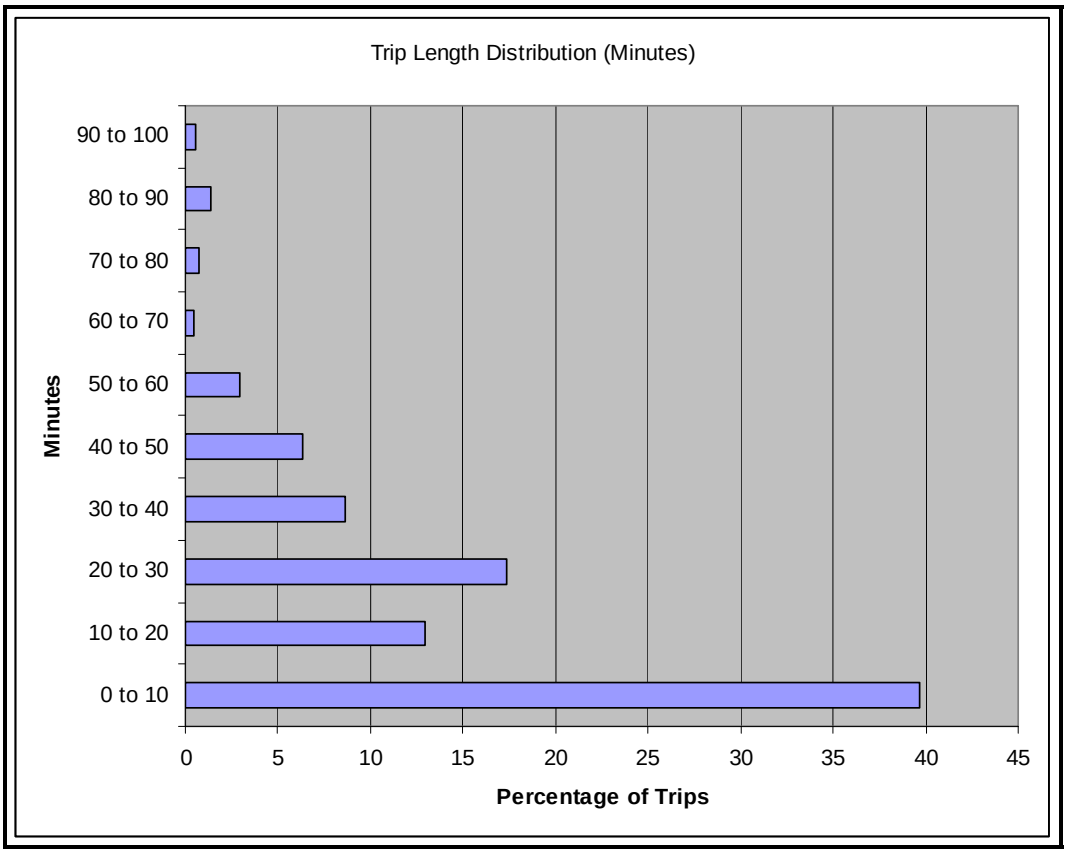


Figure 2-6: Trip Length Distribution for the Original Model



2.2. USA Parkway EA Model Development

For the USA Parkway EA travel demand modeling, the project team made several updates and modifications to the original Lyon County Model. The improvements were focused on the project traffic influence area, specifically, the area bounded by I-80 to the north, US 50 to the south, US 95A to the east and USA Parkway to the west. A region-wide model update was not performed. The updates and modifications are described in the following sections.

2.2.1. Updated Network

The project team extended the boundaries of the base year model into Storey County to include the USA Parkway Interchange at I-80. Also, the existing USA Parkway segment through the TRIC was added to the network as well as some local road connections in the area. The updated network is displayed in Figure 2-7.

2.2.2. Updated TAZ System

The TAZ system was modified to better reflect development areas for both existing areas and future development patterns. This included modifying the Fernley area, where originally only one TAZ was coded into the original structure. Some additional zones near US 95A were also included in the new TAZ system. These additional zones allowed an improved distribution of trips. Also, zones representing the TRIC and the Highlands development were added in the project area. Centroid connectors were provided for each new or modified TAZ. Figure 2-8 displays the additional/modified TAZs in red.

2.2.3. Base Year 2010

The project team updated the base year for the model to 2010. This allowed the team to validate the model results to more recent counts and to include the USA Parkway / I-80 interchange in the base year network. A review of the demographics file revealed an over estimation of the number of households in the county in the original model. According to the United States Census, Lyon County had 17,800 households in the year 2010. The original model demographic file for 2005 contained 24,700 households. The number of households in each geographic sub-area in the original model data was also higher than the corresponding US Census number, with the exception of Dayton. Therefore, adjustments were made to each geographic area in the demographics file to better reflect the number of households in the county. The US Census data was used to make these adjustments, which are shown in Table 2-3 in comparison to original 2005 model.

The project team also reviewed the number of jobs in the model area, which were found to be reasonable for the 2010 base year. However, the original file did not include the TRIC. In 2010, the businesses operating in the TRIC employed approximately 2,500 workers. The addition of these jobs to the original model employment resulted in 15,900 for the 2010 employment for the model area. This represents a jobs-to-households ratio of 0.89. Detailed demographic data can be found in Appendix D.

Figure 2-7: Updated 2005 Model Network

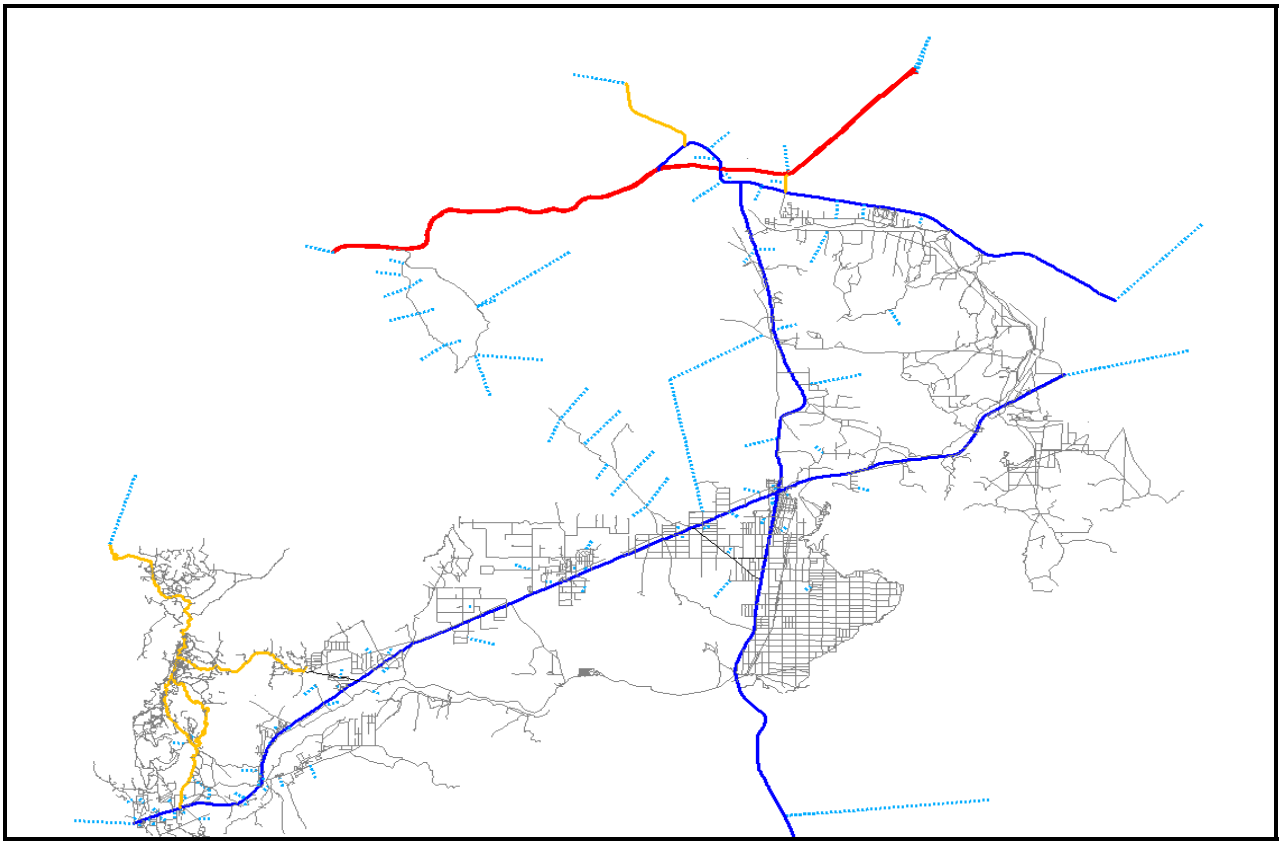


Table 2-3: Households by Type – Base Year

Geographic Area		Original 2005					Census (2010)	Updated to 2010			
		Single Family	Multi-Family	Mobile Home	Rural	Total		Single Family	Multi-Family	Mobile Home	Rural
1	Lyon County*	179	974	2,301	5,397	8,843	5,200	102	571	1,354	3,173
2	Dayton	1,622	348	494	434	2,899	3,100	1,736	372	527	462
3	Fernley	3,311	1,075	2,235	1,656	8,278	6,400	2,559	834	1,729	1,279
4	Silver Springs	-	25	2,051	587	2,662	1,800	-	16	1,386	396
5	Yerington	40	221	523	1,227	2,011	1,300	26	143	338	793
	Total	**5,152**	**2,643**	**7,604**	**9,301**	**24,693**	**17,800**	**4,423**	**1,936**	**5,335**	**6,104**

* Note that Highlands development is a proposed development, and did not exist in the year 2005 and year 2010

2.2.4. Future Year 2035 – with-Highlands Models

The project team updated the model forecast year to 2035. The demographics file was extended from 2030 to 2035 by applying the growth rates in the original model files to 2035 by TAZ. In addition, the Highlands development is projected to have approximately 1,300 single family homes and 1,300 multi-family homes by 2035. However, the same adjustments applied to 2010 to control for US Census figures were applied to the 2030 data, meaning that the number of households in 2035 is projected to be lower than the number in the original 2030 model. The resulting number of households by type is provided in Table 2-4 in comparison to original 2030 model.

Figure 2-8: Updated TAZ System

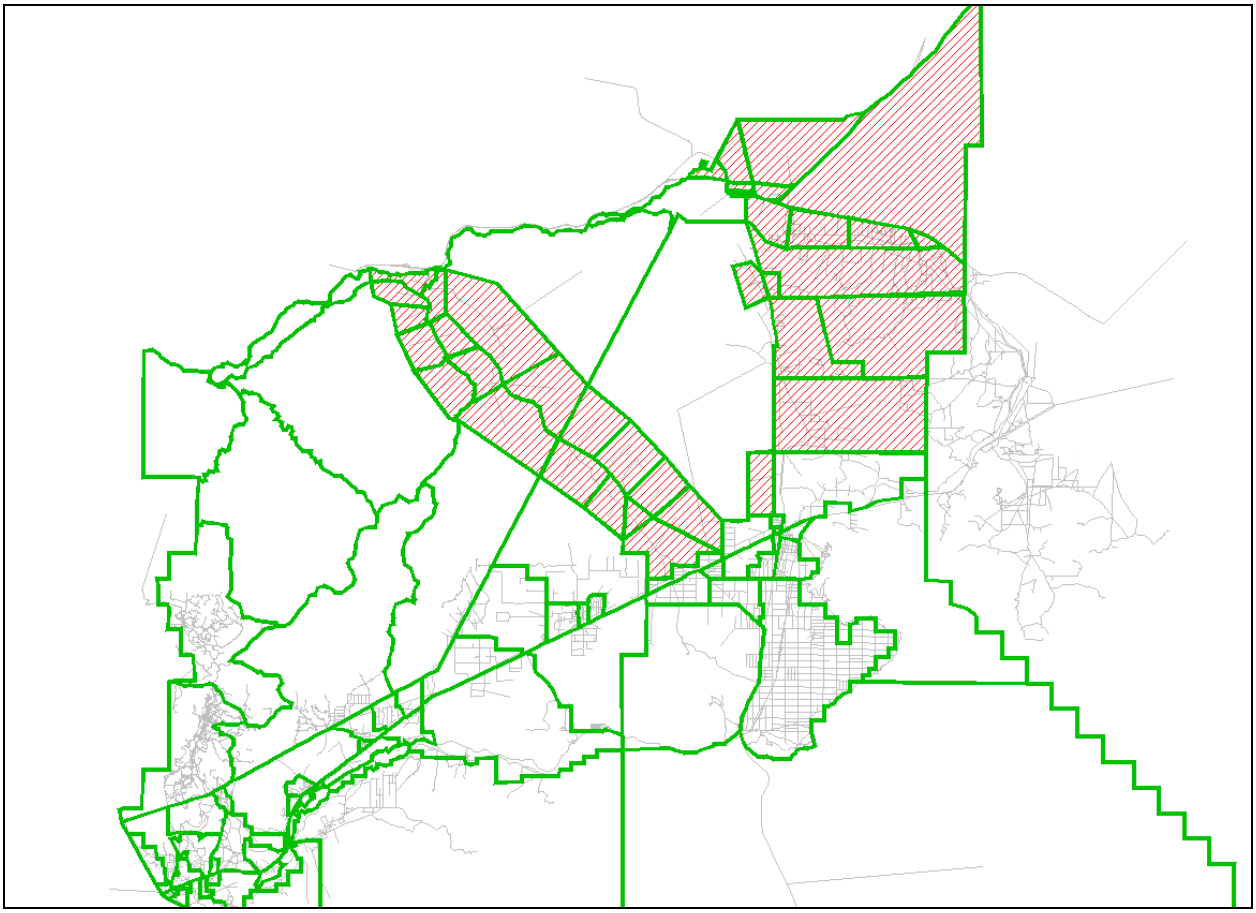


Table 2-4: Households by Type – Year 2035 with-Highlands Models

Geographic Area		Original 2030 – without Census Adjustment					Updated to 2035 – with Census Adjustment and Highlands Development				
		Single Family	Multi-Family	Mobile Home	Rural	Total	Single Family	Multi-Family	Mobile Home	Rural	Total
1	Lyon County	284	1,586	3,752	8,800	14,422	1,482	2,036	1,749	4,111	9,378
2	Dayton	2,267	487	690	609	4,053	2,504	538	764	674	4,480
3	Fernley	5,947	1,931	4,014	2,973	14,865	4,891	1,587	3,300	2,445	12,222
4	Silver Springs	-	45	3,371	963	4,379	-	27	2,136	603	2,766
5	Yerington	46	251	594	1,393	2,284	75	415	981	2,317	3,787
Total		**8,544**	**4,300**	**12,421**	**14,738**	**40,003**	**8,952**	**4,603**	**8,929**	**10,150**	**32,633**

The number of households in Lyon County in the 2035 demographic file includes the projected number of households in the Highlands development and this is reflected in Table 2-4. The number of households for Lyon County shown in Table 2-4 reflects both the census adjustment and the projected number of households for year 2035. Note that the original 2030 model did not include the Highlands development.

Highlands development's share of household numbers in relation to the number of households for the entire Lyon County is shown in Table 2-5.

Table 2-5: Households by Type – Lyon County – Year 2035 with-Highlands Models

Geographic Area	Year 2035				
	Single Family	Multi-Family	Mobile Home	Rural	Total
Lyon County – excluding Highlands development	132	740	1,749	4,111	6,732
Highlands development	1,350	1,296	-	-	2,646
Lyon County – including Highlands development	1,482	2,036	1,749	4,111	9,378

Employment projection data were limited for the area. The jobs-to-households ratio was relatively low in the original 2030 demographic file at 0.45. However, the TRIC (not part of the original model) is projecting substantial growth over the next 25 years. The report, *USA Parkway State Route 805, A Piece of Nevada's Future*, by Storey County, projects jobs growth at the TRIC to result in the employment of approximately 19,500 workers within the TRIC by 2030. Applying this growth rate to 2035 would result in approximately 23,500 employees at the TRIC in the forecast year. These jobs were added to the demographic file for 2035. Jobs in the Highlands development were also included in the forecast. The Highland development is proposed to be a mixed-use development. The project team estimated that the development would add approximately 900 jobs in 2035. The resulting number of jobs in the model area for 2035 is 38,900. This represents a jobs-to-households ratio of 1.19, indicating that the number of jobs in the area is projected to grow at a faster rate than the number of households. This is expected with the rapid development of the TRIC in the near future and results in a more reasonable forecast of socio-economic conditions for the model area. Detailed demographic data can be found in Appendix D.

2.2.5. Future Year 2035 – No-Highlands Models

The year 2035 No-Highlands models were also developed as per the procedures explained in Section 2.2.4. But, in the No-Highlands models, the projected households due to the Highlands development were not added to the TAZs corresponding to the Highlands development. The number of households by type in the No-Highlands models for the different geographical areas in comparison to original 2030 model is provided in Table 2-6.

Table 2-6: Households by Type – Year 2035 No-Highlands Models

Geographic Area		Original 2030 – without Census Adjustment					Updated to 2035 – with Census Adjustment				
		Single Family	Multi-Family	Mobile Home	Rural	Total	Single Family	Multi-Family	Mobile Home	Rural	Total
1	Lyon County	284	1,586	3,752	8,800	14,422	132	740	1,749	4,111	6,732
2	Dayton	2,267	487	690	609	4,053	2,504	538	764	674	4,480
3	Fernley	5,947	1,931	4,014	2,973	14,865	4,891	1,587	3,300	2,445	12,222
4	Silver Springs	-	45	3,371	963	4,379	-	27	2,136	603	2,766
5	Yerington	46	251	594	1,393	2,284	75	415	981	2,317	3,787
	Total	**8,544**	**4,300**	**12,421**	**14,738**	**40,003**	**8,952**	**4,603**	**8,929**	**10,150**	**29,987**

In the No-Highlands scenario, the total number of jobs in the demographics file is approximately 38,000 (in comparison to the with-Highlands model, the jobs corresponding to the Highlands development do not exist). The number of households is 29,987 as shown in Table 2-6. This represents a jobs-to-households ratio of 1.27.

2.2.6. Opening Year 2017

In addition to the base and future years, opening year 2017 travel demand models were developed. The demographic data for the opening year 2017 were developed by applying a linear growth rate. The household adjustments for all years are summarized in Table 2-7.

Table 2-7: Household Data Summary

Geographic Area		2005 Original	2010 Adjusted	2017 Final	2030 Original	2030 Adjusted	2035 Final (With-Highlands)	2035 Final (No-Highlands)
1	Lyon County	8,843	5,200	6,038	14,422	8,863	9,378[1]	6732
2	Dayton	2,899	3,097	3,484	4,053	4,525	4,480	4,480
3	Fernley	8,278	6,401	8,033	14,865	12,012	12,222	12,222
4	Silver Springs	2,662	1,798	2,070	4,379	3,091	2,766	2,766
5	Yerington	2,011	1,300	1,675	2,284	1,543	3,787	3,787
	Total	**24,693**	**17,796**	**21,300**	**40,003**	**30,034**	**32,633**	**29,987**

[1] This includes growth to 2035 and the addition of the Highlands Development

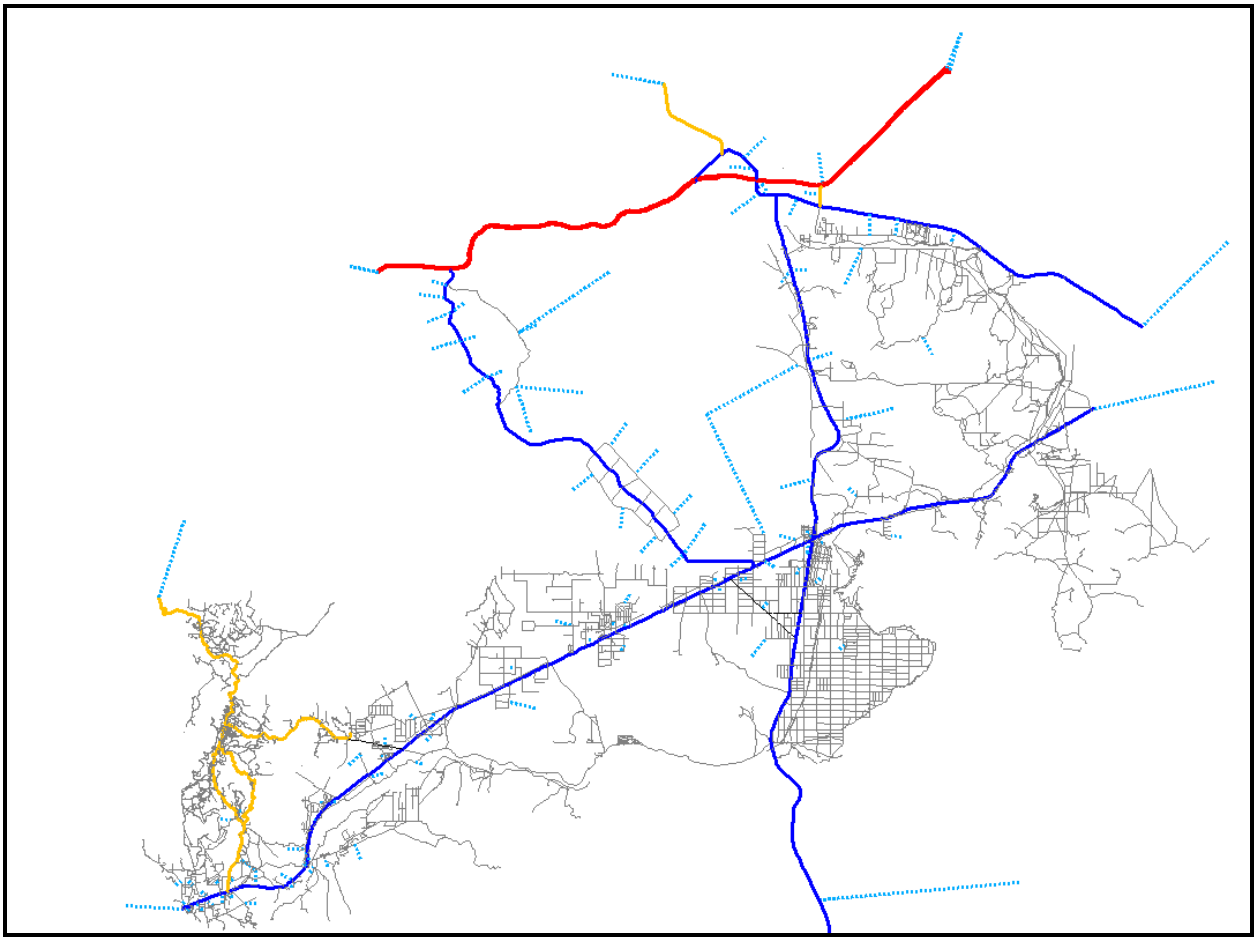
2.2.7. Future Roadway Network (No-Action and Build)

No-Action network models are used as a baseline to compare Build Alternative(s). No-Action represents the future conditions without the proposed project. Typically, a No-Action network is defined to be the existing roadway system, together with committed improvement projects as planned in state, regional and local plans. For the USA Parkway EA, no changes were made to the base year 2010 network for the No-Action network; as there are no planned/programmed improvements in the vicinity of the Traffic Study Area. The No-Action network includes local arterial road connections to US 50 for the Highlands development. The proposed USA Parkway extension (i.e. the proposed project) is not included.

The build network includes the USA Parkway extension (i.e. the proposed project) as a four-lane minor arterial facility with a 1,500 vph lane capacity and 45 mph free flow speed.

Figure 2-9 displays the 2035 Build (with-Highlands and No-Highlands) roadway network.

Figure 2-9: Updated 2035 Model Build Network



2.2.8. Trip Generation

Trip generation rates were adjusted to better reflect real-world conditions for both home based and other trips in the model. The original rates used by the model were under-producing trips from each household; several TAZs that contained only households (no jobs) were producing just one trip per household. Several adjustments were tested for the base year, and trip generation rates that produced the best combination of TAZ-generated traffic and daily volumes on major facilities were determined. Further, some minor formula corrections were made to the trip generation spreadsheet.

The trip generation rates shown in Table 2-8 produced a reasonable number of trips for the model – 6.57 daily trips per household and 3.66 home-based trips per household.

Table 2-8: Updated Trip Generation Rates

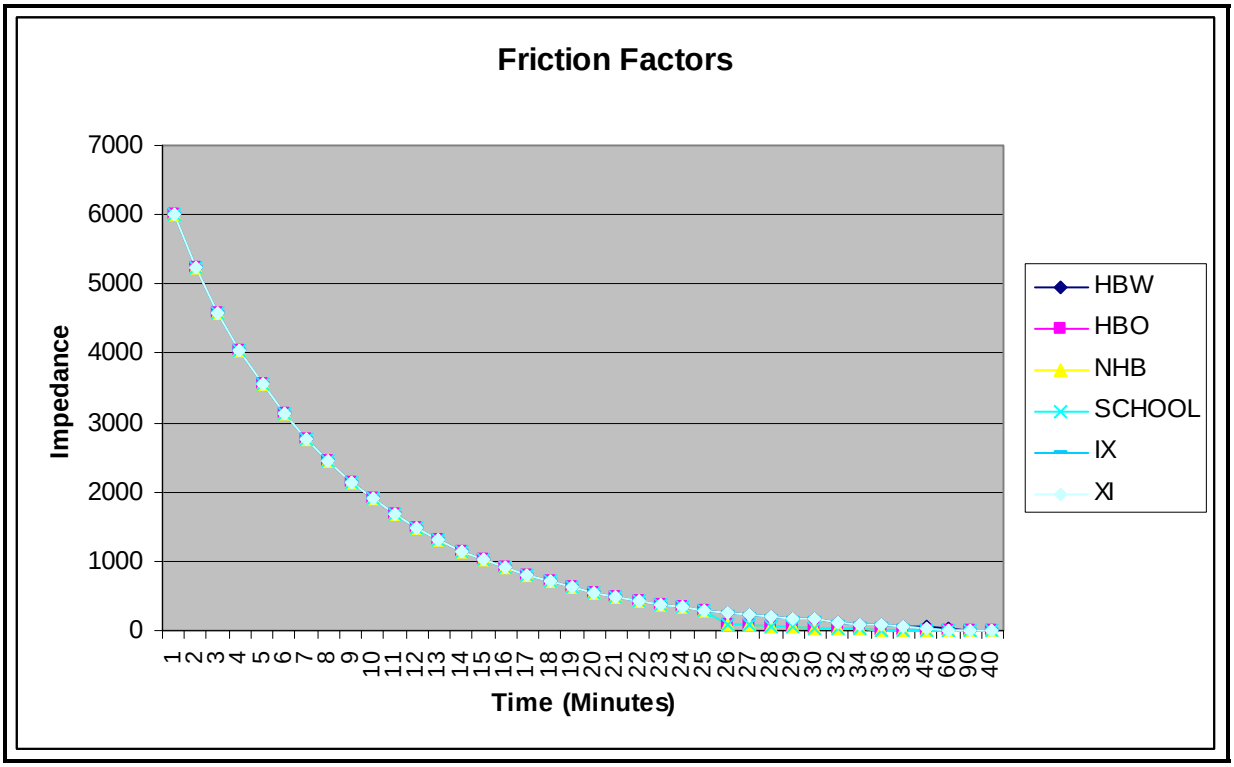
Land Use Type	Unit	Lyon County	Dayton	Fernley	Silver Springs	Yerington	External
SFR	DU	4.80	4.80	4.80	4.80	1.60	6.40
MFR	DU	2.63	2.63	2.63	2.63	0.88	3.50
MH	DU	2.63	2.63	2.63	2.63	0.88	3.50
RURAL Residential	DU	4.80	4.80	4.80	4.80	1.60	6.40
ELEM	Students	1.29	1.29	1.29	1.29	0.32	1.29
HIGHSCH	Students	1.71	1.71	1.71	1.71	0.43	1.71
Retail	Jobs	12.20	12.20	12.20	12.20	6.10	24.40
Non-Retail	Jobs	3.00	3.00	3.00	3.00	3.00	4.00

External station adjustments were also necessary for the base and future years. Trips to and from external stations are input directly into the demographics file, and are based on traffic counts in 2010. These were obtained from NDOT count stations where available and were retained from the original model if not. The future year values were determined by applying growth rates to base year volumes based on data from NDOT, RTC Washoe County, CAMPO, and the original model files. On I-80 west of USA Parkway, RTC Washoe County's travel demand model output files were obtained to determine an appropriate growth rate. The 2018 and 2030 models revealed a projected annual growth rate of approximately 2.4 percent. This amount of growth would result in approximately 50,000 vpd on I-80 in 2035, up from 28,000 vpd in 2010. The same growth rate was applied to the US 50 link near Dayton, which would grow to 42,000 vpd by 2035. This is consistent with the *US 50 East Corridor Study*, November 2007, which projects volumes above 35,000 vpd in the area. Note that the Capitol Area MPO travel demand model does not project a similar level of growth for US 50 and projects 1.0 percent annual growth in this location. The other external links were assigned growth between 1.0 percent per year and 2.4 percent per year, based on planning judgment. These data are included in the model inputs; the model subsequently performs its traffic distribution and assignment procedures, which results in slightly different volumes on these roadways, depending on the number of internal and external trips produced by the rest of the model area.

2.2.9. Trip Distribution

The friction factors from the original model seemed to produce too many short trips. Some major production and attraction areas of the model were too far away to be connected with the original friction factors. Adjustments were made to the friction factors to decrease the impedance for medium-length trips. The updated frictions factors are displayed in Figure 2-10. These friction factors allow longer trips between activity centers in the model, and produced volumes on key roadways that better matched traffic counts.

Figure 2-10: Updated Friction Factors



2.3. Base Year Model Validation

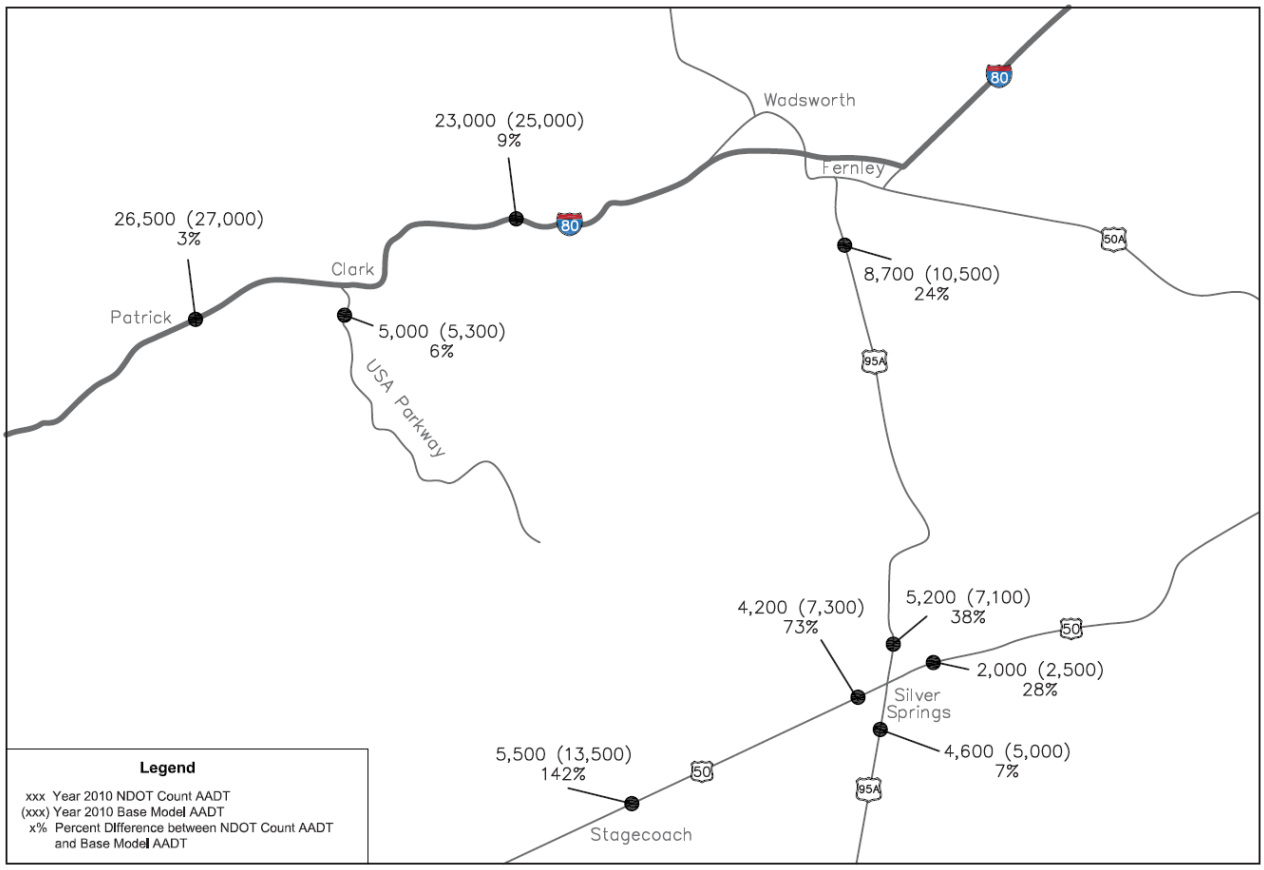
The existing year model was validated to 2010 conditions for the study area. Figure 2-11 contains counts from NDOT count locations and results from the final 2010 Base Year Model. As shown, the model performs reasonably well in the study area; however model projections are high along US 50 west of the Study Area. The reason for this is probably due to an over-estimation of the trips to/from Dayton. After some testing, the high volumes persisted. A larger scale refinement would be necessary than was feasible for this project; therefore further refinements were decided to be performed through model output post-processing. See Chapter 5 and Chapter 6 for detailed explanation of how the model output is post-processed.

2.4. Sensitivity Tests

The project team performed several sensitivity tests with the model to ensure it was reacting reasonably to changes in land use, network, and other changes to input files. The sensitivity tests that provided confirmation of reasonableness are described below.

For the base year 2010 model, a test run was performed that included the Build scenario with a completed USA Parkway. This model run resulted in approximately 3,500 vehicles per day utilizing USA Parkway between US 50 and I-80, hypothetically in 2010. A similar magnitude of traffic was reduced along US 95A and I-80 east of the USA Parkway Interchange. This volume estimation seemed reasonable to the project team given current awareness of traffic patterns and volumes in the study area.

Figure 2-11: Comparison of 2010 Base Model vs. Ground Counts at Study Area Roadway Network



In 2035, several land use scenarios were tested. A scenario with zero growth in the TRIC was tested. This model run reacted reasonably with much lower volumes than the final build scenario. USA Parkway would carry the traffic necessary to serve the existing TRIC (approximately 5,500 trips per day) plus additional through traffic (approximately 4,500 trips per day), for a total of approximately 10,000 vpd.

A scenario with a high level of growth in the TRIC was tested; this model run assumed 37,000 employees in the TRIC by 2035, based on the pro-rated full build-out scenario. This run resulted in approximately 30 to 35 percent higher trips than the final land use scenario with 23,500 employees.

These sensitivity tests confirmed that the model was performing properly and that the final base year and future year model runs were producing reasonable results.

2.5. Model Application

For the purposes of traffic forecasting for the USA Parkway EA, seven model runs were developed and fully analyzed by the project team:

- Year 2010 Base Year Model
- Year 2035 No-Action Model (with-Highlands)
- Year 2035 Build Model (with-Highlands)

- Year 2035 No-Action Model (No-Highlands)
- Year 2035 Build Model (No-Highlands)
- Year 2017 No-Action Model
- Year 2017 Build Model

These runs provide the basis for the traffic forecasting to be used in the traffic operations analysis. Volume plots of the area are available in Appendix E.

Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) are standard measures of the level of mobility in a region. Table 2-9 shows the total model-area VMT and VHT for each of the seven model runs. As shown, VMT and VHT are both more than double in the 2035 No-Action (with-Highlands), compared to the 2010 Base Year. Also, the Build Alternative (with-Highlands and No-Highlands) reduces VMT and VHT by providing a more direct route for many trips compared to the No-Action alternative (with-Highlands and No-Highlands). The average speed is also increased with the Build Alternative (with-Highlands and No-Highlands) compared to the No-Action alternative (with-Highlands and No-Highlands). In 2017 opening year, the build model reduces both VMT and VHT, compared to the No-Action.

Table 2-9: Model Area VMT and VHT

Model Run	Daily VMT	Daily VHT	Average Speed
Year 2010 Base Year	2,075,000	47,900	43
Year 2035 No-Action (with-Highlands)	4,724,000	126,100	38
Change from 2010	2,649,000	78,200	-5
Percentage	128%	163%	-12%
Year 2035 Build (with-Highlands)	4,168,000	105,200	40
Change from No-Action	-556,000	-20,900	2
Percentage	-12%	-17%	5%
Year 2035 No-Action (No-Highlands)	4,450,000	112,900	38
Change from 2010	2,375,000	65,000	-5.8
Percentage	114%	136%	-13%
Year 2035 Build (No-Highlands)	3,999,000	98,700	40
Change from No-Action	-451,000	-14,200	2.1
Percentage	-10%	-13%	6%
Year 2017 No-Action	2,625,000	62,600	42
Change from 2010	550,000	14,700	-1
Percentage	27%	31%	-2%
Year 2017 Build	2,495,000	60,100	42
Change from No-Action	-130,000	-2,500	0
Percentage	-5%	-4%	0%

The travel demand model produces daily and peak hour volumes. The calibration is performed based on the daily volumes; hence the peak hour volumes from the model are not necessarily reliable and not used for traffic forecasts.

At specific road segment locations, travel demand models may or may not accurately estimate traffic. For this reason, adjustments to travel demand model output prior to use in traffic

operations analysis is necessary. The primary reference for traffic model volume adjustments is the National Cooperative Highway Research Program Report (NCHRP) 255: *Highway Traffic Data for Urbanized Area Project Planning and Design*. The subsequent chapters of this memorandum explain the post-processing of model output for use in traffic operations analysis using NCHRP Report 255 techniques.

3. TRAFFIC STUDY AREA NETWORK

Existing USA Parkway (SR 439) begins at I-80 about 10 miles east of Reno at the USA Parkway Interchange. Currently, approximately six miles of the USA Parkway alignment within Storey County has been paved and the remaining is graded to the Lyon County line. The paved section is a four-lane divided arterial with open median.

The proposed project is the extension of the existing USA Parkway to US 50; therefore the main focus of the traffic analysis is the proposed extension of USA Parkway. The Traffic Study will also evaluate the major roadways within the project traffic influence area; specifically I-80 to the north, US 50 to the south, and US 95A to the east.

Figure 3-1 illustrates the general study area roadway network. Existing number of lanes, planned number of lanes and the NDOT functional classification are shown. The following is a general description of the study area roadways:

- Existing USA Parkway is a four-lane rural minor arterial. The extension is proposed as a rural minor arterial as well.
- I-80 within the general study area is a four-lane rural interstate. I-80 is planned to be widened to six lanes west of USA Parkway. Widening is not planned for I-80 east of the USA Parkway Interchange.
- US 50 within the project influence area is a two-lane rural principal arterial with wide shoulders. In Silver Springs, US 50 intersects with US 95A at a four-way stop controlled intersection. US 50 is planned to be widened to four lanes west of US 95A. Widening is not planned for US 50 east of US 95A.
- US 95A is a two-lane rural minor arterial between US 50 and I-80; and currently is one of the roads that connect the Reno/Sparks metropolitan area with points south and east. Widening is not planned for US 95A within the study area.
- Ramsey-Weeks Cut-off is two-lane rural minor collector that provides diversion for trips between US 50 to the west and US 95A to the south. Widening is not planned for Ramsey-Weeks cut-off.

Traffic operations analysis will be performed for year 2037 depending on the development scenario that is identified by the project team to be the most likely development scenario for the Highlands development.

In the with-Highlands scenario, intersections and roadway segments along the proposed USA Parkway extension between Storey/Lyon County line and US 50 and the interchange at I-80 will be evaluated. Figure 3-2 shows the study intersections and roadway segments for the traffic operations analysis of this scenario. Based on the available development data[1], seven (7) intersections along the USA Parkway extension will be analyzed. Six (6) of these intersections are along the proposed Highlands development (Intersections 1 through 6 in Figure 3-2). The seventh intersection is at US 50 (Intersection 7). Traffic operations analysis of the existing USA Parkway Interchange with I-80 will also be completed (Intersections 8 and 9) for both existing and future conditions.

[1] Highlands Master Streets and Highway Plan

Daily and peak hour traffic forecasts are developed for all nine (9) study intersections and adjacent roadway segments. In addition, daily traffic forecasts are developed for the roadways within the general study area network. Final traffic forecasts are presented in Chapter 5 and Chapter 6.

In the No-Highlands scenario, since the Highlands development does not exist, intersections 1 through 6 shown in Figure 3-2 do not exist. Hence, the traffic operations analysis will be performed only for the other intersections accordingly. Daily and peak hour traffic forecasts are developed for the relevant study intersections and adjacent roadway segments. In addition, daily traffic forecasts are developed for the roadways within the general study area network. Final traffic forecasts for the No-Highlands scenario are presented in Chapter 7.

Figure 3-1: General Study Area Roadway Network

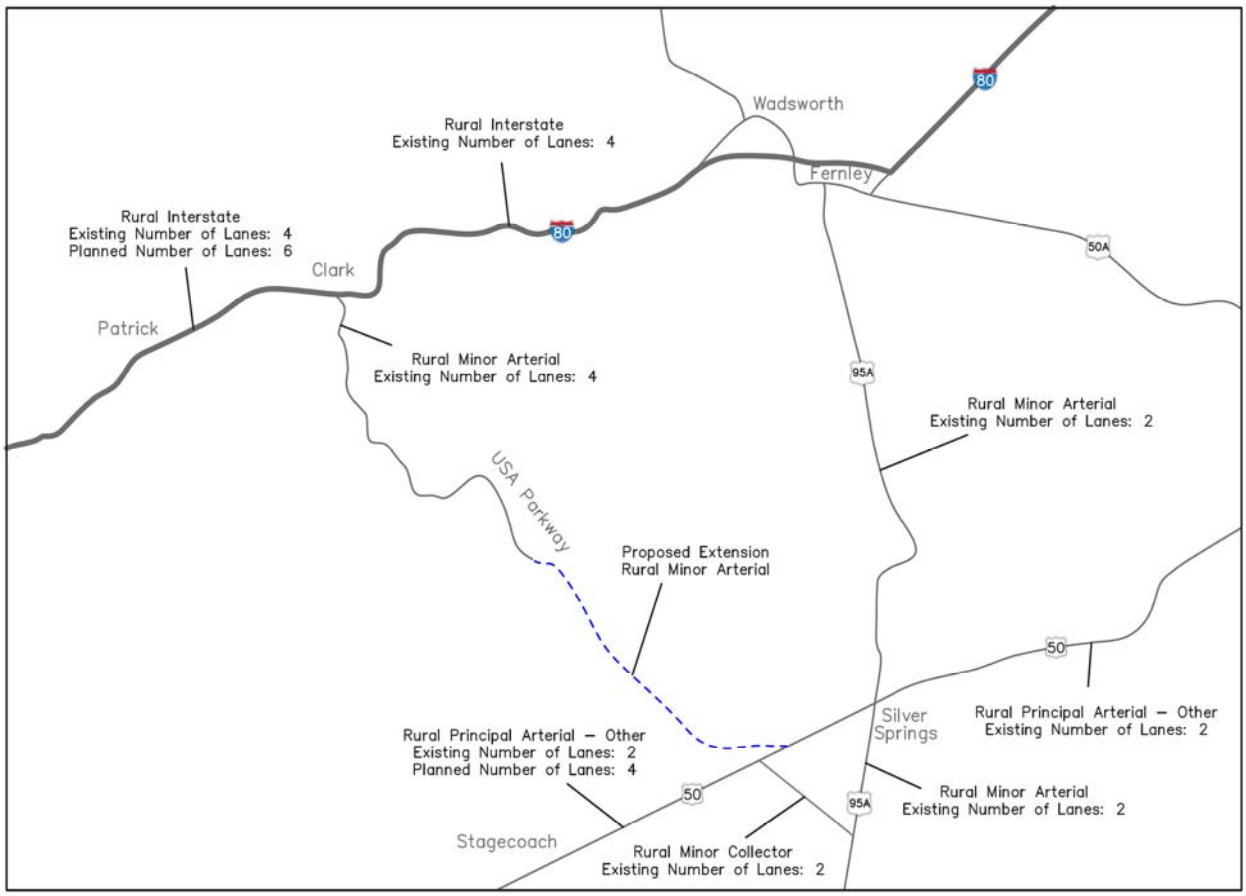
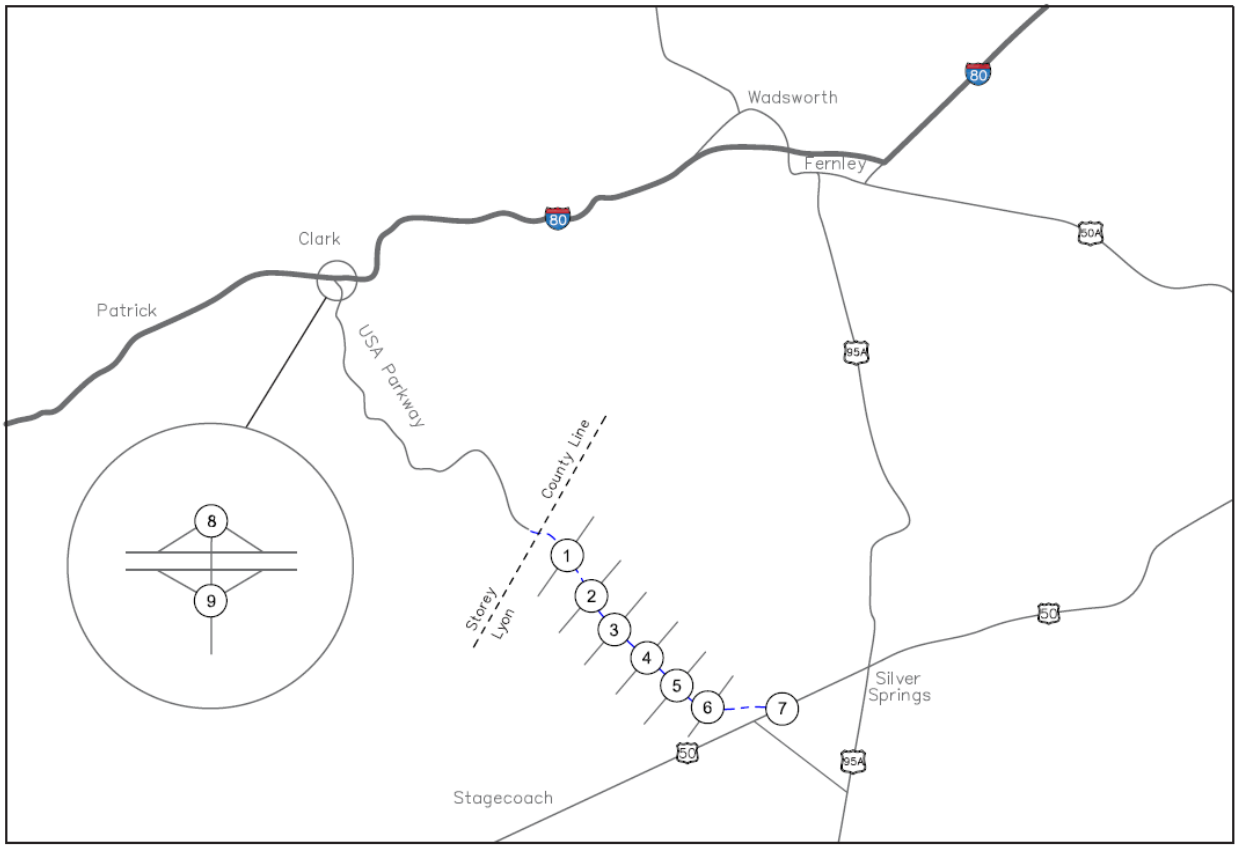


Figure 3-2: Study Intersections for Traffic Operations Analysis



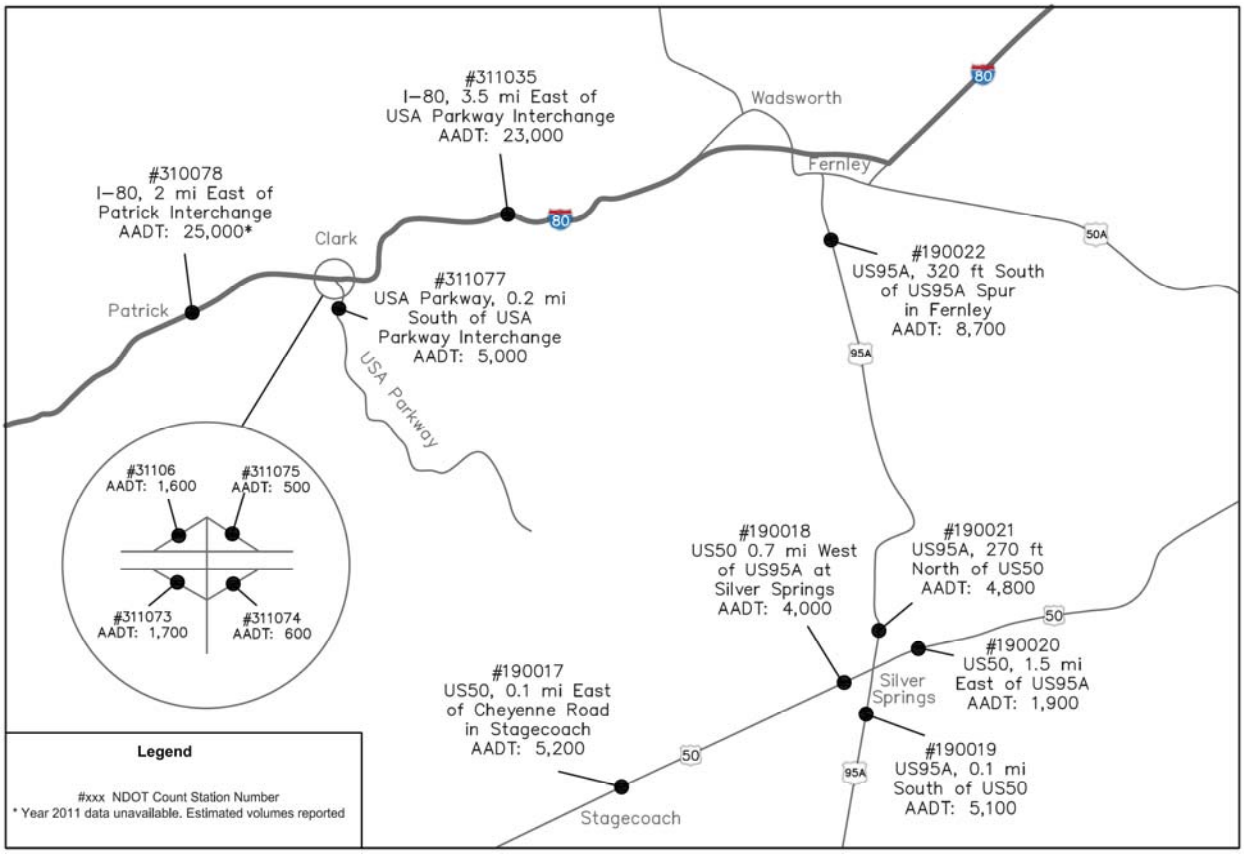
4. TRAFFIC COUNTS

Traffic counts for the study area roadway network are available from NDOT count stations. Figure 4-1 shows the selected NDOT count locations along with the existing (year 2011) daily volumes in terms of Annual Average Daily Traffic (AADT).

Figure 4-2 shows the year 2011 peak hour volumes at the USA Parkway/I-80 interchange to be used for existing conditions operations analysis. The volumes are based on average AM and PM peak hour counts for Tuesday, Wednesday and Thursday and are seasonally adjusted to reflect typical weekday peak hour volumes.

Appendix F contains all the traffic count data used for development of this memorandum.

Figure 4-1: Selected NDOT Count Locations and Year 2011 AADTs



4.1. Truck Traffic

For **USA Parkway**, the peak hour truck percentage to be used in traffic operations analysis is **12 percent**. This is as per the approved *USA Parkway Traffic Analysis Methodology* dated December 28, 2011 (see Appendix B). The daily truck percentage is 24 percent.

Current truck traffic on I-80 mainline east and west of USA Parkway Interchange and on US 50 in the vicinity of the proposed project is calculated based on the truck AADT data published in the NDOT's 2010 Vehicle Classification Distribution Report and are shown in Table 4-1.

Figure 4-2: I-80 and USA Parkway Interchange Year 2011 Peak Hour Volumes

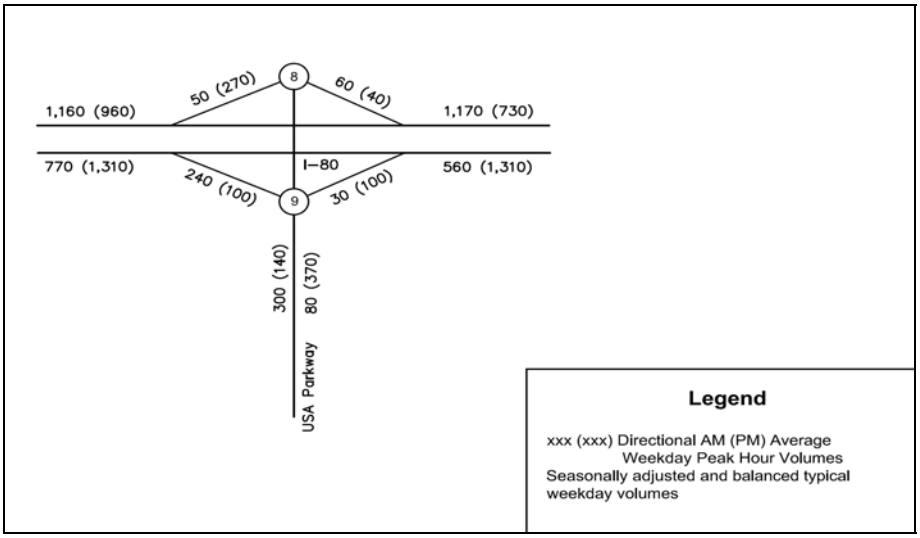


Table 4-1: Truck Traffic on I-80 and US 50

Truck AADT Location	Truck AADT	Representative NDOT Count Station for Total AADT	Total AADT	Daily Truck %
I-80 from Sparks Boulevard to USA Pkwy	5,880	312290[1]	26,000	22.6%
I-80 from USA Pkwy to Fernley	5,960	311035[2]	25,000	23.8%
US 50 from Dayton to US 95A	320	190017[3] 190018[4]	4,850	6.6%*

1. I-80 0.25 mile west of the USA Parkway Interchange
2. I-80 east of the USA Parkway Interchange
3. US 50 8.2 miles west of US 95A
4. US 50 0.7 mile west of US 95A

*US 50 is a Rural Principal Arterial. Average statewide daily truck percentage on rural principal arterials is 12.79%

On I-80 the daily truck percentage is approximately 24 percent both west and east of USA Parkway (22.6% and 23.8%). Peak hour truck percentages are typically half of the daily truck percentages. Therefore, a **12 percent** peak hour truck percentage is proposed for **I-80** mainline to be used in traffic operations analysis.

On US 50, the calculated daily truck percentage is 6.6 percent. US 50 is a Rural Principal Arterial in NDOT's functional classification. Average daily truck percentage on all rural principal arterials is 12.79% per NDOT's 2009 Annual Traffic Report. Since 12.79 percent is more conservative than 7 percent, 12.79 percent is selected as the daily truck percentage on US 50. Peak hour truck percentage on US 50 is proposed to be half of this daily truck percentage; hence **6 percent** is used as the peak hour truck percentage for **US 50.**

Truck AADT forecasts for design year 2037 (with-Highlands) are provided in Chapter 6 and for design year 2037 (No-Highlands) are provided in Chapter 7.

5. DAILY TRAFFIC (AADT) FORECASTS – WITH-HIGHLANDS SCENARIO

The travel demand models developed for the project produces Annual Average Typical Weekday Daily Traffic (AATWDT). Typical weekdays are defined as Tuesday, Wednesday and Thursday. AATWDT estimates from the model are used to obtain AADT estimates.

5.1. Model Output (AATWDT) Conversion to AADT

Model daily volumes needs to be converted to AADTs prior to estimating hourly volumes. To convert the model output (AATWDT) to AADT, a Model Output Conversion Factor (MOCF) was estimated according to guidance in the *Draft NDOT Traffic Forecasting Guidelines*. The MOCF for the project was estimated based on the year 2010 NDOT counts. AADT and AATWDT from NDOT counts were obtained for the short-term count stations shown in Figure 4-1 and listed in Table 5-1. The NDOT count AATWDT for each of these stations was estimated as the seasonally adjusted average of daily counts of typical weekdays (Tuesday, Wednesday, and Thursday). From the AATWDT and AADT values, the MOCF was calculated as

$$\text{MOCF} = \frac{\text{NDOT Count AADT}}{\text{NDOT Count AATWDT}}$$

The final MOCF for the project was the average of all the values calculated for each of the short term count stations. This MOCF was subsequently applied to each model output value to obtain AADT values.

Table 5-1: Estimation of MOCF

Location of NDOT Count Station	NDOT Count Station	2010 NDOT Count AADT	2010 Count AATWDT***	MOCF
I-80 West of USA Parkway Interchange	310078**	26,388	28,832	0.915
I-80 East of USA Parkway Interchange	311035*	22,982	24,363	0.943
US95 South of Fernley	190022	8,667	9,553	0.907
US95 North of Silver Springs	190021	5,181	5,251	0.987
US50 East of Silver Springs	190020	1,987	1,841	1.080
US95 South of Silver Springs	190019	4,634	4,588	1.010
US50 West of Silver Springs	190018	4,238	4,151	1.021
US50 near Stagecoach	190017	5,522	5,717	0.966
USA Parkway North Segment	311077*	4,975	5,949	0.836
Project MOCF				**0.963**

* Year 2010 data was unavailable, year 2011 data was used
** Year 2010 data was unavailable, year 2009 data was used
*** Seasonally adjusted from NDOT short-term counts

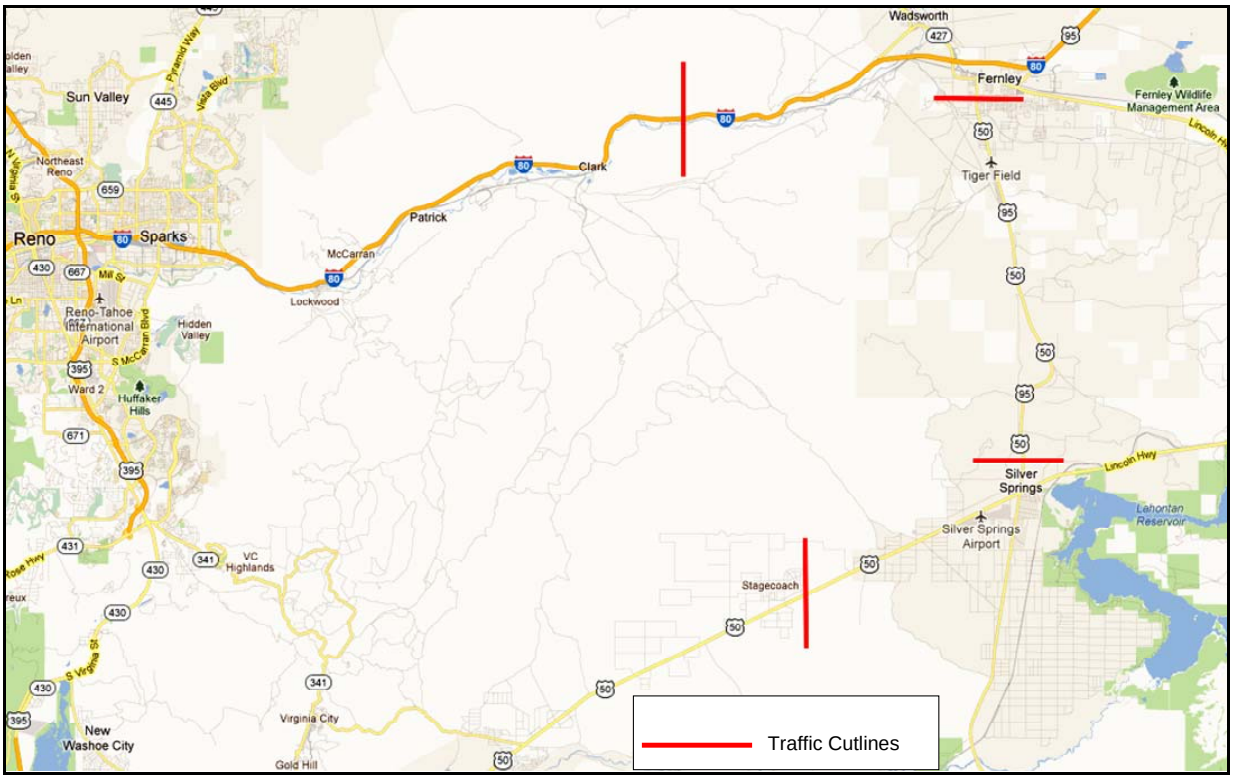
5.2. Determination of Model Output Adjustment Requirement

At specific road segment locations, the travel demand models may or may not accurately estimate traffic. For this reason, there may be a necessity to apply adjustments to the model output prior to use in traffic operations analysis. The primary reference for travel demand model volume adjustments is the NCHRP Report 255: *Highway Traffic Data for Urbanized Area Project Planning and Design*.

Base year 2010 model results were compared to the year 2010 NDOT counts to determine whether the model outputs satisfy the "consistency thresholds" stipulated in the *Draft NDOT Traffic Forecasting Guidelines.* The comparison of model output volumes and NDOT counts was made for all links along the project corridor (for which existing NDOT counts were available) and at cutlines in the model, in accordance with the *Draft NDOT Traffic Forecasting Guidelines.* The selected cutline locations are illustrated in Figure 5-1. Both the *Percent Deviation* comparisons and the *Coefficient of Variation of Root Mean Square Error* (CV[RMSE]) comparisons were made. The results of these comparisons are shown in Table 5-2 and Table 5-3.

It was determined that not all links satisfy the consistency thresholds stipulated in the *Draft NDOT Traffic Forecasting Guidelines.* As explained in Chapter 2, the base year model was adjusted during the validation process; however further adjustments to the model were deemed infeasible. Therefore it was determined that NCHRP Report 255 adjustments were needed to adjust the model output volumes to enhance the accuracy of the model results in forecasting future year traffic.

Figure 5-1: Cutline Locations



Source: Google Maps

Table 5-2: Percent Deviation & CV(RMSE) Comparison at Links along Cutlines

Location	NDOT Count Station	2010 NDOT Count AADT	2010 Model AATWDT	2010 Model AADT	Percent Deviation	Percent Deviation meets consistency thresholds?	CV(RMSE)	CV(RMSE) meets thresholds?
I-80 East of USA Parkway Interchange	311035	22,982	25,206	24,273	6%	Yes	6%	Yes
US 50 0.1 miles east of Cheyenne Rd in Stagecoach	190017	5,522	13,882	13,368	142%	No	75%	No
US 95A 270 ft north of US 50	190021	5,181	7,422	7,147	38%	No		No
US 95A 320ft S of US-95A Spur in Fernley	190022	8,667	11,146	10,734	24%	No		No

Draft NDOT Traffic Forecasting Guidelines define the maximum allowable Percent Deviation threshold as ± 10% for AADT < 50,000 AADT.
Draft NDOT Traffic Forecasting Guidelines define the maximum allowable CV(RMSE) threshold as ± 35% for AADT between 5,000 and 9,999 and ± 20% for AADT between 20,000 and 49,999.

Table 5-3: Percent Deviation & CV(RMSE) Comparison at Links along Project Corridor

Location	NDOT Count Station	2010 NDOT Count AADT	2010 Model AATWDT	2010 Model AADT	Percent Deviation	Percent Deviation meets consistency thresholds?	CV(RMSE)	CV(RMSE) meets consistency thresholds?
0.2 miles south of USA Parkway Interchange	311077	4,975	5,470	5,268	6%	Yes	6%	Yes

Draft NDOT Traffic Forecasting Guidelines define the maximum allowable Percent Deviation threshold as ± 10% for AADT < 50,000 AADT.
Draft NDOT Traffic Forecasting Guidelines define the maximum allowable CV(RMSE) threshold as ± 45% for AADT < 5,000

5.3. Model Output Adjustments (Post-Processing)

5.3.1. Re-assignment of Raw Model Volumes

Prior to applying the NCHRP Report 255 adjustments, the No-Action and Build model volume outputs were examined for general reasonableness in reflecting the regional trip patterns. It was determined that both the models underestimated the trips on I-80 west of USA Parkway and overestimated the trips on US 50 west of USA Parkway. This is attributable to the fact that the model does not include the Reno/Sparks metropolitan area. Therefore, in both the No-Action and Build networks, trips from the Reno/Sparks metropolitan area (i.e. trips on I-80) were underestimated and trips from Carson City area (i.e. trips on US 50) were overestimated.

Furthermore, in the No-Action network, trips from Carson City destined to TRIC were found to be assigned along US 95A and US 50 instead of along I-80 and US 395, because the model does not include US 395[2].Therefore, adjustments to raw model outputs were made by re-assigning portion of the trips on US 50 to I-80 for both No-Action and Build networks. Following this re-assignment of raw model volumes, further post-processing following NCHRP Report 255 methodologies and engineering judgment were performed as explained in the next section.

5.3.2. NCHRP Report 255 Adjustments

In general, there are three procedures described in NCHRP Report 255 for adjustment of link volumes obtained from travel demand models. These three methods can be described as Ratio Adjustments, Difference Adjustments and Combination Adjustments. The purpose of these adjustments is to adjust the future year link assignments to account for possible assignment errors. The underlying assumption is that errors in assignment that occur in base year model are carried through to future year forecasts.

The Ratio Adjustment method can also be described as a growth factor method where the growth between the base and future years in the travel demand model realm is applied to the field measured traffic counts.

The Difference Adjustment method provides future volumes on each link by the addition of the difference (or increment) between the base year model and future year model to the field measured traffic volume.

Combination Adjustment method takes the average of the values obtained by the Ratio Adjustment and the Difference Adjustment methods.

For the proposed project, all three NCHRP Report 255 methods were applied appropriately, in a manner that results in the most balanced traffic projections. At certain locations, where NCHRP Report 255 adjustments were not available or the adjusted volumes resulted in unbalanced projections; either the volumes from the model were directly used (if reasonable) or a more appropriate value was selected based on engineering judgment.

The proposed USA Parkway extension does not exist in the base model; hence it is not possible to directly apply NCHRP Report 255 adjustments to segment volumes along the extension. For the proposed extension, the volumes were adjusted based on the NCHRP ratio adjustments applied to the existing portion of USA Parkway.

The resulting adjusted year 2035 AADTs are shown in Figure 5-2 and Figure 5-3 for the general study area network; and in Figure 5-4 and Figure 5-5 for study roadway segments.

[2] This does not happen in the Build Network, since trips from Carson City destined for USA Parkway would in fact use US 50 to get to TRIC due to the proposed USA Parkway extension to US 50.

Figure 5-2: Year 2035 No-Action AADTs at General Study Area Roadway Network

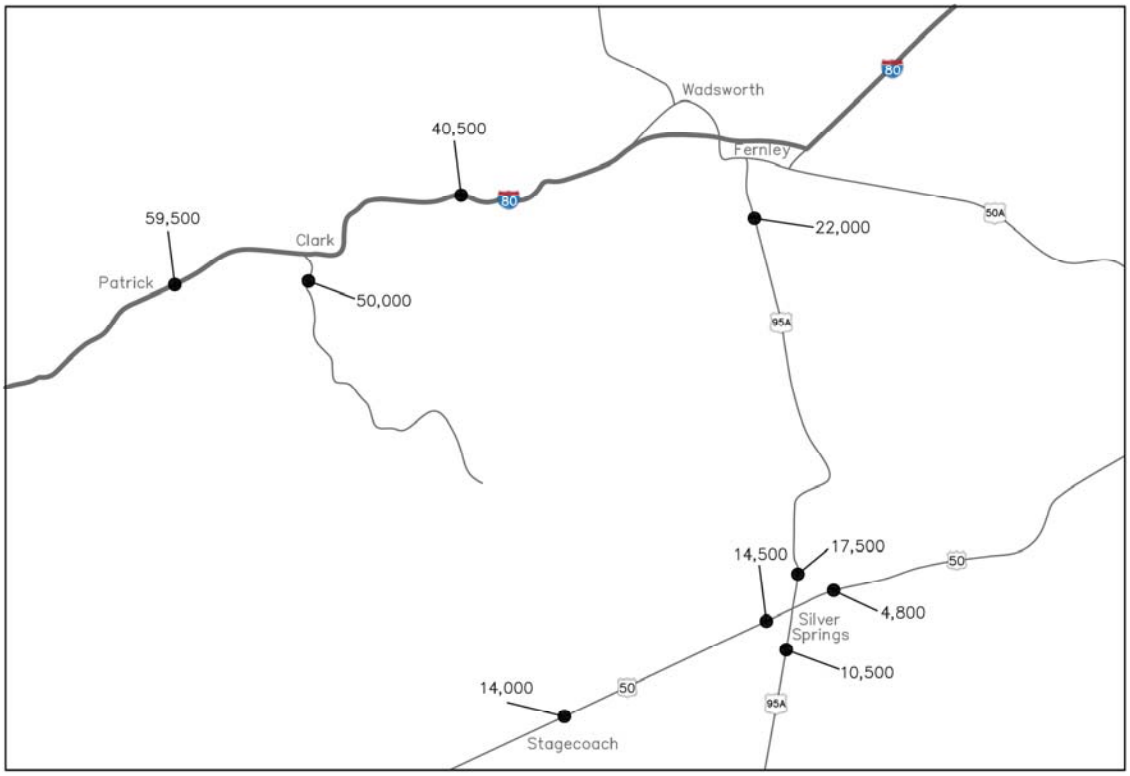


Figure 5-3: Year 2035 Build AADTs at General Study Area Roadway Network

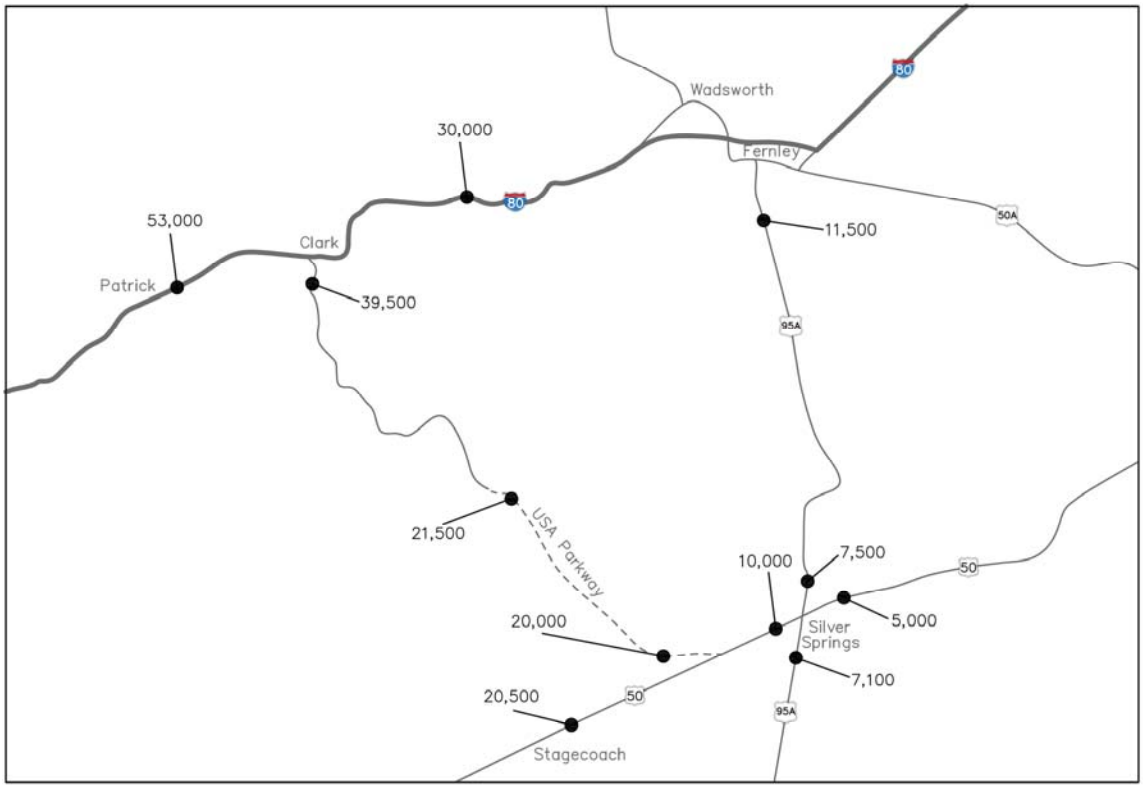
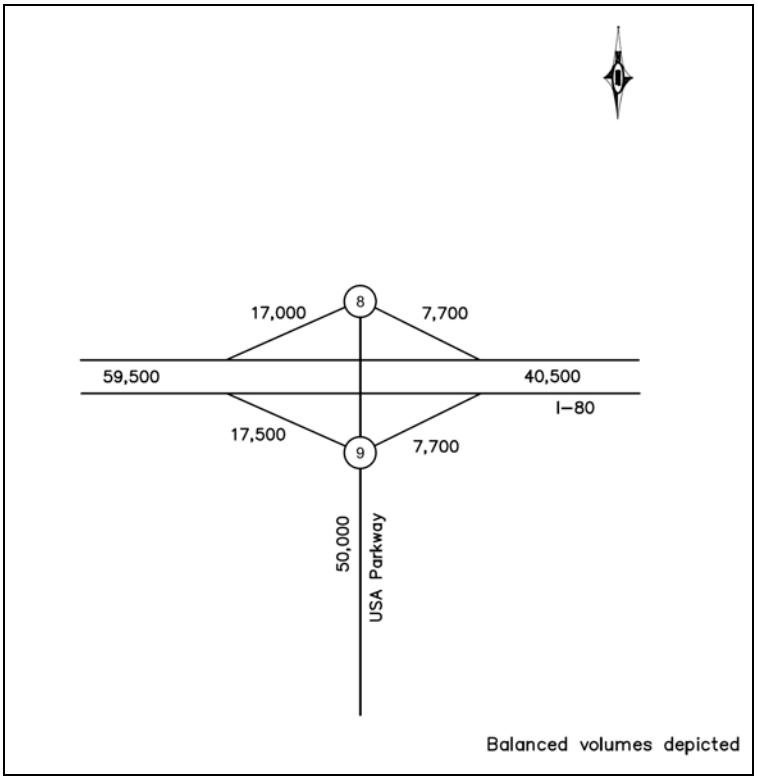


Figure 5-4: Year 2035 No-Action AADTs at Study Roadway Segments



5.4. Comparison of year 2035 AADT estimates with Historical Trend Projections

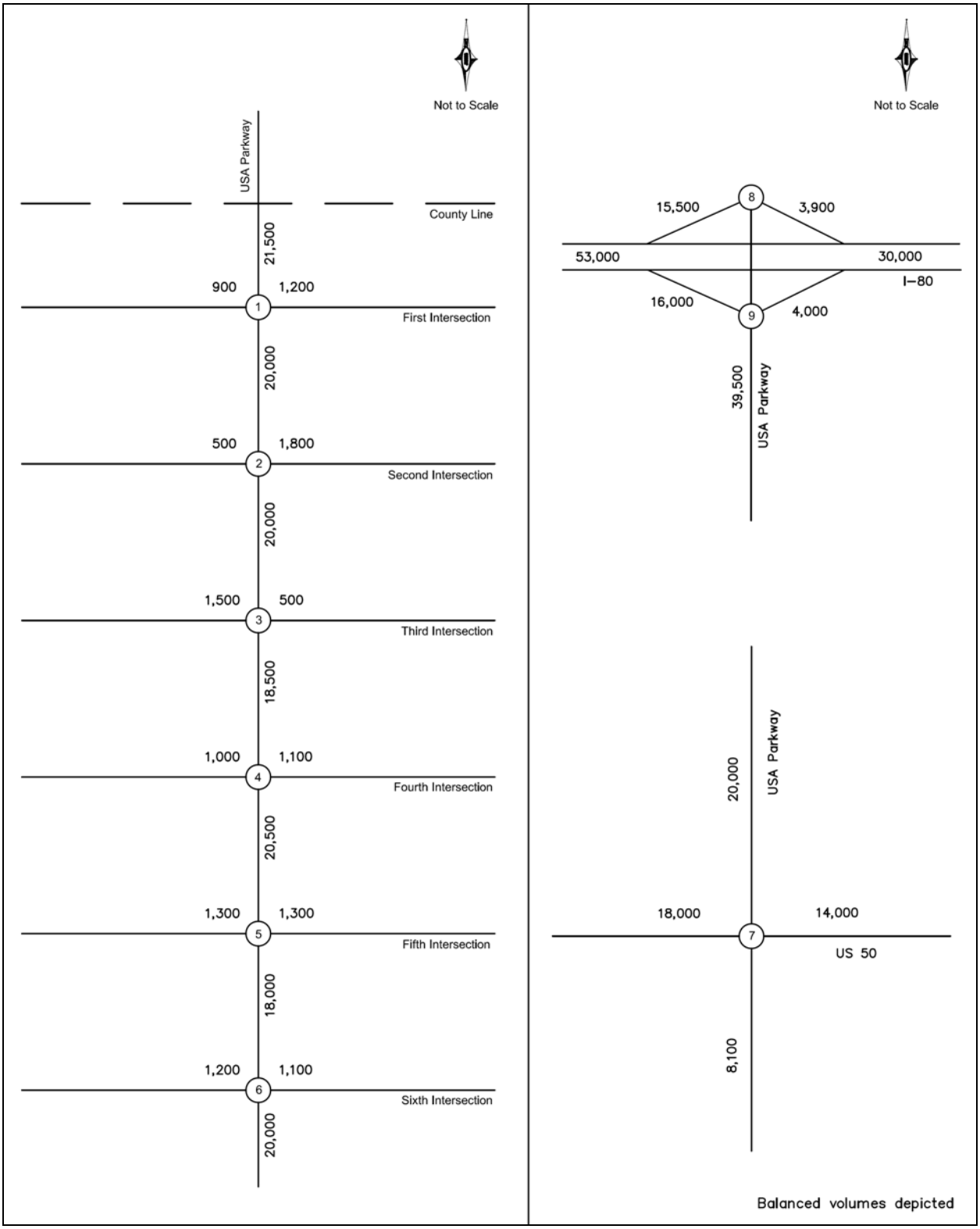
As recommended in the *Draft NDOT Traffic Forecasting Guidelines*, the reasonableness of the AADT forecasts from the travel demand model was verified by comparisons with historical trend projection of AADT. Historical AADT values extending from the year 2010 back to year 1990 were obtained for selected NDOT short-term count stations (illustrated in Figure 5-6) within the project influence area. For the historical data from each of the selected stations, either one of logarithmic trend, linear trend or exponential trend projection was performed depending upon the existing and expected land use and traffic characteristics of the location. Figure 5-6 shows the comparison of year 2035 Build Alternative model forecast AADT and the historical trend projections. The following paragraphs explain the details of the historical trend projection for each selected location and Appendix G provides the outputs of the analysis.

I-80 West of USA Parkway – Station # 310078

Type of trend projection performed: A linear trend projection was performed for the historical data at this location.

Rationale: The existing traffic at this location is fairly high and can be characterized as “mature”. Hence, a linear or a logarithmic growth trend would be suitable, depending on the expected amount of traffic growth. It is known that the TRIC and Highlands development would have a significant impact on the traffic at this location; a majority of the traffic generated due to these developments is expected to travel through this location. Hence a linear trend was found to be more appropriate than a logarithmic trend.

Figure 5-5: Year 2035 Build AADTs at Study Roadway Segments



I-80 East of USA Parkway – Station # 310811

Type of trend projection performed: A logarithmic trend projection was performed for the historical data at this location.

Rationale: The existing traffic at this location is fairly high and can be characterized as “mature”. Hence, a linear or a logarithmic growth trend would be suitable, depending on the expected amount of traffic growth. The traffic generated from the TRIC and Highlands development is mostly expected to travel to Reno or Carson City; therefore the impact on traffic at this location is expected to be minimal. The future traffic growth is likely to be stable, following a logarithmic growth trend.

US 95A South of Fernley – Station # 190022

Type of trend projection performed: A linear trend projection was performed for the historical data at this location.

Rationale: The existing traffic at this location is low; hence an exponential or a linear growth trend would be suitable, depending on the expected amount of traffic growth. The TRIC and Highlands development are not expected to contribute a lot of traffic to this location, so a linear trend is more appropriate.

US 95A North of Silver Springs – Station # 190021

Type of trend projection performed: A linear trend projection was performed for the historical data at this location.

Rationale: The existing traffic at this location is low; hence an exponential or a linear growth trend would be suitable, depending on the expected amount of traffic growth. The TRIC and Highlands development are not expected to contribute a lot of traffic to this location, so a linear trend is more appropriate.

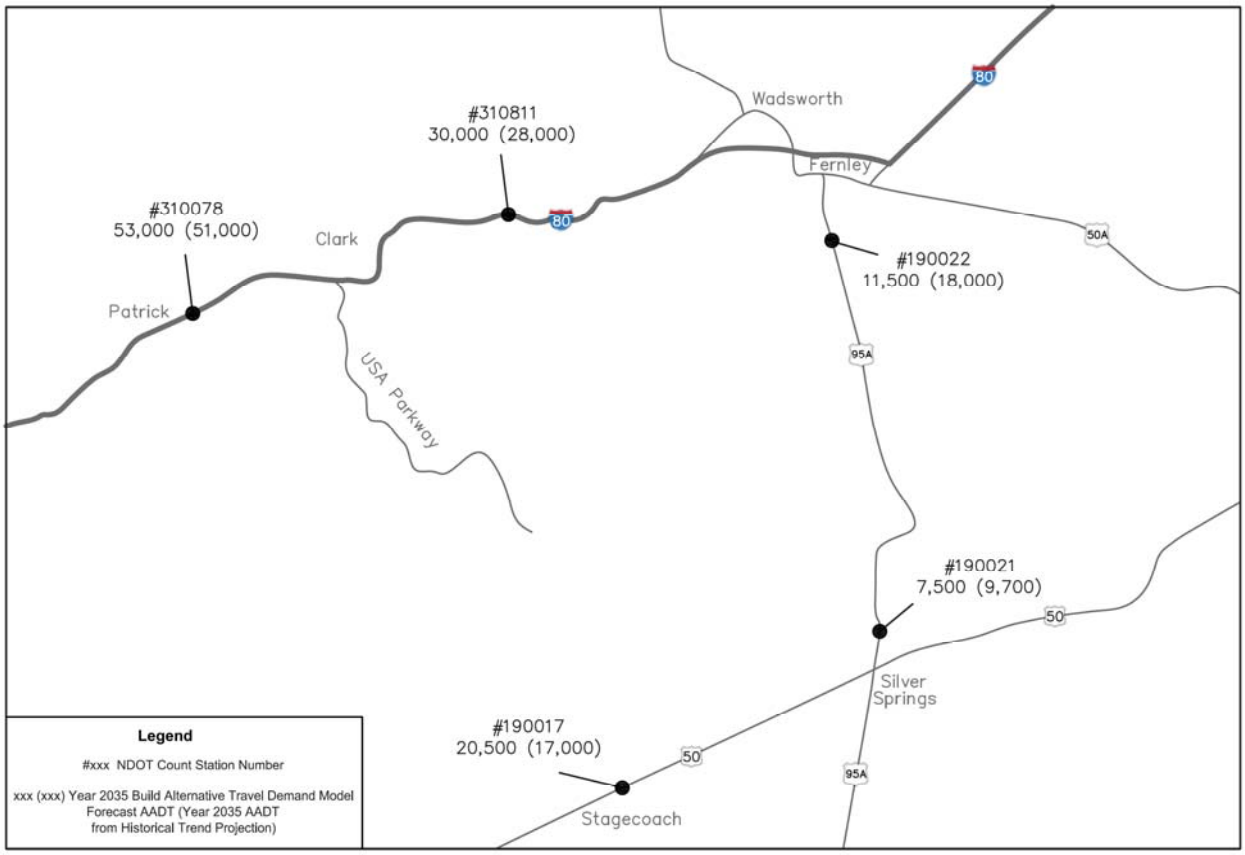
US 50 East of Stagecoach – Station # 190017

Type of trend projection performed: An exponential trend projection was performed for the historical data at this location.

Rationale: The existing traffic at this location is low; hence an exponential or a linear growth trend would be suitable, depending on the expected amount of traffic growth. A considerable portion of the traffic generated by the TRIC and Highlands development is expected to travel through this location, causing significant growth in traffic, so an exponential trend was found to be more appropriate.

From these reasonableness checks, it was found that the growth in traffic obtained from the travel demand model outputs follow a similar trend as predicted by the historical trend projection analysis. In most cases, the model forecast volumes were found to be very similar to the volumes projected by the historical trend projection analysis. Hence, model forecast volumes are determined to be reasonable and are used in developing the forecast.

Figure 5-6: Comparison of 2035 Forecasts with Historical Trend Projections



5.5. Design Year 2037 AADT Forecasts

The design year of the proposed project is 2037; therefore year 2037 volumes need to be projected from year 2035 volumes for use in the traffic operations analysis. The projections were performed separately for the No-Action Alternative and the Build Alternative.

To obtain the 2037 AADT from 2035 AADT, the compound annual growth rates between year 2010 and year 2035 were estimated. Since the initial traffic (2010 AADT) was very low compared to the 2035 AADT along USA Parkway and at the ramps of the I-80/USA Parkway Interchange, the resulting growth rates were found to be unreasonably high. Linear traffic growth was deemed more appropriate and the average annual increase in traffic for each of the study locations was estimated assuming linear growth as follows,

$$\text{Annual Increase in Traffic} = \frac{\text{Final Year AADT} - \text{Initial Year AADT}}{(\text{Final Year} - \text{Initial Year})}$$

Once the annual increase in traffic was estimated, this value was used to estimate the increase in traffic in two years (i.e. between 2035 and 2037). The increase in traffic over two years was added to the 2035 AADT to obtain the 2037 AADT.

5.5.1. Projection of Year 2037 AADTs – No-Action Alternative

The average annual increase in traffic between 2010 and 2035 was estimated for each of the project study locations for the No-Action alternative. The annual increase was used to obtain the increase in traffic over two years and was used to obtain 2037 AADT from 2035 AADT as shown in Table 5-4. The estimated 2037 AADT was appropriately balanced and rounded to obtain the final 2037 AADT values shown in Figure 5-7

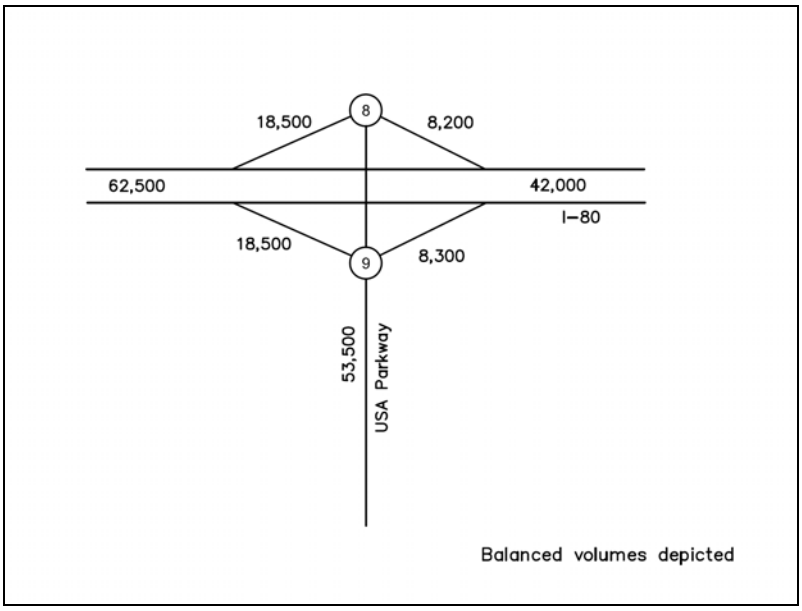
Rounding of AADT was done as per *Draft NDOT Traffic Forecasting Guidelines*.

Table 5-4 Projection of Year 2037 Volumes – No-Action Alternative

Location	2010 AADT	2035 AADT	Annual Increase in Traffic between 2010 and 2035	2037 AADT
E/B off-ramp at USA Parkway Interchange	1,660	17,187	621	18,429
E/B on-ramp at USA Parkway Interchange	707	7,733	281	8,295
W/B off-ramp at USA Parkway Interchange	582	7,656	283	8,221
W/B on-ramp at USA Parkway Interchange	1,301	16,992	628	18,247
I-80 East of USA Parkway Interchange	22,982	39,295	653	40,600
I-80 West of USA Parkway Interchange	26,388	59,739	1,334	62,407
USA Parkway North Segment	4,975	50,027	1,802	53,631

The 2037 AADT was balanced and rounded as needed to arrive at the Year 2037 AADT reported in Figure 5-7

Figure 5-7: Design Year 2037 No-Action AADTs at Study Roadway Segments



5.5.2. Projection of Year 2037 AADTs – Build Alternative

The 2037 AADT for the Build Alternative was estimated using the same procedure used for the No-Action Alternative. The projected 2037 AADTs are shown in Table 5-5 for all study segments except for USA Parkway along Highlands development.

Table 5-5: Projection of Year 2037 AADTs – Build Alternative near I-80 and US 50

Location	2010 AADT	2035 AADT	Annual Increase in Traffic between 2010 and 2035	2037 AADT
E/B off-ramp at USA Parkway Interchange	1,660	15,763	564	16,891
E/B on-ramp at USA Parkway Interchange	707	3,960	130	4,220
W/B off-ramp at USA Parkway Interchange	582	3,883	132	4,147
W/B on-ramp at USA Parkway Interchange	1,301	15,567	571	16,709
I-80 East of USA Parkway Interchange	22,982	30,088	284	30,656
I-80 West of USA Parkway Interchange	26,388	53,115	1,069	55,253
USA Parkway North Segment	4,975	39,632	1,386	42,405
US 50 west of USA Parkway	5,522	18,200	507	19,214
US 50 east of USA Parkway	4,238	14,111	395	14,901
USA Parkway South of US50 (Ramsey Cutoff)	1,905	8,127	249	8,625
The 2037 AADT was balanced and rounded as needed to arrive at the Year 2037 AADT reported in Figure 5-8				

USA Parkway along the proposed Highlands development does not exist today and the anticipated opening year of the USA Parkway extension is 2017. The Highlands development along USA Parkway is expected to start development from 2020; so the traffic on the side streets and the traffic on USA Parkway generated from Highlands is expected to start growing from 2020. As an approximation, it was assumed that traffic along USA Parkway due to TRIC would also start to grow from 2020 instead of 2017. This eliminates the need to identify the proportion of traffic along USA Parkway due to TRIC and Highlands. The resulting estimate of the 2037 AADT is also on the conservative side because a faster growth is assumed. The projected 2037 AADT for USA Parkway segments along Highlands is shown in Table 5-6.

The estimated 2037 AADT was appropriately balanced and rounded to obtain the final 2037 AADT values shown in Figure 5-8.

Table 5-6: Projection of Year 2037 AADTs – Build Alternative along Highlands Development

Location	2020 AADT	2035 AADT	Annual Increase in Traffic between 2020 and 2035	2037 AADT
North of First Intersection	0	21,714	1,448	24,610
Between First and Second Int.	0	20,215	1,348	22,910
Between Second and Third Int.	0	19,825	1,322	22,468
Between Third and Fourth Int.	0	18,509	1,234	20,976
Between Fourth and Fifth Int.	0	20,612	1,374	23,360
Between Fifth and Sixth Int.	0	17,959	1,197	20,353
South of Sixth Int.	0	19,942	1,329	22,601
East leg of First Int.	0	1,203	80	1,364
West leg of First Int.	0	932	62	1,056
East leg of Second Int.	0	1,789	119	2,027
West leg of Second Int.	0	533	36	604
East leg of Third Int.	0	500	33	567
West leg of Third Int.	0	1,452	97	1,645
East leg of Fourth Int.	0	1,120	75	1,269
West leg of Fourth Int.	0	983	66	1,115
East leg of Fifth Int.	0	1,336	89	1,515
West leg of Fifth Int.	0	1,316	88	1,492
East leg of Sixth Int.	0	1,142	76	1,294
West leg of Sixth Int.	0	1,213	81	1,374
The 2037 AADT was rounded as needed to arrive at the Year 2037 AADT reported in Figure 5-8				

Based on the daily truck percentages provided in Section 4-1 (Truck Traffic), the truck AADTs for the Build Alternative are shown in Table 5-7.

Figure 5-8: Design Year 2037 Build AADTs at Study Roadway Segments

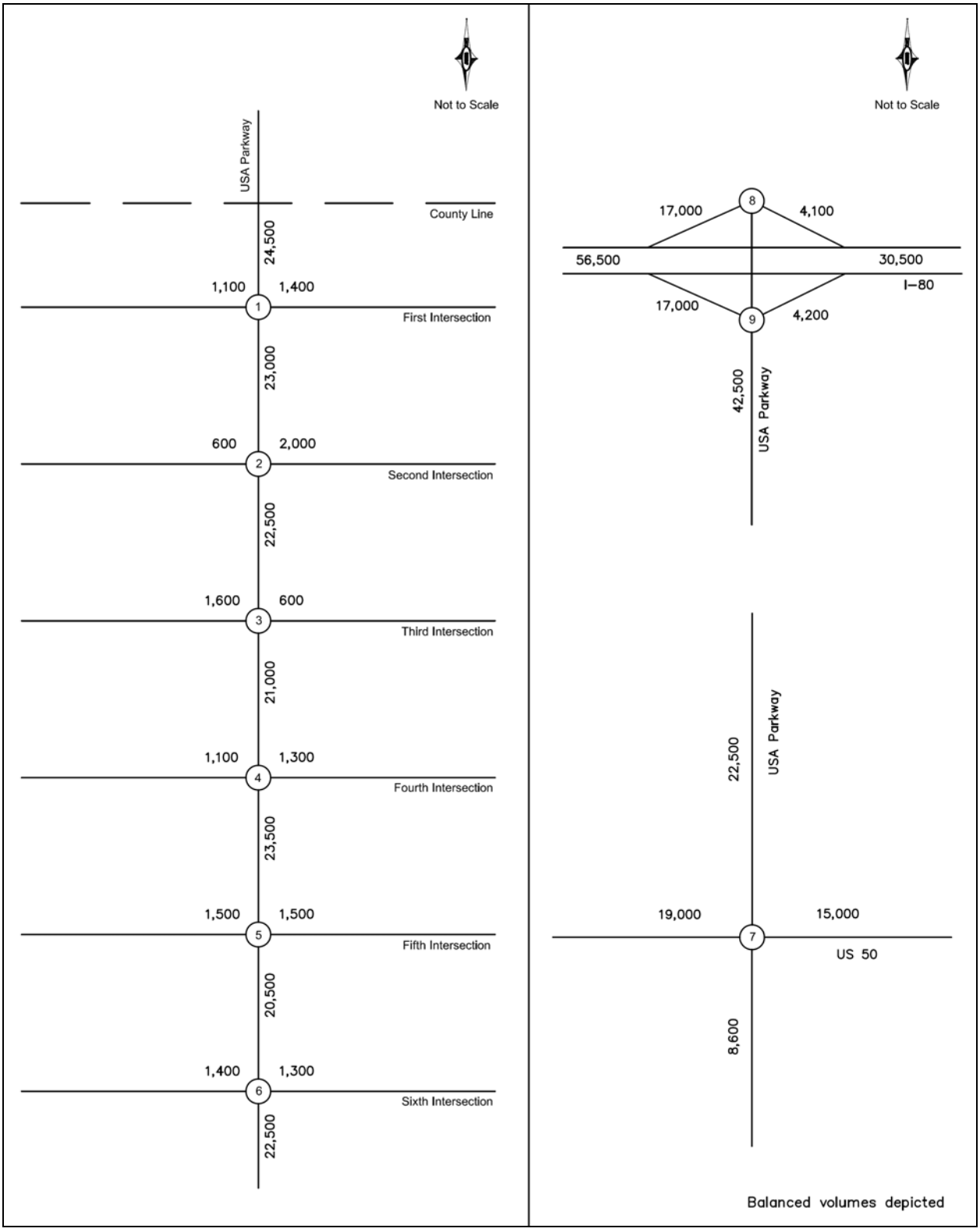


Table 5-7: Design Year 2037 Build Truck AADTs at Study Roadway Segments

Location	Year 2037 Build Total AADT	Year 2037 Build Truck AADT
I-80 West of USA Parkway Interchange	56,500	13,000
E/B off-ramp at USA Parkway Interchange	17,000	3,800
E/B on-ramp at USA Parkway Interchange	4,200	1,000
W/B off-ramp at USA Parkway Interchange	4,100	1,000
W/B on-ramp at USA Parkway Interchange	17,000	3,800
I-80 East of USA Parkway Interchange	30,500	7,300
USA Parkway North Segment	42,500	10,000
USA Parkway North of the First Intersection at Highlands	24,500	5,900
USA Parkway South of the Sixth Intersection at Highlands	22,500	5,400
USA Parkway South of US50 (Ramsey Cutoff)	8,600	2,100
US 50 west of USA Parkway	19,000	2,400
US 50 east of USA Parkway	15,000	1,900

6. PEAK HOUR TRAFFIC FORECASTS – WITH-HIGHLANDS SCENARIO

The next step in the traffic forecasting process was to obtain the Directional Design Hour Volumes (DDHV) from the 2037 AADTs. The DDHVs are the basis for the AM and PM peak hour volume estimates for use in traffic operations analysis.

6.1. Estimating K_{30} and D_{30}

For the study roadway segments, K_{30} and D_{30} values were obtained from ATRs in the vicinity and with similar characteristics as that of the study segments. The K_{30} and D_{30} values obtained from the ATRs were then adjusted to obtain the design year K_{30} and D_{30} depending on the expected land use and traffic characteristics of the study segments following the guidance offered in the *Draft NDOT Traffic Forecasting Guidelines*.

NDOT ATR # 0312350 (SR-430/US-395 1.4 miles of East Lake Blvd Jct) was chosen to represent the USA Parkway segments. This ATR was chosen because,

- Both USA Parkway and the road segment corresponding to the ATR come under the same NDOT functional classification – Rural Minor Arterial
- The expected design year AADT of USA Parkway is similar to the current AADT of the road segment corresponding to the ATR
- Both USA Parkway and the road segment corresponding to the ATR are North-South in direction

NDOT ATR # 0312290 (I-80 0.25 mile west of the USA Parkway Interchange) was chosen to represent the I-80 segment as this ATR is located at the project location.

NDOT ATR # 0012120 (US-50 0.4 mile west of US-50A) was chosen to represent the US 50 segments because this ATR is located on the same corridor as the study segment.

6.1.1. Estimating K_{30} and D_{30} for the No-Action Alternative

The K_{30} and D_{30} values from the ATRs for the study segments, the adjusted K_{30} and D_{30} values for the design year and the peak direction of traffic are listed in Table 6-1 for the No-Action Alternative.

USA Parkway near the I-80 and USA Parkway Interchange:

The K_{30} and D_{30} values for the USA Parkway segment were obtained from NDOT ATR # 0312350. These values were compared against the recommended K_{30} and D_{30} values from the *Draft NDOT Traffic Forecasting Guidelines*. The K_{30} was found to reasonably represent the design year conditions at the study segment. The median K_{30} for the Rural Minor Arterial functional class from the *Draft NDOT Traffic Forecasting Guidelines* is 11.6%. But the development at TRIC is not expected to have standard work hours; rather employees are expected to arrive at work throughout the day. This pattern (employees arriving and departing at various times of the day) was also observed on a field visit to the existing portion of the USA Parkway on April 11, 2012. Hence a K_{30} of 10.4% was found to be reasonable. The D_{30} value was adjusted to match the median D_{30} for the Rural Minor Arterial functional class from the *Draft NDOT Traffic Forecasting Guidelines*. In the No-Action Alternative, all trips travelling to/from TRIC would be forced to travel along I-80 and the USA Parkway segment near the I-80 and USA Parkway Interchange. The D_{30} value is therefore expected to be a value higher than 51.4%

as obtained from the ATR. In the design year, trips are expected to predominantly travel to TRIC during the AM peak period and away from TRIC during the PM peak period. Hence, the southbound direction would be the direction of peak traffic in the AM period and the northbound direction would be the direction of peak traffic in the PM period; this is similar to the existing conditions at this location.

Table 6-1: Estimation of K_{30} and D_{30} – No-Action Alternative

Segment	Parameter	Value from the chosen ATR	Adjusted/Estimated Design Year Value
USA Parkway near the I-80/USA Parkway Interchange	K_{30}	10.4%	10.4%
	D_{30}	51.4%	61%
	Current year AM Peak direction		SB
	Current year PM Peak direction		NB
	Design year AM Peak direction		SB
	Design year PM Peak direction		NB
I-80 near USA Parkway	K_{30}	9.5%	10.3%
	D_{30}	53.1%	57%
	Current year AM Peak direction		WB
	Current year PM Peak direction		EB
	Design year AM Peak direction (west of USA Pkwy)		EB
	Design year PM Peak direction (west of USA Pkwy)		WB
	Design year AM Peak direction (east of USA Pkwy)		WB
	Design year PM Peak direction (east of USA Pkwy)		EB

I-80 near USA Parkway:

The initial K_{30} value for I-80 was obtained from NDOT ATR # 0312290; this K_{30} value was adjusted to obtain the design year K_{30} value. The K_{30} value from the ATR was 9.5% and was determined to be low from a future design year perspective. Hence, the K_{30} value was increased to 10.3% which is the median value of K_{30} for the Rural Principal Arterial – Interstate functional class. The additional traffic travelling to TRIC is expected to have an impact on the directionality of the traffic and the D_{30}. Hence, based on engineering judgment, a higher D_{30} of 57% was assumed for I-80 east of the USA Parkway. At this location, the design year peak period directionality is expected to stay the same as the existing directionality, because vehicles are expected to travel away from TRIC in the PM peak period. The peak hour volumes for I-80 west of the USA Parkway were balanced from the volumes on I-80 east of the USA Parkway and the peak volumes of the ramps.

6.1.2. Estimating K_{30} and D_{30} for the Build Alternative

The K_{30} and D_{30} values from the ATRs for the study segments, the adjusted K_{30} and D_{30} values for the design year and the peak direction of traffic are listed in Table 6-2.

Table 6-2: Estimation of K_{30} and D_{30} – Build Alternative

Segment	Parameter	Value from the chosen ATR	Adjusted/Estimated Design Year Value
USA Parkway near the I-80/USA Parkway Interchange	K_{30}	10.4%	10.4%
	D_{30}	51.4%	57%
	Current year AM Peak direction		SB
	Current year PM Peak direction		NB
	Design year AM Peak direction		SB
	Design year PM Peak direction		NB
USA Parkway along Highlands Development	K_{30}	10.4%	10.4%
	D_{30}	51.4%	57%
	Current year AM Peak direction		N/A
	Current year PM Peak direction		N/A
	Design year AM Peak direction		NB
	Design year PM Peak direction		SB
I-80 near USA Parkway	K_{30}	9.5%	10.3%
	D_{30}	53.1%	55%
	Current year AM Peak direction		WB
	Current year PM Peak direction		EB
	Design year AM Peak direction (west of USA Pkwy)		EB
	Design year PM Peak direction (west of USA Pkwy)		WB
	Design year AM Peak direction (east of USA Pkwy)		WB
	Design year PM Peak direction (east of USA Pkwy)		EB
US 50 near USA Parkway	K_{30}	10.8%	10.8%
	D_{30}	52.5%	52.5%
	Current year AM Peak direction		WB
	Current year PM Peak direction		EB
	Design year AM Peak direction (west of USA Pkwy)		EB
	Design year PM Peak direction (west of USA Pkwy)		WB
	Design year AM Peak direction (east of USA Pkwy)		WB
	Design year PM Peak direction (east of USA Pkwy)		EB

USA Parkway near the I-80 and USA Parkway Interchange:

Similar to the No-Action Alternative, the K_{30} and D_{30} values for the USA Parkway segments (both for the segment near the I-80 and USA Parkway Interchange and the segments along Highlands development) were obtained from NDOT ATR # 0312350. These values were again compared against the recommended K_{30} and D_{30} values from the *Draft NDOT Traffic Forecasting Guidelines*. The K_{30} was found to reasonably represent the design year conditions at the study segments because of the reasons explained previously. The D_{30} from the ATR was adjusted to better reflect design year conditions. In the Build Alternative, USA Parkway would connect I-80 and US 50, passing through TRIC and the Highlands development. Trips from Carson City are expected to travel along US 50 and north along USA Parkway to reach TRIC whereas trips from Reno are expected to travel along I-80 and south along USA Parkway to reach TRIC. The D_{30} is therefore expected to be less than the D_{30} value estimated for the No-Action Alternative but still higher than the D_{30} value from the ATR; hence a D_{30} value of 57%

was selected as a reasonable value. Trips are expected to predominantly travel to TRIC during the AM peak period and away from TRIC during the PM peak period. Hence, at this location the southbound direction would be the direction of peak traffic in the AM period and the northbound direction would be the direction of peak traffic in the PM period; this is similar to the existing conditions at this location.

USA Parkway along Highlands Development:

The K_{30} and D_{30} values estimated for the USA Parkway North segment were determined to be reasonable for the segments along Highlands development also. Trips are expected to predominantly travel to TRIC during the AM peak period and away from TRIC during the PM peak period. Hence, for the USA Parkway segments along the Highlands development, the northbound direction would be the direction of peak traffic in the AM period and the southbound direction would be the direction of peak traffic in the PM period.

I-80 near USA Parkway:

The initial K_{30} value for I-80 was obtained from NDOT ATR # 0312290; this K_{30} value was adjusted to obtain the design year K_{30} value. The K_{30} value from the ATR was 9.5% and was determined to be low from a future design year perspective. Hence, the K_{30} value was increased to 10.3% which is the median value of K_{30} for the Rural Principal Arterial – Interstate functional class. The additional traffic travelling to TRIC is expected to have an impact on the directionality of the traffic and the D_{30}. Hence, based on engineering judgment, a higher D_{30} of 55% was assumed for I-80 east of the USA Parkway. At this location, the design year peak period directionality is expected to stay the same as the existing directionality, because vehicles are expected to travel away from TRIC in the PM peak period. The peak hour volumes for I-80 west of the USA Parkway were balanced from the volumes on I-80 east of the USA Parkway and the peak volumes of the ramps.

US 50 near USA Parkway:

The K_{30} and D_{30} values for US 50 were obtained from NDOT ATR # 0012120 and these values were compared against the recommended K_{30} and D_{30} values from the *Draft NDOT Traffic Forecasting Guidelines*. Both the K_{30} and D_{30} values were within the recommended range of values and were chosen to represent the design year conditions. Along US 50 during both the AM and PM peak period, traffic is expected to travel to Carson City/Dayton from Highlands, Silver Springs and other regions to the east and also from Carson City to TRIC. So, a uniform directional distribution is expected; hence a D_{30} of 52.5% was found to be reasonable. The peak period direction of traffic was determined during the balancing of volumes along USA Parkway and at the intersection of USA Parkway and US 50.

6.2. Design Year 2037 Peak Hour Traffic Forecasts

The K_{30} and D_{30} values were applied to the AADTs to obtain DDHVs. The AM and PM peak hour volumes were identified from the DDHV as follows.

6.2.1. Peak Period Identification and Ratio of AM Peak to PM Peak Hour Volume

The procedure recommended in the *Draft NDOT Traffic Forecasting Guidelines* was followed to identify the peak hour volumes from the DDHV. The annual hourly report of the chosen ATRs and the short term count stations corresponding to the study segments were analyzed to identify the typical peak periods prevalent at that location. Based on this, it was determined that the PM

peak period peak direction is critical, with a higher volume than that during the AM peak period peak direction for all study segments. Hence, the DDHV for all the study segments were taken to correspond to the PM peak hour peak direction volume. In addition, the ratio of the AM peak hour peak direction volume to the PM peak hour peak direction volume for the typical weekdays (Tuesday, Wednesday and Thursday) was estimated from the annual hourly report of each ATR. Based on this, the most conservative value among all the AM to PM peak hour peak direction volume ratios (0.9) was chosen to be applied to the PM peak hour peak direction volumes to obtain the AM peak hour peak direction volumes. This ratio of 0.9 was applied consistently at all project segments.

$$\text{AM Peak Hour Peak Direction Volume} = \text{PM Peak Hour Peak Direction Volume} \times 0.9$$

The PM peak period off-peak direction volume was estimated in the conventional manner as,

$$\text{PM Peak Period Offpeak Direction Volume} = \text{Design Hour Volume (DHV)} \times (1 - D_{30})$$

The AM peak period off-peak direction volume was estimated by applying the ratio of 0.9 to the PM peak period off-peak direction volume. This was found to be more conservative than applying the field measured AM directional factor to obtain the AM off-peak directional volume.

This procedure was applied to all the study segments; a summary of the estimation of AM and PM period volumes and their relation to DDHV is given in Table 6-3.

Table 6-3: Estimation of AM and PM peak period volumes

	Peak Direction	Off-Peak Direction
PM Peak Period	DHV x D_{30} (This corresponds to DDHV)	DHV x (1-D_{30})
AM Peak Period	0.9 x DHV x D_{30} (This corresponds to 0.9 x DDHV)*	0.9 x DHV x (1-D_{30})**

* 0.9 is the ratio of the AM to PM peak hour peak direction volumes from NDOT's short term counts for typical weekdays

** This was found to be more conservative than applying the AM peak period D factor for all study segments

6.2.2. Design Year 2037 Peak Hour Traffic Forecasts for the No-Action Alternative

Estimation of peak hour volumes at ramps of I-80 and USA Parkway Interchange:

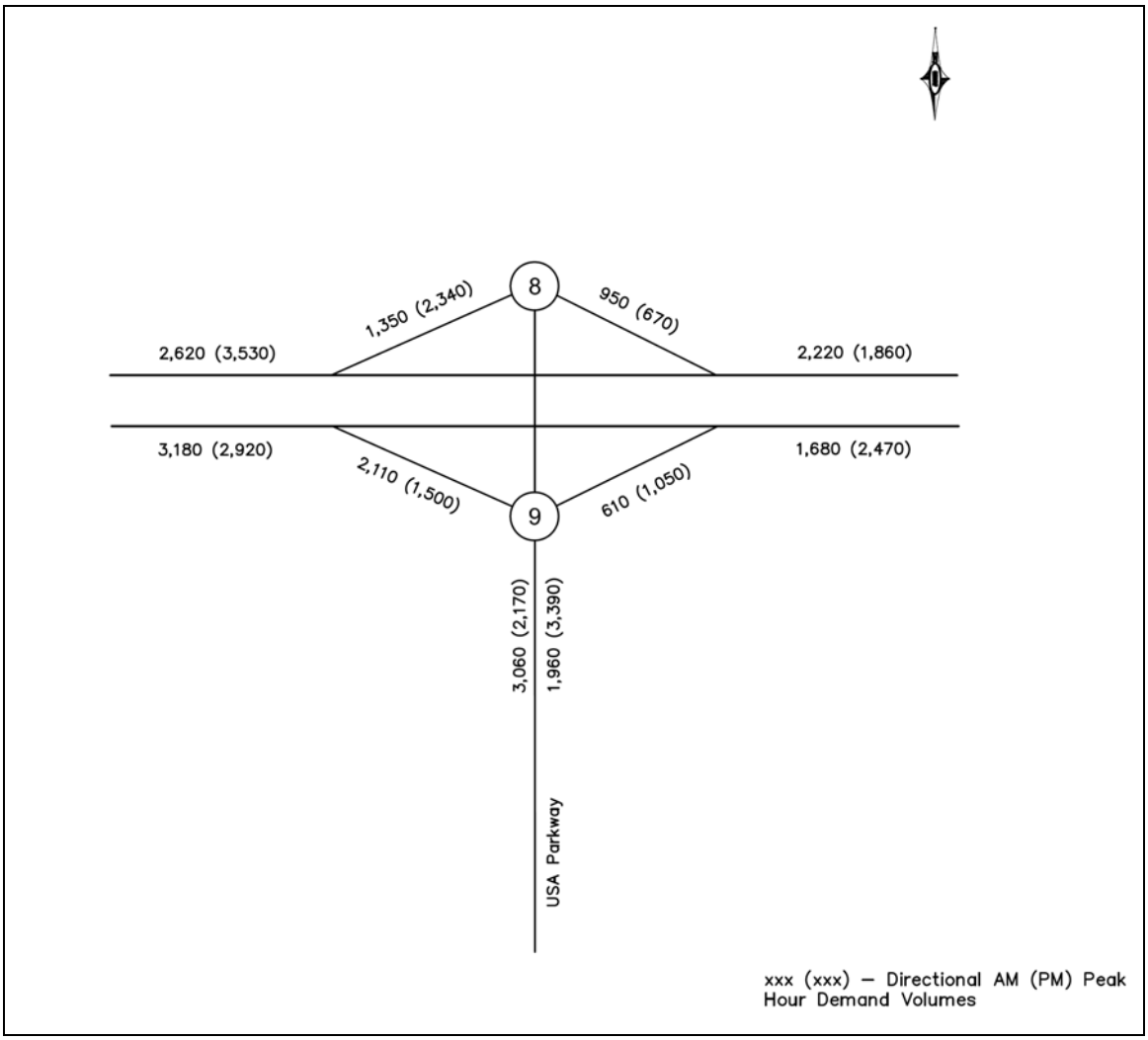
Based on the ratio of the AM to PM peak period volumes, and the estimated K_{30} and D_{30}, the peak period volumes were estimated for USA Parkway just south of I-80 (USA Parkway North Segment). The peak hour volumes at the ramps of the I-80 and USA Parkway Interchange were estimated from the volumes on the USA Parkway North segment. The sum of the EB on-ramp volumes and WB on-ramp volumes should equal the northbound volume of the USA Parkway North segment. Similarly, the sum of the EB off-ramp volumes and WB off-ramp volumes should equal the southbound volume of the USA Parkway North segment. The ramp volumes were estimated based on this condition and based on the relative distribution of 2037 AADT on the ramps.

Estimation of peak hour volumes along I-80:

As previously explained in Section 6.1.1, a D_{30} value of 57% was assumed for the I-80 segment east of the I-80 and USA Parkway Interchange. For this segment, the direction of traffic in the PM peak period was assumed to be eastbound, away from TRIC because traffic is generally expected to travel from TRIC to other destinations in the PM peak period. Based on this D_{30} and the estimated K_{30} for I-80, the peak period volumes were calculated for the I-80 segment east of USA Parkway. The peak hour volumes for the I-80 segment west of the I-80 and USA Parkway Interchange was then calculated based on the volumes from the I-80 segment east of the I-80 and USA Parkway Interchange and subtracting and adding ramp volumes.

The estimated peak period volumes for the study segments are shown in Figure 6-1 for the No-Action Alternative.

Figure 6-1: Design Year 2037 No-Action AM/PM Volume Estimates at Study Roadway Segments



6.2.3. Design Year 2037 Peak Hour Traffic Forecasts for the Build Alternative

Estimation of peak hour volumes at ramps of I-80 and USA Parkway Interchange:

The peak hour volumes at the ramps of the I-80 and USA Parkway Interchange for the Build Alternative were also calculated following the procedure explained previously in the calculation of volumes for the No-Action Alternative.

Estimation of peak hour volumes along I-80:

As previously explained in Section 6.1.2, a D_{30} value of 55% was assumed for the I-80 segment east of the I-80. Following this, the procedure explained in the calculation of volumes for the No-Action Alternative was used to determine the peak hour volumes along I-80.

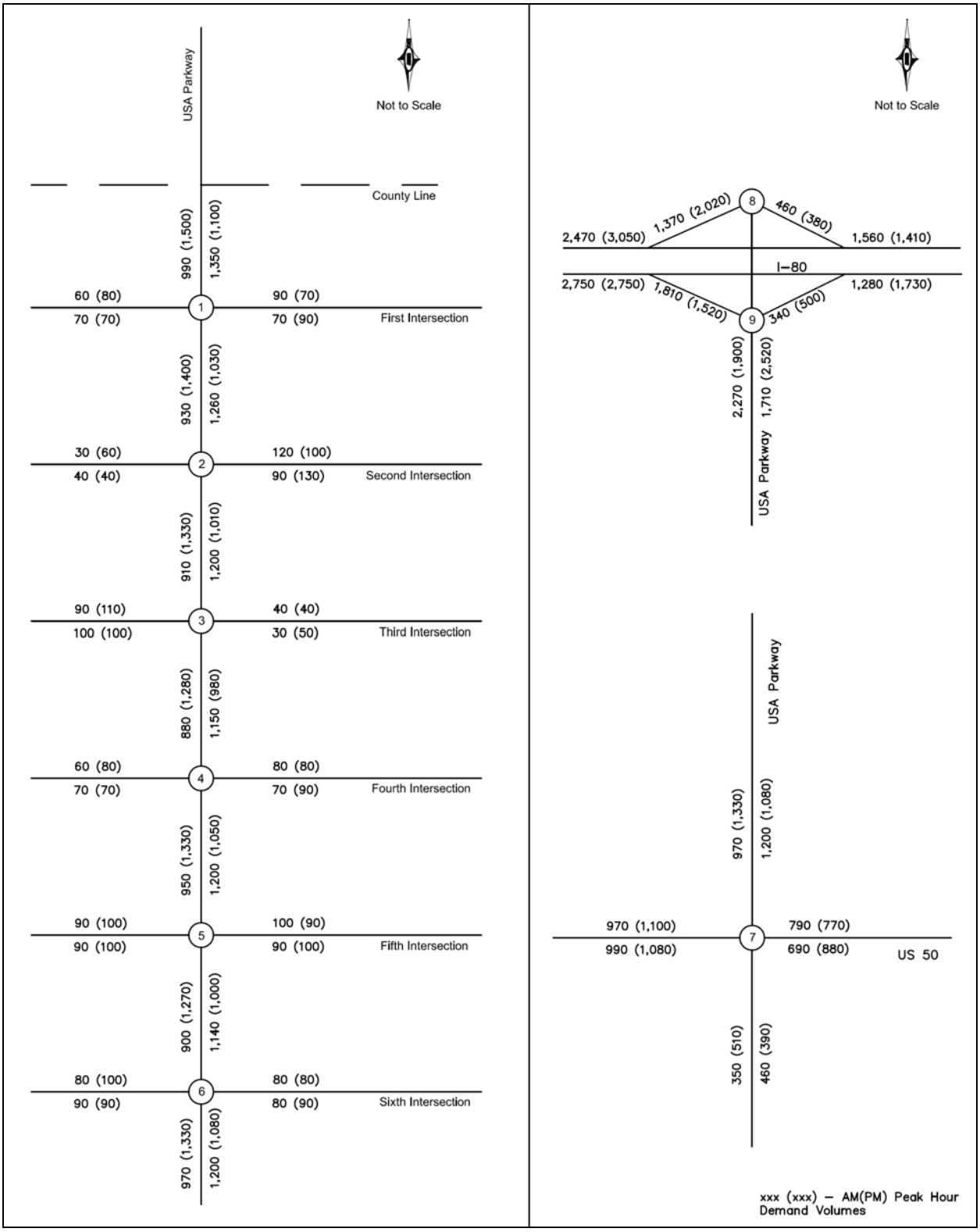
Estimation of peak hour volumes on USA Parkway along Highlands Development

Based on the ratio of the AM to PM peak period volumes, and the estimated K_{30} and D_{30}, all the peak period volumes were estimated for the USA Parkway segments along the Highlands development.

Estimation of peak hour volumes on US 50 at USA Parkway:

The peak period volumes for the segments along US 50 were also calculated based on the estimated K_{30} and D_{30} and the ratio of the AM to PM peak period volumes. The initial direction of the peak period traffic, both at the segments east and west of USA Parkway, was assumed to be eastbound in the PM period and westbound in the AM period. This assumed directionality is consistent with the existing traffic conditions. These values were used in the process of balancing the volumes along the USA Parkway corridor at Highlands in conjunction with the intersection of USA Parkway and US 50. The resulting balanced volumes are shown in Figure 6-2. The directionality of the balanced AM and PM peak hour volumes along US 50 west of USA Parkway and along US 50 east of USA Parkway is shown in Table 6-2.

Figure 6-2: Design Year 2037 Build AM/PM Volume Estimates at Study Roadway Segments



6.2.4. Intersection Turning Movement Forecasts

Design year 2037 turning movement volumes at the study intersections are derived from the directional peak hour volumes shown in Figure 6-1 and Figure 6-2 consistent with the iterative method of NCHRP Report 255. TurnsW32 software was utilized for the turning movement estimates. Figure 6-3 and Figure 6-4 show the resulting design year 2037 intersection turning movement volumes.

Figure 6-3: Design Year 2037 No-Action AM/PM Turning Movement Volumes at Study Intersections

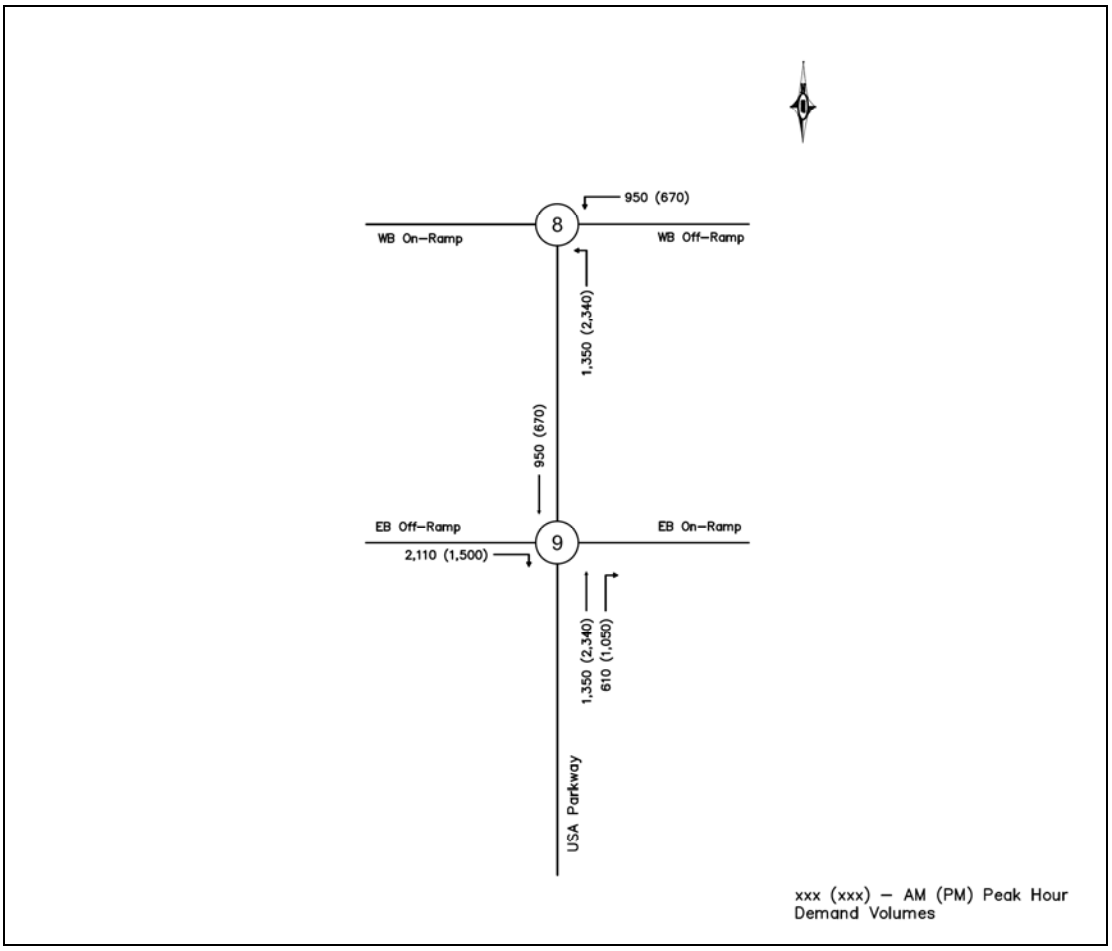
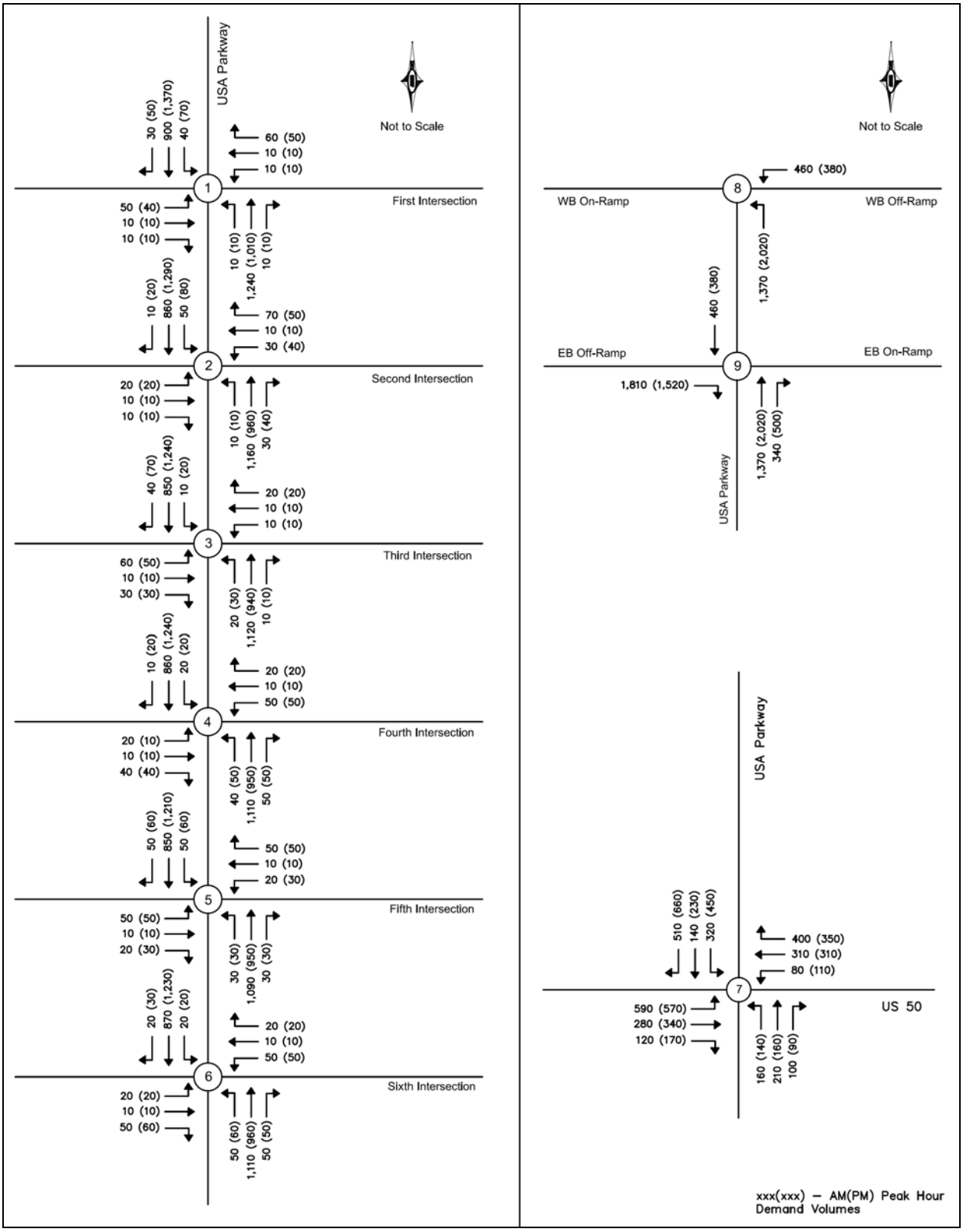


Figure 6-4: Design Year 2037 Build AM/PM Turning Movement Volumes at Study Intersections



7. YEAR 2035 AND YEAR 2037 NO-HIGHLANDS SCENARIO – TRAFFIC FORECASTS

The year 2035 and year 2037 No-Highlands scenario traffic volumes are estimated following the same methodologies used for year 2035 and year 2037 with-Highlands scenario projections as detailed in Chapters 5 and 6. The procedure can be summarized as follows:

Similar to the methodology used for forecasting the year 2035 and year 2037 with-Highlands scenario volumes, the raw daily model volumes were first investigated for reasonableness; and necessary adjustments were made (re-assignment of raw model volumes and NCHRP 255 adjustments). Once the year 2035 AADTs were estimated (see through Figures 7-1 through Figure 7-4), they were compared with historical trend projections for reasonableness (see Figure 7-5 and Appendix G). This comparison showed that the growth obtained from the travel demand outputs follow a similar trend as predicted by the historical trend projection analysis. Year 2037 AADTs were estimated from year 2035 AADTs using the same methodology as explained in Section 5.5 (see Figure 7-6 and Figure 7-7). Peak hour traffic forecasts (both DDHVs and turning movement volumes) were estimated from the AADTs following the same methodology explained for the year 2037 with-Highlands scenario projections. Figure 7-8 through Figure 7-11 present the year 2037 No-Highlands scenario peak hour traffic forecasts.

Figure 7-1: Year 2035 No-Highlands No-Action AADTs at General Study Area Roadway Network

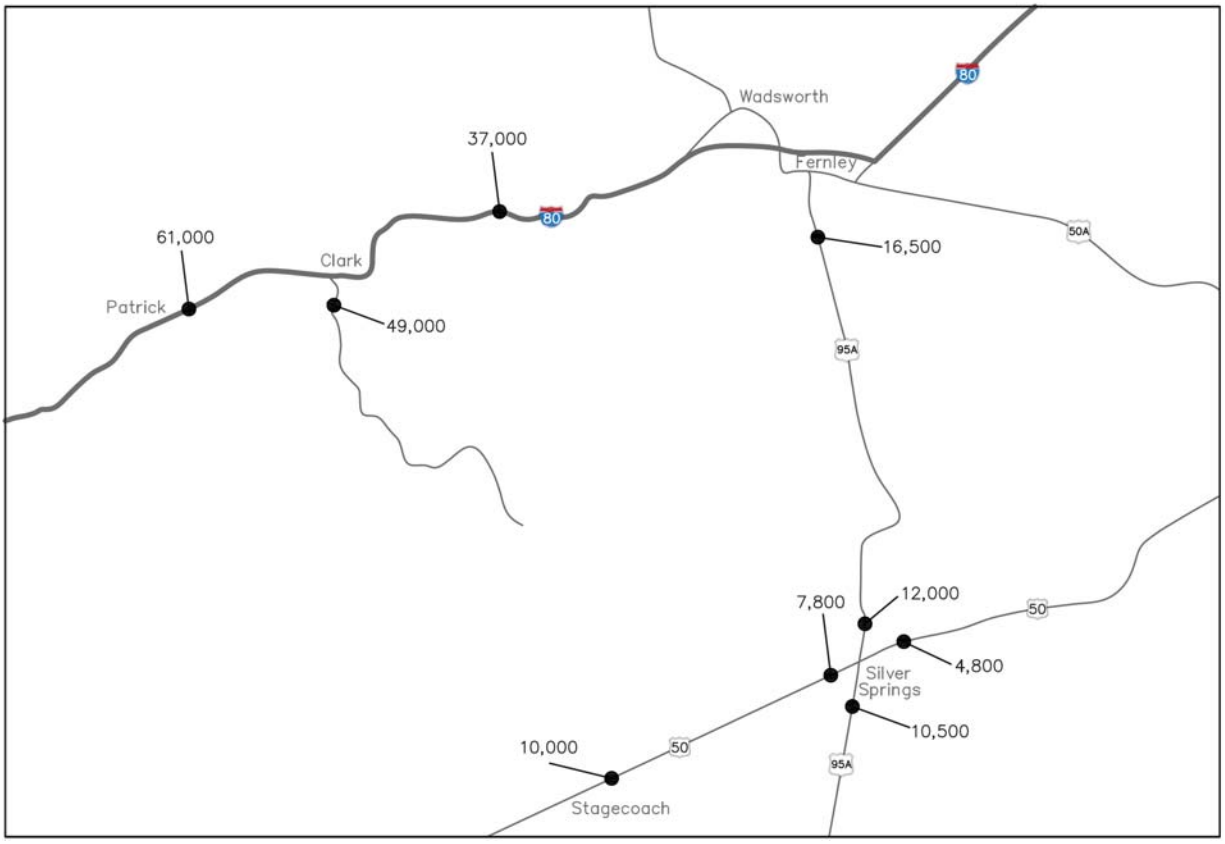


Figure 7-2: Year 2035 No-Highlands Build AADTs at General Study Area Roadway Network

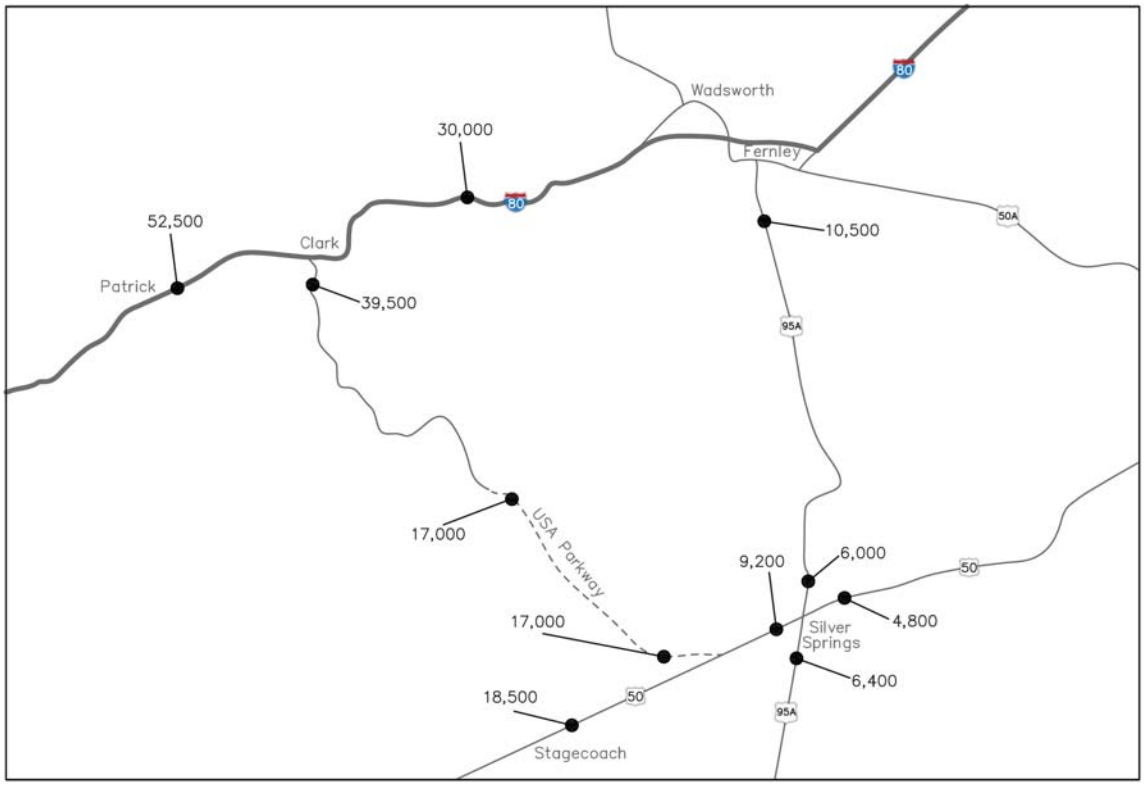


Figure 7-3: Year 2035 No-Highlands No-Action AADTs at Study Roadway Segments

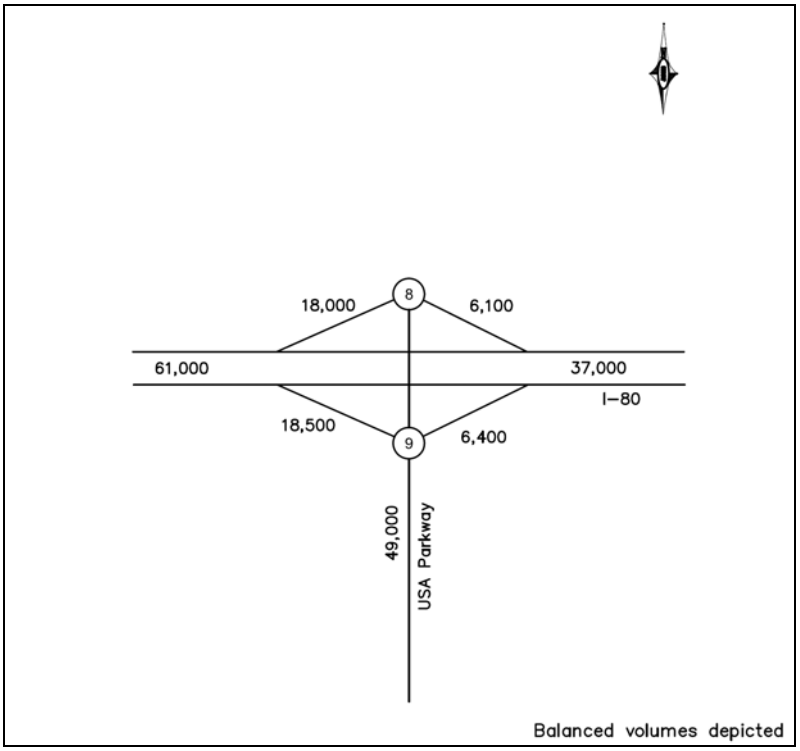


Figure 7-4: Year 2035 No-Highlands Build AADTs at Study Roadway Segments

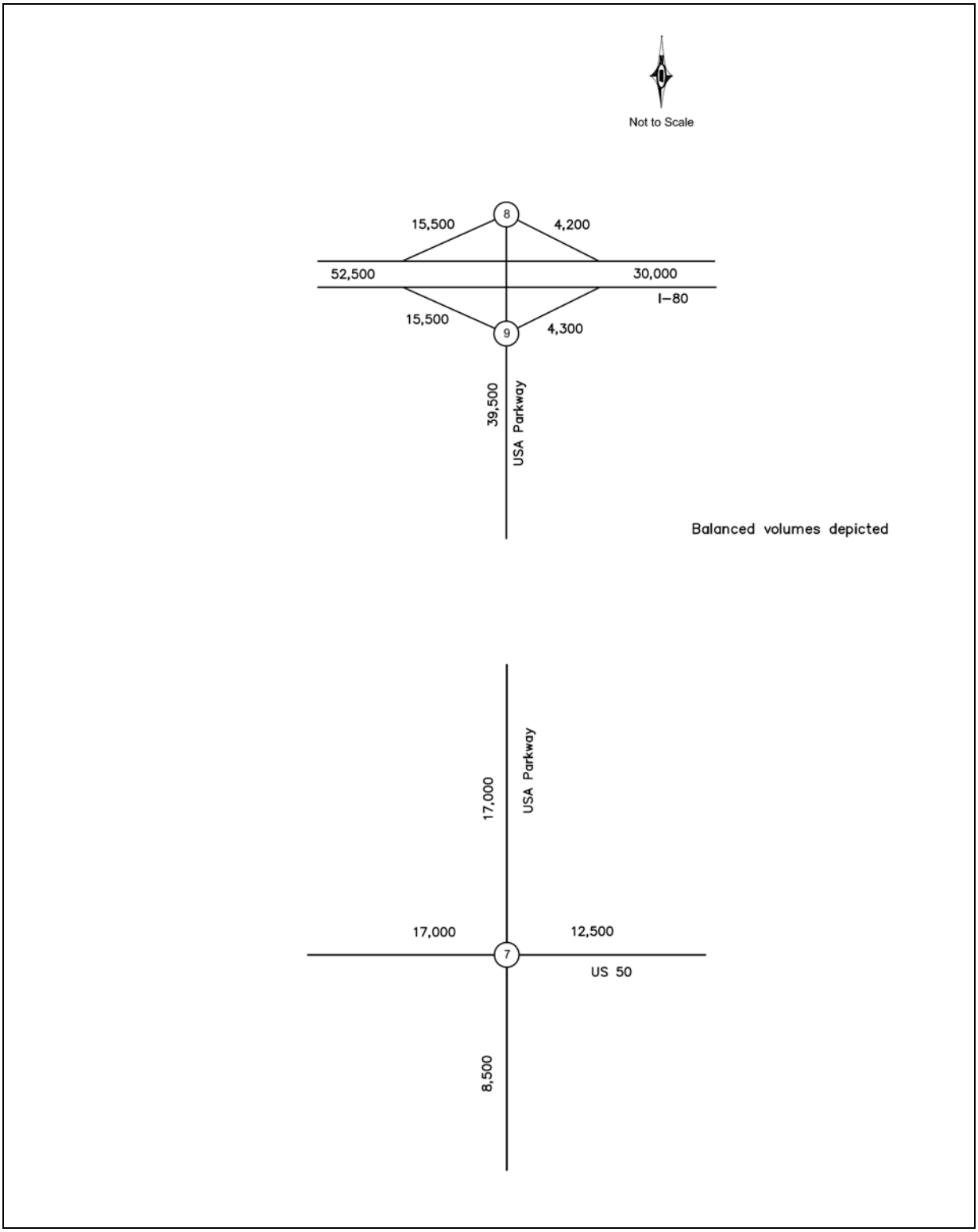


Figure 7-5: Comparison of year 2035 No-Highlands Build Forecasts with Historical Trend Projections

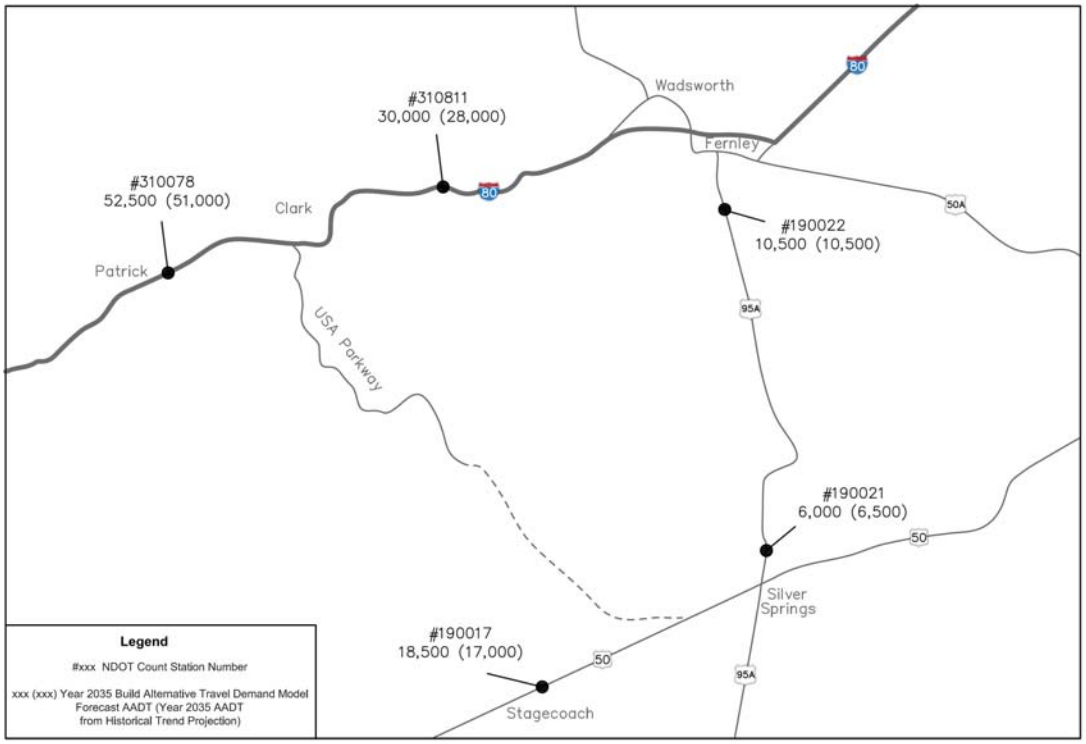


Figure 7-6: Design Year 2037 No-Highlands No-Action AADTs at Study Roadway Segments

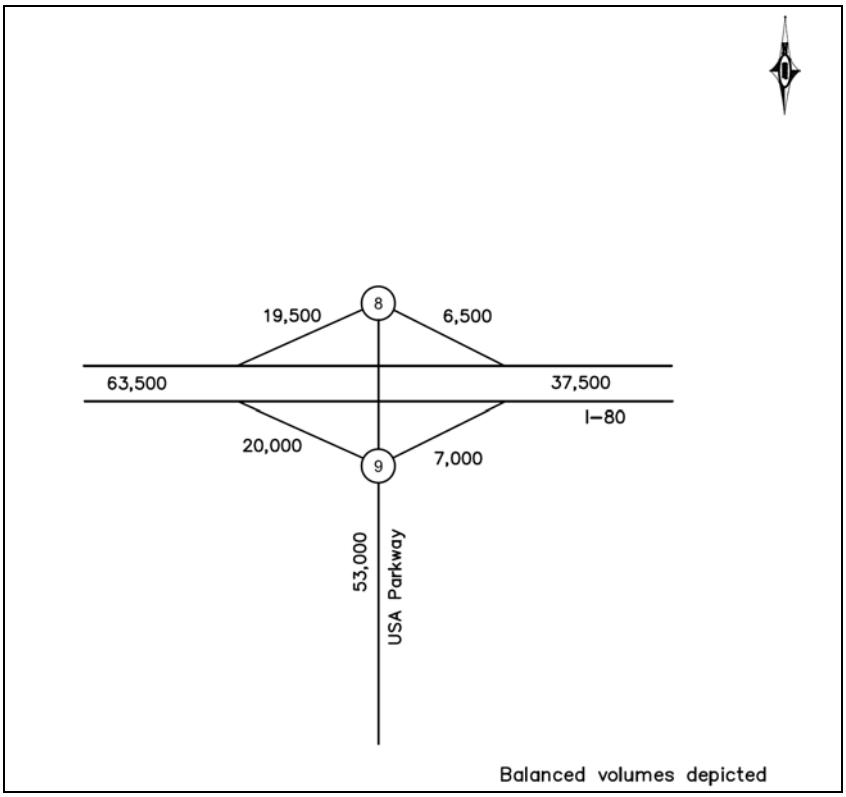


Figure 7-7: Design Year 2037 No-Highlands Build AADTs at Study Roadway Segments

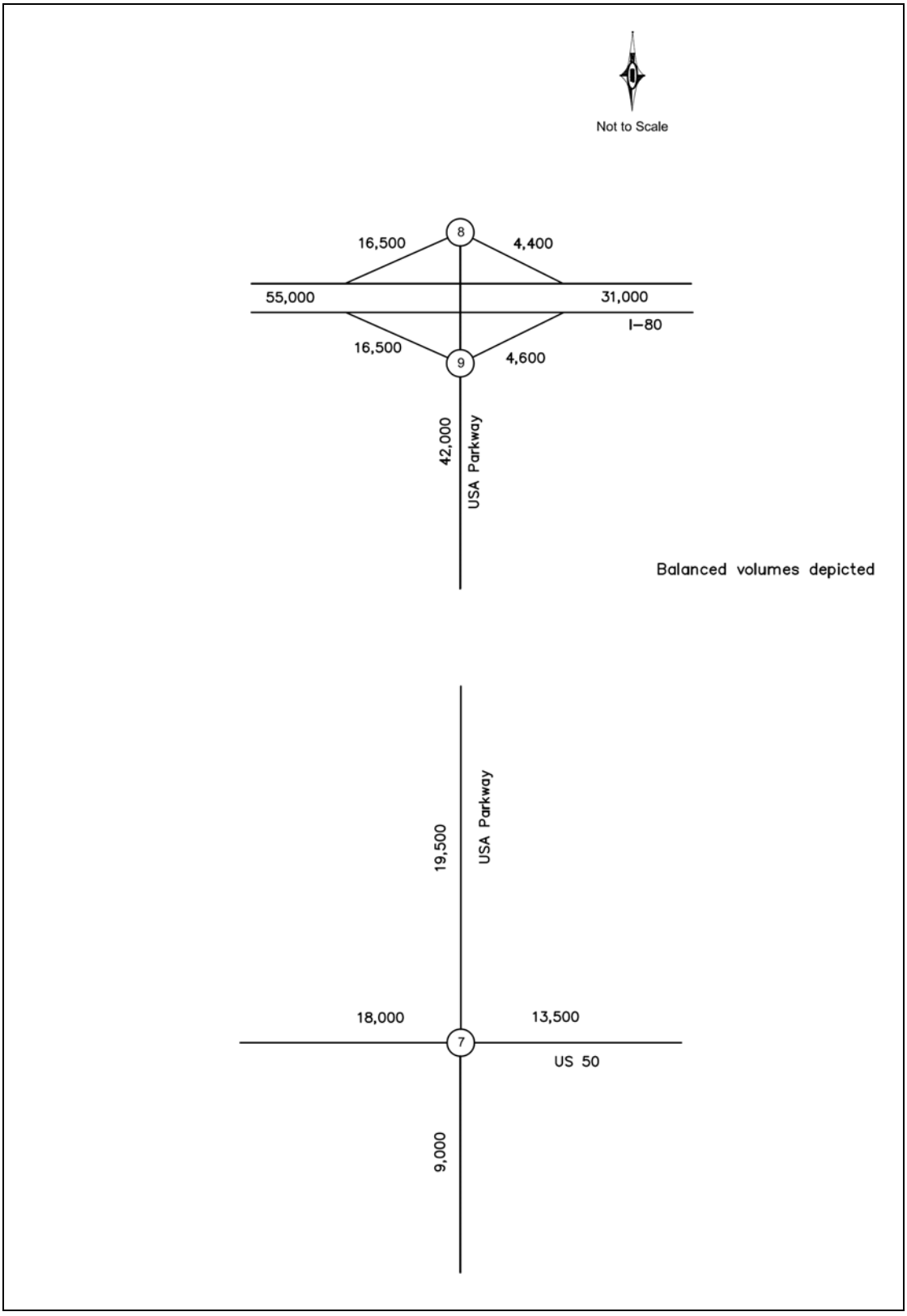


Figure 7-8: Design Year 2037 No-Highlands No-Action AM/PM Volume Estimates at Study Roadway Segments

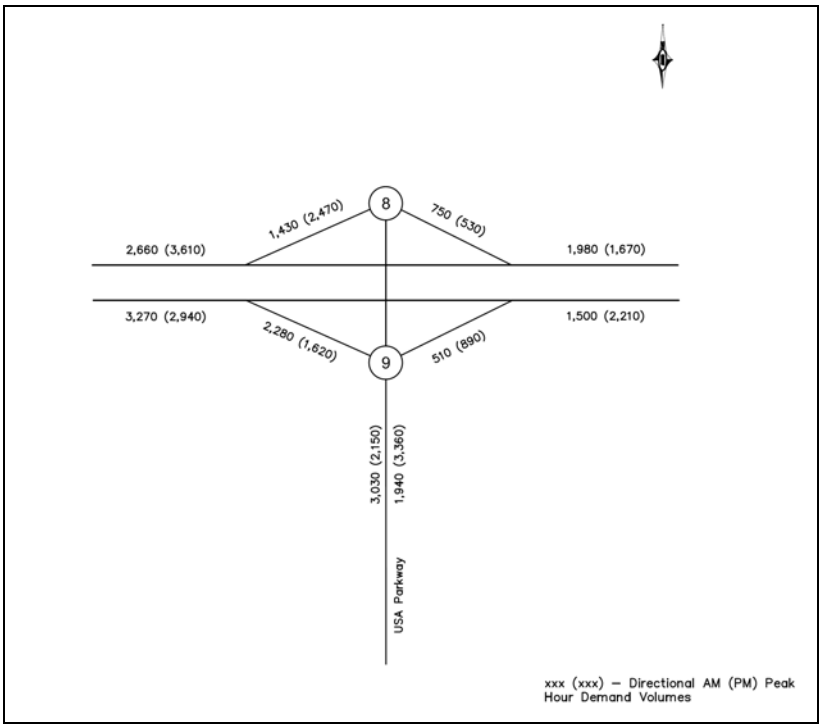


Figure 7-9: Design Year 2037 No-Highlands Build AM/PM Volume Estimates at Study Roadway Segments

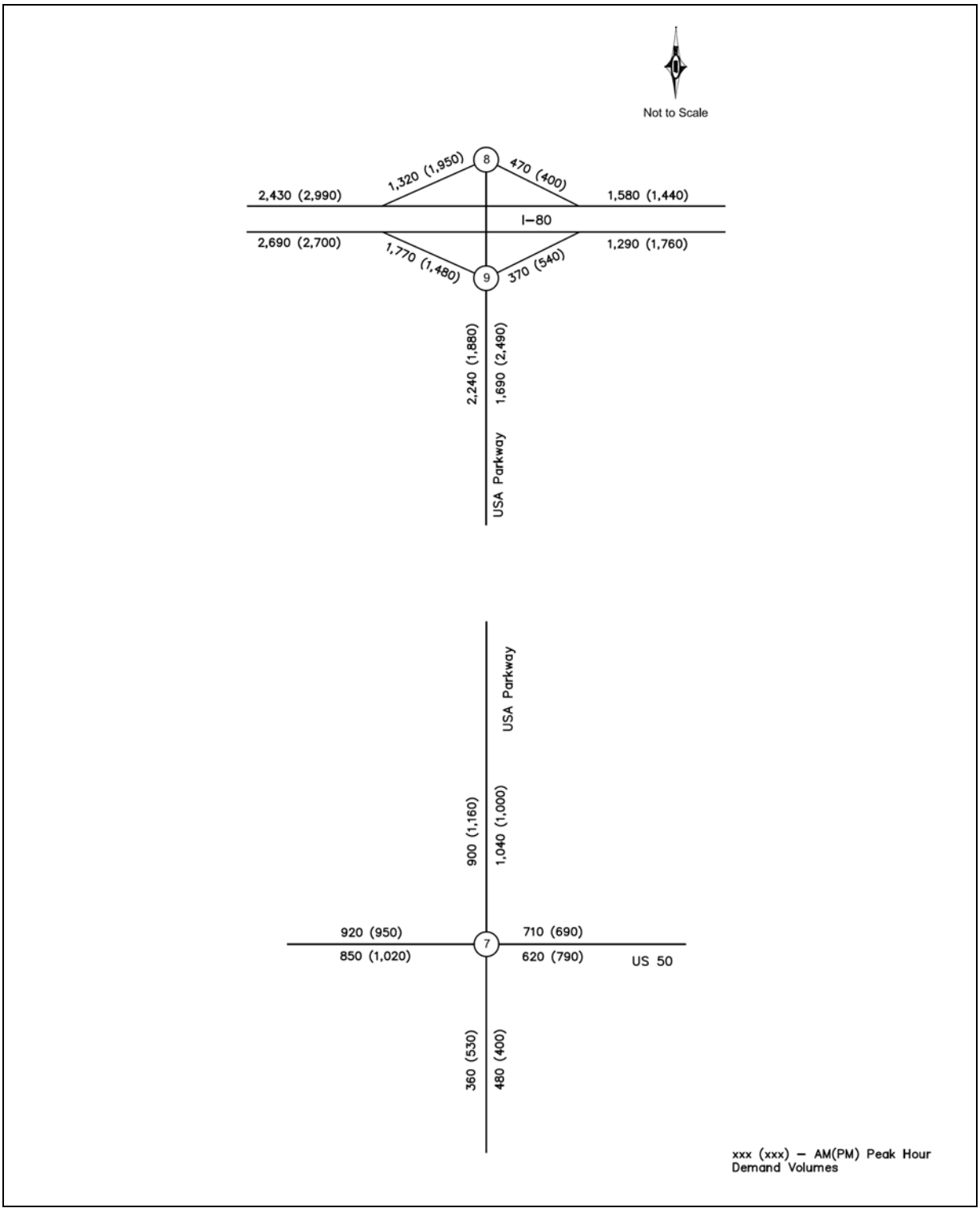


Figure 7-10: Design Year 2037 No-Highlands No-Action AM/PM Turning Movement Volumes at Study Intersections

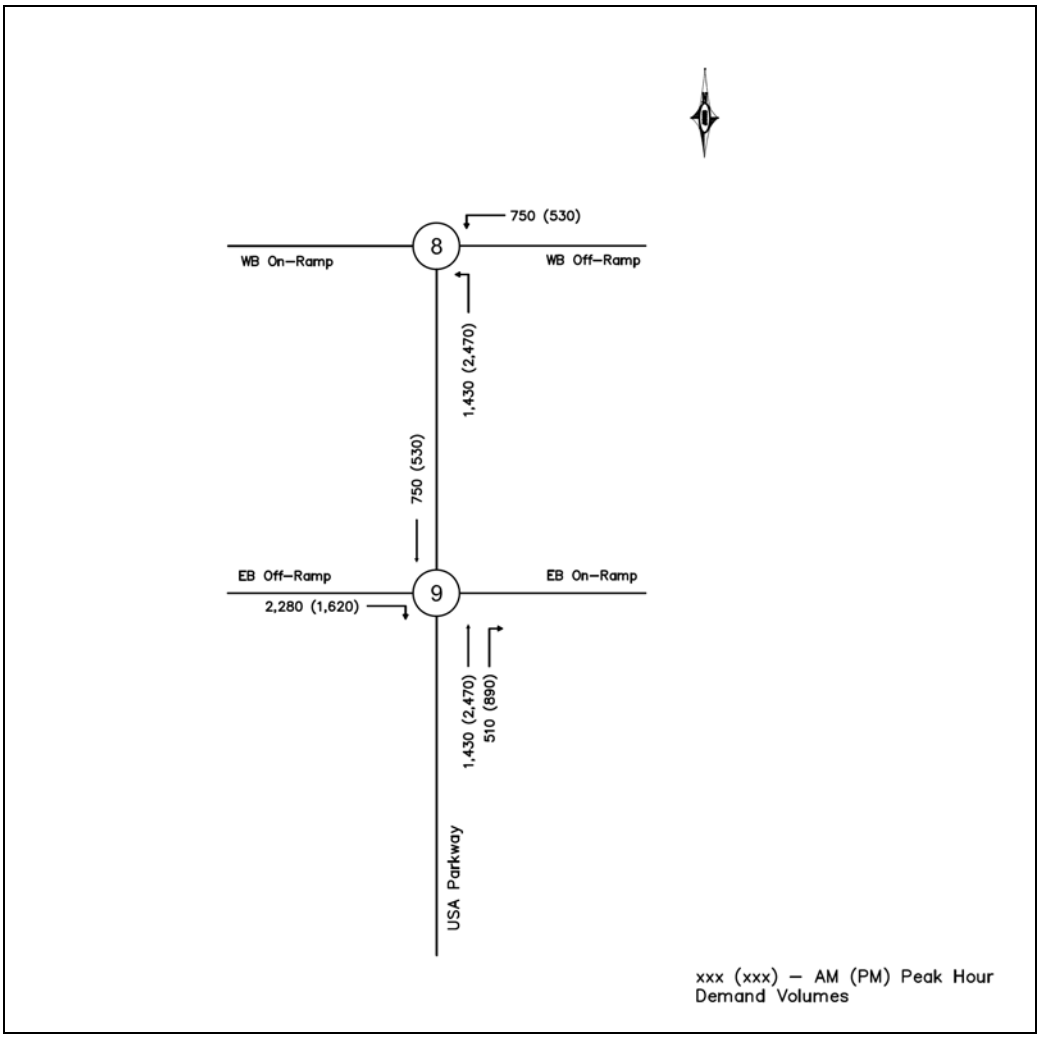
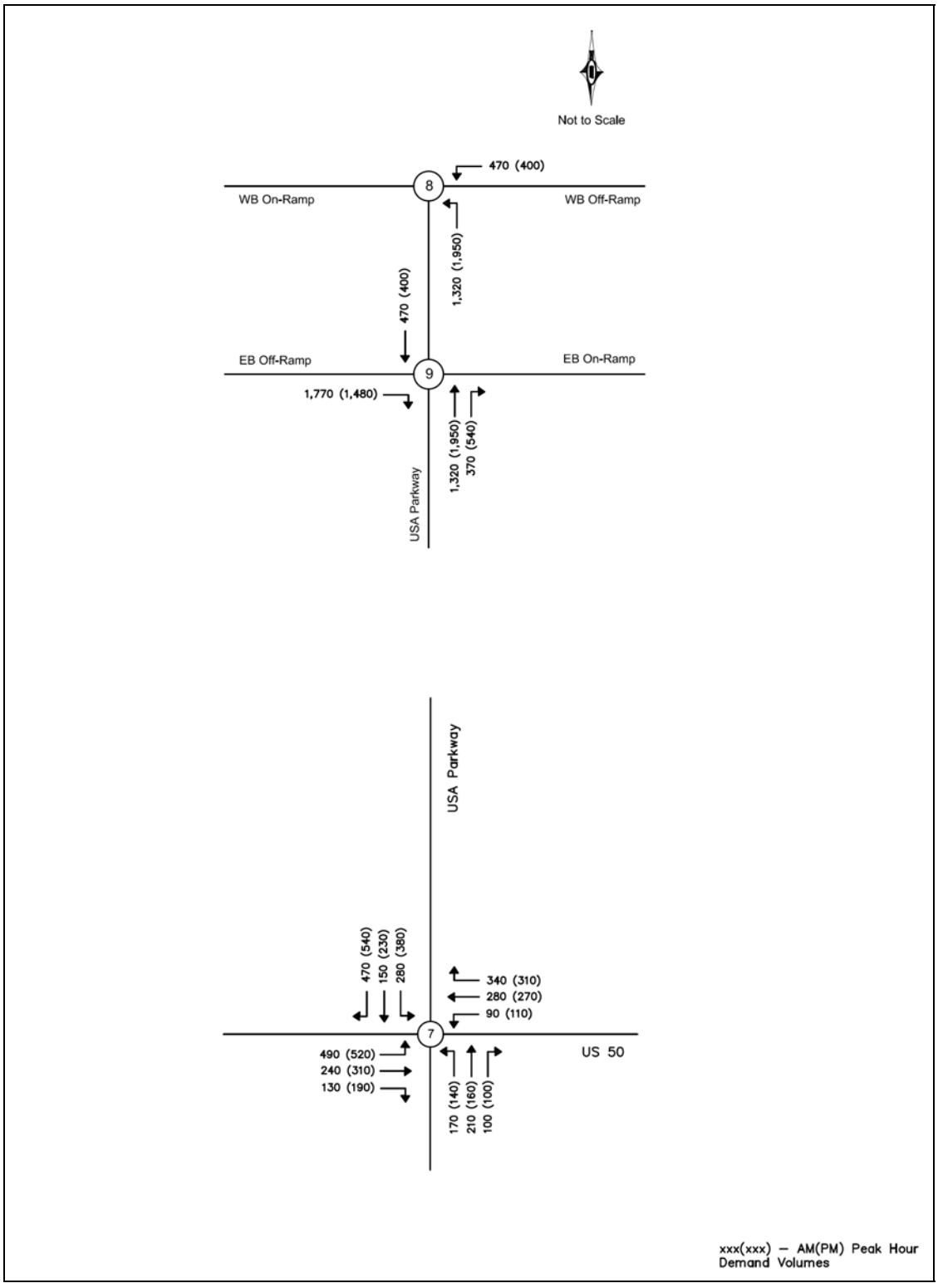


Figure 7-11: Design Year 2037 No-Highlands Build AM/PM Turning Movement Volumes at Study Intersections



Based on the daily truck percentages provided in Section 4-1 (Truck Traffic) and the forecast AADT, the truck AADTs for the design year 2037 No-Highlands scenario is shown in Table 7-1.

Table 7-1: Design Year 2037 No-Highlands Build Truck AADTs at Study Roadway Segments

Location	Year 2037 Build No-Highlands Total AADT	Year 2037 Build No-Highlands Truck AADT
I-80 West of USA Parkway Interchange	55,000	12,500
E/B off-ramp at USA Parkway Interchange	16,500	3,700
E/B on-ramp at USA Parkway Interchange	4,600	1,100
W/B off-ramp at USA Parkway Interchange	4,400	1,000
W/B on-ramp at USA Parkway Interchange	16,500	3,700
I-80 East of USA Parkway Interchange	31,000	7,400
USA Parkway North Segment	42,000	10,000
USA Parkway North of the First Intersection at Highlands	19,500	4,700
USA Parkway South of the Sixth Intersection at Highlands	19,500	4,700
USA Parkway South of US50 (Ramsey Cutoff)	9,000	2,200
US 50 west of USA Parkway	18,000	2,300
US 50 east of USA Parkway	13,500	1,700

8. YEAR 2017 – OPENING YEAR TRAFFIC FORECASTS

Since the proposed project will be designed to year 2037 conditions and built in one phase, an opening year traffic operations analysis will not be performed as part of the USA Parkway EA. Geometry and improvements will be identified based on year 2037 volumes. This means the proposed design will accommodate opening year conditions. Nonetheless, opening year 2017 traffic is estimated for the USA Parkway EA. The year 2017 forecasts will be the input for environmental air quality and noise analysis. Furthermore, the projections may be used for a potential change in control of access request (CCAR) for the US 50/USA Parkway intersection/interchange. It is noted that a CCAR is not part of the USA Parkway EA scope and will be completed (if needed) later by NDOT.

The south leg of the USA Parkway and US 50 intersection might not be completed as part of the year 2017 Build scenario. Hence, forecasts were developed for both a T-intersection configuration and a four-legged intersection configuration for the intersection of USA Parkway and US 50.

Year 2017 traffic volumes are estimated following the same methodologies as detailed in Chapters 5 and 6. A year 2017 travel demand model is developed and is the basis for the opening year projections. The procedure can be summarized as follows:

Similar to the methodology used for forecasting design year 2035 volumes, the raw daily model volumes were first investigated for reasonableness; and necessary adjustments were made (re-assignment of raw model volumes and NCHRP 255 adjustments). Once the AADTs were estimated (see Figures 8-1 through Figure 8-4), they were compared with historical trend projections for reasonableness (see Figure 8-5 and Appendix G). This comparison showed that the growth obtained from the travel demand outputs follow a similar trend as predicted by the historical trend projection analysis.

Peak hour traffic forecasts (both DDHVs and turning movement volumes) were estimated from the AADTs following the same methodology explained for year 2037 projections. Figure 8-6 through Figure 8-9 present the opening year 2017 peak hour traffic forecasts.

Figure 8-1: Year 2017 No-Action AADTs at General Study Area Roadway Network

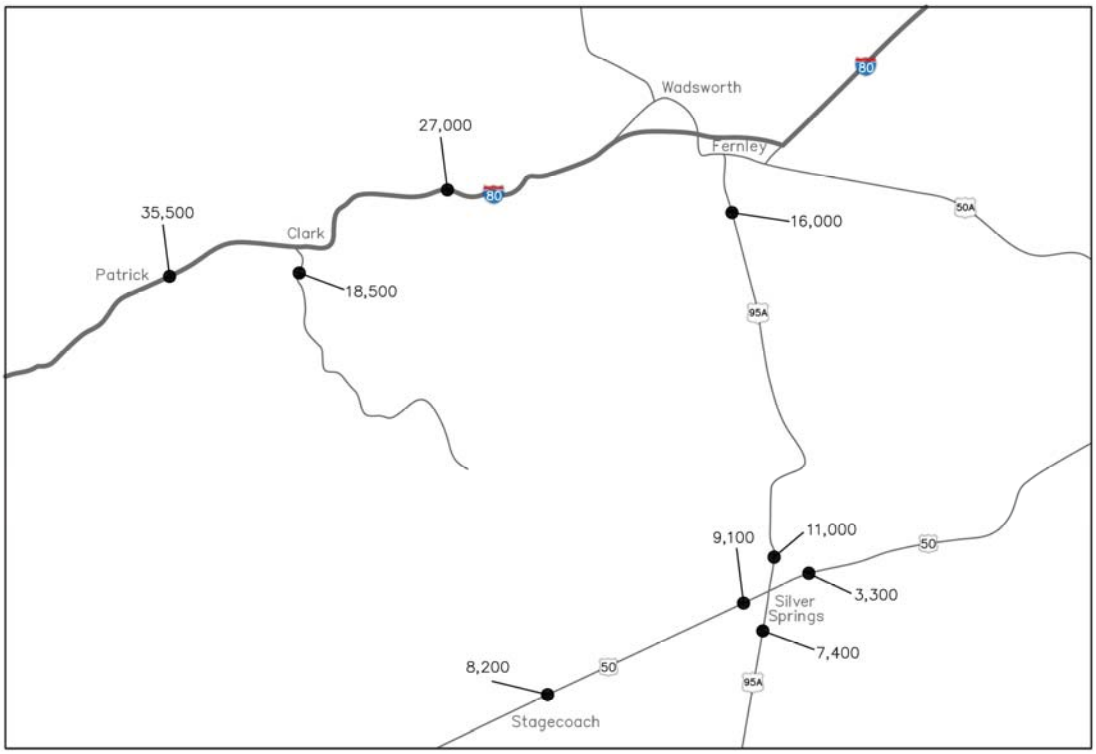


Figure 8-2: Year 2017 Build AADTs at General Study Area Roadway Network

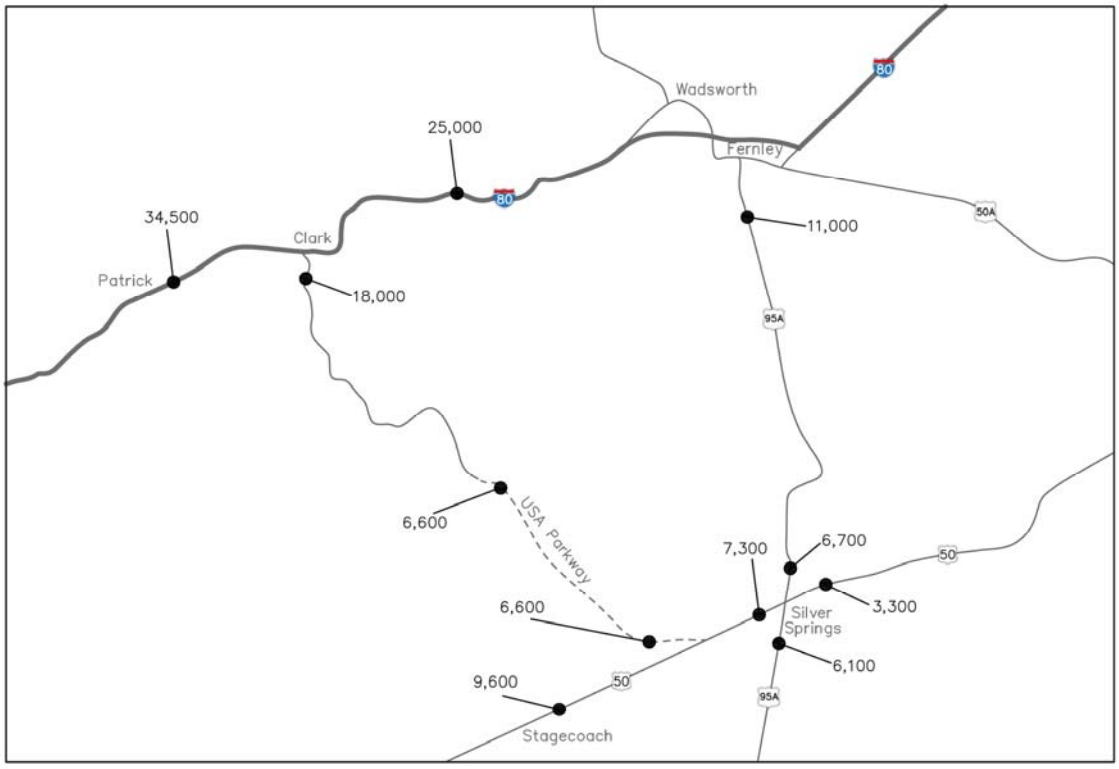


Figure 8-3: Year 2017 No-Action AADTs at Study Roadway Segments

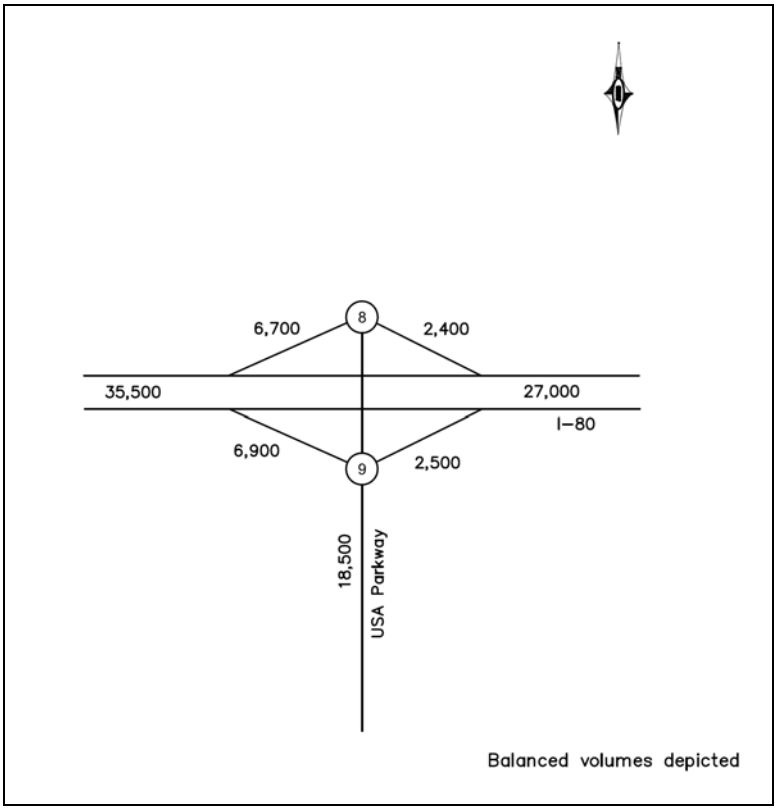


Figure 8-4: Year 2017 Build AADTs at Study Roadway Segments

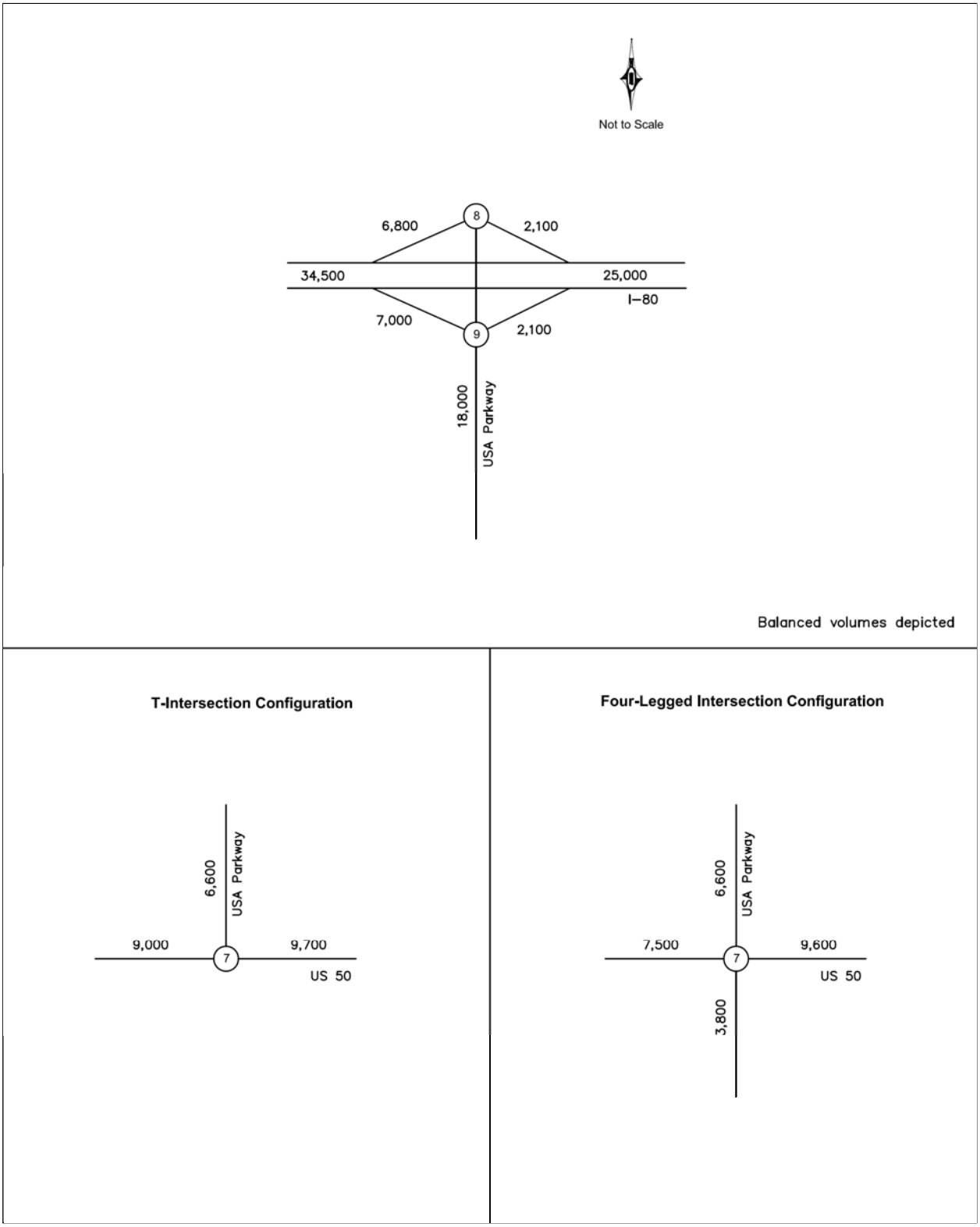


Figure 8-5: Comparison of 2017 AADT Forecasts with Historical Trend Projections

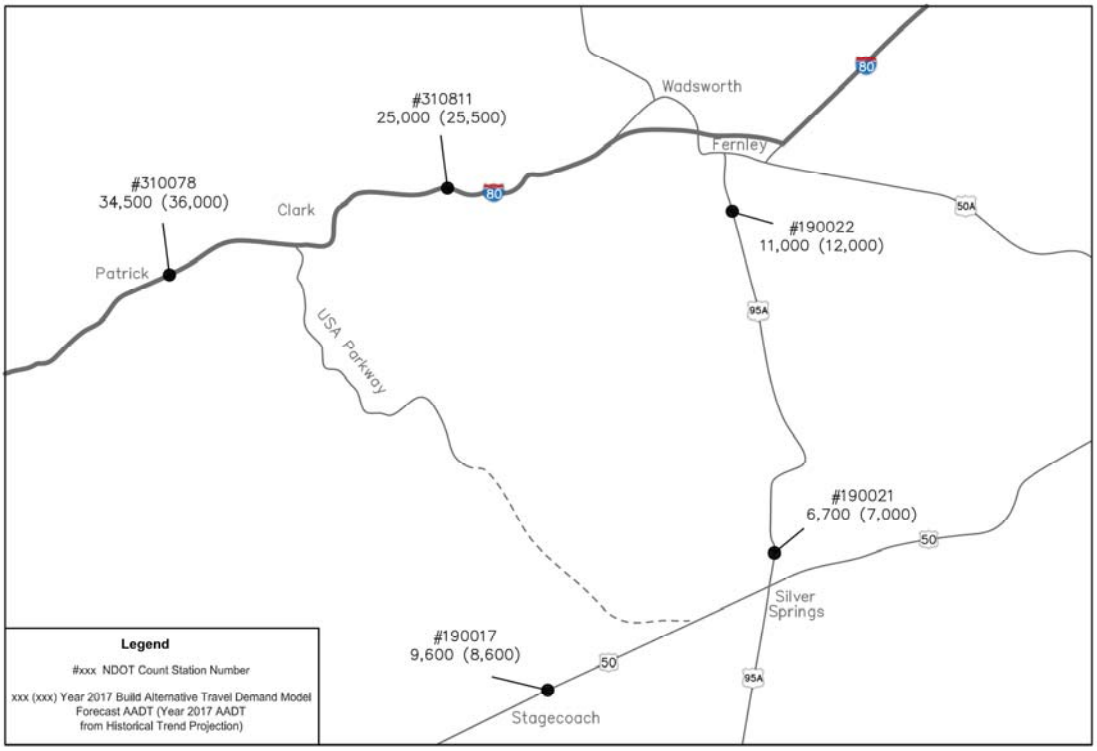


Figure 8-6: Opening Year 2017 No-Action AM/PM Volume Estimates at Study Roadway Segments

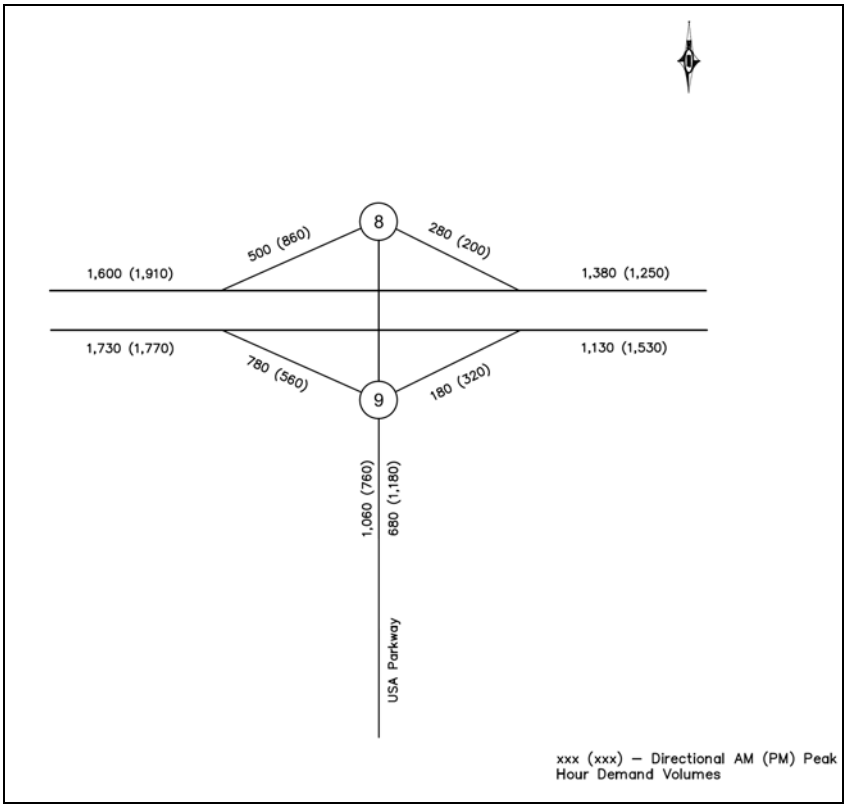


Figure 8-7: Opening Year 2017 Build AM/PM Volume Estimates at Study Roadway Segments

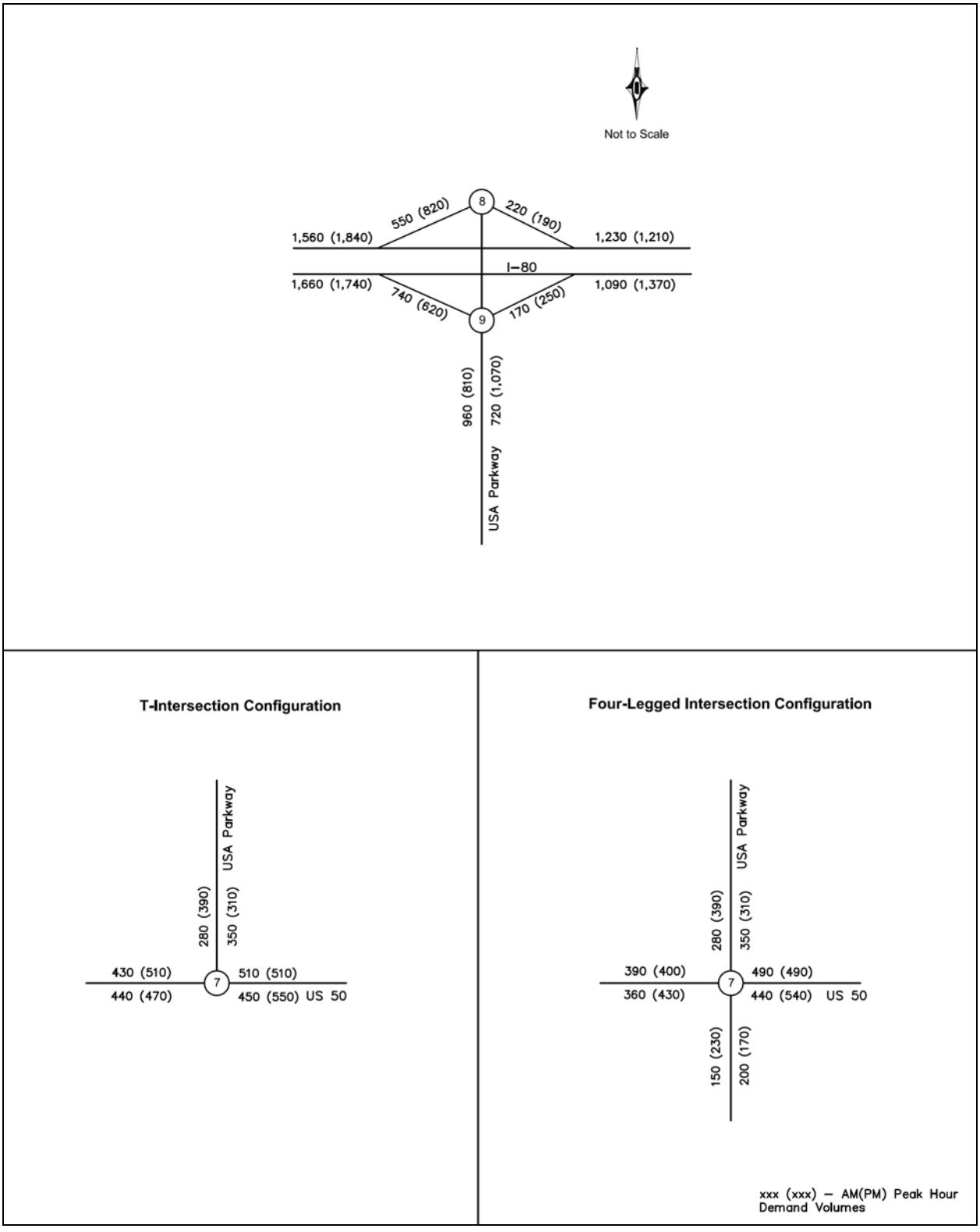


Figure 8-8: Opening Year 2017 No-Action AM/PM Turning Movement Volumes at Study Intersections

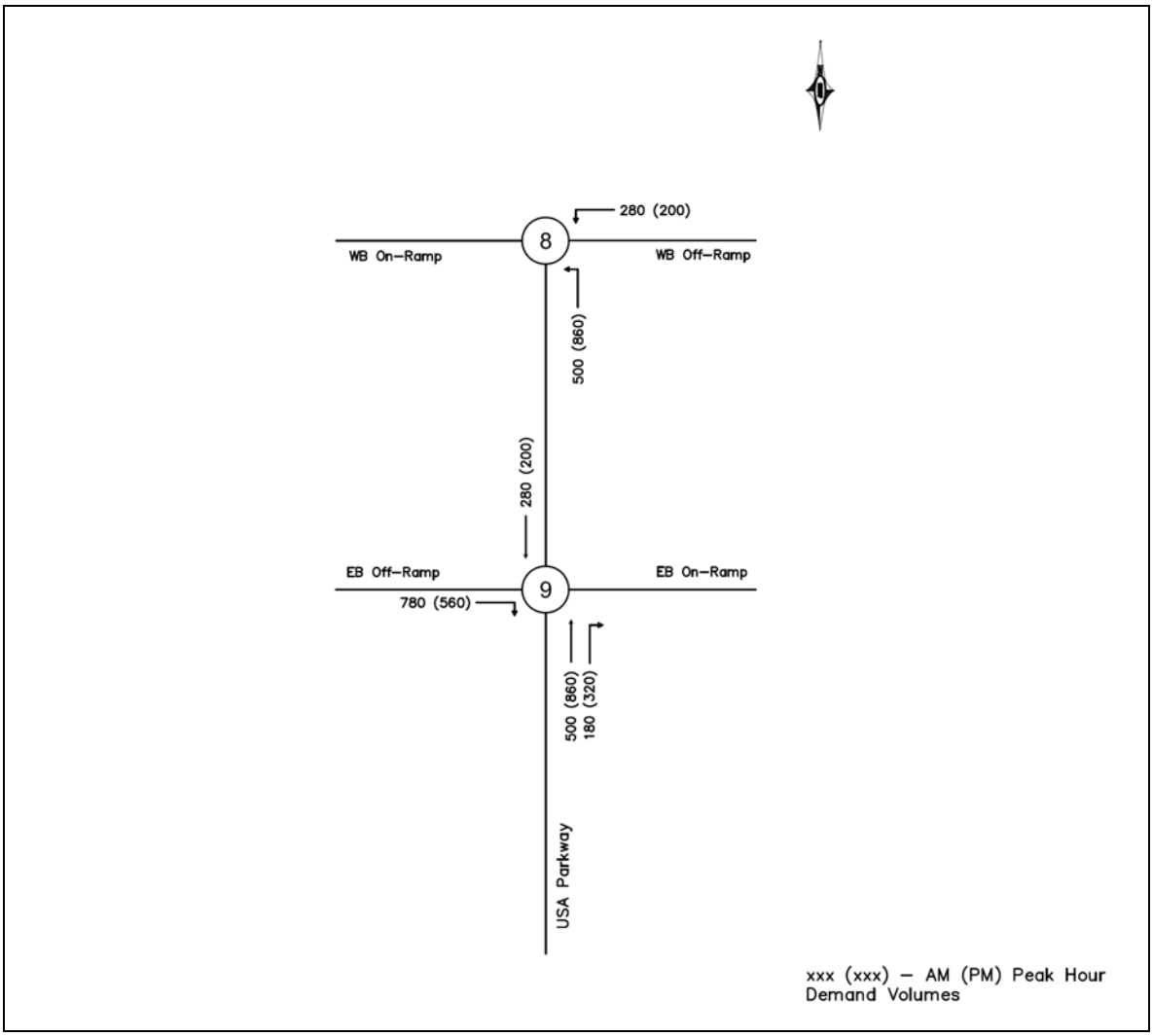
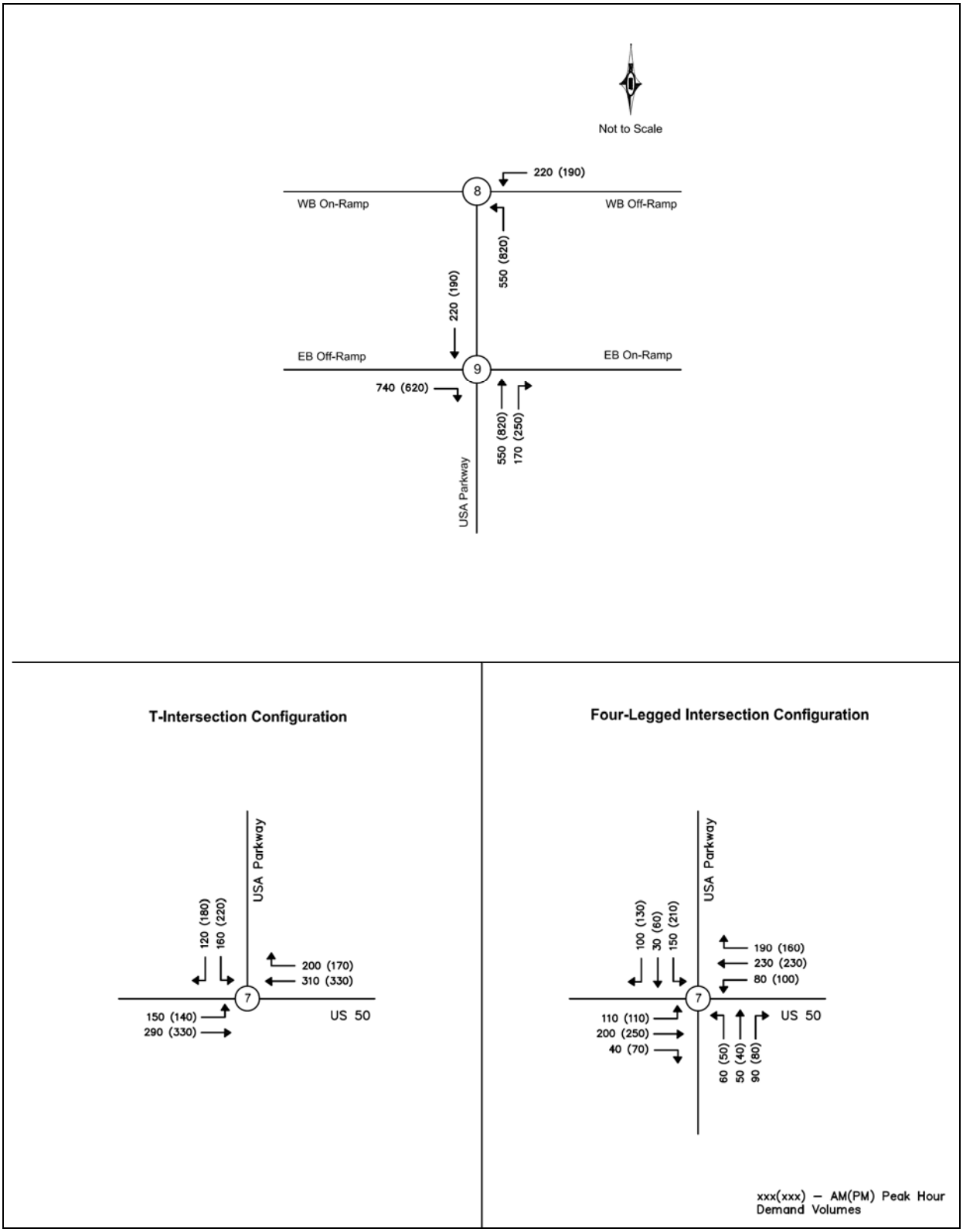


Figure 8-9: Opening Year 2017 Build AM/PM Turning Movement Volumes at Study Intersections



Based on the daily truck percentages provided in Section 4-1 (Truck Traffic) and the forecast AADT, the truck AADTs for the opening year 2017 is shown in Table 8-1.

Table 8-1: Opening Year 2017 Build Truck AADTs at Study Roadway Segments

Location	Year 2017 Build Total AADT	Year 2017 Build Truck AADT
I-80 West of USA Parkway Interchange	34,500	7,800
E/B off-ramp at USA Parkway Interchange	7,000	1,600
E/B on-ramp at USA Parkway Interchange	2,100	500
W/B off-ramp at USA Parkway Interchange	2,100	500
W/B on-ramp at USA Parkway Interchange	6,800	1,500
I-80 East of USA Parkway Interchange	25,000	6,000
USA Parkway North Segment	18,000	4,300
USA Parkway Mid Segment	6,600	1,600
USA Parkway South Segment	6,600	1,600
USA Parkway South of US50 (Ramsey Cutoff)	3,800	900
US 50 west of USA Parkway - Four-legged intersection configuration	7,500	950
US 50 east of USA Parkway - Four-legged intersection configuration	9,600	1,200
US 50 west of USA Parkway - T-intersection configuration	9,000	1,200
US 50 east of USA Parkway - T-intersection configuration	9,700	1,200

9. CONCLUSION

The travel demand forecasts documented in this memorandum are developed from the travel demand model developed specifically for the USA Parkway EA. The raw model volumes were post-processed using nationally accepted practices including ones explained in the NCHRP Report 255, to produce travel demand forecasts for the USA Parkway EA. These travel demand forecasts documented in this memorandum are reasonable; and recommended for use in traffic operations analysis for the USA Parkway EA.

Appendix B
Approved Traffic Analysis Methodology Memorandum

Dhanaraju, Sharan

From: Karachepone, John S.
Sent: Thursday, January 05, 2012 3:10 PM
To: Mulazimoglu, Cigdem X.
Subject: FW: USA Parkway Traffic Methodology - NDOT Comments

Approved – see below and save email for documentation.

From: Rodriguez, Pedro [mailto:PRodriguez@dot.state.nv.us]
Sent: Thursday, January 05, 2012 3:05 PM
To: Karachepone, John S.
Cc: Gant, Bryan; Primus, Chris J.; Hong, Hoang; Travis, Randy; Wang, Xuan; Madewell, Robert A
Subject: RE: USA Parkway Traffic Methodology - NDOT Comments

Good Afternoon John.
Please be advised that NDOT approves this copy of the Traffic Methodology for the USA Parkway Project. If you have any questions or concerns, please don't hesitate to call me.
Thank you.

Pedro Rodriguez, P.E.
Project Manager
Nevada Department of Transportation
Direct: 775.888.7320
Mobile: 775.434.8507

From: Karachepone, John S. [mailto:John.Karachepone@jacobs.com]
Sent: Thursday, December 29, 2011 4:33 PM
To: Rodriguez, Pedro
Cc: Gant, Bryan; Primus, Chris J.
Subject: RE: USA Parkway Traffic Methodology - NDOT Comments

Good Afternoon Pedro:
I have attached the updated Traffic Analysis Memorandum for your approval. The attachment includes a Cover Letter, the Actual Traffic Analysis Methodology Memorandum, and Department comments with responses. Please call me if you have any questions.
Here's wishing you a Happy New Year!

John K
702.938.5508

From: Gant, Bryan
Sent: Friday, November 25, 2011 9:49 AM
To: Karachepone, John S.; Primus, Chris J.
Subject: FW: USA Parkway Traffic Methodology - NDOT Comments

All comments received and included....

From: Rodriguez, Pedro [mailto:PRodriguez@dot.state.nv.us]

Sent: Wednesday, November 23, 2011 11:22 AM
To: Gant, Bryan
Cc: Travis, Randy; Hong, Hoang
Subject: USA Parkway Traffic Methodology - NDOT Comments

Bryan.
Attached, please find the compiled comments on the Traffic Methodology for the USA Parkway Job. Please let me know if you need anything else. Happy Thanksgiving!

Pedro Rodriguez, P.E.
Project Manager
Nevada Department of Transportation
Direct: 775.888.7320
Mobile: 775.434.8507

JACOBS™

319 E. Warm Springs Road, Suite 200
Las Vegas, Nevada 89119
702.938.5400 Fax 702.938.5454

December 28, 2011

Pedro Rodriguez, P.E.,
Project Manager,
Nevada Department of Transportation
1263 S. Stewart Street
Carson City, NV 89712

REF: USA Parkway Traffic Analysis Methodology – Request for Approval

Dear Pedro:

A draft Traffic Methodology for USA Parkway was submitted to you on November 10, 2011. Jacobs received Department comments to this draft on November 25, 2011. These comments have now been addressed and the attached is the resulting final Traffic Analysis Methodology for use on the USA Parkway project.

We request your approval of the attached Traffic Analysis Methodology. The Department's comments and Jacobs responses are attached at the end of the Methodology document so that reviewers can confirm that their comments have been addressed.

We look forward to your approval of this Traffic Analysis Methodology and to rapidly moving forward to complete project activities. Thank you and Happy New Year!

Sincerely,

John Karachepone, P.E.,
Traffic Lead

Cc: Bryan Gant, P.E., Jacobs Project Manager

Encl: USA Parkway Traffic Analysis Methodology
USA Parkway NDOT Summary of Complied Comments and Responses

USA Parkway Traffic Analysis Methodology

1. INTRODUCTION

USA Parkway (SR 439) has been envisioned for some time as an important link between US 50 and I-80. Currently, US 395 through Carson City, SR 341 through Virginia City and US 95A through Fernley are used to connect the Reno metro area with points south and east. USA Parkway will help improve that connectivity. In addition, the development of the Tahoe-Reno Industrial Center (TRIC) along USA Parkway continues to change the employment and transportation character of the region. The TRIC is planned to become a large industrial park.

USA Parkway begins at the USA Parkway interchange with I-80 about 10 miles east of Reno. Currently, approximately 6 miles of the USA Parkway alignment within Storey County has been paved and the remaining is graded to the Lyon County line. The existing paved roadway consists of a four-lane divided arterial section with open median. This proposed project will consider the extension of the roadway southeast from Storey County into Lyon County and tie into US 50 in Silver Springs. **Figure 1** illustrates the proposed project in relation to surrounding roadways and land use.

Jacobs is retained by the Nevada Department of Transportation (NDOT) to provide environmental and preliminary engineering services for the proposed USA Parkway Project (Project). At the present time, it appears that an Environmental Assessment (EA) will be the appropriate class of action for National Environmental Policy Act (NEPA) conformance. The lead agency is the Federal Highway Administration (FHWA) with joint NDOT and Bureau of Land Management (BLM) participation. The anticipated opening year for the Project is 2017. The proposed design year is 2037, consistent with NDOT and FHWA's 20 year beyond opening year policy.

As part of the Project, a traffic analysis will be performed. This memorandum documents the methodology for conducting the traffic analysis. The design year analysis will be based on forecast traffic conditions in the Study Area and will include both a No-Action alternative and a build alternative(s) to include USA Parkway.

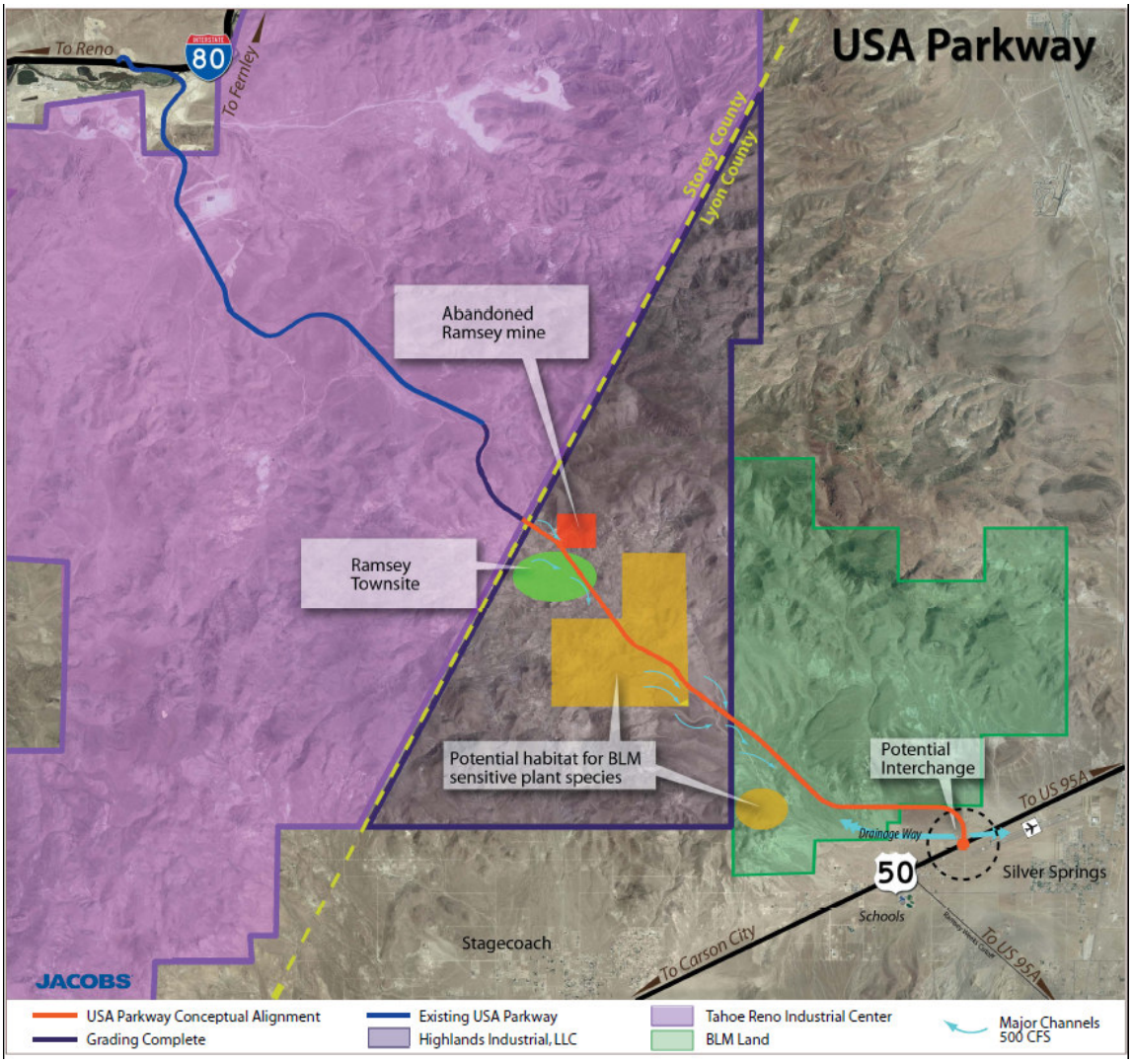


Figure 1: Project Description

2. TRAFFIC MODELING

Traffic projections are currently not available for USA Parkway. The Project team will use a TransCAD travel demand model to support project decisions and analysis. This proposed regional facility is well outside Washoe County's travel demand model boundary. The Lyon County Travel Demand Model, developed as part of the US 50 East Corridor Study (and further improved afterwards), will be used as a starting point to develop the TransCAD model for the USA Parkway Project. The USA Parkway travel demand model will be used to produce existing and year 2035 No-Action and build scenarios. The following discussions document the proposed development and application of the travel model for the project.

2.1 Lyon County Travel Demand Model

The Lyon County TransCAD travel demand model was developed by Fehr & Peers and calibrated and validated to year 2005 conditions. Fehr & Peers provided the most current version of the 2005 travel model network and input files. **Figure 2** displays the Lyon County Model in a regional context, **Figure 3** displays the model Traffic Analysis Zone (TAZ) system, **Figure 4** displays the model roadway network for existing and future, and **Figure 5** displays the location of the proposed USA Parkway within the model framework. **Table 1** displays the totals of population and employment in Lyon County for the base year 2005.

Table 1: 2005 Lyon County Socio-Economic Data

Households	24,693
Employees	12,627

A primary input of the model is future estimates of population and employment, distributed geographically by TAZ. The future socio-economic data set from the Lyon County model, if available, will be used as the basis for the project. Other sources, including US Census data, Nevada State Demographer data, Lyon County Planning data, and approved or planned development scenarios will be used (if the future model dataset is not available), or to confirm the future socio-economic conditions in the model dataset.

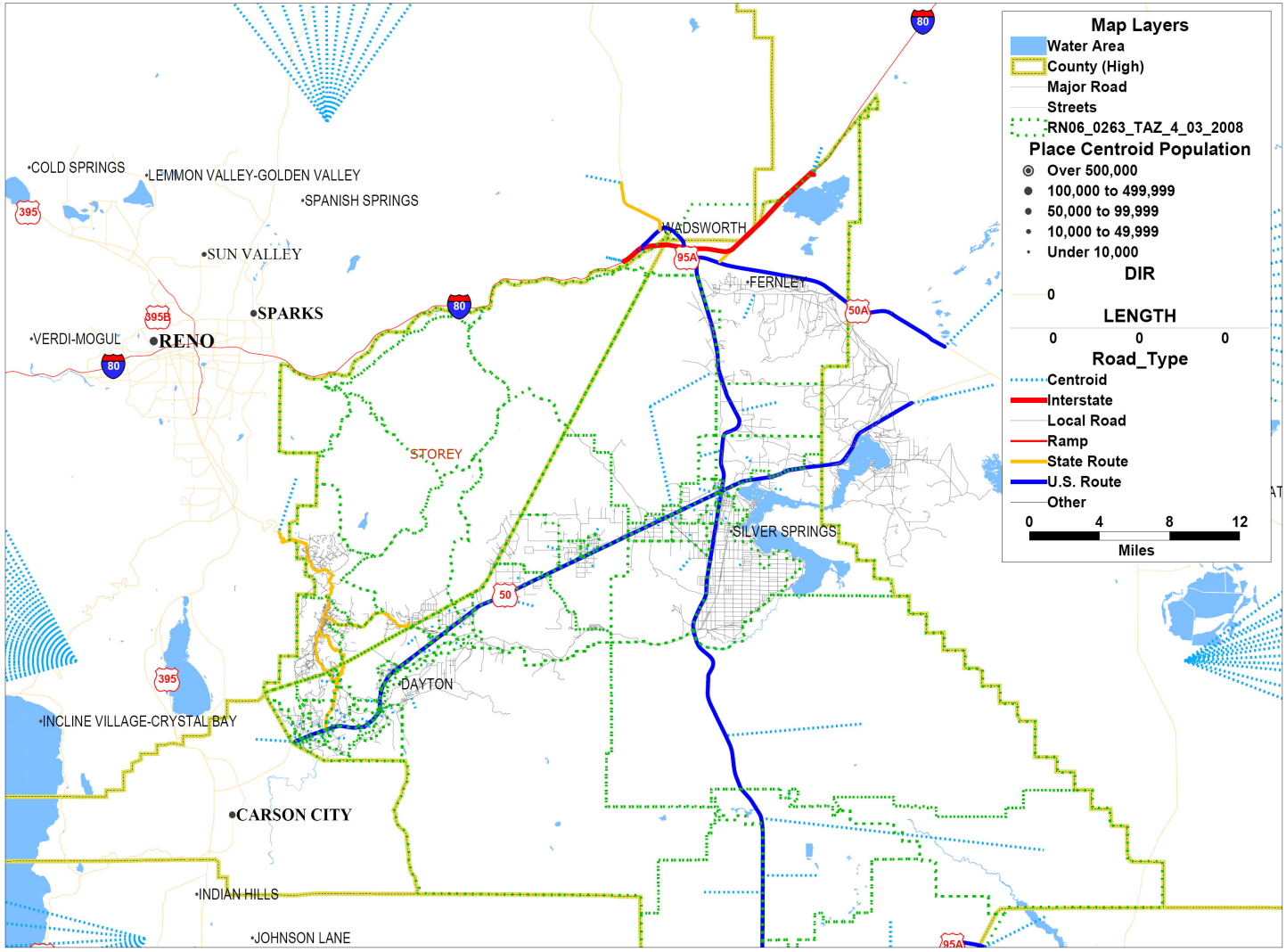


Figure 2: Lyon County Model Context

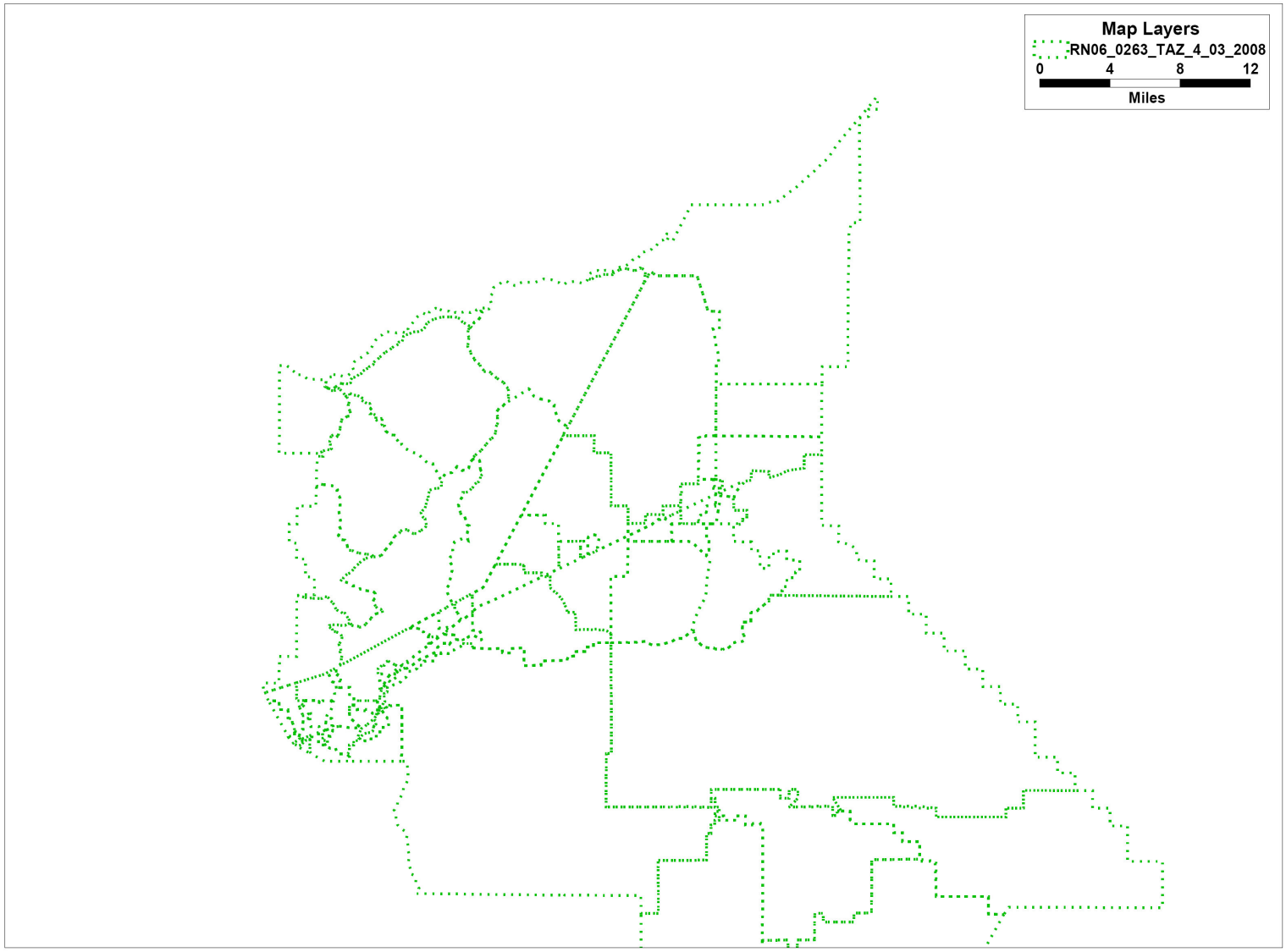


Figure 3: Lyon County Model TAZ System

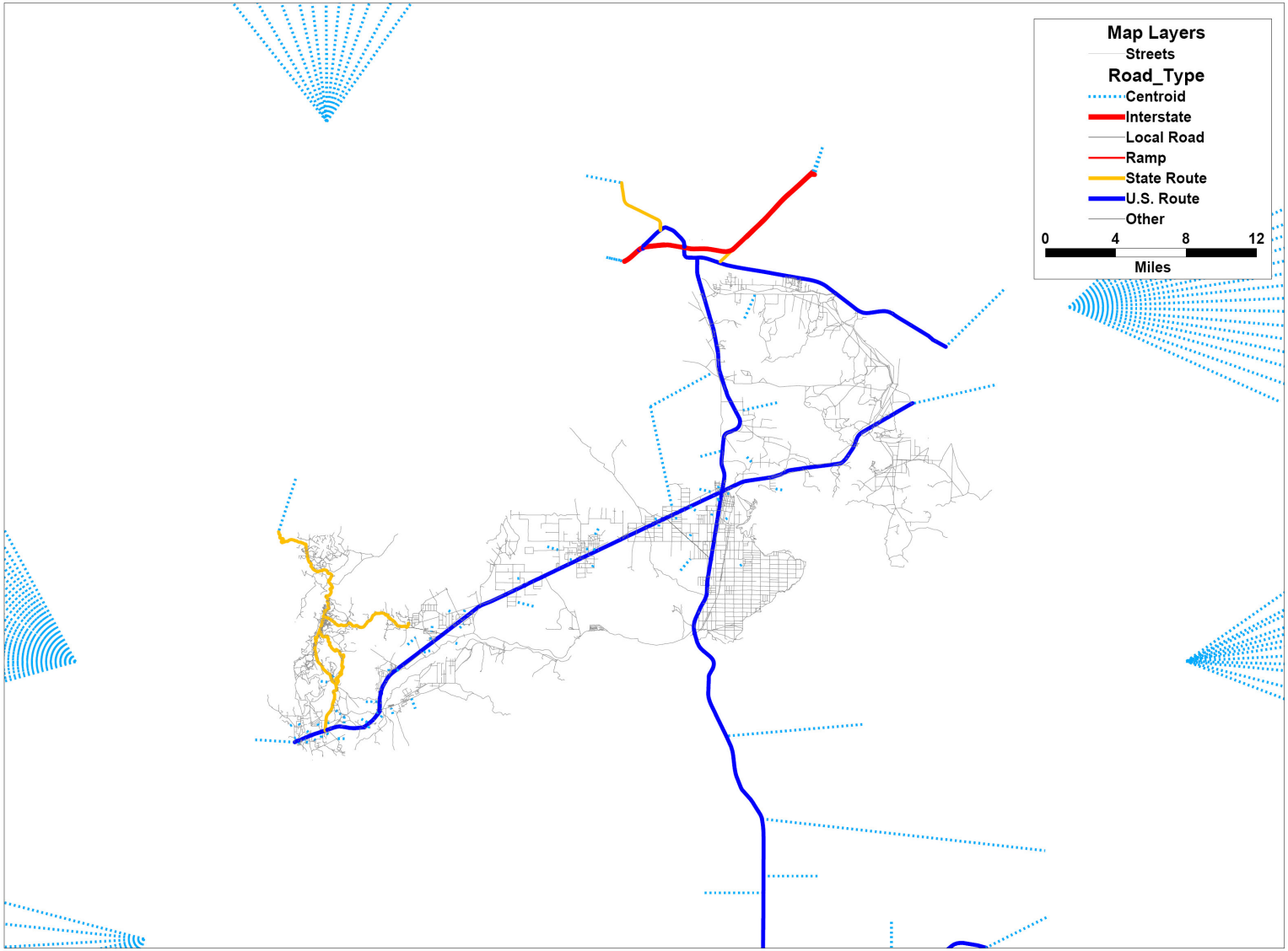


Figure 4: Lyon County Model Network

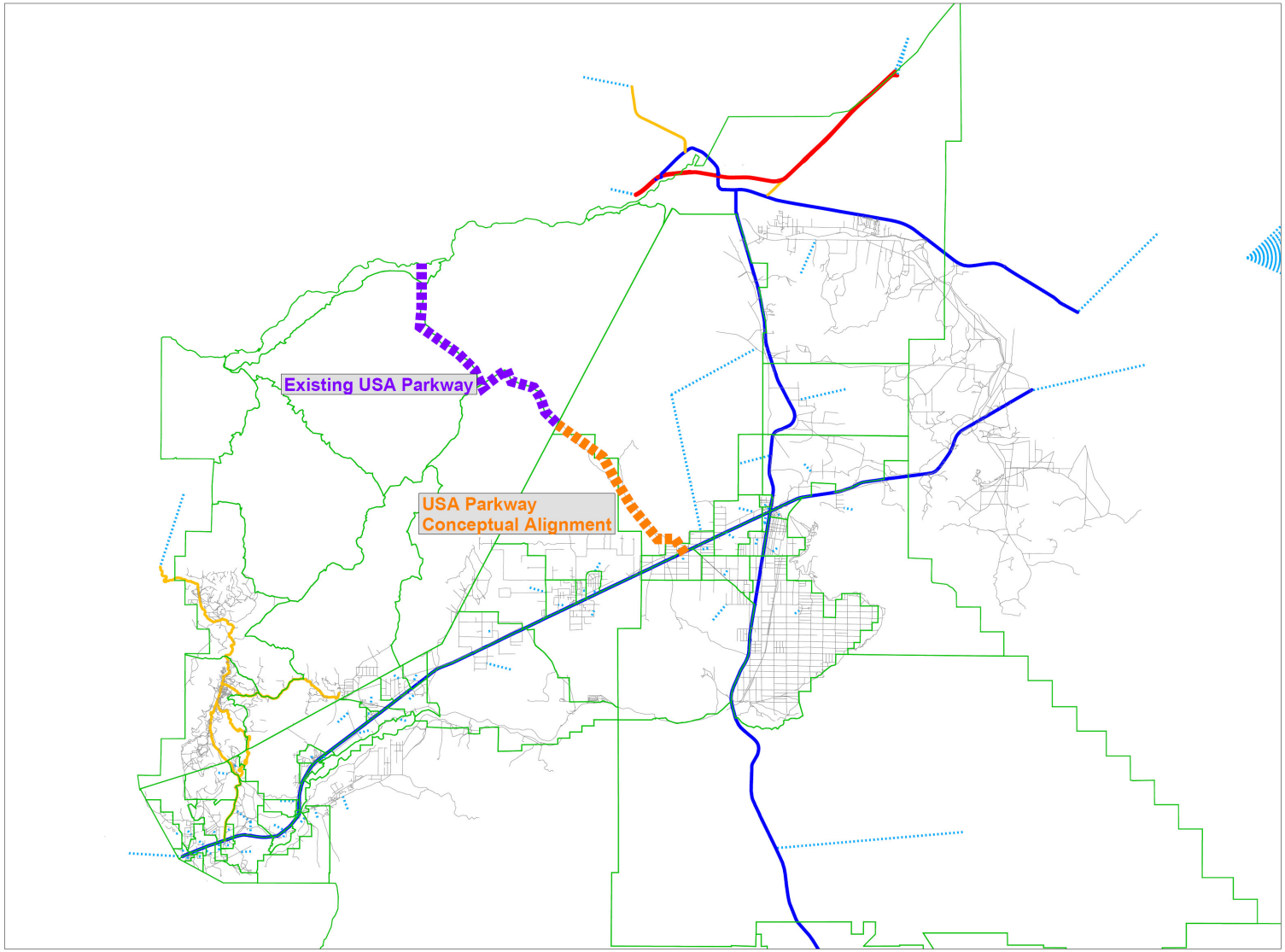


Figure 5: USA Parkway location within Lyon County Model Network

2.2 Travel Demand Model Expansion

The USA Parkway project area is not entirely within the boundary of the County model -- part of the corridor is to the west of the current boundary. The Lyon County model will be expanded by extending I-80 to the west, and adding and/or refining zones to cover geography west of the current model border. The Lyon County model also has relatively large traffic analysis zones. Large traffic zones inhibit the precision of the localized volume forecasts, and zones will be re-sized to better capture the future trip generation loading points along the proposed roadway.

Figure 5 displays the location of the proposed USA Parkway within the model framework. The Project Team is proposing an expansion of the model that would be comprised of the following major steps:

1. Modification of the network
    a. Coding I-80 from its current terminus in the model to the west beyond its interchange with USA Parkway.
    b. Modification of the background network to reflect the location of and types of roadways in the Study Area
    c. Coding in the proposed USA Parkway (Build network only)
2. Expanding the TAZ system to include the entire Study Area and zones along I-80 to the west. This process would include:
    a. The review of existing and future travel demand model socio-economic data
    b. The review of planned development along the corridor
    c. Modification of the TAZ system to reflect proposed development patterns and refinement of TAZ sizes where necessary
3. Re-validation of the expanded model to existing conditions
4. Documentation of the model expansion effort and results

The Project Team will work closely with stakeholders throughout the process to ensure collaboration and consensus on the forecasts. In particular, the Project Team will request a thorough review of the development forecasts from Lyon County Planning Department.

2.3 Model Application

2.3.1 Model Operation

The model is implemented in the TransCAD software platform. TransCAD version 4.8, will be used for all modeling exercises. Alternatives will be tested using the model, according to instructions received from Fehr & Peers.

2.3.2 Coding Assumptions

Roadway improvements for capacity and facility type will be coded per Lyon County model standard protocol.

2.4 Interpretation of Model Results

A review of the 2005 model volumes compared to observed traffic counts on key roadways in the Study Area will be performed. This will be done as part of model calibration/validation. Observed traffic counts will be obtained from available NDOT traffic count data. NDOT has count stations on several roadways within the general area. Adjustments to future year model results will be performed to account for

differences in the observed volumes and those from the model. See Section 2.8. for description of these adjustments. Additionally, the eastern portion of the Washoe County's travel demand model will be reviewed and compared for consistency as part of the model calibration/validation process.

2.5 2035 No-Action Network Model

A No-Action network model is used as a baseline to compare build alternatives. The network to be used for the model is defined to be the existing roadway system, together with committed improvement projects as planned by the County and NDOT outside of the specific action being proposed. The 2035 network will be developed and reviewed to ensure that all applicable, planned projects are included in the Study Area. The proposed USA Parkway extension will not be included.

2.6 2035 Build Network

The 2035 Build network will be coded to include USA Parkway using the 2035 No-Action network as a base. As a preliminary build alternative, USA Parkway will be coded as a 4-lane divided minor arterial through the Study Area.

2.7 2035 Results Comparative Analysis

The results of the traffic forecasting model will provide comparative statistics between the Build and No-Action including:

- Traffic volumes by segment
- Diversion from other routes
- Roadway speeds
- VMT and VHT for the study area
- Travel times for select origins and destinations

2.8 Year 2035 Model Output Adjustment and Design Year 2037 Forecasts

As with any simulation model, there are limitations to its capabilities. The model developed for this Project may or may not accurately estimate traffic at specific road segments. Direct use of model output (raw model results) for traffic operations analysis, unless the base model volumes are reasonably close to observed volumes, is usually not appropriate. It is standard industry practice to apply adjustments to travel demand model output prior to use in traffic operations analysis. The model results will be compared to observed conditions and historic growth rates in the area, and adjusted as necessary to best reflect expected traffic growth and/or changes in travel behavior due to the addition of the proposed USA Parkway. These adjustments will be based on sound engineering judgment and, where possible, real-world data. The primary reference for traffic model volume adjustments is the National Cooperative Highway Research Program Report (NCHRP) 255: *Highway Traffic Data for Urbanized Area Project Planning and Design* (1982). For USA Parkway Project NCHRP 255 methods will be applied appropriately, in a manner that results in the most reasonable and balanced traffic projections.

It should be noted that the proposed USA Parkway does not exist in the base year; hence it will not be possible to directly apply NCHRP adjustments to segment volumes along USA Parkway. For this case, we propose to apply the NCHRP 255 adjustments (in this case ratio method) to other roadways in the area; and then apply the 'adjusted versus raw percentage difference' for these roadways to USA Parkway raw volumes. Direct use of model volumes, as appropriate and reasonable, may also be considered for certain

segments. In summary, the final forecast volumes will be based on engineering judgment supported with the appropriate use of NCHRP 255 methods and documentation of key assumptions.

Design year of this project is 2037; therefore year 2037 volumes need to be projected for use in traffic operations analysis. In order to accomplish this, an appropriate growth rate will be estimated and applied to adjusted year 2035 link volumes. In other words, year 2035 model adjusted volumes will be "bumped up" two years to reflect design year 2037 volumes. Growth rate will be calculated based on model to model volume comparison and/or historical growth rates and will be documented.

Design year 2037 turning movement volumes at study intersections will be derived from the adjusted year 2037 segment volumes based on the Iterative Method consistent with NCHRP 255. TurnsW32 Tool developed by Dowling Associates will be used for this purpose. Manual adjustments will be prudently applied based on engineering judgment, and documented.

The adjusted traffic forecasts, link and turning movements, will be used in traffic operations analysis.

3 TRAFFIC OPERATIONS ANALYSIS

Traffic operations analysis will be performed along the proposed USA Parkway (i.e. new segment of USA Parkway) between Storey/Lyon County line and US 50.

3.1 *Existing and No-Action Analysis*

Since the proposed USA Parkway does not exist, an existing operations analysis can not be performed. However, all available relevant traffic data will be compiled and reviewed including existing traffic counts for selected roadways within the general study area. This information will be used to describe existing conditions such as existing highways in the general area, and existing access or known safety issues. Similarly the No-Action operations analysis will be limited to general conditions on the same selected roadways that were included in the assessment of existing conditions. An analysis of the existing USA Parkway Interchange with I-80 will be completed to identify the potential impact of the proposed project on this existing interchange. Analysis of the ramp terminal intersections will be completed using Synchro software following Highway Capacity Manual (HCM) methodology. The on-and off-ramps will be analyzed using Highway Capacity Software (HCS).

3.2 *Build Alternative Operations Analysis*

Although more than one build alternative may be proposed for the EA (due to different alignment/design options), traffic operations will largely be the same for all build alternatives. The proposed USA Parkway is a minor arterial for all build alternatives and the general cross-section will be determined based on model run results. Therefore, traffic operations analysis will be performed along the proposed USA Parkway for one build alternative. The methodology and assumptions for the traffic operations analysis of the build alternative for the USA Parkway Project is as follows:

- The analysis will be performed for design year 2037 conditions. An opening year analysis will not be performed since the roadway will be designed to 2037 conditions.
- Analysis will be done for AM and PM peak hour conditions. A peak hour factor of 0.90 will be assumed.
- Operations analysis of the proposed USA Parkway (along Lyon County) will be based on intersection and arterial analysis. A queue length analysis will also be performed to ensure adequate storage is provided at the intersections.
    - Intersection Analysis: Based on the available development data[1], six intersections along USA Parkway will be analyzed (i.e. six study intersections). Five of these intersections are along the proposed Highlands Development and will be at-grade intersections. No intersections are planned along the BLM land between the southeast boundary of Highlands Development and US 50. The sixth intersection is at US 50 and may possibly be an interchange, in which case, several interchange types will be conceptually evaluated.
    - Arterial analysis: Arterial analysis will be based on arterial speeds between intersections.
- The intersection and arterial analysis of the proposed USA Parkway will be performed using Trafficware's Synchro 8.0 software following HCM 2010 methodology.
- Intersection control will be determined on the basis of estimated traffic volumes.
- Intersection lane configuration will be based on required minimum intersection geometry to meet acceptable operations in the design year of 2037. Acceptable operations are defined as:

[1] Highlands Master Streets and Highway Plan

- HCM LOS D or better for the overall intersections for signalized intersections within the proposed Highlands Development. It is noted that the proposed Highlands Development is a mixed-use development with over 3,500 multi-family dwelling units, and additional 1000+ acres of land available for single family residential dwelling units. Associated commercial and ancillary development will also be located within the Highlands Development. This proposed Highlands Development is expected to therefore have over 5,000 residents (population) in year 2037 forming an urban cluster. The intersections of USA Parkway within the proposed Highlands Development can therefore be expected to operate similar to intersections in small urban communities; therefore the LOS D threshold is an appropriate one.
- HCM LOS D or better for the intersection (or interchange) of USA Parkway at US 50. It is noted that LOS C is desired for this intersection and therefore: The improvements required to meet the LOS C threshold at the US 50 intersection/interchange will be discussed with NDOT and Lyon County Planning Department.
- LOS E or better for each movement at signalized intersections.
- LOS E or better for minor street approach(es) at unsignalized intersections
- Intersection Volume to Capacity Ratio, including each movement, less than 1.0

- Optimized traffic signal cycle lengths and splits will be used. Phasing will be based on most reasonable phasing scenario.
- Analysis of the I-80/USA Parkway Interchange (which exists today) will be performed using Synchro and HCS. The ramp merge/diverge analysis will be performed using HCS and ramp terminal intersection analysis will be performed using Synchro. The LOS criterion is LOS C on I-80 as this is a rural interchange.
- Peak hour truck percentage will be assumed to be 12 percent. This value is calculated based on the average of truck percentages reported for similar existing NDOT roadways in the area, namely US 95A, US 50A and SR 341, published in the NDOT's 2010 Vehicle Classification Distribution Report. **Table 2** below shows the calculations. The calculated 12 percent is also close to the values published in NDOT's 2009 Annual Traffic Report for Rural Minor and Principal Arterials – 10.16% and 12.79% respectively. Note that the 12 percent is daily truck percentage, which is in general higher than the peak hour truck percentage. However, to complete a more conservative analysis, 12 percent will be used as the peak hour truck percentage.

Table 2: Calculation of Truck Percentage

Location	From	To	Truck AADT	Representative NDOT Count Station	AADT	Truck %	Average Truck %
US 95 A	US 50	SR 427	620	190022	9,710	6.4%	**11.6%**
US 50A	US 50 Alt	US 50	810	0012150	7,700	10.5%	
SR 341	US 50	SR 342	520	190003	3,210	16.2%	
SR 341	SR 342	US 395	355	0291110	2,700	13.1%	
Source: NDOT 2010 Average Day Vehicle Classification Distribution Report and NDOT AADT Counts							

In addition to the above data, year 2011 truck traffic data along the existing portion of USA Parkway was provided by NDOT. This data indicates that the daily truck percentage on the existing section of USA Parkway is approximately 24 percent. The peak hour truck percentages are calculated as 14.89 percent in the PM peak hour (10.75 percent for peak direction); and 6.82 percent in the AM peak hour (4.18 percent for the peak direction). These calculations are shown in Tables 3 and 4 below. As shown, the peak hour truck percentages are much lower than the daily truck percentages. Furthermore, the existing portion of

USA Parkway is along the TRIC which is an industrial development; while the proposed extension of USA Parkway will be along the proposed Highlands Development; a mixed-use residential/commercial development. The majority of the trips from TRIC (up to 90 percent), are anticipated to travel to and from I-80; hence the heavy truck traffic of the TRIC is not likely to have a major impact on the proposed USA Parkway extension. Therefore, the recommended **12 percent** peak hour truck factor for the proposed extension of USA Parkway is a conservative estimate.

Table 3: PM Peak Hour Truck Percentage on USA Parkway

Typical Weekday	PM Peak Hour	Total Traffic (Two Way)	Trucks (Two Way)	Truck Percentage (Two Way)	Total Traffic (Peak Direction - NB)	Trucks (Peak Direction)	Truck Percentage (Peak Direction)
Tuesday	4 to 5 PM	519	75	14.45%	394	41	10.41%
Wednesday	4 to 5 PM	600	90	15.00%	466	53	11.37%
Thursday	4 to 5 PM	580	88	15.17%	452	47	10.40%
Total		1699	253	**14.89%**	1312	141	**10.75%**

Table 4: AM Peak Hour Truck Percentage on USA Parkway

Typical Weekday	AM Peak Hour	Total Traffic (Two Way)	Trucks (Two Way)	Truck Percentage (Two Way)	Total Traffic (Peak Direction - SB)	Trucks (Peak Direction)	Truck Percentage (Peak Direction)
Tuesday	5 to 6 AM	462	32	6.93%	415	15	3.61%
Wednesday	5 to 6 AM	465	28	6.02%	420	16	3.81%
Thursday	5 to 6 AM	481	36	7.48%	434	22	5.07%
Total		1408	96	**6.82%**	1269	53	**4.18%**

4 CONCLUSION

This memorandum presents the methodology for conducting the traffic analysis for the USA Parkway Project. The USA Parkway project team requests approval of this methodology for traffic modeling and analysis. This will ensure that the procedures and methodologies that are acceptable to NDOT are followed for the traffic analysis for the USA Parkway Project.

On approval of this methodology, Jacobs will perform the traffic analysis. The draft analysis results and recommendations will be presented to NDOT in a traffic report for review and comments. The feedback from NDOT will be addressed and the traffic report will be finalized and submitted for approval. The traffic report will be one of the many supporting documents for the USA Parkway EA.

USA PKWY Traffic Methodology

Summary of Compiled Comments

Responses are in Italics

After reviewing the USA Pkwy Traffic Analysis Methodology document submitted by Jacobs, NDOT has the following questions/concerns/comments:

General:

- **J. Lerud:**
  - Regarding the Travel Demand Models, Jacobs should verify that the western limit of the Lyon County model matches or is close with the eastern portion of the Washoe County model. I don't want to speak for Randy, but they should probably address it one way or the other.

    Response: Agreed. We will review the Washoe County Model as part of our validation exercise. This is now stated in the updated Memorandum in Section 2.4.

  - Will a change in control of access be required? I think it will be required, so they should make sure that they have enough data to satisfy FHWA's 8 point policy.

    Response: It is not known at this point if a Change of Access Request will be required at the USA Parkway/I-80 Interchange. If required, it will not be part of this study; but rather be a follow up to this study. Nonetheless, the data/information used in this USA Parkway Study will set the background information for the potential Change of Access Study.

2.1:

- **S. Daniels:**
  - I would emphasize caution in starting with the 2005 Lyon County model as a base. Adjustments beyond observed vs. model traffic volumes may be required. In relation, Table 1 is missing from the document. I agree with Jeff Lerud's comment regarding the inclusion of and comparison with the eastern portion of the Washoe County model given the nature of current and future businesses operating off of USA Parkway.

    Response: 2005 Lyon County model is the only available travel demand model for the area; hence we believe it is a good starting point as opposed to starting from scratch. Note that the model will be validated first; i.e. it will not be used as is. Table 1 is now populated in the updated memorandum. Agreed with the need to compare with eastern portion of Washoe County Model and will proceed accordingly.

2.2:

- **S. Daniels:**
  - There is a little confusion over the wording "Coding I-80"…"to the west beyond the proposed intersection with USA Parkway." The I-80/USA Parkway Interchange is existing, is there any planned modification to this facility as part of this analysis?

    Response: The word "proposed" is a mistake and is now taken out in the updated memorandum. The I-80/USA Parkway Interchange exists today. Currently, there are no planned modifications to this facility as part of this analysis.

2.4:

- **X. Wang:**
  - The observed traffic counts should be used to calibrate the model parameters

    Response: Agreed – observed traffic counts will be used for calibration and validation of the model. This is stated in Section 2.4 of the Memorandum.

2.8:

- **J. Lerud:**
  - Do we want them to put much effort into interpolating from 2035 to 2037? I don't know how extensive the exercise is though.

    Response: It is not an extensive exercise. To be consistent with NDOT's 20 year beyond opening policy, we propose to estimate year 2037 volumes.

- **R. Travis:**
  - I believe we stick with the 2037 future year. It doesn't require much more effort to expand the volumes out. I want to also keep that year for consistency in how we deal with all projected traffic (20 years from estimated opening).

    Response: Agreed.

- **S. Daniels:**
  - An analysis of the existing I-80/USA Parkway Interchange is very important to this model. With the number of logistics oriented companies in the Tahoe-Reno Industrial Center (TRIC), there might be some current validating data from stakeholders for the proposed facility as well.

    Response: It is decided to include the I-80/USA Parkway Interchange as part of the analysis. The updated memorandum reflects this.

- **H. Hong:**
  - YES, and Randy already addressed that.

3.0:

- **J. Lerud:**
  - General: There is not a discussion on calibration parameters.

    Response: The traffic operations analysis will be performed in Synchro software following the HCM methodology. Since Synchro (implementing the HCM's deterministic procedures) is not a stochastic micro-simulation model, typical calibration process that applies to micro-simulation models will not be performed and is not necessary. Furthermore, an existing traffic operations analysis for the proposed roadway will not be performed as the roadway does not exist. Nonetheless, for the build Synchro models, default parameters such as truck percentage, speed etc. will be modified to reflect actual expected conditions.

3.1:

- **J. Lerud:**
  - Existing and No-Action analysis: Although they say an existing operations analysis cannot be performed, it will be important to see what the I80 impacts; therefore, they should do some kind of analysis of existing I80 versus I80 when it has the interchange (on/off ramps) in place.

    Response: Agreed – an analysis of the I-80 interchange with USA Parkway will be performed. Note that, this interchange already exists (i.e. on/off ramps are in place).

- **H. Hong:**
  - Please have Jacobs clarify which proposed USA Parkway does not exist? USA Parkway interchange at I-80 is already operational, right?

    Response: Yes, USA Parkway interchange at I-80 is already operational. USA Parkway in Lyon County does not exist and is the subject of this study.

3.2:

- **J. Lerud:**
  - Build Alternative Analysis: It states that traffic operations will be the same for all build alternatives, so they are only going to perform one analysis. How do they intend to identify the preferred alternative- what measures of effectiveness (MOEs)?

    Response: The preferred alternative will not be decided based on traffic operational analysis. It will be decided based on alignment options and the location options for the termination at US 50. The general cross-section will be decided based on analysis of the demand volumes. Once the general cross-section is decided, the traffic operations will be same for all alternatives regardless of the alignment. It is noted, however, that there is more than one option for the proposed intersection of USA Parkway with US 50 – at grade versus an interchange. The intersection/interchange options will be separate scenarios within the analyzed build alternative.

  - 2nd bullet: Is Hoang ok with a .90 peak hour factor for the build year? Since it is the build year, is a PHF required? On the flip side, it will make the volumes more conservative.

    Response: For intersection analysis, it is typical to use a peak hour factor to account for the fluctuations in the model. This results in more conservative analysis. The 0.90 was chosen based on defaults published in the Highway Capacity Manual. As per Hoang (see below for his comment); we will keep the 0.90 PHF.

- **H. Hong:**
  - I'm good with using 0.9 PHF.

- **J. Lerud:**
  - 3rd bullet: Need more than an "intersection analysis". They will need to show the impacts to I80 merges and diverges. This could be done with Highway Capacity Software (HCS), but be wary of the merge and "minimum Greenbook designs (a lot of trucks and curves). There will have to be some sort of parallel on ramps. Also, they need to show that the arterial works between intersections. For example, if an intersection has only one lane feeding into it, the traffic may be getting metered. An isolated LOS analysis would show that the intersection is operating just fine as a standalone intersection while the operations of the arterial are congested. They should also be documenting the queue lengths- this will let you know if the signal is getting metered (note high truck % will impact queue lengths).

    Response: Analysis of I-80 interchange will be performed. Ramp terminal intersection analysis will be performed with Synchro and ramp merge/diverge analyses will be performed with HCS.

For the proposed USA Parkway extension, in addition to the intersection capacity analyses, an arterial analysis will be performed based on arterial speeds. Additionally, queue lengths will be estimated to ensure adequate storage is provided. The updated memorandum includes these requested additions.

- 6th bullet
  - States to meet minimum operations for 2035. Everything else says 2037- probably just a typo, but inconsistent.

    Response: Yes, this is a typo and corrected in the updated memorandum.

  - "Acceptable Operations" states LOS D for overall intersection; LOS E for individual signalized movement; LOS for minor street or unsignalized approach; and an intersection volume to capacity ratio <1.0
    - Don't know where they got their proposed metrics. I recall the Greenbook calling out LOS C for all rural interchanges. I think they need to show backup documentation to justify their metrics.

      Response: LOS threshold at the existing I-80 interchange will be C since this is a rural interchange. LOS threshold at the proposed intersections along Highlands Development will be D, as these intersections are anticipated to operate similar to ones within small urban communities. The desired LOS threshold at the intersection (or interchange) of the proposed USA Parkway with US 50 will be LOS C. The Department will have the flexibility to allow for LOS D at the US 50 intersection/interchange following review of the proposed improvements to meet the desired LOS C threshold. The updated Methodology Memorandum provides for this flexibility at the proposed USA Parkway at US 50 intersection/interchange.

    - LOS should not be only metric as there will be a lot of trucks. They should do a queue analysis to determine storage lengths and take into account the high truck %.

      Response: Agreed. It is planned to perform a queue analysis to ensure adequate length for queue storage. The updated memorandum includes this.

    - Speed between intersections could also be an MOE. What will the posted speed limit be versus the speed of the traffic?

      Response: Agreed – speed between the intersections will be the MOE for the arterial analysis. In general the free flow speed will be assumed to be 5 mph greater than the posted speed.

  - 8th bullet: Truck percentage assumption = 12%. Won't USA Parkway be an industrial area? If so, I'd imagine that the truck percentages would be higher than the "average". What is the current T% at the TRIC?

- **X. Wang:**
  - The current truck percentage on the existing USA Parkway is around 24%

    Response: Truck percentages on the existing USA Parkway are obtained from NDOT. Existing daily truck percentage along USA Parkway is around 24 percent. However, this truck percentage is the daily value and does not reflect the peak hour conditions; which is the basis for the traffic operations analysis. We calculated peak hour truck percentages from this data provided by NDOT. The calculations and results are included in the updated memorandum. As per the previous information that was provided in the draft memorandum and the new information obtained from NDOT, the proposed peak hour truck percentage continues to be 12 percent.

- **S. Daniels:**
  - Again, given the business types at the TRIC, comparison to US95A, US50A and SR341 for items such as truck percentages may not be the best method. I am also curious about why the PHF of .90 was chosen. A sample analysis of the existing portion of USA Parkway may provide direction (i.e. arrival and departure times and volumes for employees vs. trucks/shipments). I would also like to echo Jeff's comments concerning the inclusion of other MOE's (in addition to LOS) and that traffic operations cannot be the same for all build alternatives (e.g. the possibility of an interchange or an intersection at US50 as stated in the report).

    Response: These comments are addressed within the responses to previous comments.

Appendix C
Conditions on the General Project Influence Area Roadway Network

Appendix C 1

Existing Conditions on the General Project Influence Area Roadway Network

Existing Conditions								
Location	**K**	**D**	**Terrain**	**Lanes**	**Volume from Counts**	**Prevailing LOS (from HCM tables)**	**Capacity (Volume for LOS E from HCM tables)**	**v/c**
I-80 west of USA Parkway	0.10	0.55	Rolling	4	**25,000**	**B**	55,300	**0.45**
I-80 east of USA Parkway	0.10	0.55	Rolling	4	**23,000**	**B**	55,300	**0.42**
US 95A south of Fernley	0.10	0.50	Rolling	2	**8,700**	**D**	27,200	**0.32**
US 95A north of Silver Springs	0.10	0.50	Rolling	2	**4,800**	**C**	27,200	**0.18**
US 50 east of Silver Springs	0.12	0.55	Level	2	**1,900**	**B**	22,600	**0.08**
US 95A south of Silver Springs	0.10	0.50	Rolling	2	**5,100**	**C**	27,200	**0.19**
US 50 west of Silver Springs	0.12	0.55	Level	2	**4,000**	**C**	22,600	**0.18**
US 50 near Stagecoach	0.12	0.55	Level	2	**5,200**	**C**	22,600	**0.23**
USA Parkway North Segment	0.10	0.65	Rolling	4	**5,000**	**B**	45,900	**0.11**
Weeks-Ramsey Cutoff Rd.	0.10	0.65	Rolling	2	**1,700**	**B**	22,300	**0.08**

HCM LOS thresholds were obtained from HCM 2010 Exhibits: Exhibit 10-9, 14-18, 15-30

Appendix C 2

No-Action Alternative - Conditions on the General Project Influence Area Roadway Network

No-Action Alternative								
Location	**K**	**D**	**Terrain**	**Lanes**	**Forecast Volume**	**Prevailing LOS (from HCM tables)**	**Capacity (Volume for LOS E from HCM tables)**	**v/c**
I-80 west of USA Parkway	0.10	0.55	Rolling	6	**61,000**	**D**	83,000	**0.73**
I-80 east of USA Parkway	0.10	0.55	Rolling	4	**37,000**	**C**	55,300	**0.67**
US 95A south of Fernley	0.10	0.50	Rolling	2	**16,500**	**E**	27,200	**0.61**
US 95A north of Silver Springs	0.10	0.50	Rolling	2	**12,000**	**D**	27,200	**0.44**
US 50 east of Silver Springs	0.12	0.55	Level	2	**4,800**	**C**	22,600	**0.21**
US 95A south of Silver Springs	0.10	0.50	Rolling	2	**10,500**	**D**	27,200	**0.39**
US 50 west of Silver Springs	0.12	0.55	Level	4	**7,800**	**B**	50,300	**0.16**
US 50 near Stagecoach	0.12	0.55	Level	4	**10,000**	**B**	50,300	**0.20**
USA Parkway North Segment	0.10	0.60	Rolling	4	**49,000**	**E**	49,700	**0.99**
Weeks-Ramsey Cutoff Rd.	0.10	0.60	Rolling	2	**4,300**	**C**	24,100	**0.18**

HCM LOS thresholds were obtained from HCM 2010 Exhibits: Exhibit 10-9, 14-18, 15-30

Appendix C 3

Build Alternative - Conditions on the General Project Influence Area Roadway Network

Build Alternative								
Location	**K**	**D**	**Terrain**	**Lanes**	**Forecast Volume**	**Prevailing LOS (from HCM tables)**	**Capacity (Volume for LOS E from HCM tables)**	**v/c**
I-80 west of USA Parkway	0.10	0.55	Rolling	6	**52,500**	**C**	83,000	**0.63**
I-80 east of USA Parkway	0.10	0.55	Rolling	4	**30,000**	**B**	55,300	**0.54**
US 95A south of Fernley	0.10	0.50	Rolling	2	**10,500**	**D**	27,200	**0.39**
US 95A north of Silver Springs	0.10	0.50	Rolling	2	**6,000**	**C**	27,200	**0.22**
US 50 east of Silver Springs	0.12	0.55	Level	2	**4,800**	**C**	22,600	**0.21**
US 95A south of Silver Springs	0.10	0.50	Rolling	2	**6,400**	**C**	27,200	**0.24**
US 50 west of Silver Springs	0.11	0.55	Level	4	**9,200**	**B**	54,900	**0.17**
US 50 near Stagecoach	0.11	0.55	Level	4	**18,500**	**B**	54,900	**0.34**
USA Parkway South Segment	0.10	0.55	Rolling	4	**17,000**	**B**	54,200	**0.31**
USA Parkway Mid Segment	0.10	0.55	Rolling	4	**17,000**	**B**	54,200	**0.31**
USA Parkway North Segment	0.10	0.55	Rolling	4	**39,500**	**D**	54,200	**0.73**
Weeks-Ramsey Cutoff Rd.	0.10	0.55	Rolling	2	**8,500**	**D**	26,300	**0.32**

HCM LOS thresholds were obtained from HCM 2010 Exhibits: Exhibit 10-9, 14-18, 15-30

Appendix D
HCS Intersection Analysis Worksheets

Appendix D 1
Existing Conditions – HCS Intersection Analysis Worksheets

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*Existing - AM*

Site Information

Intersection	*USA Parkway and I-80 EB - AM*
Jurisdiction	
Analysis Year	*2011*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*50*		*2*	*60*	
Peak-Hour Factor, PHF	*1.00*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*55*	*0*	*2*	*66*	*0*
Percent Heavy Vehicles	*0*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*1*	*1*	*0*
Configuration		*T*		*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*2*	*2*				
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2*	*2*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration	*LT*					

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*LT*		
v (veh/h)		*2*				*4*		
C (m) (veh/h)		*1488*				*793*		
v/c		*0.00*				*0.01*		
95% queue length		*0.00*				*0.02*		
Control Delay (s/veh)		*7.4*				*9.6*		
LOS		*A*				*A*		
Approach Delay (s/veh)	--	--				*9.6*		
Approach LOS	--	--				*A*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*Existing - PM*

Site Information

Intersection	*USA Parkway and I-80 EB - PM*
Jurisdiction	
Analysis Year	

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* North/South Street: *USA Parkway*

Intersection Orientation: *North-South* Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*270*		*2*	*40*	
Peak-Hour Factor, PHF	*1.00*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*300*	*0*	*2*	*44*	*0*
Percent Heavy Vehicles	*0*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*1*	*1*	*0*
Configuration		*T*		*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*2*	*2*				
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2*	*2*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration	*LT*					

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*LT*		
v (veh/h)		*2*				*4*		
C (m) (veh/h)		*1206*				*591*		
v/c		*0.00*				*0.01*		
95% queue length		*0.00*				*0.02*		
Control Delay (s/veh)		*8.0*				*11.1*		
LOS		*A*				*B*		
Approach Delay (s/veh)	--	--				*11.1*		
Approach LOS	--	--				*B*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*Existing - AM*

Site Information

Intersection	*USA Parkway and I-80 WB - AM*
Jurisdiction	
Analysis Year	

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*50*					
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*55*	*0*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*0*	*0*
Configuration	*L*					
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*60*	*2*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*66*	*2*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*12*	*12*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration				*LT*		

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*LT*					
v (veh/h)	*55*		*68*					
C (m) (veh/h)	*1560*		*830*					
v/c	*0.04*		*0.08*					
95% queue length	*0.11*		*0.27*					
Control Delay (s/veh)	*7.4*		*9.7*					
LOS	*A*		*A*					
Approach Delay (s/veh)	--	--	*9.7*					
Approach LOS	--	--	*A*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*Existing - PM*

Site Information

Intersection	*USA Parkway and I-80 WB - PM*
Jurisdiction	
Analysis Year	

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*270*					
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*300*	*0*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*0*	*0*
Configuration	*L*					
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*40*	*2*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*44*	*2*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*12*	*12*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration				*LT*		

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*LT*					
v (veh/h)	*300*		*46*					
C (m) (veh/h)	*1560*		*360*					
v/c	*0.19*		*0.13*					
95% queue length	*0.71*		*0.43*					
Control Delay (s/veh)	*7.9*		*16.5*					
LOS	*A*		*C*					
Approach Delay (s/veh)	--	--	*16.5*					
Approach LOS	--	--	*C*					

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Appendix D 2

Year 2037 No-Action Alternative – HCS Intersection Analysis Worksheets

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action - AM*

Site Information

Intersection	*USA Parkway and I-80 EB - AM*
Jurisdiction	
Analysis Year	*2037*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*1430*		*2*	*750*	
Peak-Hour Factor, PHF	*1.00*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*1588*	*0*	*2*	*833*	*0*
Percent Heavy Vehicles	*0*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*1*	*1*	*0*
Configuration		*T*		*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*2*	*2*				
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2*	*2*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration	*LT*					

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*LT*		
v (veh/h)		*2*				*4*		
C (m) (veh/h)		*386*				*31*		
v/c		*0.01*				*0.13*		
95% queue length		*0.02*				*0.40*		
Control Delay (s/veh)		*14.4*				*137.6*		
LOS		*B*				*F*		
Approach Delay (s/veh)	--	--				*137.6*		
Approach LOS	--	--				*F*		

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action - PM*

Site Information

Intersection	*USA Parkway and I-80 EB - PM*
Jurisdiction	
Analysis Year	*2037*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*2470*		*2*	*530*	
Peak-Hour Factor, PHF	*1.00*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*2744*	*0*	*2*	*588*	*0*
Percent Heavy Vehicles	*0*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*1*	*1*	*0*
Configuration		*T*		*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*2*	*2*				
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2*	*2*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration	*LT*					

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*LT*		
v (veh/h)		*2*				*4*		
C (m) (veh/h)		*133*				*7*		
v/c		*0.02*				*0.57*		
95% queue length		*0.05*				*1.05*		
Control Delay (s/veh)		*32.5*				*799.1*		
LOS		*D*				*F*		
Approach Delay (s/veh)	--	--				*799.1*		
Approach LOS	--	--				*F*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action AM*

Site Information

Intersection	*USA Parkway and I-80 WB - AM*
Jurisdiction	
Analysis Year	*2037*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*1430*					
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*1588*	*0*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*0*	*0*
Configuration	*L*					
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*750*	*2*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*833*	*2*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*12*	*12*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration				*LT*		

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*LT*					
v (veh/h)	*1588*		*835*					
C (m) (veh/h)	*1560*		*0*					
v/c	*1.02*							
95% queue length	*26.22*							
Control Delay (s/veh)	*44.1*							
LOS	*E*		*F*					
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action PM*

Site Information

Intersection	*USA Parkway and I-80 WB - PM*
Jurisdiction	
Analysis Year	*2037*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*2470*					
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2744*	*0*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*0*	*0*
Configuration	*L*					
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*530*	*2*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*588*	*2*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*12*	*12*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration				*LT*		

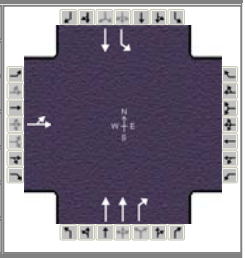
Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*LT*					
v (veh/h)	*2744*		*590*					
C (m) (veh/h)	*1560*		*0*					
v/c	*1.76*							
95% queue length	*154.65*							
Control Delay (s/veh)	*354.1*							
LOS	*F*		*F*					
Approach Delay (s/veh)	--	--						
Approach LOS	--	--						

Appendix D 3
Year 2037 Build Alternative – HCS Intersection Analysis Worksheets

HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/2/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 EB	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and I-80 EB Ramps - AM.xus				
Project Description	Build - AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	2	2						1320	370	2	470	

Signal Information					EB		WB		NB		SB		
Cycle, s	64.0	Reference Phase	2		L	T	L	T	L	T	L	T	R
Offset, s	0	Reference Point	End	Green	44.0	10.0	0.0	0.0	0.0	0.0			
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0			
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	0.0	0.0	0.0	0.0			

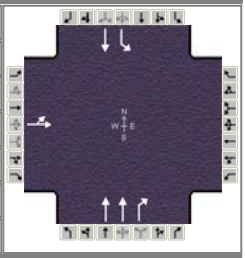
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2		6
Case Number		12.0				7.0		6.0
Phase Duration, s		15.0				49.0		49.0
Change Period, *(Y+Rc)*, s		5.0				5.0		5.0
Max Allow Headway *(MAH)*, s		2.9				2.9		2.9
Queue Clearance Time *(g_s)*, s		2.1				18.6		18.9
Green Extension Time *(g_e)*, s		0.0				6.2		6.2
Phase Call Probability		1.00				1.00		1.00
Max Out Probability		0.00				0.05		0.06

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4						2	12	1	6	
Adjusted Flow Rate *(v)*, veh/h		4						1467	309	2	522	
Adjusted Saturation Flow Rate *(s)*, veh/h/ln		1655						1615	1438	328	1696	
Queue Service Time *(g_s)*, s		0.1						16.6	5.5	0.3	8.9	
Cycle Queue Clearance Time *(g_c)*, s		0.1						16.6	5.5	16.9	8.9	
Capacity *(c)*, veh/h		259						2221	988	253	1166	
Volume-to-Capacity Ratio *(X)*		0.017						0.660	0.313	0.009	0.448	
Available Capacity *(c_a)*, veh/h		414						2221	988	253	1166	
Back of Queue *(Q)*, veh/ln (95th percentile)		0.1						5.2	1.7	0.0	3.1	
Overflow Queue *(Q_3)*, veh/ln		0.0						0.0	0.0	0.0	0.0	
Queue Storage Ratio *(RQ)* (95th percentile)		0.00						0.00	0.00	0.00	0.00	
Uniform Delay *(d_1)*, s/veh		22.8						5.7	4.0	10.6	4.5	
Incremental Delay *(d_2)*, s/veh		0.0						1.6	0.8	0.1	1.2	
Initial Queue Delay *(d_3)*, s/veh		0.0						0.0	0.0	0.0	0.0	
Control Delay *(d)*, s/veh		22.9						7.3	4.8	10.6	5.8	
Level of Service (LOS)		C						A	A	B	A	
Approach Delay, s/veh / LOS	22.9	C		0.0			6.9	A		5.8	A	
Intersection Delay, s/veh / LOS	6.6						A					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.6	B	2.7	B	1.8	A	1.3	A
Bicycle LOS Score / LOS	0.5	A			2.0	A	1.4	A

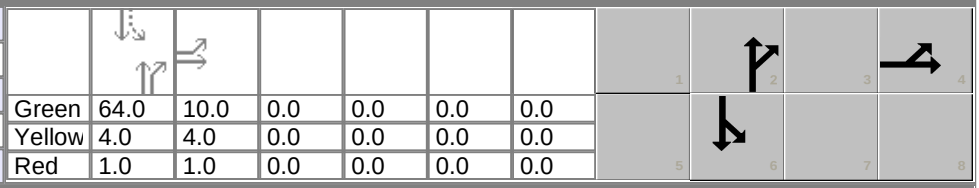
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/2/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 EB	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and I-80 EB Ramps - PM.xus				
Project Description	Build - PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	2	2						1950	540	2	400	

Signal Information			
Cycle, s	84.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	64.0	10.0	0.0	0.0	0.0	0.0						
Yellow	4.0	4.0	0.0	0.0	0.0	0.0						
Red	1.0	1.0	0.0	0.0	0.0	0.0						

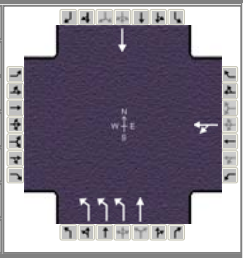
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		4				2		6
Case Number		12.0				7.0		6.0
Phase Duration, s		15.0				69.0		69.0
Change Period, *(Y+Rc)*, s		5.0				5.0		5.0
Max Allow Headway *(MAH)*, s		2.9				2.9		2.9
Queue Clearance Time *(g_s)*, s		2.2				42.8		43.6
Green Extension Time *(g_e)*, s		0.0				10.0		9.8
Phase Call Probability		1.00				1.00		1.00
Max Out Probability		0.00				0.31		0.33

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4						2	12	1	6	
Adjusted Flow Rate *(v)*, veh/h		4						2167	450	2	444	
Adjusted Saturation Flow Rate *(s)*, veh/h/ln		1655						1615	1438	166	1696	
Queue Service Time *(g_s)*, s		0.2						40.8	9.1	0.8	7.1	
Cycle Queue Clearance Time *(g_c)*, s		0.2						40.8	9.1	41.6	7.1	
Capacity *(c)*, veh/h		197						2461	1095	132	1293	
Volume-to-Capacity Ratio *(X)*		0.023						0.880	0.411	0.017	0.344	
Available Capacity *(c_a)*, veh/h		315						2461	1095	132	1293	
Back of Queue *(Q)*, veh/ln (95th percentile)		0.1						12.1	2.7	0.1	2.4	
Overflow Queue *(Q_3)*, veh/ln		0.0						0.0	0.0	0.0	0.0	
Queue Storage Ratio *(RQ)* (95th percentile)		0.00						0.00	0.00	0.00	0.00	
Uniform Delay *(d_1)*, s/veh		32.7						7.2	3.5	22.3	3.2	
Incremental Delay *(d_2)*, s/veh		0.0						4.9	1.1	0.2	0.7	
Initial Queue Delay *(d_3)*, s/veh		0.0						0.0	0.0	0.0	0.0	
Control Delay *(d)*, s/veh		32.7						12.2	4.6	22.5	4.0	
Level of Service (LOS)		C						B	A	C	A	
Approach Delay, s/veh / LOS	32.7	C		0.0			10.9	B		4.0	A	
Intersection Delay, s/veh / LOS	9.9						A					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.7	B	2.7	B	1.8	A	1.3	A
Bicycle LOS Score / LOS	0.5	A			2.6	B	1.2	A

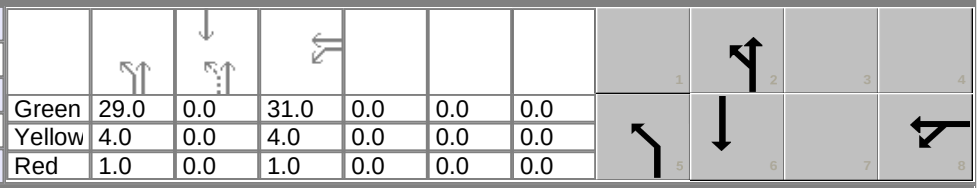
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/2/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 WB	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and I-80 WB Ramps - AM.xus				
Project Description	Build - AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				470	2		1320	0			0	

Signal Information			
Cycle, s	70.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	29.0	0.0	31.0	0.0	0.0	0.0						
Yellow	4.0	0.0	4.0	0.0	0.0	0.0						
Red	1.0	0.0	1.0	0.0	0.0	0.0						

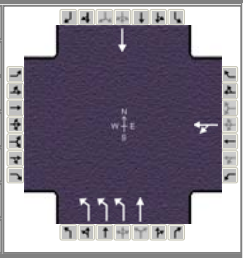
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8	5	2		6
Case Number				12.0	1.0	4.0		8.3
Phase Duration, s				36.0	34.0	34.0		0.0
Change Period, *(Y+Rc)*, s				5.0	5.0	0.0		0.0
Max Allow Headway *(MAH)*, s				3.0	3.0	0.0		0.0
Queue Clearance Time *(g_s)*, s				20.7	19.7			
Green Extension Time *(g_e)*, s				0.8	3.1	0.0		0.0
Phase Call Probability				1.00	1.00			
Max Out Probability				0.01	0.19			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3	8		5	2			6	
Adjusted Flow Rate *(v)*, veh/h					524		1467	0			0	
Adjusted Saturation Flow Rate *(s)*, veh/h/ln					1616		1569	1900			1900	
Queue Service Time *(g_s)*, s					18.7		17.7	0.0			0.0	
Cycle Queue Clearance Time *(g_c)*, s					18.7		17.7	0.0			0.0	
Capacity *(c)*, veh/h					716		2258	923			3	
Volume-to-Capacity Ratio *(X)*					0.733		0.649	0.000			0.000	
Available Capacity *(c_a)*, veh/h					716		2258	923			27	
Back of Queue *(Q)*, veh/ln (95th percentile)					11.0		9.1	0.0			0.0	
Overflow Queue *(Q_3)*, veh/ln					0.0		0.0	0.0			0.0	
Queue Storage Ratio *(RQ)* (95th percentile)					0.00		0.00	0.00			0.00	
Uniform Delay *(d_1)*, s/veh					16.1		15.8	0.0			0.0	
Incremental Delay *(d_2)*, s/veh					6.5		1.5	0.0			0.0	
Initial Queue Delay *(d_3)*, s/veh					0.0		0.0	0.0			0.0	
Control Delay *(d)*, s/veh					22.6		17.3	0.0			0.0	
Level of Service (LOS)					C		B					
Approach Delay, s/veh / LOS	0.0			22.6		C	17.3		B	0.0		
Intersection Delay, s/veh / LOS	18.7						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.5	B	2.1	B	1.4	A	2.8	C
Bicycle LOS Score / LOS			1.4	A	2.9	C	0.5	A

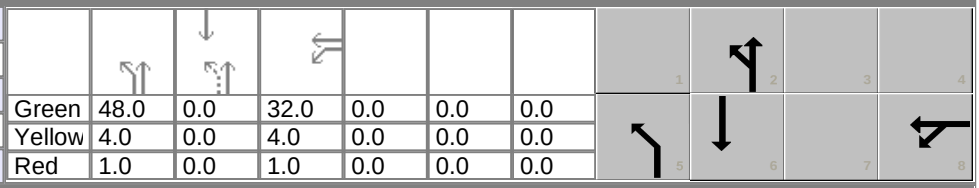
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/2/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 WB	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and I-80 WB Ramps - PM.xus				
Project Description	Build - PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h				400	2		1950	0			0	

Signal Information			
Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	48.0	0.0	32.0	0.0	0.0	0.0						
Yellow	4.0	0.0	4.0	0.0	0.0	0.0						
Red	1.0	0.0	1.0	0.0	0.0	0.0						

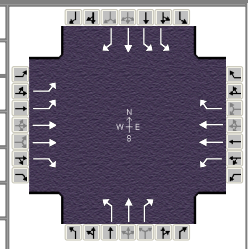
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase				8	5	2		6
Case Number				12.0	1.0	4.0		8.3
Phase Duration, s				37.0	53.0	53.0		0.0
Change Period, *(Y+Rc)*, s				5.0	5.0	0.0		0.0
Max Allow Headway *(MAH)*, s				3.0	3.0	0.0		0.0
Queue Clearance Time *(g_s)*, s				24.2	36.1			
Green Extension Time *(g_e)*, s				0.6	5.6	0.0		0.0
Phase Call Probability				1.00	1.00			
Max Out Probability				0.04	0.30			

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement				3	8		5	2			6	
Adjusted Flow Rate *(v)*, veh/h					447		2167	0			0	
Adjusted Saturation Flow Rate *(s)*, veh/h/ln					1616		1569	1900			1900	
Queue Service Time *(g_s)*, s					22.2		34.1	0.0			0.0	
Cycle Queue Clearance Time *(g_c)*, s					22.2		34.1	0.0			0.0	
Capacity *(c)*, veh/h					575		2750	1119			2	
Volume-to-Capacity Ratio *(X)*					0.777		0.788	0.000			0.000	
Available Capacity *(c_a)*, veh/h					575		2750	1119			21	
Back of Queue *(Q)*, veh/ln (95th percentile)					14.2		15.7	0.0			0.0	
Overflow Queue *(Q_3)*, veh/ln					0.0		0.0	0.0			0.0	
Queue Storage Ratio *(RQ)* (95th percentile)					0.00		0.00	0.00			0.00	
Uniform Delay *(d_1)*, s/veh					25.8		16.5	0.0			0.0	
Incremental Delay *(d_2)*, s/veh					10.0		2.4	0.0			0.0	
Initial Queue Delay *(d_3)*, s/veh					0.0		0.0	0.0			0.0	
Control Delay *(d)*, s/veh					35.8		18.9	0.0			0.0	
Level of Service (LOS)					D		B					
Approach Delay, s/veh / LOS	0.0			35.8		D	18.9		B	0.0		
Intersection Delay, s/veh / LOS	21.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.6	B	2.1	B	1.4	A	2.9	C
Bicycle LOS Score / LOS			1.2	A	4.1	D	0.5	A

HCS 2010 Signalized Intersection Results Summary

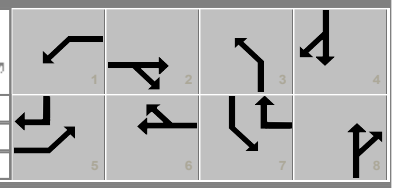
General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/2/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and US 50	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and US 50 - AM - With pedestrians.xus				
Project Description	Build - AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	490	240	130	90	280	340	170	210	100	280	150	470

Signal Information			
Cycle, s	65.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	5.7	2.4	10.0	8.8	0.7	12.3	
Yellow	4.0	4.0	4.0	4.0	0.0	4.0	
Red	1.0	1.0	1.0	1.0	0.0	1.0	



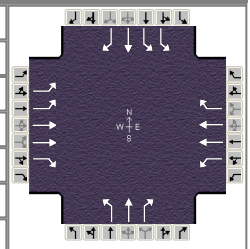
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	18.2	22.4	10.7	15.0	14.5	18.0	13.8	17.3
Change Period, *(Y+R_c)*, s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway *(MAH)*, s	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.1
Queue Clearance Time *(g_s)*, s	12.2	6.0	5.7	12.0	9.3	10.3	8.2	14.3
Green Extension Time *(g_e)*, s	1.0	2.0	0.0	0.0	0.2	0.7	0.7	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.01	0.00	0.62	1.00	0.02	1.00	0.00	1.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate *(v)*, veh/h	544	267	109	100	311	283	189	233	83	311	167	392
Adjusted Saturation Flow Rate *(s)*, veh/h/ln	1658	1706	1491	1707	1706	1489	1616	1696	1416	1569	1696	1415
Queue Service Time *(g_s)*, s	10.2	4.0	3.7	3.7	5.5	10.0	7.3	8.3	3.3	6.2	5.7	12.3
Cycle Queue Clearance Time *(g_c)*, s	10.2	4.0	3.7	3.7	5.5	10.0	7.3	8.3	3.3	6.2	5.7	12.3
Capacity *(c)*, veh/h	671	915	400	150	525	436	236	339	283	427	322	560
Volume-to-Capacity Ratio *(X)*	0.811	0.291	0.272	0.665	0.593	0.650	0.799	0.688	0.294	0.728	0.518	0.701
Available Capacity *(c_a)*, veh/h	1122	1207	527	236	525	436	398	339	283	1978	322	560
Back of Queue *(Q)*, veh/ln (95th percentile)	6.4	2.5	2.0	2.6	3.7	6.3	4.8	7.0	2.1	3.8	4.5	8.7
Overflow Queue *(Q_3)*, veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queue Storage Ratio *(RQ)* (95th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uniform Delay *(d_1)*, s/veh	24.7	18.9	18.8	28.7	25.6	20.2	26.8	24.1	22.1	26.9	23.7	16.6
Incremental Delay *(d_2)*, s/veh	0.9	0.1	0.1	1.9	1.2	2.7	2.4	10.9	2.6	0.9	5.9	7.2
Initial Queue Delay *(d_3)*, s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay *(d)*, s/veh	25.7	19.0	18.9	30.6	26.9	22.9	29.2	35.0	24.7	27.8	29.5	23.8
Level of Service (LOS)	C	B	B	C	C	C	C	C	C	C	C	C
Approach Delay, s/veh / LOS	22.9	C		25.8	C		31.1	C		26.3	C	
Intersection Delay, s/veh / LOS	26.0						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.5	B	3.1	C	3.1	C	3.1	C
Bicycle LOS Score / LOS	1.2	A	1.1	A	1.3	A	1.9	A

HCS 2010 Signalized Intersection Results Summary

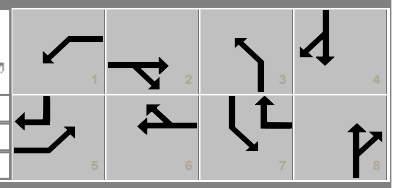
General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/2/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and US 50	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and US 50 - PM - With pedestrians.xus				
Project Description	Build - PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	520	310	190	110	270	310	140	160	100	380	230	540

Signal Information			
Cycle, s	66.4	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	6.7	2.4	10.0	8.3	3.1	10.9	
Yellow	4.0	4.0	4.0	4.0	0.0	4.0	
Red	1.0	1.0	1.0	1.0	0.0	1.0	



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	19.1	22.4	11.7	15.0	13.3	15.9	16.4	19.0
Change Period, *(Y+Rc)*, s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway *(MAH)*, s	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.1
Queue Clearance Time *(g_s)*, s	13.0	7.8	6.6	11.5	8.2	8.5	10.6	16.0
Green Extension Time *(g_e)*, s	1.0	2.3	0.0	0.0	0.1	0.5	0.8	0.0
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.01	0.00	0.58	1.00	0.03	1.00	0.00	1.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate *(v)*, veh/h	578	344	159	122	300	259	156	178	83	422	256	450
Adjusted Saturation Flow Rate *(s)*, veh/h/ln	1658	1706	1490	1707	1706	1489	1616	1696	1411	1569	1696	1417
Queue Service Time *(g_s)*, s	11.0	5.5	5.8	4.6	5.4	9.5	6.2	6.5	3.5	8.6	9.3	14.0
Cycle Queue Clearance Time *(g_c)*, s	11.0	5.5	5.8	4.6	5.4	9.5	6.2	6.5	3.5	8.6	9.3	14.0
Capacity *(c)*, veh/h	704	896	391	171	514	484	202	279	232	538	357	604
Volume-to-Capacity Ratio *(X)*	0.820	0.384	0.406	0.713	0.584	0.534	0.769	0.637	0.359	0.785	0.715	0.745
Available Capacity *(c_a)*, veh/h	1148	3955	1727	257	514	484	340	279	232	1133	357	604
Back of Queue *(Q)*, veh/ln (95th percentile)	6.9	3.4	3.2	3.2	3.7	5.1	4.1	5.6	2.3	5.2	7.8	9.8
Overflow Queue *(Q_3)*, veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queue Storage Ratio *(RQ)* (95th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uniform Delay *(d_1)*, s/veh	25.0	20.1	20.2	29.0	26.3	18.5	28.1	25.9	24.6	26.4	24.4	16.2
Incremental Delay *(d_2)*, s/veh	1.0	0.1	0.3	2.1	1.1	0.6	2.3	10.6	4.3	1.0	11.6	8.1
Initial Queue Delay *(d_3)*, s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay *(d)*, s/veh	25.9	20.2	20.5	31.0	27.4	19.1	30.5	36.5	28.9	27.3	35.9	24.3
Level of Service (LOS)	C	C	C	C	C	B	C	D	C	C	D	C
Approach Delay, s/veh / LOS	23.3	C		24.9	C		32.7	C		28.1	C	
Intersection Delay, s/veh / LOS	26.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.5	B	3.1	C	3.1	C	3.1	C
Bicycle LOS Score / LOS	1.4	A	1.0	A	1.2	A	2.3	B

Appendix D 4

Year 2017 No-Action Alternative – HCS Intersection Analysis Worksheets

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action - AM*

Site Information

Intersection	*USA Parkway and I-80 EB - AM*
Jurisdiction	
Analysis Year	*2017*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*500*		*2*	*280*	
Peak-Hour Factor, PHF	*1.00*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*555*	*0*	*2*	*311*	*0*
Percent Heavy Vehicles	*0*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*1*	*1*	*0*
Configuration		*T*		*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*2*	*2*				
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2*	*2*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration	*LT*					

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*LT*		
v (veh/h)		*2*				*4*		
C (m) (veh/h)		*967*				*292*		
v/c		*0.00*				*0.01*		
95% queue length		*0.01*				*0.04*		
Control Delay (s/veh)		*8.7*				*17.5*		
LOS		*A*				*C*		
Approach Delay (s/veh)	--	--				*17.5*		
Approach LOS	--	--				*C*		

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action - PM*

Site Information

Intersection	*USA Parkway and I-80 EB - PM*
Jurisdiction	
Analysis Year	*2017*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)		*860*		*2*	*280*	
Peak-Hour Factor, PHF	*1.00*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*955*	*0*	*2*	*311*	*0*
Percent Heavy Vehicles	*0*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*1*	*1*	*0*
Configuration		*T*		*L*	*T*	
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)	*2*	*2*				
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*1.00*	*1.00*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*2*	*2*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*0*	*0*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*1*	*0*	*0*	*0*	*0*
Configuration	*LT*					

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration		*L*				*LT*		
v (veh/h)		*2*				*4*		
C (m) (veh/h)		*681*				*168*		
v/c		*0.00*				*0.02*		
95% queue length		*0.01*				*0.07*		
Control Delay (s/veh)		*10.3*				*27.0*		
LOS		*B*				*D*		
Approach Delay (s/veh)	--	--				*27.0*		
Approach LOS	--	--				*D*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action AM*

Site Information

Intersection	*USA Parkway and I-80 WB - AM*
Jurisdiction	
Analysis Year	*2017*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*500*					
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*555*	*0*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*0*	*0*
Configuration	*L*					
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*280*	*2*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*311*	*2*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*12*	*12*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration				*LT*		

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*LT*					
v (veh/h)	*555*		*313*					
C (m) (veh/h)	*1560*		*142*					
v/c	*0.36*		*2.20*					
95% queue length	*1.64*		*25.91*					
Control Delay (s/veh)	*8.6*		*615.2*					
LOS	*A*		*F*					
Approach Delay (s/veh)	--	--	*615.2*					
Approach LOS	--	--	*F*					

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/2/2012*
Analysis Time Period	*No-Action PM*

Site Information

Intersection	*USA Parkway and I-80 WB - PM*
Jurisdiction	
Analysis Year	*2017*

Project Description *USA Parkway*

East/West Street: *I-80 Ramps* | North/South Street: *USA Parkway*

Intersection Orientation: *North-South* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Northbound			Southbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*860*					
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*955*	*0*	*0*	*0*	*0*	*0*
Percent Heavy Vehicles	*12*	--	--	*12*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*0*	*0*
Configuration	*L*					
Upstream Signal		*0*			*0*	

Minor Street	Eastbound			Westbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*200*	*2*	
Peak-Hour Factor, PHF	*0.90*	*0.90*	*1.00*	*0.90*	*0.90*	*1.00*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*222*	*2*	*0*
Percent Heavy Vehicles	*12*	*12*	*0*	*12*	*12*	*0*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*0*	*1*	*0*
Configuration				*LT*		

Delay, Queue Length, and Level of Service

Approach	Northbound	Southbound	Westbound			Eastbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*		*LT*					
v (veh/h)	*955*		*224*					
C (m) (veh/h)	*1560*		*27*					
v/c	*0.61*		*8.30*					
95% queue length	*4.47*		*27.66*					
Control Delay (s/veh)	*10.9*		*3567*					
LOS	*B*		*F*					
Approach Delay (s/veh)	--	--	*3567*					
Approach LOS	--	--	*F*					

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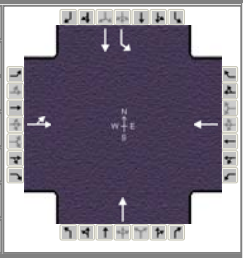
Appendix D 5
Year 2017 Build Alternative – HCS Intersection Analysis Worksheets

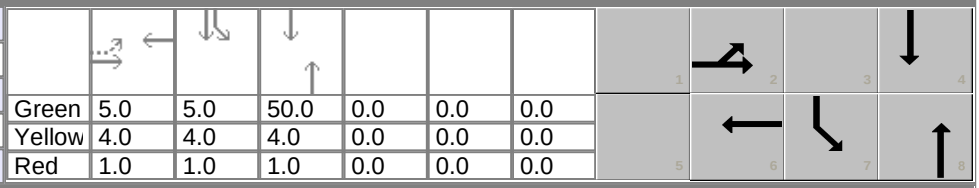
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/8/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 EB	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and I-80 EB Ramps - AM.xus				
Project Description	2017 - AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	2	2			0			550		2	220	

Signal Information												
Cycle, s	75.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On									
Force Mode	Fixed	Simult. Gap N/S	On									
				Green	5.0	5.0	50.0	0.0	0.0	0.0		
				Yellow	4.0	4.0	4.0	0.0	0.0	0.0		
				Red	1.0	1.0	1.0	0.0	0.0	0.0		



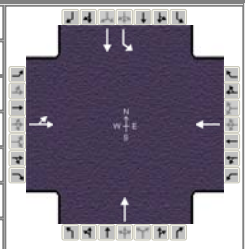
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8	7	4
Case Number		8.0		8.0		8.3	2.0	4.0
Phase Duration, s		10.0		10.0		55.0	10.0	65.0
Change Period, *(Y+Rc)*, s		5.0		5.0		5.0	5.0	5.0
Max Allow Headway *(MAH)*, s		2.9		0.0		2.9	3.0	2.9
Queue Clearance Time *(g_s)*, s		2.2				16.1	2.1	4.5
Green Extension Time *(g_e)*, s		0.0		0.0		1.5	0.0	1.5
Phase Call Probability		1.00				1.00	1.00	1.00
Max Out Probability		0.00				0.00	0.00	0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6			8		7	4	
Adjusted Flow Rate *(v)*, veh/h		4			0			611		2	244	
Adjusted Saturation Flow Rate *(s)*, veh/h/ln		1233			1696			1696		1616	1696	
Queue Service Time *(g_s)*, s		0.0			0.0			14.1		0.1	2.5	
Cycle Queue Clearance Time *(g_c)*, s		0.2			0.0			14.1		0.1	2.5	
Capacity *(c)*, veh/h		154			113			1131		108	1357	
Volume-to-Capacity Ratio *(X)*		0.029			0.000			0.540		0.021	0.180	
Available Capacity *(c_a)*, veh/h		221			226			1131		215	1357	
Back of Queue *(Q)*, veh/ln (95th percentile)		0.1			0.0			6.5		0.1	0.4	
Overflow Queue *(Q_3)*, veh/ln		0.0			0.0			0.0		0.0	0.0	
Queue Storage Ratio *(RQ)* (95th percentile)		0.00			0.00			0.00		0.00	0.00	
Uniform Delay *(d_1)*, s/veh		32.8			0.0			6.5		32.7	1.8	
Incremental Delay *(d_2)*, s/veh		0.0			0.0			1.9		0.0	0.3	
Initial Queue Delay *(d_3)*, s/veh		0.0			0.0			0.0		0.0	0.0	
Control Delay *(d)*, s/veh		32.8			0.0			8.4		32.7	2.0	
Level of Service (LOS)		C						A		C	A	
Approach Delay, s/veh / LOS	32.8	C		0.0			8.4	A		2.3	A	
Intersection Delay, s/veh / LOS	6.8						A					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.1	B	2.3	B	2.0	B	2.0	B
Bicycle LOS Score / LOS	0.5	A	0.5	A	1.5	A	0.9	A

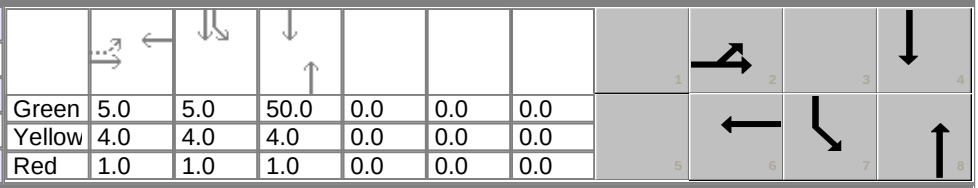
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/8/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 EB	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and I-80 EB Ramps - PM.xus				
Project Description	2017 - PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	2	2			0			820		2	190	

Signal Information			
Cycle, s	75.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	5.0	5.0	50.0	0.0	0.0	0.0						
Yellow	4.0	4.0	4.0	0.0	0.0	0.0						
Red	1.0	1.0	1.0	0.0	0.0	0.0						

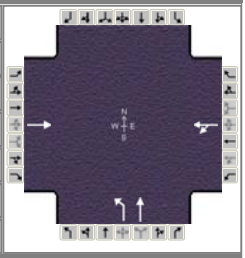
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8	7	4
Case Number		8.0		8.0		8.3	2.0	4.0
Phase Duration, s		10.0		10.0		55.0	10.0	65.0
Change Period, *(Y+Rc)*, s		5.0		5.0		5.0	5.0	5.0
Max Allow Headway *(MAH)*, s		2.9		0.0		2.9	3.0	2.9
Queue Clearance Time *(g_s)*, s		2.2				31.0	2.1	4.1
Green Extension Time *(g_e)*, s		0.0		0.0		2.2	0.0	2.2
Phase Call Probability		1.00				1.00	1.00	1.00
Max Out Probability		0.00				0.01	0.00	0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6			8		7	4	
Adjusted Flow Rate *(v)*, veh/h		4			0			911		2	211	
Adjusted Saturation Flow Rate *(s)*, veh/h/ln		1233			1696			1696		1616	1696	
Queue Service Time *(g_s)*, s		0.0			0.0			29.0		0.1	2.1	
Cycle Queue Clearance Time *(g_c)*, s		0.2			0.0			29.0		0.1	2.1	
Capacity *(c)*, veh/h		154			113			1131		108	1357	
Volume-to-Capacity Ratio *(X)*		0.029			0.000			0.806		0.021	0.156	
Available Capacity *(c_a)*, veh/h		221			226			1131		215	1357	
Back of Queue *(Q)*, veh/ln (95th percentile)		0.1			0.0			12.9		0.1	0.3	
Overflow Queue *(Q_3)*, veh/ln		0.0			0.0			0.0		0.0	0.0	
Queue Storage Ratio *(RQ)* (95th percentile)		0.00			0.00			0.00		0.00	0.00	
Uniform Delay *(d_1)*, s/veh		32.8			0.0			9.0		32.7	1.7	
Incremental Delay *(d_2)*, s/veh		0.0			0.0			6.2		0.0	0.2	
Initial Queue Delay *(d_3)*, s/veh		0.0			0.0			0.0		0.0	0.0	
Control Delay *(d)*, s/veh		32.8			0.0			15.2		32.7	2.0	
Level of Service (LOS)		C						B		C	A	
Approach Delay, s/veh / LOS	32.8	C		0.0			15.2	B		2.3	A	
Intersection Delay, s/veh / LOS	12.8						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.1	B	2.3	B	2.0	B	2.0	B
Bicycle LOS Score / LOS	0.5	A	0.5	A	2.0	A	0.8	A

HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/8/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 WB	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and I-80 WB Ramps - AM.xus				
Project Description	2017 - AM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h		0		220	2		550	0				

Signal Information					EB		WB				NB				SB			
Cycle, s	50.0	Reference Phase	2		→	⇜	↰					1	→ 2	↱ 3	4			
Offset, s	0	Reference Point	End	Green	12.0	28.0	0.0	0.0	0.0	0.0	5	↰ 6	7	↱ 8				
Uncoordinated	Yes	Simult. Gap E/W	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0								
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.0	1.0	0.0	0.0	0.0	0.0								

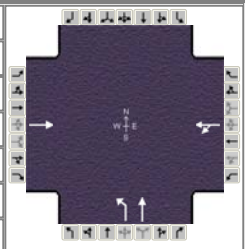
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		
Case Number		8.0		8.0		10.0		
Phase Duration, s		17.0		17.0		33.0		
Change Period, *(Y+Rc)*, s		5.0		5.0		5.0		
Max Allow Headway *(MAH)*, s		0.0		2.9		3.0		
Queue Clearance Time *(gs)*, s				14.0		15.4		
Green Extension Time *(ge)*, s		0.0		0.0		1.0		
Phase Call Probability				0.97		1.00		
Max Out Probability				1.00		0.01		

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2		1	6		3	8				
Adjusted Flow Rate *(v)*, veh/h		0			247		611	0				
Adjusted Saturation Flow Rate *(s)*, veh/h/ln		1900			718		1616	1900				
Queue Service Time *(gs)*, s		0.0			12.0		13.4	0.0				
Cycle Queue Clearance Time *(gc)*, s		0.0			12.0		13.4	0.0				
Capacity *(c)*, veh/h		456			316		905	1064				
Volume-to-Capacity Ratio *(X)*		0.000			0.781		0.675	0.000				
Available Capacity *(ca)*, veh/h		456			316		905	1064				
Back of Queue *(Q)*, veh/ln (95th percentile)		0.0			6.0		5.9	0.0				
Overflow Queue *(Q3)*, veh/ln		0.0			0.0		0.0	0.0				
Queue Storage Ratio *(RQ)* (95th percentile)		0.00			0.00		0.00	0.00				
Uniform Delay *(d1)*, s/veh		0.0			20.8		7.8	0.0				
Incremental Delay *(d2)*, s/veh		0.0			10.9		4.0	0.0				
Initial Queue Delay *(d3)*, s/veh		0.0			0.0		0.0	0.0				
Control Delay *(d)*, s/veh		0.0			31.8		11.8	0.0				
Level of Service (LOS)					C		B					
Approach Delay, s/veh / LOS	0.0			31.8		C	11.8		B	0.0		
Intersection Delay, s/veh / LOS	17.5						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.7	A	1.9	A	2.1	B	2.1	B
Bicycle LOS Score / LOS	0.5	A	0.9	A	1.5	A		

HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/8/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and I-80 WB	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and I-80 WB Ramps - PM.xus				
Project Description	2017 - PM				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h		0		190	2		820	0				

Signal Information			
Cycle, s	56.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

								1	2	3	4	
Green	10.0	36.0	0.0	0.0	0.0	0.0						
Yellow	4.0	4.0	0.0	0.0	0.0	0.0						
Red	1.0	1.0	0.0	0.0	0.0	0.0	5	6	7	8		

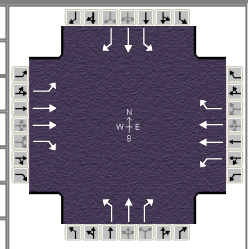
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		
Case Number		8.0		8.0		10.0		
Phase Duration, s		15.0		15.0		41.0		
Change Period, *(Y+Rc)*, s		5.0		5.0		5.0		
Max Allow Headway *(MAH)*, s		0.0		2.9		3.0		
Queue Clearance Time *(gs)*, s				12.0		27.9		
Green Extension Time *(ge)*, s		0.0		0.0		1.5		
Phase Call Probability				0.96		1.00		
Max Out Probability				1.00		0.16		

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2		1	6		3	8				
Adjusted Flow Rate *(v)*, veh/h		0			213		911	0				
Adjusted Saturation Flow Rate *(s)*, veh/h/ln		1900			719		1616	1900				
Queue Service Time *(gs)*, s		0.0			10.0		25.9	0.0				
Cycle Queue Clearance Time *(gc)*, s		0.0			10.0		25.9	0.0				
Capacity *(c)*, veh/h		339			256		1039	1221				
Volume-to-Capacity Ratio *(X)*		0.000			0.833		0.877	0.000				
Available Capacity *(ca)*, veh/h		339			256		1039	1221				
Back of Queue *(Q)*, veh/ln (95th percentile)		0.0			7.0		10.9	0.0				
Overflow Queue *(Q3)*, veh/ln		0.0			0.0		0.0	0.0				
Queue Storage Ratio *(RQ)* (95th percentile)		0.00			0.00		0.00	0.00				
Uniform Delay *(d1)*, s/veh		0.0			25.0		8.2	0.0				
Incremental Delay *(d2)*, s/veh		0.0			19.2		10.4	0.0				
Initial Queue Delay *(d3)*, s/veh		0.0			0.0		0.0	0.0				
Control Delay *(d)*, s/veh		0.0			44.2		18.6	0.0				
Level of Service (LOS)					D		B					
Approach Delay, s/veh / LOS	0.0			44.2		D	18.6		B	0.0		
Intersection Delay, s/veh / LOS	23.5						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.7	A	1.9	A	2.1	B	2.0	B
Bicycle LOS Score / LOS	0.5	A	0.8	A	2.0	A		

HCS 2010 Signalized Intersection Results Summary

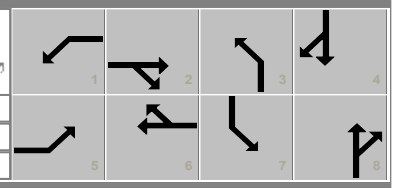
General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/20/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and US 50	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and US50 AM - 4 legged.xus				
Project Description	2017 Build AM - 4-legged				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	110	200	40	80	230	190	60	50	90	150	30	100

Signal Information			
Cycle, s	54.2	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	4.9	1.0	10.9	4.2	3.3	10.0	
Yellow	4.0	0.0	4.0	4.0	0.0	4.0	
Red	1.0	0.0	1.0	1.0	0.0	1.0	



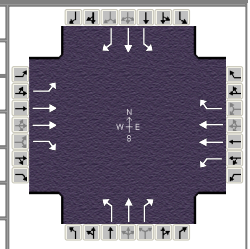
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	10.8	16.8	9.9	15.9	9.2	15.0	12.5	18.3
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway (*MAH*), s	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.1
Queue Clearance Time (g_s), s	5.7	5.0	4.7	7.2	4.2	4.5	7.4	4.6
Green Extension Time (g_e), s	0.1	1.3	0.1	0.5	0.1	0.2	0.1	0.2
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.00	0.00	0.00	1.00	0.00	0.11	0.01	0.12

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate (*v*), veh/h	122	222	33	89	256	159	67	56	76	167	33	83
Adjusted Saturation Flow Rate (*s*), veh/h/ln	1707	1706	1484	1707	1706	1481	1616	1696	1414	1616	1696	1420
Queue Service Time (g_s), s	3.7	3.0	1.0	2.7	3.5	5.2	2.2	1.5	2.5	5.4	0.8	2.6
Cycle Queue Clearance Time (g_c), s	3.7	3.0	1.0	2.7	3.5	5.2	2.2	1.5	2.5	5.4	0.8	2.6
Capacity (*c*), veh/h	184	745	324	153	683	297	126	313	261	224	416	348
Volume-to-Capacity Ratio (*X*)	0.664	0.298	0.103	0.580	0.374	0.536	0.529	0.178	0.290	0.744	0.080	0.239
Available Capacity (c_a), veh/h	441	1762	766	2612	683	297	715	313	261	417	416	348
Back of Queue (*Q*), veh/ln (95th percentile)	2.4	1.7	0.5	1.8	2.1	2.8	1.3	1.1	1.6	3.3	0.5	1.5
Overflow Queue (Q_3), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queue Storage Ratio (*RQ*) (95th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uniform Delay (d_1), s/veh	23.3	17.7	16.9	23.7	18.7	19.4	24.0	18.7	19.1	22.4	15.8	16.4
Incremental Delay (d_2), s/veh	1.5	0.1	0.1	1.3	0.1	1.0	1.3	1.2	2.8	1.8	0.4	1.6
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	24.8	17.8	17.0	25.0	18.9	20.4	25.3	19.9	21.8	24.3	16.1	18.0
Level of Service (LOS)	C	B	B	C	B	C	C	B	C	C	B	B
Approach Delay, s/veh / LOS	20.0	B		20.5	C		22.5	C		21.5	C	
Intersection Delay, s/veh / LOS	20.8						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.5	B	2.5	B	3.0	C	2.9	C
Bicycle LOS Score / LOS	0.8	A	0.9	A	0.8	A	1.0	A

HCS 2010 Signalized Intersection Results Summary

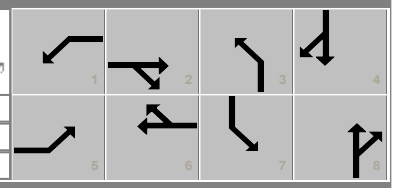
General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/20/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and US 50	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and US50 PM - 4 legged.xus				
Project Description	2017 Build PM - 4-legged				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	110	250	70	100	230	160	50	40	80	210	60	130

Signal Information			
Cycle, s	57.5	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

Green	5.7	0.3	11.2	4.0	1.3	10.0	
Yellow	4.0	0.0	4.0	4.0	4.0	4.0	
Red	1.0	0.0	1.0	1.0	1.0	1.0	



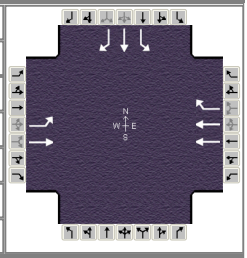
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2	1	6	3	8	7	4
Case Number	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0
Phase Duration, s	11.0	16.5	10.7	16.2	9.0	15.0	15.3	21.3
Change Period, *(Y+Rc)*, s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Allow Headway *(MAH)*, s	3.0	3.0	3.0	3.0	3.0	3.1	3.0	3.1
Queue Clearance Time *(g_s)*, s	6.0	6.1	5.6	6.6	3.9	4.4	10.0	5.4
Green Extension Time *(g_e)*, s	0.0	1.0	0.1	0.7	0.1	0.3	0.4	0.4
Phase Call Probability	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max Out Probability	0.93	0.20	0.00	0.79	0.00	0.11	0.00	0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate *(v)*, veh/h	122	278	59	111	256	133	56	44	67	233	67	109
Adjusted Saturation Flow Rate *(s)*, veh/h/ln	1707	1706	1481	1707	1706	1480	1616	1696	1413	1616	1696	1422
Queue Service Time *(g_s)*, s	4.0	4.1	1.9	3.6	3.8	4.6	1.9	1.3	2.4	8.0	1.7	3.4
Cycle Queue Clearance Time *(g_c)*, s	4.0	4.1	1.9	3.6	3.8	4.6	1.9	1.3	2.4	8.0	1.7	3.4
Capacity *(c)*, veh/h	179	681	296	170	662	287	112	295	245	291	482	404
Volume-to-Capacity Ratio *(X)*	0.683	0.408	0.199	0.655	0.386	0.464	0.494	0.151	0.272	0.803	0.138	0.270
Available Capacity *(c_a)*, veh/h	267	712	309	445	662	287	2442	295	245	898	482	404
Back of Queue *(Q)*, veh/ln (95th percentile)	2.6	2.5	1.0	2.4	2.3	2.5	1.2	0.9	1.5	4.9	1.1	1.9
Overflow Queue *(Q_3)*, veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Queue Storage Ratio *(RQ)* (95th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uniform Delay *(d_1)*, s/veh	24.8	20.1	19.2	25.0	20.2	20.5	25.8	20.2	20.6	22.6	15.4	16.0
Incremental Delay *(d_2)*, s/veh	1.7	0.1	0.1	1.6	0.1	0.4	1.2	1.1	2.7	2.0	0.6	1.6
Initial Queue Delay *(d_3)*, s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Control Delay *(d)*, s/veh	26.6	20.2	19.3	26.6	20.3	21.0	27.0	21.3	23.3	24.6	16.0	17.6
Level of Service (LOS)	C	C	B	C	C	C	C	C	C	C	B	B
Approach Delay, s/veh / LOS	21.8	C		21.9	C		24.0	C		21.3	C	
Intersection Delay, s/veh / LOS	21.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.5	B	2.5	B	3.0	C	3.0	C
Bicycle LOS Score / LOS	0.9	A	0.9	A	0.8	A	1.2	A

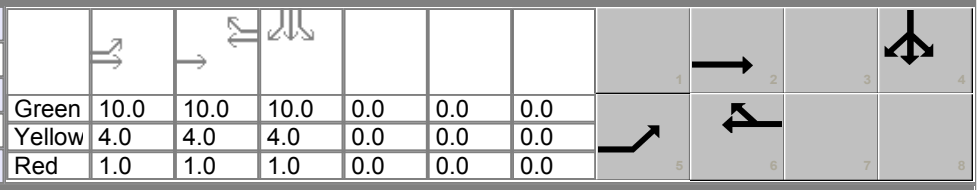
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/29/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and US 50	Analysis Year	2012	Analysis Period	1> 7:00
File Name	USA Parkway and US 50 - AM - Signalized High-T.xus				
Project Description	2017 Build AM - T-intersection				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	150	0			310	200				160	0	120

Signal Information			
Cycle, s	45.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



Green	10.0	10.0	10.0	0.0	0.0	0.0						
Yellow	4.0	4.0	4.0	0.0	0.0	0.0						
Red	1.0	1.0	1.0	0.0	0.0	0.0						

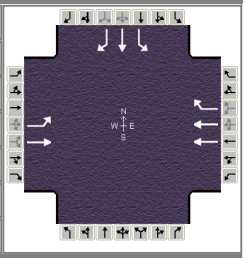
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	2.0	4.0		7.3				9.0
Phase Duration, s	15.0	30.0		15.0				15.0
Change Period, *(Y+Rc)*, s	5.0	5.0		5.0				5.0
Max Allow Headway *(MAH)*, s	3.0	0.0		3.0				3.1
Queue Clearance Time *(g_s)*, s	5.8			6.3				6.3
Green Extension Time *(g_e)*, s	0.1	0.0		0.9				0.2
Phase Call Probability	1.00			1.00				1.00
Max Out Probability	0.08			0.00				0.25

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7	4	14
Adjusted Flow Rate *(v)*, veh/h	167	0			344	167				178	0	100
Adjusted Saturation Flow Rate *(s)*, veh/h/ln	1707	1792			1706	1519				1616	1696	1418
Queue Service Time *(g_s)*, s	3.8	0.0			3.9	4.3				4.3	0.0	2.7
Cycle Queue Clearance Time *(g_c)*, s	3.8	0.0			3.9	4.3				4.3	0.0	2.7
Capacity *(c)*, veh/h	379	996			758	338				359	377	315
Volume-to-Capacity Ratio *(X)*	0.439	0.000			0.454	0.494				0.495	0.000	0.317
Available Capacity *(c_a)*, veh/h	417	996			1289	574				395	415	347
Back of Queue *(Q)*, veh/ln (50th percentile)	1.1	0.0			1.2	1.2				1.2	0.0	0.7
Overflow Queue *(Q_3)*, veh/ln	0.0	0.0			0.0	0.0				0.0	0.0	0.0
Queue Storage Ratio *(RQ)* (50th percentile)	0.00	0.00			0.00	0.00				0.00	0.00	0.00
Uniform Delay *(d_1)*, s/veh	15.1	0.0			15.1	15.3				15.3	0.0	14.6
Incremental Delay *(d_2)*, s/veh	0.3	0.0			0.2	0.4				0.4	0.0	0.2
Initial Queue Delay *(d_3)*, s/veh	0.0	0.0			0.0	0.0				0.0	0.0	0.0
Control Delay *(d)*, s/veh	15.4	0.0			15.3	15.7				15.7	0.0	14.9
Level of Service (LOS)	B				B	B				B		B
Approach Delay, s/veh / LOS	15.4	B		15.4	B		0.0			15.4	B	
Intersection Delay, s/veh / LOS	15.4						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.8	A	2.5	B	2.5	B	2.7	B
Bicycle LOS Score / LOS	0.8	A	0.9	A			0.9	A

HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency				Duration, h	0.25
Analyst		Analysis Date	8/29/2012	Area Type	Other
Jurisdiction		Time Period		PHF	0.90
Intersection	USA Parkway and US 50	Analysis Year	2012	Analysis Period	1> 16:00
File Name	USA Parkway and US 50 - PM - Signalized High-T.xus				
Project Description	2017 Build PM - T-intersection				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	140	0			330	170				220	0	180

Signal Information			
Cycle, s	45.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	Yes	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

							1	2	3	4	
Green	10.0	10.0	10.0	0.0	0.0	0.0	5	6	7	8	
Yellow	4.0	4.0	4.0	0.0	0.0	0.0					
Red	1.0	1.0	1.0	0.0	0.0	0.0					

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	2.0	4.0		7.3				9.0
Phase Duration, s	15.0	30.0		15.0				15.0
Change Period, *(Y+Rc)*, s	5.0	5.0		5.0				5.0
Max Allow Headway *(MAH)*, s	3.0	0.0		3.0				3.1
Queue Clearance Time *(g_s)*, s	5.5			6.2				8.2
Green Extension Time *(g_e)*, s	0.2	0.0		1.0				0.7
Phase Call Probability	1.00			1.00				1.00
Max Out Probability	0.00			0.00				0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7	4	14
Adjusted Flow Rate *(v)*, veh/h	156	0			367	142				244	0	150
Adjusted Saturation Flow Rate *(s)*, veh/h/ln	1707	1792			1706	1519				1616	1696	1418
Queue Service Time *(g_s)*, s	3.5	0.0			4.2	3.6				6.2	0.0	4.1
Cycle Queue Clearance Time *(g_c)*, s	3.5	0.0			4.2	3.6				6.2	0.0	4.1
Capacity *(c)*, veh/h	379	996			758	338				359	377	315
Volume-to-Capacity Ratio *(X)*	0.410	0.000			0.483	0.421				0.681	0.000	0.476
Available Capacity *(c_a)*, veh/h	834	3226			3867	1721				1651	1734	1450
Back of Queue *(Q)*, veh/ln (50th percentile)	1.0	0.0			1.2	1.0				1.8	0.0	1.0
Overflow Queue *(Q_3)*, veh/ln	0.0	0.0			0.0	0.0				0.0	0.0	0.0
Queue Storage Ratio *(RQ)* (50th percentile)	0.00	0.00			0.00	0.00				0.00	0.00	0.00
Uniform Delay *(d_1)*, s/veh	15.0	0.0			15.3	15.0				16.0	0.0	15.2
Incremental Delay *(d_2)*, s/veh	0.3	0.0			0.2	0.3				0.9	0.0	0.4
Initial Queue Delay *(d_3)*, s/veh	0.0	0.0			0.0	0.0				0.0	0.0	0.0
Control Delay *(d)*, s/veh	15.2	0.0			15.4	15.3				16.9	0.0	15.6
Level of Service (LOS)	B				B	B				B		B
Approach Delay, s/veh / LOS	15.2	B		15.4	B		0.0			16.4	B	
Intersection Delay, s/veh / LOS	15.8						B					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.8	A	2.5	B	2.5	B	2.7	B
Bicycle LOS Score / LOS	0.7	A	0.9	A			1.1	A

TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/20/2012*
Analysis Time Period	*AM*

Site Information

Intersection	*USA Parkway and US 50*
Jurisdiction	*NDOT*
Analysis Year	*2017*

Project Description *T-intersection*

East/West Street: *US 50* | North/South Street: *USA Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*150*				*310*	*200*
Peak-Hour Factor, PHF	*0.90*	*1.00*	*1.00*	*1.00*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*166*	*0*	*0*	*0*	*344*	*222*
Percent Heavy Vehicles	*6*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*2*	*1*
Configuration	*L*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*160*		*120*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*0.90*	*1.00*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*177*	*0*	*133*
Percent Heavy Vehicles	*0*	*0*	*0*	*12*	*0*	*12*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*					*L*		*R*
v (veh/h)	*166*					*177*		*133*
C (m) (veh/h)	*986*					*336*		*846*
v/c	*0.17*					*0.53*		*0.16*
95% queue length	*0.60*					*2.91*		*0.56*
Control Delay (s/veh)	*9.4*					*27.0*		*10.0*
LOS	*A*					*D*		*B*
Approach Delay (s/veh)	--	--				*19.7*		
Approach LOS	--	--				*C*		

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TWO-WAY STOP CONTROL SUMMARY

General Information

Analyst	*SD*
Agency/Co.	*Jacobs*
Date Performed	*8/20/2012*
Analysis Time Period	*PM*

Site Information

Intersection	*USA Parkway and US 50*
Jurisdiction	*NDOT*
Analysis Year	*2017*

Project Description *T-intersection*

East/West Street: *US 50* | North/South Street: *USA Parkway*

Intersection Orientation: *East-West* | Study Period (hrs): *0.25*

Vehicle Volumes and Adjustments

Major Street	Eastbound			Westbound		
Movement	1	2	3	4	5	6
	L	T	R	L	T	R
Volume (veh/h)	*140*				*330*	*170*
Peak-Hour Factor, PHF	*0.90*	*1.00*	*1.00*	*1.00*	*0.90*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*155*	*0*	*0*	*0*	*366*	*188*
Percent Heavy Vehicles	*6*	--	--	*0*	--	--
Median Type	*Undivided*					
RT Channelized			*0*			*0*
Lanes	*1*	*0*	*0*	*0*	*2*	*1*
Configuration	*L*				*T*	*R*
Upstream Signal		*0*			*0*	

Minor Street	Northbound			Southbound		
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
Volume (veh/h)				*220*		*180*
Peak-Hour Factor, PHF	*1.00*	*1.00*	*1.00*	*0.90*	*1.00*	*0.90*
Hourly Flow Rate, HFR (veh/h)	*0*	*0*	*0*	*244*	*0*	*200*
Percent Heavy Vehicles	*0*	*0*	*0*	*12*	*0*	*12*
Percent Grade (%)		*0*			*0*	
Flared Approach		*N*			*N*	
Storage		*0*			*0*	
RT Channelized			*0*			*0*
Lanes	*0*	*0*	*0*	*1*	*0*	*1*
Configuration				*L*		*R*

Delay, Queue Length, and Level of Service

Approach	Eastbound	Westbound	Northbound			Southbound		
Movement	1	4	7	8	9	10	11	12
Lane Configuration	*L*					*L*		*R*
v (veh/h)	*155*					*244*		*200*
C (m) (veh/h)	*996*					*341*		*834*
v/c	*0.16*					*0.72*		*0.24*
95% queue length	*0.55*					*5.26*		*0.94*
Control Delay (s/veh)	*9.3*					*38.1*		*10.7*
LOS	*A*					*E*		*B*
Approach Delay (s/veh)	--	--				*25.8*		
Approach LOS	--	--				*D*		

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Appendix E
HCS Freeway Merge & Diverge Analysis Worksheets

Appendix E 1

Existing Conditions – HCS Freeway Merge & Diverge Analysis Worksheets

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	770	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	240	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	30	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	770	240	30	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	214	67	8	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1010	315	39	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1010 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1010	4800	No
$v_{FO} = v_F - v_R$	695	4800	No
v_R	315	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 1010 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1010	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 10.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.261

Space mean speed in ramp influence area, S_R = 62.7 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.7 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	560	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	30	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	240	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	560	30	240	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	156	8	67	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	734	39	315	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 734 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	773	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 734 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	773	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 8.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable,	M_S = 0.279	
Space mean speed in ramp influence area,	S_R = 62.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1170	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	60	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	50	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1170	60	50	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	325	17	14	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1534	79	66	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1534 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1534	4800	No
$v_{FO} = v_F - v_R$	1455	4800	No
v_R	79	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1534 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1534	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 14.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.240

Space mean speed in ramp influence area, S_R = 63.3 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 63.3 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1160	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	50	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	60	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1160	50	60	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	322	14	17	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1521	66	79	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1521 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1587	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1521 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	1587	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 13.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.275	
Space mean speed in ramp influence area,	S_R = 62.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.3	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1310	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	100	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	100	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1310	100	100	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	364	28	28	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1718	131	131	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1718 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1718	4800	No
$v_{FO} = v_F - v_R$	1587	4800	No
v_R	131	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1718 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1718	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 16.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.245

Space mean speed in ramp influence area, S_R = 63.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 63.1 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1310	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	100	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	100	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1310	100	100	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	364	28	28	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1718	131	131	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1718 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1849	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 1718 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	1849	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 16.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, M_S = 0.296

Space mean speed in ramp influence area, S_R = 61.7 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.7 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	730	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	40	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	270	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	730	40	270	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	203	11	75	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	957	52	354	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 957 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	957	4800	No
$v_{FO} = v_F - v_R$	905	4800	No
v_R	52	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 957 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	957	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 9.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.238

Space mean speed in ramp influence area, S_R = 63.3 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 63.3 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	Existing

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	960	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	270	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	40	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	960	270	40	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	267	75	11	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1259	354	52	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1259 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1613	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1259 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	1613	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 13.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.276	
Space mean speed in ramp influence area,	S_R = 62.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 62.3	mph

Appendix E 2

Year 2037 No-Action Alternative – HCS Freeway Merge & Diverge Analysis Worksheets

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	3270	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	2280	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	510	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3270	2280	510	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	908	633	142	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4287	2989	669	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.515 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3658 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	4287	7200	No
$v_{FO} = v_F - v_R$	1298	7200	No
v_R	2989	2100	Yes
v_3 or v_{av34}	629 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3658 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3658	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_{12}$ = 22.2 pc/mi/ln D

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.502

Space mean speed in ramp influence area, S_R = 55.9 mph

Space mean speed in outer lanes, S_0 = 76.8 mph

Space mean speed for all vehicles, S = 58.3 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1500	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	510	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	2280	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1500	510	2280	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	417	142	633	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1967	669	2989	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1967 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2636	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1967 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2636	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 22.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.325	
Space mean speed in ramp influence area,	S_R = 60.9	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 60.9	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1980	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	750	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1430	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1980	750	1430	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	550	208	397	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2596	983	1875	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2596 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2596	4800	No
$v_{FO} = v_F - v_R$	1613	4800	No
v_R	983	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2596 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2596	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ = 23.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.321

Space mean speed in ramp influence area, S_R = 61.0 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.0 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2660	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1430	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	750	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2660	1430	750	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	739	397	208	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3488	1875	983	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2026.68 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2161 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	5363	7200	No
v_3 or v_{av34}	1327 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2161 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	5363	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 26.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.392	
Space mean speed in ramp influence area,	S_R = 59.0	mph
Space mean speed in outer lanes,	S_0 = 67.0	mph
Space mean speed for all vehicles,	S = 60.8	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.3

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2940	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	1620	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	890	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2940	1620	890	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	817	450	247	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3855	2124	1167	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.566 Using Equation 5

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3104 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3855	7200	No
$v_{FO} = v_F - v_R$	1731	7200	No
v_R	2124	2100	Yes
v_3 or v_{av34}	751 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 3104 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3104	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 17.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.424

Space mean speed in ramp influence area, S_R = 58.1 mph

Space mean speed in outer lanes, S_0 = 76.8 mph

Space mean speed for all vehicles, S = 61.0 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2210	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	890	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1620	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2210	890	1620	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	614	247	450	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2898	1167	2124	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2898 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4065	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2898 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	4065	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 33.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable, M_S = 0.498

Space mean speed in ramp influence area, S_R = 56.0 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 56.0 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1670	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	530	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	2470	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1670	530	2470	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	464	147	686	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2190	695	3238	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2190 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2190	4800	No
$v_{FO} = v_F - v_R$	1495	4800	No
v_R	695	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2190 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2190	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 20.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.296

Space mean speed in ramp influence area, S_R = 61.7 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.7 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands No Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	3610	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	2470	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	530	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3610	2470	530	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	1003	686	147	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	4733	3238	695	pcph

Estimation of V12 Merge Areas

L_{EQ} = 2584.79 (Equation 13-6 or 13-7)

P_{FM} = 0.619 Using Equation 1

$v_{12} = v_F (P_{FM})$ = 2932 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	7971	7200	Yes
v_3 or v_{av34}	1801 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2932 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	7971	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 42.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	M_S = 2.036	
Space mean speed in ramp influence area,	S_R = 13.0	mph
Space mean speed in outer lanes,	S_0 = 65.3	mph
Space mean speed for all vehicles,	S = 15.9	mph

Appendix E 3

Year 2037 Build Alternative – HCS Freeway Merge & Diverge Analysis Worksheets

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2690	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	1770	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane	0	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	370	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2690	1770	370	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	747	492	103	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3527	2321	485	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2864 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3527	7200	No
$v_{FO} = v_F - v_R$	1206	7200	No
v_R	2321	4200	No
v_3 or v_{av34}	663 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2864 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2864	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 1.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.442

Space mean speed in ramp influence area, S_R = 57.6 mph

Space mean speed in outer lanes, S_0 = 76.8 mph

Space mean speed for all vehicles, S = 60.5 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1290	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	370	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1770	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1290	370	1770	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	358	103	492	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1691	485	2321	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1691 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2176	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1691 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2176	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 19.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.305	
Space mean speed in ramp influence area,	S_R = 61.4	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.4	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1580	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	470	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1320	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1580	470	1320	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	439	131	367	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2072	616	1731	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2072 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2072	4800	No
$v_{FO} = v_F - v_R$	1456	4800	No
v_R	616	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2072 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2072	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 19.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.288

Space mean speed in ramp influence area, S_R = 61.9 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.9 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2430	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1320	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	470	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2430	1320	470	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	675	367	131	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3186	1731	616	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.555 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1768 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	4917	7200	No
v_3 or v_{av34}	1418 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 1820 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	4917	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 14.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.177	
Space mean speed in ramp influence area,	S_R = 65.0	mph
Space mean speed in outer lanes,	S_0 = 66.9	mph
Space mean speed for all vehicles,	S = 65.5	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2700	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	1480	vph
Length of first accel/decel lane	1500	ft
Length of second accel/decel lane	0	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	540	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2700	1480	540	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	750	411	150	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3540	1940	708	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.450 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2660 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3540	7200	No
$v_{FO} = v_F - v_R$	1600	7200	No
v_R	1940	4200	No
v_3 or v_{av34}	880 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2660 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2660	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 0.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence A

Speed Estimation

Intermediate speed variable, D_S = 0.408

Space mean speed in ramp influence area, S_R = 58.6 mph

Space mean speed in outer lanes, S_0 = 76.8 mph

Space mean speed for all vehicles, S = 62.3 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.3

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1760	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	540	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	1480	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1760	540	1480	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	489	150	411	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2308	708	1940	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2308 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3016	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2308 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3016	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 25.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.351	
Space mean speed in ramp influence area,	S_R = 60.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 60.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1440	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	400	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	1950	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1440	400	1950	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	400	111	542	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1888	524	2557	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1888 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1888	4800	No
$v_{FO} = v_F - v_R$	1364	4800	No
v_R	524	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1888 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1888	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 17.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.280

Space mean speed in ramp influence area, S_R = 62.2 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.2 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2037
Description:	No-Highlands Build

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	3	
Free-flow speed on freeway	70.0	mph
Volume on freeway	2990	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	2	
Free-flow speed on ramp	50.0	mph
Volume on ramp	1950	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane	1500	ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	400	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2990	1950	400	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	831	542	111	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3920	2557	524	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.555 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2176 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	6477	7200	No
v_3 or v_{av34}	1744 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 Yes

If yes, v_{12A} = 2240 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{12A}	6477	4600	Yes

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 24.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.513	
Space mean speed in ramp influence area,	S_R = 55.6	mph
Space mean speed in outer lanes,	S_0 = 65.8	mph
Space mean speed for all vehicles,	S = 57.9	mph

Appendix E 4

Year 2017 No-Action Alternative – HCS Freeway Merge & Diverge Analysis Worksheets

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1730	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	780	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	180	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1730	780	180	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	481	217	50	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2268	1023	236	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2268 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2268	4800	No
$v_{FO} = v_F - v_R$	1245	4800	No
v_R	1023	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2268 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2268	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 21.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.325

Space mean speed in ramp influence area, S_R = 60.9 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 60.9 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1130	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	180	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	780	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1130	180	780	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	314	50	217	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1482	236	1023	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1482 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1718	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1482 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	1718	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 15.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.293	
Space mean speed in ramp influence area,	S_R = 61.8	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.8	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1380	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	280	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	500	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1380	280	500	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	383	78	139	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1809	367	656	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1809 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1809	4800	No
$v_{FO} = v_F - v_R$	1442	4800	No
v_R	367	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1809 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1809	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086 v_R - 0.009 L_D$ = 17.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.266

Space mean speed in ramp influence area, S_R = 62.6 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.6 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1600	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	500	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	280	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1600	500	280	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	444	139	78	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2098	656	367	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2098 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2754	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2098 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2754	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 22.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.317

Space mean speed in ramp influence area, S_R = 61.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.1 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB Off-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1770	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	560	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	320	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1770	560	320	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	492	156	89	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2321	734	420	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2321 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2321	4800	No
$v_{FO} = v_F - v_R$	1587	4800	No
v_R	734	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2321 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2321	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 21.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.299

Space mean speed in ramp influence area, S_R = 61.6 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.6 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1530	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	320	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	560	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1530	320	560	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	425	89	156	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2006	420	734	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2006 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2426	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2006 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2426	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734\ v_R + 0.0078\ v_{12} - 0.00627\ L_A$ = 21.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	M_S = 0.315	
Space mean speed in ramp influence area,	S_R = 61.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB Off-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1250	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	200	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	860	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1250	200	860	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	347	56	239	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1639	262	1128	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1639 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1639	4800	No
$v_{FO} = v_F - v_R$	1377	4800	No
v_R	262	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 1639 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1639	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 15.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.257

Space mean speed in ramp influence area, S_R = 62.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.8 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	5/10/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	
Analysis Year:	2017
Description:	No-Action

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1910	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	860	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	200	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1910	860	200	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	531	239	56	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2504	1128	262	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2504 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3632	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 2504 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3632	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 29.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.403	
Space mean speed in ramp influence area,	S_R = 58.7	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.7	mph

Appendix E 5

Year 2017 Build Alternative – HCS Freeway Merge & Diverge Analysis Worksheets

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	AM
Freeway/Dir of Travel:	I-80 EB
Junction:	I-80 and USA Parkway
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1660	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	740	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	170	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1660	740	170	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	461	206	47	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2176	970	223	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2176 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2176	4800	No
$v_{FO} = v_F - v_R$	1206	4800	No
v_R	970	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2176 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2176	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 20.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.320

Space mean speed in ramp influence area, S_R = 61.0 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.0 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	AM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1090	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	170	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	740	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1090	170	740	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	303	47	206	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1429	223	970	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1429 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	1652	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 1429 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	1652	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 15.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.291	
Space mean speed in ramp influence area,	S_R = 61.8	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.8	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	AM
Freeway/Dir of Travel:	I-80 WB
Junction:	I-80 and USA Parkway
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1230	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	220	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	550	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1230	220	550	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	342	61	153	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1613	288	721	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1613 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1613	4800	No
$v_{FO} = v_F - v_R$	1325	4800	No
v_R	288	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 1613 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1613	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 15.4 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.259

Space mean speed in ramp influence area, S_R = 62.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.8 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	AM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1560	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	550	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	220	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1560	550	220	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	433	153	61	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2045	721	288	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2045 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2766	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2045 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2766	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 22.6 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, M_S = 0.318

Space mean speed in ramp influence area, S_R = 61.1 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.1 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	PM
Freeway/Dir of Travel:	I-80 EB
Junction:	I-80 and USA Parkway
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1740	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	620	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	250	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1740	620	250	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	483	172	69	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2281	813	328	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2281 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2281	4800	No
$v_{FO} = v_F - v_R$	1468	4800	No
v_R	813	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2281 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2281	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 21.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.306

Space mean speed in ramp influence area, S_R = 61.4 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 61.4 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	PM
Freeway/Dir of Travel:	EB
Junction:	I-80 and EB On-Ramp
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1370	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	250	vph
Length of first accel/decel lane	500	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	620	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	2400	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1370	250	620	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	381	69	172	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1796	328	813	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 1796 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	2124	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 1796 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	2124	4600	No

Level of Service Determination (if not F)

Density, $D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ = 18.8 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable,	M_S = 0.304	
Space mean speed in ramp influence area,	S_R = 61.5	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 61.5	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	PM
Freeway/Dir of Travel:	I-80 WB
Junction:	I-80 and USA Parkway
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1210	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	50.0	mph
Volume on ramp	190	vph
Length of first accel/decel lane	300	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	820	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1210	190	820	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	336	53	228	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	1586	249	1075	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 1586 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	1586	4800	No
$v_{FO} = v_F - v_R$	1337	4800	No
v_R	249	2100	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12}/2 No

If yes, v_{12A} = 1586 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	1586	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 15.2 pc/mi/ln

Level of service for ramp-freeway junction areas of influence B

Speed Estimation

Intermediate speed variable, D_S = 0.255

Space mean speed in ramp influence area, S_R = 62.8 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 62.8 mph

Phone: Fax:
E-mail:

Merge Analysis

Analyst:	SD
Agency/Co.:	Jacobs
Date performed:	8/8/2012
Analysis time period:	PM
Freeway/Dir of Travel:	WB
Junction:	I-80 and WB On-Ramp
Jurisdiction:	NDOT
Analysis Year:	2017
Description:	

Freeway Data

Type of analysis	Merge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.0	mph
Volume on freeway	1840	vph

On Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-flow speed on ramp	50.0	mph
Volume on ramp	820	vph
Length of first accel/decel lane	650	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent Ramp	190	vph
Position of adjacent Ramp	Upstream	
Type of adjacent Ramp	Off	
Distance to adjacent Ramp	3300	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1840	820	190	vph
Peak-hour factor, PHF	0.90	0.90	0.90	
Peak 15-min volume, v15	511	228	53	v
Trucks and buses	12	12	12	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Rolling	Rolling	
Grade	%	%	%	
Length	mi	mi	mi	
Trucks and buses PCE, ET	2.5*	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	

Heavy vehicle adjustment, fHV	0.847	0.847	0.847	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2412	1075	249	pcph

Estimation of V12 Merge Areas

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 Using Equation 0

$v_{12} = v_F (P_{FM})$ = 2412 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
v_{FO}	3487	4800	No

v_3 or v_{av34} = 0 pc/h (Equation 13-14 or 13-17)

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 2412 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Merge Influence Area

	Actual	Max Desirable	Violation?
v_{R12}	3487	4600	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, v_{12} - 0.00627\, L_A$ = 28.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	M_S = 0.383	
Space mean speed in ramp influence area,	S_R = 59.3	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 59.3	mph

Appendix F
HCS Multilane Highway Analysis Worksheets

Appendix F 1

Year 2037 Build Alternative – HCS Multilane Highway Analysis Worksheets

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst: SD
Agency/Co: Jacobs
Date: 5/9/2012
Analysis Period: AM
Highway: USA Parkway
From/To: County Line to US50
Jurisdiction:
Analysis Year: 2037
Project ID: No-Highlands

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	0		0	
Median type				
Free-flow speed:	Measured		Measured	
FFS or BFFS	60.0	mph	60.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	0.0	mph	0.0	mph
Free-flow speed	60.0	mph	60.0	mph

VOLUME

Direction	1		2	
Volume, V	900	vph	1040	vph
Peak-hour factor, PHF	0.90		0.90	
Peak 15-minute volume, v15	250		289	
Trucks and buses	12	%	12	%
Recreational vehicles	0	%	0	%
Terrain type	Rolling		Rolling	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	2.5		2.5	
Recreational vehicles PCE, ER	2.0		2.0	
Heavy vehicle adjustment, fHV	0.847		0.847	
Flow rate, vp	590	pcphpl	681	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	590	pcphpl	681	pcphpl
Free-flow speed, FFS	60.0	mph	60.0	mph
Avg. passenger-car travel speed, S	60.0	mph	60.0	mph
Level of service, LOS	A		B	
Density, D	9.8	pc/mi/ln	11.4	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp		55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	500.0	577.8
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	5.94	6.02
Bicycle LOS	F	F

Overall results are not computed when free-flow speed is less than 45 mph.

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst:	SD
Agency/Co:	Jacobs
Date:	5/9/2012
Analysis Period:	PM
Highway:	USA Parkway
From/To:	County Line to US50
Jurisdiction:	
Analysis Year:	2037
Project ID:	No-Highlands

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	0		0	
Median type				
Free-flow speed:	Measured		Measured	
FFS or BFFS	60.0	mph	60.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	0.0	mph	0.0	mph
Free-flow speed	60.0	mph	60.0	mph

VOLUME

Direction	1		2	
Volume, V	1160	vph	1000	vph
Peak-hour factor, PHF	0.90		0.90	
Peak 15-minute volume, v15	322		278	
Trucks and buses	12	%	12	%
Recreational vehicles	0	%	0	%
Terrain type	Rolling		Rolling	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	2.5		2.5	
Recreational vehicles PCE, ER	2.0		2.0	
Heavy vehicle adjustment, fHV	0.847		0.847	
Flow rate, vp	760	pcphpl	655	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	760	pcphpl	655	pcphpl
Free-flow speed, FFS	60.0	mph	60.0	mph
Avg. passenger-car travel speed, S	60.0	mph	60.0	mph
Level of service, LOS	B		A	
Density, D	12.7	pc/mi/ln	10.9	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp	55	55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	644.4	555.6
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	6.07	6.00
Bicycle LOS	F	F

Overall results are not computed when free-flow speed is less than 45 mph.

Appendix F 2
Year 2017 Build Alternative – HCS Multilane Highway Analysis Worksheets

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst: SD
Agency/Co: Jacobs
Date: 8/8/2012
Analysis Period: AM
Highway: USA Parkway
From/To: County line to US50
Jurisdiction: NDOT
Analysis Year: 2017
Project ID:

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	0		0	
Median type				
Free-flow speed:	Measured		Measured	
FFS or BFFS	60.0	mph	60.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	0.0	mph	0.0	mph
Free-flow speed	60.0	mph	60.0	mph

VOLUME

Direction	1		2	
Volume, V	280	vph	350	vph
Peak-hour factor, PHF	0.90		0.90	
Peak 15-minute volume, v15	78		97	
Trucks and buses	12	%	12	%
Recreational vehicles	0	%	0	%
Terrain type	Rolling		Rolling	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	2.5		2.5	
Recreational vehicles PCE, ER	2.0		2.0	
Heavy vehicle adjustment, fHV	0.847		0.847	
Flow rate, vp	183	pcphpl	229	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	183	pcphpl	229	pcphpl
Free-flow speed, FFS	60.0	mph	60.0	mph
Avg. passenger-car travel speed, S	60.0	mph	60.0	mph
Level of service, LOS	A		A	
Density, D	3.0	pc/mi/ln	3.8	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp		55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	155.6	194.4
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	5.35	5.46
Bicycle LOS	E	E

Overall results are not computed when free-flow speed is less than 45 mph.

Phone: Fax:
E-mail:

OPERATIONAL ANALYSIS

Analyst:	SD
Agency/Co:	Jacobs
Date:	8/8/2012
Analysis Period:	PM
Highway:	USA Parkway
From/To:	County line to US50
Jurisdiction:	NDOT
Analysis Year:	2017
Project ID:	

FREE-FLOW SPEED

Direction	1		2	
Lane width	12.0	ft	12.0	ft
Lateral clearance:				
Right edge	6.0	ft	6.0	ft
Left edge	6.0	ft	6.0	ft
Total lateral clearance	12.0	ft	12.0	ft
Access points per mile	0		0	
Median type				
Free-flow speed:	Measured		Measured	
FFS or BFFS	60.0	mph	60.0	mph
Lane width adjustment, FLW	0.0	mph	0.0	mph
Lateral clearance adjustment, FLC	0.0	mph	0.0	mph
Median type adjustment, FM	0.0	mph	0.0	mph
Access points adjustment, FA	0.0	mph	0.0	mph
Free-flow speed	60.0	mph	60.0	mph

VOLUME

Direction	1		2	
Volume, V	390	vph	310	vph
Peak-hour factor, PHF	0.90		0.90	
Peak 15-minute volume, v15	108		86	
Trucks and buses	12	%	12	%
Recreational vehicles	0	%	0	%
Terrain type	Rolling		Rolling	
Grade	0.00	%	0.00	%
Segment length	0.00	mi	0.00	mi
Number of lanes	2		2	
Driver population adjustment, fP	1.00		1.00	
Trucks and buses PCE, ET	2.5		2.5	
Recreational vehicles PCE, ER	2.0		2.0	
Heavy vehicle adjustment, fHV	0.847		0.847	
Flow rate, vp	255	pcphpl	203	pcphpl

RESULTS

Direction	1		2	
Flow rate, vp	255	pcphpl	203	pcphpl
Free-flow speed, FFS	60.0	mph	60.0	mph
Avg. passenger-car travel speed, S	60.0	mph	60.0	mph
Level of service, LOS	A		A	
Density, D	4.3	pc/mi/ln	3.4	pc/mi/ln

Bicycle Level of Service

Posted speed limit, Sp		55
Percent of segment with occupied on-highway parking	0	0
Pavement rating, P	3	3
Flow rate in outside lane, vOL	216.7	172.2
Effective width of outside lane, We	24.00	24.00
Effective speed factor, St	4.79	4.79
Bicycle LOS Score, BLOS	5.52	5.40
Bicycle LOS	F	E

Overall results are not computed when free-flow speed is less than 45 mph.