

# I-190/Silver Street Study

Interchange Modification Justification Report  
December, 2011



# **Interchange Modification Justification Report**

## **I-190/Silver Street Interchange**

Rapid City, South Dakota  
December 2011

Prepared for:



South Dakota Department of Transportation  
Office of Project Development  
700 East Broadway Avenue  
Pierre, South Dakota 57501-2586

Prepared by:



HDR Engineering, Inc.  
6300 South Old Village Place  
Suite 100  
Sioux Falls, SD 57108

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## Summary

The Federal Highway Administration (FHWA) has instituted rules and regulations guiding any new access points or proposed changes to existing access points on the Interstate Highway System. FHWA's interest is designed to preserve the smooth operation of the Interstate system and prevent the safety of the Interstate system from being compromised by ill-considered access points. Specifically, FHWA lists the following concerns regarding new and revised Interstate access:

- Access should be based on information and analysis of the planning, environmental, design, safety and operational affects of the proposed change.
- Support the intended purpose of the Interstate System.
- Do not have an adverse impact on the safety or operations of the Interstate System and connecting local roadway network or other elements of the transportation system.
- Are designed to acceptable standards.

These rules are most important in the consideration of applications for new access points, but also apply to any revision of existing access points. Typically, an Interstate access report, such as this one, is used to document the analysis and consideration of Interstate access requests.

In this case, the access modification requested is the revision of the existing Silver Street interchange (Exit 1C) on Interstate 190 (I-190) in Rapid City, SD. The existing interchange has structural deficiencies that require structure replacement in a relatively short time frame. This appears to be an opportune time to also upgrade the interchange to meet current design standards and to comply with current community plans. No changes are planned that would materially change the expected loading of the Interstate system above what is expected for the existing interchange.

The No-Build alternative for the interchange was considered along with a number of revised interchange configurations. All the revised interchange configurations are intended to eliminate the existing design deficiencies. A change of the local street configuration was considered to comply with local transportation planning. The revised local street configuration would eliminate a severe skew in the interchange area and create a more useful east-west arterial street pattern.

The study was conducted under the overview of a Study Advisory Team (SAT) comprised of representatives from the Federal Highway Administration (FHWA), South Dakota Department of Transportation (SDDOT), the City of Rapid City, and the Rapid City Metropolitan Planning Organization. Data were supplied by the Study Team agencies and the consultant, and traffic forecasts were prepared using the regional travel demand model (City/MPO). Interchange alternatives were developed and evaluated with public input provided at public meetings, and through comments received via electronic and mail services. A project web page was maintained by SDDOT, with links from the City web site and other sources.

An Environmental Assessment (EA) is being prepared on a parallel track with this Interstate access study. Therefore, data and findings have been shared between the two studies. Alternatives that have been screened out through the environmental process are so identified in this report. The preferred alternative is also being identified by the EA, with input and confirmation provided by the Interstate access process.

The Interstate access analysis shows that Alternative 2a, a single-point interchange with a re-aligned cross-road configuration best meets the purpose and need for an updated Silver Street interchange on I-190. All eight policy requirements for revised Interstate access are satisfied by the proposal and are detailed in Chapter 9 – Recommendations.

# 1.0 Introduction

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## 1.1. *Background*

SDDOT is conducting a multi-phase study to evaluate the design, operations, policy and funding implications of replacing the Silver Street interchange on I-190 in Rapid City. The study was spurred by structural deficiencies with the Silver Street Interchange bridges. The first phase of the study developed interchange and intersection alternatives to replace the existing interchange, coordinated the alternatives with SDDOT and the City of Rapid City, measured public opinion regarding potential changes, estimated the implications on federal funding, recommended a path for regulatory approval (if needed), and forecast the impacts on transportation operations and the environment. The current phase of the study is investigating the chosen options in more detail to fulfill the Federal requirements for analysis contained in an Interstate Modification Justification Report (IMJR). The IMJR is being conducted in conjunction with an Environmental Assessment, with the IMJR providing operational analysis and the preferred alternative being selected as part of the Environmental Assessment.

## 1.2. *Purpose*

The purpose of this report is to investigate the feasibility of modifying the existing service interchange on Interstate 190 in Rapid City, South Dakota. The Interstate access study is based on guidelines identified by the Federal Highway Administration (FHWA) in the Federal Register. This report was prepared for SDDOT for submittal to FHWA for approval.

## 1.3. *Project Location*

The proposed modified service interchange will be located along the existing Interstate 190. An area map showing the location of Exit 1 along with the existing transportation network is shown in Figure 1.

The guidelines for the report are published in the Federal Register by the FHWA and recommend that the first adjacent existing or proposed interchange be studied for operation/capacity. It is also recommended that crossroads and other streets be included in the analysis to insure their ability to distribute traffic to and from the proposed interchange. The study area boundary is shown in Figure 2. It includes the Silver Street interchange on I-190, the adjacent system interchange at I-90/I-190, the terminal intersection at I-190/Omaha Street, and the intersecting streets (North Street, Silver Street, and Philadelphia Street) from Mt. Rushmore Road on the east to Founders Park Drive on the west. It also shows the portion of the study area being considered in the Environmental Assessment. Note that Federal policy requires analysis of Interstate interchanges for operations and capacity that are not required for the environmental assessment.

Figure 1-1 – I-190/Silver Street Interchange Location (including I-90 exit 57)





Figure 1-2 – Proposed Study Area Boundary



## 2.0 Methodology

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Preparation of this report used the following work tasks:

1. Data gathering
2. Develop alternative concepts
3. Determine special needs related to Central High School, Rushmore Plaza Civic Center and other study area institutions.
4. Determine operational characteristics of Interstate and local street facilities.
5. Coordinate with Study Area utilities
6. Coordinate with City and developers regarding study area development plans.
7. Estimate the safety effects of each alternative.
8. Conduct public outreach and gather public input
9. Prepare layouts of interchange alternatives and local street improvements.
10. Prepare deliverable reports, including:
  - a. Structure type selection report
  - b. Traffic memo
  - c. Plan/profile sheets
  - d. Utility memo
  - e. Constructability memo
  - f. Interchange Modification Justification Report (draft and final)

Traffic forecasts were prepared using output from the regional travel demand model maintained by the City of Rapid City. Traffic operations were analyzed using Highway Capacity Manual techniques and Synchro™ signal analysis techniques.

This IMJR document is organized in accordance with section 2.5.2 of FHWA's *Interstate System Access Information Guide*, August 2010.

## 3.0 Existing Conditions

### 3.1. *Demographics*

Rapid City's 2010 Demographic Profile includes the following statistics:

Total Population	67,956
Total Housing Units	30,254
Male	33,605
Female	34,351
Under 18	16,241
18 and over	51,715
20-24	5,369
25-34	9,989
35-49	12,009
50-64	12,598
65 & over	9,850
White	54,658
African American	764
Asian	795
American Indian/Al. native	8,416
Hawaiian/Pacific	52
Other	477
Identified by two or more	2,794

The Environmental Analysis indicated that populations may be present in the study area requiring consideration of environmental justice in the environmental process.

### 3.2. *Existing Land Use*

The study area is characterized by primarily single family residential neighborhoods, with scattered multi-family residential and neighborhood institutional uses. Parks exist along Rapid Creek in the southern study area and at other scattered locations. Large parcels of institutional use are devoted to Central High School and the Rushmore Plaza Civic Center.

### 3.3. *Existing Roadway Network*

Interstate 190 is a spur route on the Interstate Highway System connecting Interstate 90 with Omaha Street (SD Highway 44) in the central business district of Rapid City, SD. Interstate 190 is an auxiliary Interstate Highway that runs 1.72 miles from I-90 Exit 57 southward into downtown Rapid City. It also carries the designation U.S. Highway 16 and was opened in 1962. It was constructed to fulfill part of the Interstate's original mission of connecting major cities. At the time that the route for Interstate 90 was being selected, Rapid City did not extend as far north as it currently does. Consequently, the I-190 link was built to provide the desired Interstate link between Rapid City and the rest of the Interstate system. Rapid City has now grown to encompass roughly six miles of Interstate 90 and is served by six I-90 interchanges.

City of Rapid City roadways North Street and Silver Street intersect at the existing Silver Street interchange creating a crossroad with an extreme forty five degree skew on the west side of the interchange and a more standard right-angle approach on the east side of the interchange. Omaha Street is the primary east-west arterial street in Rapid City and intersects with the south termini of Interstate 190. West Boulevard forms the south leg of the I-190/Omaha St. intersection and also exists as the frontage road on both sides of I-190. The Anamosa Street bridge crosses over I-190 five blocks north of the Silver

Street interchange and Haines Avenue provides a parallel arterial east of I-190. Other residential streets also exist within the study area.

City of Rapid City land use and transportation plans call for changes to the local street system in the future, with North Street connecting to Philadelphia Street and creating a desirable through-route instead of the existing skewed connection with Silver Street.

### 3.4. Interchanges

There is only one service interchange on Interstate 190, the Silver St./North St. interchange (exit 1). It is configured as a non-traditional diamond interchange with a variety of non-standard ramp and interchange layout components. The southbound off-ramp intersects with Silver Street west of I-190 with an all-way stop intersection. The southbound on-ramp is served by channelized movements from Silver St. and North St. and functions as a frontage road for approximately 1200', with access from properties to the

Figure 3-1 – Silver St. Interchange Area

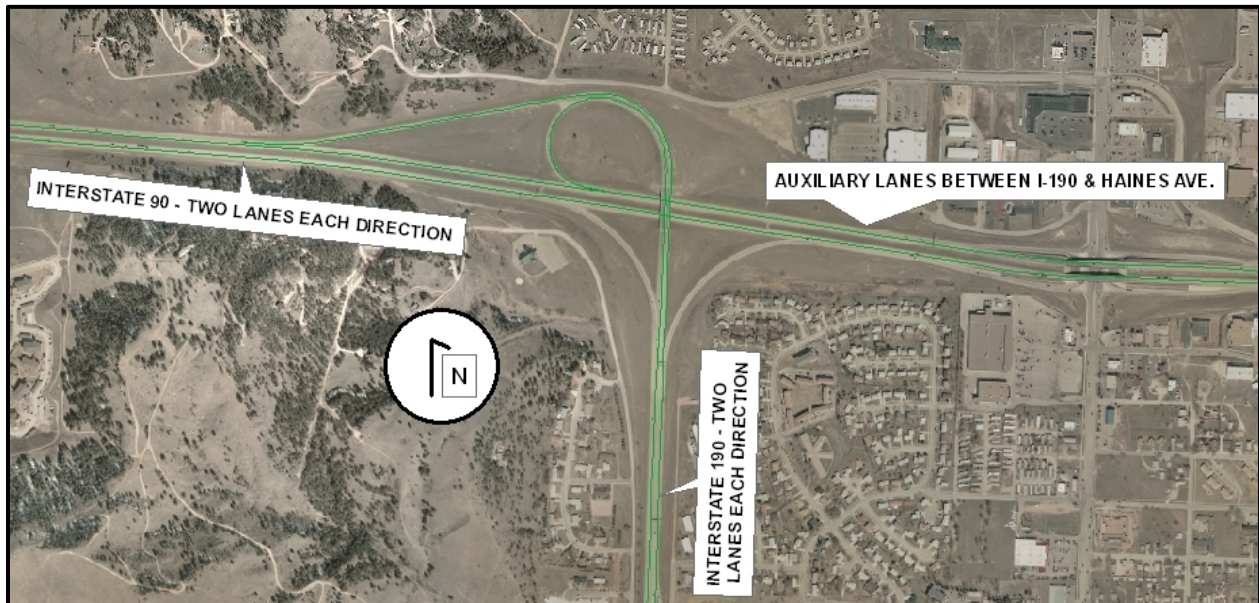


southwest. Both south ramps have minimal separation from the I-190 mainline. On the east side of the interchange, an all-way stop intersection serves the northbound off-ramp connecting the north and south segments of West Boulevard. West Boulevard also serves as an I-190 frontage road and provides access for a high school in the southeast quadrant of the interchange. The northbound on-ramp to I-190 is located five blocks north of Silver Street, just north of Anamosa Street. West Boulevard serves as a frontage road between the two locations.

The existing Silver Street interchange has deficiencies related to its non-standard configuration along with limited overhead clearance under I-190 at the bridges. While these were acceptable designs when the Silver Street interchange was built, the current Silver Street interchange configuration would not be allowed on the Interstate system today.

A system interchange exists north of the Silver Street interchange at the junction of I-190 with I-90. This interchange is a T-type system connection with a loop for westbound to southbound traffic and standard ramps for other movements. The interchange is in generally good condition and no large scale modifications are currently planned. Auxiliary lanes connect the system interchange with the service interchange at Haines Street, the next interchange east of I-190.

Figure 3-2 – I-90/I-190 System Interchange (I-190 Exit 1A & 1B)



### 3.5. *Alternative Travel Modes*

Rapid City, like most of South Dakota and the West, is dependent on automobile travel to meet most travel needs. Rapid City does operate fixed-route and demand bus transit services, with the Roosevelt Route winding through the study area. Pedestrian and bicycle modes are both present in the study area for all trip purposes, with service provided on recreational trails, sidewalks and streets. The proportion of total trips provided by alternative travel modes is quite small.

### 3.6. *Existing Data*

Most study data was available from the participating agencies, including counts, crash data, and raw travel demand model output. The available data was supplemented with additional counts, travel time runs, and traffic observations.

### 3.7. Operational Performance

The existing Silver Street interchange provides adequate capacity, although there are design deficiencies related to confusing channelization, low clearance, cross-road skew, driveways on Interstate ramps, and an on-ramp separated from the rest of the interchange.

Interstate 190 also provides adequate capacity and has experienced no significant operational problems.

The local street network provides adequate capacity, although certain movements experience brief congestion during peak travel times. Overall, local street intersections meet State and City level of service goals.

The results of operational analyses are shown in Tables 3-1 through 3-3.

**TABLE 3-1 INTERSTATE MAINLINE LOS**

SECTION	2010 AM	2010 PM
NB OMAHA TO SILVER OFF	A	A
NB SILVER OFF TO ANAMOSA ON	A	A
NB ANAMOSA ON TO I-90	A	A
SB I-90 TO SILVER OFF	A	A
SB SILVER OFF TO SILVER ON	A	A
SB SILVER ON TO OMAHA	A	A

**TABLE 3-2 INTERSTATE RAMP LOS**

RAMP	2010 AM	2010 PM
NB SILVER OFF	A	B
NB ANAMOSA ON	A	B
NB I-90 OFF	A	A
SB I-90 ON	A	A
SB SILVER OFF	A	A
SB SILVER ON	A	A

**TABLE 3-3 INTERSECTION LOS**

<b>INTERSECTION</b>	<b>2010 AM</b>	<b>2010 PM</b>
SILVER ST./I-190 SB	A	A
NORTH ST./I-190 NB	A	A
NORTH ST./MT. RUSHMORE RD.	C	B
OMAHA ST./MT. RUSHMORE RD.	C	D
OMAHA ST./I-190	C	C

Study area traffic volumes are shown in Figures 3-3 through 3-6.

### **3.8. Existing Safety Conditions**

A comprehensive safety analysis was conducted as part of Phase 1 of this study. That analysis, which looked at a larger study area and evaluated crash statistics for the Interstate and local street systems, has been reproduced in the Appendix for reference.

The crash analysis found that the crash rate at the existing interchange is relatively low and no trends were observed that indicated the need for safety improvements, although there are potential safety problems related to the existing design deficiencies. Specifically, the driveways on the Interstate ramps and the cross-road skew are viewed as sources of potential future crashes.

Other street intersections within the study area, including North St./Mt. Rushmore Rd., Omaha St./Mt. Rushmore Rd., and Omaha St./I-190/West Blvd., had slightly elevated crash rates that may indicate the need for safety-related improvements. Recommendations for those intersections are made in the Phase 1 report and none of the suggested improvements were related to the interchange configuration at I-190/Silver St.

A Road Safety Audit is planned to be conducted on the EA's preferred alternative prior to proceeding to final design.

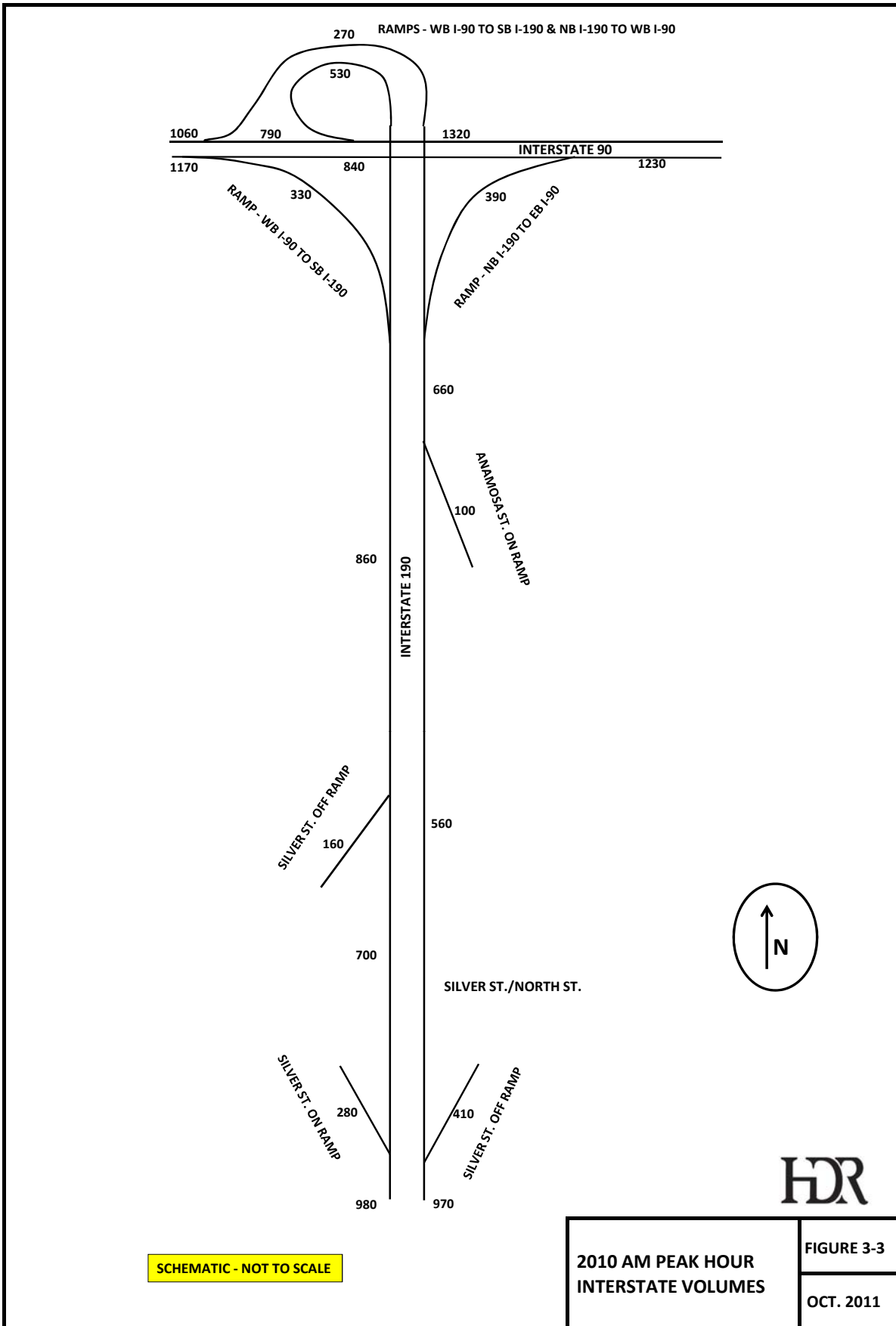
### **3.9. Existing Environmental Constraints**

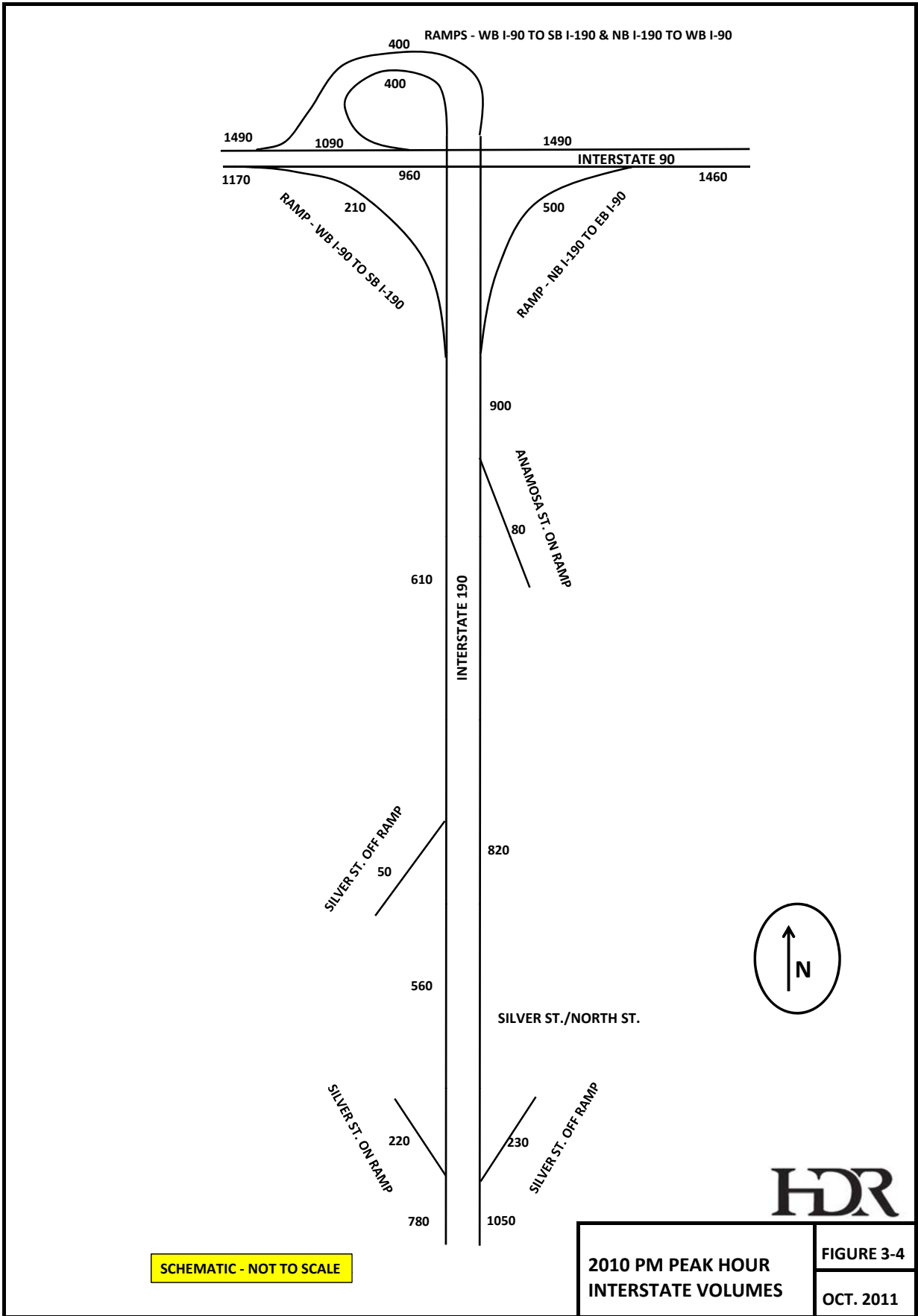
Environmental constraints are discussed thoroughly in the Environmental Assessment that is being prepared on a parallel track with this Interstate access study. Some of the most notable constraints identified in the study area include:

- Existing parks and public facilities.
- Existing utilities.
- Potential archeological or historical resources.
- Rapid Creek floodplain.
- Steep slopes and adjacent terrain.
- Existing established neighborhoods.
- Potential environmental justice populations.
- Potential noise impacts.
- Potential wetland and short-term water quality impacts.



The selection of a preferred alternative in the EA is being guided by the need to minimize and mitigate any potential impacts. At the time of this report, it appears that a preferred alternative will be found that will allow reconstruction of the existing interchange.

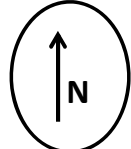
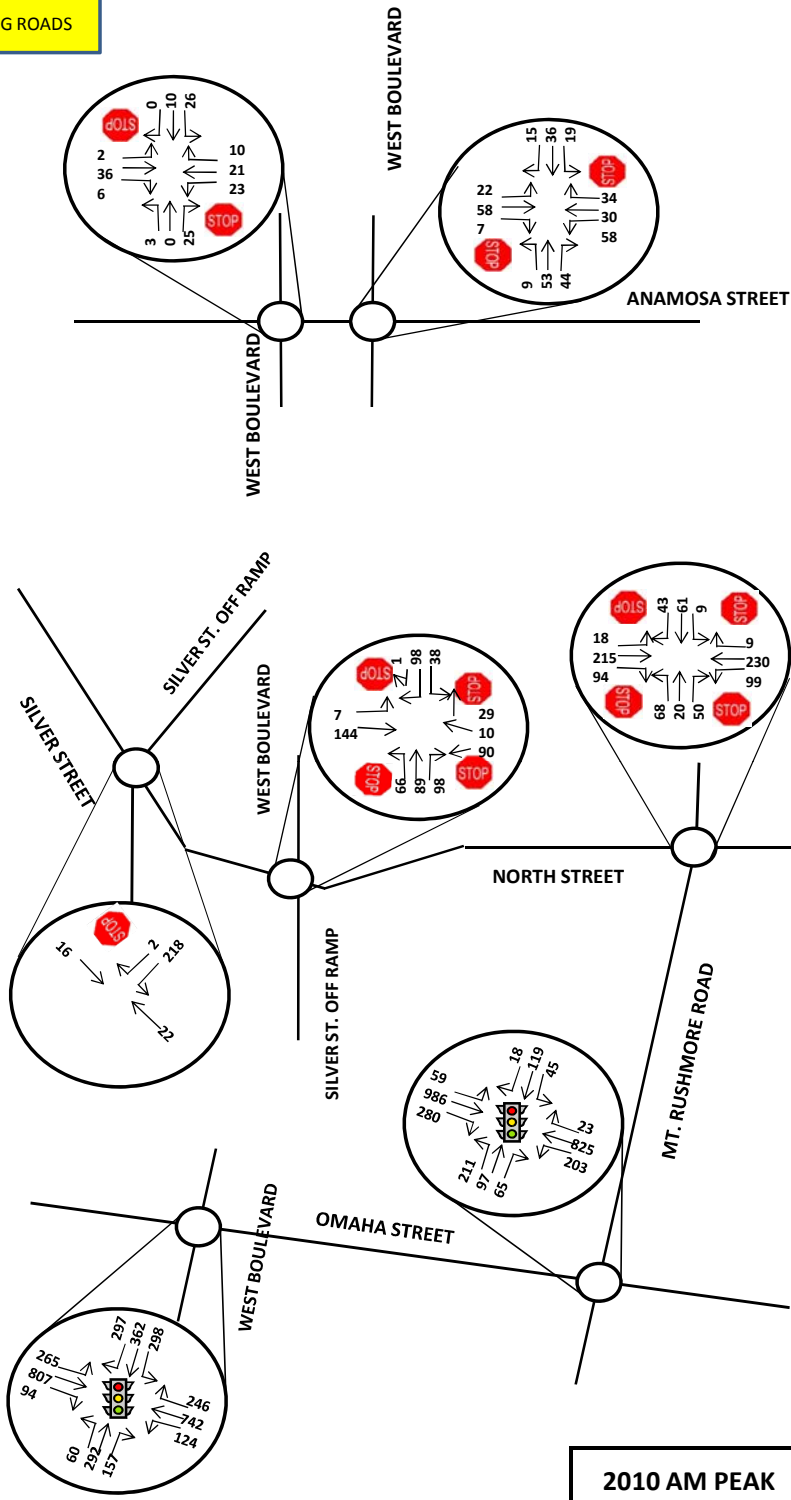






**LEGEND**

- 123 TURNING MOVEMENTS
-  TRAFFIC SIGNAL
-  STOP SIGN
- EXISTING ROADS





**SCHEMATIC - NOT TO SCALE**

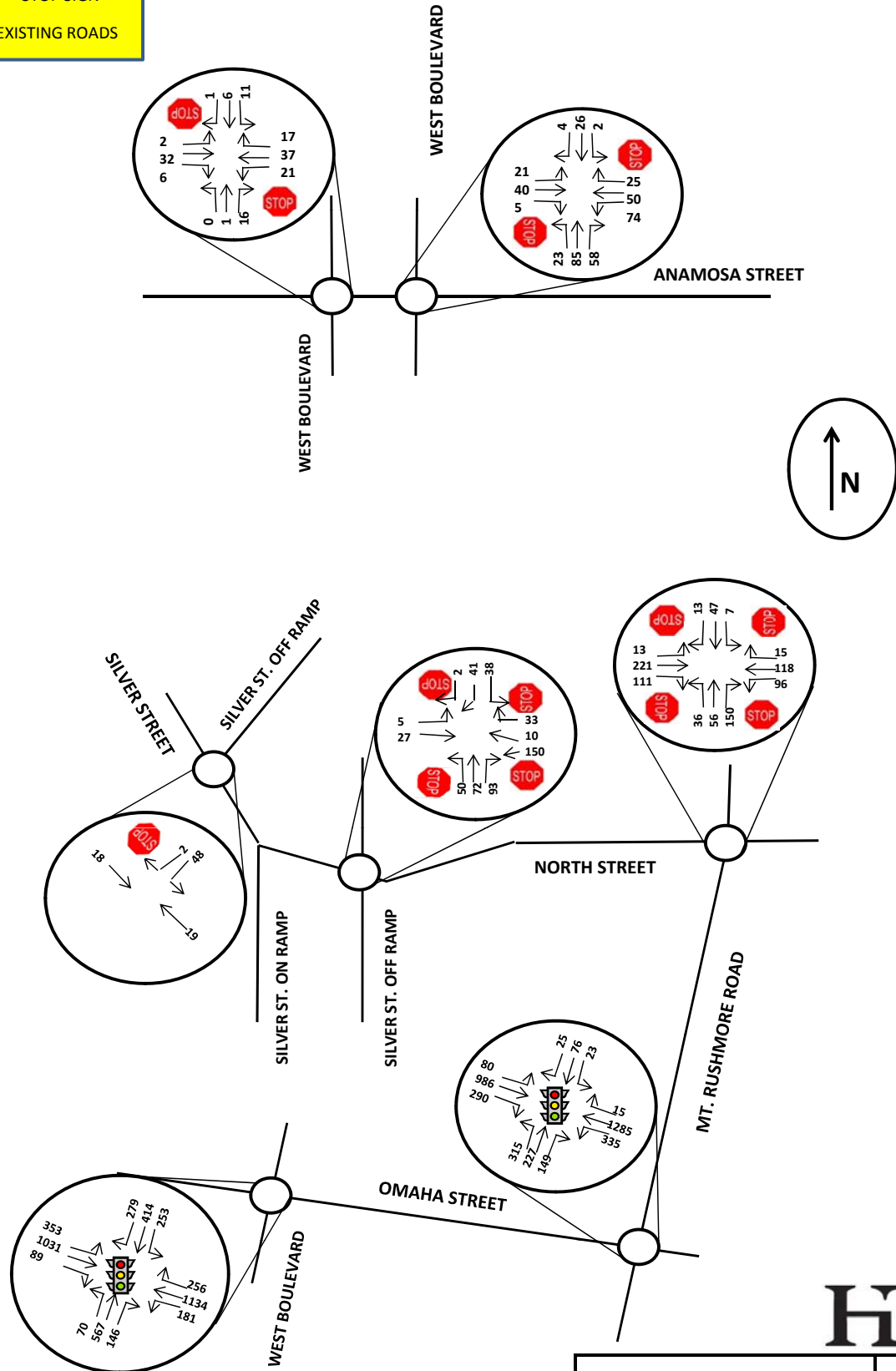


**2010 AM PEAK  
HOUR ARTERIAL  
TURNING VOLUMES**

**FIGURE 3-5  
OCT. 2011**

**LEGEND**

- 123 TURNING MOVEMENTS
-  TRAFFIC SIGNAL
-  STOP SIGN
- EXISTING ROADS



**SCHEMATIC - NOT TO SCALE**

**2010 PM PEAK  
HOUR ARTERIAL  
TURNING VOLUMES**

**FIGURE 3-6  
OCT. 2011**



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## 4.0 Need

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The purpose and need for the project is discussed in detail in the Environmental Assessment that is proceeding in parallel with this study. The primary needs have been identified as:

- **Structural Deficiencies** - Need to improve the existing structure due to deficiencies
- **Transportation Demand** - Need to construct an interchange that is consistent with the City's long-range transportation plan
- **Safety** - Need to construct an interchange that meets current design standards, specifically for safety

## 5.0 Alternative Concepts

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### 5.1. **No-Build Alternative**

There is always a choice available to not proceed with reconstruction of existing infrastructure. In this case, failure to rebuild the existing interchange will result in eventual closure of this portion of Interstate 190 because of the structures' declining condition. The no-build choice will also allow existing design deficiencies to remain in place.

### 5.2. **Improvements to Alternative Interchanges**

The Silver Street interchange is the only service interchange on Interstate 190. Therefore, there are no alternative interchanges on I-190 that may be improved to carry the traffic currently using the existing interchange. Adjacent interchanges on Interstate 90 are already experiencing periodic congestion, which would be worsened by any additional traffic from the Silver Street interchange. Also, rerouting traffic to I-90 interchanges would disrupt the community's existing land use and transportation plans.

### 5.3. **Transportation Systems Management Alternative**

While Transportation Systems Management (TSM) measures are being used and will continue to be used in the study area, they do not provide a solution either for the existing structural deficiencies or the need to maintain Interstate access at this location.

### 5.4. **Alternatives Providing a Change in Access**

The existing non-standard interchange design, with the skewed crossroad connection, use of city streets to reach the northbound on-ramp, and multiple driveways intersecting ramps, spurred the consideration of interchange reconfiguration at the time that the existing interchange bridges needed to be replaced. The bridges are reaching the end of their serviceable lives creating a pressing need to replace and update the interchange configuration.

#### 5.4.1. **Preliminary Build Alternatives –Diamond, Single Point and Loop Interchanges**

Each of the eight diamond, single-point and loop interchange alternatives developed by HDR for the reconstruction of the I-190/Silver Street Interchange were presented to FHWA and SDDOT and the Public during Phase 1 of the I-190/Silver Street Study and at a public meeting held on March 29, 2011.

The general design criteria used to develop the eight options are as follows:

- Replace deficient bridges
- Provide adequate mainline spacing to adjacent interchanges.
- Maintain acceptable service within the current roadway/highway network.
- Utilize acceptable design speeds for all interchange roadways.
- Eliminate access to the school from the northbound off ramp due to safety.
- Eliminate the northbound on-ramp 5 blocks north on Anamosa Street.

#### **Alternative 1**

Full diamond interchange at Silver Street/North Street with I-190 shifted west. Shifting the I-190 alignment to the west allows for sufficient room to build all interchange options and provide adequate turn lanes and other geometric features. The southbound I-190 ramp terminal in this option exhibits a fairly high degree of skew on the cross-road and subsequent sharp turning paths on some movements. The mainline bridges would be relatively long due to the cross-road skew.

Additional right-of-way would be needed west of the existing I-190, although some of the needed property is already in public ownership. Additional local street connections would be needed west of the interchange to facilitate local traffic movement. The parking lots at Central High School would no longer be allowed to access the Interstate off ramp in this concept. Please refer to Figure 5-1 for a graphic depiction of Alternative 1.

### ***Alternative 1a***

Full diamond interchange at North Street with I-190 shifted west. This option is similar to option 1, except the cross-road has been realigned to connect to the new local street west of the interchange. The geometry of the ramp terminal intersections is improved over option 1. Please refer to Figure 5-2 for a graphic depiction of Alternative 1a.

### ***Alternative 2***

Single point diamond interchange at Silver Street/North Street with I-190 shifted west. The single-point ramp terminal suffers from a fairly high degree of skew on the cross-road and a large area of pavement for turning movements. The mainline bridges would be relatively long and wide due to the cross-road skew. Additional right-of-way would be needed west of the existing I-190, although some of the needed property is already in public ownership. The additional right-of-way required would be less than option 1 or option 1a. Additional local street connections would be needed west of the interchange to facilitate local traffic movement. The parking lots at Central High School would no longer be allowed to access the Interstate off ramp in this concept. Please refer to Figure 5-3 for a graphic depiction of Alternative 2.

### ***Alternative 2a***

Single point diamond interchange at North Street with I-190 shifted west. This option is similar to option 2, except the cross-road has been realigned to connect to the new local street west of the interchange. The geometry of the ramp terminal intersection is improved over option 2 and the bridge dimensions are reduced from option 2. Please refer to Figure 5-4 for a graphic depiction of Alternative 2a.

### ***Alternative 2b***

Hybrid interchange with features of diamond and single-point interchanges. The on-ramps are served by a central intersection and the off-ramps terminate in stop-controlled intersections. The interchange configuration fits the existing street system, but would produce greater delay for off-ramp traffic than other configurations. Please refer to Figure 5-5 for a graphic depiction of Alternative 2b.

### ***Alternative 3***

I-190 interchange with loop at North Street. Connecting the cross-road to the new roadway west of the interchange results in the opportunity to provide a loop ramp to handle one of the largest turning volumes. Eastbound traffic would not be able to turn south at the interchange in this concept, but other local street alternatives are available. The mainline bridges would be relatively short in this option, but the southbound bridge would need to be three lanes wide to handle the accelerating loop traffic. Additional right-of-way would be needed west of the existing I-190, although some of the needed property is already in public ownership. The additional right-of-way required would be larger in the loop quadrant, but less in the southwest quadrant. Additional local street connections would be needed west of the interchange to facilitate local traffic movement. The parking lots at Central High School would no longer be allowed to access the Interstate off ramp in this concept. Please refer to Figure 5-6 for a graphic depiction of Alternative 3.

### ***Alternative 3a***

I-190 interchange with loop at North Street and EB to SB access. This concept is similar to option 3, but a connection is provided for eastbound traffic to access the loop. Please refer to Figure 5-7 for a graphic depiction of Alternative 3a.

### ***Alternative 3b***

I-190 interchange with Loop at North Street and EB to SB on-ramp. This concept is similar to option 3, but a southbound on ramp is provided to serve eastbound traffic. Please refer to Figure 5-8 for a graphic depiction of Alternative 3b.

Many of the interchange alternatives would require revised local street connections to provide continued neighborhood transportation service. These neighborhood connections were the subject of design consideration and public consultation and are shown on the alternatives layouts. Please refer to the EA for more in-depth discussion of the neighborhood connections and neighborhood impact mitigation.

## **5.4.2. Preliminary Build Alternatives – At Grade Signalized**

Alternatives for at-grade signalized intersections were developed for the existing interchange area as part of the Phase 1 analysis. Phase 1 resulted in the decision by SDDOT to maintain the Interstate highway designation for I-190 and not further pursue at-grade alternatives for replacement of the Silver Street interchange.

## **5.5. Determination of Alternatives to Carry Forward**

Each of the Preliminary Build Alternatives along with the No-Build Alternative was presented at a Public Open House on March 29, 2011. Comments from the Open House were considered and design criteria were applied to all the Preliminary Build Alternatives. As a result, the Study Advisory Team meeting recommended the following dispositions for the Preliminary Build Alternatives:

- Alternative 1, Diamond with skewed crossroad: retain for further analysis.
- Alternative 1a, Diamond with realigned crossroad: retain for further analysis.
- Alternative 2, Single point with skewed crossroad: the skewed crossroad resulted in larger structures than other alternatives, an oversized local street intersection, difficult ramp alignment, poor signalization geometrics, safety concerns and other issues. This alternative was screened out from further analysis.
- Alternative 2a, Single point with realigned crossroad: retain for further analysis.
- Alternative 2b, Combined single point/diamond: the skewed crossroad resulted in larger structures than other alternatives and other issues similar to Alternative 2. This alternative was screened out from further analysis.
- Alternative 3, partial cloverleaf: the alternative had a larger footprint and greater potential for environmental impacts than other alternatives and didn't provide for all movements, as required by FHWA rules. This alternative was screened out from further analysis.
- Alternative 3a, partial cloverleaf: retain for further analysis
- Alternative 3b, partial cloverleaf: the alternative had a larger footprint and greater potential for environmental impacts than other alternatives, particularly impacts within the floodway and on the existing structures over Rapid Creek. This alternative was screened out from further analysis.



### **5.5.1. Build Alternatives**

Four build alternatives; 1, 1a, 2a, and 3a, were evaluated as part of the operational analysis in this report and were carried forward to the environmental assessment that is being simultaneously developed.

### **5.5.2. No-Build Alternative**

As pointed out in the previous sections, the existing interchange configuration does not meet current design standards. Since the existing structures need to be replaced in the immediate future, the time is appropriate for bringing the interchange up to a currently acceptable configuration. The No Build alternative will be carried forward to the Environmental Assessment as a baseline for comparison with the Build Alternatives, but will not likely be selected as the preferred alternative.

Figure 5-1 Alternative 1

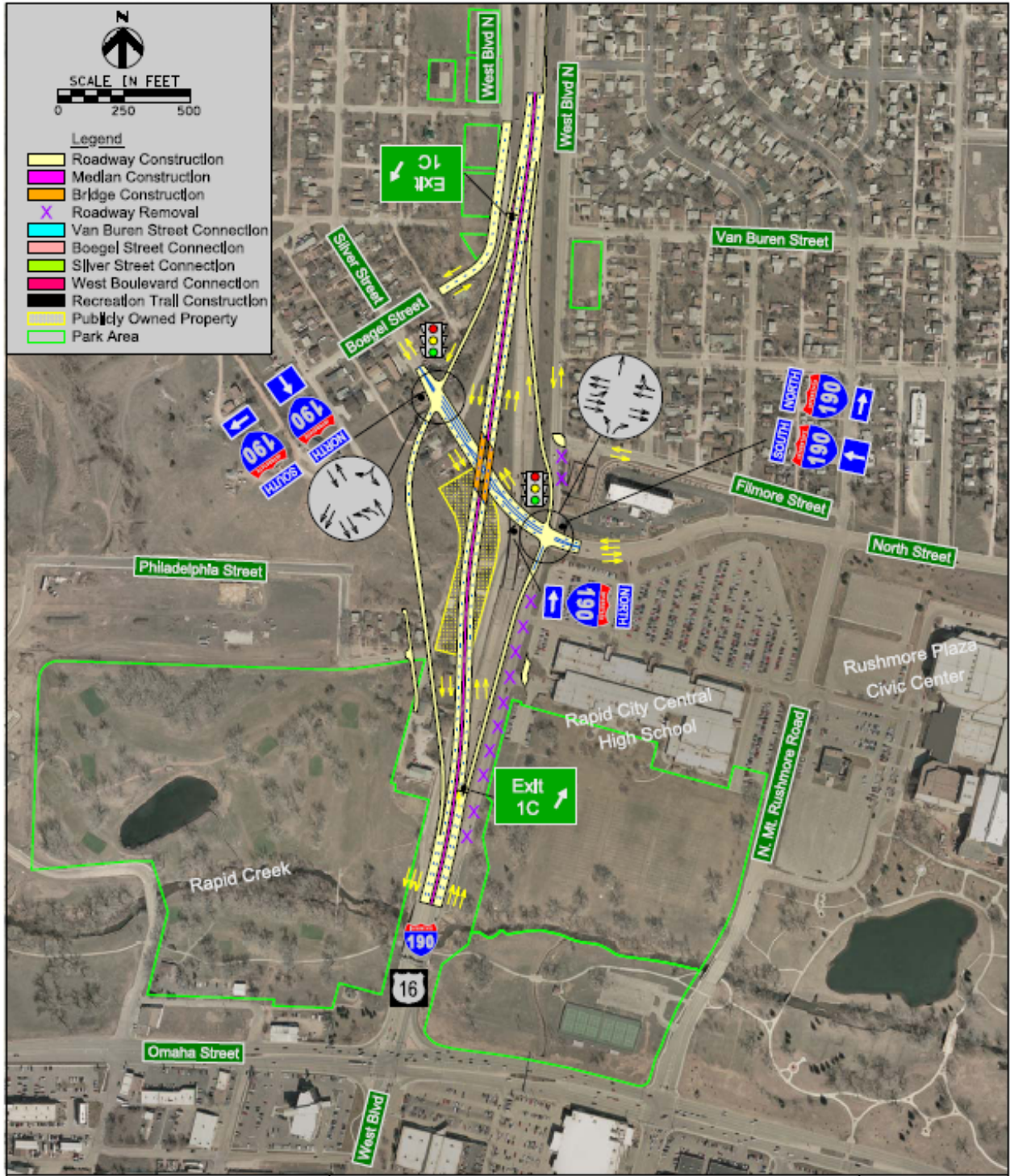


Figure 5-2 Alternative 1a

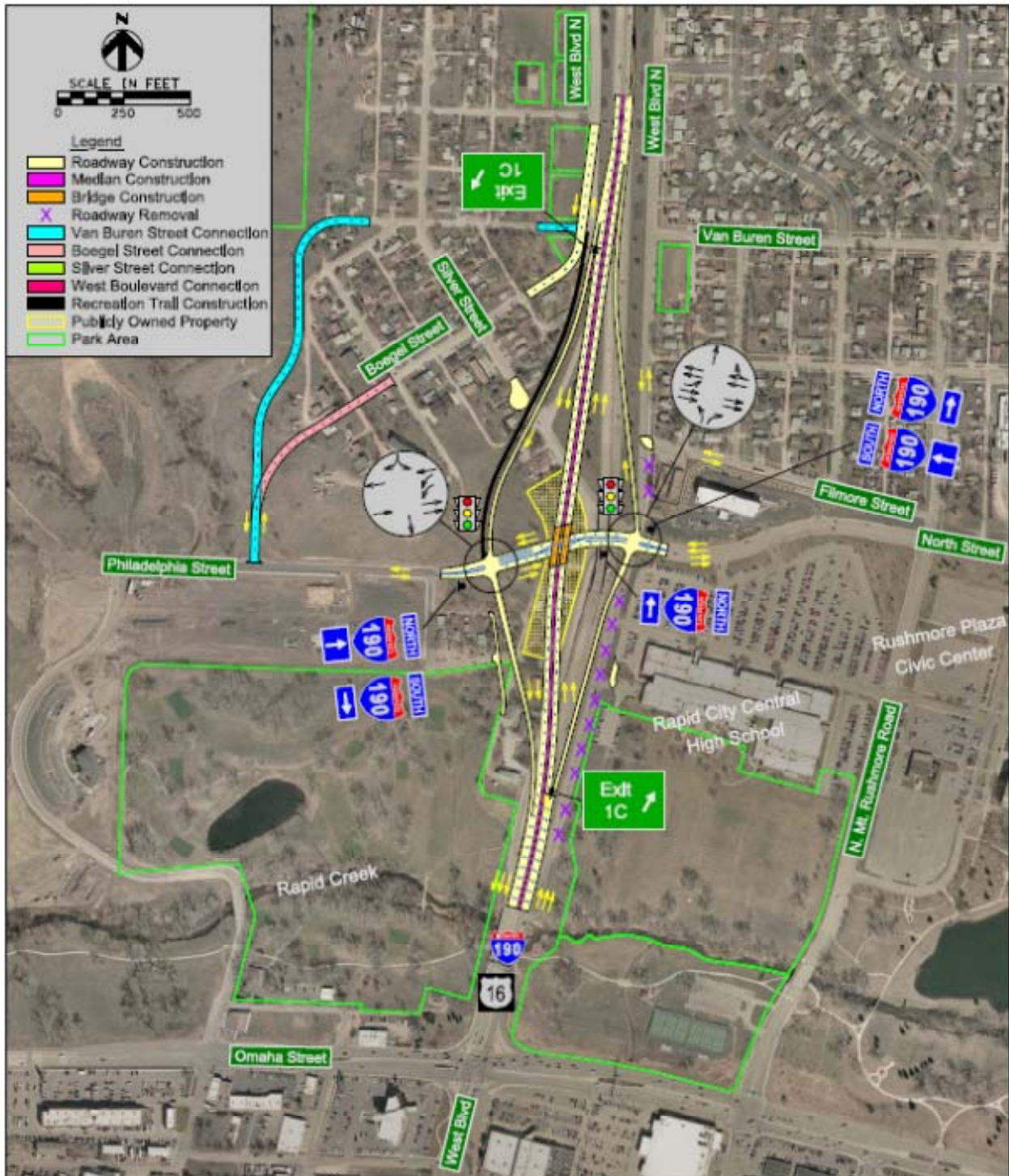


Figure 5-3 Alternative 2

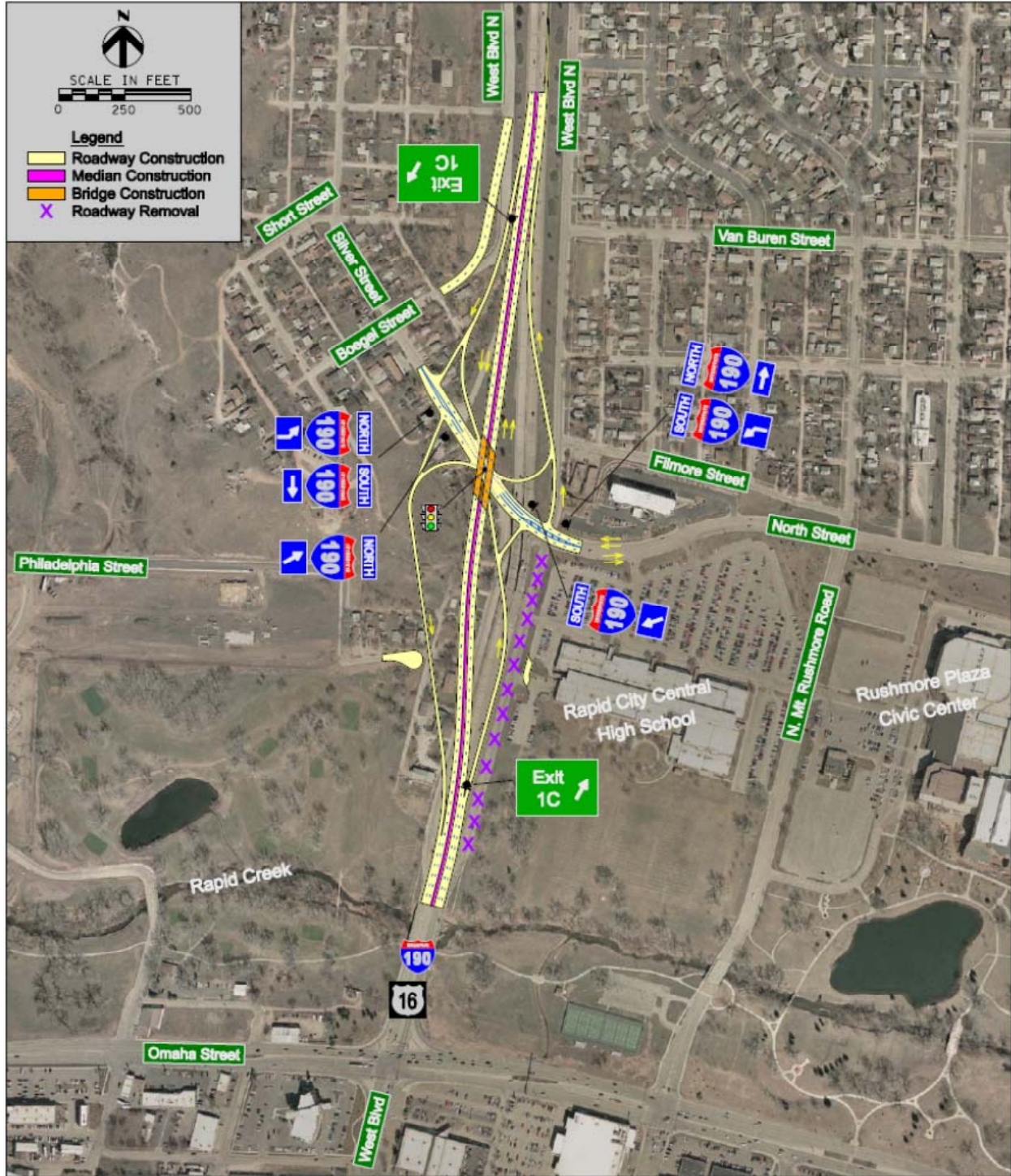


Figure 5-4 Alternative 2a

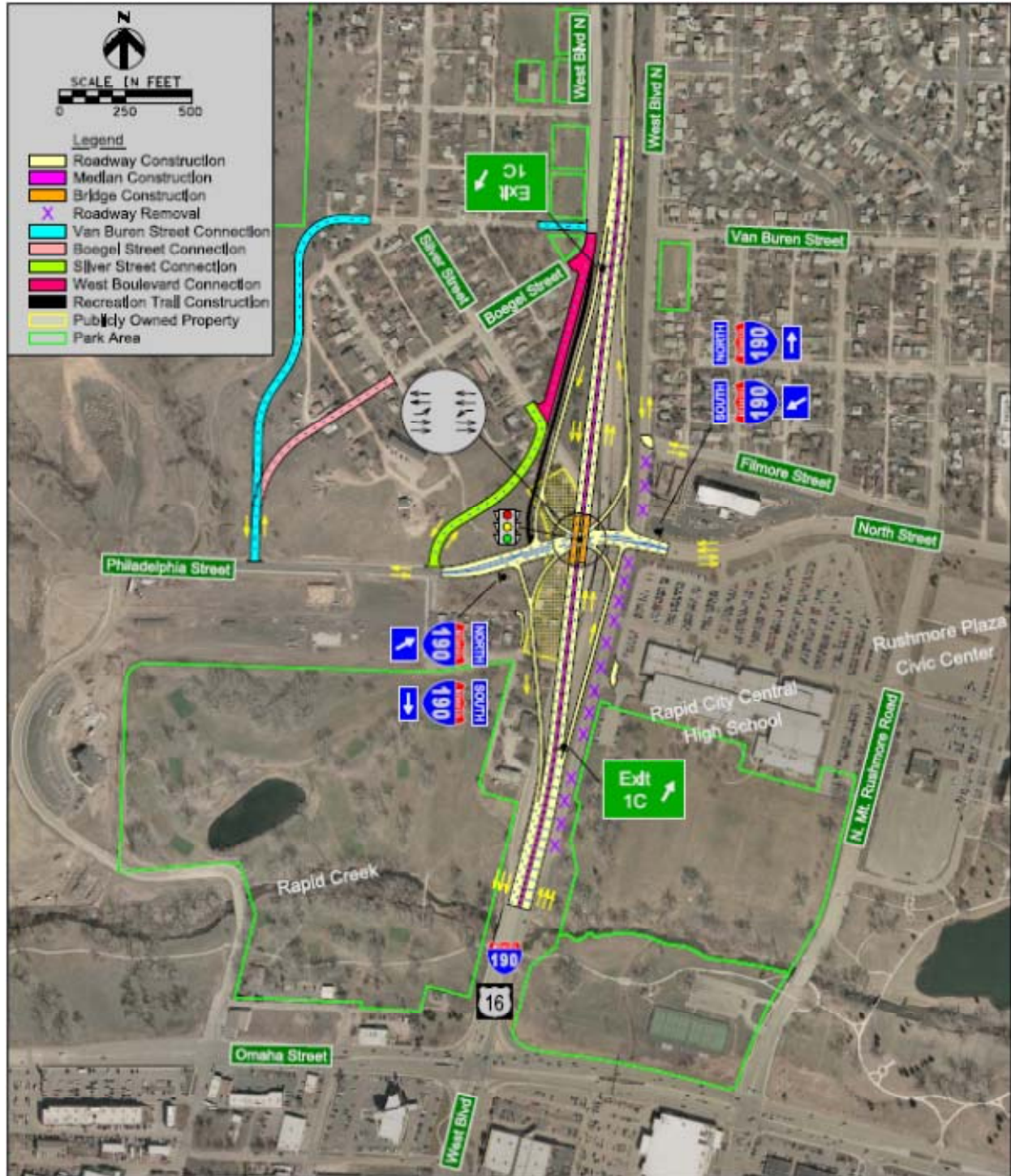


Figure 5-5 Alternative 2b

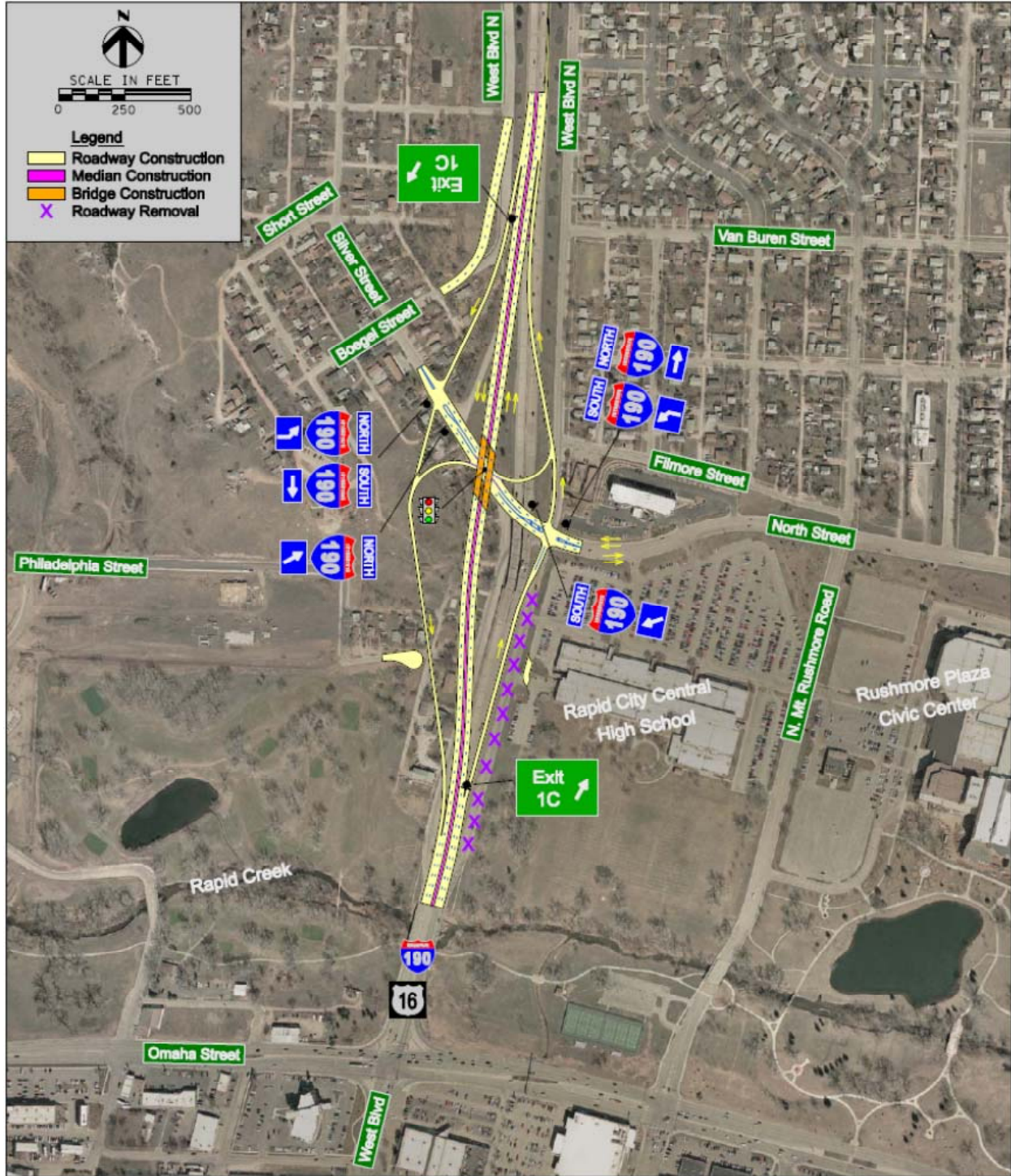


Figure 5-6 Alternative 3

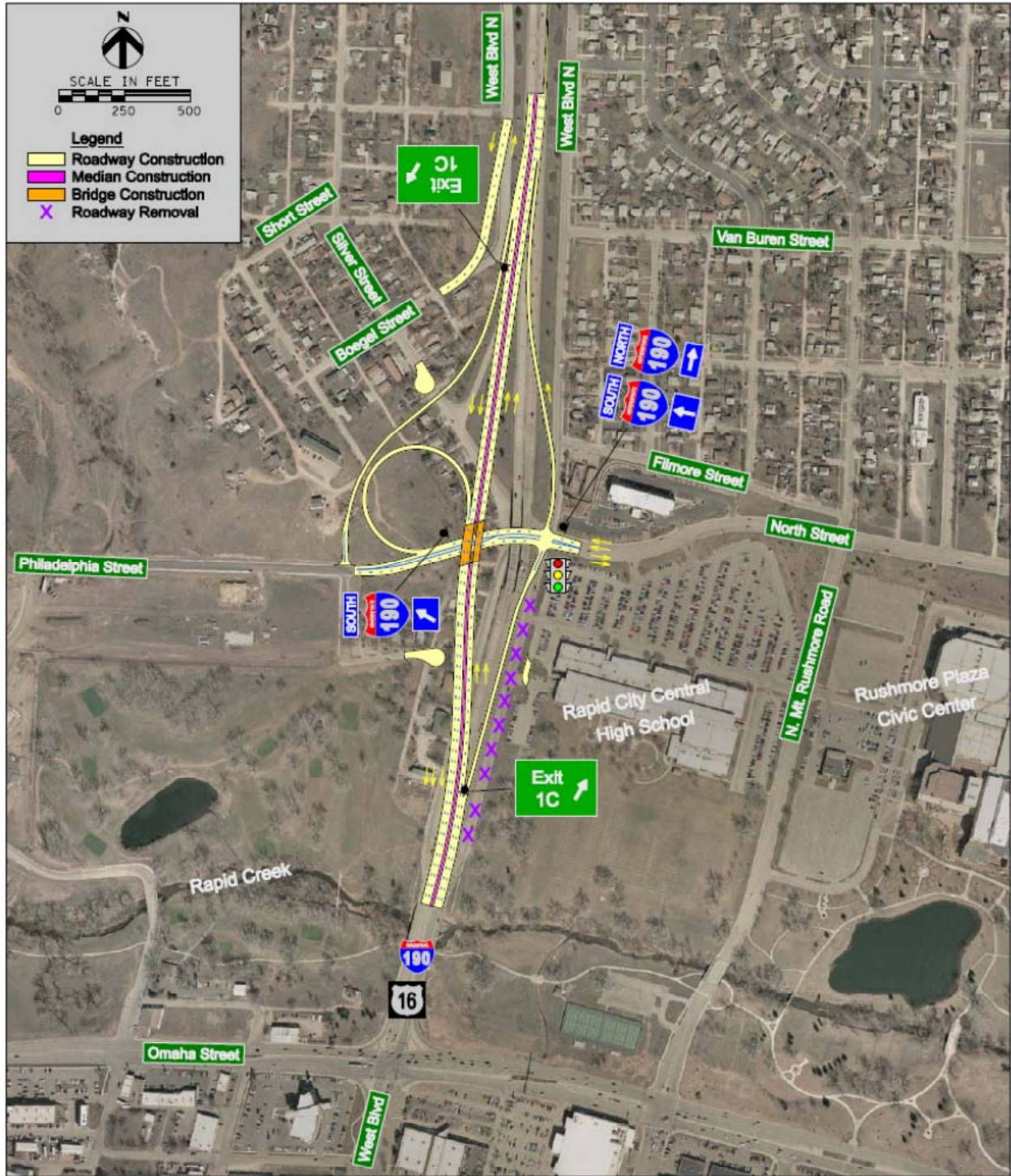


Figure 5-7 Alternative 3a

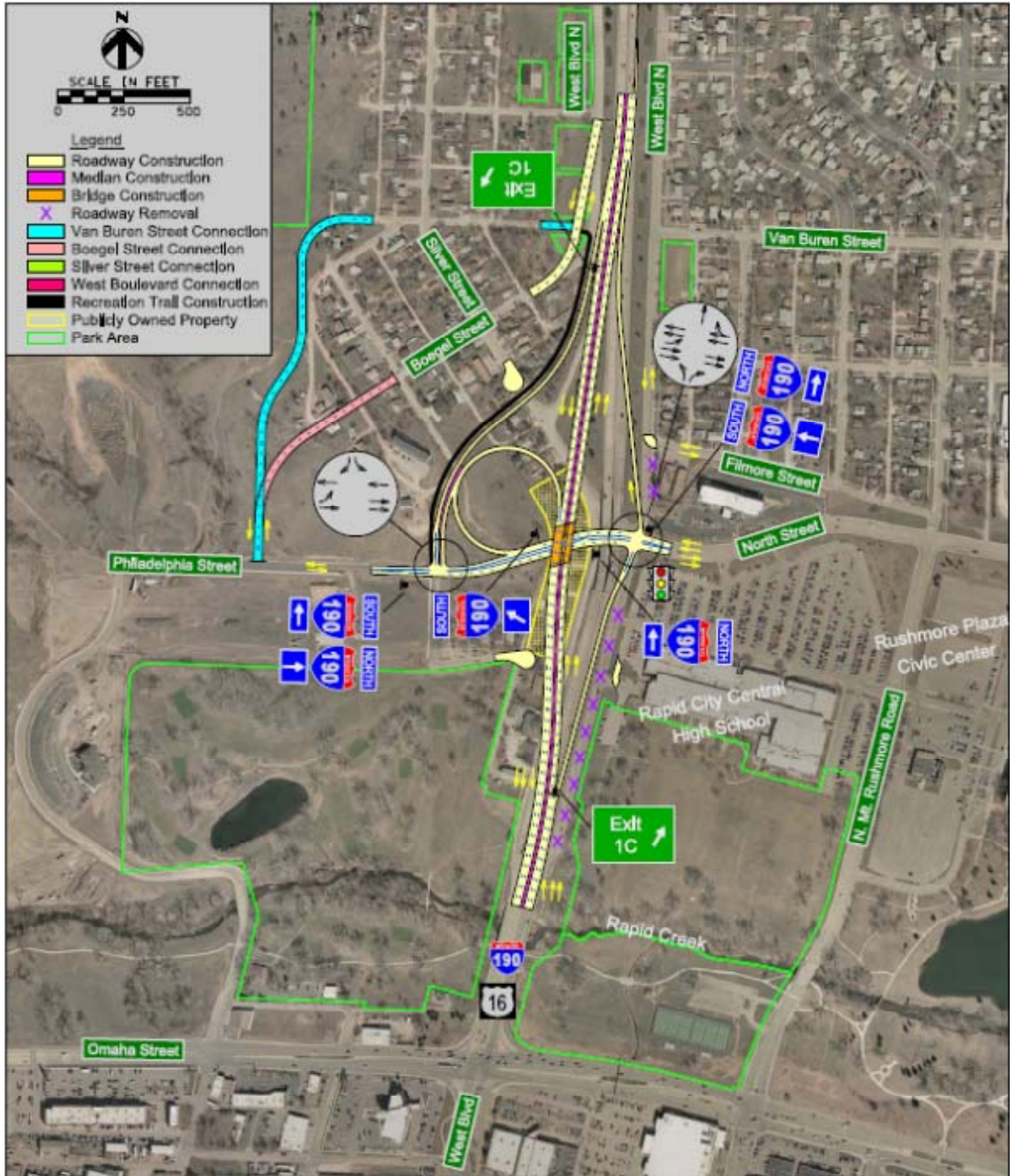
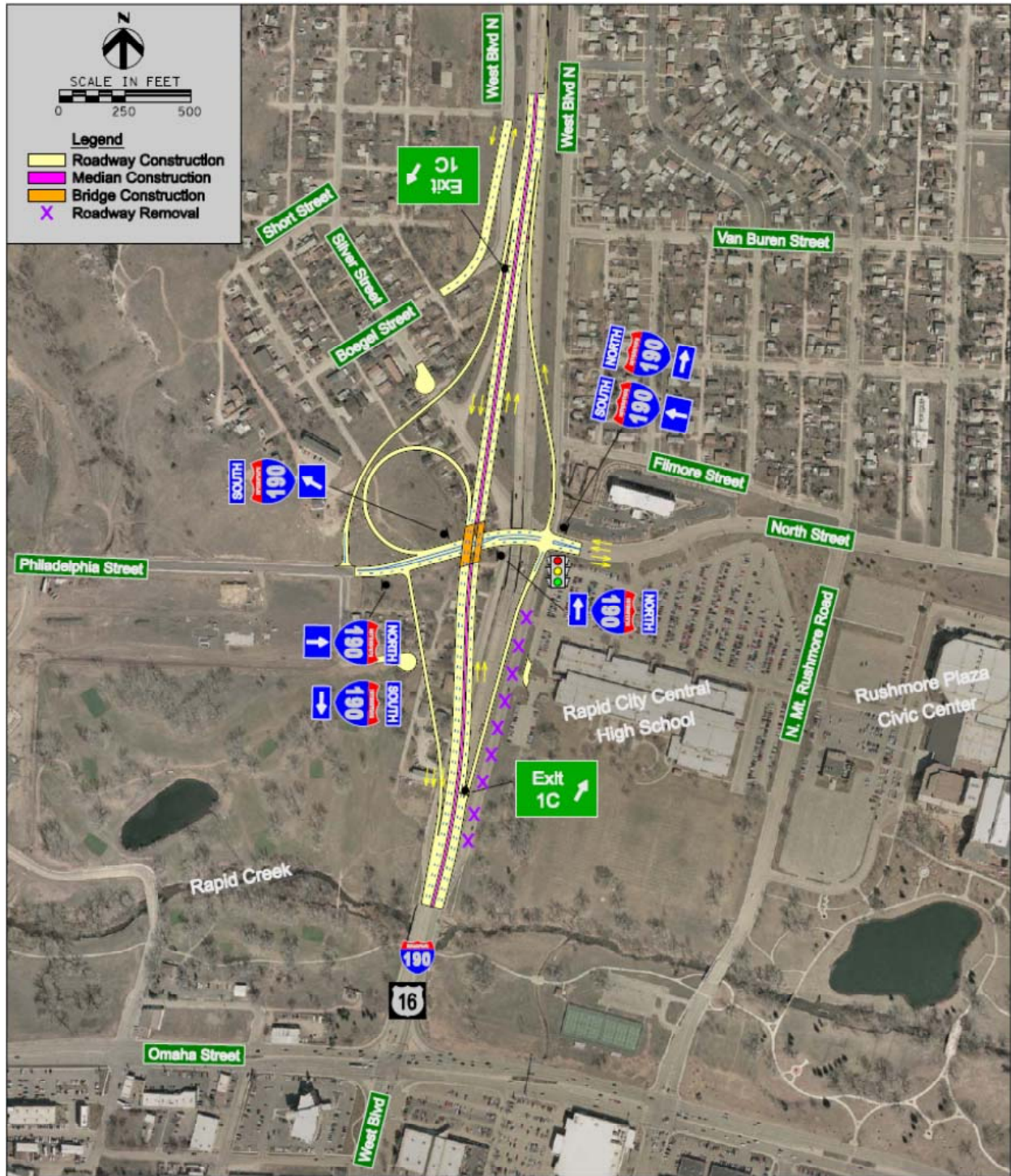




Figure 5-8 Alternative 3b



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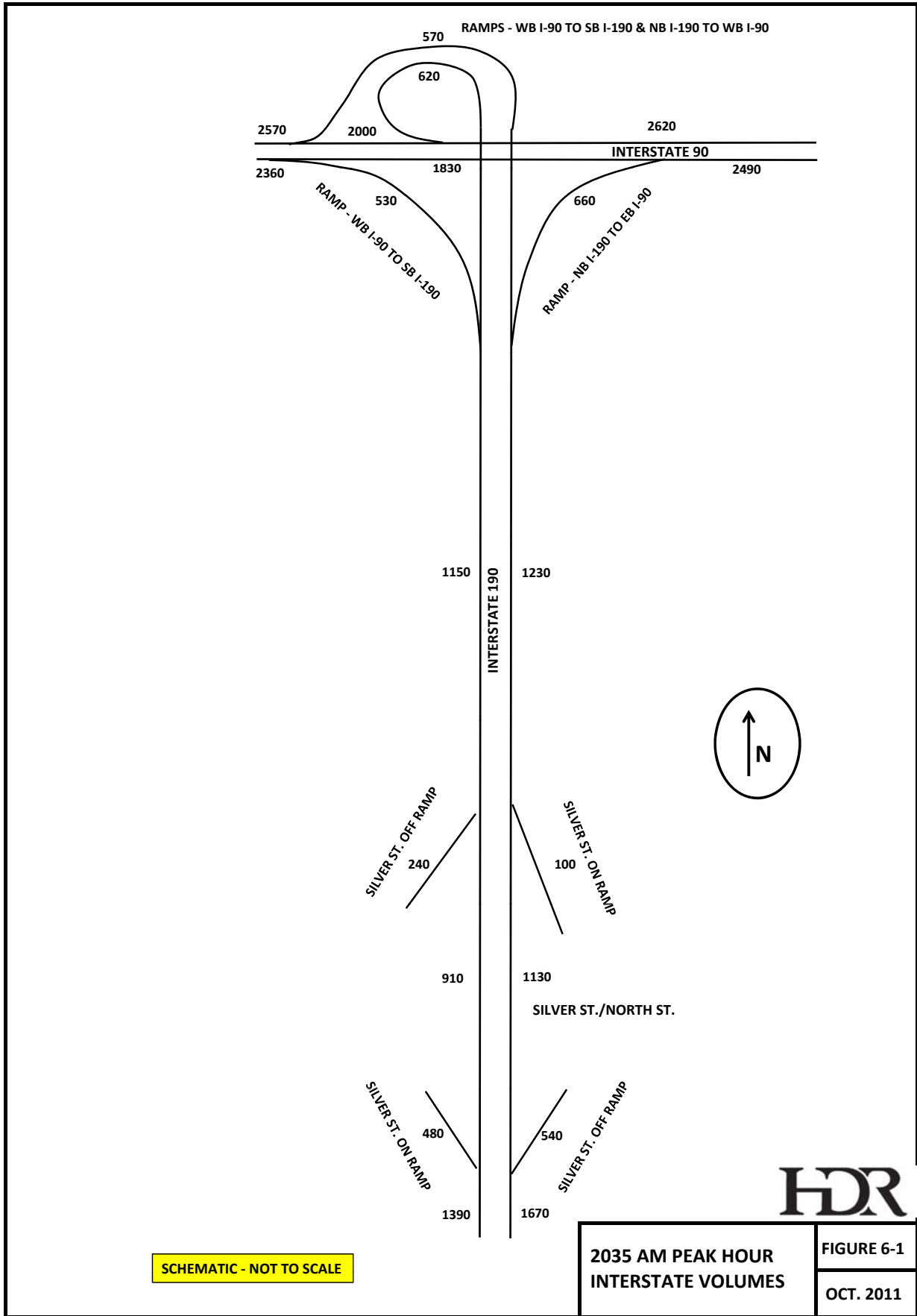
## 6.0 Future Year Traffic

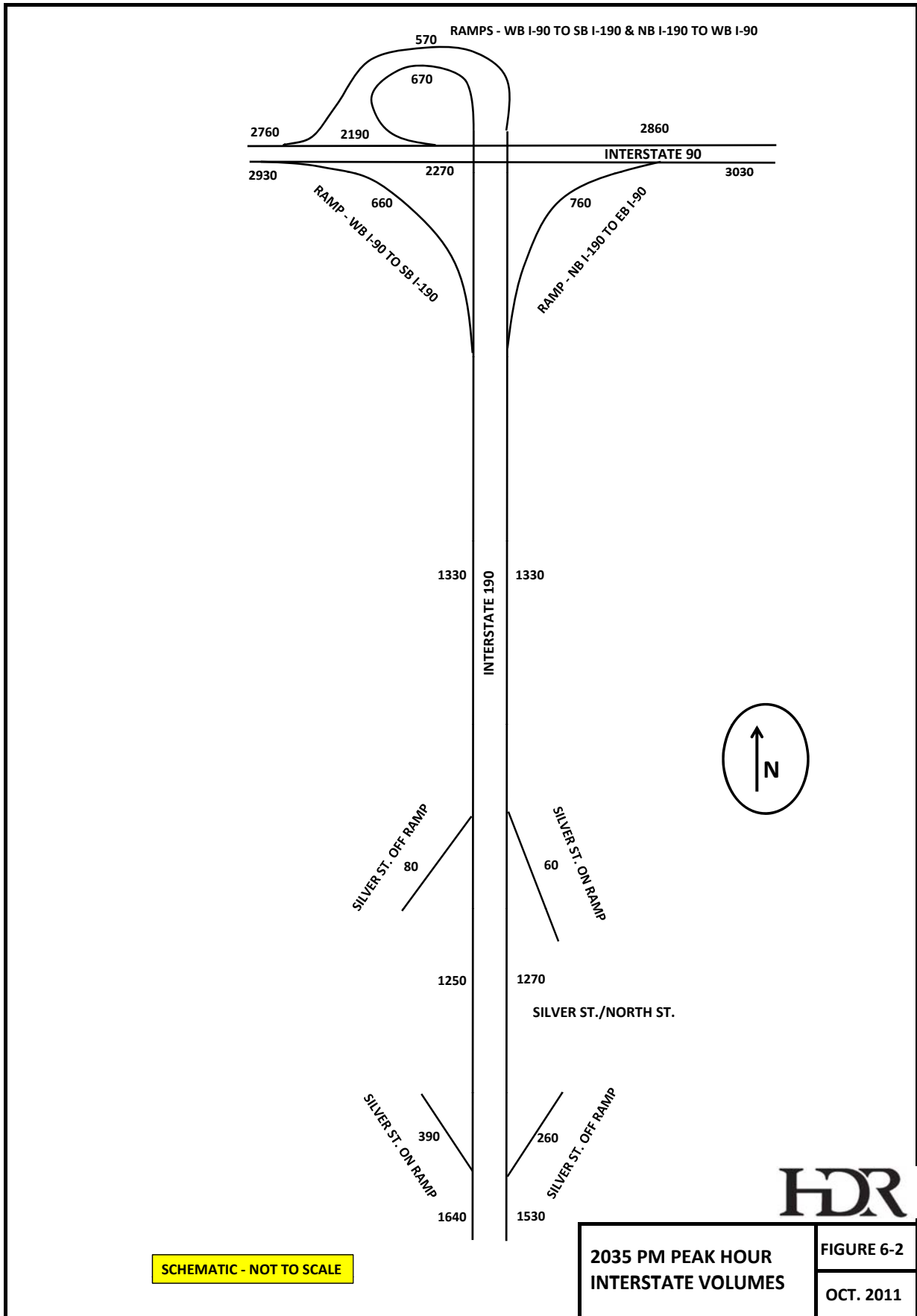
---

Traffic volumes for the AM and PM peak periods have been provided in the following graphics:



- Figure 6-1: 2035 AM Interstate volumes
- Figure 6-2: 2035 PM Interstate volumes
- Figure 6-3: 2035 AM arterial turning volumes
- Figure 6-4: 2035 PM arterial turning volumes

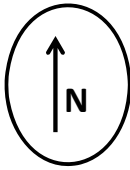
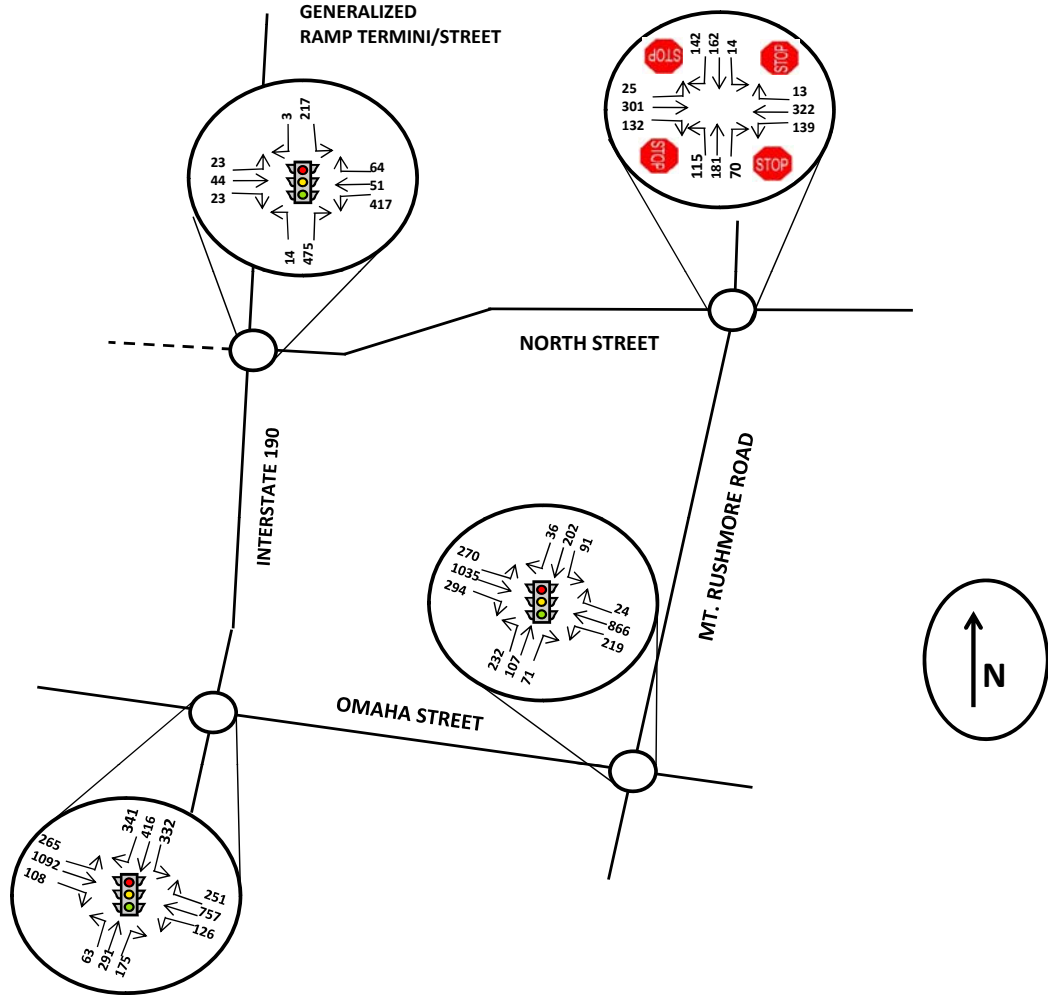
Note that the regional forecasting model discerns no difference in demand between the different interchange configurations, so only one set of future volumes is provided. The ramp lengths, spacing, and other geometric details, however, are specific to each of the interchange alternatives, resulting in the need for specific capacity analyses for each of the future alternatives, contained in Chapter 7.





**LEGEND**

- 123 TURNING MOVEMENTS
-  TRAFFIC SIGNAL
-  STOP SIGN
- EXISTING ROADS





**SCHEMATIC - NOT TO SCALE**

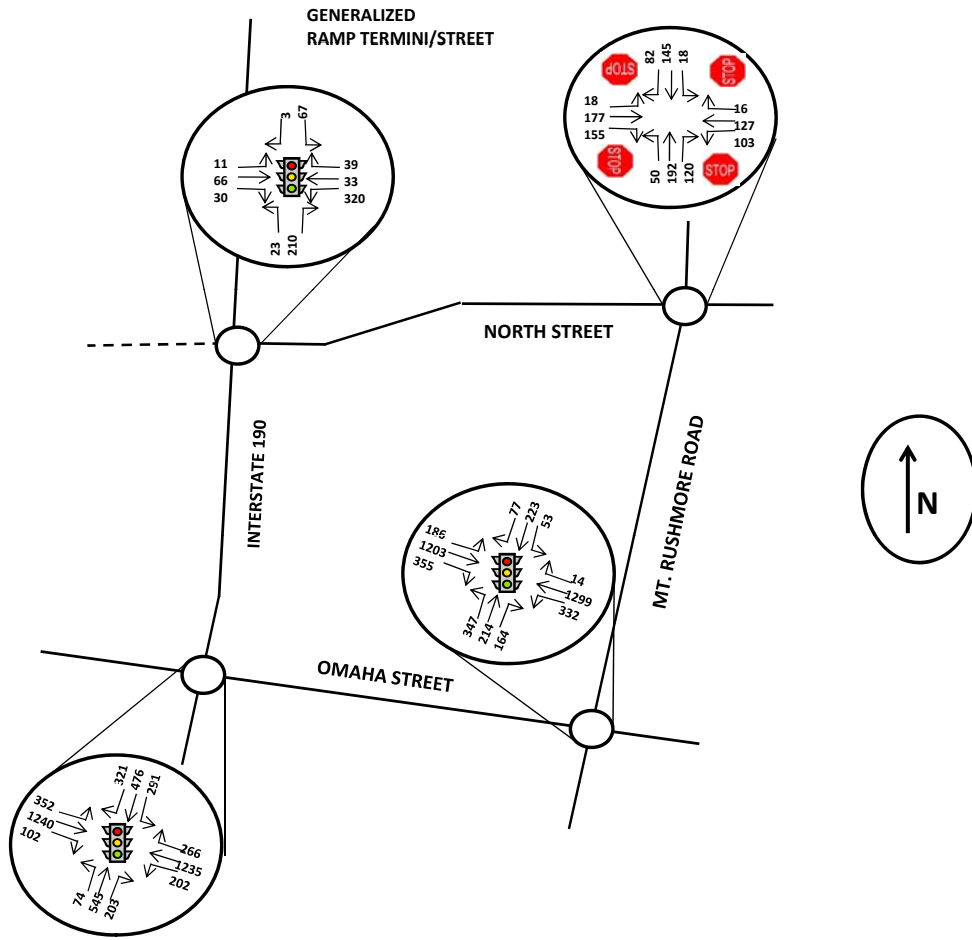
**2035 AM PEAK  
HOUR ARTERIAL  
TURNING VOLUMES**



**FIGURE 6-3  
OCT. 2011**

**LEGEND**

- 123 TURNING MOVEMENTS
-  TRAFFIC SIGNAL
-  STOP SIGN
- EXISTING ROADS



**SCHEMATIC - NOT TO SCALE**

**2035 PM PEAK  
HOUR ARTERIAL  
TURNING VOLUMES**

**FIGURE 6-4  
OCT. 2011**



## 7.0 Alternative Analysis

---

Alternatives 1, 1a, 2a and 3a have been carried forward for further analysis and evaluation. They are shown in Figures 5-1, 5-2, 5-4, and 5-7.

### 7.1. **Conformance with Transportation Plans**

All the interchange alternatives provide Interstate access at the location of the existing Silver Street interchange, a feature of RapidTRIP 2035, the current long range transportation plan for the Rapid City MPO. Only alternatives 1a, 2a, and 3a, however, contain a revision of the arterial street system contained in the current Rapid City Major Streets Plan. That revision involves connecting North Street east of the existing interchange with Philadelphia Street west of the interchange. This creates better cross-town traffic flow and corrects much of the cross-road skew at the existing interchange.

### 7.2. **Compliance with Policies and Engineering Standards**

All the build alternatives will be designed to comply with existing policies and engineering standards. The no-build alternative, however, has a long list of design deficiencies previously documented in this report.

### 7.3. **Environmental Impacts**

The Environmental Assessment being prepared concurrently with this Interstate access study contains a thorough evaluation of the alternatives. Based on the 10/28/2011 Technical Memo “Evaluation and Recommendation of I-190/Silver Street Interchange Alternatives”, the draft Environmental Assessment will only continue forward with build Alternatives 1a and 2a for consideration as the feasibly preferred alternative. The other build alternatives have greater impacts on existing neighborhoods, require more residential relocations, and present other environmental challenges.

### 7.4. **Safety**

Alternative 1 has potential safety issues related to skewed intersections and consequent sight-distance restrictions. Alternative 3a presents potential safety issues related to its tight southbound loop on-ramp. Loop ramps in South Dakota have experienced elevated crash frequency, especially during winter weather. Nationwide crash reduction statistics also indicate that this type of interchange may be slightly less safe than non-loop configurations. The no-build alternative also has the potential safety issues previously documented. A road safety audit is planned to be conducted on the EA’s preferred alternative prior to proceeding to final design.

### 7.5. **Operational Performance**

Operational analysis was conducted for the interchange configurations that best meet transportation needs and satisfy design standards, as identified in Chapter 5. The analysis included consideration of the Interstate 190 mainline from Omaha Street to I-90, all interchange ramps on I-190 and ramp connections to I-90, and the surface street intersections at the Silver Street interchange, North Street/Mt. Rushmore Road, Omaha Street/Mt. Rushmore Road, and at Omaha Street/I-190/West Boulevard. No Interstate weaving areas were identified within the study area. Operational analyses were conducted for the AM and PM peak hours using existing traffic volumes and traffic volumes forecast for 2035, based on the Rapid City regional travel demand model maintained by the City of Rapid City.

#### 7.5.1. **Interstate mainline level of service**

The levels of service were calculated for each Interstate mainline section within the study area for each of the alternatives under future traffic conditions. The mainline levels of service are shown in Table 7-1 and level of service reports are provided in the Appendix.

**TABLE 7-1 2035 INTERSTATE MAINLINE LOS**

SECTION	NO-BUILD AM	NO-BUILD PM	ALT. 1 AM	ALT. 1 PM	ALT. 1A AM	ALT. 1A PM	ALT. 2A AM	ALT. 2A PM	ALT. 3A AM	ALT. 3A PM
NB OMAHA TO SILVER OFF	B	C	B	B	B	B	B	B	B	B
NB SILVER OFF TO SILVER ON	B	B	B	B	B	B	B	B	B	B
NB SILVER ON TO I-90 OFF	B	B	B	B	B	B	B	B	B	B
SB I-90 ON TO SILVER OFF	B	B	B	B	B	B	B	B	B	B
SB SILVER OFF TO SILVER ON	B	A	A	B	A	B	A	B	A	B
SB SILVER ON TO OMAHA	B	B	B	B	B	B	B	B	B	B

**7.5.2. Interstate ramp level of service**

The levels of service were calculated for each Interstate ramp within the study area for each of the alternatives under future traffic conditions. The ramp levels of service are shown in Table 7-2 and level of service reports are provided in the Appendix.

**TABLE 7-2 2035 INTERSTATE RAMP LOS**

SECTION	NO-BUILD AM	NO-BUILD PM	ALT. 1 AM	ALT. 1 PM	ALT. 1A AM	ALT. 1A PM	ALT. 2A AM	ALT. 2A PM	ALT. 3A AM	ALT. 3A PM
SILVER OFF NB	B	B	B	A	B	A	B	B	B	B
SILVER ON NB	B	B	A	A	A	A	A	A	A	A
I-90 OFF NB	A	A	A	A	A	A	A	A	A	A
I-90 ON SB	B	B	A	A	A	A	A	A	A	A
SILVER OFF SB	B	A	A	A	A	A	A	A	A	A
SILVER ON SB	B	A	A	A	B	B	B	B	A	B

**7.5.3. Intersection level of service**

The levels of service were calculated for each major street intersection within the study area for each of the alternatives under future traffic conditions. The intersection levels of service are shown in Table 7-3 and level of service reports are provided in the Appendix.





**TABLE 7-3 2035 INTERSECTION LOS**

INTERSECTION	NO-BUILD AM	NO-BUILD PM	ALT. 1 AM	ALT. 1 AM	ALT. 1A AM	ALT. 1A PM	ALT. 2A AM	ALT. 2A PM	ALT. 3A AM	ALT. 3A PM
CROSSROAD/I-190 SB	A	A	B	B	B	B			A	A
CROSSROAD/I-190 NB	C	B	B	B	B	B			B	B
CROSSROAD/I-90 COMMON							B	B		
NORTH ST./ MT. RUSHMORE RD.	C	C	B	A	B	A	B	A	B	A
OMAHA ST./MT. RUSHMORE RD.	D	D	D	D	D	D	D	D	D	D
OMAHA ST./I-190	C	C	C	C	C	C	C	C	C	C

**7.5.4. Operations comparison**

Any of the future alternatives appear to provide acceptable levels of service, without detrimental effect on the Interstate highway system or appreciable change to the local street system. The decision to change the configuration of the existing interchange is, therefore, solely dependent on the need to bring the interchange up to current design standards. It should be noted that the reported LOS D for Omaha St./Mt. Rushmore Rd. is at the border between LOS C and LOS D. SYNCHRO’s percentile delay analysis method shows the operations at this intersection as LOS C, while the HCS method indicates LOS D.

**7.6. Evaluation Matrix**

An evaluation matrix (Table 7-4) was prepared to allow easy comparison of the alternatives based on the evaluation criteria contained in this chapter. The matrix provides a quick reference to the following information:

- Conformance with transportation plans – of the four alternatives, only 1A, 2A, and 3A comply with the Rapid City MPO Long Range Transportation Plan by providing a connection between North Street on the east side of the Silver Street interchange and Philadelphia Street on the west side of the interchange.
- Compliance with policies and standards – while the existing condition (No-Build) alternative has a number of design deficiencies previously noted, any of the Build alternatives may be designed to meet design policies and standards.
- Environmental impacts – please refer to the Environmental Assessment for details of the environmental considerations for each alternative. In summary, Alternative 2a results in the least impacts on the neighborhoods surrounding the interchange in terms of property needed, relocations, noise and travel disruptions, thereby earning a favorable rating in the matrix.
- Safety – Alternatives 1 and 3a have characteristics that may result in less safe operations than Alternatives 1a and 2a, as documented previously in this chapter.
- Operational performance – all the Build alternatives provide similar improved operating characteristics compared to the No-Build alternative, in terms of level of service.
- Public input – public comments are documented in the appendix of this report and in the EA. The comments favor Alternative 2a by a wide margin. In addition, the Rapid City Council and the Rapid City MPO have officially endorsed Alternative 2a.



The matrix shows that Alternative 2a, the single point interchange configuration with the realigned crossroad, appears to be the best solution to the problems presented at this location.

**TABLE 7-4 EVALUATION MATRIX**

CRITERIA	NO-BUILD	ALT. 1	ALT. 1A	ALT. 2A	ALT. 3A
CONFORMANCE WITH TRANS. PLANS	-	-	+	+	+
COMPLIANCE WITH POLICIES, STANDARDS	-	+	+	+	+
ENVIRONMENTAL IMPACTS	+	-	-	+	-
SAFETY	-	-	+	+	-
OPERATIONAL PERFORMANCE	-	+	+	+	+
PUBLIC INPUT	-	-	-	+	-

### **7.7. Coordination**

Extensive public involvement has been carried out as part of this Interchange Modification Justification Report and the parallel Environmental Assessment. Additional public involvement occurred as part of a preliminary phase of the study which helped develop interchange alternatives and consider administrative issues. During both phases of the study, documents and presentations were provided on a website maintained by the South Dakota Department of Transportation, with links from the City of Rapid City and other sources. Public meetings were conducted and are planned for the Interchange Modification Justification Report and Environmental Assessment on the following occasions:

- March 29, 2011 – a public meeting was held at Community Room at the Rapid City municipal/school district facility. The Interstate access study process was introduced and the public had the opportunity to discuss improvement alternatives with staff. Comments were received at the meeting and after the meeting via electronic and mail transmittal.
- September 14, 2011 – a public meeting was held at the ballroom at the Howard Johnson motel immediately adjacent to the Silver Street interchange. Details of the interchange alternatives were presented, concentrating on environmental issues developed to-date. The public had the opportunity to discuss improvement alternatives and environmental issues with staff. Comments were received at the meeting and after the meeting via electronic and mail transmittal.
- January, 2012 – a public meeting is planned to present the draft EA and discuss the preferred alternative.
- MPO meetings – updates on the study were presented to the MPO committees throughout the study process.
- Web presence – a study web page was established and maintained to provide the public easy access to study documents and other information.

Summaries of the public meetings held to date have been provided in the Appendix.



## 8.0 Funding Plan

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The project, IM 1902(61)0 PCN 1162, has been placed in the SDDOT's 2012-2016 State Highway Improvements Program (STIP) for 2015 to correct the deficiencies at the Silver Street interchange. The project has been programmed for \$11.664 million (2011 dollars). The SDDOT is currently anticipating funding the project with Interstate Maintenance (IM) funds totaling \$10.173 million and \$1.491 million in State funds. The programmed STIP amount will be updated based on the results of this study, the EA and further design work. The project was programmed at this early stage in project development due to the need to correct the structural deficiencies at the interchange. As this project is currently anticipated to be let to contract in Federal fiscal year 2015, the current inflated estimated total cost for the project is \$12.625 million. As funding is fluid, category breakdown may be different at time of project authorization.

The City of Rapid City has two current projects in their Capital Improvements Program (CIP) which may be adapted to assist with improvements in the interchange area. They include a 2013 project for Silver Street utility improvements (\$1.440 million) and a 2016 project for reconstruction of West Boulevard from North Street to Anamosa Street.

Improvements on the local street system may also include the following:

- Extension of Boegel Street to connect to Philadelphia Street
- Extension of Van Buren Street to connect to Philadelphia Street
- Extension of West Boulevard to connect to Philadelphia Street

One of these local street improvements will be chosen to complement the feasible preferred alternative. The local street improvement will likely be constructed concurrently with the interchange project, possibly as a single letting. Details of design and local participation will be finalized as the project proceeds through development.

## 9.0 Recommendations

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This study has considered alternatives for addressing existing structural and design deficiencies at the Silver Street interchange (Exit 1) on Interstate 190 in Rapid City, SD. While the no-build alternative was found to not solve these deficiencies, a number of build alternatives would solve the deficiencies and satisfy FHWA access criteria. Alternatives 1, 1a, 2a, and 3a meet acceptable operational performance for the interchange. The following discussion regarding FHWA Criteria is generic and pertains to all four remaining alternatives (1, 1a, 2a, and 3a). The Environmental Assessment, being concurrently conducted, will select the preferred alternative.

### 9.1. FHWA Criteria

The following discussion provides the factors for consideration required by FHWA policy, along with responses (*italics*) formulated for the I-190/Silver Street proposal.

1. The need being addressed by the request cannot be adequately satisfied by existing interchanges to the Interstate, and/or local roads and streets in the corridor can neither provide the desired access, nor can they be reasonably improved (such as access control along surface streets, improving traffic control, modifying ramp terminals and intersections, adding turn bays or lengthening storage) to satisfactorily accommodate the design-year traffic demands (23 CFR 625.2(a)).

*The requested action is for modification of an existing interchange configuration to bring it up to current standards and into compliance with local land use and transportation plans. No additional access to the Interstate System is being requested. The existing interchange structures are reaching the end of their useful life, resulting in the need to determine the proper configuration and design for their replacement.*

2. The need being addressed by the request cannot be adequately satisfied by reasonable transportation system management (such as ramp metering, mass transit, and HOV facilities), geometric design, and alternative improvements to the Interstate without the proposed change(s) in access (23 CFR 625.2(a)).

*The proposed change is an improvement to the geometric design of the existing interchange and replacement of structures. The need for the change is not capacity-driven, but is intended to restore the structural sufficiency of the interchange and bring it up to current design standards. There are no areas within the State of South Dakota that are anticipated to consistently experience congestion levels extreme enough to make ramp metering or HOV facilities economically feasible in the foreseeable future.*

3. An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, shall be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access

and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access must include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

*The operational and safety analysis conducted as part of this study, including a Phase 1 study of a larger area and more comprehensive administrative issues, shows that the Interstate highway system and the local street network will function at acceptable levels of service regardless of the action taken, or the interchange configuration alternative being considered. Conceptual plans of the interchange alternatives and signing plans are included in this report.*

4. The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access for managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)).

*The interchange configuration alternatives being considered all provide for all movements at the I-190/Silver St. location, although Alternative 3 was screened out from consideration for failing this test.*

5. The proposal considers and is consistent with local and regional land use and transportation plans. Prior to receiving final approval, all requests for new or revised access must be included in an adopted Metropolitan Transportation Plan, in the adopted Statewide or Metropolitan Transportation Improvement Program (STIP or TIP), and the Congestion Management Process within transportation management areas, as appropriate, and as specified in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93.

*The proposal was prepared in compliance with City of Rapid City and MPO land use and transportation plans. The results of this Interchange Modification Justification Report and the Environmental Assessment are being coordinated with the City and the MPO and will be included in an adopted STIP/TIP as part of the coordination process. Local transportation plans called for a reconfiguration of the local street system in the vicinity of the interchange. This concern was considered in screening and evaluating the various interchange alternatives.*

6. In corridors where the potential exists for future multiple interchange additions, a comprehensive corridor or network study must accompany all requests for new or revised access with recommendations that address all of the proposed and desired access changes within the context of a longer-range system or network plan (23 U.S.C. 109(d), 23 CFR 625.2(a), 655.603(d), and 771.111).

*Comprehensive corridor and network analyses have recently been completed as part of the Phase 1 of the 2010 Decennial Interstate Corridor Study and the MPO's Long Range Transportation Plan. No additional interchanges have been identified in the vicinity of the I-190/Silver St. interchange. The Decennial Interstate Corridor Study identified the need for a changed*

*interchange configuration at I-190/Silver St., but did not identify any other interchange needs on I-190.*

7. When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvements (23 CFR 625.2(a) and 655.603(d)). The request must describe the commitments agreed upon to assure adequate collection and dispersion of the traffic resulting from the development with the adjoining local street network and Interstate access point (23 CFR 625.2(a) and 655.603(d)).

*One planned development has been identified in the study area and the developer's plans have been coordinated with preparation of the interchange alternatives. The development is west of the I-190 Silver Street interchange and northwest of the western terminus of Philadelphia Street. It consists of multi-family housing units. The need for the interchange reconfiguration, however, is not due to the proposed development. The interchange proposal is in compliance with general and specific land use plans created by the City of Rapid City and all interchange alternatives provide sufficient capacity to accommodate all proposed development within the interchange traffic-shed. The City of Rapid City's transportation plans show the realignment of North Street to connect to Philadelphia Street, as shown in Alternatives 1a, 2a, 3, 3a, and 3b. The regional travel demand forecasting model was used to develop the travel forecasts for this study.*

8. The proposal can be expected to be included as an alternative in the required environmental evaluation, review and processing. The proposal should include supporting information and current status of the environmental processing (23 CFR 771.111).

*The Environmental Assessment for this proposed interchange is being conducted concurrently with this Interchange Modification Justification Report. The EA will include reference to the operational analysis contained in the IMJR and will determine the preferred alternative. The methodology for conducting this investigation is consistent with all state and federal regulations.*

# Appendix

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# Traffic Memo





To: Steve Gramm, SDDOT	
From: Rick Laughlin, HDR	Project: I-190/Silver St. Study, Phase II
CC:	
Date: 7/20/11	Job No: HDR 137390, Work order PD-02-09, Amendment 3, Agreement 410445

**RE: Traffic Analysis**

This memorandum documents the traffic analysis conducted for the second phase of the Interstate 190/Silver Street study in Rapid City, SD. The results of the traffic analysis have also been carried forward for use in the Interchange Justification Report (IJR) and Environmental Assessment (EA) being prepared for this study.

**Lane Demand**

The number and types of lanes needed to provide at least Level of Service D were determined using traffic forecasts and Synchro software. The traffic forecasts were based on output from the regional travel demand model maintained by the City of Rapid City. While a similar analysis was conducted for a much larger area in Phase 1, this memorandum is confined to the IJR study area.

The analysis shows that no additional mainline lanes will be required on I-190, with all sections of I-190 running at LOS "A" or "B" with the existing 4-lane configuration. The mainline levels of service are summarized in the following table:

**TABLE: INTERSTATE MAINLINE LOS**

SECTION	2030 CONDITIONS												
	2010		NO-BUILD		ALT. 1		ALT. 1A		ALT. 2A		ALT. 3A		
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	
NB OMAHA TO SILVER OFF	A	A	B	C	B	B	B	B	B	B	B	B	B
NB SILVER OFF TO ANAMOSA	A	A	B	B									
NB SILVER OFF TO SILVER ON					B	B	B	B	B	B	B	B	B
NB SILVER ON TO I-90					B	B	B	B	B	B	B	B	B
NB ANAMOSA TO I-90	A	A	B	B									
SB I-90 TO SILVER OFF	A	A	B	B	B	B	B	B	B	B	B	B	B
SB SILVER OFF TO SILVER ON	A	A	B	A	A	B	A	B	A	B	A	B	B
SB SILVER ON TO OMAHA	A	A	B	B	B	B	B	B	B	B	B	B	B

The ramps at the I-190/Silver Street interchange and at Interstate 90 are also expected to operate well with the existing single-lane configuration. The ramp levels of service are summarized in the following table:

**TABLE: INTERSTATE RAMP LOS**

RAMP	2030 CONDITIONS											
	2010		NO-BUILD		ALT. 1		ALT. 1A		ALT. 2A		ALT. 3A	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
SILVER OFF NB	A	B	B	B	B	A	B	A	B	B	B	B
ANAMOSA ON NB	A	B	B	B								
SILVER ON NB					A	A	A	A	A	A	A	A
I-90 OFF NB	A	A	A	A	A	A	A	A	A	A	A	A
I-90 OFF WB	A	A	A	A	A	A	A	A	A	A	A	A
I-90 ON WB	A	A	A	A	A	A	A	A	A	A	A	A
I-90 ON SB	A	A	B	B	A	A	A	A	A	A	A	A
SILVER OFF SB	A	A	B	A	A	A	A	A	A	A	A	A
SILVER ON SB	A	A	B	A	A	A	B	B	B	B	A	B

The study area intersections are expected to continue to operate at acceptable levels of service into the future, with a few changes related to the implementation of each of the future interchange alternatives. The intersection operations are summarized in the following table:

**TABLE: INTERSECTION LOS**

INTERSECTION	2030 CONDITIONS											
	2010		NO-BUILD		ALT. 1		ALT. 1A		ALT. 2A		ALT. 3A	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
CROSSROAD/I-190 SB	A	A	A	A	B	B	B	B			A	A
CROSSROAD/I190 NB	A	A	C	B	B	B	B	B			B	B
CROSSROAD/I-190 COMMON									B	B		
NORTH ST./MT. RUSHMORE RD.	C	B	C	C	B	A	B	A	B	A	B	A
OMAHA ST./MT. RUSHMORE RD.	C	D	D	D	D	D	D	D	D	D	D	D
OMAHA ST./I-190/WEST BLVD.	C	C	C	C	C	C	C	C	C	C	C	C

The lane demand for each study area intersection is shown in the following table for each interchange alternative. The lane demand is also shown in the interchange alternative graphics included later in this memorandum. The code used in the table is outlined below:

- L = left turn lane
- T = thru lane
- R = right turn lane
- LT = combined left/thru lane
- RT = combined right/thru lane
- (lanes are separated by commas)

# LANE DEMAND

## I-190/SILVER STREET STUDY AREA INTERSECTIONS

EXISTING CONDITIONS				
INTERSECTION	SOUTHBOUND	WESTBOUND	NORTHBOUND	EASTBOUND
I-190/SILVER	LTR	L, TR	LT,R	LT,T
MT. RUSHMORE/NORTH	LTR	LT, TR	LT,R	LT,TR
MT. RUSHMORE/OMAHA	L,T,T,R	L,L,T,T,TR	L,L,T,T,R	L,L,T,T,T,R
I-190/OMAHA	L,L,T,T,R	L,L,T,T,T,R	L,T,T,R	L,L,T,T,T,R
ALTERNATIVE 1				
INTERSECTION	SOUTHBOUND	WESTBOUND	NORTHBOUND	EASTBOUND
I-190/SILVER	L,R	L,L,T,TR	L,R	L,T,TR
MT. RUSHMORE/NORTH	L,TR	LT, TR	LT,R	LT,TR
MT. RUSHMORE/OMAHA	L,T,T,R	L,L,T,T,TR	L,L,T,T,R	L,L,T,T,T,R
I-190/OMAHA	L,L,T,T,R	L,L,T,T,T,R	L,T,T,R	L,L,T,T,T,R
ALTERNATIVE 1a				
INTERSECTION	SOUTHBOUND	WESTBOUND	NORTHBOUND	EASTBOUND
I-190/SILVER	L,R	L,L,T,TR	L,R	L,T,TR
MT. RUSHMORE/NORTH	L,TR	LT, TR	LT,R	LT,TR
MT. RUSHMORE/OMAHA	L,T,T,R	L,L,T,T,TR	L,L,T,T,R	L,L,T,T,T,R
I-190/OMAHA	L,L,T,T,R	L,L,T,T,T,R	L,T,T,R	L,L,T,T,T,R
ALTERNATIVE 2a				
INTERSECTION	SOUTHBOUND	WESTBOUND	NORTHBOUND	EASTBOUND
I-190/SILVER	L,R	L,L,T,TR	L,R	L,T,TR
MT. RUSHMORE/NORTH	L,TR	LT, TR	LT,R	LT,TR
MT. RUSHMORE/OMAHA	L,T,T,R	L,L,T,T,TR	L,L,T,T,R	L,L,T,T,T,R
I-190/OMAHA	L,L,T,T,R	L,L,T,T,T,R	L,T,T,R	L,L,T,T,T,R
ALTERNATIVE 3a				
INTERSECTION	SOUTHBOUND	WESTBOUND	NORTHBOUND	EASTBOUND
I-190/SILVER	L,R	T,TR	L,R	L,T,TR
MT. RUSHMORE/NORTH	L,TR	LT, TR	LT,R	LT,TR
MT. RUSHMORE/OMAHA	L,T,T,R	L,L,T,T,TR	L,L,T,T,R	L,L,T,T,T,R
I-190/OMAHA	L,L,T,T,R	L,L,T,T,T,R	L,T,T,R	L,L,T,T,T,R

## **Safety Analysis**

A search of the crash reduction factors related to interchange configuration was conducted as part of this study. While there were many crash reduction factors related to improving the length of ramps, those factors would apply equally well to any of the interchange alternatives under consideration. The crash reduction factors indicate that extending ramps by about 100 feet results in about a 10% reduction in future crashes, while providing a long ramp instead of a short ramp results in about a 40% reduction in future crashes.

Two studies were found that relate specifically to clover-leaf ramps such as the one envisioned in Alternative 3a. One study found a crash reduction of about 45% by replacing a clover-leaf ramp with a straight ramp, while the other found a crash reduction of about 23% by replacing a straight ramp with a clover-leaf ramp. The actual affect on crash rates can depend greatly on the design of the clover-leaf ramp and environmental factors. In this case, the approach to the loop ramp is on a city street with lower speeds, but the loop has a fairly tight radius. Crash statistics examined in Phase 1, however, indicated a significant incidence of crashes related to winter weather driving conditions. On balance, it appears that Alternative 3a may see a slightly higher crash rate than the other alternatives.

The preferred alternative identified during the Environmental Assessment process will be the subject of a Road Safety Audit as part of the overall study and the audit findings will serve as input to the final design.

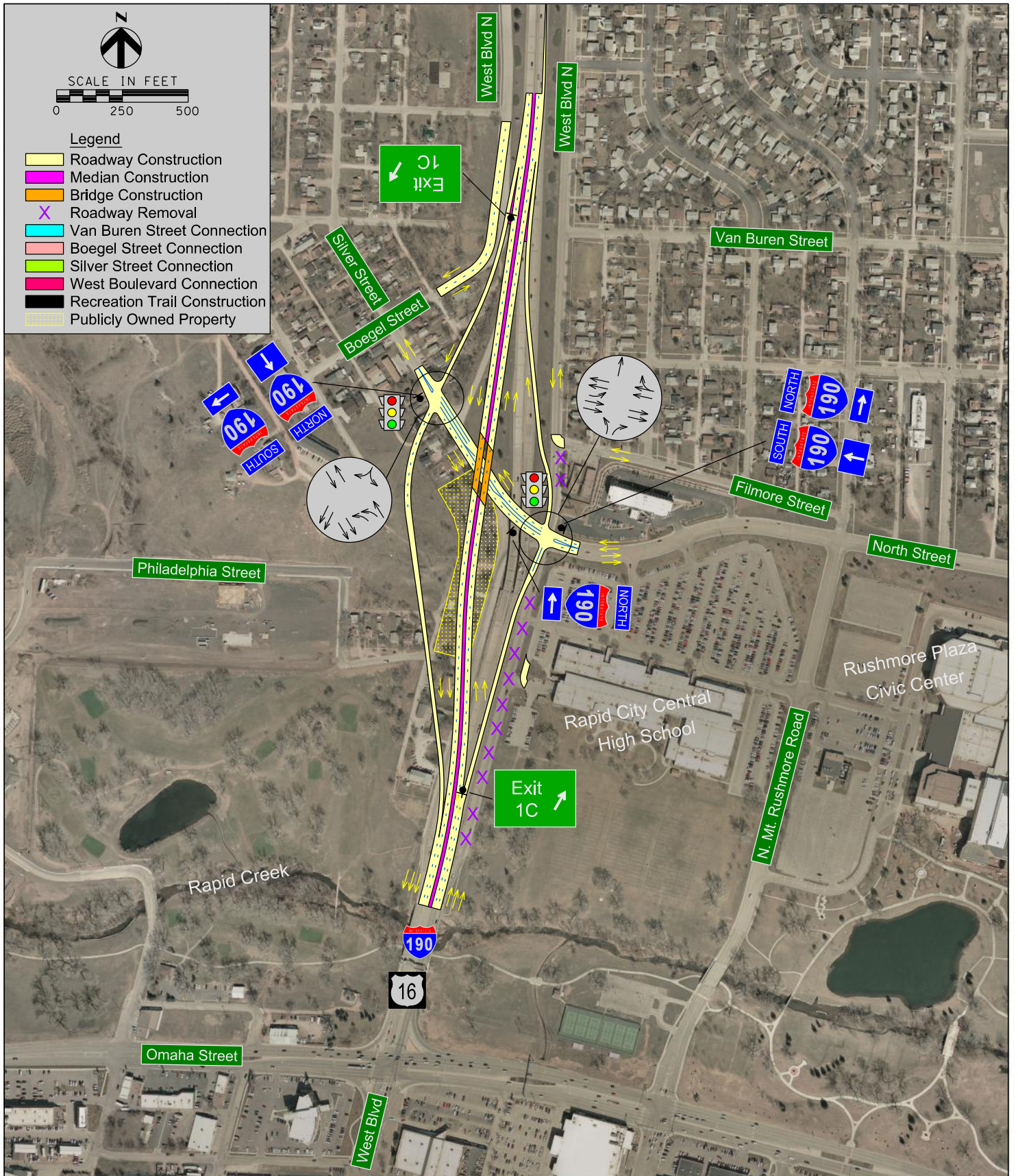
## **Neighborhood Connections**

A number of alternative local street connections have been examined to address the cross-street alignment change proposed in several of the interchange alternatives. Specifically, Alternatives 1a, 2a, and 3a show connection of North Street to Philadelphia Street, rather than the existing North Street to Silver Street connection. The change would require extension of at least one local street south to Philadelphia Street to allow neighborhood traffic to continue to use the I-190 interchange. The local street connections would either result in an intersection within about 590' of the center of the interchange or an intersection within about 1230' of the center of the interchange. For purposes of this memorandum, the nearer intersection will be called the West/Silver extension and the farther intersection will be called the Boegel/Van Buren extension.

Peak hour traffic forecasts were prepared for these two intersections based on data available from the Rapid City regional traffic forecasting model. Please note that most forecasting models, including the Rapid City model, have difficulty providing forecasts for local street intersections due to the larger network structure employed. The model is also based on generalized forecasts of future land uses and does not discern differences between the interchange alternatives as long as all the alternatives provide acceptable service.

The forecasts, however, support reasonable belief that either of the intersections will operate at acceptable level of service and not unduly interfere with interchange operations. Either intersection will operate at level of service A during the AM and PM peak hours with stop sign control. Queues at the intersections and the adjacent leg of the interchange are all minimal and no queue interference is anticipated.

Volume/Level of Service summaries and SYNCHRO analysis reports are attached to this memorandum to document analysis conditions and results.

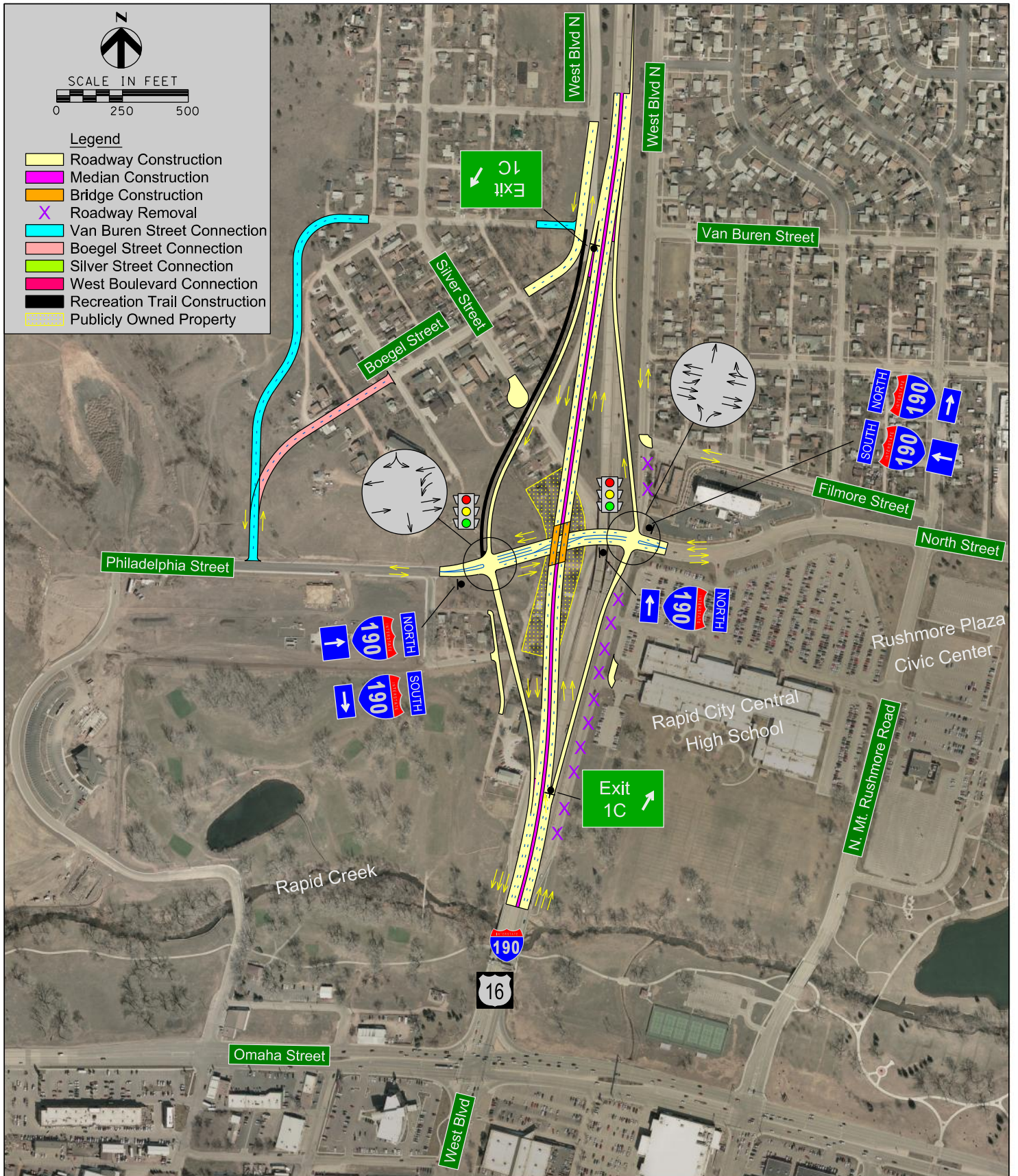


**Interchange Alternative 1**  
Philadelphia Street Connection Options

Interstate 190/Silver Street Interchange Study  
Rapid City, South Dakota

Figure 1

July 1, 2011



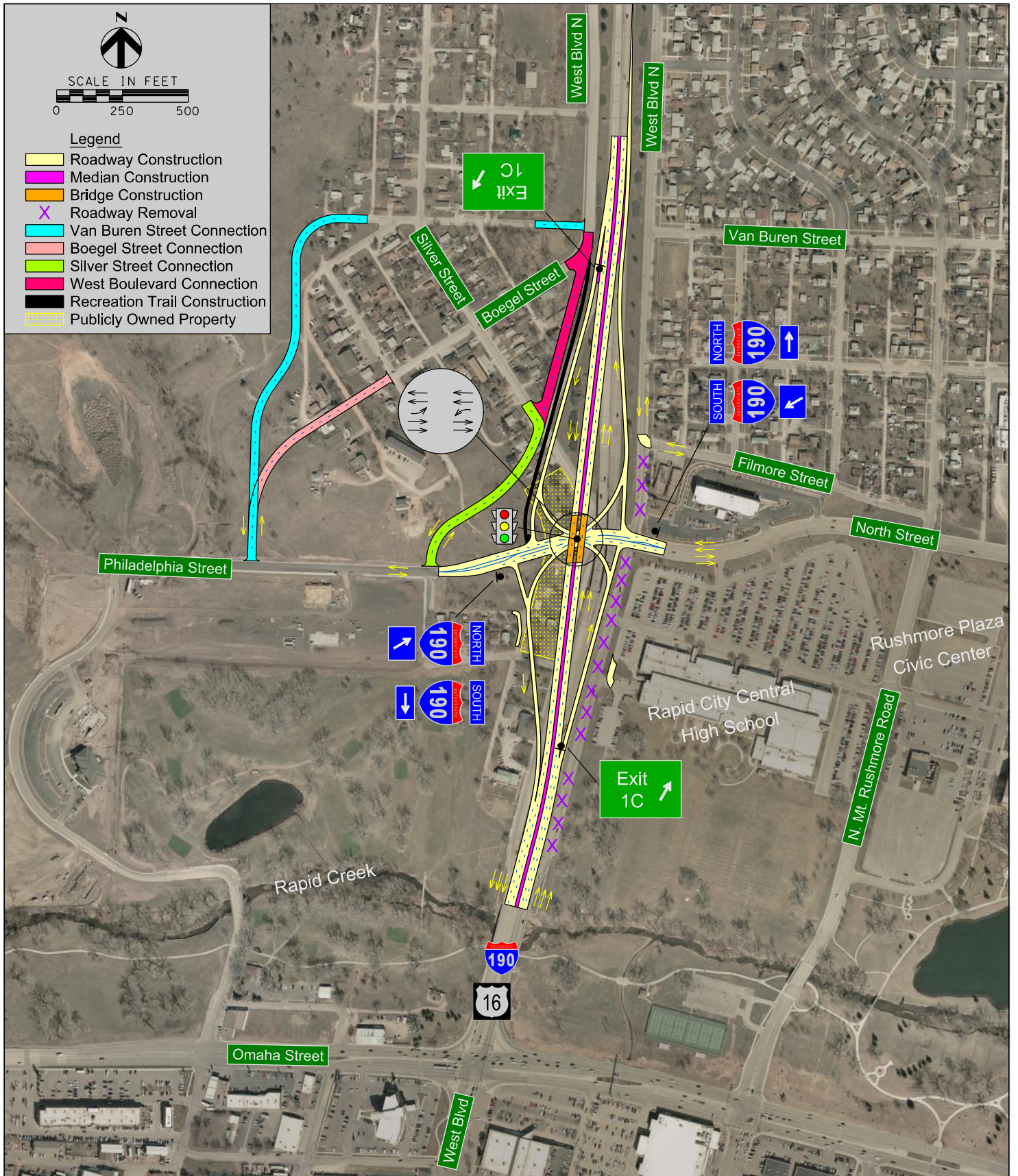
**Interchange Alternative 1a**  
Philadelphia Street Connection Options

Figure 2

Interstate 190/Silver Street Interchange Study  
Rapid City, South Dakota

July 1, 2011

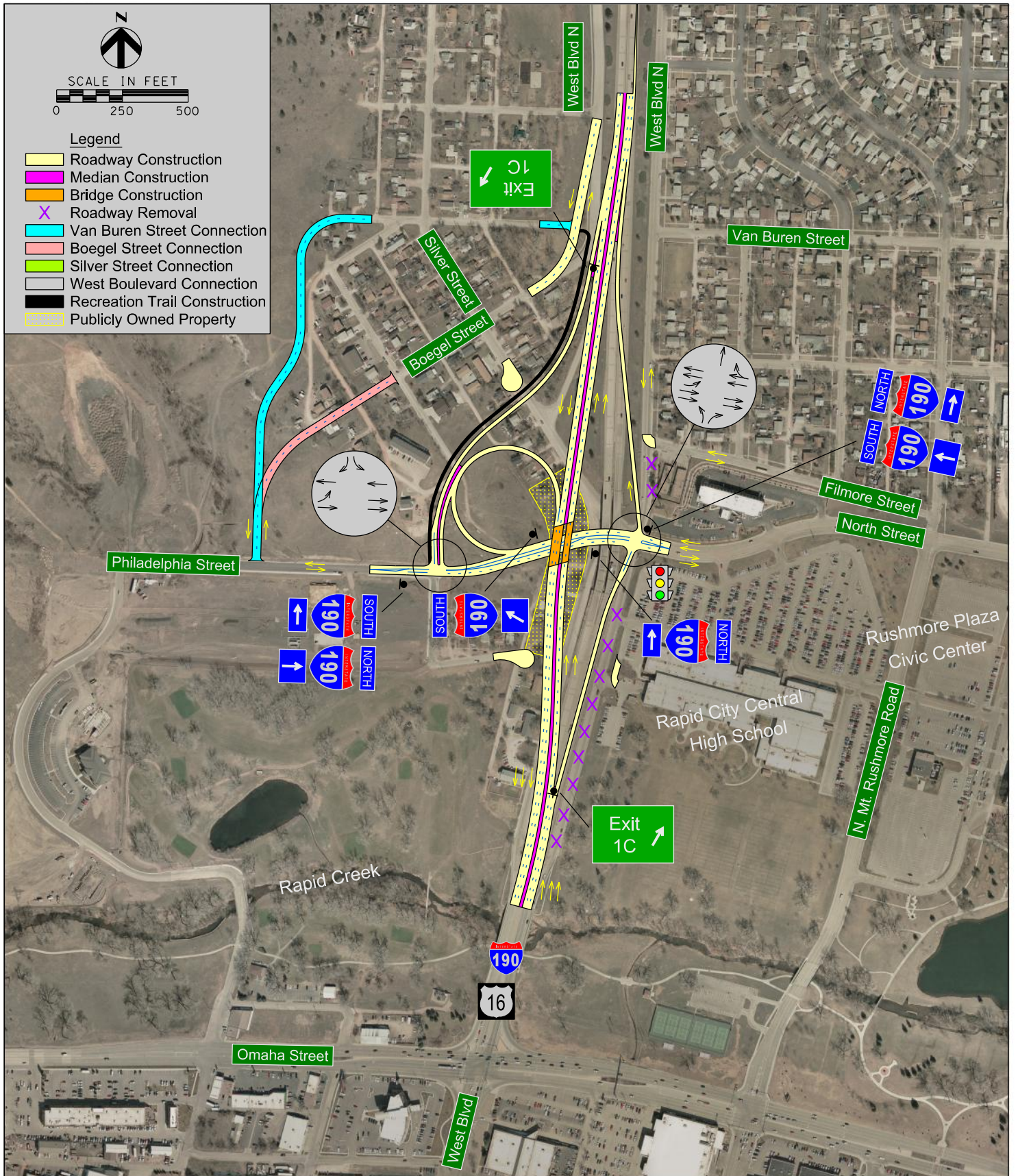







**Interchange Alternative 2a**  
 Philadelphia Street Connection Options  
 Interstate 190/Silver Street Interchange Study  
 Rapid City, South Dakota

Figure 3  
 July 1, 2011



**Interchange Alternative 3a**  
Philadelphia Street Connection Options

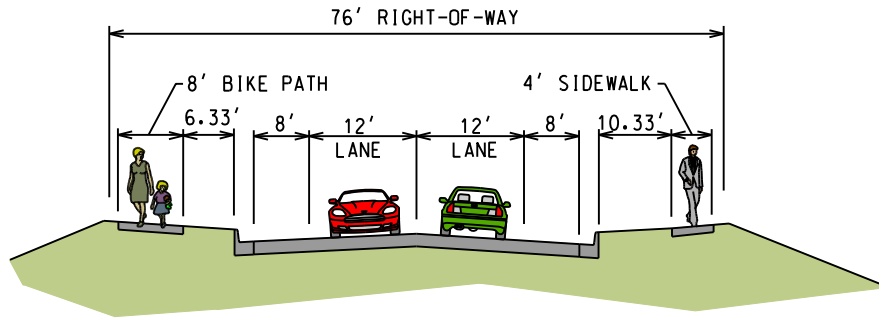
Interstate 190/Silver Street Interchange Study  
Rapid City, South Dakota

Figure 4

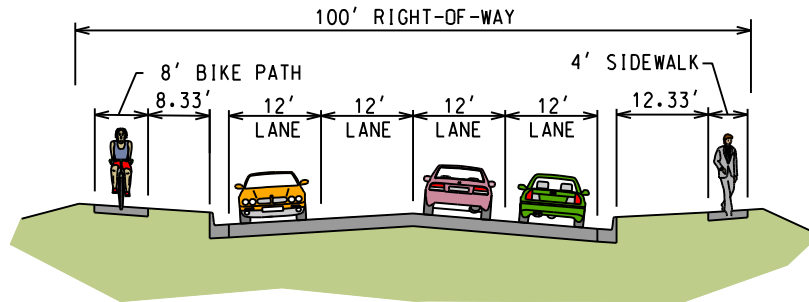
July 1, 2011



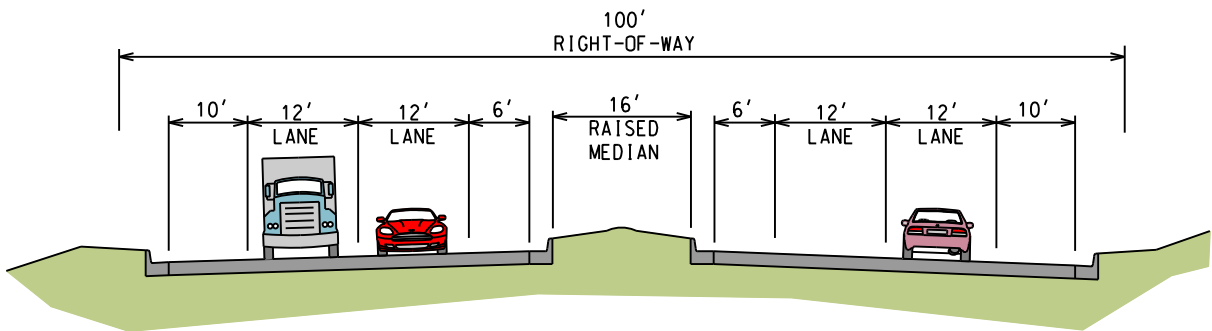
NOTE:  
 TYPICAL PLANNING WIDTHS SHOWN. ACTUAL DIMENSIONS WILL BE  
 DETERMINED DURING PROJECT SCOPE AND DESIGN PHASE



Urban Collector



Urban Arterial



I-190



## Typical Planning Sections

Interstate 190/Silver Street Interchange Study  
 Rapid City, South Dakota

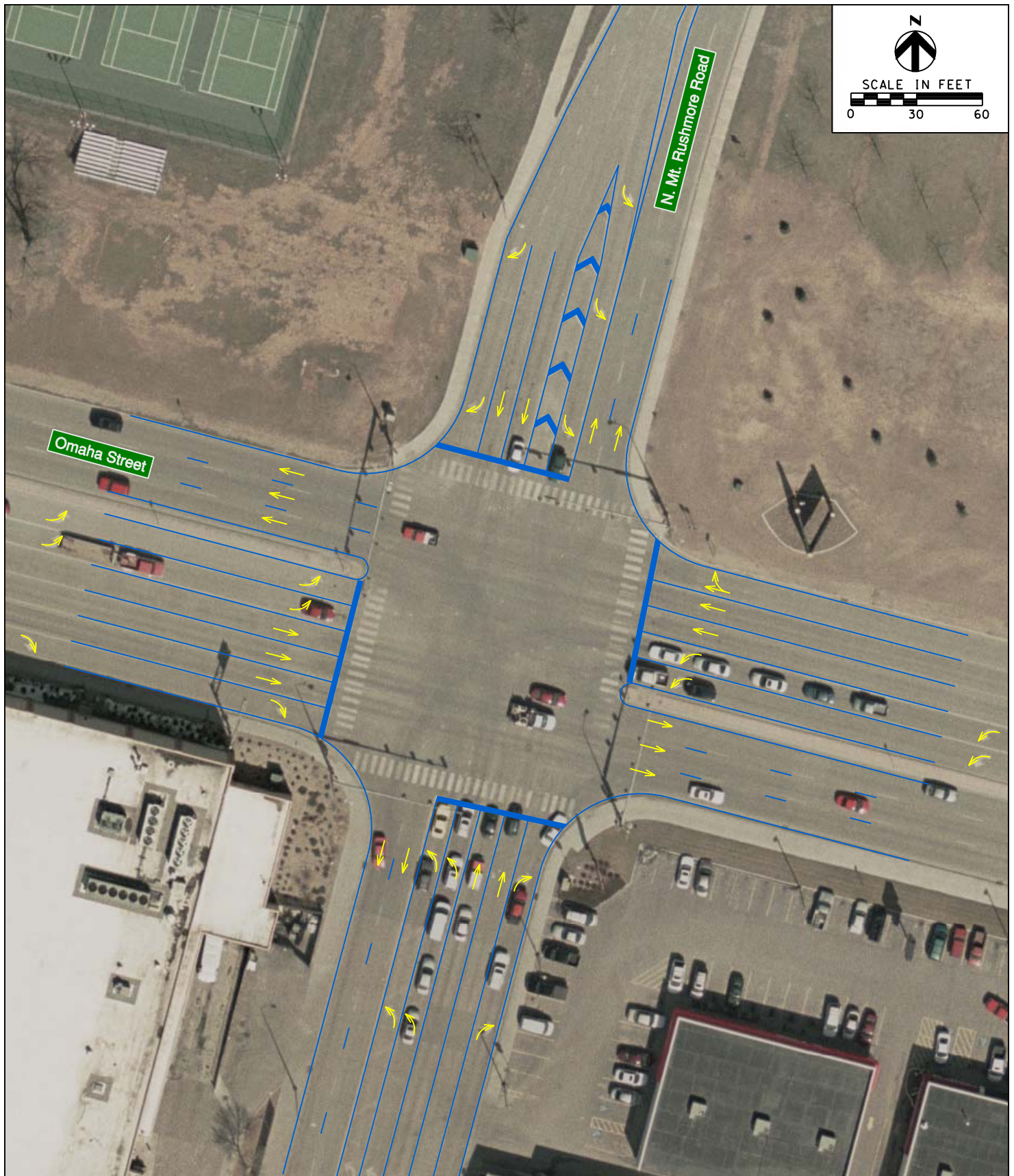
June 15,  
 2011



# North Street / Mt. Rushmore Road

Interstate 190/Silver Street Interchange Study  
 Rapid City, South Dakota

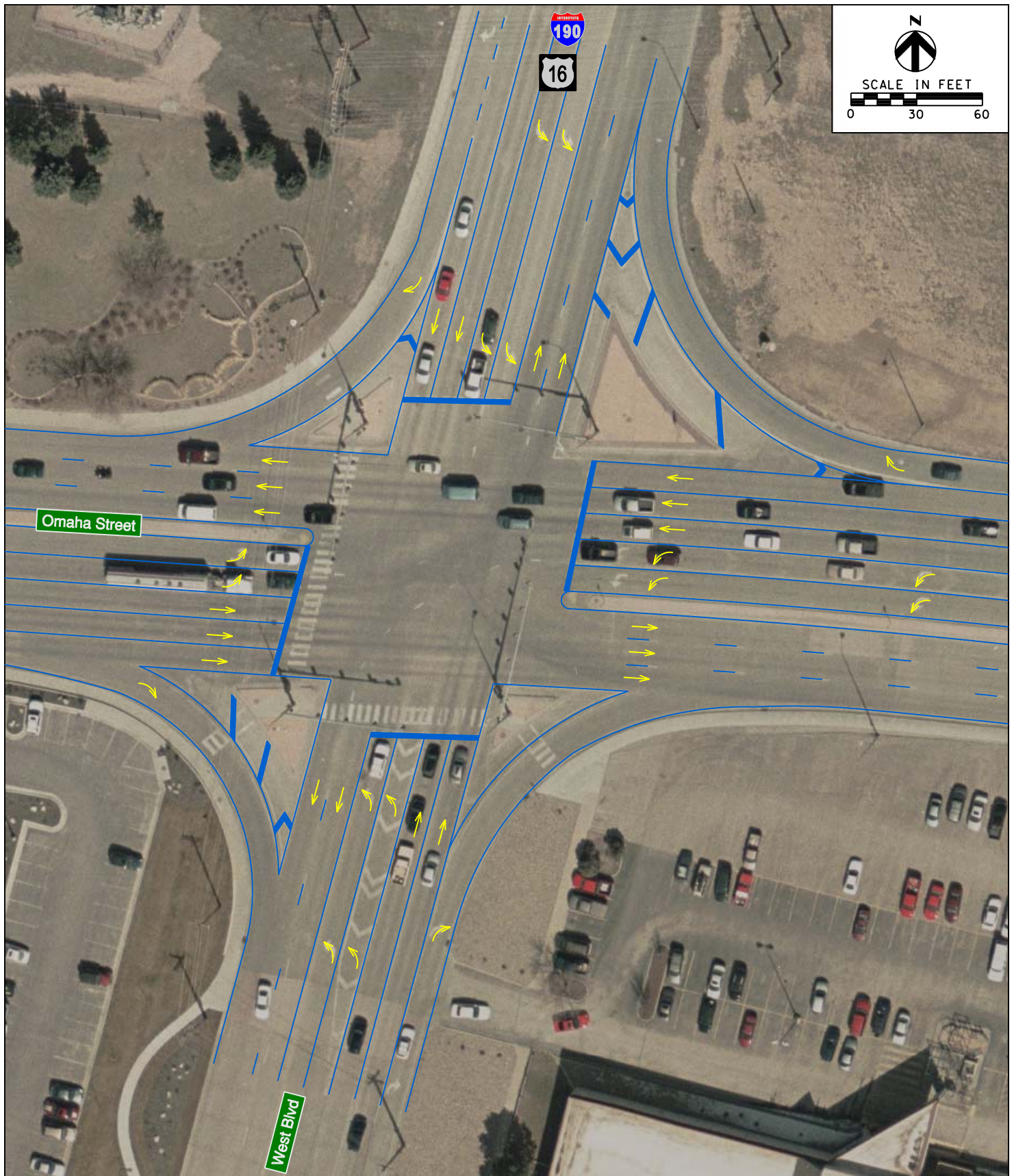
June 15,  
 2011



## Omaha Street / Mt. Rushmore Road

Interstate 190/Silver Street Interchange Study  
 Rapid City, South Dakota

June 15,  
 2011

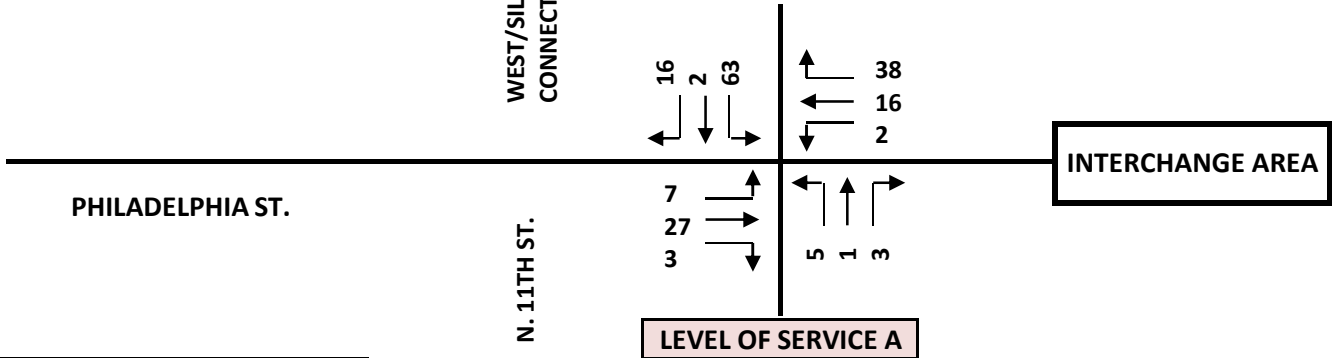


## Omaha Street / West Blvd. (I-190)

Interstate 190/Silver Street Interchange Study  
 Rapid City, South Dakota

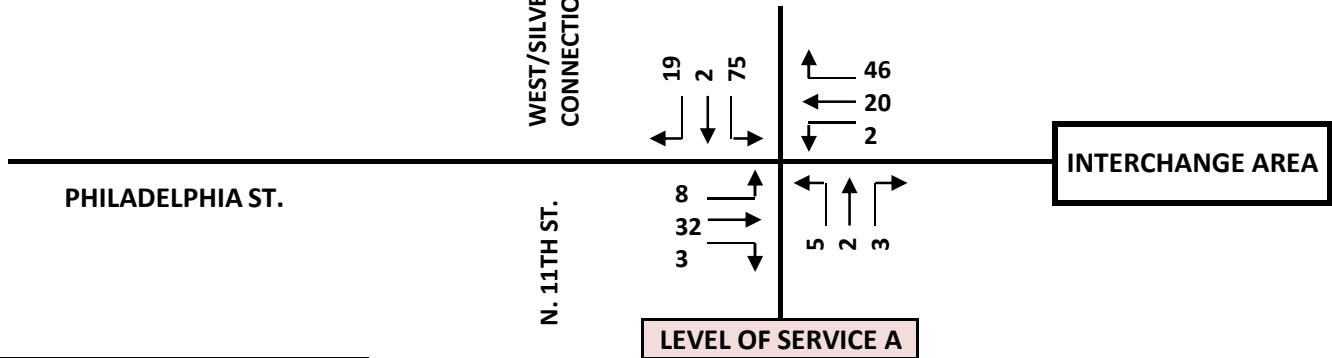
June 15,  
 2011

WEST/SILVER  
CONNECTION



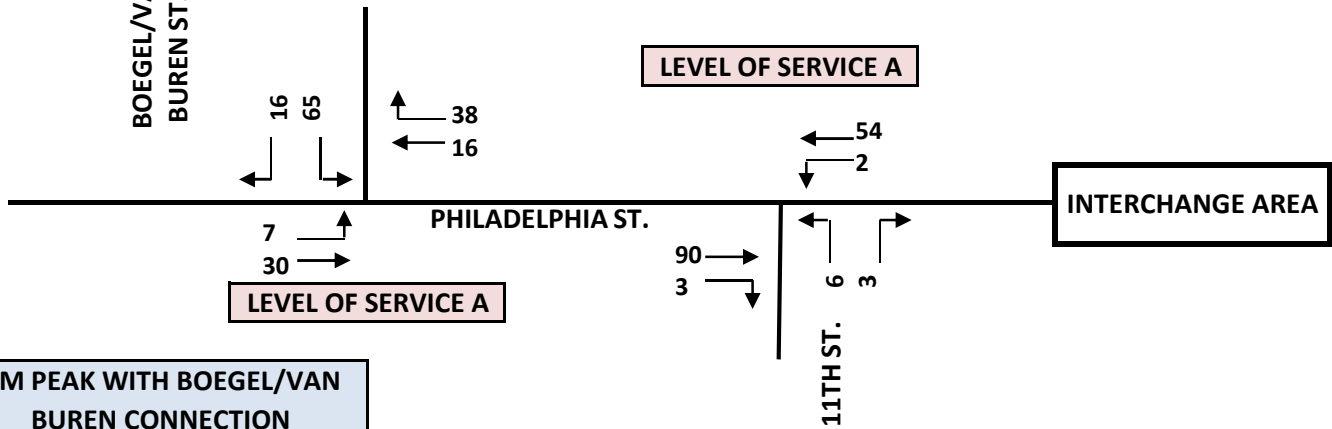
AM PEAK WITH WEST/SILVER  
CONNECTION

WEST/SILVER  
CONNECTION



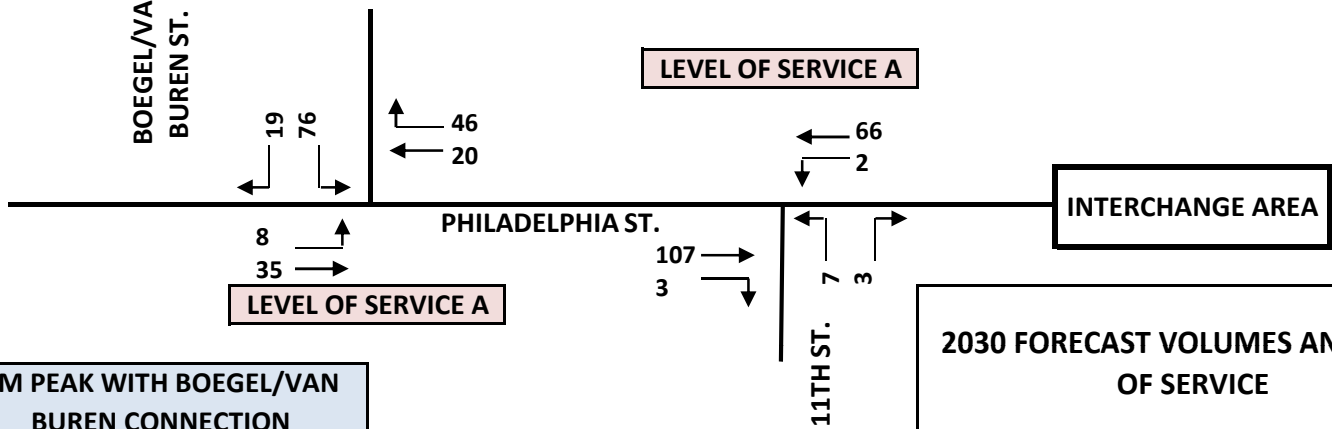
PM PEAK WITH WEST/SILVER  
CONNECTION

BOEGEL/VAN  
BUREN ST.



AM PEAK WITH BOEGEL/VAN  
BUREN CONNECTION

BOEGEL/VAN  
BUREN ST.






















PM PEAK WITH BOEGEL/VAN  
BUREN CONNECTION

2030 FORECAST VOLUMES AND LEVEL  
OF SERVICE

# HCM Unsignalized Intersection Capacity Analysis

## 6: Silver Street & West/Silver Connection




















7/19/2011

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	27	3	2	16	38	5	1	3	63	2	16
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	29	3	2	17	41	5	1	3	68	2	17
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)					590							
pX, platoon unblocked												
vC, conflicting volume	59			33			86	109	31	91	90	38
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	59			33			86	109	31	91	90	38
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			100			99	100	100	92	100	98
cM capacity (veh/h)	1545			1579			878	776	1043	886	795	1034
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>EB 2</b>	<b>WB 1</b>	<b>WB 2</b>	<b>NB 1</b>	<b>SB 1</b>	<b>SB 2</b>					
Volume Total	8	33	2	59	10	68	20					
Volume Left	8	0	2	0	5	68	0					
Volume Right	0	3	0	41	3	0	17					
cSH	1545	1700	1579	1700	913	886	1000					
Volume to Capacity	0.00	0.02	0.00	0.03	0.01	0.08	0.02					
Queue Length 95th (ft)	0	0	0	0	1	6	1					
Control Delay (s)	7.3	0.0	7.3	0.0	9.0	9.4	8.7					
Lane LOS	A		A		A	A	A					
Approach Delay (s)	1.4		0.3		9.0	9.2						
Approach LOS					A	A						
<b>Intersection Summary</b>												
Average Delay			4.9									
Intersection Capacity Utilization			18.1%		ICU Level of Service					A		
Analysis Period (min)			15									

# HCM Unsignalized Intersection Capacity Analysis

## 6: Silver Street & West-Silver Connection

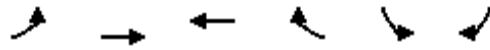
7/19/2011

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	32	3	2	20	46	5	2	3	75	2	19
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	35	3	2	22	50	5	2	3	82	2	21
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)					590							
pX, platoon unblocked												
vC, conflicting volume	72			38			102	130	36	108	107	47
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	72			38			102	130	36	108	107	47
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	99			100			99	100	100	91	100	98
cM capacity (veh/h)	1528			1572			855	755	1036	862	778	1023
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>EB 2</b>	<b>WB 1</b>	<b>WB 2</b>	<b>NB 1</b>	<b>SB 1</b>	<b>SB 2</b>					
Volume Total	9	38	2	72	11	82	23					
Volume Left	9	0	2	0	5	82	0					
Volume Right	0	3	0	50	3	0	21					
cSH	1528	1700	1572	1700	878	862	993					
Volume to Capacity	0.01	0.02	0.00	0.04	0.01	0.09	0.02					
Queue Length 95th (ft)	0	0	0	0	1	8	2					
Control Delay (s)	7.4	0.0	7.3	0.0	9.2	9.6	8.7					
Lane LOS	A		A		A	A	A					
Approach Delay (s)	1.4		0.2		9.2	9.4						
Approach LOS					A	A						
<b>Intersection Summary</b>												
Average Delay			4.9									
Intersection Capacity Utilization			20.6%		ICU Level of Service					A		
Analysis Period (min)			15									

# HCM Unsignalized Intersection Capacity Analysis

## 6: Silver Street & Boegel-Van Buren Connection

7/19/2011



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	7	30	16	38	65	16
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	8	33	17	41	71	17
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	59				86	38
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	59				86	38
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	100				92	98
cM capacity (veh/h)	1545				911	1034

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	8	33	59	88
Volume Left	8	0	0	71
Volume Right	0	0	41	17
cSH	1545	1700	1700	933
Volume to Capacity	0.00	0.02	0.03	0.09
Queue Length 95th (ft)	0	0	0	8
Control Delay (s)	7.3	0.0	0.0	9.3
Lane LOS	A			A
Approach Delay (s)	1.4		0.0	9.3
Approach LOS				A

Intersection Summary			
Average Delay		4.7	
Intersection Capacity Utilization		17.1%	ICU Level of Service A
Analysis Period (min)		15	



# HCM Unsignalized Intersection Capacity Analysis

## 9: Silver Street & 11th St.

7/19/2011



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	→		←	→	↔	
Volume (veh/h)	90	3	2	54	6	3
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	98	3	2	59	7	3
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)				700		
pX, platoon unblocked						
vC, conflicting volume			101		162	99
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			101		162	99
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	100
cM capacity (veh/h)			1491		827	956

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	101	2	59	10
Volume Left	0	2	0	7
Volume Right	3	0	0	3
cSH	1700	1491	1700	866
Volume to Capacity	0.06	0.00	0.03	0.01
Queue Length 95th (ft)	0	0	0	1
Control Delay (s)	0.0	7.4	0.0	9.2
Lane LOS		A		A
Approach Delay (s)	0.0	0.3		9.2
Approach LOS				A

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		14.9%	ICU Level of Service A
Analysis Period (min)		15	

# HCM Unsignalized Intersection Capacity Analysis

## 6: Silver Street & Boegel-Van Buren Connection

7/19/2011



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	8	35	20	46	76	19
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	9	38	22	50	83	21
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	72				102	47
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	72				102	47
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	99				91	98
cM capacity (veh/h)	1528				891	1023

Direction, Lane #	EB 1	EB 2	WB 1	SB 1
Volume Total	9	38	72	103
Volume Left	9	0	0	83
Volume Right	0	0	50	21
cSH	1528	1700	1700	915
Volume to Capacity	0.01	0.02	0.04	0.11
Queue Length 95th (ft)	0	0	0	10
Control Delay (s)	7.4	0.0	0.0	9.4
Lane LOS	A			A
Approach Delay (s)	1.4		0.0	9.4
Approach LOS				A

Intersection Summary			
Average Delay		4.7	
Intersection Capacity Utilization		18.7%	ICU Level of Service A
Analysis Period (min)		15	

# HCM Unsignalized Intersection Capacity Analysis

## 9: Silver Street & 11th St.

7/19/2011



Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↩		↩	↩	↩	
Volume (veh/h)	107	3	2	66	7	3
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	116	3	2	72	8	3
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage (veh)						
Upstream signal (ft)				740		
pX, platoon unblocked						
vC, conflicting volume			120		194	118
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			120		194	118
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			100		99	100
cM capacity (veh/h)			1468		794	934

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	120	2	72	11
Volume Left	0	2	0	8
Volume Right	3	0	0	3
cSH	1700	1468	1700	831
Volume to Capacity	0.07	0.00	0.04	0.01
Queue Length 95th (ft)	0	0	0	1
Control Delay (s)	0.0	7.5	0.0	9.4
Lane LOS		A		A
Approach Delay (s)	0.0	0.2		9.4
Approach LOS				A

Intersection Summary			
Average Delay		0.6	
Intersection Capacity Utilization		15.8%	ICU Level of Service A
Analysis Period (min)		15	

## Plan/Profile Sheets

# I-190 / Silver Street Preliminary Plan / Profile Design - Alternative 1

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	HP 5596(12)	1	2
FILE: Alternative 1.dgn		REV DATE: INITIAL:	
PLOTTING DATE: 08/18/2011			

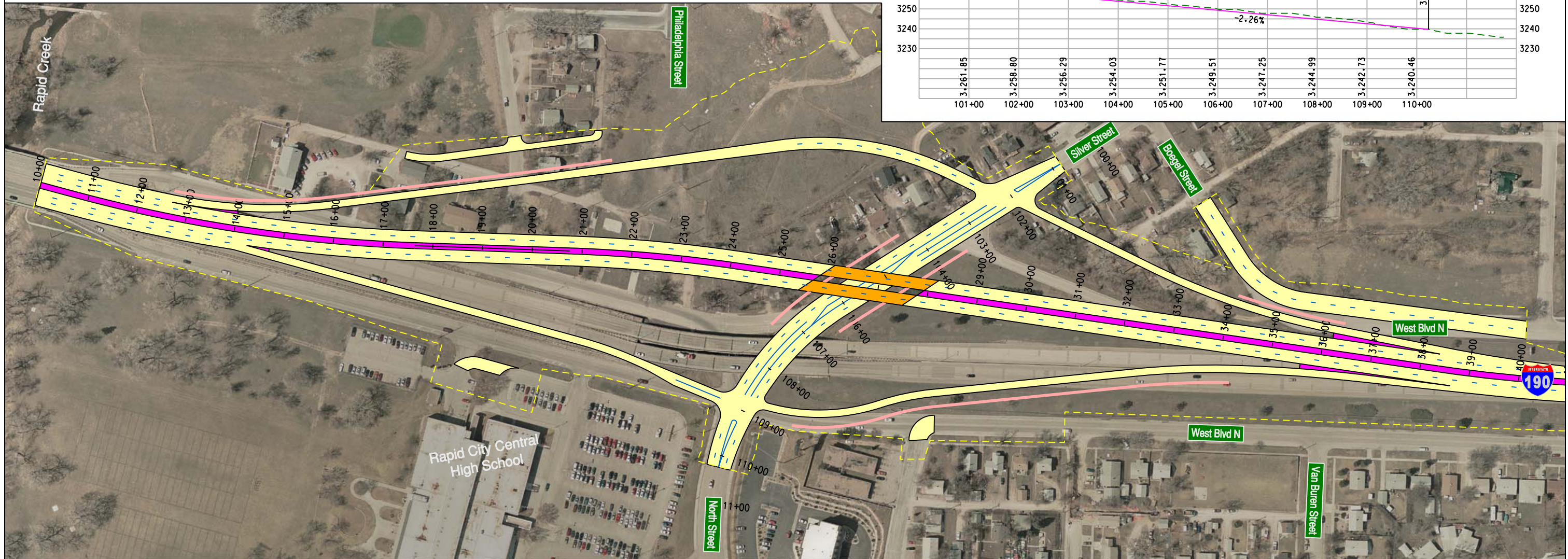
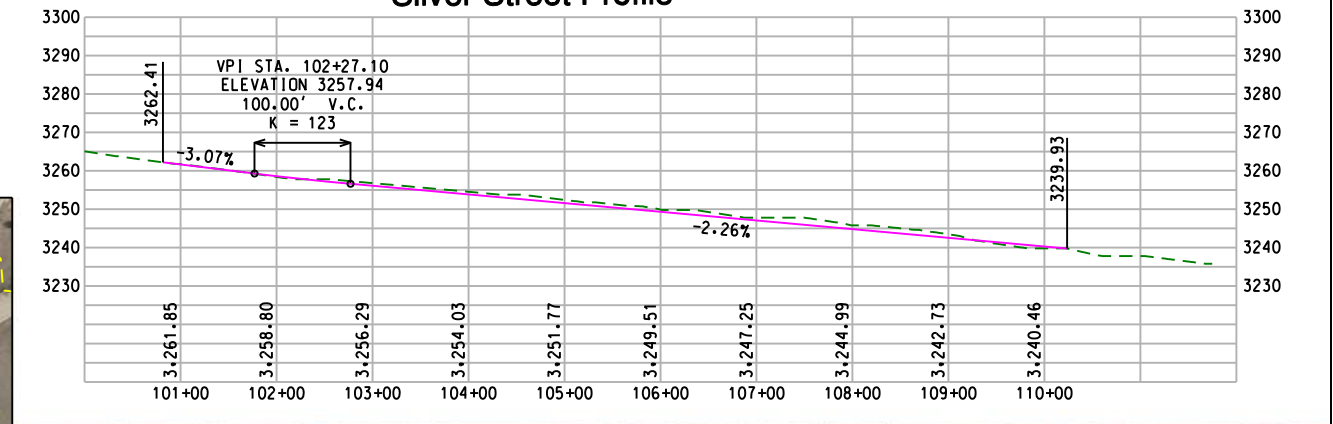
**Legend**

- Roadway
- Bridge
- Raised Island / Median
- Local Access Option
- Construction Limit
- Retaining Wall

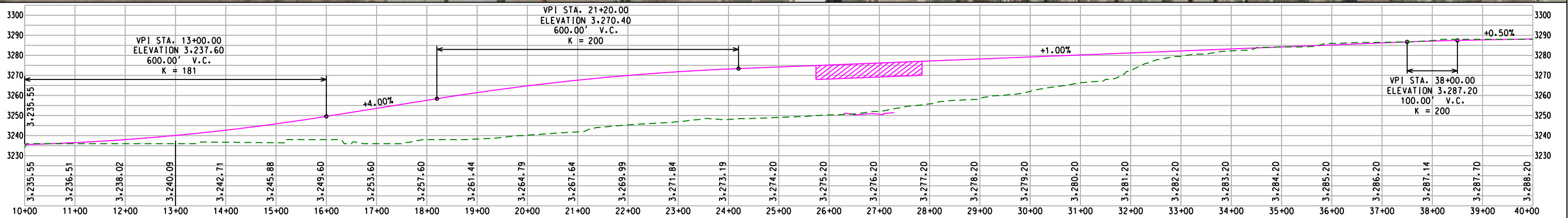


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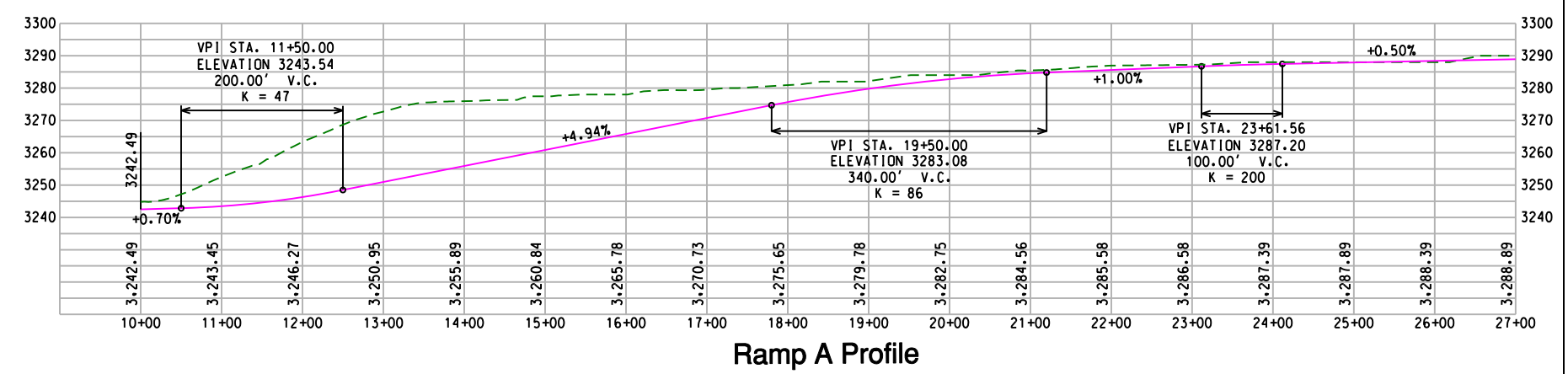
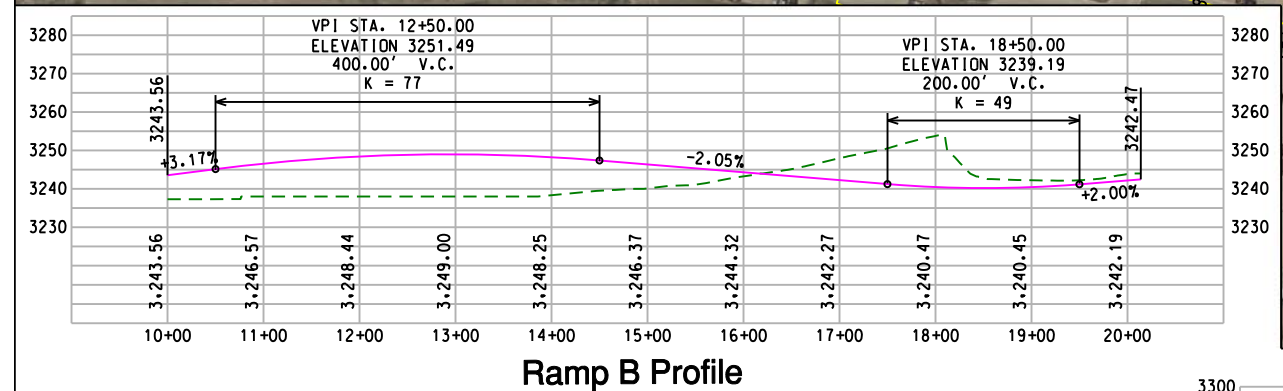
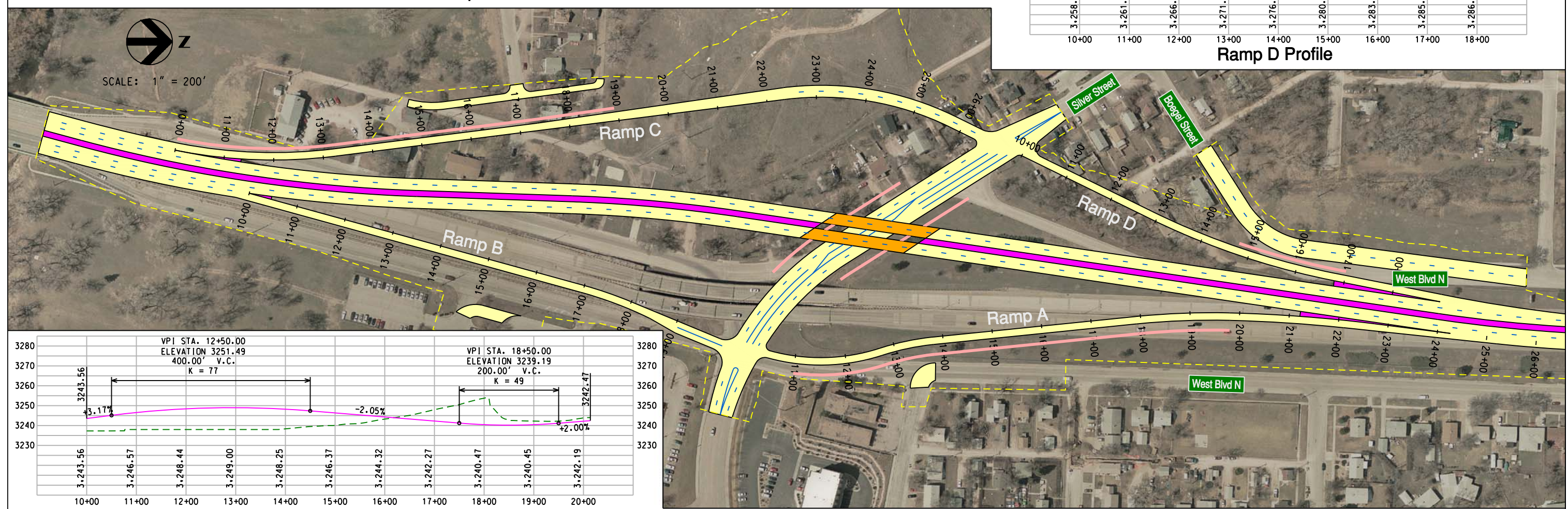
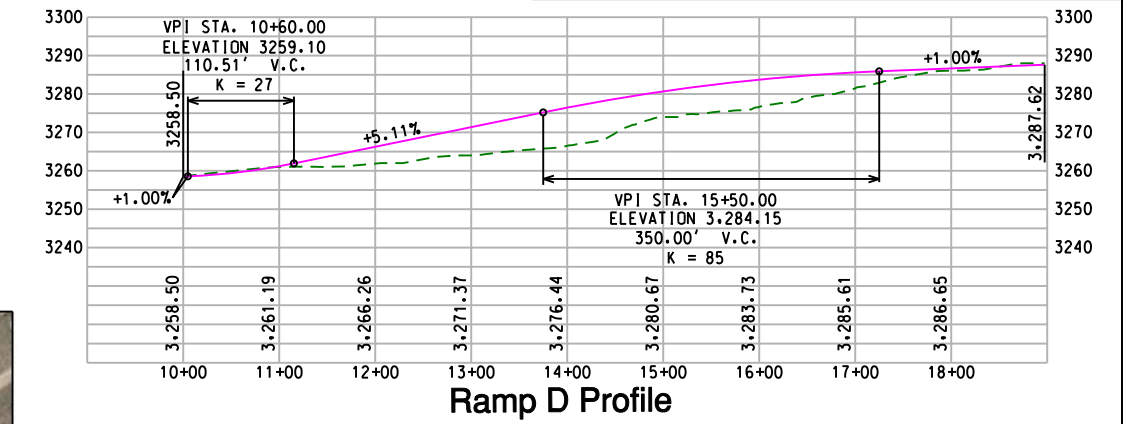
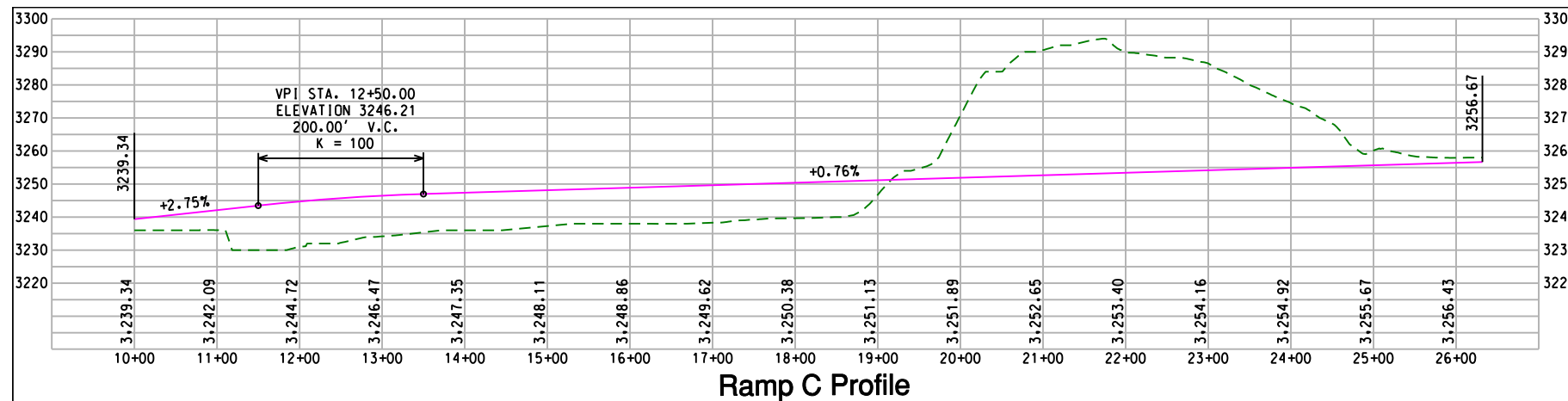
Silver Street Profile



I-190 Profile



STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	HP 5596(12)	2	2
FILE: Alternative 1.dgn		REV DATE:	
PLOTTING DATE: 08/18/2011		INITIAL:	



# I-190 / Silver Street Preliminary Plan / Profile Design - Alternative 1

Legend	
	Roadway
	Bridge
	Raised Island / Median
	Local Access Option
	Construction Limit
	Retaining Wall

SCALE: 1" = 200'

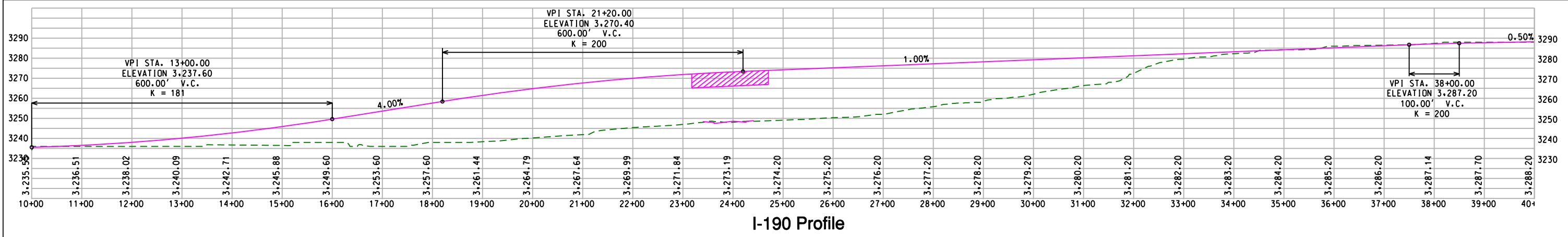
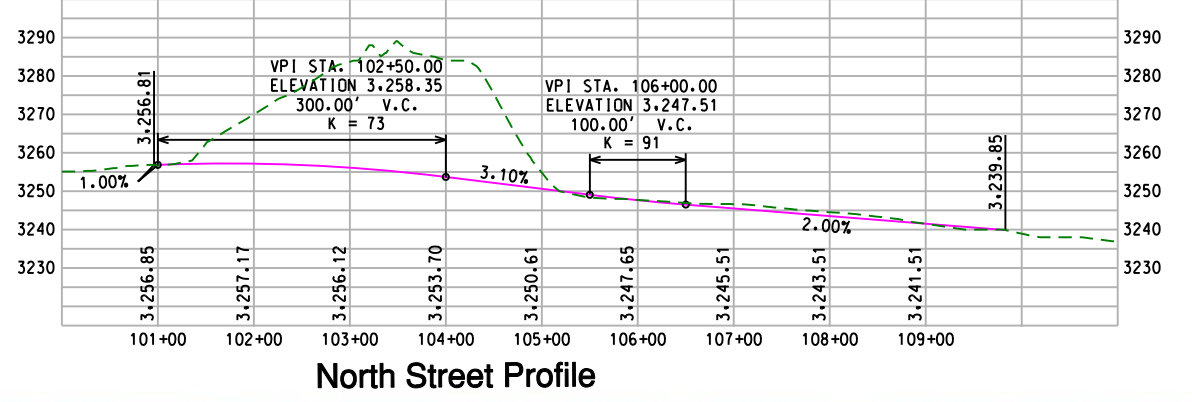
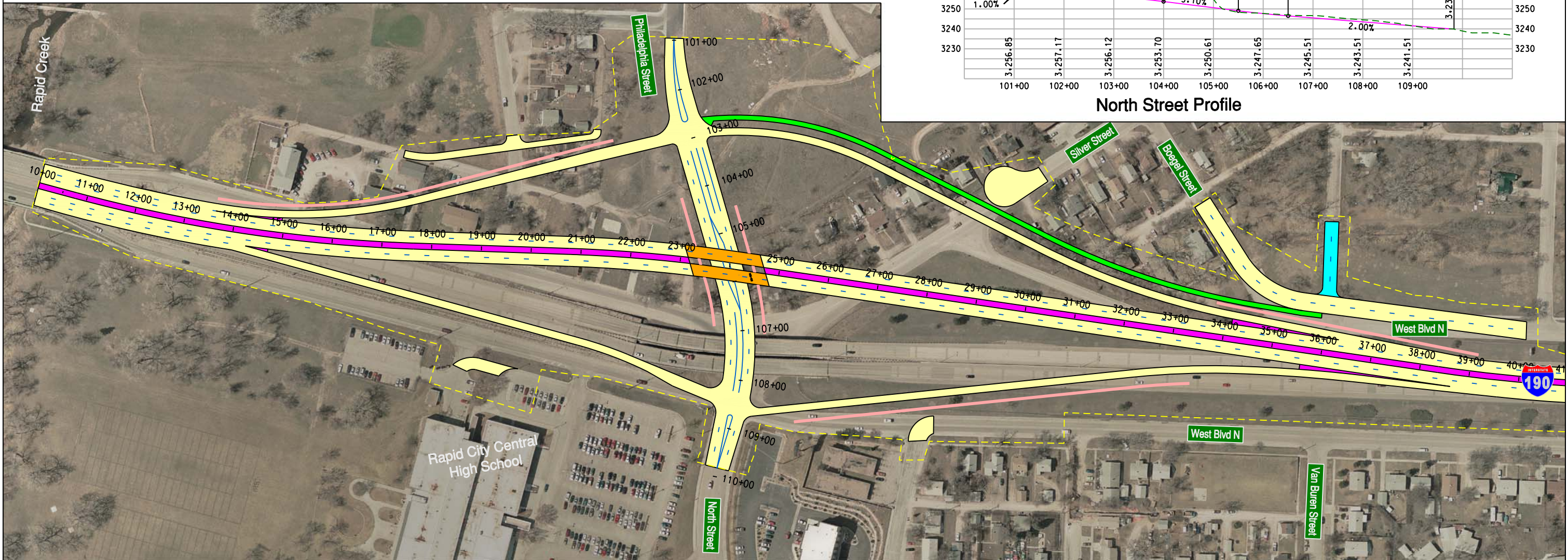
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STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	HP 5596(12)	1	2
FILE: Alternative 1a.dgn		REV DATE: INITIAL:	
PLOTTING DATE: 08/18/2011			

Legend	
	Roadway
	Bridge
	Raised Island / Median
	Recreation Trail
	Local Access Option
	Construction Limit
	Retaining Wall



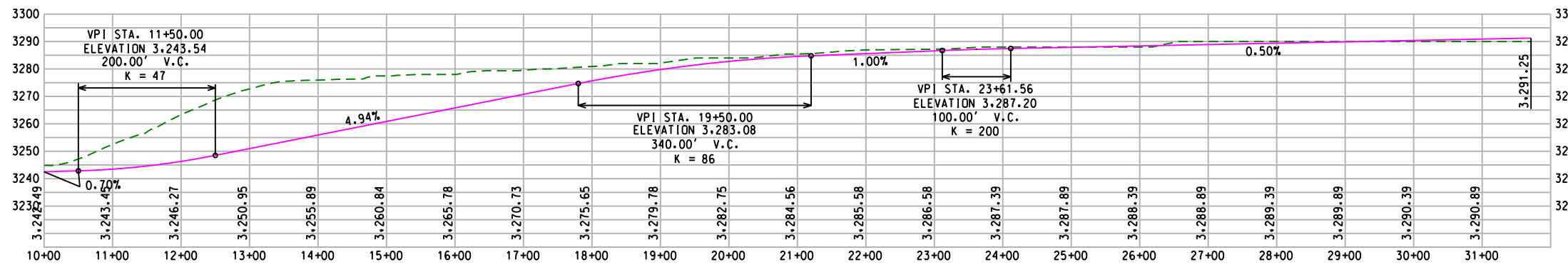
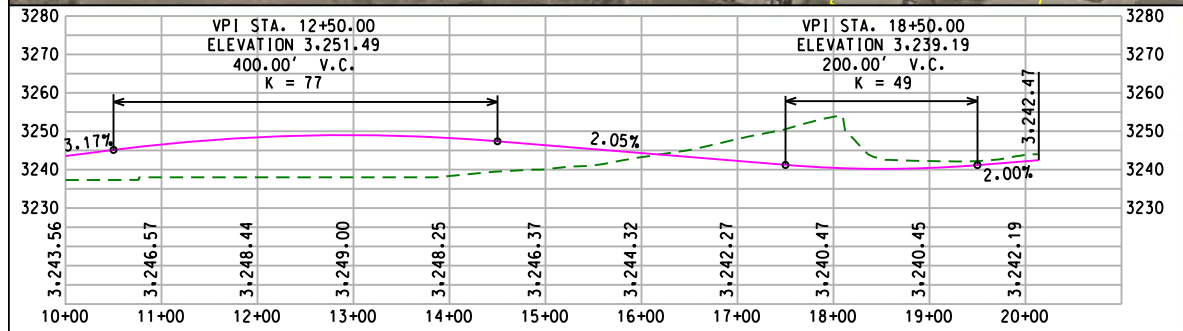
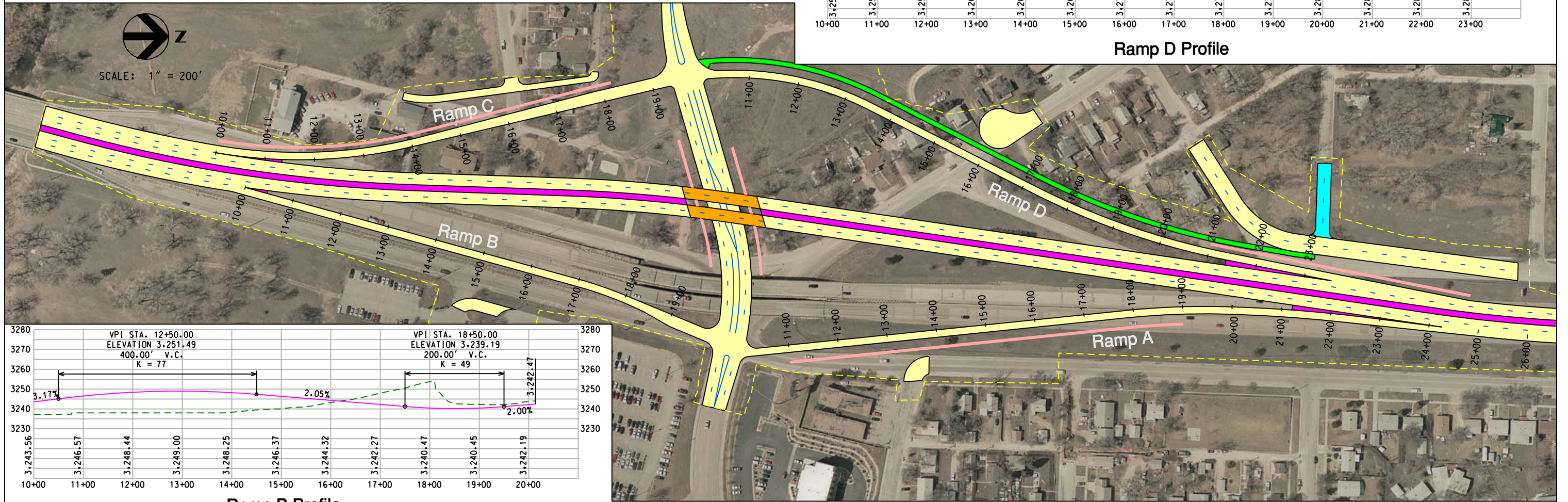
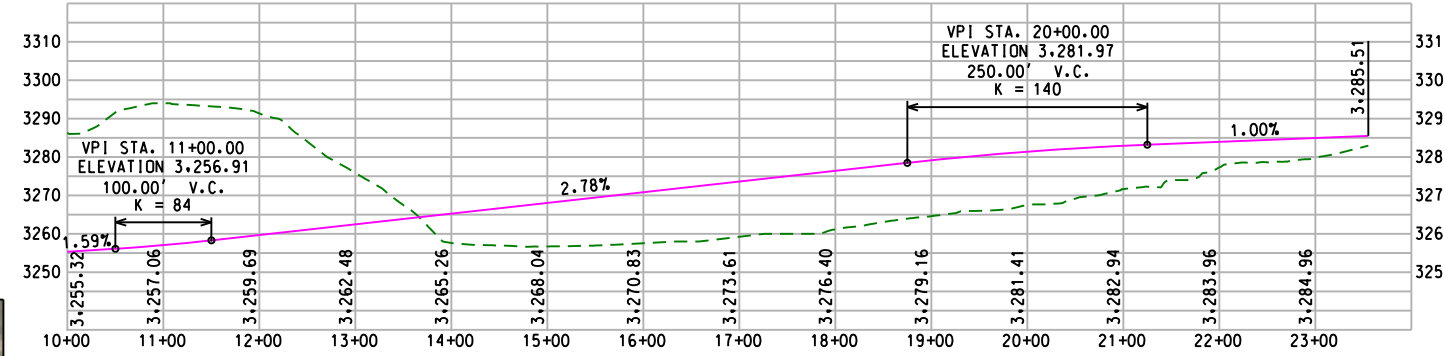
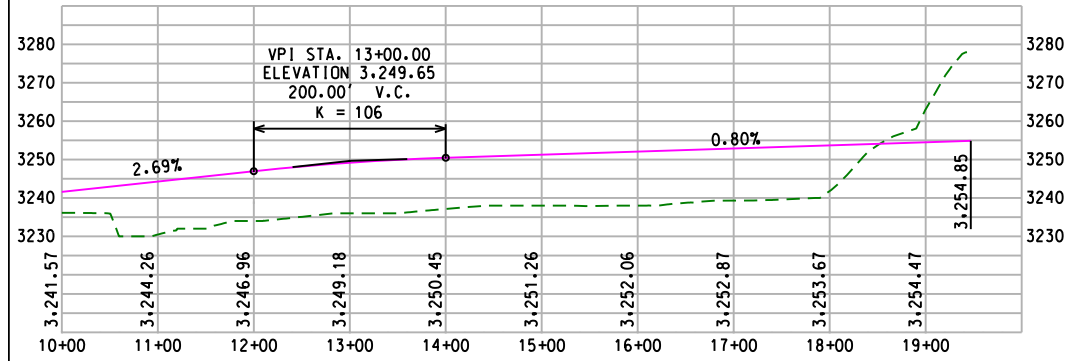
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I-190 Profile

# I-190 / Silver Street Preliminary Plan / Profile Design - Alternative 1A

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	HP 5596(12)	2	2
FILE: Alternative 1a.dgn		REV DATE: INITIAL:	
PLOTTING DATE: 08/18/2011			





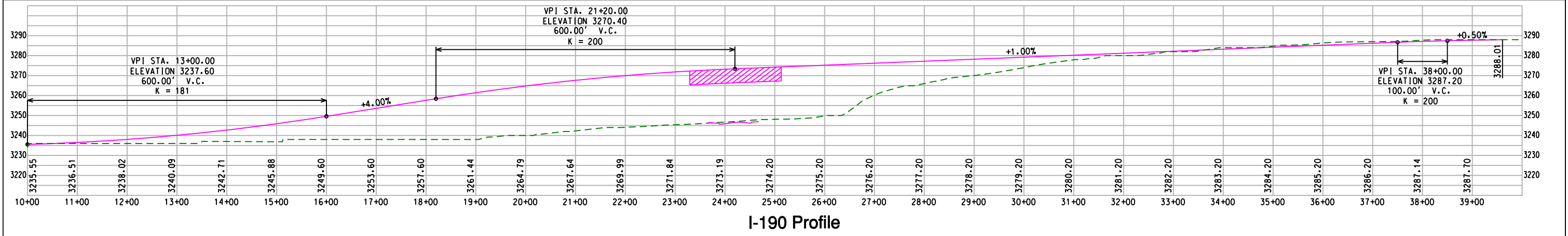
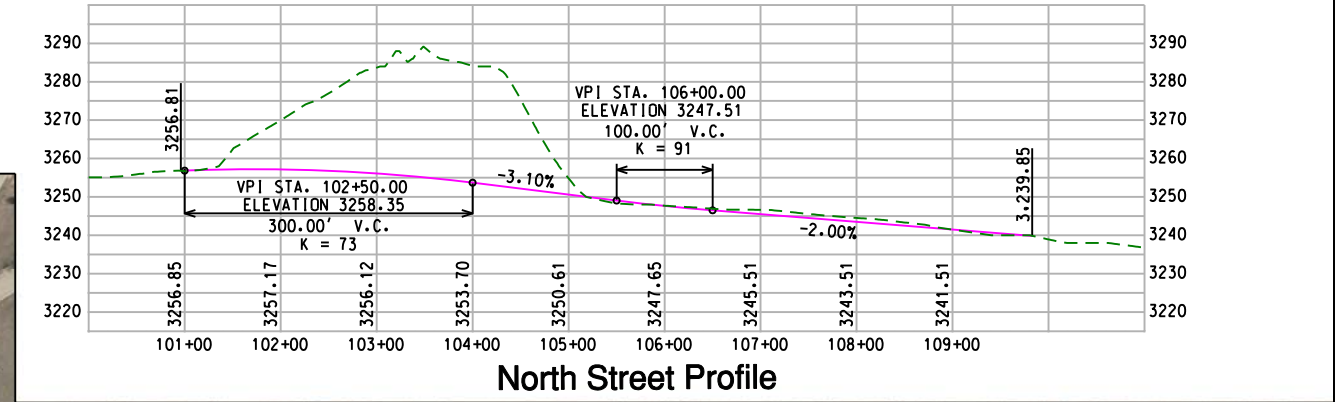
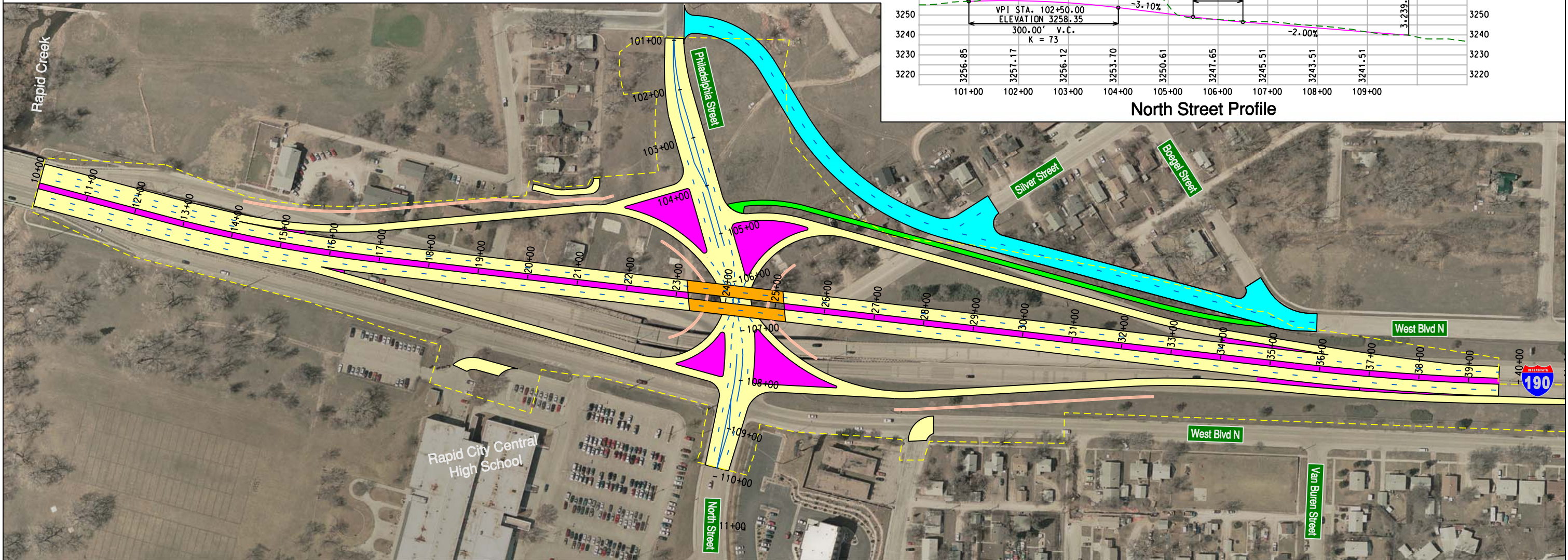
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STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
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FILE: Alternative 2a.dgn		REV DATE: INITIAL:	
PLOTTING DATE: 08/18/2011			

Legend	
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	Bridge
	Raised Island / Median
	Recreation Trail
	Local Access Option
	Construction Limit
	Retaining Wall

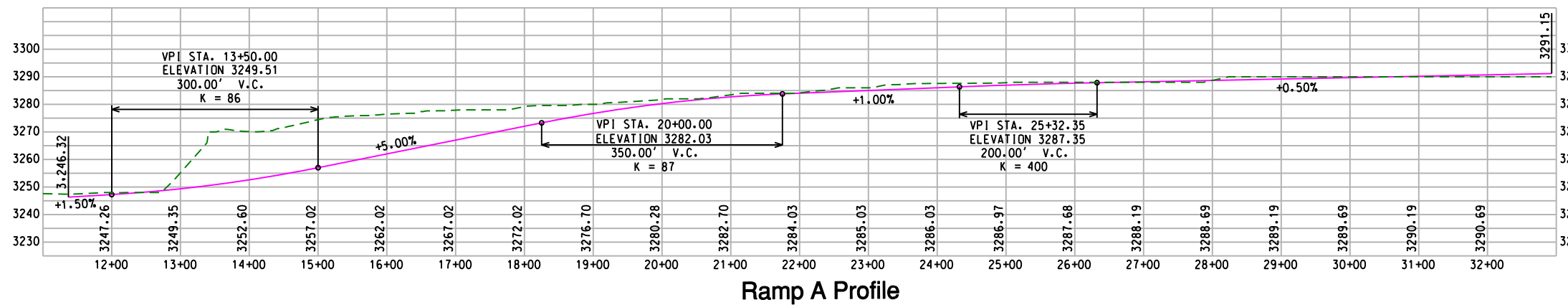
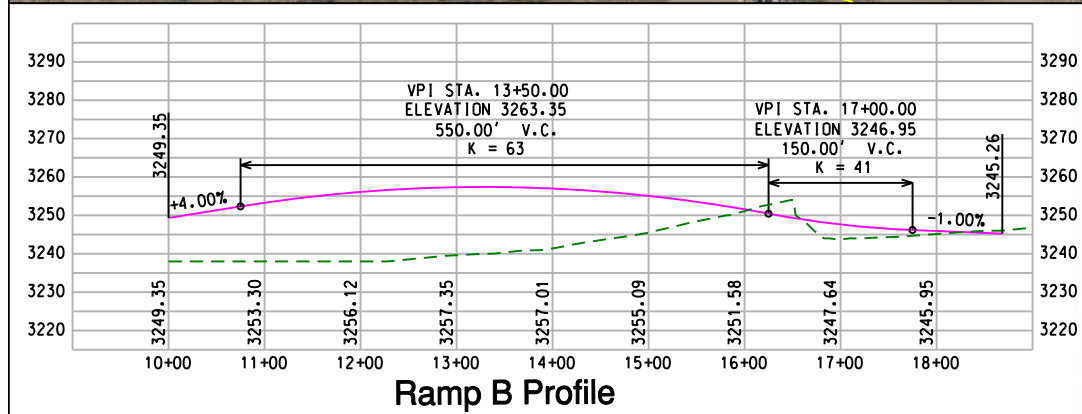
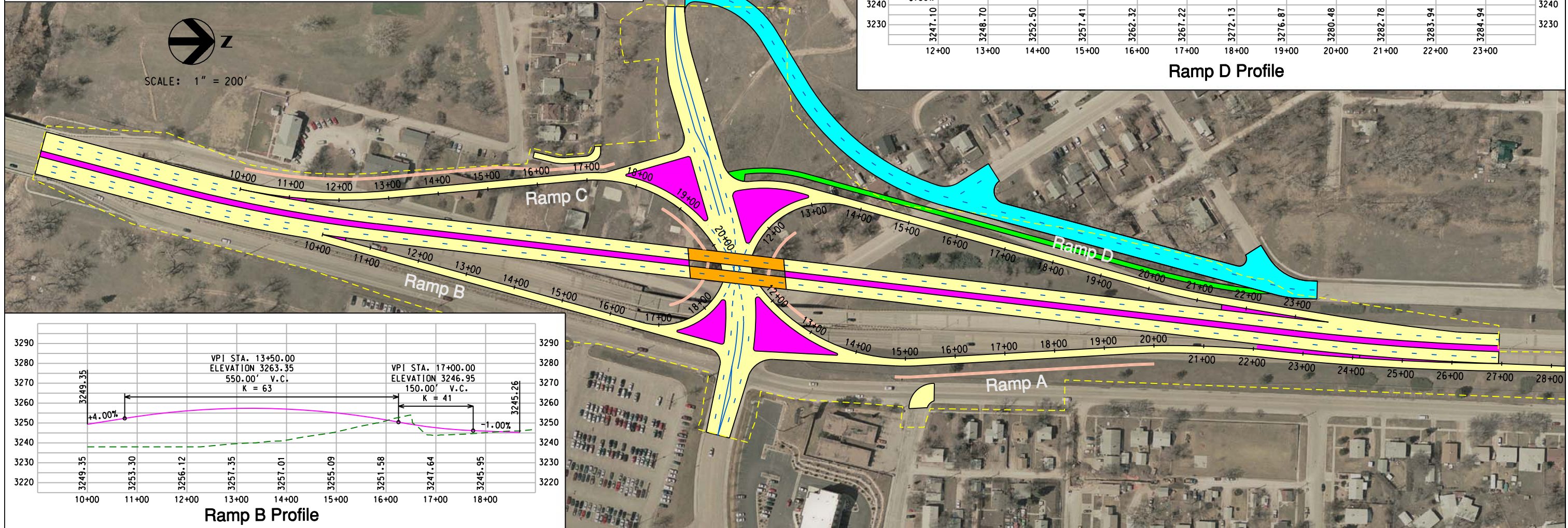
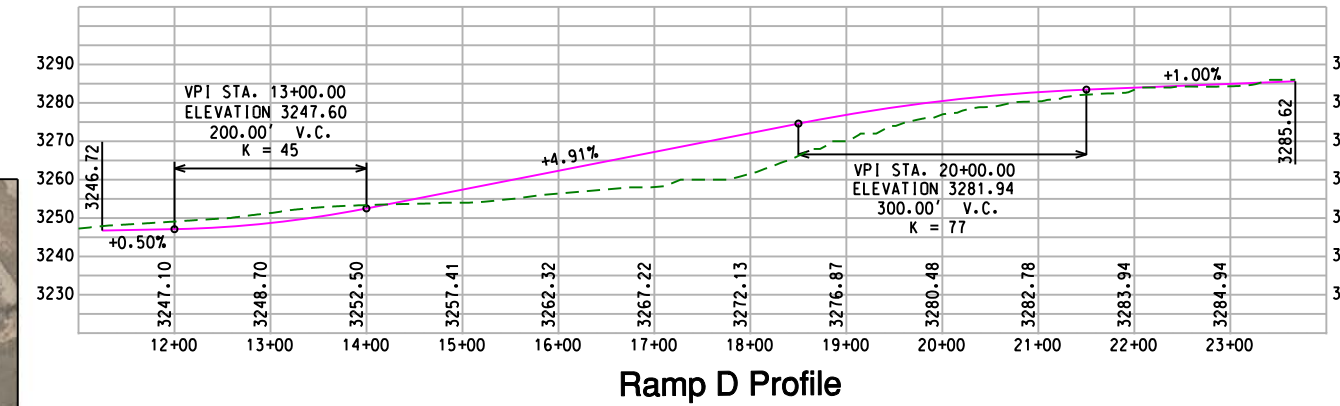
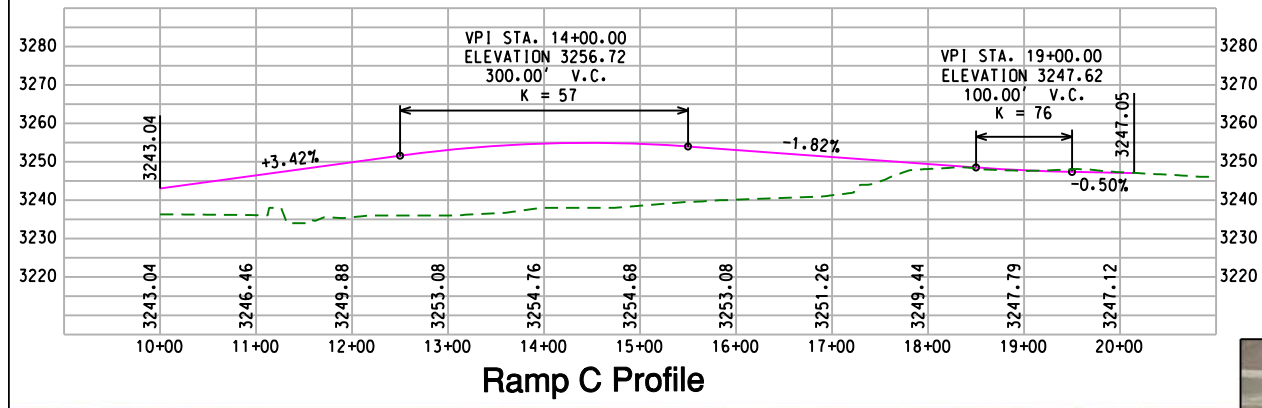


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# I-190 / Silver Street Preliminary Plan / Profile Design - Alternative 2A

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	HP 5596(12)		
FILE: Alternative 2a.dgn		REV DATE: INITIAL:	
PLOTTING DATE: 08/18/2011			



Legend	
	Roadway
	Bridge
	Raised Island / Median
	Recreation Trail
	Local Access Option
	Construction Limit
	Retaining Wall

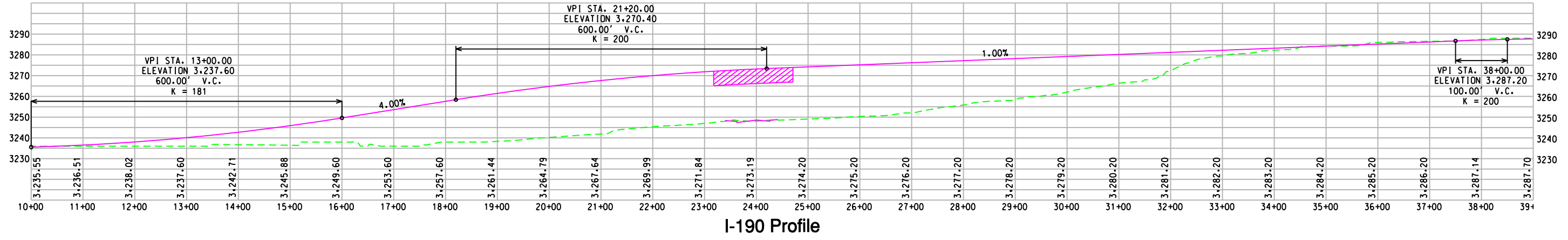
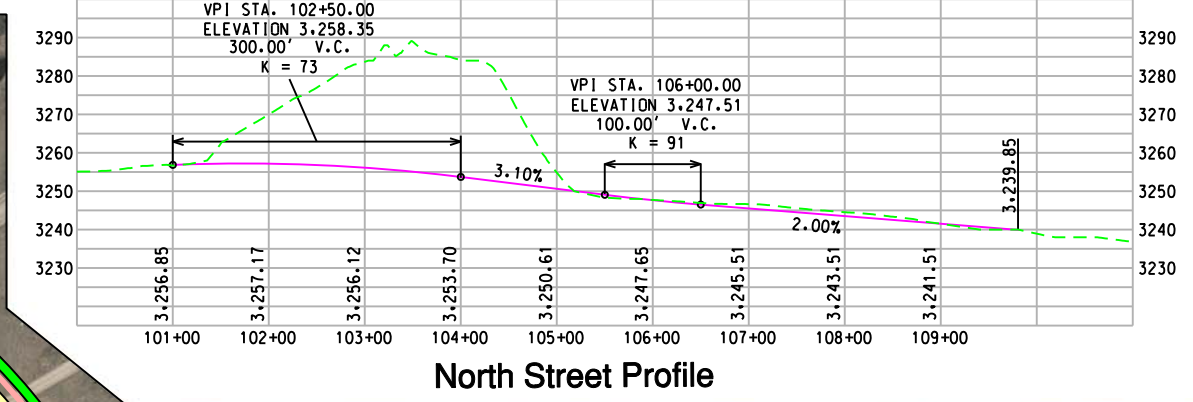
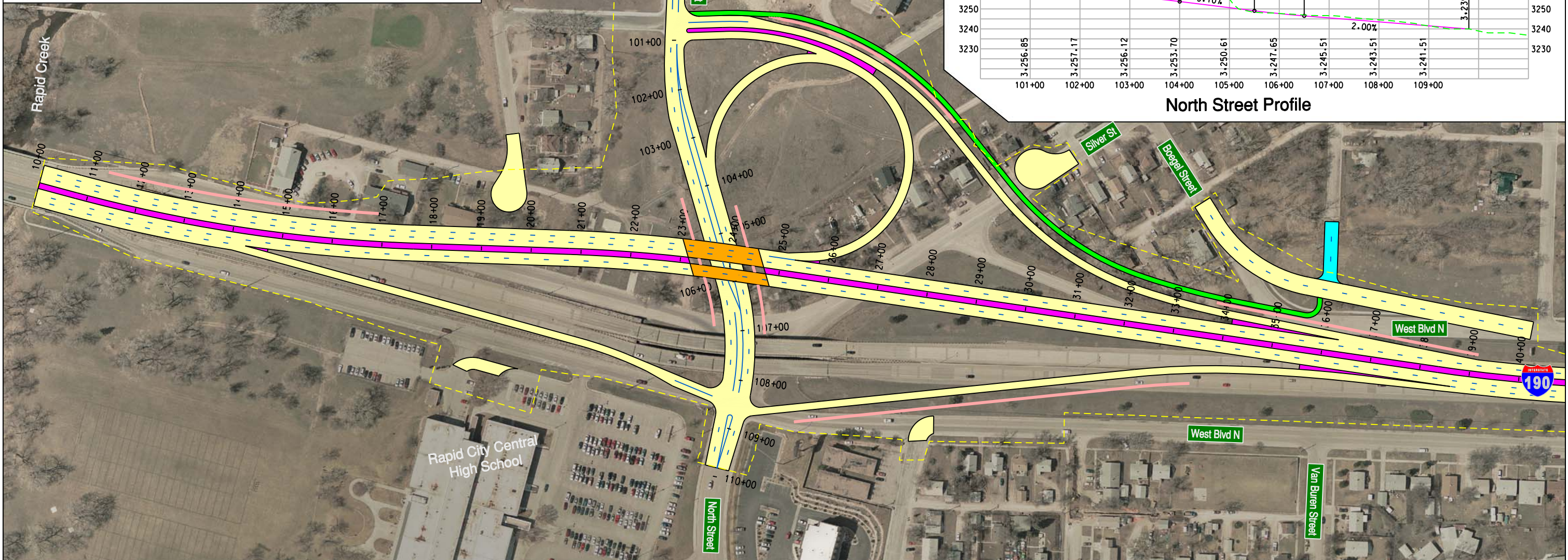
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	HP 5596(12)	1	3
FILE: Alternative 3a.dgn		REV DATE: INITIAL:	
PLOTTING DATE: 08/18/2011			

Legend	
	Roadway
	Bridge
	Raised Island / Median
	Recreation Trail
	Local Access Option
	Construction Limit
	Retaining Wall

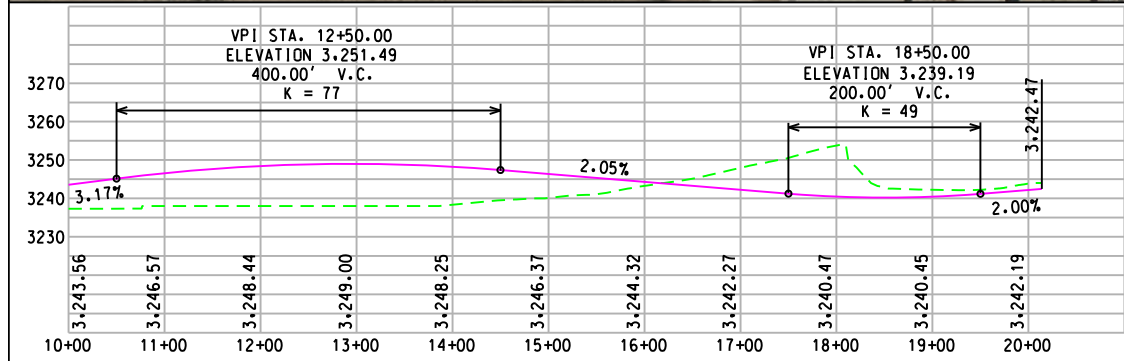
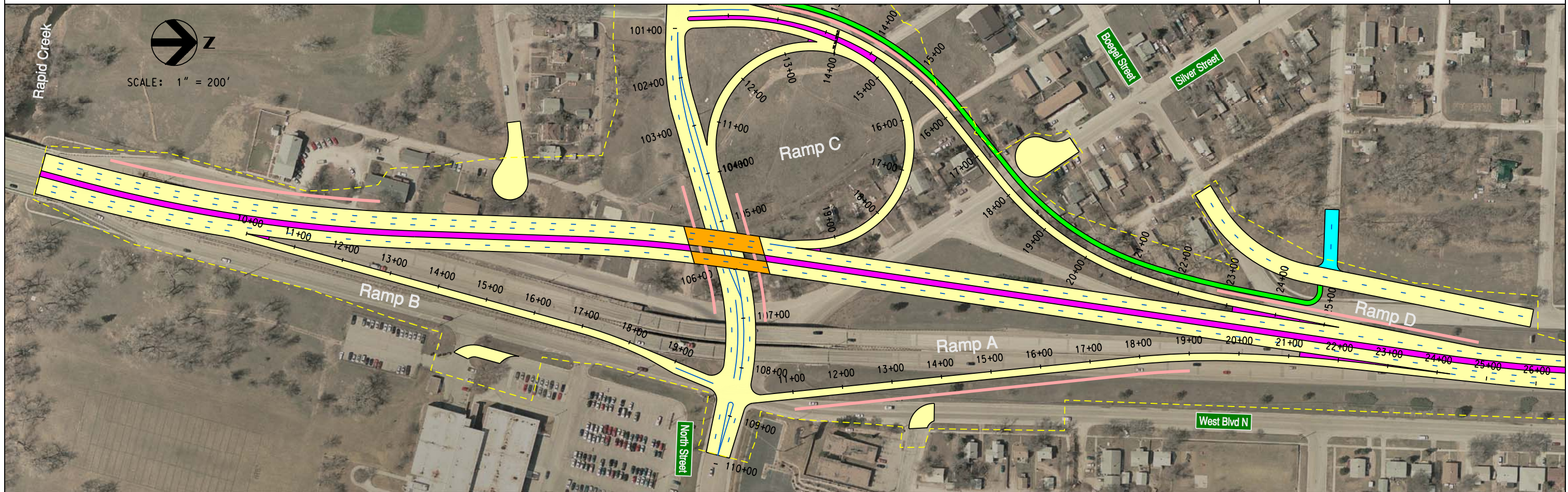


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# I-190 / Silver Street Preliminary Plan / Profile Design - Alternative 3A

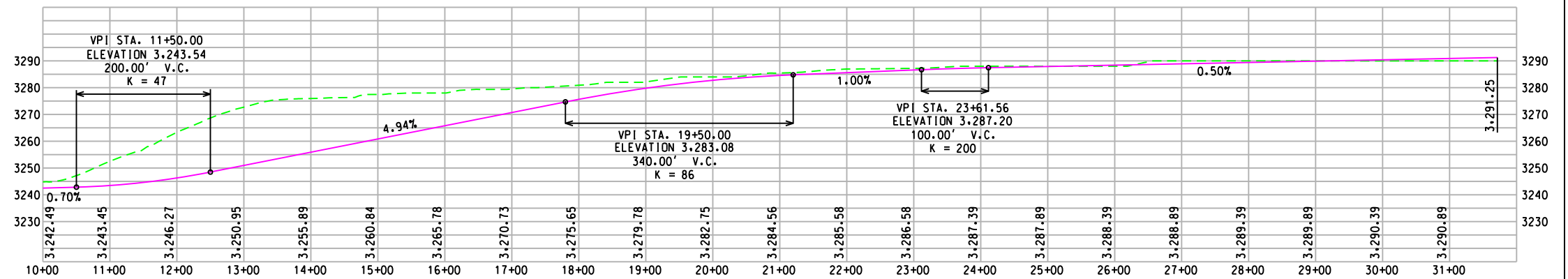
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	HP 5596(12)	2	3
FILE: Alternative 3a.dgn		REV DATE:	
PLOTTING DATE: 08/18/2011		INITIAL:	



**Ramp B Profile**

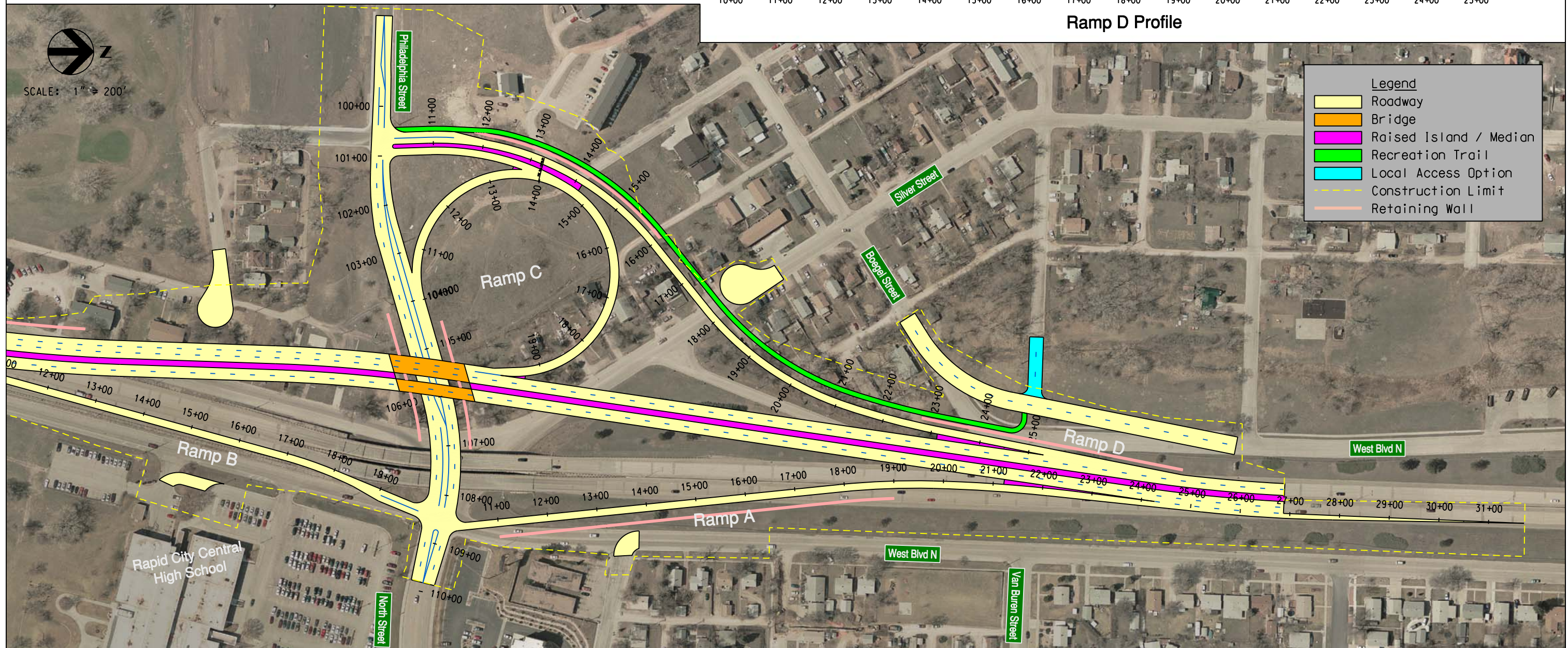
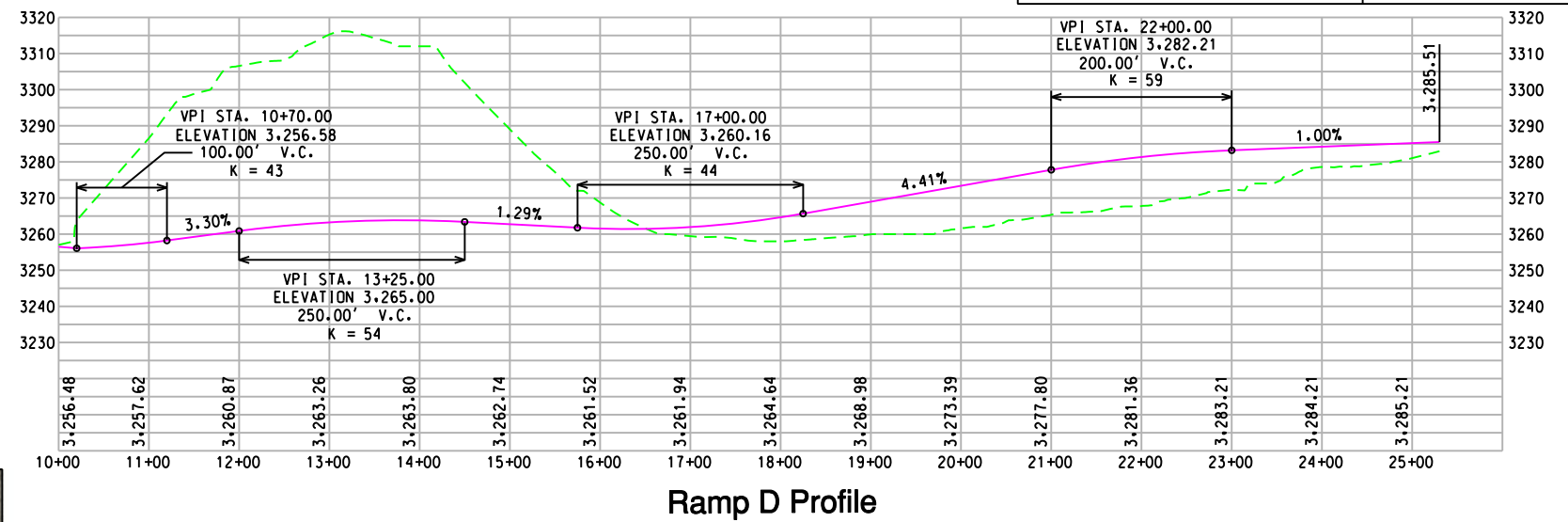
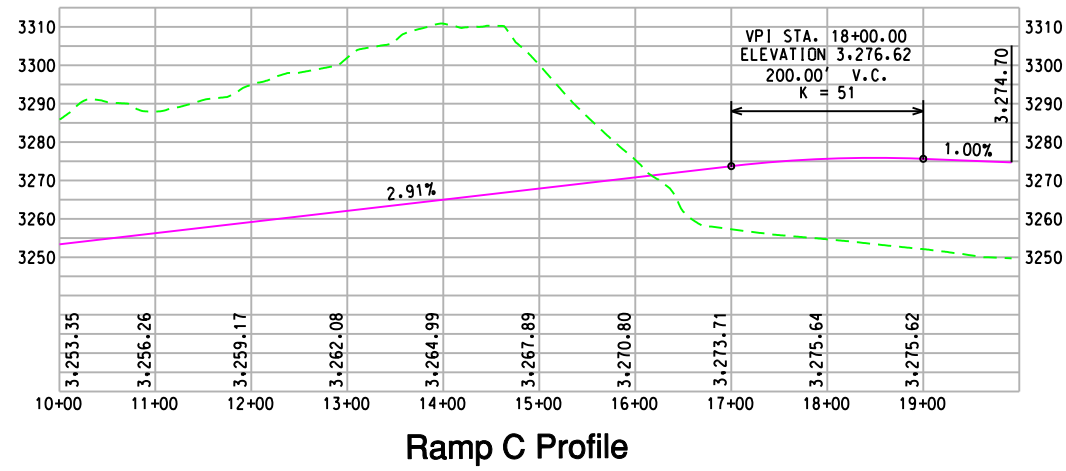
- Legend**
- Roadway
  - Bridge
  - Raised Island / Median
  - Recreation Trail
  - Local Access Option
  - Construction Limit
  - Retaining Wall

**Ramp A Profile**



# I-190 / Silver Street Preliminary Plan / Profile Design - Alternative 3A

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	HP 5596(12)	3	3
FILE: Alternative 3a.dgn PLOTTING DATE: 08/18/2011		REV DATE: INITIAL:	

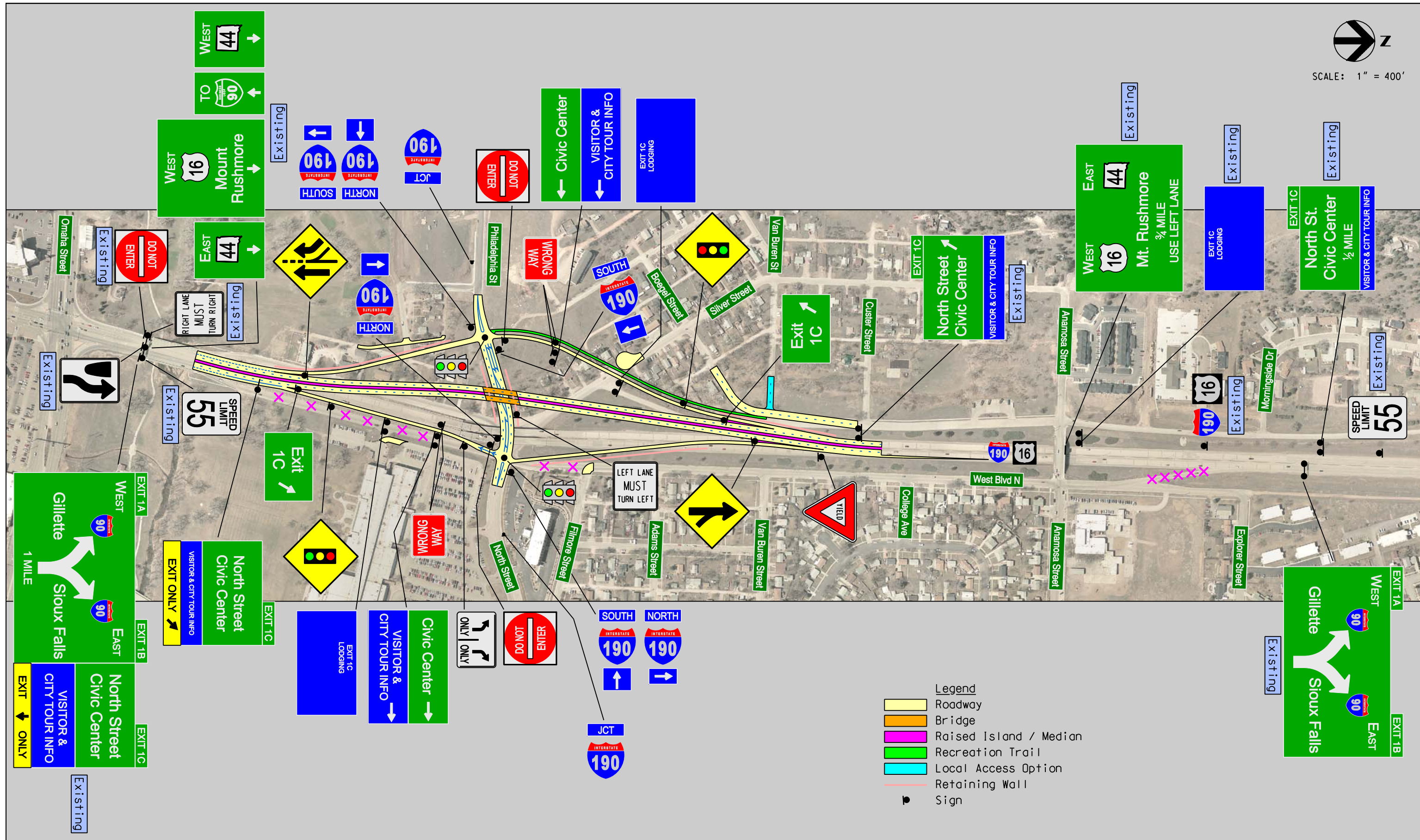


# Signing Layout





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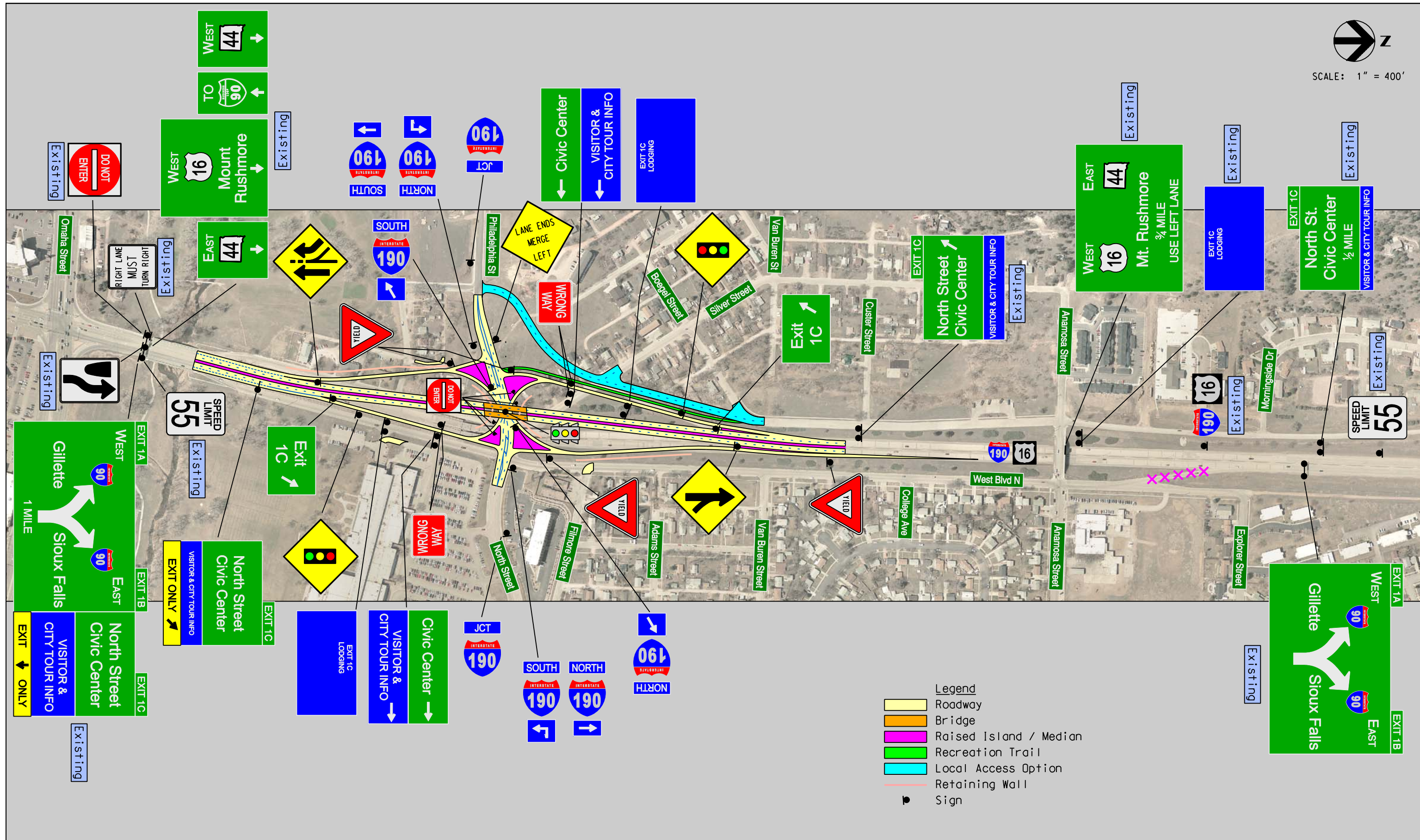
Drawn By: B. Miller  
 Date: 10-25-11  
 Checked By: C. Mizera  
 Date: 10-25-11  
 Revisions:



**Concept Sign Layout - Option 1a Diamond Interchange**  
 Interstate 190 / Silver Street Interchange Study  
 Rapid City, South Dakota

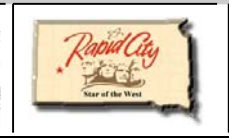


SCALE: 1" = 400'



- Legend
- Roadway
  - Bridge
  - Raised Island / Median
  - Recreation Trail
  - Local Access Option
  - Retaining Wall
  - Sign

Drawn By: B. Miller  
 Date: 10-25-11  
 Checked By: C. Mizera  
 Date: 10-25-11  
 Revisions:



**Concept Sign Layout - Option 2a Single Point Interchange**  
 Interstate 190 / Silver Street Interchange Study  
 Rapid City, South Dakota



# Phase 1 Crash Analysis

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**Subtask 108 – Crash analysis.** Crash data for the study area was provided in a geo-referenced database, displayed in ArcGIS format. The GIS allowed display of crash locations on top of a study area map and easy identification of crash clusters and potential crash problems needing improvements.

Overall, the Interstate system showed randomly scattered crashes, with two exceptions – the I-90/I-190 interchange area and the weave area on eastbound I-90, between I-190 and Haines Avenue.



**Figure 2-10 – Crash display I-90/I-190 interchange area**

The I-90/I-190 interchange area (Figure 2-10), showed a slight concentration of crashes, but analysis of the crash records showed no trend toward any particular type of crash. Rather, crashes appear to be related to operating on hills and curves during winter driving conditions, as well as a number of animal-related crashes. No particular road-related remedy is suggested, although continued attention to winter maintenance may help control crash rates.

The crash rate for the eastbound I-90 segment between I-190 and Haines Avenue (Figure 2-11) appears fairly high, although the rate may be skewed by the short length of the segment. Review of the crash details shows that 83% of the crashes occurred in

increment driving conditions. Again, continued attention to winter maintenance may help control crash rates.

Interstate segment crash rates are shown in Table 2-6.



Figure 2-11 – Crash display I-90 between I-190 and Haines Avenue

TABLE 2-6 - INTERSTATE AREA CRASH RATES

AREA	CRASHES	MILEAGE	AADT	CRASH RATE (CRASHES PER MILLION VEHICLE MILES)
I-90/I-190 INTERCHANGE	31	2.9	8300	1.18
I-90 EASTBOUND WEAVE, I-190 TO HAINES	12	0.14	16190	4.83

Intersection crash rates for the arterial street intersections are shown in Table 2-7. The critical crash rate that triggers improvement can vary from community to community and year to year, depending on the statistical analysis of crash rates from a large population of intersections. While the small number of intersections in this study do not permit

calculation of a critical crash rate, arterial intersection critical rates in South Dakota usually range in the vicinity of 0.80 – 1.20 crashes per million entering vehicles. This would point toward the following intersections as potential candidates for improvement:

- Omaha St./West Blvd./I-190
- Omaha St./5<sup>th</sup> St.
- North St./Mt. Rushmore Rd.
- Haines St./I-90
- Haines St./Disk Dr.

Since this study is limited to a small number of arterial intersections, it was possible to review the crash records for each intersection to look for trends and indications of potential problems. The crash location display for each intersection is shown starting on the following page, along with a short summary of the findings.

**TABLE 2-7 - INTERSECTION CRASH RATES**

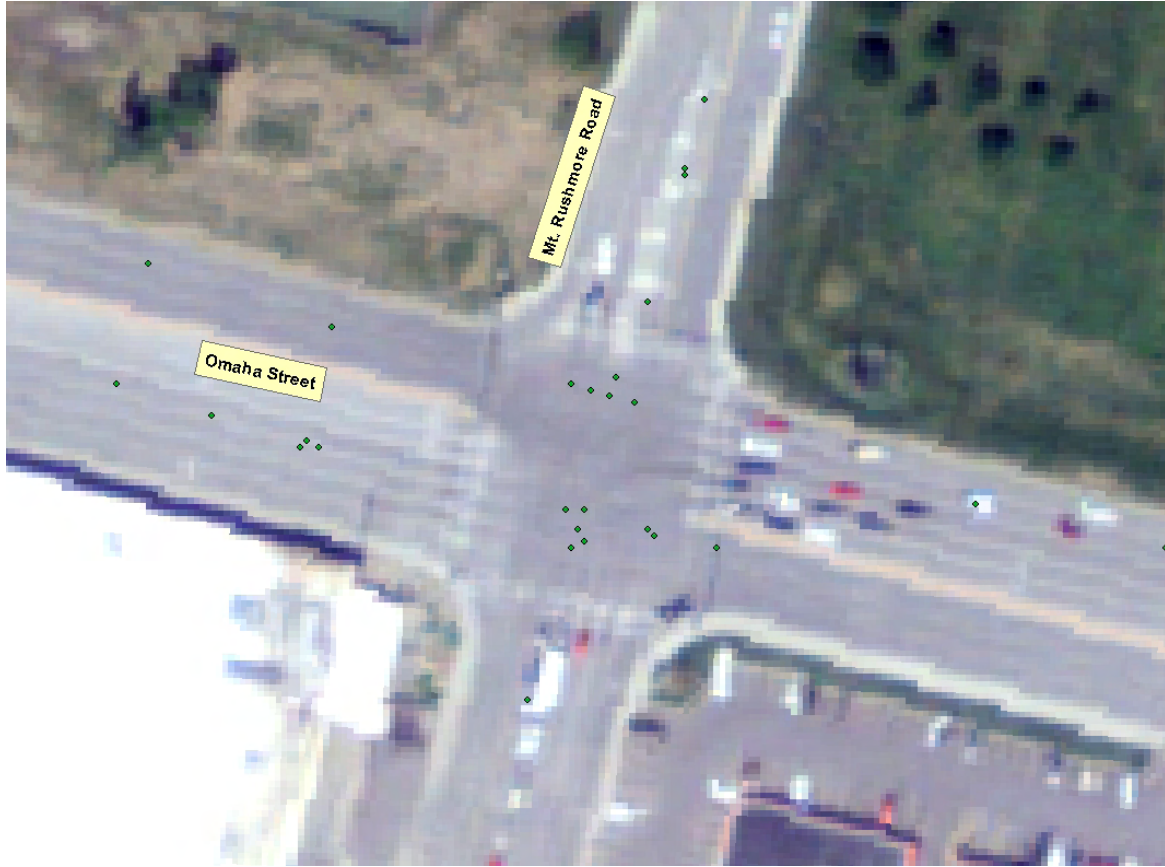
<b>INTERSECTION</b>	<b>NUMBER OF CRASHES</b>	<b>DAILY VEHICLES</b>	<b>CRASH RATE (CRASHES PER MILLION ENTERING VEHICLES)</b>
OMAHA/WEST/I-190	72	59,700	1.10
OMAHA/MT. RUSHMORE	28	32,600	0.78
OMAHA/5TH	57	49,900	1.04
NORTH/WEST/SILVER	7	8,000	0.80
NORTH/MT. RUSHMORE	10	8,000	1.14
HAINES/5TH/NORTH	15	24,000	0.57
HAINES/ANAMOSA	16	25,100	0.58
WEST/ANAMOSA	3	6,000	0.46
HAINES/I-90	40	25,900	1.41
HAINES/DISK	31	27,800	1.02



### Omaha St./West Blvd./I-190

A total of 72 crashes were reported in three years (2007, 2008, 2009). Over 72% of the crashes were rear-end, while over 18% were angle crashes. The crash display indicates that many of the crashes are occurring after vehicles have crossed the stop-bar and entered the intersection. This suggests that rear-end crashes may be occurring due to downstream congestion and downstream merging. Some potential countermeasures may include:

- Downstream acceleration lane for southbound to westbound right turn.
- Check peak hour queues on southbound West Boulevard.
- Check lane marking for double left turn lanes to reduce vehicles drifting into others' paths.



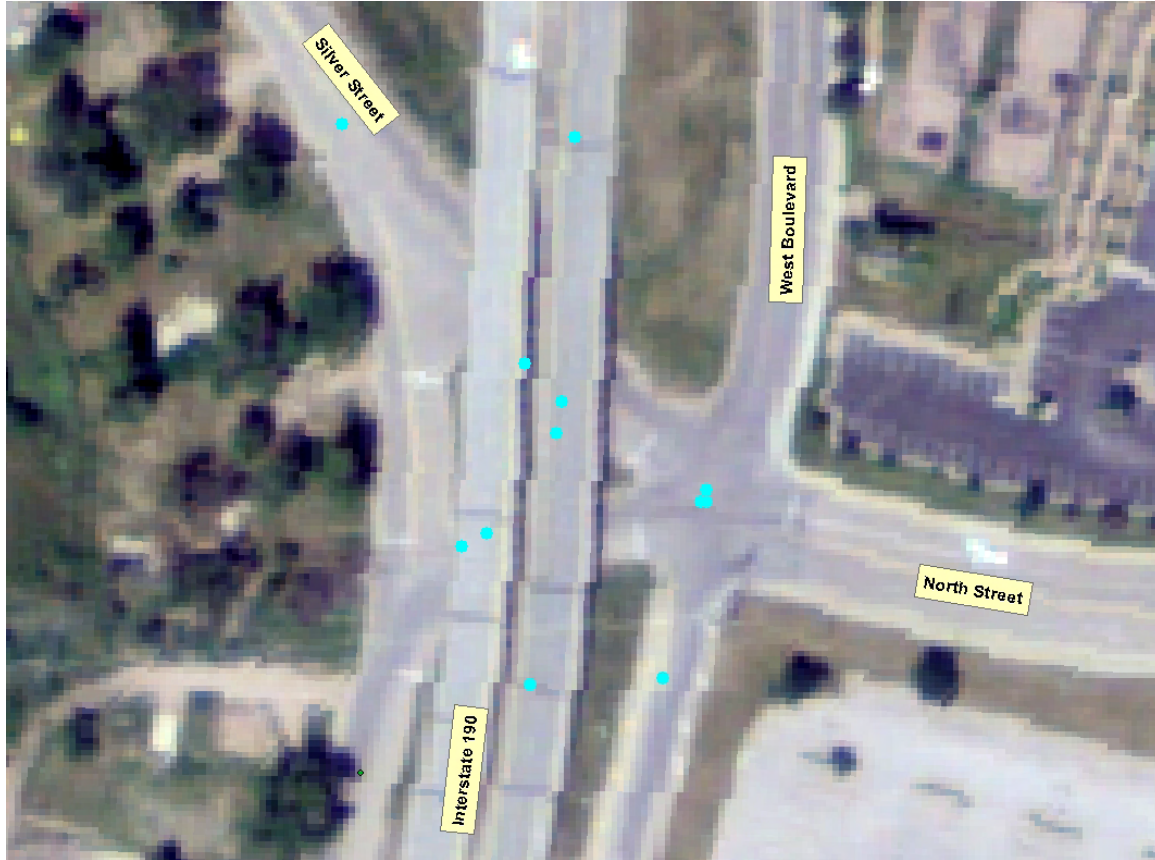
Omaha St./Mt. Rushmore Rd.

A total of 28 crashes were reported in three years (2007 – 2009), split primarily between rear-end (50%) and angle (32%) crashes. Crash locations are scattered around the intersection, although a concentration may be developing related to the westbound to southbound left turn. No other trends were noted or improvements suggested.



Omaha St./5<sup>th</sup> St.

A total of 57 crashes were reported in three years (2007 – 2009), split primarily between rear-end (72%) and angle (21%) crashes. The majority of the crashes appear to be occurring in the center of the intersection in line with left turn lanes. It is possible that some of the rear-end accidents are occurring due to downstream congestion, perhaps related to railroad operations in the vicinity.



I-190/West Blvd./Silver St./North St.

A total of 13 crashes were reported at this location, but 6 of the 13 were single-vehicle crashes actually on I-190 in inclement weather conditions. Seven of the 13 were listed as intersection-related. There were an insufficient number of crashes to establish trends or suggest crash-related improvements.





Mt. Rushmore Rd./North St./Allen St.

A total of 10 crashes were reported in three years (2007 – 2009), split primarily between rear-end (30%) and angle (60%) crashes. The intersection is currently operating with all-way stop control. Intersections of this type typically have a slightly higher critical crash rate than larger signal-controlled arterial intersections. It appears that the crash rate at this intersection may not be critical and that the majority of the crashes are related to driver difficulties in determining right-of-way. The location does not currently meet the number of crashes necessary to warrant conversion to a traffic signal, but conditions should continue to be monitored in the future.



Haines Ave./5<sup>th</sup> St./North St.

A total of 15 crashes were reported in three years (2007 – 2009), split primarily between rear-end (27%) and angle (67%) crashes. Most of the crashes were related to drivers failing to yield or not obeying the traffic signals. No other trends were noted and the crash rate does not appear to be critical. No crash-related improvements are suggested.



Haines Ave./Anamosa St.

A total of 16 crashes were reported in three years (2007 – 2009), split primarily between rear-end (31%) and angle (50%) crashes. Most of the crashes were related to drivers failing to yield or not obeying the traffic signals. No other trends were noted and the crash rate does not appear to be critical. No crash-related improvements are suggested.



Anamosa St./West Blvd.

A total of 3 crashes were reported in three years (2007 – 2009). No trends were noted and the crash rate does not appear to be critical. No crash-related improvements are suggested.



I-90/Haines Ave.

A total of 40 crashes were reported in the interchange area in a three year period (2007-2009). A large portion of the crashes (43%) occurred during inclement driving conditions and it appears that a significant number involved single-vehicle incidents on I-90. A cluster of rear-end crashes appears to be developing in the southbound lanes of Haines Ave., south of the interchange. One potential cause for this cluster may be the interaction of vehicles trying to turn left onto Knollwood Dr. The intersection influence areas of these two intersections appear to overlap, making it difficult for drivers to react in time to avoid collisions. While Knollwood Drive serves businesses and residences fronting I-90, safety concerns may require rerouting Knollwood traffic in the future.



### Haines Ave./Disk Drive

A total of 31 crashes were reported in the three reporting years (2007-2009). They were comprised primarily of rear-end (45%) and angle (48%) crashes. Failure to yield citations were prevalent in the crash records, indicating that some drivers may be using the yellow, all-red and red portions of the turning phases to continue to turn under congested conditions. The intersection crash rate may not reach the critical threshold in a city-wide statistical analysis, but operations at the intersection should be reviewed as development continues and volumes rise.

# Constructability Memo

To: Steve Gramm, SDDOT

From: HDR Engineering

Project: I-190/Silver Street Interchange

CC: File

Date: September 20, 2011

Job No: 137390

## RE: Constructability Review

The South Dakota Department of Transportation (SDDOT) has requested a review of the potential construction issues associated with the interchange concepts proposed for the Silver Street interchange (Exit 1) on Interstate 190 in Rapid City. The constructability review documented in this technical memo is part of a comprehensive study of the Silver Street interchange which includes preparation of an interchange justification report (IJR) and an environmental assessment (EA).

The alternative interchange concepts described below have several similar aspects and pose fairly routine constructability issues of similar magnitude. In general, the new interchanges are proposed to be constructed to the west of its existing location. This was recognized early in the design option analysis due to the availability of right-of-way created by previous property buyouts and traffic construction and phasing benefits over rebuilding the bridge structures in the same location. By shifting the I-190 alignment west, the majority of the interchange and ramps could be constructed with reduced impacts to I-190 traffic. During the initial stages of the re-construction project, traffic would remain on the existing interstate roadway with closures to the southbound on and off-ramps. Following construction of a major portion of the new lanes including a big percentage of the southbound lanes and the northbound bridge, traffic would be shifted to the existing northbound lanes to allow completion of the southbound lanes (tying into the existing alignment at both ends of the project). In the latter stages of construction, traffic would then be shifted onto the new southbound lanes and bridge for completion of the northbound lanes. Use of temporary ramp tie-ins and traffic control devices would allow the existing northbound I-190 off-ramp at North Street and the on-ramp at Anamosa remain open throughout the project.

In addition to a review of traffic impacts both during and following construction, a review of utility impacts and expected adjacent land improvements were also reviewed for construction impacts. Public utility impacts would be minor and consist of expected drainage improvements and storm sewer upgrades improving drainage in the northwest quadrant and minor city utility modifications would be needed. The biggest impact would be to private utilities. Specifically, a major impact would be to the Black Hills Power high-voltage line running east-west along the North Street corridor. This will need to be addressed during final design to determine new placement of relocated poles and to ensure proper clearance from the new bridge structures. It should be noted that a critical pole exists on the southeast corner of the interchange by the Rapid City Central parking lot. Due to the expense of relocating this structure, the proposed interchange alternatives purposely avoided the utility structure.

Potentially larger constructability issues are posed by the associated neighborhood street connections. The local street connection issues have been further investigated and will also be covered in this memorandum to provide an overall picture of the constructability of a new Silver Street interchange.

## Interchange Alternatives

Eight interchange alternatives were developed during the first phase of the study. A number of the alternatives have been eliminated through the environmental review process. All the alternatives are discussed in this memorandum to provide a complete comparison of constructability issues.

### *Alternative 1*

This alternative consists of a diamond interchange at Silver Street/North Street with I-190 shifted west. Shifting the I-190 alignment to the west allows for sufficient room to build all interchange options and provide adequate turn lanes and other geometric features. The southbound I-190 ramp terminal in this option has a fairly high degree of skew on the cross-road and subsequent sharp



turning paths on some movements. The mainline bridges would be relatively long due to the cross-road skew. Additional right-of-way will be needed west of the existing I-190, although some of the needed property is already in public ownership. Additional local street connections will be needed west of the interchange to facilitate local traffic movement. The parking lots at Central High School will no longer be allowed to access the Interstate off ramp in this concept. The ramp in the northeast quadrant may also provide limited local street access for a short distance before the actual entrance ramp begins (optional).

Constructability issues include:

- I-190 realignment allows structure construction while maintaining traffic.
- Construction on Silver Street/North Street would require phased completion or a long detour.
- Due to safety concerns during construction, it is recommended that the accesses to the high school parking lot from the northbound off-ramp should be closed when construction begins.
- The I-190 bridges would be located on a straight tangent of I-190. Due to the alignment of the crossing Street, the bridge would be skewed at approximately 45 degrees and requires a longer bridge when compared to the other alternatives. Except for reconstruction of North Street/Silver Street due to the condition of the roadway, there will be no major changes to the non-interstate street network.
- Unless a network of temporary ramps are provided during construction, long-term ramp closures for southbound traffic will be expected.
- A borrow site will need to be identified due to the large volume of embankment needed. There is a large hill directly west of the interstate and south of Silver Street that could be considered for borrow.

### ***Alternative 1a***

This alternative consists of a diamond interchange at North Street with I-190 shifted west. This alternative is similar to Alternative 1, except North Street would be extended straight west connecting to Philadelphia Street and eliminating direct access to the interchange from Silver Street west of the interstate. The closure of direct access to the interchange from Silver Street would require a connection of the existing development to Philadelphia Street.

Constructability issues include:

- I-190 realignment allows structure construction while maintaining traffic on existing I-190 lanes.
- Due to safety concerns during construction, it is recommended that the accesses to the high school parking lot from the northbound off-ramp should be closed when construction begins.
- The I-190 bridges would be located on a straight tangent of I-190. The structure required in this alternative is shorter than in others.
- The Van Buren local street connection is recommended and would be constructed prior to closing the interchange to serve neighborhood access.
- Unless a network of temporary ramps are provided during construction, long-term ramp closures for southbound traffic will be expected.
- A borrow site will need to be identified due to the large volume of embankment needed. There is a large hill directly west of the interstate and south of Silver Street that could be considered for borrow.

### ***Alternative 2***

Single point diamond interchange at Silver Street/North Street with I-190 shifted west. The single-point ramp terminal suffers from a fairly high degree of skew on the cross-road and a large area of pavement for turning movements. The mainline bridges would be relatively long and wide due to the cross-road skew. Additional right-of-way will be needed west of the existing I-190, although some of the needed property is already in public ownership. The additional right-of-way required will be less than option 1 or option 1a. Additional local street connections will be needed west of the interchange to facilitate local traffic movement. The parking lots at Central High School will no longer be allowed to access the Interstate off ramp in this concept.

Construction issues include:

- I-190 realignment allows structure construction while maintaining traffic.
- Construction on Silver Street would require phased completion or a long detour.
- Traffic using the high school driveway from the northbound off ramp would need to be rerouted prior to construction.
- A straight structure with skewed ends would be required. The structure required in this alternative is longer than in others.
- No new local street connection would be required, but Silver Street would need to be reconstructed in phases in order to keep neighborhood access during construction.
- Earthmoving and potential borrow activities would affect construction phasing and progress. Ramp closures may be necessary to allow earthmoving to take place.

### ***Alternative 2a***

This alternative consists of a Single Point Diamond Interchange at North Street with I-190 shifted to the west. The alignment of the intersecting street is similar to Alternative 1a. North Street would be extended straight west connecting to Philadelphia Street and eliminating direct access to the interchange from Silver Street west of the interstate. The closure of direct access to the interchange from Silver Street would require a connection of the existing development to Philadelphia Street.

Construction issues include:

- I-190 realignment allows structure construction while maintaining traffic. Also, the realignment allows for additional room to the east of I-190 for improved northbound ramp alignment.
- Temporary access to the neighborhood will be provided during construction.
- Ramp access for north and southbound traffic will be intermittent during construction and use of temporary ramps will be determined during final design.
- Direct access to the high school parking lots from the northbound off-ramp will be closed prior to construction beginning.
- The I-190 bridges would be located on a straight tangent of I-190. This alternative utilizes a structure associated with this alternative is shorter than used with other alternatives.
- The West Boulevard local street connection is recommended and would be phased to serve neighborhood access at Silver Street. The local street connection would require a large cut and retaining wall so a mass haul diagram should be considered during the phasing plan.
- Earthmoving and potential borrow activities would affect construction phasing and progress. Ramp closures may be necessary to allow earthmoving to take place.

### ***Alternative 2b***

Hybrid interchange with features of diamond and single-point interchanges. The on-ramps are served by a central intersection and the off-ramps terminate in stop-controlled intersections. The interchange configuration fits the existing street system, but would produce greater delay for off-ramp traffic than other configurations.

Construction issues include:

- I-190 realignment allows structure construction while maintaining traffic.
- Construction on Silver Street would require phased completion or a long detour.
- Traffic using the high school driveway from the northbound off ramp would need to be rerouted prior to construction.
- A straight structure with skewed ends would be required. The structure required in this alternative is longer than in others.
- No new local street connection would be required, but Silver Street would need to be reconstructed in phases in order to maintain neighborhood access during construction.
- Earthmoving and potential borrow activities would affect construction phasing and progress. Ramp closures may be necessary to allow earthmoving to take place.

### **Alternative 3**

I-190 interchange with loop at North Street. Connecting the cross-road to the new roadway west of the interchange results in the opportunity to provide a loop ramp to handle one of the largest turning volumes. Eastbound traffic would not be able to turn south at the interchange in this concept, but other local street alternatives are available. The mainline bridges would be relatively short in this option, but the southbound bridge would need to be three lanes wide to handle the accelerating loop traffic. Additional right-of-way will be needed west of the existing I-190, although some of the needed property is already in public ownership. The additional right-of-way required will be larger in the loop quadrant, but less in the southwest quadrant. Additional local street connections will be needed west of the interchange to facilitate local traffic movement. The parking lots at Central High School will no longer be allowed to access the Interstate off ramp in this concept.

Construction issues include:

- I-190 realignment allows structure construction while maintaining traffic.
- Construction on Philadelphia Street could begin while Silver Street remains open to serve neighborhood access.
- Traffic using the high school driveway from the northbound off ramp would need to be rerouted prior to construction.
- A straight structure with skewed ends would be required. One structure required in this alternative is wider than in others.
- The Van Buren local street connection is recommended and would be phased to serve neighborhood access.
- Earthmoving and potential borrow activities would affect construction phasing and progress. Ramp closures may be necessary to allow earthmoving to take place.
- The larger interchange footprint to the west encroaches on the large hill with potential impacts to the driveway access to the apartment building.

### **Alternative 3a**

This alternative consists of a modified diamond interchange. The southbound on ramp is relocated into the northwest quadrant as a loop. Connecting the cross-road to the new roadway west of the interchange results in the opportunity to provide a loop ramp to handle the largest turning volume within the interchange. Eastbound traffic would access the southbound interstate via a slip ramp onto the loop ramp. The interstate bridges would be relatively short in this option, but the southbound bridge would need to be three lanes wide to handle the accelerating loop traffic. Additional right-of-way will be needed west of existing I-190, although some of the needed property is already in public ownership. The additional right-of-way required will be larger in the loop quadrant, but less in the southwest quadrant. Additional local street connections will be needed west of the interchange to facilitate local traffic movement.

Constructability issues include:

- I-190 realignment allows structure construction while maintaining traffic. Also, the realignment allows for additional room to the east of I-190 for improved northbound ramp alignment.
- Temporary access to the neighborhood will be provided during construction. Ramp access for north and southbound traffic will be intermittent during construction and use of temporary ramps will be determined during final design.
- Direct access to the high school parking lots from the northbound off-ramp will be closed prior to construction beginning.
- The I-190 bridges would be located on a straight tangent of I-190. This alternative utilizes a structure associated with this alternative is shorter than used with other alternatives.
- The Van Buren local street connection is recommended and would be constructed prior to closure of the interchange to serve neighborhood access.
- Earthmoving and potential borrow activities would affect construction phasing and progress. Ramp closures may be necessary to allow earthmoving to take place.
- The larger interchange footprint to the west encroaches on the large hill with potential impacts to the driveway access an apartment building.

### **Alternative 3b**

I-190 interchange with Loop at North Street and EB to SB on-ramp. This concept is similar to option 3, but a southbound on ramp is provided to serve eastbound traffic.

Construction issues include:

- I-190 realignment allows structure construction while maintaining traffic.
- Construction on Philadelphia Street could begin while Silver Street remains open to serve neighborhood access.
- Traffic using the high school driveway from the northbound off ramp would need to be rerouted prior to construction.
- A straight structure with skewed ends would be required. One structure required in this alternative is wider than in others.
- The Van Buren local street connection is recommended and would be phased to serve neighborhood access.
- Earthmoving and potential borrow activities would affect construction phasing and progress. Ramp closures may be necessary to allow earthmoving to take place.
- The larger interchange footprint to the west encroaches on the large hill with potential impacts to the driveway access to the apartment building.

## Public Involvement Documents



# CITY OF RAPID CITY

RAPID CITY, SOUTH DAKOTA 57701-5035

## Growth Management Department

300 Sixth Street

Patsy Horton, Community Planning Coordinator  
Growth Management Department-Community Planning  
city web: [www.rcgov.org](http://www.rcgov.org)

Phone: 605-394-4120  
Fax: 605-394-6636  
e-mail: [patsy.horton@rcgov.org](mailto:patsy.horton@rcgov.org)

## MEMORANDUM

TO: Public Works Committee

FROM: Patsy Horton, Community Planning Coordinator

DATE: September 12, 2011

RE: Silver Street/I-190 Interchange Study

For the past 18-24 months, the South Dakota Department of Transportation has been studying the I-190 Corridor. Given the aging I-190 structures with low clearance at the Silver Street interchange, the South Dakota Department of Transportation has targeted the interchange for replacement. They have contracted with HDR Engineering to determine the eventual design of the replaced interchange. As part of the interchange study, HDR Engineering has proposed several potential designs. The South Dakota Department of Transportation is hosting a public meeting to be held at the Howard Johnson Hotel, 950 North Street, Rapid City, South Dakota on Wednesday, September 14, 2011, from 4:30 p.m. to 6:30 p.m. Four proposed designs will be on display to encourage participation and receive input from the neighborhood and the public.

Based on the final four designs under consideration (as attached), Public Works and Growth Management staff recommend support of the Interchange Alternative 2a as it requires the least amount of right-of-way for the interchange, ensures an east-west neighborhood connection from Philadelphia Street to East North Street, and ensures a north-south neighborhood connection from Van Buren Street to Philadelphia Street.

**STAFF RECOMMENDATION:** Staff recommends that the City Council forward public comment to the South Dakota Department of Transportation supporting the proposed I-190 Interchange Alternative 2a because it requires the least amount of right-of-way for the interchange, ensures an east-west neighborhood connection from Philadelphia Street to East North Street, and ensures a north-south neighborhood connection from Van Buren Street to Philadelphia Street.



EQUAL HOUSING  
OPPORTUNITY

EQUAL OPPORTUNITY EMPLOYER

PROCEEDINGS OF THE CITY COUNCIL  
Rapid City, South Dakota

September 19, 2011

Pursuant to due call and notice thereof, a regular meeting of the City Council of the City of Rapid City was held at the City/School Administration Center in Rapid City, South Dakota on Monday, September 19, 2011 at 7:00 P.M.

The following members were present: Mayor Sam Kooiker and the following Alderpersons: Ritchie Nordstrom, Jordon Mason, Charity Doyle, Ron Sasso, Dave Davis, Bonny Petersen, John B. Roberts, Gary Brown and Jerry Wright; and the following Alderpersons arrived during the course of the meeting: None; and the following were absent: None.

Staff members present included: Finance Officer Pauline Sumption, Assistant City Attorney Joel Landeen, Acting Public Works Director Dale Tech, Growth Management Director Brett Limbaugh, Police Captain Deborah Cade, Fire Chief Mike Maltaverne, Community Resources Director Jeff Barbier, Airport Executive Director Cameron Humphres and Administrative Coordinator Sharlene Mitchell

**NON-PUBLIC HEARING ITEMS**

Motion was made by Mason, second by Roberts and carried to open public comment on items 5 - 55. No comments were received. Motion was made by Brown, second by Petersen and carried to close public comment on items 5 - 55.

**CONSENT ITEMS**

Motion was made by Doyle, second by Mason and carried to approve Items 5 – 55 as they appear on the Consent Items and Continued Consent Items with the exception of Items 23 and 50.

***Public Works Committee Consent Items***

26. No. PW091311-21 – Recommend Alternative 2a of the Silver Street/I-90 Interchange Study.

To: Steve Gramm, Study Team members	
From: Rick Laughlin	Project: I-190/Silver St. Phase 2
CC:	
Date: 3/31/11	Job No:

**RE: Public Meeting, March 29, 2011**

A total of 42 people signed the attendance roster for the first public meeting in Phase 2 of the I-190/Silver St. study, held on March 29, 2011. Of the 42, 7 represented SDDOT, 2 represented the City of Rapid City, 2 represented news media, 1 represented utilities, 4 represented HDR, 3 represented citizen groups and 22 either represented themselves or did not identify an association. The sign-in sheets are attached.

Eight comment cards were received at the public meeting. The information from the comment cards is summarized below:

- Tom Baumgartner, 229 Alta Vista – “I like option 2a the best.”
- (anonymous) – “We own the properties at 703/709 & 713 Silver Streets. We would be willing to sell you our properties for \$500k.”
- John Fortune, 718 Silver St. – “The only option that doesn’t bother my property is 2a.”
- John Fortune, 718 Silver St. – “The only option that doesn’t bother me is 2a, the rest are on my property or right next to it. I have small kids and don’t want to live next to an off ramp.”
- Dennis Miller – “As a 30+ year user of the area, I see option 1 as the most desirable. Any options should allow exits onto side streets from the “off ramp” rather than driving past your house to intersection then back to street you passed several blocks earlier.”
- Doug Kinniburgh – “Main concern for RC area schools is access to Central High School – with current construction project, eliminating direct access from the west to our 9<sup>th</sup> grade & facility parking areas.”
- Duane Lahoe (comment area blank).
- David L. Brown, Faith, SD – “Prefer option 2a over the others – simple, smaller footprint, efficient traffic flow – would like more information from City on future development.”



Interstate 190/Silver Street Study  
 OPEN HOUSE ATTENDANCE  
 March 29, 2011  
 - PLEASE PRINT -

Name	Address	City, State ZIP
Jim Petersen	KEVN TV	Rapid City, SD 57701
Brendyn Medina	KEVN TV	Rapid City 57701
AJ SILVA		RAPID CITY 57701
R.F.O. Daniel	727 Gold St.	Rapid City, SD 57701
Steve Gramm	700 E Broadway	Pierre, SD 57501
Brad Remmick	700 E Broadway	Pierre, SD 57501
RICK LAUGHLIN	6300 Old Village Pl., Sioux Falls	Sioux Falls SD 57108
GARY L. SPAWN	City Council Ward I	R.C. SD 57701
Rodney Nelson	SD DOT	R.C. SD
David L. + Valarie Brown	PO Box 666	Faith, S.D. 57626
Kip Harrington	3006th St.	RC SD 57701
SARAH EUGER	SIDDOT	
Debra Jensen	MT. RUSHMORE ROAD GROUP	RC SD 57701
Tatsy Forten	300 6th St	RC SD
TODD SEAMAN	RAPID CITY SDDOT	RAPID CITY

Interstate 190/Silver Street Study  
 OPEN HOUSE ATTENDANCE  
 March 29, 2011  
 - PLEASE PRINT -

Name	Address	City, State ZIP
JODY PAISE	3820 JACKSON BLVD, RC SD 57701	Rapid City, SD 57702
Chris Bailey	3820 Jackson Blvd Ste 1	RC SD 57702
DAN STATION	3820 COSPORT CT	RC SD 57702
Jenny + Sandy Wagner	1621 West Blvd NO.	RC SD 57701
DAN BRITTON	4515 STEELER	RC SD 57701
Brenda Deegen-Whiting	4000 Elk Vale Rd.	RC SD 57701
BRAD RENNICH	50 DOT	Pierre
MERVYN KREBS	1503 Morningside Dr	
Craig + Renee Dahke	310 Kinney Ave	Rapid City 57702
MIKE BRASNEY	1512 LARK DR	R.C.
BETTY QUASNEY	1512 LARK DR	R.C.
Richard Chumwood	1504 Morningside Dr.	RC 01
Mami Viejeler	3010 Park Dr	RC 02
STEVE MOUSEL	3286 SNOWMASS CT B.	RC 57702
Theresa J Schaefer	706 N Blvd W/PO Box 205	RC 57709





To: Steve Gramm, Study Team members	
From: Rick Laughlin	Project: I-190/Silver St. Phase 2
CC: file	
Date: 9/30/2011	Job No:

**RE: Public Meeting, September 14, 2011**

A total of 38 people signed the attendance roster for the second public meeting in Phase 2 of the I-190/Silver St. study, held on September 14, 2011. Of the 38, 9 represented SDDOT, 2 represented the City of Rapid City, 2 represented the Rapid City Council, 1 represented FHWA, 2 represented HDR, and 22 either represented themselves or listed no affiliation. Other staff were also present, but not reflected in the attendance roster. The sign-in sheets are attached.

Seven comment cards were received at the public meeting. The information from the comment cards is summarized below:

- Tom Baumgartner, 229 Alta Vista – “I like the 2a with the West Boulevard connection.”
- D.L. Brown, Faith, SD – “2a with the red option appears to be the best option. 1a would be second choice. Do not like #1 as it has too many problems that do not solve the traffic from Central High & option 3a impacts too large an area, not standard.”
- Ritchie Nordstrom, 401 East Meade St. – “Like 2a – smallest footprint. Drainage, sidewalks and grade. Stormwater runoff, sidewalk installation and how flat the construction completion will be for winter sand/salt. What about plantings? Overhead utilities being placed underground.”
- Clifford Larive, 737 Highway 81 – “Alt 1a is the best approach – all others take up too much space and are of no value to the community. Under no circumstances do we need to better other streets and make easier access for future builders. They can make their own expenses, let’s stick strictly to the I-190 interchange.”
- Rex Perestine, 1505 Custer St. – “I like the 2a with West Blvd. connection – least disturbing and closest to the same connection.”
- Chuck Rausch, 602 Dilger Ave. – “At the present time (9/14/11), I prefer option 2a.”
- Jeanette McGough Thorstenson, 610 Fairlawn Dr. – “Why are you taking all property to the west instead of the land by the high school.”

One comment was also received via email on 9/28/11 from Jean Jackson, 1028 Philadelphia St. She writes:

“My comments and concerns are coming from the point of view of a home owner on Philadelphia St.

First of all, all the alternatives seem to have my house cornered in with three streets surrounding it. By this statement I mean that as one of the three remaining houses left on the block my house will be next to the off ramp or the closest to the ramp.

The plans I've seen are from the top so it leaves a lot to the imagination. Are there any plans I could see that show this project from the ground so I could get a better idea of what the bridge options are? How much room will each actually take up? What and how big will the bridge be? At what height will the new Philadelphia St.-North street be behind my house? How close will it be to my house? How close will the ramp be to my house?

Alternative 1: I don't like this one. It leaves only one way in and out of the neighborhood to get to work, school, shopping etc. That's by traveling around the golf course to Omaha St. and choosing the direction from there.

Alternative 1a: Is a little more favorable because it has more options of getting over to the east side of I-90 for Central High or Civic Center and traveling through the north part of town rather than taking Omaha etc. it also gives me the option of going south via the off ramp by my house. Although a couple of minus' is there are no quick access to Silver St. and West Blvd. N. area, one would have to travel in a loop of sorts to get to it.

Alternative 2a: Is a little more favorable because it gives better access to Silver St. and for travel to any direction of town but I'm still not sure if I like the plan of something that big by my house. A concern for this option is that the busy intersection is the foot traffic that crosses under the bridge for students or people walking to Central, Civic Center, Rapid Ride stop, or kids going to The Club for Boys etc.

Alternative 3a: I don't like this option at all.

More pros and cons:

I'm not completely opposed to the Van Buren St. connection in option 1a unless it's for future residential development along the hill side which I'm assuming is the real reason for it. I like the West Blvd N connection in alternative 2a, but the placement of the recreation trail doesn't make sense. Does it just stop there at Philadelphia St. or is supposed to go through to the bike path? I think it should follow the West Blvd. connector to Philadelphia St.

I didn't see a plan of what the area around my house would look like. Will it have landscape or will it be a concrete retaining wall? Will it be part bridge on the side of my house? Will it be a hill? Will it turn into an alley or alcove of sorts for high school students or others to hang out in. If concrete wall will graffiti end up on it? What plans are there for drainage and rain/snow runoff? I'll probably have more questions the more I think about this.

I've lived in this neighborhood for 30 years and I love it because it's always been a quiet out of the way street and neighborhood. Now with this plan it will all be gone because of the increased level of traffic and noise that comes with it. I also have to wonder what this new situation will do to my property value? In the future I wonder if I wanted to sell could I get a buyer to live next door to an off ramp??

Any answers to these questions would be greatly appreciated."

**Interstate 190/Silver St. Study**

**WE WANT TO KNOW WHAT YOU THINK!** What are your concerns? What do you feel the SDDOT and the consulting engineer need to take into account? Which options do you prefer and why? Please submit your comments before September 29, 2011 to:

Mail: HDR Engineering, Inc.  
ATTN: Jody Page  
3820 Jackson Blvd., Suite 1  
Rapid City, SD 57702

E-mail: [jody.page@hdrinc.com](mailto:jody.page@hdrinc.com)

Fax: 605-791-6161

Web: [http://www.sddot.com/pe/projdev/planning\\_ss\\_I190.asp](http://www.sddot.com/pe/projdev/planning_ss_I190.asp)

Write the Sa with West Blvd connection

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(optional)

Name:

Tom Baumgartner

Address:

229 Alta Vista

Phone:

348-9528

Email:

## Interstate 190/Silver St. Study

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2a With the Real option Seems to be Best  
option 1a would be 2nd choice  
Do Not Like #1 as it Has too Many Problems that  
Do Not Solve the Traffic from Central High's Option  
3a Impacts to Large Area Not Standard

(optional)  
Name:

D.L. Brown

Address:

PO Box 616 Faith, SD

Phone:

739-5101

Email:



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Fax: 605-791-6161

Web: [http://www.sddot.com/pe/projdev/planning\\_ss\\_11190.asp](http://www.sddot.com/pe/projdev/planning_ss_11190.asp)

Diagnose, side walks and grade, Storm water  
Run off, side walk installation and how flat  
the construction completion will be for winter  
Sand Salt. What about plantings? Overhead  
utilities being placed underground.

Like La  
Smalley st Foot  
print

(optional)  
Name: R. Michelle Nordstrom Address: 401 E Meade St, Rapid City  
Phone: 726-6398 Email: ritch@rushmore.com

## Interstate 190/Silver St. Study

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Fax: 605-791-6161

Web: [http://www.sddot.com/pe/projdev/planning\\_ss\\_1190.asp](http://www.sddot.com/pe/projdev/planning_ss_1190.asp)

ALTA is the BEST Approach. All Others  
Take up too much space and are of no value  
to the community under no circumstances do  
we need to better other streets and make  
easier access for future builders they can  
make their own expenses, lets stick strictly  
to I-190 interchange

(optional)

Name: Clifford Landa

Address: 737 High St

Phone: 605-391-2827 (cell)

Email: clifford@rushmore.com

## Interstate 190/Silver St. Study

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Web: [http://www.sddot.com/pe/projdev/planning\\_ss\\_1190.asp](http://www.sddot.com/pe/projdev/planning_ss_1190.asp)

E-mail: [jody.page@hdrinc.com](mailto:jody.page@hdrinc.com)

Fax: 605-791-6161

I like the 2A mph w. Blvd connection  
least disruptive and closest to the  
same connection.

(optional)  
Name:

RxPepesghe

Phone:

Address:

1505 Wyster St

Email:

**Interstate 190/Silver St. Study**

**WE WANT TO KNOW WHAT YOU THINK!** What are your concerns? What do you feel the SDDOT and the consulting engineer need to take into account? Which options do you prefer and why? Please submit your comments before September 29, 2011 to:

**Mail:** HDR Engineering, Inc.  
ATTN: Jody Page  
3820 Jackson Blvd., Suite 1  
Rapid City, SD 57702  
**E-mail:** [jody.page@hdrinc.com](mailto:jody.page@hdrinc.com)  
**Fax:** 605-791-6161  
**Web:** [http://www.sddot.com/pe/projdev/planning\\_ss\\_1190.asp](http://www.sddot.com/pe/projdev/planning_ss_1190.asp)

*At the present time (9/14/11)  
I prefer option 2A*

(optional) Name: Chuck Raunch Address: 602 Dilger Ave  
Phone: 605-343-3023 Email: \_\_\_\_\_

## Interstate 190/Silver St. Study

WE WANT TO KNOW WHAT YOU THINK! What are your concerns? What do you feel the SDDOT and the consulting engineer need to take into account? Which options do you prefer and why? Please submit your comments before September 29, 2011 to:

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**Web:** [http://www.sddot.com/pe/projdev/planning\\_ss\\_1190.asp](http://www.sddot.com/pe/projdev/planning_ss_1190.asp)

Why are you taking all property to the west instead of the land by the High School,

(optional)

Name:

Jessmith McLeod Johnson

Address:

610 Sankarwood Dr.

Phone:

342-6024

Email:

No Email

Interstate 190/Silver Street Study  
 OPEN HOUSE ATTENDANCE  
 September 14, 2011  
 - PLEASE PRINT -

Name	Address	City, State ZIP
Steve Gramm	700 E. Broadway	Pierre, SD 57501
Terry Keller	" " "	" "
Becky Baker	6100 S Old Village Place	S Falls, SD 57107
Edda Winnelman	1935 Sugar Creek Pl Spearfish SD	57783
R. Richie Nordstrom	401 E Meade St	Rapid
Tom Bauganher	229 Alta Vista	Rapid City
Kip Hamington	300 6th St	RC SD 57701
John Fortune	718 Silver St	RC SD 57701
Ed + Peggy Kiepner + David		
HAROLD MESSNER	1022 Philadelphia	RC SD 57701
Merry Elyon	1124 Anomosa St	RC SD 57701
Robert P. Oronick	727 Fald St	RC SD 57701
Paul Knotczynski	700 E Broadway	Pierre, SD
Clifford Kavira	737 High St.	Rapid City SD 57701
BILL KEVIN	Pierre RC	

Interstate 190/Silver Street Study  
 OPEN HOUSE ATTENDANCE  
 September 14, 2011  
 - PLEASE PRINT -

Name	Address	City, State ZIP
Derek Levi	Box 9462	RCSA 57709
Steve Palmer	DOT - Rapid City	
Mike Waba	Dot Watoufou SD.	
DAN STATION	DOT RAPID CITY	
David Brown	Faith .SD PO Box 66	
Craig Dahlke	310 Kinney Ave 57702	Rapid 57702
Todd Seaman	SDDOT	Rapid City
Rexford Peregrine	1505 West 4th St.	RC, S.D. 57701
Janet Hordness	610 - Laurelwood Dr.	RCSA 57702
PAT JUSTIS	3357 Broadmoor Dr	R5SD 57702
GARY ENGEL	SIDOT - RC	
MARION BAKER	FHWA	Pierre. SD
Patrick McDaniel	5060 Pine Tree Dr.	R.C.
JUDY PAKK		

Interstate 190/Silver Street Study  
 OPEN HOUSE ATTENDANCE  
 September 14, 2011  
 - PLEASE PRINT -

Name	Address	City, State ZIP
Jean Jackson	1028 Philadelphia St.	RCSD 57701
Patsy Horton - C/RC	<del>1008</del> 300 6th St	RCSD 57701
Jess McGough	1008 Howard Lot #114	RCSD 57701
Charles White	1030 Philadelphia St	RCSD 57701
James O'Donnell	725 Good St	RCSD 57701
Benny Pitter	City Council	57701
Kerry Anwarony	1016 Silver	RCSD 57701
Arhanda Sheehan	4345 Steeler Lane	57701
Cathy Martinson	4133 S Garlike 478	RC 511



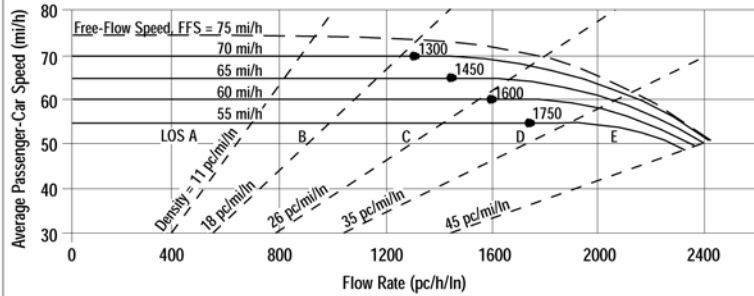
# Operations Analysis Documents



# Operations Analysis Section 1

AM 2010 Mainline

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Highway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM 2010</u>	From/To	<u>Omaha St./Silver St. off</u>
Comment	<u>northbound</u>		

<input checked="" type="checkbox"/> Oper. (LOS)	<input type="checkbox"/> Des. (N)	<input type="checkbox"/> Des. ( $v_p$ )	<input type="checkbox"/> Plan. (LOS)	<input type="checkbox"/> Plan. (N)	<input type="checkbox"/> Plan. ( $v_p$ )
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Flow Inputs				
Volume, V	<u>970</u>	veh/h	Peak-hour factor, PHF	<u>0.92</u>
Annual avg. daily traffic, AADT		veh/day	% Trucks and buses, $P_T$	<u>5</u>
Peak-hour proportion of AADT, K			% RVs, $P_R$	<u>2</u>
Peak-hour direction proportion, D			General terrain	
DDHV = AADT x K x D		veh/h	<input type="checkbox"/> Level <input type="checkbox"/> Rolling <input type="checkbox"/> Mountainous	
Driver type	<input checked="" type="checkbox"/> Commuter/Weekday	<input type="checkbox"/> Recreational/Weekend	Grade Length	<u>0.1</u> mi Up/Down <u>0.2</u> %

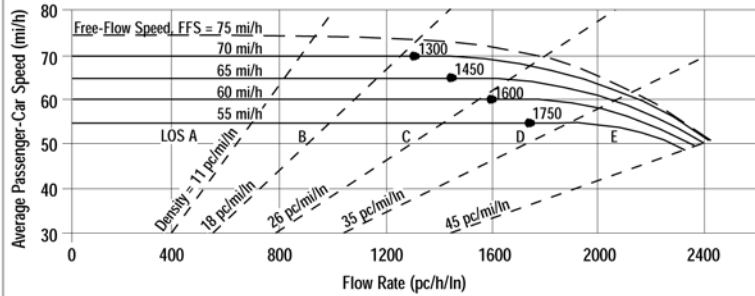
Calculate Flow Adjustments			
$f_p$ ( <input type="checkbox"/> Field data?)	<u>1.00</u>	$E_R$ ( <input type="checkbox"/> Field data?)	<u>1.2</u>
$E_T$ ( <input type="checkbox"/> Field data?)	<u>1.5</u>	$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.972</u>

Speed Inputs		Calculate Speed Adjustments and FFS			
Lane width		ft	$f_{LW}$ ( <input type="checkbox"/> Field data?)		mi/h
Rt-shoulder lat. clearance		ft	$f_{LC}$ ( <input type="checkbox"/> Field data?)		mi/h
Interchange density		l/mi	$f_{ID}$ ( <input type="checkbox"/> Field data?)		mi/h
Number of lanes, N	<u>2</u>		$f_N$ ( <input type="checkbox"/> Field data?)		mi/h
FFS (measured)	<u>55.0</u>	mi/h	FFS = BFFS - $f_{LW}$ - $f_{LC}$ - $f_{ID}$ - $f_N$		mi/h
Base free-flow speed, BFFS		mi/h			

LOS and Performance Measures				
<u>Operational (LOS) or Planning (LOS)</u>		<u>Design (N) or Planning (N) 1st Iteration</u>		
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>542</u>	pc/h/ln	N	<u>assumed</u>
S	<u>55.0</u>	mi/h	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>pc/h/ln</u>
D = $v_p/S$	<u>9.9</u>	pc/i/ln	LOS	<u></u>
LOS	<u>A</u>		<u>Design (N) or Planning (N) 2nd Iteration</u>	
<u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>		N		<u>assumed</u>
LOS	<u></u>		$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>pc/h/ln</u>
$v_p$	<u></u>	pc/h/ln	S	<u>mi/h</u>
$V = v_p \times PHF \times N \times f_{HV} \times f_p$	<u></u>	veh/h	D = $v_p/S$	<u>pc/mi/ln</u>
S	<u></u>	mi/h	LOS	<u></u>
D = $v_p/S$	<u></u>	pc/mi/ln		

Glossary		Factor Location	
N - Number of lanes	S - Speed	$E_R$ - Exhibits 23-8, 23-10	$f_{LW}$ - Exhibit 23-4
V - Hourly volume	D - Density	$E_T$ - Exhibits 23-8, 23-9, 23-11	$f_{LC}$ - Exhibit 23-5
$v_p$ - Flow rate	FFS - Free-flow speed	$f_p$ - Page 23-12	$f_N$ - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, $v_p$ - Exhibits 23-2, 23-3	$f_{ID}$ - Exhibit 23-7
DDHV - Directional design hour volume			

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2010  
 Comment northbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Silver St. off/Anamosa on

Oper. (LOS)       Des. (N)       Des. ( $v_p$ )       Plan. (LOS)       Plan. (N)       Plan. ( $v_p$ )

### Flow Inputs

Volume, V 560 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length 0.9 mi    Up/Down 2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 2.0       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.949

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<u>Operational (LOS) or Planning (LOS)</u>		<u>Design (N) or Planning (N) 1st Iteration</u>	
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>321</u> pc/h/ln	N	_____ assumed
S	<u>55.0</u> mi/h	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
D = $v_p/S$	<u>5.8</u> pc/i/ln	LOS	_____
LOS	<u>A</u>	<u>Design (N) or Planning (N) 2nd Iteration</u>	
<u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>		N	_____ assumed
LOS	_____	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
$v_p$	_____ pc/h/ln	S	_____ mi/h
$V = v_p \times PHF \times N \times f_{HV} \times f_p$	_____ veh/h	D = $v_p/S$	_____ pc/mi/ln
S	_____ mi/h	LOS	_____
D = $v_p/S$	_____ pc/mi/ln		

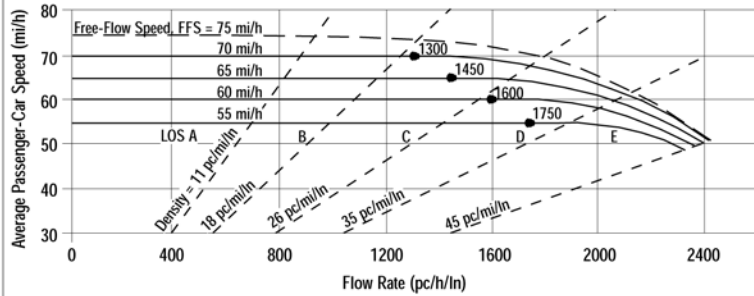
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2010  
 Comment northbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Anamosa on/I-90 off

Oper. (LOS)     Des. (N)     Des. ( $v_p$ )     Plan. (LOS)     Plan. (N)     Plan. ( $v_p$ )

### Flow Inputs

Volume, V 660 veh/h    Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day    % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_    % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_    General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h     Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend    Grade Length 0.2 mi    Up/Down 2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00     $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5     $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>369</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>6.7</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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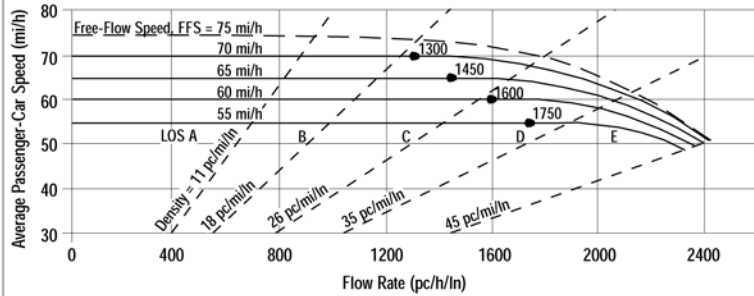
### Glossary

N - Number of lanes    S - Speed  
 V - Hourly volume    D - Density  
 $v_p$  - Flow rate    FFS - Free-flow speed  
 LOS - Level of service    BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10     $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11     $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12     $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3     $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2010  
 Comment southbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To I-90 on/Silver St. off

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 860 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length 0.7 mi Up/Down -2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>481</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>8.7</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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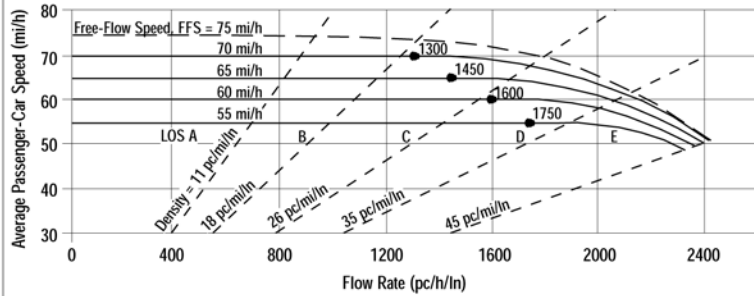
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2010  
 Comment southbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Silver off/Silver on

Oper. (LOS)     Des. (N)     Des. ( $v_p$ )     Plan. (LOS)     Plan. (N)     Plan. ( $v_p$ )

### Flow Inputs

Volume, V 700 veh/h    Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day    % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_    % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_    General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h     Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend    Grade Length 0.5 mi    Up/Down -2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00     $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5     $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>391</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>7.1</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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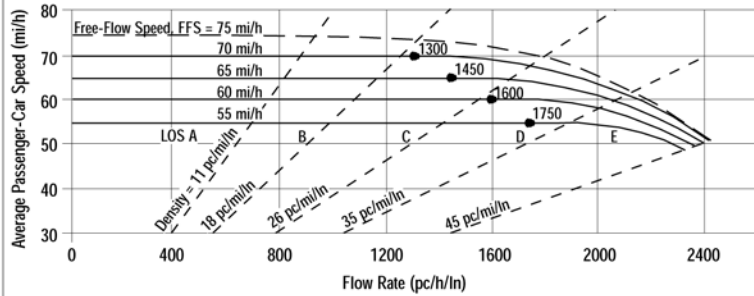
### Glossary

N - Number of lanes    S - Speed  
 V - Hourly volume    D - Density  
 $v_p$  - Flow rate    FFS - Free-flow speed  
 LOS - Level of service    BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10     $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11     $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12     $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3     $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2010  
 Comment southbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Silver on/Omaha

Oper. (LOS)       Des. (N)       Des. ( $v_p$ )       Plan. (LOS)       Plan. (N)       Plan. ( $v_p$ )

### Flow Inputs

Volume, V 980 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length 0.1 mi    Up/Down -0.2 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>548</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>10.0</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
--	--

### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7



## Operations Analysis Section 2

### AM 2010 Ramps

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2010</u>	Junction	<u>NB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	<table style="width: 100%;"> <tr> <td style="width: 50%;">                             Freeway terrain <u>Specific grade</u>                              Ramp Type  <input type="checkbox"/> Merge  <input checked="" type="checkbox"/> Right side                              Number of freeway lanes <u>2</u>                              Number of ramp lanes <u>1</u>                              Length of ramp roadway <u>410</u> ft                         </td> <td style="width: 50%;">                             Ramp terrain <u>Specific grade</u>  <input checked="" type="checkbox"/> Diverge  <input type="checkbox"/> Left side                              Number of freeway lanes <u>2</u>                              Number of ramp lanes <u>1</u>                              Length of ramp roadway <u>410</u> ft                         </td> </tr> <tr> <td style="text-align: center;">S<sub>FF</sub> = <u>55.0</u> mi/h</td> <td style="text-align: center;">S<sub>FR</sub> = <u>45.0</u> mi/h</td> </tr> </table>	Freeway terrain <u>Specific grade</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft	Ramp terrain <u>Specific grade</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft	S <sub>FF</sub> = <u>55.0</u> mi/h	S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>4470</u> ft V <sub>D</sub> = <u>100</u> veh/h
Freeway terrain <u>Specific grade</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft	Ramp terrain <u>Specific grade</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft					
S <sub>FF</sub> = <u>55.0</u> mi/h	S <sub>FR</sub> = <u>45.0</u> mi/h					

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
V <sub>F</sub>				970	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			1081
V <sub>R</sub>				410	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			457
V <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			
V <sub>D</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			117

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1081</u> pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1081	See Exhibit 25-14	
				v <sub>12</sub>	1081	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	624	See Exhibit 25-14	
				v <sub>R</sub>	410	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>9.9</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
---	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.339</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.6</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.6</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2010</u>	Junction	<u>NB Anamosa on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>4470</u> ft V <sub>u</sub> = <u>410</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>470</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>1200</u> ft V <sub>D</sub> = <u>390</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				560	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	654
v <sub>R</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
v <sub>U</sub>				410	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	479
v <sub>D</sub>				390	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	456

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>654</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	771	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	771	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.287</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2010</u>	Junction	<u>NB 90 off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>1200</u> ft V <sub>u</sub> = <u>100</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
v <sub>R</sub>				390	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	456
v <sub>U</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>771</u> pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	771	See Exhibit 25-14	
				v <sub>12</sub>	771	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	315	See Exhibit 25-14	
				v <sub>R</sub>	390	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>-3.2</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.339</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.6</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.6</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2010</u>	Junction	<u>SB 90 on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3920</u> ft V <sub>D</sub> = <u>160</u> veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
v <sub>R</sub>				330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	386
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				160	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	187

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>619</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1005	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1005	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>4.7</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.211</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2010</u>	Junction	<u>SB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3920</u> ft V <sub>u</sub> = <u>330</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2580</u> ft V <sub>D</sub> = <u>280</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				860	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1005
v <sub>R</sub>				160	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	187
v <sub>U</sub>				330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	386
v <sub>D</sub>				280	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	327

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1005</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1005	See Exhibit 25-14	
				v <sub>12</sub>	1005	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	818	See Exhibit 25-14	
				v <sub>R</sub>	160	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>0.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.315</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.9</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.9</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2010</u>	Junction	<u>SB Silver on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2580</u> ft V <sub>u</sub> = <u>160</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
v <sub>F</sub>				700	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			818
v <sub>R</sub>				280	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			327
v <sub>U</sub>				160	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			187
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>818</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
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### Capacity Checks

### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1145	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1145	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

### Level-of-Service Determination (if not F)

### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>5.9</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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### Speed Estimation

### Speed Estimation

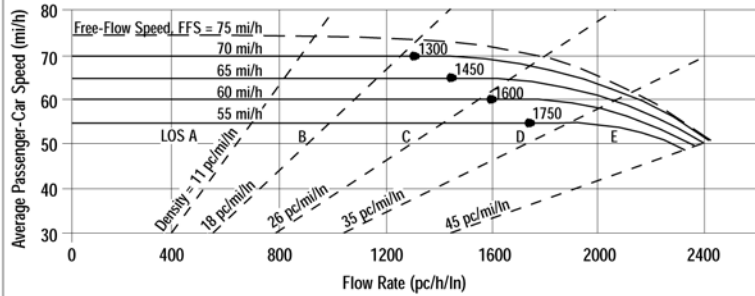
M <sub>s</sub> = <u>0.213</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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# Operations Analysis Section 3

PM 2010 Mainline



## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2010  
 Comment northbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Omaha St./Silver St. off

Oper. (LOS)       Des. (N)       Des. ( $v_p$ )       Plan. (LOS)       Plan. (N)       Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1050 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length 0.1 mi    Up/Down 0.2 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>587</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>10.7</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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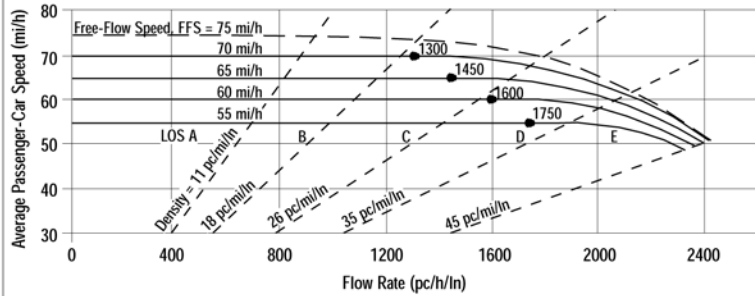
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2010  
 Comment northbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Silver St. off/Anamosa on

Oper. (LOS)       Des. (N)       Des. ( $v_p$ )       Plan. (LOS)       Plan. (N)       Plan. ( $v_p$ )

### Flow Inputs

Volume, V 820 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length 0.9 mi    Up/Down 2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 2.0       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.949

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u>  <math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>470</u> pc/h/ln                  S <u>55.0</u> mi/h                  D = <math>v_p/S</math> <u>8.5</u> pc/i/ln                  LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>                  LOS _____  <math>v_p</math> _____ pc/h/ln                  V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h                  S _____ mi/h                  D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u>                  N _____ assumed  <math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln                  LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u>                  N _____ assumed  <math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln                  S _____ mi/h                  D = <math>v_p/S</math> _____ pc/mi/ln                  LOS _____</p>
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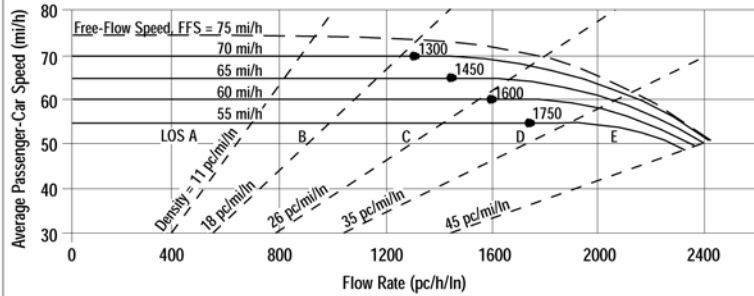
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2010  
 Comment northbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Anamosa on/I-90 off

Oper. (LOS)    
  Des. (N)    
  Des. ( $v_p$ )    
  Plan. (LOS)    
  Plan. (N)    
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 900 veh/h     Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day     % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_ % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_ General terrain  
 DDHV = AADT x K x D \_\_\_\_\_  Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend  
 Grade Length 0.2 mi Up/Down 2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00      $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5      $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>503</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>9.2</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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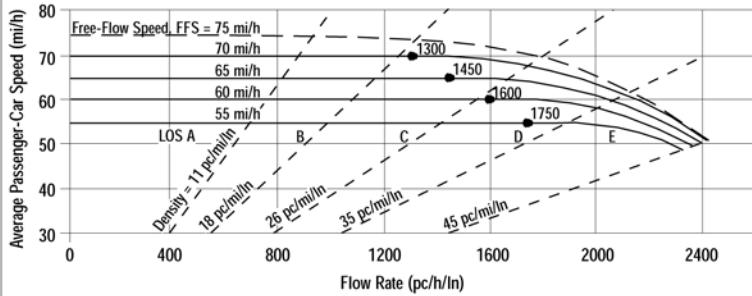
### Glossary

- N - Number of lanes
- V - Hourly volume
- $v_p$  - Flow rate
- LOS - Level of service
- DDHV - Directional design hour volume
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed

### Factor Location

- $E_R$  - Exhibits 23-8, 23-10
- $E_T$  - Exhibits 23-8, 23-9, 23-11
- $f_p$  - Page 23-12
- LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3
- $f_{LW}$  - Exhibit 23-4
- $f_{LC}$  - Exhibit 23-5
- $f_N$  - Exhibit 23-6
- $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2010  
 Comment southbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To I-90 on/Silver St. off

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 610 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length 0.7 mi Up/Down -2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>341</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>6.2</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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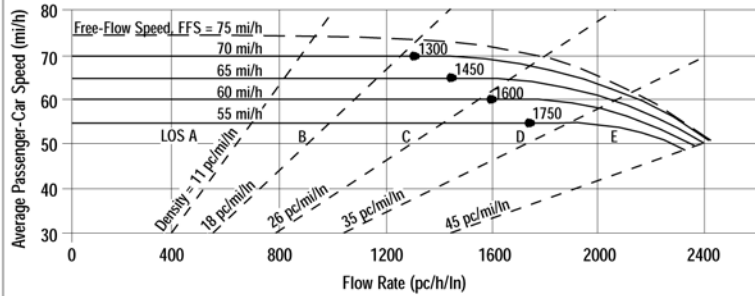
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2010  
 Comment southbound

### Site Information

Jurisdiction/Date Jurisdiction 3/25/2010  
 Highway/Direction of Travel I-190  
 From/To Silver off/Silver on

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 560 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length 0.5 mi Up/Down -2.0 %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>313</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>5.7</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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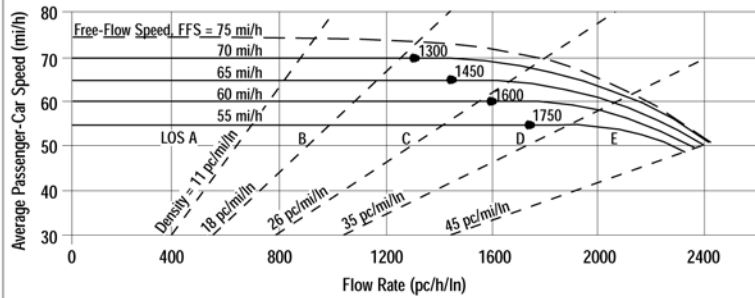
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Highway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2010</u>	From/To	<u>Silver on/Omaha</u>
Comment	<u>southbound</u>		

<input checked="" type="checkbox"/> Oper. (LOS)	<input type="checkbox"/> Des. (N)	<input type="checkbox"/> Des. ( $v_p$ )	<input type="checkbox"/> Plan. (LOS)	<input type="checkbox"/> Plan. (N)	<input type="checkbox"/> Plan. ( $v_p$ )
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Flow Inputs			
Volume, V	<u>780</u> veh/h	Peak-hour factor, PHF	<u>0.92</u>
Annual avg. daily traffic, AADT	_____ veh/day	% Trucks and buses, $P_T$	<u>5</u>
Peak-hour proportion of AADT, K	_____	% RVs, $P_R$	<u>2</u>
Peak-hour direction proportion, D	_____	General terrain	
DDHV = AADT x K x D	_____ veh/h	<input type="checkbox"/> Level <input type="checkbox"/> Rolling <input type="checkbox"/> Mountainous	
Driver type	<input checked="" type="checkbox"/> Commuter/Weekday <input type="checkbox"/> Recreational/Weekend	Grade Length <u>0.1</u> mi	Up/Down <u>-0.2</u> %

Calculate Flow Adjustments			
$f_p$ ( <input type="checkbox"/> Field data?)	<u>1.00</u>	$E_R$ ( <input type="checkbox"/> Field data?)	<u>1.2</u>
$E_T$ ( <input type="checkbox"/> Field data?)	<u>1.5</u>	$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.972</u>

Speed Inputs		Calculate Speed Adjustments and FFS	
Lane width	_____ ft	$f_{LW}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Rt-shoulder lat. clearance	_____ ft	$f_{LC}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Interchange density	_____ /mi	$f_{ID}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Number of lanes, N	<u>2</u>	$f_N$ ( <input type="checkbox"/> Field data?)	_____ mi/h
FFS (measured)	<u>55.0</u> mi/h	FFS = BFFS - $f_{LW}$ - $f_{LC}$ - $f_{ID}$ - $f_N$	_____ mi/h
Base free-flow speed, BFFS	_____ mi/h		

LOS and Performance Measures			
<u>Operational (LOS) or Planning (LOS)</u>		<u>Design (N) or Planning (N) 1st Iteration</u>	
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>436</u> pc/h/ln	N	_____ assumed
S	<u>55.0</u> mi/h	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
$D = v_p/S$	<u>7.9</u> pc/i/ln	LOS	_____
LOS	<u>A</u>	<u>Design (N) or Planning (N) 2nd Iteration</u>	
<u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>		N	_____ assumed
LOS	_____	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
$v_p$	_____ pc/h/ln	S	_____ mi/h
$V = v_p \times PHF \times N \times f_{HV} \times f_p$	_____ veh/h	$D = v_p/S$	_____ pc/mi/ln
S	_____ mi/h	LOS	_____
$D = v_p/S$	_____ pc/mi/ln		

Glossary		Factor Location	
N - Number of lanes	S - Speed	$E_R$ - Exhibits 23-8, 23-10	$f_{LW}$ - Exhibit 23-4
V - Hourly volume	D - Density	$E_T$ - Exhibits 23-8, 23-9, 23-11	$f_{LC}$ - Exhibit 23-5
$v_p$ - Flow rate	FFS - Free-flow speed	$f_p$ - Page 23-12	$f_N$ - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, $v_p$ - Exhibits 23-2, 23-3	$f_{ID}$ - Exhibit 23-7
DDHV - Directional design hour volume			

# Operations Analysis Section 4

## PM 2010 Ramps

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2010</u>	Junction	<u>NB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	<table style="width: 100%;"> <tr> <td style="width: 50%;">                             Freeway terrain <u>Specific grade</u>                              Ramp Type  <input type="checkbox"/> Merge  <input checked="" type="checkbox"/> Right side                              Number of freeway lanes <u>2</u>                              Number of ramp lanes <u>1</u>                              Length of ramp roadway <u>410</u> ft                         </td> <td style="width: 50%;">                             Ramp terrain <u>Specific grade</u>  <input checked="" type="checkbox"/> Diverge  <input type="checkbox"/> Left side                              Number of freeway lanes <u>2</u>                              Number of ramp lanes <u>1</u>                              Length of ramp roadway <u>410</u> ft                         </td> </tr> <tr> <td style="text-align: center;">S<sub>FF</sub> = <u>55.0</u> mi/h</td> <td style="text-align: center;">S<sub>FR</sub> = <u>45.0</u> mi/h</td> </tr> </table>	Freeway terrain <u>Specific grade</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft	Ramp terrain <u>Specific grade</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft	S <sub>FF</sub> = <u>55.0</u> mi/h	S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>4470</u> ft V <sub>D</sub> = <u>80</u> veh/h
Freeway terrain <u>Specific grade</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft	Ramp terrain <u>Specific grade</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft					
S <sub>FF</sub> = <u>55.0</u> mi/h	S <sub>FR</sub> = <u>45.0</u> mi/h					

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1050	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1170
V <sub>R</sub>				230	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	256
V <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
V <sub>D</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1170</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1170	See Exhibit 25-14	
				v <sub>12</sub>	1170	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	914	See Exhibit 25-14	
				v <sub>R</sub>	230	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>10.6</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.321</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2010</u>	Junction	<u>NB Anamosa on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>4470</u> ft V <sub>u</sub> = <u>230</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>470</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>1200</u> ft V <sub>D</sub> = <u>570</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				820	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	958
V <sub>R</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93
V <sub>U</sub>				230	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	269
V <sub>D</sub>				570	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	666

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>958</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1052	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1052	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>10.7</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.290</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2010</u>	Junction	<u>NB 90 off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>1200</u> ft V <sub>u</sub> = <u>80</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
--	---	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				900	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1052
v <sub>R</sub>				570	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	666
v <sub>U</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1052</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1052	See Exhibit 25-14	
				v <sub>12</sub>	1052	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	386	See Exhibit 25-14	
				v <sub>R</sub>	570	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>-0.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.358</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.3</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2010</u>	Junction	<u>SB 90 on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3920</u> ft V <sub>D</sub> = <u>50</u> veh/h
---	--	--

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				470	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	549
v <sub>R</sub>				210	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	245
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				50	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	58

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>549</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	795	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>			
v <sub>R12</sub>	795	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>			

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>3.2</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.209</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2010</u>	Junction	<u>SB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3920</u> ft V <sub>u</sub> = <u>210</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2580</u> ft V <sub>D</sub> = <u>220</u> veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713
v <sub>R</sub>				50	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	58
v <sub>U</sub>				210	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	245
v <sub>D</sub>				220	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	257

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>713</u> pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	713	See Exhibit 25-14	
				v <sub>12</sub>	713	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	654	See Exhibit 25-14	
				v <sub>R</sub>	50	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>-1.7</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.303</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.1</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.1</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>3/25/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2010</u>	Junction	<u>SB Silver on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2580</u> ft V <sub>u</sub> = <u>50</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
--	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				560	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	654
v <sub>R</sub>				220	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	257
v <sub>U</sub>				50	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	58
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>654</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	911	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	911	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>4.1</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

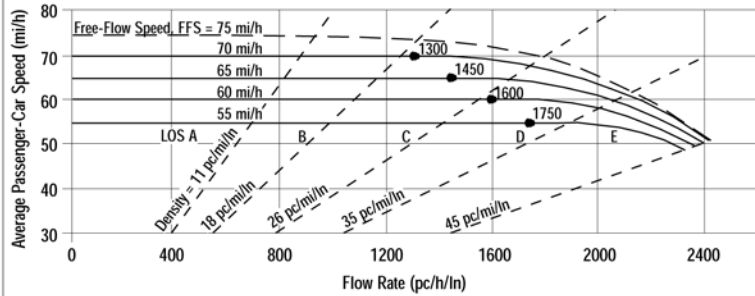
#### Speed Estimation

M <sub>s</sub> = <u>0.210</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

# Operations Analysis Section 5

## AM 2035 Mainline No-Build

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To Omaha/Silver off nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1670 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ <u>934</u> pc/h/ln S <u>55.0</u> mi/h D = $v_p/S$ <u>17.0</u> pc/i/ln LOS <u>B</u> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> LOS _____ $v_p$ _____ pc/h/ln V = $v_p \times PHF \times N \times f_{HV} \times f_p$ _____ veh/h S _____ mi/h D = $v_p/S$ _____ pc/mi/ln	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln LOS _____ <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln S _____ mi/h D = $v_p/S$ _____ pc/mi/ln LOS _____
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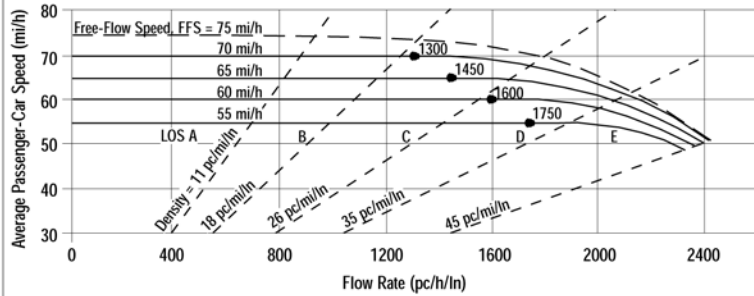
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To Silver off-Silver on nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1130 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ <u>632</u> pc/h/ln S <u>55.0</u> mi/h D = $v_p/S$ <u>11.5</u> pc/i/ln LOS <u>B</u> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> LOS _____ $v_p$ _____ pc/h/ln $V = v_p \times PHF \times N \times f_{HV} \times f_p$ _____ veh/h S _____ mi/h D = $v_p/S$ _____ pc/mi/ln	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln LOS _____ <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln S _____ mi/h D = $v_p/S$ _____ pc/mi/ln LOS _____
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### Glossary

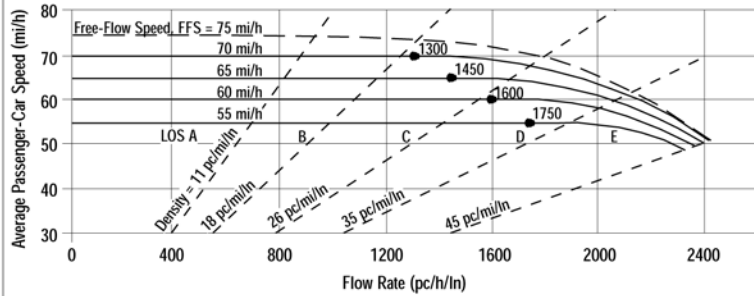
N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7



## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver on-I90 nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1230 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>732</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>13.3</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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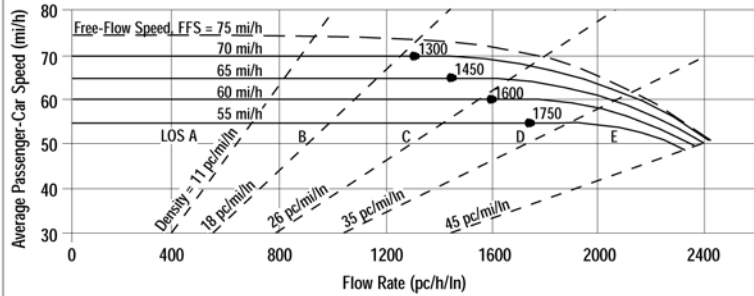
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Highway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM 2035</u>	From/To	<u>I90-silver off sb</u>
Comment	<u>Comments</u>		

<input checked="" type="checkbox"/> Oper. (LOS)	<input type="checkbox"/> Des. (N)	<input type="checkbox"/> Des. ( $v_p$ )	<input type="checkbox"/> Plan. (LOS)	<input type="checkbox"/> Plan. (N)	<input type="checkbox"/> Plan. ( $v_p$ )
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Flow Inputs			
Volume, V	<u>1150</u> veh/h	Peak-hour factor, PHF	<u>0.92</u>
Annual avg. daily traffic, AADT	_____ veh/day	% Trucks and buses, $P_T$	<u>5</u>
Peak-hour proportion of AADT, K	_____	% RVs, $P_R$	<u>2</u>
Peak-hour direction proportion, D	_____	General terrain	
DDHV = AADT x K x D	_____ veh/h	<input type="checkbox"/> Level <input checked="" type="checkbox"/> Rolling <input type="checkbox"/> Mountainous	
Driver type	<input checked="" type="checkbox"/> Commuter/Weekday <input type="checkbox"/> Recreational/Weekend	Grade Length _____ mi	Up/Down _____ %

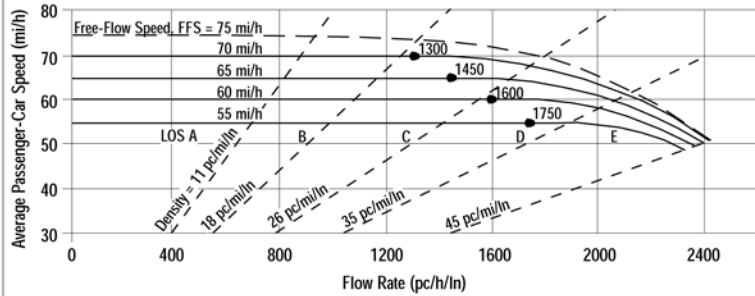
Calculate Flow Adjustments			
$f_p$ ( <input type="checkbox"/> Field data?)	<u>1.00</u>	$E_R$ ( <input type="checkbox"/> Field data?)	<u>2.0</u>
$E_T$ ( <input type="checkbox"/> Field data?)	<u>2.5</u>	$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.913</u>

Speed Inputs		Calculate Speed Adjustments and FFS	
Lane width	_____ ft	$f_{LW}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
RT-shoulder lat. clearance	_____ ft	$f_{LC}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Interchange density	_____ /mi	$f_{ID}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Number of lanes, N	<u>2</u>	$f_N$ ( <input type="checkbox"/> Field data?)	_____ mi/h
FFS (measured)	<u>55.0</u> mi/h	FFS = BFFS - $f_{LW}$ - $f_{LC}$ - $f_{ID}$ - $f_N$	_____ mi/h
Base free-flow speed, BFFS	_____ mi/h		

LOS and Performance Measures			
<u>Operational (LOS) or Planning (LOS)</u>		<u>Design (N) or Planning (N) 1st Iteration</u>	
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>684</u> pc/h/ln	N	_____ assumed
S	<u>55.0</u> mi/h	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
D = $v_p/S$	<u>12.4</u> pc/i/ln	LOS	_____
LOS	<u>B</u>		
<u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>		<u>Design (N) or Planning (N) 2nd Iteration</u>	
LOS	_____	N	_____ assumed
$v_p$	_____ pc/h/ln	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
V = $v_p \times PHF \times N \times f_{HV} \times f_p$	_____ veh/h	S	_____ mi/h
S	_____ mi/h	D = $v_p/S$	_____ pc/mi/ln
D = $v_p/S$	_____ pc/mi/ln	LOS	_____

Glossary		Factor Location	
N - Number of lanes	S - Speed	$E_R$ - Exhibits 23-8, 23-10	$f_{LW}$ - Exhibit 23-4
V - Hourly volume	D - Density	$E_T$ - Exhibits 23-8, 23-9, 23-11	$f_{LC}$ - Exhibit 23-5
$v_p$ - Flow rate	FFS - Free-flow speed	$f_p$ - Page 23-12	$f_N$ - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, $v_p$ - Exhibits 23-2, 23-3	$f_{ID}$ - Exhibit 23-7
DDHV - Directional design hour volume			

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-silver on sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 910 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>509</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>9.3</u> pc/i/ln</p> <p>LOS <u>A</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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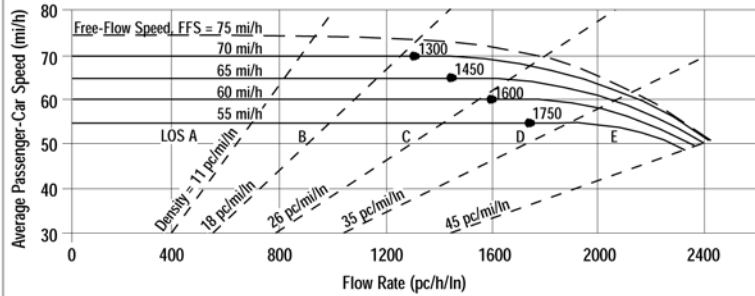
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver on-omaha sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1390 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>777</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>14.1</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
--	--

### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## Operations Analysis Section 6

AM 2035 Ramps, No-Build

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/5/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>NB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>4740</u> ft V <sub>D</sub> = <u>180</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1740	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1939
v <sub>R</sub>				730	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	813
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				180	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	210

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1939</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1939	See Exhibit 25-14	
				v <sub>12</sub>	1939	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1125	See Exhibit 25-14	
				v <sub>R</sub>	730	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>17.2</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.371</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.2</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/5/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>NB Anamosa on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>4740</u> ft V <sub>u</sub> = <u>730</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>470</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>1200</u> ft V <sub>D</sub> = <u>700</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1010	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1180
V <sub>R</sub>				180	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	210
V <sub>U</sub>				730	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	853
V <sub>D</sub>				700	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	818

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1180</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1390	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1390	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>13.3</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.294</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/5/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>NB 90 off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>1200</u> ft V <sub>u</sub> = <u>180</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF \cdot f_{HV} \cdot f_p}$
							Field data if checked		
v <sub>F</sub>				1190	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1390
v <sub>R</sub>				700	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	818
v <sub>U</sub>				180	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	210
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F \cdot P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1390</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1390	See Exhibit 25-14	
				v <sub>12</sub>	1390	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	573	See Exhibit 25-14	
				v <sub>R</sub>	700	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>2.1</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.372</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.2</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/5/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>SB 90 on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3920</u> ft V <sub>D</sub> = <u>220</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				950	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1110
v <sub>R</sub>				590	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	689
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				220	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	257

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1110</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1799	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1799	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>10.8</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
---	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.224</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.1</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.1</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/5/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>SB Silve off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3920</u> ft V <sub>u</sub> = <u>590</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>810</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2580</u> ft V <sub>D</sub> = <u>440</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1540	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1799
v <sub>R</sub>				220	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	257
v <sub>U</sub>				590	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	689
v <sub>D</sub>				440	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	514

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1799</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1799	See Exhibit 25-14	
				v <sub>12</sub>	1799	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1542	See Exhibit 25-14	
				v <sub>R</sub>	220	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>12.4</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.321</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/5/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>SB Silver on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2580</u> ft V <sub>u</sub> = <u>220</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>870</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1320	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1542
V <sub>R</sub>				440	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	514
V <sub>U</sub>				220	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	257
V <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1542</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	2057	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	2057	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>15.8</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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#### Speed Estimation

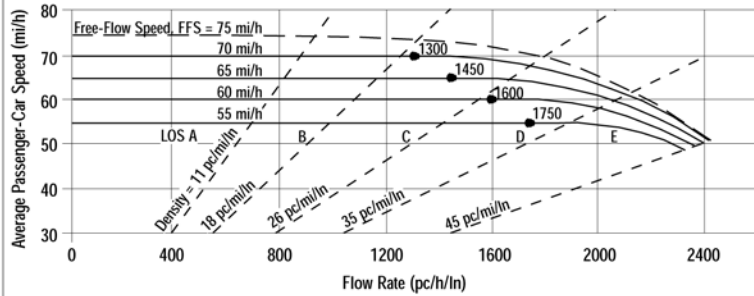
#### Speed Estimation

M <sub>s</sub> = <u>0.273</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.4</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.4</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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# Operations Analysis Section 7

PM 2035 Mainline, No-Build

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To omaha-silver off nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1530 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type     Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>856</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>15.6</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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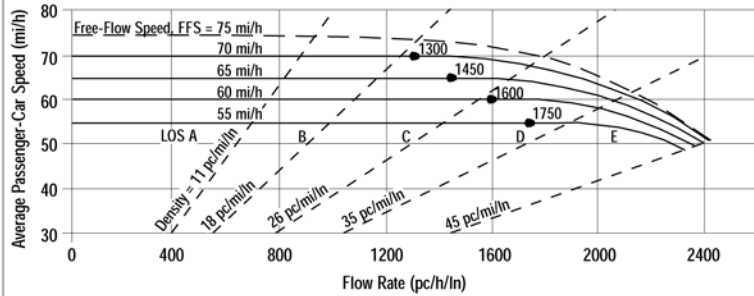
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-silver on nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1270 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>756</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>13.7</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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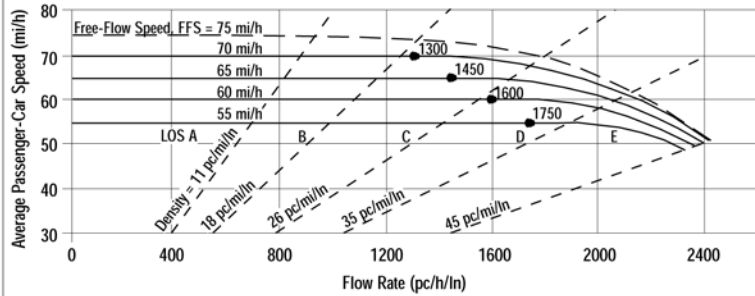
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-I90 nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1330 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>791</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>14.4</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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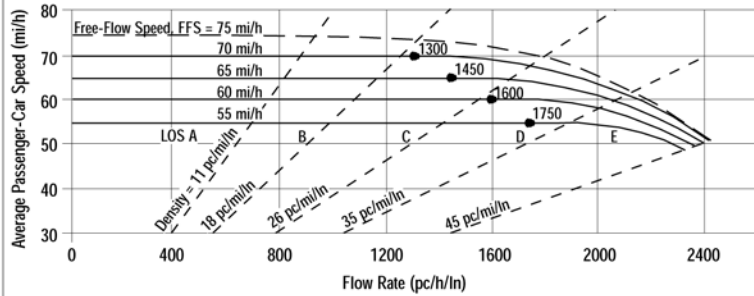
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To 190-silver off sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1330 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ l/mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>791</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>14.4</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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### Glossary

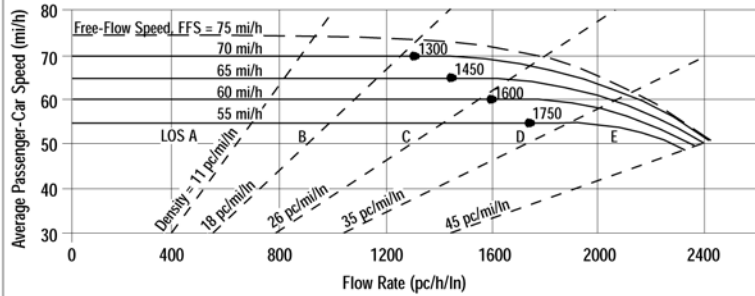
N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7



## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Highway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	From/To	<u>silver off-silver on sb</u>
Comment	<u>Comments</u>		

<input checked="" type="checkbox"/> Oper. (LOS)	<input type="checkbox"/> Des. (N)	<input type="checkbox"/> Des. ( $v_p$ )	<input type="checkbox"/> Plan. (LOS)	<input type="checkbox"/> Plan. (N)	<input type="checkbox"/> Plan. ( $v_p$ )
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Flow Inputs			
Volume, V	<u>1250</u> veh/h	Peak-hour factor, PHF	<u>0.92</u>
Annual avg. daily traffic, AADT	_____ veh/day	% Trucks and buses, $P_T$	<u>5</u>
Peak-hour proportion of AADT, K	_____	% RVs, $P_R$	<u>2</u>
Peak-hour direction proportion, D	_____	General terrain	
DDHV = AADT x K x D	_____ veh/h	<input checked="" type="checkbox"/> Level <input type="checkbox"/> Rolling <input type="checkbox"/> Mountainous	
Driver type	<input checked="" type="checkbox"/> Commuter/Weekday <input type="checkbox"/> Recreational/Weekend	Grade Length _____ mi	Up/Down _____ %

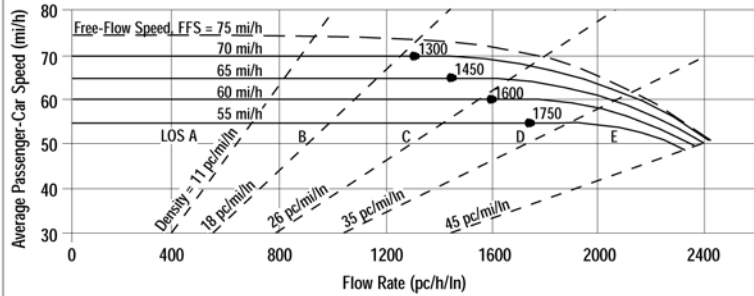
Calculate Flow Adjustments			
$f_p$ ( <input type="checkbox"/> Field data?)	<u>1.00</u>	$E_R$ ( <input type="checkbox"/> Field data?)	<u>1.2</u>
$E_T$ ( <input type="checkbox"/> Field data?)	<u>1.5</u>	$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.972</u>

Speed Inputs		Calculate Speed Adjustments and FFS	
Lane width	_____ ft	$f_{LW}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Rt-shoulder lat. clearance	_____ ft	$f_{LC}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Interchange density	_____ /mi	$f_{ID}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Number of lanes, N	<u>2</u>	$f_N$ ( <input type="checkbox"/> Field data?)	_____ mi/h
FFS (measured)	<u>55.0</u> mi/h	FFS = BFFS - $f_{LW}$ - $f_{LC}$ - $f_{ID}$ - $f_N$	_____ mi/h
Base free-flow speed, BFFS	_____ mi/h		

LOS and Performance Measures			
<u>Operational (LOS) or Planning (LOS)</u>		<u>Design (N) or Planning (N) 1st Iteration</u>	
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>699</u> pc/h/ln	N	_____ assumed
S	<u>55.0</u> mi/h	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
D = $v_p/S$	<u>12.7</u> pc/i/ln	LOS	_____
LOS	<u>B</u>		
<u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>		<u>Design (N) or Planning (N) 2nd Iteration</u>	
LOS	_____	N	_____ assumed
$v_p$	_____ pc/h/ln	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
$V = v_p \times PHF \times N \times f_{HV} \times f_p$	_____ veh/h	S	_____ mi/h
S	_____ mi/h	D = $v_p/S$	_____ pc/mi/ln
D = $v_p/S$	_____ pc/mi/ln	LOS	_____

Glossary		Factor Location	
N - Number of lanes	S - Speed	$E_R$ - Exhibits 23-8, 23-10	$f_{LW}$ - Exhibit 23-4
V - Hourly volume	D - Density	$E_T$ - Exhibits 23-8, 23-9, 23-11	$f_{LC}$ - Exhibit 23-5
$v_p$ - Flow rate	FFS - Free-flow speed	$f_p$ - Page 23-12	$f_N$ - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, $v_p$ - Exhibits 23-2, 23-3	$f_{ID}$ - Exhibit 23-7
DDHV - Directional design hour volume			

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver on-omaha sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1640 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>917</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>16.7</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
--	--

### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

# Operations Analysis Section 8

PM 2035 Ramps, No-Build

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/6/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>NB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>410</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>4740</u> ft V <sub>D</sub> = <u>140</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
v <sub>F</sub>				1880	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			2095
v <sub>R</sub>				400	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			446
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			
v <sub>D</sub>				140	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			164

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>2095</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	2095	See Exhibit 25-14	
				v <sub>12</sub>	2095	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1649	See Exhibit 25-14	
				v <sub>R</sub>	400	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>18.6</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.338</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.6</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.6</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/6/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>NB Anamosa on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>4740</u> ft V <sub>u</sub> = <u>400</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>470</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>1200</u> ft V <sub>D</sub> = <u>1030</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1480	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1729
V <sub>R</sub>				140	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	164
V <sub>U</sub>				400	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	446
V <sub>D</sub>				1030	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1204

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1729</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1893	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1893	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>17.2</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
---	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.305</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.0</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.0</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/6/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>NB 90 off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>1200</u> ft V <sub>u</sub> = <u>140</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1620	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1893
V <sub>R</sub>				1030	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1204
V <sub>U</sub>				140	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	164
V <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1893</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1893	See Exhibit 25-14	
				v <sub>12</sub>	1893	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	689	See Exhibit 25-14	
				v <sub>R</sub>	1030	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>6.4</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.406</u> (Exhibit 25-19) S <sub>R</sub> = <u>49.7</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>49.7</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/6/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>SB 90 on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3920</u> ft V <sub>D</sub> = <u>70</u> veh/h
---	--	--

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				650	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	760
v <sub>R</sub>				440	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	514
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				70	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	82

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>760</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1274	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1274	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>6.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.214</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/6/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>SB Silver off</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3920</u> ft V <sub>u</sub> = <u>440</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>810</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2580</u> ft V <sub>D</sub> = <u>350</u> veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
V <sub>F</sub>				1090	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			1274
V <sub>R</sub>				70	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			82
V <sub>U</sub>				440	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			514
V <sub>D</sub>				350	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			390

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1274</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1274	See Exhibit 25-14	
				v <sub>12</sub>	1274	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1192	See Exhibit 25-14	
				v <sub>R</sub>	70	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>7.9</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.305</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.0</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.0</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>4/6/2010</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>SB Silver on</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2580</u> ft V <sub>u</sub> = <u>70</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>810</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
--	---	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1020	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1136
v <sub>R</sub>				350	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	390
v <sub>U</sub>				70	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	82
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1136</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1526	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1526	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>12.1</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
---	--

#### Speed Estimation

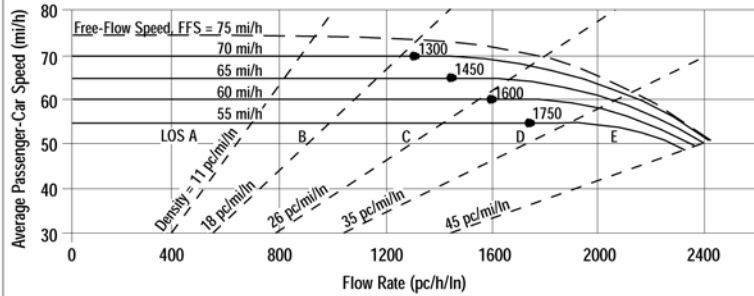
#### Speed Estimation

M <sub>s</sub> = <u>0.266</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.5</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.5</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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# Operations Analysis Section 9

AM 2035 Mainline, Build

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To Omaha/Silver off nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1670 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>934</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>17.0</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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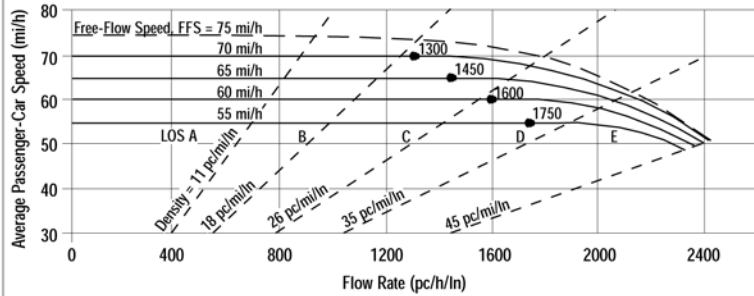
### Glossary

- N - Number of lanes
- V - Hourly volume
- $v_p$  - Flow rate
- LOS - Level of service
- DDHV - Directional design hour volume
- S - Speed
- D - Density
- FFS - Free-flow speed
- BFFS - Base free-flow speed

### Factor Location

- $E_R$  - Exhibits 23-8, 23-10
- $E_T$  - Exhibits 23-8, 23-9, 23-11
- $f_p$  - Page 23-12
- LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3
- $f_{LW}$  - Exhibit 23-4
- $f_{LC}$  - Exhibit 23-5
- $f_N$  - Exhibit 23-6
- $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To Silver off-Silver on nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1130 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_ % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h      General terrain  
 Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend  
 Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ <u>632</u> pc/h/ln S <u>55.0</u> mi/h D = $v_p/S$ <u>11.5</u> pc/i/ln LOS <u>B</u> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> LOS _____ $v_p$ _____ pc/h/ln V = $v_p \times PHF \times N \times f_{HV} \times f_p$ _____ veh/h S _____ mi/h D = $v_p/S$ _____ pc/mi/ln	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln LOS _____ <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln S _____ mi/h D = $v_p/S$ _____ pc/mi/ln LOS _____
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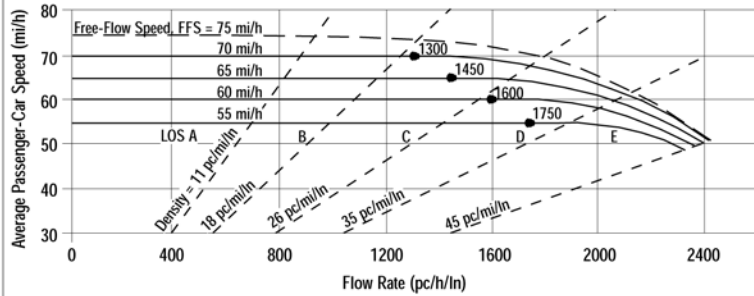
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver on-I90 nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1230 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>732</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>13.3</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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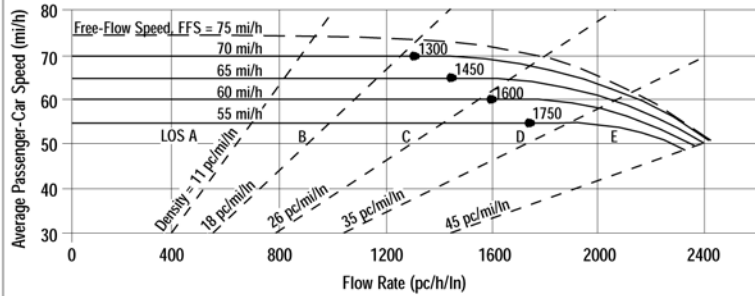
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To I90-silver off sb

Oper. (LOS)       Des. (N)       Des. ( $v_p$ )       Plan. (LOS)       Plan. (N)       Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1150 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>684</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>12.4</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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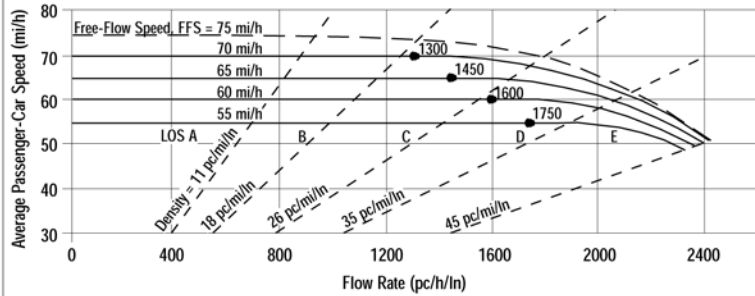
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-silver on sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 910 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ <u>509</u> pc/h/ln S <u>55.0</u> mi/h D = $v_p/S$ <u>9.3</u> pc/i/ln LOS <u>A</u> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> LOS _____ $v_p$ _____ pc/h/ln $V = v_p \times PHF \times N \times f_{HV} \times f_p$ _____ veh/h S _____ mi/h D = $v_p/S$ _____ pc/mi/ln	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln LOS _____ <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> N _____ assumed $v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln S _____ mi/h D = $v_p/S$ _____ pc/mi/ln LOS _____
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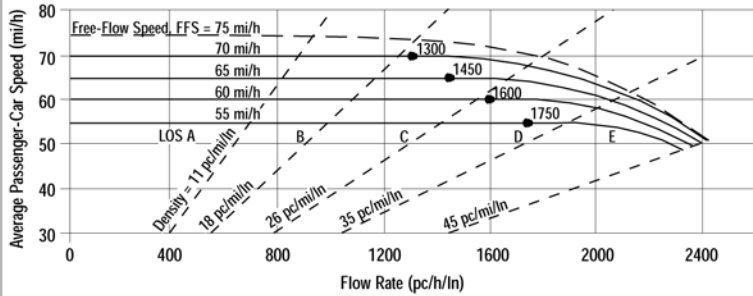
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year AM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver on-omaha sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1390 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>777</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>14.1</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7



Operations Analysis Section 10

AM 2035 Ramps, Build

Alternative 1

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>Silver off nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1040</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2430</u> ft V <sub>D</sub> = <u>100</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1670	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1861
v <sub>R</sub>				540	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	602
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				100	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	111

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1861</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1861	See Exhibit 25-14	
				v <sub>12</sub>	1861	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1259	See Exhibit 25-14	
				v <sub>R</sub>	540	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>10.9</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.352</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.4</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.4</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>Silver on nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2430</u> ft V <sub>u</sub> = <u>540</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1380</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>610</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1130	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1320
V <sub>R</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
V <sub>U</sub>				540	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	631
V <sub>D</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1320</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1437	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1437	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.0</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.213</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>I-90 off nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>100</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1230	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1437
v <sub>R</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713
v <sub>U</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1437</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1437	See Exhibit 25-14	
				v <sub>12</sub>	1437	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	724	See Exhibit 25-14	
				v <sub>R</sub>	610	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>2.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.362</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.3</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>I-90 on sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3620</u> ft V <sub>D</sub> = <u>240</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				620	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	724
v <sub>R</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>724</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1344	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1344	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>7.3</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.215</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3620</u> ft V <sub>u</sub> = <u>530</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>910</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2590</u> ft V <sub>D</sub> = <u>480</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1150	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1344
v <sub>R</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280
v <sub>U</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
v <sub>D</sub>				480	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	561

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1344</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1344	See Exhibit 25-14	
				v <sub>12</sub>	1344	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1063	See Exhibit 25-14	
				v <sub>R</sub>	240	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>7.6</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.323</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2590</u> ft V <sub>u</sub> = <u>240</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1560</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				910	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1014
v <sub>R</sub>				480	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	535
v <sub>U</sub>				240	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	267
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1014</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1549	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1549	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>7.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.199</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.4</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.4</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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Operations Analysis Section 11

AM 2035 Ramps, Build

Alternative 1a



## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1040</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2430</u> ft V <sub>D</sub> = <u>100</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1670	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1861
v <sub>R</sub>				540	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	602
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				100	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	111

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1861</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1861	See Exhibit 25-14	
				v <sub>12</sub>	1861	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1259	See Exhibit 25-14	
				v <sub>R</sub>	540	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>10.9</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.352</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.4</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.4</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2430</u> ft V <sub>u</sub> = <u>540</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1380</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>610</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF \cdot f_{HV} \cdot f_p}$
							Field data if checked		
V <sub>F</sub>				1130	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1320
V <sub>R</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
V <sub>U</sub>				540	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	631
V <sub>D</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F \cdot P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1320</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1437	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1437	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.0</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.213</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>I-90 off nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>100</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1230	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1437
v <sub>R</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713
v <sub>U</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1437</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1437	See Exhibit 25-14	
				v <sub>12</sub>	1437	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	724	See Exhibit 25-14	
				v <sub>R</sub>	610	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>2.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.362</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.3</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>I-90 on sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3850</u> ft V <sub>D</sub> = <u>240</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
v <sub>F</sub>				620	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			724
v <sub>R</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			619
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			
v <sub>D</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			280

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>724</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

### Capacity Checks

### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1344	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1344	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

### Level-of-Service Determination (if not F)

### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>7.3</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

### Speed Estimation

### Speed Estimation

M <sub>s</sub> = <u>0.215</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3850</u> ft V <sub>u</sub> = <u>530</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1330</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2350</u> ft V <sub>D</sub> = <u>480</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1150	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1344
v <sub>R</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280
v <sub>U</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
v <sub>D</sub>				480	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	561

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1344</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1344	See Exhibit 25-14	
				v <sub>12</sub>	1344	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1063	See Exhibit 25-14	
				v <sub>R</sub>	240	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>3.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.323</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2350</u> ft V <sub>u</sub> = <u>240</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1040</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				910	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1014
V <sub>R</sub>				480	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	535
V <sub>U</sub>				240	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	267
V <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$   
 L<sub>EQ</sub> = \_\_\_\_\_ (Equation 25-2 or 25-3)  
 P<sub>FM</sub> = 1.000 using Equation \_\_\_\_\_ (Exhibit 25-5)  
 v<sub>12</sub> = 1014 pc/h

$v_{12} = v_R + (v_F - v_R)P_{FD}$   
 L<sub>EQ</sub> = \_\_\_\_\_ (Equation 25-8 or 25-9)  
 P<sub>FD</sub> = \_\_\_\_\_ using Equation \_\_\_\_\_ (Exhibit 25-12)  
 v<sub>12</sub> = \_\_\_\_\_ pc/h

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1549	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1549	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$   
 D<sub>R</sub> = 10.8 pc/mi/ln  
 LOS = B (Exhibit 25-4)

$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$   
 D<sub>R</sub> = \_\_\_\_\_ pc/mi/ln  
 LOS = \_\_\_\_\_ (Exhibit 25-4)

#### Speed Estimation

#### Speed Estimation

M<sub>s</sub> = 0.246 (Exhibit 25-19)  
 S<sub>R</sub> = 51.8 mi/h (Exhibit 25-19)  
 S<sub>0</sub> = \_\_\_\_\_ mi/h (Exhibit 25-19)  
 S = 51.8 mi/h (Equation 25-14)

D<sub>s</sub> = \_\_\_\_\_ (Exhibit 25-19)  
 S<sub>R</sub> = \_\_\_\_\_ mi/h (Exhibit 25-19)  
 S<sub>0</sub> = \_\_\_\_\_ mi/h (Exhibit 25-19)  
 S = \_\_\_\_\_ mi/h (Equation 25-15)

Operations Analysis Section 12

AM 2035 Ramps, Build

Alternative 2a

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver off nb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)
  Planning (LOS)
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>830</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Level</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2380</u> ft V <sub>D</sub> = <u>100</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1670	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1861
V <sub>R</sub>				540	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	602
V <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
V <sub>D</sub>				100	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	111

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1861</u> pc/h
---	--

### Capacity Checks

### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1861	See Exhibit 25-14	
				v <sub>12</sub>	1861	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1259	See Exhibit 25-14	
				v <sub>R</sub>	540	See Exhibit 25-3	

### Level-of-Service Determination (if not F)

### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>12.8</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

### Speed Estimation

### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.352</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.4</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.4</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2380</u> ft V <sub>u</sub> = <u>540</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1480</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>610</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1130	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1320
V <sub>R</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
V <sub>U</sub>				540	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	631
V <sub>D</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$$v_{12} = v_F * P_{FM}$$

L<sub>EQ</sub> = \_\_\_\_\_ (Equation 25-2 or 25-3)  
 P<sub>FM</sub> = 1.000 using Equation \_\_\_\_\_ (Exhibit 25-5)  
 v<sub>12</sub> = 1320 pc/h

$$v_{12} = v_R + (v_F - v_R)P_{FD}$$

L<sub>EQ</sub> = \_\_\_\_\_ (Equation 25-8 or 25-9)  
 P<sub>FD</sub> = \_\_\_\_\_ using Equation \_\_\_\_\_ (Exhibit 25-12)  
 v<sub>12</sub> = \_\_\_\_\_ pc/h

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1437	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1437	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$$

D<sub>R</sub> = 7.4 pc/mi/ln  
 LOS = A (Exhibit 25-4)

$$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$$

D<sub>R</sub> = \_\_\_\_\_ pc/mi/ln  
 LOS = \_\_\_\_\_ (Exhibit 25-4)

#### Speed Estimation

#### Speed Estimation

M<sub>s</sub> = 0.204 (Exhibit 25-19)  
 S<sub>R</sub> = 52.3 mi/h (Exhibit 25-19)  
 S<sub>0</sub> = \_\_\_\_\_ mi/h (Exhibit 25-19)  
 S = 52.3 mi/h (Equation 25-14)

D<sub>s</sub> = \_\_\_\_\_ (Exhibit 25-19)  
 S<sub>R</sub> = \_\_\_\_\_ mi/h (Exhibit 25-19)  
 S<sub>0</sub> = \_\_\_\_\_ mi/h (Exhibit 25-19)  
 S = \_\_\_\_\_ mi/h (Equation 25-15)

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>i90 off nb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>100</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF \cdot f_{HV} \cdot f_p}$
							Field data if checked		
v <sub>F</sub>				1230	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1437
v <sub>R</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713
v <sub>U</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F \cdot P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1437</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1437	See Exhibit 25-14	
				v <sub>12</sub>	1437	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	724	See Exhibit 25-14	
				v <sub>R</sub>	610	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>2.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.362</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.3</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>i90 on sb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3850</u> ft V <sub>D</sub> = <u>240</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				620	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	724
V <sub>R</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
V <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
V <sub>D</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>724</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

### Capacity Checks

### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1344	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1344	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

### Level-of-Service Determination (if not F)

### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>7.3</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

### Speed Estimation

### Speed Estimation

M <sub>s</sub> = <u>0.215</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3850</u> ft V <sub>u</sub> = <u>530</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1230</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2360</u> ft V <sub>D</sub> = <u>480</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1150	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1344
V <sub>R</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280
V <sub>U</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
V <sub>D</sub>				480	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	561

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1344</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1344	See Exhibit 25-14	
				v <sub>12</sub>	1344	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1063	See Exhibit 25-14	
				v <sub>R</sub>	240	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>4.7</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.323</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2360</u> ft V <sub>u</sub> = <u>240</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1090</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
---	--	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				910	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1014
v <sub>R</sub>				480	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	535
v <sub>U</sub>				240	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	267
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1014</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1549	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1549	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>10.5</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
---	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.241</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.9</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.9</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

Operations Analysis Section 13

AM 2035 Ramps, Build

Alternative 3a

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver off nb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>970</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2430</u> ft V <sub>D</sub> = <u>100</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1670	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1861
v <sub>R</sub>				540	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	602
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				100	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	111

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1861</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1861	See Exhibit 25-14	
				v <sub>12</sub>	1861	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1259	See Exhibit 25-14	
				v <sub>R</sub>	540	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>11.5</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.352</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.4</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.4</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2430</u> ft V <sub>u</sub> = <u>540</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1400</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>610</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1130	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1320
V <sub>R</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
V <sub>U</sub>				540	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	631
V <sub>D</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1320</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1437	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1437	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>7.9</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.211</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---



## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>I-90 off nb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)
  Planning (LOS)
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>100</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF \cdot f_{HV} \cdot f_p}$
							Field data if checked		
v <sub>F</sub>				1230	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1437
v <sub>R</sub>				610	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	713
v <sub>U</sub>				100	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	117
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F \cdot P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1437</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1437	See Exhibit 25-14	
				v <sub>12</sub>	1437	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	724	See Exhibit 25-14	
				v <sub>R</sub>	610	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>2.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.362</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.3</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>I-90 on sb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3850</u> ft V <sub>D</sub> = <u>240</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				620	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	724
v <sub>R</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>724</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1344	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1344	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>7.3</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.215</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)
  Planning (LOS)
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3850</u> ft V <sub>u</sub> = <u>530</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1460</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>1110</u> ft V <sub>D</sub> = <u>480</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1150	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1344
V <sub>R</sub>				240	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	280
V <sub>U</sub>				530	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	619
V <sub>D</sub>				480	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	561

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1344</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1344	See Exhibit 25-14	
				v <sub>12</sub>	1344	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1063	See Exhibit 25-14	
				v <sub>R</sub>	240	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>2.7</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.323</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>AM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>1110</u> ft V <sub>u</sub> = <u>240</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1240</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>35.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				910	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1014
V <sub>R</sub>				480	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	535
V <sub>U</sub>				240	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	267
V <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1014</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1549	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				V <sub>12</sub>		4400: All	
V <sub>R12</sub>	1549	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>9.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

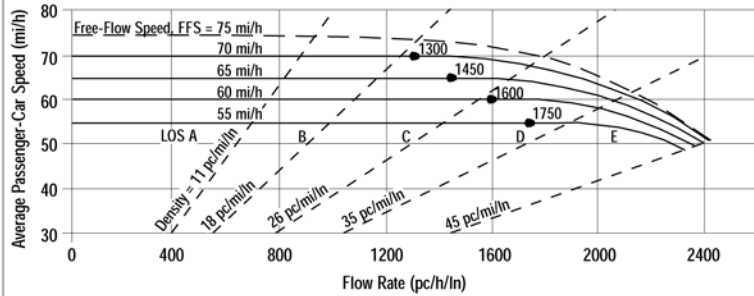
#### Speed Estimation

M <sub>s</sub> = <u>0.253</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.7</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.7</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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# Operations Analysis Section 14

PM 2035 Mainline, Build

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To omaha-silver off nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V	<u>1530</u> veh/h	Peak-hour factor, PHF	<u>0.92</u>
Annual avg. daily traffic, AADT	_____ veh/day	% Trucks and buses, $P_T$	<u>5</u>
Peak-hour proportion of AADT, K	_____	% RVs, $P_R$	<u>2</u>
Peak-hour direction proportion, D	_____	General terrain	
DDHV = AADT x K x D	_____ veh/h	<input checked="" type="checkbox"/> Level <input type="checkbox"/> Rolling <input type="checkbox"/> Mountainous	
Driver type	<input checked="" type="checkbox"/> Commuter/Weekday <input type="checkbox"/> Recreational/Weekend	Grade Length _____ mi	Up/Down _____ %

### Calculate Flow Adjustments

$f_p$ ( <input type="checkbox"/> Field data?)	<u>1.00</u>	$E_R$ ( <input type="checkbox"/> Field data?)	<u>1.2</u>
$E_T$ ( <input type="checkbox"/> Field data?)	<u>1.5</u>	$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.972</u>

### Speed Inputs

Lane width	_____ ft
Rt-shoulder lat. clearance	_____ ft
Interchange density	_____ /mi
Number of lanes, N	<u>2</u>
FFS (measured)	<u>55.0</u> mi/h
Base free-flow speed, BFFS	_____ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
$f_{LC}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
$f_{ID}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
$f_N$ ( <input type="checkbox"/> Field data?)	_____ mi/h
FFS = BFFS - $f_{LW}$ - $f_{LC}$ - $f_{ID}$ - $f_N$	_____ mi/h

### LOS and Performance Measures

Operational (LOS) or Planning (LOS)	Design (N) or Planning (N) 1st Iteration
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	N _____ assumed
S _____	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln
D = $v_p/S$ _____ pc/i/ln	LOS _____
LOS <u>B</u>	
Design ( $v_p$ ) or Planning ( $v_p$ )	Design (N) or Planning (N) 2nd Iteration
LOS _____	N _____ assumed
$v_p$ _____ pc/h/ln	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$ _____ pc/h/ln
V = $v_p \times PHF \times N \times f_{HV} \times f_p$ _____ veh/h	S _____ mi/h
S _____ mi/h	D = $v_p/S$ _____ pc/mi/ln
D = $v_p/S$ _____ pc/mi/ln	LOS _____

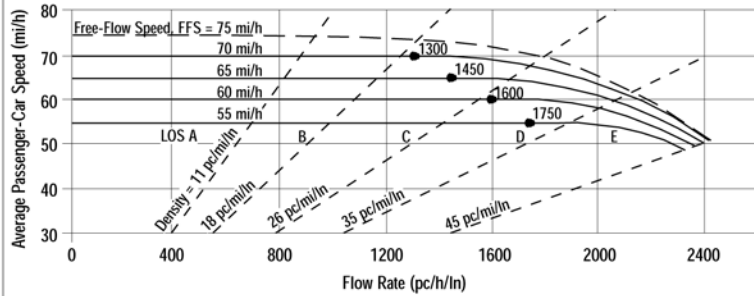
### Glossary

N - Number of lanes  
 V - Hourly volume  
 $v_p$  - Flow rate  
 LOS - Level of service  
 DDHV - Directional design hour volume  
 S - Speed  
 D - Density  
 FFS - Free-flow speed  
 BFFS - Base free-flow speed

### Factor Location

$E_R$  - Exhibits 23-8, 23-10  
 $E_T$  - Exhibits 23-8, 23-9, 23-11  
 $f_p$  - Page 23-12  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3  
 $f_{LW}$  - Exhibit 23-4  
 $f_{LC}$  - Exhibit 23-5  
 $f_N$  - Exhibit 23-6  
 $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-silver on nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1270 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>756</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>13.7</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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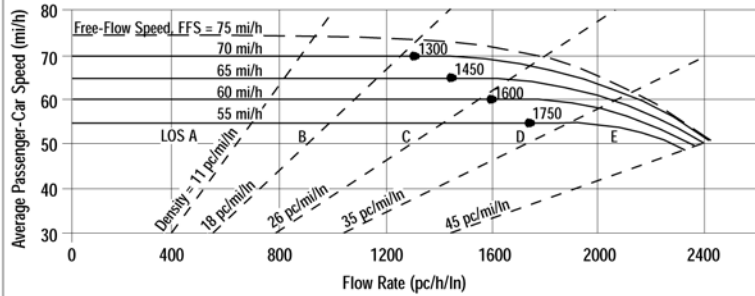
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-I90 nb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1330 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level  Rolling  Mountainous  
 Driver type  Commuter/Weekday  Recreational/Weekend      Grade Length \_\_\_\_\_ mi Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 2.0  
 $E_T$  ( Field data?) 2.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.913

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>791</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>14.4</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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### Glossary

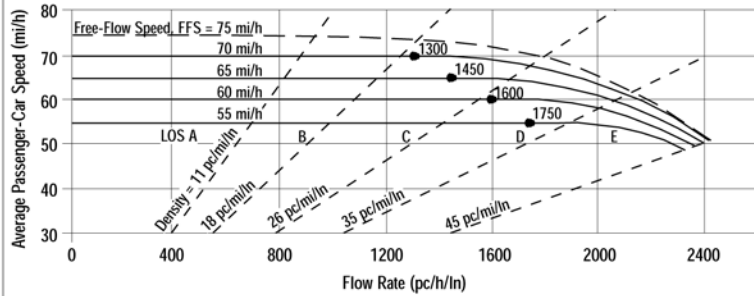
N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7



## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Highway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	From/To	<u>I90-silver off sb</u>
Comment	<u>Comments</u>		

<input checked="" type="checkbox"/> Oper. (LOS)	<input type="checkbox"/> Des. (N)	<input type="checkbox"/> Des. ( $v_p$ )	<input type="checkbox"/> Plan. (LOS)	<input type="checkbox"/> Plan. (N)	<input type="checkbox"/> Plan. ( $v_p$ )
---	-----------------------------------	---	--------------------------------------	------------------------------------	--

Flow Inputs			
Volume, V	<u>1330</u> veh/h	Peak-hour factor, PHF	<u>0.92</u>
Annual avg. daily traffic, AADT	_____ veh/day	% Trucks and buses, $P_T$	<u>5</u>
Peak-hour proportion of AADT, K	_____	% RVs, $P_R$	<u>2</u>
Peak-hour direction proportion, D	_____	General terrain	
DDHV = AADT x K x D	_____ veh/h	<input type="checkbox"/> Level <input checked="" type="checkbox"/> Rolling <input type="checkbox"/> Mountainous	
Driver type	<input checked="" type="checkbox"/> Commuter/Weekday <input type="checkbox"/> Recreational/Weekend	Grade Length _____ mi	Up/Down _____ %

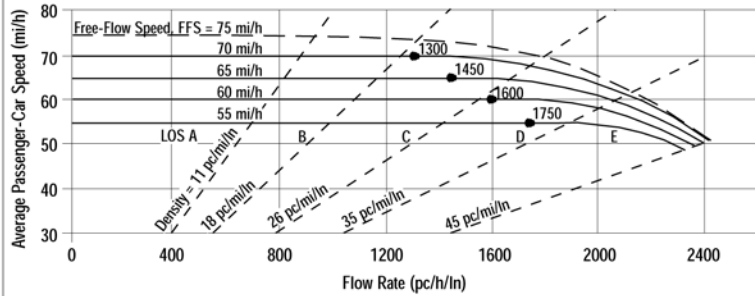
Calculate Flow Adjustments			
$f_p$ ( <input type="checkbox"/> Field data?)	<u>1.00</u>	$E_R$ ( <input type="checkbox"/> Field data?)	<u>2.0</u>
$E_T$ ( <input type="checkbox"/> Field data?)	<u>2.5</u>	$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$	<u>0.913</u>

Speed Inputs		Calculate Speed Adjustments and FFS	
Lane width	_____ ft	$f_{LW}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Rt-shoulder lat. clearance	_____ ft	$f_{LC}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Interchange density	_____ /mi	$f_{ID}$ ( <input type="checkbox"/> Field data?)	_____ mi/h
Number of lanes, N	<u>2</u>	$f_N$ ( <input type="checkbox"/> Field data?)	_____ mi/h
FFS (measured)	<u>55.0</u> mi/h	FFS = BFFS - $f_{LW}$ - $f_{LC}$ - $f_{ID}$ - $f_N$	_____ mi/h
Base free-flow speed, BFFS	_____ mi/h		

LOS and Performance Measures			
<u>Operational (LOS) or Planning (LOS)</u>		<u>Design (N) or Planning (N) 1st Iteration</u>	
$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	<u>791</u> pc/h/ln	N	_____ assumed
S	<u>55.0</u> mi/h	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
D = $v_p/S$	<u>14.4</u> pc/i/ln	LOS	_____
LOS	<u>B</u>		
<u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u>		<u>Design (N) or Planning (N) 2nd Iteration</u>	
LOS	_____	N	_____ assumed
$v_p$	_____ pc/h/ln	$v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}$	_____ pc/h/ln
V = $v_p \times PHF \times N \times f_{HV} \times f_p$	_____ veh/h	S	_____ mi/h
S	_____ mi/h	D = $v_p/S$	_____ pc/mi/ln
D = $v_p/S$	_____ pc/mi/ln	LOS	_____

Glossary		Factor Location	
N - Number of lanes	S - Speed	$E_R$ - Exhibits 23-8, 23-10	$f_{LW}$ - Exhibit 23-4
V - Hourly volume	D - Density	$E_T$ - Exhibits 23-8, 23-9, 23-11	$f_{LC}$ - Exhibit 23-5
$v_p$ - Flow rate	FFS - Free-flow speed	$f_p$ - Page 23-12	$f_N$ - Exhibit 23-6
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, $v_p$ - Exhibits 23-2, 23-3	$f_{ID}$ - Exhibit 23-7
DDHV - Directional design hour volume			

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver off-silver on sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1250 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 $FFS = BFFS - f_{LW} - f_{LC} - f_{ID} - f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>699</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p><math>D = v_p/S</math> <u>12.7</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p><math>V = v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p><math>D = v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
--	--

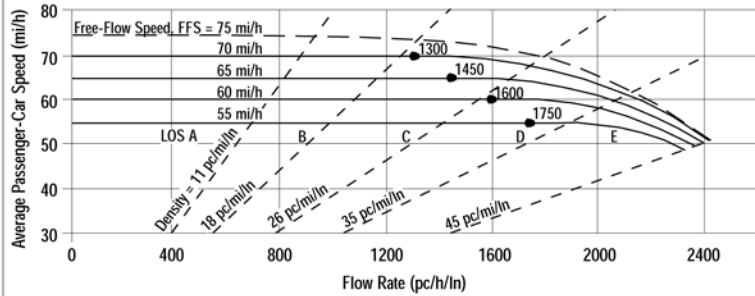
### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

## CHAPTER 23 - BASIC FREEWAY SEGMENTS WORKSHEET



Application	Input	Output
Oper. (LOS)	FFS, N, $v_p$	LOS, S, D
Des. (N)	FFS, LOS, $v_p$	N, S, D
Des. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D
Plan. (LOS)	FFS, N, AADT	LOS, S, D
Plan. (N)	FFS, LOS, AADT	N, S, D
Plan. ( $v_p$ )	FFS, LOS, N	$v_p$ , S, D

### General Information

Analyst Laughlin  
 Agency or Company HDR  
 Analysis Period/Year PM 2035  
 Comment Comments

### Site Information

Jurisdiction/Date Jurisdiction 5/17/2011  
 Highway/Direction of Travel I-190  
 From/To silver on-omaha sb

Oper. (LOS)     
  Des. (N)     
  Des. ( $v_p$ )     
  Plan. (LOS)     
  Plan. (N)     
  Plan. ( $v_p$ )

### Flow Inputs

Volume, V 1640 veh/h      Peak-hour factor, PHF 0.92  
 Annual avg. daily traffic, AADT \_\_\_\_\_ veh/day      % Trucks and buses,  $P_T$  5  
 Peak-hour proportion of AADT, K \_\_\_\_\_      % RVs,  $P_R$  2  
 Peak-hour direction proportion, D \_\_\_\_\_      General terrain  
 DDHV = AADT x K x D \_\_\_\_\_ veh/h       Level     Rolling     Mountainous  
 Driver type  Commuter/Weekday     Recreational/Weekend      Grade Length \_\_\_\_\_ mi    Up/Down \_\_\_\_\_ %

### Calculate Flow Adjustments

$f_p$  ( Field data?) 1.00       $E_R$  ( Field data?) 1.2  
 $E_T$  ( Field data?) 1.5       $f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)}$  0.972

### Speed Inputs

Lane width \_\_\_\_\_ ft  
 Rt-shoulder lat. clearance \_\_\_\_\_ ft  
 Interchange density \_\_\_\_\_ /mi  
 Number of lanes, N 2  
 FFS (measured) 55.0 mi/h  
 Base free-flow speed, BFFS \_\_\_\_\_ mi/h

### Calculate Speed Adjustments and FFS

$f_{LW}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{LC}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_{ID}$  ( Field data?) \_\_\_\_\_ mi/h  
 $f_N$  ( Field data?) \_\_\_\_\_ mi/h  
 FFS = BFFS -  $f_{LW}$  -  $f_{LC}$  -  $f_{ID}$  -  $f_N$  \_\_\_\_\_ mi/h

### LOS and Performance Measures

<p><u>Operational (LOS) or Planning (LOS)</u></p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> <u>917</u> pc/h/ln</p> <p>S <u>55.0</u> mi/h</p> <p>D = <math>v_p/S</math> <u>16.7</u> pc/i/ln</p> <p>LOS <u>B</u></p> <p><u>Design (<math>v_p</math>) or Planning (<math>v_p</math>)</u></p> <p>LOS _____</p> <p><math>v_p</math> _____ pc/h/ln</p> <p>V = <math>v_p \times PHF \times N \times f_{HV} \times f_p</math> _____ veh/h</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p>	<p><u>Design (N) or Planning (N) 1st Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>LOS _____</p> <p><u>Design (N) or Planning (N) 2nd Iteration</u></p> <p>N _____ assumed</p> <p><math>v_p = \frac{V \text{ or DDHV}}{(PHF \times N \times f_{HV} \times f_p)}</math> _____ pc/h/ln</p> <p>S _____ mi/h</p> <p>D = <math>v_p/S</math> _____ pc/mi/ln</p> <p>LOS _____</p>
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### Glossary

N - Number of lanes      S - Speed  
 V - Hourly volume      D - Density  
 $v_p$  - Flow rate      FFS - Free-flow speed  
 LOS - Level of service      BFFS - Base free-flow speed  
 DDHV - Directional design hour volume

### Factor Location

$E_R$  - Exhibits 23-8, 23-10       $f_{LW}$  - Exhibit 23-4  
 $E_T$  - Exhibits 23-8, 23-9, 23-11       $f_{LC}$  - Exhibit 23-5  
 $f_p$  - Page 23-12       $f_N$  - Exhibit 23-6  
 LOS, S, FFS,  $v_p$  - Exhibits 23-2, 23-3       $f_{ID}$  - Exhibit 23-7

Operations Analysis Section 15

PM 2035 Ramps, Build

Alternative 1

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver off nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1040</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2430</u> ft V <sub>D</sub> = <u>60</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1530	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1705
v <sub>R</sub>				260	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	290
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				60	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	67

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1705</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1705	See Exhibit 25-14	
				v <sub>12</sub>	1705	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1415	See Exhibit 25-14	
				v <sub>R</sub>	260	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>9.6</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.324</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2430</u> ft V <sub>u</sub> = <u>260</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1380</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>760</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1270	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1484
V <sub>R</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
V <sub>U</sub>				260	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	304
V <sub>D</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1484</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1554	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1554	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.9</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.215</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>I-90 off nb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>60</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
--	---	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
V <sub>R</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888
V <sub>U</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
V <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	666	See Exhibit 25-14	
				v <sub>R</sub>	760	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>3.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.378</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.1</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.1</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>I-90 on sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3620</u> ft V <sub>D</sub> = <u>80</u> veh/h
---	--	--

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				670	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	783
v <sub>R</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>783</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1554	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1554	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.219</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---



## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3620</u> ft V <sub>u</sub> = <u>660</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>910</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2590</u> ft V <sub>D</sub> = <u>390</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
V <sub>R</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93
V <sub>U</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
V <sub>D</sub>				390	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	456

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1461	See Exhibit 25-14	
				v <sub>R</sub>	80	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>9.4</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.306</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.0</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.0</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/17/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Comments</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2590</u> ft V <sub>u</sub> = <u>80</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1560</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1250	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1393
v <sub>R</sub>				390	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	435
v <sub>U</sub>				80	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	89
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1393</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1827	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1827	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>9.7</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.205</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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Operations Analysis Section 16

PM 2035 Ramps, Build

Alternative 1a

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>silver off nb</u>
Comment	<u>Alt. 1a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1040</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2430</u> ft V <sub>D</sub> = <u>60</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1530	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1705
V <sub>R</sub>				260	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	290
V <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
V <sub>D</sub>				60	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	67

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1705</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1705	See Exhibit 25-14	
				v <sub>12</sub>	1705	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1415	See Exhibit 25-14	
				v <sub>R</sub>	260	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>9.6</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.324</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Alt. 1a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2430</u> ft V <sub>u</sub> = <u>260</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1380</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>760</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1270	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1484
V <sub>R</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
V <sub>U</sub>				260	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	304
V <sub>D</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1484</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1554	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1554	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.9</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.215</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>I-90 nb</u>
Comment	<u>Alt. 1a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>60</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
v <sub>R</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888
v <sub>U</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	666	See Exhibit 25-14	
				v <sub>R</sub>	760	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>3.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.378</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.1</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.1</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>i-90 on sb</u>
Comment	<u>Alt. 1a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3850</u> ft V <sub>D</sub> = <u>80</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				670	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	783
v <sub>R</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>783</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1554	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1554	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.219</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Alt. 1a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3850</u> ft V <sub>u</sub> = <u>660</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1330</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2350</u> ft V <sub>D</sub> = <u>390</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
V <sub>R</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93
V <sub>U</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
V <sub>D</sub>				390	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	456

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1461	See Exhibit 25-14	
				v <sub>R</sub>	80	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>5.6</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.306</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.0</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.0</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Alt. 1a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2350</u> ft V <sub>u</sub> = <u>80</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1040</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1250	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1393
v <sub>R</sub>				390	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	435
v <sub>U</sub>				80	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	89
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1393</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1827	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1827	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>13.0</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
---	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.252</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.7</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.7</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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Operations Analysis Section 17

PM 2035 Ramps, Build

Alternative 2a

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>silver off nb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>830</u> ft <hr/> S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2380</u> ft V <sub>D</sub> = <u>60</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1530	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1705
v <sub>R</sub>				260	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	290
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				60	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	67

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1705</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1705	See Exhibit 25-14	
				v <sub>12</sub>	1705	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1415	See Exhibit 25-14	
				v <sub>R</sub>	260	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>11.4</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.324</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2380</u> ft V <sub>u</sub> = <u>260</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1480</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>760</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1270	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1484
V <sub>R</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
V <sub>U</sub>				260	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	304
V <sub>D</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1484</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1554	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1554	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.3</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.206</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.3</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.3</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>i-90 off nb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)
  Planning (LOS)
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>60</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
--	---	---

### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
v <sub>R</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888
v <sub>U</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	666	See Exhibit 25-14	
				v <sub>R</sub>	760	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>3.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.378</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.1</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.1</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>i-90 on sb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)
  Planning (LOS)
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3850</u> ft V <sub>D</sub> = <u>80</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				670	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	783
v <sub>R</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
v <sub>D</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>783</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1554	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1554	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.219</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3850</u> ft V <sub>u</sub> = <u>660</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1230</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2360</u> ft V <sub>D</sub> = <u>390</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF \cdot f_{HV} \cdot f_p}$
							Field data if checked		
V <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
V <sub>R</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93
V <sub>U</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
V <sub>D</sub>				390	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	456

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F \cdot P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
---	--

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1461	See Exhibit 25-14	
				v <sub>R</sub>	80	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>6.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.306</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.0</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.0</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Alt. 2a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2360</u> ft V <sub>u</sub> = <u>80</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1090</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1250	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1393
v <sub>R</sub>				390	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	435
v <sub>U</sub>				80	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	89
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1393</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1827	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1827	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>12.7</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
---	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.247</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.8</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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Operations Analysis Section 18

PM 2035 Ramps, Build

Alternative 3a

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>silver off nb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Level</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>970</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>2430</u> ft V <sub>D</sub> = <u>60</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
V <sub>F</sub>				1530	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1705
V <sub>R</sub>				260	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	290
V <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	
V <sub>D</sub>				60	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	67

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1705</u> pc/h
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### Capacity Checks

### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>		See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>	1705	See Exhibit 25-14	
				v <sub>12</sub>	1705	4400: All	
V <sub>R12</sub>		4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1415	See Exhibit 25-14	
				v <sub>R</sub>	260	See Exhibit 25-3	

### Level-of-Service Determination (if not F)

### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>10.2</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)
--	---

### Speed Estimation

### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.324</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.8</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.8</u> mi/h (Equation 25-15)
---	--

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver on nb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>2430</u> ft V <sub>u</sub> = <u>260</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1400</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3350</u> ft V <sub>D</sub> = <u>760</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
V <sub>F</sub>				1270	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			1484
V <sub>R</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			70
V <sub>U</sub>				260	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			304
V <sub>D</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			888

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1484</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
V <sub>F0</sub>	1554	See Exhibit 25-7		V <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
V <sub>R12</sub>	1554	4600: All		V <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.213</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>I-90 off nb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3350</u> ft V <sub>u</sub> = <u>60</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1570</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
v <sub>R</sub>				760	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	888
v <sub>U</sub>				60	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	70
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	666	See Exhibit 25-14	
				v <sub>R</sub>	760	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>3.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.378</u> (Exhibit 25-19) S <sub>R</sub> = <u>50.1</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>50.1</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM 2035</u>	Junction	<u>I-90 on sb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = _____ ft V <sub>u</sub> = _____ veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1340</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>down</sub> = <u>3850</u> ft V <sub>D</sub> = <u>80</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>		f <sub>p</sub>		v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked				
v <sub>F</sub>				670	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			783
v <sub>R</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			771
v <sub>U</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00			
v <sub>D</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00			93

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>783</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
---	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1554	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1554	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>8.8</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
--	--

#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.219</u> (Exhibit 25-19) S <sub>R</sub> = <u>52.2</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>52.2</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
--	---

## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver off sb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>up</sub> = <u>3850</u> ft V <sub>u</sub> = <u>660</u> veh/h	Freeway terrain <u>Rolling</u> Ramp Type <input type="checkbox"/> Merge <input checked="" type="checkbox"/> Right side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1460</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>45.0</u> mi/h	Ramp terrain <u>Rolling</u> <input checked="" type="checkbox"/> Diverge <input type="checkbox"/> Left side Downstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input checked="" type="checkbox"/> On <input type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = <u>1110</u> ft V <sub>D</sub> = <u>390</u> veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub> f <sub>p</sub>		v = $\frac{V}{PHF \cdot f_{HV} \cdot f_p}$
							Field data if checked		
v <sub>F</sub>				1330	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	1554
v <sub>R</sub>				80	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	93
v <sub>U</sub>				660	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	771
v <sub>D</sub>				390	0.92	5	<input type="checkbox"/> 0.930	<input type="checkbox"/> 1.00	456

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F \cdot P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = _____ using Equation _____ (Exhibit 25-5) v <sub>12</sub> = _____ pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-12) v <sub>12</sub> = <u>1554</u> pc/h
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#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>		See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>	1554	See Exhibit 25-14	
				v <sub>12</sub>	1554	4400: All	
v <sub>R12</sub>		4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>	1461	See Exhibit 25-14	
				v <sub>R</sub>	80	See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = <u>4.5</u> pc/mi/ln LOS = <u>A</u> (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-14)	D <sub>s</sub> = <u>0.306</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.0</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.0</u> mi/h (Equation 25-15)
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## CHAPTER 25 - RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information		Site Information	
Analyst	<u>Laughlin</u>	Jurisdiction/Date	Jurisdiction <u>5/19/2011</u>
Agency or Company	<u>HDR</u>	Freeway/Direction of Travel	<u>I-190</u>
Analysis Period/Year	<u>PM</u> <u>2035</u>	Junction	<u>silver on sb</u>
Comment	<u>Alt. 3a</u>		

Operational (LOS)     
  Design (L<sub>A</sub>, L<sub>D</sub>, or N)     
  Planning (LOS)     
  Planning (L<sub>A</sub>, L<sub>D</sub>, or N)

### Inputs

Upstream Adjacent Ramp <input checked="" type="checkbox"/> Yes <input type="checkbox"/> On <input type="checkbox"/> No <input checked="" type="checkbox"/> Off L <sub>up</sub> = <u>1110</u> ft V <sub>u</sub> = <u>80</u> veh/h	Freeway terrain <u>Level</u> Ramp Type <input checked="" type="checkbox"/> Merge <input type="checkbox"/> Diverge <input checked="" type="checkbox"/> Right side <input type="checkbox"/> Left side Number of freeway lanes <u>2</u> Number of ramp lanes <u>1</u> Length of ramp roadway <u>1240</u> ft S <sub>FF</sub> = <u>55.0</u> mi/h      S <sub>FR</sub> = <u>35.0</u> mi/h	Downstream Adjacent Ramp <input type="checkbox"/> Yes <input type="checkbox"/> On <input checked="" type="checkbox"/> No <input type="checkbox"/> Off L <sub>down</sub> = _____ ft V <sub>D</sub> = _____ veh/h
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### Conversion to pch Under Base Conditions

(pc/h)	AADT (veh/day)	K	D (veh/h)	V	PHF	% HV	f <sub>HV</sub>	f <sub>p</sub>	v = $\frac{V}{PHF f_{HV} f_p}$
							Field data if checked		
v <sub>F</sub>				1250	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	1393
v <sub>R</sub>				390	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	435
v <sub>U</sub>				80	0.92	5	<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	89
v <sub>D</sub>							<input type="checkbox"/> 0.976	<input type="checkbox"/> 1.00	

### Merge Areas

### Diverge Areas

#### Estimation of v<sub>12</sub>

#### Estimation of v<sub>12</sub>

$v_{12} = v_F * P_{FM}$ L <sub>EQ</sub> = _____ (Equation 25-2 or 25-3) P <sub>FM</sub> = <u>1.000</u> using Equation _____ (Exhibit 25-5) v <sub>12</sub> = <u>1393</u> pc/h	$v_{12} = v_R + (v_F - v_R)P_{FD}$ L <sub>EQ</sub> = _____ (Equation 25-8 or 25-9) P <sub>FD</sub> = _____ using Equation _____ (Exhibit 25-12) v <sub>12</sub> = _____ pc/h
--	---

#### Capacity Checks

#### Capacity Checks

	Actual	Maximum	LOS F?		Actual	Maximum	LOS F?
v <sub>F0</sub>	1827	See Exhibit 25-7		v <sub>F1</sub> = v <sub>F</sub>		See Exhibit 25-14	
				v <sub>12</sub>		4400: All	
v <sub>R12</sub>	1827	4600: All		v <sub>F0</sub> = v <sub>F</sub> - v <sub>R</sub>		See Exhibit 25-14	
				v <sub>R</sub>		See Exhibit 25-3	

#### Level-of-Service Determination (if not F)

#### Level-of-Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 v_{12} - 0.00627 L_A$ D <sub>R</sub> = <u>11.8</u> pc/mi/ln LOS = <u>B</u> (Exhibit 25-4)	$D_R = 4.252 + 0.0086 v_{12} - 0.009 L_D$ D <sub>R</sub> = _____ pc/mi/ln LOS = _____ (Exhibit 25-4)
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#### Speed Estimation

#### Speed Estimation

M <sub>s</sub> = <u>0.258</u> (Exhibit 25-19) S <sub>R</sub> = <u>51.6</u> mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = <u>51.6</u> mi/h (Equation 25-14)	D <sub>s</sub> = _____ (Exhibit 25-19) S <sub>R</sub> = _____ mi/h (Exhibit 25-19) S <sub>0</sub> = _____ mi/h (Exhibit 25-19) S = _____ mi/h (Equation 25-15)
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# Operations Analysis Section 19

## AM 2010 Intersections



HCM Unsignalized Intersection Capacity Analysis  
 29: Anamosa St. & West Blvd. W

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Volume (veh/h)	2	36	6	23	21	10	3	0	25	26	10	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.73	0.73	0.73	0.52	0.52	0.52	0.70	0.70	0.70	0.64	0.64	0.64
Hourly flow rate (vph)	3	49	8	44	40	19	4	0	36	41	16	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	60			58			205	207	53	233	201	50
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	60			58			205	207	53	233	201	50
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			99	100	96	94	98	100
cM capacity (veh/h)	1544			1547			722	669	1014	680	674	1018

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	60	104	40	56
Volume Left	3	44	4	41
Volume Right	8	19	36	0
cSH	1544	1547	972	678
Volume to Capacity	0.00	0.03	0.04	0.08
Queue Length 95th (ft)	0	2	3	7
Control Delay (s)	0.3	3.3	8.9	10.8
Lane LOS	A	A	A	B
Approach Delay (s)	0.3	3.3	8.9	10.8
Approach LOS			A	B

Intersection Summary			
Average Delay		5.1	
Intersection Capacity Utilization	24.8%		ICU Level of Service A
Analysis Period (min)		15	

# HCM Unsignalized Intersection Capacity Analysis

## 27: Anamosa St. & West Blvd E

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔	↔		↔	↔		↕			↕	
Volume (veh/h)	22	58	7	58	30	34	9	53	44	19	36	15
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.59	0.59	0.59	0.62	0.62	0.62	0.83	0.83	0.83	0.63	0.63	0.63
Hourly flow rate (vph)	37	98	12	94	48	55	11	64	53	30	57	24
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)			2			16						
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293	268	69	296	253	90	81			117		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293	268	69	296	253	90	81			117		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	93	84	99	83	92	94	99			98		
cM capacity (veh/h)	573	621	994	557	632	967	1517			1472		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	147	197	128	111
Volume Left	37	94	11	30
Volume Right	12	55	53	24
cSH	661	808	1517	1472
Volume to Capacity	0.22	0.24	0.01	0.02
Queue Length 95th (ft)	21	24	1	2
Control Delay (s)	12.3	12.0	0.7	2.2
Lane LOS	B	B	A	A
Approach Delay (s)	12.3	12.0	0.7	2.2
Approach LOS	B	B		

Intersection Summary			
Average Delay		7.7	
Intersection Capacity Utilization	26.7%		ICU Level of Service A
Analysis Period (min)		15	

# HCM Unsignalized Intersection Capacity Analysis

## 24: North Street & West Blvd E

6/21/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↑		↔	↔			↑	↔		↔	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	7	144	0	90	10	29	66	89	98	38	0	99
Peak Hour Factor	0.66	0.66	0.66	0.78	0.78	0.78	0.67	0.67	0.67	0.68	0.68	0.68
Hourly flow rate (vph)	11	218	0	115	13	37	99	133	146	56	0	146

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1
Volume Total (vph)	83	145	115	50	231	146	201
Volume Left (vph)	11	0	115	0	99	0	56
Volume Right (vph)	0	0	0	37	0	146	146
Hadj (s)	0.10	0.03	0.53	-0.49	0.25	-0.67	-0.34
Departure Headway (s)	6.5	6.4	7.0	6.0	6.2	5.3	5.9
Degree Utilization, x	0.15	0.26	0.23	0.08	0.40	0.22	0.33
Capacity (veh/h)	514	523	474	549	543	640	577
Control Delay (s)	9.4	10.5	10.9	8.3	12.2	8.6	11.7
Approach Delay (s)	10.1		10.1		10.8		11.7
Approach LOS	B		B		B		B

Intersection Summary	
Delay	10.7
HCM Level of Service	B
Intersection Capacity Utilization	34.0%
ICU Level of Service	A
Analysis Period (min)	15

# HCM Unsignalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔			↕	↗		↕	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	18	215	94	99	230	9	68	20	50	9	61	43
Peak Hour Factor	0.63	0.63	0.63	0.67	0.67	0.67	0.68	0.68	0.68	0.64	0.64	0.64
Hourly flow rate (vph)	29	341	149	148	343	13	100	29	74	14	95	67
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1					
Volume Total (vph)	199	320	319	185	129	74	177					
Volume Left (vph)	29	0	148	0	100	0	14					
Volume Right (vph)	0	149	0	13	0	74	67					
Hadj (s)	0.11	-0.29	0.27	-0.02	0.42	-0.67	-0.18					
Departure Headway (s)	6.9	6.5	7.0	6.7	8.1	7.0	7.3					
Degree Utilization, x	0.38	0.58	0.62	0.35	0.29	0.14	0.36					
Capacity (veh/h)	502	530	489	515	406	471	456					
Control Delay (s)	12.8	16.7	19.8	12.1	13.1	9.9	14.4					
Approach Delay (s)	15.2		16.9		12.0		14.4					
Approach LOS	C		C		B		B					
Intersection Summary												
Delay			15.3									
HCM Level of Service			C									
Intersection Capacity Utilization			42.0%		ICU Level of Service			A				
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	265	807	94	124	742	246	60	292	157	298	362	297
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.51	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	952	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.81	0.81	0.81	0.86	0.86	0.86	0.83	0.83	0.83	0.88	0.88	0.88
Adj. Flow (vph)	327	996	116	144	863	286	72	352	189	339	411	338
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	327	996	116	144	863	286	72	352	189	339	411	338
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	6.0	18.2	60.0	4.0	16.2	60.0	17.6	15.2	60.0	6.6	19.4	60.0
Effective Green, g (s)	6.0	18.2	60.0	4.0	16.2	60.0	17.6	15.2	60.0	6.6	19.4	60.0
Actuated g/C Ratio	0.10	0.30	1.00	0.07	0.27	1.00	0.29	0.25	1.00	0.11	0.32	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	343	1542	1583	229	1373	1583	312	897	1583	378	1144	1583
v/s Ratio Prot	c0.10	c0.20		0.04	0.17		0.01	0.10		c0.10	c0.12	
v/s Ratio Perm			0.07			0.18	0.06		0.12			c0.21
v/c Ratio	0.95	0.65	0.07	0.63	0.63	0.18	0.23	0.39	0.12	0.90	0.36	0.21
Uniform Delay, d1	26.9	18.1	0.0	27.3	19.3	0.0	15.6	18.6	0.0	26.4	15.5	0.0
Progression Factor	1.00	1.00	1.00	0.94	1.54	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	36.2	0.9	0.1	4.8	0.8	0.2	0.4	1.3	0.2	22.9	0.9	0.3
Delay (s)	63.1	19.0	0.1	30.6	30.5	0.2	16.0	19.9	0.2	49.2	16.4	0.3
Level of Service	E	B	A	C	C	A	B	B	A	D	B	A
Approach Delay (s)		27.5			23.8			13.3			21.6	
Approach LOS		C			C			B			C	

### Intersection Summary

HCM Average Control Delay	23.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.57		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis  
 22: Omaha St. & Mt. Rushmore Rd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	59	986	280	209	825	23	211	97	65	45	119	18
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5065		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.69	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5065		3433	3539	1583	1282	3539	1583
Peak-hour factor, PHF	0.94	0.94	0.94	0.92	0.92	0.92	0.96	0.96	0.96	0.84	0.84	0.84
Adj. Flow (vph)	63	1049	298	227	897	25	220	101	68	54	142	21
RTOR Reduction (vph)	0	0	211	0	5	0	0	0	48	0	0	16
Lane Group Flow (vph)	63	1049	87	227	917	0	220	101	20	54	142	5
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	2.4	17.6	17.6	6.0	21.2		6.0	18.0	18.0	16.8	14.4	14.4
Effective Green, g (s)	2.4	17.6	17.6	6.0	21.2		6.0	18.0	18.0	16.8	14.4	14.4
Actuated g/C Ratio	0.04	0.29	0.29	0.10	0.35		0.10	0.30	0.30	0.28	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	137	1492	464	343	1790		343	1062	475	378	849	380
v/s Ratio Prot	0.02	c0.21		c0.07	c0.18		c0.06	c0.03		0.01	c0.04	
v/s Ratio Perm			0.06						0.01	0.03		0.00
v/c Ratio	0.46	0.70	0.19	0.66	0.51		0.64	0.10	0.04	0.14	0.17	0.01
Uniform Delay, d1	28.2	18.9	15.9	26.0	15.3		26.0	15.1	14.9	16.0	18.1	17.4
Progression Factor	0.80	1.56	5.32	0.72	1.42		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.9	1.2	0.2	4.1	0.2		4.1	0.2	0.2	0.2	0.4	0.1
Delay (s)	24.5	30.6	84.4	22.9	22.0		30.0	15.3	15.1	16.2	18.5	17.4
Level of Service	C	C	F	C	C		C	B	B	B	B	B
Approach Delay (s)		41.7			22.2			23.6			17.8	
Approach LOS		D			C			C			B	

Intersection Summary		
HCM Average Control Delay	30.7	HCM Level of Service C
HCM Volume to Capacity ratio	0.57	
Actuated Cycle Length (s)	60.0	Sum of lost time (s) 24.0
Intersection Capacity Utilization	47.7%	ICU Level of Service A
Analysis Period (min)	15	
c Critical Lane Group		

## Operations Analysis Section 20

### PM 2010 Intersections

# HCM Unsignalized Intersection Capacity Analysis

## 29: Anamosa St. & West Blvd. (W)

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Volume (veh/h)	2	32	6	21	37	17	0	1	16	11	6	1
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.77	0.77	0.77	0.67	0.67	0.67	0.71	0.71	0.71	0.75	0.75	0.75
Hourly flow rate (vph)	3	42	8	31	55	25	0	1	23	15	8	1
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	81			49			187	194	45	204	185	68
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	81			49			187	194	45	204	185	68
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			100	100	98	98	99	100
cM capacity (veh/h)	1517			1557			753	686	1024	723	694	995

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	52	112	24	24
Volume Left	3	31	0	15
Volume Right	8	25	23	1
cSH	1517	1557	995	724
Volume to Capacity	0.00	0.02	0.02	0.03
Queue Length 95th (ft)	0	2	2	3
Control Delay (s)	0.4	2.2	8.7	10.1
Lane LOS	A	A	A	B
Approach Delay (s)	0.4	2.2	8.7	10.1
Approach LOS			A	B



















Intersection Summary			
Average Delay		3.4	
Intersection Capacity Utilization	25.1%		ICU Level of Service A
Analysis Period (min)		15	



# HCM Unsignalized Intersection Capacity Analysis

























## 27: Anamosa St. & West Blvd. (E)

4/27/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	21	40	5	74	50	25	23	85	58	2	26	4
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.87	0.87	0.87	0.79	0.79	0.79	0.78	0.78	0.78	0.80	0.80	0.80
Hourly flow rate (vph)	24	46	6	94	63	32	29	109	74	2	32	5
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)			2			16						
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	293	282	35	271	248	146	38			183		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	293	282	35	271	248	146	38			183		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	96	93	99	85	90	96	98			100		
cM capacity (veh/h)	579	614	1038	629	641	901	1573			1392		
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>WB 1</b>	<b>NB 1</b>	<b>SB 1</b>								
Volume Total	76	189	213	40								
Volume Left	24	94	29	2								
Volume Right	6	32	74	5								
cSH	651	762	1573	1392								
Volume to Capacity	0.12	0.25	0.02	0.00								
Queue Length 95th (ft)	10	24	1	0								
Control Delay (s)	11.5	12.0	1.1	0.5								
Lane LOS	B	B	A	A								
Approach Delay (s)	11.5	12.0	1.1	0.5								
Approach LOS	B	B										
<b>Intersection Summary</b>												
Average Delay			6.6									
Intersection Capacity Utilization			35.8%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis  
 24: North Street & West Blvd.

6/21/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 		 	 			 	 		 	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	5	27	0	150	10	33	50	72	93	38	0	41
Peak Hour Factor	0.66	0.66	0.66	0.78	0.78	0.78	0.67	0.67	0.67	0.68	0.68	0.68
Hourly flow rate (vph)	8	41	0	192	13	42	75	107	139	56	0	60
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1					
Volume Total (vph)	21	27	192	55	182	139	116					
Volume Left (vph)	8	0	192	0	75	0	56					
Volume Right (vph)	0	0	0	42	0	139	60					
Hadj (s)	0.21	0.03	0.53	-0.50	0.24	-0.67	-0.18					
Departure Headway (s)	6.2	6.0	6.2	5.2	5.7	4.8	5.6					
Degree Utilization, x	0.04	0.05	0.33	0.08	0.29	0.19	0.18					
Capacity (veh/h)	531	549	549	652	603	709	610					
Control Delay (s)	8.3	8.1	11.1	7.5	9.9	7.7	9.8					
Approach Delay (s)	8.2		10.3		8.9		9.8					
Approach LOS	A		B		A		A					
Intersection Summary												
Delay			9.5									
HCM Level of Service			A									
Intersection Capacity Utilization			32.9%	ICU Level of Service								A
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis  
 21: North Street & Mt. Rushmore Rd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑	↗		↔	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	13	221	111	96	118	15	36	56	150	7	47	13
Peak Hour Factor	0.59	0.59	0.59	0.75	0.75	0.75	0.79	0.79	0.79	0.88	0.88	0.88
Hourly flow rate (vph)	22	375	188	128	157	20	46	71	190	8	53	15
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1					
Volume Total (vph)	209	375	207	99	116	190	76					
Volume Left (vph)	22	0	128	0	46	0	8					
Volume Right (vph)	0	188	0	20	0	190	15					
Hadj (s)	0.09	-0.32	0.34	-0.11	0.23	-0.67	-0.06					
Departure Headway (s)	6.3	5.9	6.9	6.4	7.1	6.2	7.2					
Degree Utilization, x	0.37	0.62	0.40	0.18	0.23	0.33	0.15					
Capacity (veh/h)	548	584	497	527	473	538	452					
Control Delay (s)	11.7	16.7	13.2	9.6	11.1	11.1	11.5					
Approach Delay (s)	14.9		12.0		11.1		11.5					
Approach LOS	B		B		B		B					
Intersection Summary												
Delay			13.1									
HCM Level of Service			B									
Intersection Capacity Utilization			38.2%		ICU Level of Service			A				
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	353	1031	89	181	1134	256	70	567	146	253	414	279
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.50	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	925	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.87	0.87	0.87	0.96	0.96	0.96	0.97	0.97	0.97	0.94	0.94	0.94
Adj. Flow (vph)	406	1185	102	189	1181	267	72	585	151	269	440	297
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	406	1185	102	189	1181	267	72	585	151	269	440	297
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	7.0	18.0	60.0	5.0	16.0	60.0	18.4	16.0	60.0	5.0	18.6	60.0
Effective Green, g (s)	7.0	18.0	60.0	5.0	16.0	60.0	18.4	16.0	60.0	5.0	18.6	60.0
Actuated g/C Ratio	0.12	0.30	1.00	0.08	0.27	1.00	0.31	0.27	1.00	0.08	0.31	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	401	1526	1583	286	1356	1583	317	944	1583	286	1097	1583
v/s Ratio Prot	c0.12	c0.23		0.06	0.23		0.01	c0.17		c0.08	0.12	
v/s Ratio Perm			0.06			0.17	0.06		0.10			c0.19
v/c Ratio	1.01	0.78	0.06	0.66	0.87	0.17	0.23	0.62	0.10	0.94	0.40	0.19
Uniform Delay, d1	26.5	19.2	0.0	26.7	21.0	0.0	15.0	19.3	0.0	27.4	16.3	0.0
Progression Factor	1.00	1.00	1.00	0.85	1.68	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	48.1	2.6	0.1	3.1	3.6	0.1	0.4	3.1	0.1	37.5	1.1	0.3
Delay (s)	74.6	21.7	0.1	25.7	39.0	0.1	15.4	22.4	0.1	64.8	17.4	0.3
Level of Service	E	C	A	C	D	A	B	C	A	E	B	A
Approach Delay (s)		33.1			31.1			17.6			25.0	
Approach LOS		C			C			B			C	

### Intersection Summary

HCM Average Control Delay	28.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	68.2%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	986	290	335	1285	15	315	227	149	23	76	25
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5077		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5077		3433	3539	1583	1121	3539	1583
Peak-hour factor, PHF	0.96	0.96	0.96	0.98	0.98	0.98	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	83	1027	302	342	1311	15	335	241	159	24	81	27
RTOR Reduction (vph)	0	0	218	0	2	0	0	0	107	0	0	20
Lane Group Flow (vph)	83	1027	84	342	1324	0	335	241	52	24	81	7
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	3.2	16.6	16.6	6.0	19.4		6.2	19.8	19.8	16.8	15.2	15.2
Effective Green, g (s)	3.2	16.6	16.6	6.0	19.4		6.2	19.8	19.8	16.8	15.2	15.2
Actuated g/C Ratio	0.05	0.28	0.28	0.10	0.32		0.10	0.33	0.33	0.28	0.25	0.25
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	183	1407	438	343	1642		355	1168	522	331	897	401
v/s Ratio Prot	0.02	0.20		c0.10	c0.26		c0.10	c0.07		0.00	0.02	
v/s Ratio Perm			0.05						0.03	0.02		0.00
v/c Ratio	0.45	0.73	0.19	1.00	0.81		0.94	0.21	0.10	0.07	0.09	0.02
Uniform Delay, d1	27.6	19.7	16.6	27.0	18.6		26.7	14.5	13.9	15.8	17.1	16.8
Progression Factor	0.80	1.72	5.62	0.70	1.25		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	1.3	0.1	42.2	2.4		33.2	0.4	0.4	0.1	0.2	0.1
Delay (s)	23.3	35.1	93.3	61.1	25.6		60.0	14.9	14.3	15.9	17.3	16.9
Level of Service	C	D	F	E	C		E	B	B	B	B	B
Approach Delay (s)		46.8			32.9			35.3			17.0	
Approach LOS		D			C			D			B	

### Intersection Summary

HCM Average Control Delay	37.8	HCM Level of Service	D
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	54.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Operations Analysis Section 21

AM 2035 Intersections, No-Build

# HCM Unsignalized Intersection Capacity Analysis

## 29: Anamosa St. & West Blvd. W

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Volume (veh/h)	3	57	10	37	33	16	4	2	39	41	15	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	3	65	11	42	38	18	5	2	44	47	17	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	56			76			219	217	70	253	214	47
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	56			76			219	217	70	253	214	47
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			99	100	96	93	97	100
cM capacity (veh/h)	1549			1523			705	661	992	652	664	1023

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	80	98	51	66
Volume Left	3	42	5	47
Volume Right	11	18	44	2
cSH	1549	1523	937	663
Volume to Capacity	0.00	0.03	0.05	0.10
Queue Length 95th (ft)	0	2	4	8
Control Delay (s)	0.3	3.3	9.1	11.0
Lane LOS	A	A	A	B
Approach Delay (s)	0.3	3.3	9.1	11.0
Approach LOS			A	B

Intersection Summary			
Average Delay		5.2	
Intersection Capacity Utilization	27.9%		ICU Level of Service
Analysis Period (min)		15	A

# HCM Unsignalized Intersection Capacity Analysis

## 27: Anamosa St. & West Blvd E

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕	↗		↕	↗		↕			↕	
Volume (veh/h)	35	93	11	93	48	54	14	85	71	30	58	24
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	40	106	12	106	55	61	16	97	81	34	66	27
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)			2			16						
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	374	357	80	376	330	137	93			177		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	374	357	80	376	330	137	93			177		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	81	99	78	90	93	99			98		
cM capacity (veh/h)	490	549	981	477	569	912	1501			1399		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	158	222	193	127
Volume Left	40	106	16	34
Volume Right	12	61	81	27
cSH	579	703	1501	1399
Volume to Capacity	0.27	0.32	0.01	0.02
Queue Length 95th (ft)	28	34	1	2
Control Delay (s)	13.8	13.6	0.7	2.2
Lane LOS	B	B	A	A
Approach Delay (s)	13.8	13.6	0.7	2.2
Approach LOS	B	B		

























Intersection Summary			
Average Delay		8.0	
Intersection Capacity Utilization	34.7%		ICU Level of Service A
Analysis Period (min)		15	



# HCM Unsignalized Intersection Capacity Analysis





















## 24: North Street & West Blvd E

4/27/2010

															
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR			
Lane Configurations		 		 	 			 	 		 				
Sign Control		Stop			Stop			Stop			Stop				
Volume (vph)	11	223	0	0	144	46	83	160	176	53	0	137			
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88			
Hourly flow rate (vph)	12	253	0	0	164	52	94	182	200	60	0	156			
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1								
Volume Total (vph)	97	169	0	216	276	200	216								
Volume Left (vph)	13	0	0	0	94	0	60								
Volume Right (vph)	0	0	0	52	0	200	156								
Hadj (s)	0.10	0.03	0.00	-0.14	0.20	-0.67	-0.34								
Departure Headway (s)	7.1	7.0	7.1	6.9	6.7	5.9	6.6								
Degree Utilization, x	0.19	0.33	0.00	0.41	0.52	0.33	0.40								
Capacity (veh/h)	470	467	486	477	507	585	508								
Control Delay (s)	10.6	12.2	8.9	13.5	15.5	10.5	13.8								
Approach Delay (s)	11.6		13.5		13.4		13.8								
Approach LOS	B		B		B		B								
Intersection Summary															
Delay			13.1												
HCM Level of Service			B												
Intersection Capacity Utilization			48.7%					ICU Level of Service			A				
Analysis Period (min)			15												

HCM Unsignalized Intersection Capacity Analysis  
 21: North Street & Mt. Rushmore Rd.

4/27/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	25	301	132	139	322	13	95	28	70	14	98	69
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	28	342	150	158	366	15	108	32	80	16	111	78
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1					
Volume Total (vph)	199	321	341	198	140	80	206					
Volume Left (vph)	28	0	158	0	108	0	16					
Volume Right (vph)	0	150	0	15	0	80	78					
Hadj (s)	0.11	-0.29	0.27	-0.02	0.42	-0.67	-0.18					
Departure Headway (s)	7.2	6.8	7.3	7.0	8.4	7.2	7.5					
Degree Utilization, x	0.40	0.61	0.69	0.39	0.32	0.16	0.43					
Capacity (veh/h)	480	506	474	497	394	455	447					
Control Delay (s)	13.7	18.5	23.9	13.1	14.1	10.4	16.1					
Approach Delay (s)	16.7		20.0		12.8		16.1					
Approach LOS	C		C		B		C					
Intersection Summary												
Delay			17.2									
HCM Level of Service			C									
Intersection Capacity Utilization			56.8%		ICU Level of Service			B				
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	305	899	108	126	757	251	63	306	160	332	416	341
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.48	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	896	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	347	1022	123	143	860	285	72	348	182	377	473	388
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	347	1022	123	143	860	285	72	348	182	377	473	388
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	6.0	18.2	60.0	4.0	16.2	60.0	17.6	15.2	60.0	6.6	19.4	60.0
Effective Green, g (s)	6.0	18.2	60.0	4.0	16.2	60.0	17.6	15.2	60.0	6.6	19.4	60.0
Actuated g/C Ratio	0.10	0.30	1.00	0.07	0.27	1.00	0.29	0.25	1.00	0.11	0.32	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	343	1542	1583	229	1373	1583	298	897	1583	378	1144	1583
v/s Ratio Prot	c0.10	c0.20		0.04	0.17		0.01	0.10		c0.11	c0.13	
v/s Ratio Perm			0.08			0.18	0.06		0.11			c0.25
v/c Ratio	1.01	0.66	0.08	0.62	0.63	0.18	0.24	0.39	0.11	1.00	0.41	0.25
Uniform Delay, d1	27.0	18.2	0.0	27.3	19.2	0.0	15.6	18.5	0.0	26.7	15.9	0.0
Progression Factor	1.00	1.00	1.00	0.91	1.61	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	51.6	1.1	0.1	4.3	0.7	0.2	0.4	1.3	0.1	45.3	1.1	0.4
Delay (s)	78.6	19.3	0.1	29.0	31.7	0.2	16.0	19.8	0.1	72.0	17.0	0.4
Level of Service	E	B	A	C	C	A	B	B	A	E	B	A
Approach Delay (s)		31.5			24.4			13.4			28.5	
Approach LOS		C			C			B			C	

### Intersection Summary

HCM Average Control Delay	26.4	HCM Level of Service	C
HCM Volume to Capacity ratio	0.62		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	54.6%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	62	1035	294	219	866	24	232	107	71	91	242	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5065		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5065		3433	3539	1583	1257	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	70	1176	334	249	984	27	264	122	81	103	275	41
RTOR Reduction (vph)	0	0	236	0	5	0	0	0	59	0	0	31
Lane Group Flow (vph)	70	1176	98	249	1006	0	264	122	22	103	275	10
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	2.4	17.6	17.6	6.0	21.2		6.0	16.4	16.4	18.4	14.4	14.4
Effective Green, g (s)	2.4	17.6	17.6	6.0	21.2		6.0	16.4	16.4	18.4	14.4	14.4
Actuated g/C Ratio	0.04	0.29	0.29	0.10	0.35		0.10	0.27	0.27	0.31	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	137	1492	464	343	1790		343	967	433	420	849	380
v/s Ratio Prot	0.02	c0.23		c0.07	c0.20		c0.08	0.03		0.02	c0.08	
v/s Ratio Perm			0.06						0.01	0.06		0.01
v/c Ratio	0.51	0.79	0.21	0.73	0.56		0.77	0.13	0.05	0.25	0.32	0.03
Uniform Delay, d1	28.2	19.5	16.0	26.2	15.7		26.3	16.4	16.1	15.3	18.8	17.4
Progression Factor	0.79	1.53	5.48	0.78	1.35		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.3	2.1	0.2	5.9	0.3		10.0	0.3	0.2	0.3	1.0	0.1
Delay (s)	24.6	32.0	87.6	26.5	21.5		36.3	16.7	16.3	15.6	19.8	17.6
Level of Service	C	C	F	C	C		D	B	B	B	B	B
Approach Delay (s)		43.4			22.5			27.7			18.6	
Approach LOS		D			C			C			B	

### Intersection Summary

HCM Average Control Delay	31.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	52.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Operations Analysis Section 22

PM 2035 Intersections, No-Build

# HCM Unsignalized Intersection Capacity Analysis

## 29: Anamosa St. & West Blvd. (W)

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Volume (veh/h)	3	51	10	34	59	27	2	2	26	18	10	2
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	3	58	11	39	67	31	2	2	30	20	11	2
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	98			69			238	245	64	261	236	82
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	98			69			238	245	64	261	236	82
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			100	100	97	97	98	100
cM capacity (veh/h)	1495			1532			690	639	1001	656	647	977



















Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	73	136	34	34
Volume Left	3	39	2	20
Volume Right	11	31	30	2
cSH	1495	1532	937	667
Volume to Capacity	0.00	0.03	0.04	0.05
Queue Length 95th (ft)	0	2	3	4
Control Delay (s)	0.4	2.2	9.0	10.7
Lane LOS	A	A	A	B
Approach Delay (s)	0.4	2.2	9.0	10.7
Approach LOS			A	B

Intersection Summary			
Average Delay		3.6	
Intersection Capacity Utilization	27.8%		ICU Level of Service
Analysis Period (min)		15	A

# HCM Unsignalized Intersection Capacity Analysis

## 27: Anamosa St. & West Blvd. (E)

4/27/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	34	64	8	118	80	40	37	136	93	3	42	38
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	39	73	9	134	91	45	42	155	106	3	48	43
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)			2			16						
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	436	420	69	409	389	207	91			260		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	436	420	69	409	389	207	91			260		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	91	86	99	72	83	95	97			100		
cM capacity (veh/h)	426	508	994	477	529	833	1504			1304		
<b>Direction, Lane #</b>	<b>EB 1</b>	<b>WB 1</b>	<b>NB 1</b>	<b>SB 1</b>								
Volume Total	120	270	302	94								
Volume Left	39	134	42	3								
Volume Right	9	45	106	43								
cSH	519	599	1504	1304								
Volume to Capacity	0.23	0.45	0.03	0.00								
Queue Length 95th (ft)	22	58	2	0								
Control Delay (s)	14.3	16.6	1.3	0.3								
Lane LOS	B	C	A	A								
Approach Delay (s)	14.3	16.6	1.3	0.3								
Approach LOS	B	C										
<b>Intersection Summary</b>												
Average Delay			8.4									
Intersection Capacity Utilization			45.6%		ICU Level of Service				A			
Analysis Period (min)			15									

# HCM Unsignalized Intersection Capacity Analysis

## 24: North Street & West Blvd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↑		↔	↔			↔	↔		↔	
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	11	173	0	0	144	46	83	160	136	41	0	137
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	12	197	0	0	164	52	94	182	155	47	0	156

Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1
Volume Total (vph)	78	131	0	216	276	155	202
Volume Left (vph)	13	0	0	0	94	0	47
Volume Right (vph)	0	0	0	52	0	155	156
Hadj (s)	0.11	0.03	0.00	-0.14	0.20	-0.67	-0.38
Departure Headway (s)	6.8	6.8	6.7	6.5	6.4	5.5	6.2
Degree Utilization, x	0.15	0.25	0.00	0.39	0.49	0.24	0.35
Capacity (veh/h)	482	490	511	512	529	612	539
Control Delay (s)	9.8	10.8	8.5	12.5	14.3	9.1	12.5
Approach Delay (s)	10.4		12.5		12.4		12.5
Approach LOS	B		B		B		B


















### Intersection Summary

Delay	12.1
HCM Level of Service	B
Intersection Capacity Utilization	46.8%
ICU Level of Service	A
Analysis Period (min)	15



HCM Unsignalized Intersection Capacity Analysis  
 21: North Street & Mt. Rushmore Rd.

4/27/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Volume (vph)	18	177	155	103	127	16	50	78	120	6	75	21
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	20	201	176	117	144	18	57	89	136	7	85	24
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	NB 1	NB 2	SB 1					
Volume Total (vph)	121	277	189	90	145	136	116					
Volume Left (vph)	20	0	117	0	57	0	7					
Volume Right (vph)	0	176	0	18	0	136	24					
Hadj (s)	0.12	-0.41	0.34	-0.11	0.23	-0.67	-0.08					
Departure Headway (s)	6.3	5.8	6.6	6.2	6.8	5.9	6.7					
Degree Utilization, x	0.21	0.44	0.35	0.16	0.27	0.22	0.21					
Capacity (veh/h)	541	598	513	547	500	570	495					
Control Delay (s)	9.8	12.0	12.0	9.1	11.1	9.3	11.5					
Approach Delay (s)	11.3		11.0		10.2		11.5					
Approach LOS	B		B		B		B					
Intersection Summary												
Delay			11.0									
HCM Level of Service			B									
Intersection Capacity Utilization			40.9%					ICU Level of Service			A	
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	406	1186	102	202	1235	266	74	595	153	291	476	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.38	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	703	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	461	1348	116	230	1403	302	84	676	174	331	541	365
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	461	1348	116	230	1403	302	84	676	174	331	541	365
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	11.0	26.0	75.0	7.0	22.0	75.0	22.8	18.0	75.0	8.0	21.2	75.0
Effective Green, g (s)	11.0	26.0	75.0	7.0	22.0	75.0	22.8	18.0	75.0	8.0	21.2	75.0
Actuated g/C Ratio	0.15	0.35	1.00	0.09	0.29	1.00	0.30	0.24	1.00	0.11	0.28	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	504	1763	1583	320	1492	1583	282	849	1583	366	1000	1583
v/s Ratio Prot	c0.13	c0.27		0.07	c0.28		0.02	c0.19		c0.10	0.15	
v/s Ratio Perm			0.07			0.19	0.07		0.11			c0.23
v/c Ratio	0.91	0.76	0.07	0.72	0.94	0.19	0.30	0.80	0.11	0.90	0.54	0.23
Uniform Delay, d1	31.5	21.8	0.0	33.0	25.9	0.0	19.1	26.8	0.0	33.1	22.8	0.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	21.1	2.0	0.1	7.5	11.9	0.3	0.6	7.6	0.1	24.8	2.1	0.3
Delay (s)	52.7	23.8	0.1	40.6	37.8	0.3	19.7	34.4	0.1	57.9	24.9	0.3
Level of Service	D	C	A	D	D	A	B	C	A	E	C	A
Approach Delay (s)		29.3			32.2			26.7			26.5	
Approach LOS		C			C			C			C	

### Intersection Summary

HCM Average Control Delay	29.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	73.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

4/27/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	72	1203	355	332	1299	14	347	214	164	53	173	57
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5077		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5077		3433	3539	1583	1119	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	82	1367	403	377	1476	16	394	243	186	60	197	65
RTOR Reduction (vph)	0	0	283	0	1	0	0	0	125	0	0	50
Lane Group Flow (vph)	82	1367	120	377	1491	0	394	243	61	60	197	15
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	3.2	20.8	20.8	8.0	25.6		9.0	22.8	22.8	18.6	16.2	16.2
Effective Green, g (s)	3.2	20.8	20.8	8.0	25.6		9.0	22.8	22.8	18.6	16.2	16.2
Actuated g/C Ratio	0.05	0.30	0.30	0.11	0.37		0.13	0.33	0.33	0.27	0.23	0.23
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	157	1511	470	392	1857		441	1153	516	320	819	366
v/s Ratio Prot	0.02	c0.27		c0.11	0.29		c0.11	c0.07		0.01	0.06	
v/s Ratio Perm			0.08						0.04	0.04		0.01
v/c Ratio	0.52	0.90	0.25	0.96	0.80		0.89	0.21	0.12	0.19	0.24	0.04
Uniform Delay, d1	32.7	23.6	18.7	30.8	19.9		30.0	17.1	16.5	19.5	21.9	20.9
Progression Factor	1.00	1.00	1.00	0.73	1.45		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.1	8.0	0.3	25.8	1.6		19.9	0.4	0.5	0.3	0.7	0.2
Delay (s)	35.8	31.7	19.0	48.3	30.5		49.9	17.5	17.0	19.8	22.6	21.1
Level of Service	D	C	B	D	C		D	B	B	B	C	C
Approach Delay (s)		29.1			34.1			32.9			21.8	
Approach LOS		C			C			C			C	

### Intersection Summary

HCM Average Control Delay	31.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.66		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	60.7%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



















Operations Analysis Section 23

AM 2035 Intersections, Build

Alternative 1

HCM Signalized Intersection Capacity Analysis  
 35: I-190 SB on ramp & Silver St.

6/29/2010

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (vph)	0	0	0	217	0	3	0	44	23	417	51	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Lane Util. Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Frt				1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected				0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)				1770		1583		1863	1583	1770	1863	
Flt Permitted				0.95		1.00		1.00	1.00	0.13	1.00	
Satd. Flow (perm)				1770		1583		1863	1583	237	1863	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	236	0	3	0	48	25	453	55	0
RTOR Reduction (vph)	0	0	0	0	0	2	0	0	23	0	0	0
Lane Group Flow (vph)	0	0	0	236	0	1	0	48	2	453	55	0
Turn Type				Prot		custom			Perm	pm+pt		
Protected Phases				6!				4		5	2!	
Permitted Phases						6			4		2	
Actuated Green, G (s)				27.5		27.5		4.8	4.8	47.2	47.2	
Effective Green, g (s)				27.5		27.5		4.8	4.8	47.2	47.2	
Actuated g/C Ratio				0.46		0.46		0.08	0.08	0.79	0.79	
Clearance Time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Vehicle Extension (s)				3.0		3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)				811		726		149	127	588	1466	
v/s Ratio Prot				0.13				c0.03		c0.20	0.03	
v/s Ratio Perm						0.00			0.00	c0.41		
v/c Ratio				0.29		0.00		0.32	0.02	0.77	0.04	
Uniform Delay, d1				10.2		8.8		26.1	25.4	15.1	1.4	
Progression Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2				0.9		0.0		1.3	0.0	6.2	0.0	
Delay (s)				11.1		8.8		27.3	25.5	21.3	1.5	
Level of Service				B		A		C	C	C	A	
Approach Delay (s)		0.0			11.0			26.7			19.1	
Approach LOS		A			B			C			B	

Intersection Summary

HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

5/19/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↘	↑↑			↑↑			↑	↘			
Volume (vph)	23	238	0	0	454	64	14	0	475	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0	4.0			
Lane Util. Factor	1.00	0.95			0.95			1.00	1.00			
Frt	1.00	1.00			0.98			1.00	0.85			
Flt Protected	0.95	1.00			1.00			0.95	1.00			
Satd. Flow (prot)	1770	3539			3473			1770	1583			
Flt Permitted	0.24	1.00			1.00			0.95	1.00			
Satd. Flow (perm)	456	3539			3473			1770	1583			
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	26	270	0	0	516	73	16	0	540	0	0	0
RTOR Reduction (vph)	0	0	0	0	24	0	0	0	280	0	0	0
Lane Group Flow (vph)	26	270	0	0	565	0	0	16	260	0	0	0
Turn Type	pm+pt						Perm		Perm			
Protected Phases	7	4			8			2				
Permitted Phases	4						2		2			
Actuated Green, G (s)	18.4	18.4			13.6			23.6	23.6			
Effective Green, g (s)	18.4	18.4			13.6			23.6	23.6			
Actuated g/C Ratio	0.37	0.37			0.27			0.47	0.47			
Clearance Time (s)	4.0	4.0			4.0			4.0	4.0			
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0			
Lane Grp Cap (vph)	189	1302			945			835	747			
v/s Ratio Prot	0.00	c0.08			c0.16							
v/s Ratio Perm	0.05							0.01	c0.16			
v/c Ratio	0.14	0.21			0.60			0.02	0.35			
Uniform Delay, d1	10.7	10.8			15.8			7.0	8.3			
Progression Factor	1.00	1.00			1.00			1.00	1.00			
Incremental Delay, d2	0.3	0.1			1.0			0.0	1.3			
Delay (s)	11.1	10.9			16.8			7.1	9.6			
Level of Service	B	B			B			A	A			
Approach Delay (s)		10.9			16.8			9.5			0.0	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmroe Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↖	↗		↖	↗	
Volume (vph)	25	301	132	139	322	13	115	181	70	14	162	142
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.96			1.00		1.00	0.96		1.00	0.93	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3377			3474		1770	1785		1770	1732	
Flt Permitted		0.91			0.69		0.52	1.00		0.58	1.00	
Satd. Flow (perm)		3090			2438		967	1785		1083	1732	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	28	342	150	158	366	15	131	206	80	16	184	161
RTOR Reduction (vph)	0	99	0	0	5	0	0	31	0	0	71	0
Lane Group Flow (vph)	0	421	0	0	534	0	131	255	0	16	274	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Effective Green, g (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Actuated g/C Ratio		0.34			0.34		0.46	0.46		0.46	0.46	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1058			835		442	817		495	792	
v/s Ratio Prot								0.14			c0.16	
v/s Ratio Perm		0.14			c0.22		0.14			0.01		
v/c Ratio		0.40			0.64		0.30	0.31		0.03	0.35	
Uniform Delay, d1		10.0			11.1		6.8	6.9		6.0	7.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2			1.6		1.7	1.0		0.1	1.2	
Delay (s)		10.3			12.7		8.5	7.9		6.1	8.2	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		10.3			12.7			8.1			8.1	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	10.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	265	1092	108	126	757	251	63	291	175	332	416	341
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.48	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	896	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Effective Green, g (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Actuated g/C Ratio	0.08	0.30	1.00	0.05	0.27	1.00	0.31	0.27	1.00	0.11	0.34	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	286	1526	1583	183	1373	1583	313	956	1583	378	1203	1583
v/s Ratio Prot	c0.09	c0.24		0.04	0.17		0.01	0.09		c0.11	c0.13	
v/s Ratio Perm			0.08			0.18	0.06		0.13			c0.25
v/c Ratio	1.05	0.81	0.08	0.78	0.63	0.18	0.23	0.35	0.13	1.00	0.39	0.25
Uniform Delay, d1	27.5	19.4	0.0	28.1	19.2	0.0	14.9	17.6	0.0	26.7	15.1	0.0
Progression Factor	1.00	1.00	1.00	0.82	1.76	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	67.7	3.4	0.1	13.4	0.6	0.2	0.4	1.0	0.2	45.3	1.0	0.4
Delay (s)	95.2	22.9	0.1	36.5	34.5	0.2	15.3	18.6	0.2	72.0	16.1	0.4
Level of Service	F	C	A	D	C	A	B	B	A	E	B	A
Approach Delay (s)		34.3			27.1			12.1			28.2	
Approach LOS		C			C			B			C	

### Intersection Summary

HCM Average Control Delay	28.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	270	1035	294	219	866	24	232	107	71	91	202	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5065		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5065		3433	3539	1583	1257	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	307	1176	334	249	984	27	264	122	81	103	230	41
RTOR Reduction (vph)	0	0	245	0	4	0	0	0	56	0	0	30
Lane Group Flow (vph)	307	1176	89	249	1007	0	264	122	25	103	230	11
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Effective Green, g (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Actuated g/C Ratio	0.10	0.27	0.27	0.10	0.27		0.10	0.31	0.31	0.32	0.27	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	343	1356	422	343	1351		343	1109	496	430	944	422
v/s Ratio Prot	c0.09	c0.23		0.07	0.20		c0.08	c0.03		0.01	c0.06	
v/s Ratio Perm			0.06						0.02	0.06		0.01
v/c Ratio	0.90	0.87	0.21	0.73	0.75		0.77	0.11	0.05	0.24	0.24	0.03
Uniform Delay, d1	26.7	21.0	17.1	26.2	20.1		26.3	14.7	14.4	14.7	17.3	16.2
Progression Factor	0.88	1.58	5.48	0.78	1.32		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.5	3.8	0.2	5.9	1.8		10.0	0.2	0.2	0.3	0.6	0.1
Delay (s)	40.1	37.0	93.9	26.5	28.4		36.3	14.9	14.6	15.0	17.9	16.4
Level of Service	D	D	F	C	C		D	B	B	B	B	B
Approach Delay (s)		48.0			28.0			26.9			16.9	
Approach LOS		D			C			C			B	

### Intersection Summary

HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Operations Analysis Section 24



















AM 2035 Intersections, Build

Alternative 1a

# HCM Signalized Intersection Capacity Analysis

## 35: I-190 SB ramp & Silver St.

6/29/2010

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (vph)	0	0	0	217	0	3	0	44	23	417	51	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Lane Util. Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Fr <sub>t</sub>				1.00		0.85		1.00	0.85	1.00	1.00	
Fl <sub>t</sub> Protected				0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)				1770		1583		1863	1583	1770	1863	
Fl <sub>t</sub> Permitted				0.95		1.00		1.00	1.00	0.13	1.00	
Satd. Flow (perm)				1770		1583		1863	1583	237	1863	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	236	0	3	0	48	25	453	55	0
RTOR Reduction (vph)	0	0	0	0	0	2	0	0	23	0	0	0
Lane Group Flow (vph)	0	0	0	236	0	1	0	48	2	453	55	0
Turn Type				Prot		custom			Perm	pm+pt		
Protected Phases				6!				4		5	2!	
Permitted Phases						6			4		2	
Actuated Green, G (s)				27.5		27.5		4.8	4.8	47.2	47.2	
Effective Green, g (s)				27.5		27.5		4.8	4.8	47.2	47.2	
Actuated g/C Ratio				0.46		0.46		0.08	0.08	0.79	0.79	
Clearance Time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Vehicle Extension (s)				3.0		3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)				811		726		149	127	588	1466	
v/s Ratio Prot				0.13				c0.03		c0.20	0.03	
v/s Ratio Perm						0.00			0.00	c0.41		
v/c Ratio				0.29		0.00		0.32	0.02	0.77	0.04	
Uniform Delay, d <sub>1</sub>				10.2		8.8		26.1	25.4	15.1	1.4	
Progression Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d <sub>2</sub>				0.9		0.0		1.3	0.0	6.2	0.0	
Delay (s)				11.1		8.8		27.3	25.5	21.3	1.5	
Level of Service				B		A		C	C	C	A	
Approach Delay (s)		0.0			11.0			26.7			19.1	
Approach LOS		A			B			C			B	

### Intersection Summary

HCM Average Control Delay	17.4	HCM Level of Service	B
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

5/19/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↘	↑↑			↑↑			↑	↘			
Volume (vph)	23	238	0	0	454	64	14	0	475	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0	4.0			
Lane Util. Factor	1.00	0.95			0.95			1.00	1.00			
Frt	1.00	1.00			0.98			1.00	0.85			
Flt Protected	0.95	1.00			1.00			0.95	1.00			
Satd. Flow (prot)	1770	3539			3473			1770	1583			
Flt Permitted	0.24	1.00			1.00			0.95	1.00			
Satd. Flow (perm)	456	3539			3473			1770	1583			
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	26	270	0	0	516	73	16	0	540	0	0	0
RTOR Reduction (vph)	0	0	0	0	24	0	0	0	280	0	0	0
Lane Group Flow (vph)	26	270	0	0	565	0	0	16	260	0	0	0
Turn Type	pm+pt						Perm		Perm			
Protected Phases	7	4			8			2				
Permitted Phases	4						2		2			
Actuated Green, G (s)	18.4	18.4			13.6			23.6	23.6			
Effective Green, g (s)	18.4	18.4			13.6			23.6	23.6			
Actuated g/C Ratio	0.37	0.37			0.27			0.47	0.47			
Clearance Time (s)	4.0	4.0			4.0			4.0	4.0			
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0			
Lane Grp Cap (vph)	189	1302			945			835	747			
v/s Ratio Prot	0.00	c0.08			c0.16							
v/s Ratio Perm	0.05							0.01	c0.16			
v/c Ratio	0.14	0.21			0.60			0.02	0.35			
Uniform Delay, d1	10.7	10.8			15.8			7.0	8.3			
Progression Factor	1.00	1.00			1.00			1.00	1.00			
Incremental Delay, d2	0.3	0.1			1.0			0.0	1.3			
Delay (s)	11.1	10.9			16.8			7.1	9.6			
Level of Service	B	B			B			A	A			
Approach Delay (s)		10.9			16.8			9.5			0.0	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	48.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔		↔	↔	
Volume (vph)	25	301	132	139	322	13	115	181	70	14	162	142
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.96			1.00		1.00	0.96		1.00	0.93	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3377			3474		1770	1785		1770	1732	
Flt Permitted		0.91			0.69		0.52	1.00		0.58	1.00	
Satd. Flow (perm)		3090			2438		967	1785		1083	1732	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	28	342	150	158	366	15	131	206	80	16	184	161
RTOR Reduction (vph)	0	99	0	0	5	0	0	31	0	0	71	0
Lane Group Flow (vph)	0	421	0	0	534	0	131	255	0	16	274	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Effective Green, g (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Actuated g/C Ratio		0.34			0.34		0.46	0.46		0.46	0.46	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1058			835		442	817		495	792	
v/s Ratio Prot								0.14			c0.16	
v/s Ratio Perm		0.14			c0.22		0.14			0.01		
v/c Ratio		0.40			0.64		0.30	0.31		0.03	0.35	
Uniform Delay, d1		10.0			11.1		6.8	6.9		6.0	7.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2			1.6		1.7	1.0		0.1	1.2	
Delay (s)		10.3			12.7		8.5	7.9		6.1	8.2	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		10.3			12.7			8.1			8.1	
Approach LOS		B			B			A			A	


































### Intersection Summary

HCM Average Control Delay	10.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	 	  		 	  			 		 	 	
Volume (vph)	265	1092	108	126	757	251	63	291	175	332	416	341
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.48	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	896	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Effective Green, g (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Actuated g/C Ratio	0.08	0.30	1.00	0.05	0.27	1.00	0.31	0.27	1.00	0.11	0.34	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	286	1526	1583	183	1373	1583	313	956	1583	378	1203	1583
v/s Ratio Prot	c0.09	c0.24		0.04	0.17		0.01	0.09		c0.11	c0.13	
v/s Ratio Perm			0.08			0.18	0.06		0.13			c0.25
v/c Ratio	1.05	0.81	0.08	0.78	0.63	0.18	0.23	0.35	0.13	1.00	0.39	0.25
Uniform Delay, d1	27.5	19.4	0.0	28.1	19.2	0.0	14.9	17.6	0.0	26.7	15.1	0.0
Progression Factor	1.00	1.00	1.00	0.82	1.76	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	67.7	3.4	0.1	13.4	0.6	0.2	0.4	1.0	0.2	45.3	1.0	0.4
Delay (s)	95.2	22.9	0.1	36.5	34.5	0.2	15.3	18.6	0.2	72.0	16.1	0.4
Level of Service	F	C	A	D	C	A	B	B	A	E	B	A
Approach Delay (s)		34.3			27.1			12.1			28.2	
Approach LOS		C			C			B			C	
<b>Intersection Summary</b>												
HCM Average Control Delay			28.0			HCM Level of Service				C		
HCM Volume to Capacity ratio			0.65									
Actuated Cycle Length (s)			60.0			Sum of lost time (s)			8.0			
Intersection Capacity Utilization			55.5%			ICU Level of Service				B		
Analysis Period (min)			15									
c	Critical Lane Group											

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	270	1035	294	219	866	24	232	107	71	91	202	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5065		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5065		3433	3539	1583	1257	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	307	1176	334	249	984	27	264	122	81	103	230	41
RTOR Reduction (vph)	0	0	245	0	4	0	0	0	56	0	0	30
Lane Group Flow (vph)	307	1176	89	249	1007	0	264	122	25	103	230	11
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Effective Green, g (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Actuated g/C Ratio	0.10	0.27	0.27	0.10	0.27		0.10	0.31	0.31	0.32	0.27	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	343	1356	422	343	1351		343	1109	496	430	944	422
v/s Ratio Prot	c0.09	c0.23		0.07	0.20		c0.08	c0.03		0.01	c0.06	
v/s Ratio Perm			0.06						0.02	0.06		0.01
v/c Ratio	0.90	0.87	0.21	0.73	0.75		0.77	0.11	0.05	0.24	0.24	0.03
Uniform Delay, d1	26.7	21.0	17.1	26.2	20.1		26.3	14.7	14.4	14.7	17.3	16.2
Progression Factor	0.88	1.58	5.48	0.78	1.32		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.5	3.8	0.2	5.9	1.8		10.0	0.2	0.2	0.3	0.6	0.1
Delay (s)	40.1	37.0	93.9	26.5	28.4		36.3	14.9	14.6	15.0	17.9	16.4
Level of Service	D	D	F	C	C		D	B	B	B	B	B
Approach Delay (s)		48.0			28.0			26.9			16.9	
Approach LOS		D			C			C			B	

### Intersection Summary

HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Operations Analysis Section 25

AM 2035 Intersections, Build

Alternative 2a



# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	23	44	23	417	51	64	14	0	475	217	0	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0		4.0	4.0		4.0
Lane Util. Factor	1.00	0.95		0.97	0.95		1.00		1.00	1.00		1.00
Frt	1.00	0.95		1.00	0.92		1.00		0.85	1.00		0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (prot)	1770	3358		3433	3243		1770		1583	1770		1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (perm)	1770	3358		3433	3243		1770		1583	1770		1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	26	50	26	474	58	73	16	0	540	247	0	3
RTOR Reduction (vph)	0	24	0	0	52	0	0	0	0	0	0	2
Lane Group Flow (vph)	26	52	0	474	79	0	16	0	540	247	0	1
Turn Type	Prot			Prot			Prot		Free	Prot		custom
Protected Phases	7	4		3	8		5			1		
Permitted Phases									Free			6
Actuated Green, G (s)	3.0	5.0		15.1	17.1		1.5		60.0	27.9		22.4
Effective Green, g (s)	3.0	5.0		15.1	17.1		1.5		60.0	27.9		22.4
Actuated g/C Ratio	0.05	0.08		0.25	0.29		0.02		1.00	0.46		0.37
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0			4.0		4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0		3.0
Lane Grp Cap (vph)	89	280		864	924		44		1583	823		591
v/s Ratio Prot	0.01	0.02		c0.14	0.02		0.01			0.14		
v/s Ratio Perm									c0.34			0.00
v/c Ratio	0.29	0.19		0.55	0.09		0.36		0.34	0.30		0.00
Uniform Delay, d1	27.5	25.6		19.5	15.7		28.8		0.0	10.0		11.8
Progression Factor	1.00	1.00		1.00	1.00		1.00		1.00	1.00		1.00
Incremental Delay, d2	1.8	0.3		0.7	0.0		5.1		0.6	0.2		0.0
Delay (s)	29.3	25.9		20.2	15.8		33.8		0.6	10.2		11.8
Level of Service	C	C		C	B		C		A	B		B
Approach Delay (s)		26.8			19.2			1.5			10.2	
Approach LOS		C			B			A			B	

### Intersection Summary

HCM Average Control Delay	11.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.40		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	37.3%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔		↔	↔	
Volume (vph)	25	301	132	139	322	13	115	181	70	14	162	142
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.96			1.00		1.00	0.96		1.00	0.93	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3377			3474		1770	1785		1770	1732	
Flt Permitted		0.91			0.69		0.52	1.00		0.58	1.00	
Satd. Flow (perm)		3090			2438		967	1785		1083	1732	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	28	342	150	158	366	15	131	206	80	16	184	161
RTOR Reduction (vph)	0	99	0	0	5	0	0	31	0	0	71	0
Lane Group Flow (vph)	0	421	0	0	534	0	131	255	0	16	274	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Effective Green, g (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Actuated g/C Ratio		0.34			0.34		0.46	0.46		0.46	0.46	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1058			835		442	817		495	792	
v/s Ratio Prot								0.14			c0.16	
v/s Ratio Perm		0.14			c0.22		0.14			0.01		
v/c Ratio		0.40			0.64		0.30	0.31		0.03	0.35	
Uniform Delay, d1		10.0			11.1		6.8	6.9		6.0	7.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2			1.6		1.7	1.0		0.1	1.2	
Delay (s)		10.3			12.7		8.5	7.9		6.1	8.2	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		10.3			12.7			8.1			8.1	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	10.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	265	1092	108	126	757	251	63	291	175	332	416	341
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.48	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	896	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Effective Green, g (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Actuated g/C Ratio	0.08	0.30	1.00	0.05	0.27	1.00	0.31	0.27	1.00	0.11	0.34	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	286	1526	1583	183	1373	1583	313	956	1583	378	1203	1583
v/s Ratio Prot	c0.09	c0.24		0.04	0.17		0.01	0.09		c0.11	c0.13	
v/s Ratio Perm			0.08			0.18	0.06		0.13			c0.25
v/c Ratio	1.05	0.81	0.08	0.78	0.63	0.18	0.23	0.35	0.13	1.00	0.39	0.25
Uniform Delay, d1	27.5	19.4	0.0	28.1	19.2	0.0	14.9	17.6	0.0	26.7	15.1	0.0
Progression Factor	1.00	1.00	1.00	0.82	1.76	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	67.7	3.4	0.1	13.4	0.6	0.2	0.4	1.0	0.2	45.3	1.0	0.4
Delay (s)	95.2	22.9	0.1	36.5	34.5	0.2	15.3	18.6	0.2	72.0	16.1	0.4
Level of Service	F	C	A	D	C	A	B	B	A	E	B	A
Approach Delay (s)		34.3			27.1			12.1			28.2	
Approach LOS		C			C			B			C	

### Intersection Summary

HCM Average Control Delay	28.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	270	1035	294	219	866	24	232	107	71	91	202	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5065		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5065		3433	3539	1583	1257	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	307	1176	334	249	984	27	264	122	81	103	230	41
RTOR Reduction (vph)	0	0	245	0	4	0	0	0	56	0	0	30
Lane Group Flow (vph)	307	1176	89	249	1007	0	264	122	25	103	230	11
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Effective Green, g (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Actuated g/C Ratio	0.10	0.27	0.27	0.10	0.27		0.10	0.31	0.31	0.32	0.27	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	343	1356	422	343	1351		343	1109	496	430	944	422
v/s Ratio Prot	c0.09	c0.23		0.07	0.20		c0.08	c0.03		0.01	c0.06	
v/s Ratio Perm			0.06						0.02	0.06		0.01
v/c Ratio	0.90	0.87	0.21	0.73	0.75		0.77	0.11	0.05	0.24	0.24	0.03
Uniform Delay, d1	26.7	21.0	17.1	26.2	20.1		26.3	14.7	14.4	14.7	17.3	16.2
Progression Factor	0.88	1.58	5.48	0.78	1.32		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.5	3.8	0.2	5.9	1.8		10.0	0.2	0.2	0.3	0.6	0.1
Delay (s)	40.1	37.0	93.9	26.5	28.4		36.3	14.9	14.6	15.0	17.9	16.4
Level of Service	D	D	F	C	C		D	B	B	B	B	B
Approach Delay (s)		48.0			28.0			26.9			16.9	
Approach LOS		D			C			C			B	

### Intersection Summary

HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			


















Operations Analysis Section 26

AM 2035 Intersections, Build

Alternative 3a

HCM Unsignalized Intersection Capacity Analysis  
 35: I-190 SB on ramp & Silver St.

6/29/2010

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (veh/h)	0	0	0	217	0	3	0	44	23	0	51	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	236	0	3	0	48	25	0	55	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)						6						
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)											537	
pX, platoon unblocked												
vC, conflicting volume	105	103	48	103	128	55	55			73		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	105	103	48	103	128	55	55			73		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	73	100	100	100			100		
cM capacity (veh/h)	872	787	1021	877	762	1011	1549			1527		
<b>Direction, Lane #</b>	<b>SB 1</b>	<b>SE 1</b>	<b>SE 2</b>	<b>NW 1</b>								
Volume Total	239	48	25	55								
Volume Left	236	0	0	0								
Volume Right	3	0	25	0								
cSH	889	1700	1700	1700								
Volume to Capacity	0.27	0.03	0.01	0.03								
Queue Length 95th (ft)	27	0	0	0								
Control Delay (s)	10.6	0.0	0.0	0.0								
Lane LOS	B											
Approach Delay (s)	10.6	0.0		0.0								
Approach LOS	B											
<b>Intersection Summary</b>												
Average Delay			6.9									
Intersection Capacity Utilization			39.6%		ICU Level of Service				A			
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

5/19/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	23	238	0	0	454	64	14	0	475	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0		4.0		4.0			
Lane Util. Factor	1.00	0.95			0.95		1.00		1.00			
Frt	1.00	1.00			0.98		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1770	3539			3473		1770		1583			
Flt Permitted	0.24	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	456	3539			3473		1770		1583			
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	26	270	0	0	516	73	16	0	540	0	0	0
RTOR Reduction (vph)	0	0	0	0	24	0	0	0	280	0	0	0
Lane Group Flow (vph)	26	270	0	0	565	0	16	0	260	0	0	0
Turn Type	pm+pt						custom		custom			
Protected Phases	7	4			8							
Permitted Phases	4						2		2			
Actuated Green, G (s)	18.4	18.4			13.6		23.6		23.6			
Effective Green, g (s)	18.4	18.4			13.6		23.6		23.6			
Actuated g/C Ratio	0.37	0.37			0.27		0.47		0.47			
Clearance Time (s)	4.0	4.0			4.0		4.0		4.0			
Vehicle Extension (s)	3.0	3.0			3.0		3.0		3.0			
Lane Grp Cap (vph)	189	1302			945		835		747			
v/s Ratio Prot	0.00	c0.08			c0.16							
v/s Ratio Perm	0.05						0.01		c0.16			
v/c Ratio	0.14	0.21			0.60		0.02		0.35			
Uniform Delay, d1	10.7	10.8			15.8		7.0		8.3			
Progression Factor	1.00	1.00			1.00		1.00		1.00			
Incremental Delay, d2	0.3	0.1			1.0		0.0		1.3			
Delay (s)	11.1	10.9			16.8		7.1		9.6			
Level of Service	B	B			B		A		A			
Approach Delay (s)		10.9			16.8			9.5			0.0	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	12.8	HCM Level of Service	B
HCM Volume to Capacity ratio	0.44		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	42.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔		↔	↔	
Volume (vph)	25	301	132	139	322	13	115	181	70	14	162	142
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.96			1.00		1.00	0.96		1.00	0.93	
Flt Protected		1.00			0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3377			3474		1770	1785		1770	1732	
Flt Permitted		0.91			0.69		0.52	1.00		0.58	1.00	
Satd. Flow (perm)		3090			2438		967	1785		1083	1732	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	28	342	150	158	366	15	131	206	80	16	184	161
RTOR Reduction (vph)	0	99	0	0	5	0	0	31	0	0	71	0
Lane Group Flow (vph)	0	421	0	0	534	0	131	255	0	16	274	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Effective Green, g (s)		13.7			13.7		18.3	18.3		18.3	18.3	
Actuated g/C Ratio		0.34			0.34		0.46	0.46		0.46	0.46	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		1058			835		442	817		495	792	
v/s Ratio Prot								0.14			c0.16	
v/s Ratio Perm		0.14			c0.22		0.14			0.01		
v/c Ratio		0.40			0.64		0.30	0.31		0.03	0.35	
Uniform Delay, d1		10.0			11.1		6.8	6.9		6.0	7.0	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.2			1.6		1.7	1.0		0.1	1.2	
Delay (s)		10.3			12.7		8.5	7.9		6.1	8.2	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		10.3			12.7			8.1			8.1	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	10.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			



# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	265	1092	108	126	757	251	63	291	175	332	416	341
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.48	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	896	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	301	1241	123	143	860	285	72	331	199	377	473	388
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Effective Green, g (s)	5.0	18.0	60.0	3.2	16.2	60.0	18.6	16.2	60.0	6.6	20.4	60.0
Actuated g/C Ratio	0.08	0.30	1.00	0.05	0.27	1.00	0.31	0.27	1.00	0.11	0.34	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	286	1526	1583	183	1373	1583	313	956	1583	378	1203	1583
v/s Ratio Prot	c0.09	c0.24		0.04	0.17		0.01	0.09		c0.11	c0.13	
v/s Ratio Perm			0.08			0.18	0.06		0.13			c0.25
v/c Ratio	1.05	0.81	0.08	0.78	0.63	0.18	0.23	0.35	0.13	1.00	0.39	0.25
Uniform Delay, d1	27.5	19.4	0.0	28.1	19.2	0.0	14.9	17.6	0.0	26.7	15.1	0.0
Progression Factor	1.00	1.00	1.00	0.82	1.76	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	67.7	3.4	0.1	13.4	0.6	0.2	0.4	1.0	0.2	45.3	1.0	0.4
Delay (s)	95.2	22.9	0.1	36.5	34.5	0.2	15.3	18.6	0.2	72.0	16.1	0.4
Level of Service	F	C	A	D	C	A	B	B	A	E	B	A
Approach Delay (s)		34.3			27.1			12.1			28.2	
Approach LOS		C			C			B			C	

### Intersection Summary

HCM Average Control Delay	28.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	55.5%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖↗	↑↑↑	↖	↖↗	↑↑↑		↖↗	↑↑	↖	↖	↑↑	↖
Volume (vph)	270	1035	294	219	866	24	232	107	71	91	202	36
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5065		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.67	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5065		3433	3539	1583	1257	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	307	1176	334	249	984	27	264	122	81	103	230	41
RTOR Reduction (vph)	0	0	245	0	4	0	0	0	56	0	0	30
Lane Group Flow (vph)	307	1176	89	249	1007	0	264	122	25	103	230	11
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Effective Green, g (s)	6.0	16.0	16.0	6.0	16.0		6.0	18.8	18.8	19.2	16.0	16.0
Actuated g/C Ratio	0.10	0.27	0.27	0.10	0.27		0.10	0.31	0.31	0.32	0.27	0.27
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	343	1356	422	343	1351		343	1109	496	430	944	422
v/s Ratio Prot	c0.09	c0.23		0.07	0.20		c0.08	c0.03		0.01	c0.06	
v/s Ratio Perm			0.06						0.02	0.06		0.01
v/c Ratio	0.90	0.87	0.21	0.73	0.75		0.77	0.11	0.05	0.24	0.24	0.03
Uniform Delay, d1	26.7	21.0	17.1	26.2	20.1		26.3	14.7	14.4	14.7	17.3	16.2
Progression Factor	0.88	1.58	5.48	0.78	1.32		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	16.5	3.8	0.2	5.9	1.8		10.0	0.2	0.2	0.3	0.6	0.1
Delay (s)	40.1	37.0	93.9	26.5	28.4		36.3	14.9	14.6	15.0	17.9	16.4
Level of Service	D	D	F	C	C		D	B	B	B	B	B
Approach Delay (s)		48.0			28.0			26.9			16.9	
Approach LOS		D			C			C			B	

### Intersection Summary

HCM Average Control Delay	36.1	HCM Level of Service	D
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	51.8%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



















Operations Analysis Section 27

PM 2035 Intersections, Build

Alternative 1

HCM Signalized Intersection Capacity Analysis  
 35: I-190 SB on ramp & Silver St.

6/29/2010

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (vph)	0	0	0	67	0	3	0	66	30	320	33	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Lane Util. Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Fr <sub>t</sub>				1.00		0.85		1.00	0.85	1.00	1.00	
Fl <sub>t</sub> Protected				0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)				1770		1583		1863	1583	1770	1863	
Fl <sub>t</sub> Permitted				0.95		1.00		1.00	1.00	0.13	1.00	
Satd. Flow (perm)				1770		1583		1863	1583	248	1863	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	73	0	3	0	72	33	348	36	0
RTOR Reduction (vph)	0	0	0	0	0	2	0	0	30	0	0	0
Lane Group Flow (vph)	0	0	0	73	0	1	0	72	3	348	36	0
Turn Type				Prot		custom			Perm	pm+pt		
Protected Phases				6!				4		5	2!	
Permitted Phases						6			4		2	
Actuated Green, G (s)				26.1		26.1		5.2	5.2	41.8	41.8	
Effective Green, g (s)				26.1		26.1		5.2	5.2	41.8	41.8	
Actuated g/C Ratio				0.47		0.47		0.09	0.09	0.76	0.76	
Clearance Time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Vehicle Extension (s)				3.0		3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)				840		751		176	150	512	1416	
v/s Ratio Prot				0.04				c0.04		c0.14	0.02	
v/s Ratio Perm						0.00			0.00	c0.37		
v/c Ratio				0.09		0.00		0.41	0.02	0.68	0.03	
Uniform Delay, d <sub>1</sub>				7.9		7.6		23.5	22.6	13.0	1.6	
Progression Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d <sub>2</sub>				0.2		0.0		1.5	0.1	3.6	0.0	
Delay (s)				8.1		7.6		25.0	22.6	16.6	1.6	
Level of Service				A		A		C	C	B	A	
Approach Delay (s)		0.0			8.1			24.3			15.2	
Approach LOS		A			A			C			B	

Intersection Summary		
HCM Average Control Delay	15.9	HCM Level of Service
HCM Volume to Capacity ratio	0.63	B
Actuated Cycle Length (s)	55.0	Sum of lost time (s)
Intersection Capacity Utilization	34.9%	8.0
Analysis Period (min)	15	ICU Level of Service
		A

! Phase conflict between lane groups.  
 c Critical Lane Group

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

5/19/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	66	30	320	33	39	23	0	210	67	0	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0		4.0	4.0		4.0
Lane Util. Factor	1.00	0.95		0.97	0.95		1.00		1.00	1.00		1.00
Frt	1.00	0.95		1.00	0.92		1.00		0.85	1.00		0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (prot)	1770	3374		3433	3254		1770		1583	1770		1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (perm)	1770	3374		3433	3254		1770		1583	1770		1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	12	75	34	364	38	44	26	0	239	76	0	3
RTOR Reduction (vph)	0	29	0	0	30	0	0	0	0	0	0	2
Lane Group Flow (vph)	12	80	0	364	52	0	26	0	239	76	0	1
Turn Type	Prot			Prot			Prot		Free	Prot		custom
Protected Phases	7	4		3	8		5			1		
Permitted Phases									Free			6
Actuated Green, G (s)	1.4	8.1		11.8	18.5		3.0		60.0	28.1		21.1
Effective Green, g (s)	1.4	8.1		11.8	18.5		3.0		60.0	28.1		21.1
Actuated g/C Ratio	0.02	0.13		0.20	0.31		0.05		1.00	0.47		0.35
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0			4.0		4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0		3.0
Lane Grp Cap (vph)	41	455		675	1003		89		1583	829		557
v/s Ratio Prot	0.01	0.02		c0.11	0.02		0.01			0.04		
v/s Ratio Perm									c0.15			0.00
v/c Ratio	0.29	0.17		0.54	0.05		0.29		0.15	0.09		0.00
Uniform Delay, d1	28.8	23.0		21.7	14.6		27.5		0.0	8.9		12.6
Progression Factor	1.00	1.00		1.00	1.00		1.00		1.00	1.00		1.00
Incremental Delay, d2	3.9	0.2		0.8	0.0		1.8		0.2	0.0		0.0
Delay (s)	32.8	23.2		22.5	14.6		29.3		0.2	8.9		12.6
Level of Service	C	C		C	B		C		A	A		B
Approach Delay (s)		24.1			21.0			3.1				9.0
Approach LOS		C			C			A				A

### Intersection Summary

HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	26.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔		↔	↔	
Volume (vph)	18	177	155	103	127	16	50	192	120	18	145	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.93			0.99		1.00	0.94		1.00	0.95	
Flt Protected		1.00			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3296			3433		1770	1755		1770	1762	
Flt Permitted		0.93			0.71		0.60	1.00		0.54	1.00	
Satd. Flow (perm)		3070			2479		1117	1755		1009	1762	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	20	201	176	117	144	18	57	218	136	20	165	93
RTOR Reduction (vph)	0	134	0	0	14	0	0	41	0	0	37	0
Lane Group Flow (vph)	0	263	0	0	265	0	57	313	0	20	221	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Effective Green, g (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Actuated g/C Ratio		0.24			0.24		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		737			595		626	983		565	987	
v/s Ratio Prot							c0.18				0.13	
v/s Ratio Perm		0.09			c0.11		0.05			0.02		
v/c Ratio		0.36			0.45		0.09	0.32		0.04	0.22	
Uniform Delay, d1		12.6			12.9		4.1	4.7		4.0	4.4	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.5		0.3	0.9		0.1	0.5	
Delay (s)		12.9			13.5		4.4	5.6		4.1	5.0	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		12.9			13.5			5.4			4.9	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	352	1240	102	202	1235	266	74	545	203	291	476	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.40	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	736	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Effective Green, g (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Actuated g/C Ratio	0.13	0.31	1.00	0.10	0.29	1.00	0.31	0.26	1.00	0.10	0.30	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	441	1598	1583	343	1453	1583	290	910	1583	343	1062	1583
v/s Ratio Prot	c0.12	c0.28		0.07	0.28		0.02	c0.17		c0.10	0.15	
v/s Ratio Perm			0.07			0.19	0.07		0.15			c0.23
v/c Ratio	0.91	0.88	0.07	0.67	0.97	0.19	0.29	0.68	0.15	0.97	0.51	0.23
Uniform Delay, d1	30.1	22.8	0.0	30.4	24.7	0.0	17.3	23.4	0.0	31.4	20.2	0.0
Progression Factor	1.00	1.00	1.00	0.97	1.45	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	21.9	6.1	0.1	2.5	9.6	0.1	0.6	4.1	0.2	39.0	1.7	0.3
Delay (s)	52.0	28.9	0.1	31.9	45.3	0.1	17.9	27.5	0.2	70.4	22.0	0.3
Level of Service	D	C	A	C	D	A	B	C	A	E	C	A
Approach Delay (s)		31.9			36.7			19.9			28.5	
Approach LOS		C			D			B			C	

### Intersection Summary

HCM Average Control Delay	30.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	186	1203	355	332	1299	14	347	214	164	53	223	77
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5077		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5077		3433	3539	1583	1119	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	211	1367	403	377	1476	16	394	243	186	60	253	88
RTOR Reduction (vph)	0	0	272	0	1	0	0	0	123	0	0	67
Lane Group Flow (vph)	211	1367	131	377	1491	0	394	243	63	60	253	21
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Effective Green, g (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Actuated g/C Ratio	0.07	0.29	0.29	0.11	0.33		0.13	0.34	0.34	0.28	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	245	1453	452	392	1668		441	1193	534	332	859	384
v/s Ratio Prot	0.06	0.27		c0.11	c0.29		c0.11	0.07		0.01	c0.07	
v/s Ratio Perm			0.08						0.04	0.04		0.01
v/c Ratio	0.86	0.94	0.29	0.96	0.89		0.89	0.20	0.12	0.18	0.29	0.06
Uniform Delay, d1	32.2	24.4	19.5	30.8	22.3		30.0	16.5	16.0	18.9	21.6	20.3
Progression Factor	0.85	1.77	5.59	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	15.9	7.8	0.2	35.4	6.6		19.9	0.4	0.4	0.3	0.9	0.3
Delay (s)	43.3	50.9	109.1	66.2	28.9		49.9	16.9	16.5	19.2	22.5	20.6
Level of Service	D	D	F	E	C		D	B	B	B	C	C
Approach Delay (s)		61.9			36.4			32.6			21.6	
Approach LOS		E			D			C			C	

### Intersection Summary

HCM Average Control Delay	44.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			





















Operations Analysis Section 28

PM 2035 Intersections, Build

Alternative 1a

HCM Signalized Intersection Capacity Analysis  
 35: I-190 SB on ramp & Silver St.

6/29/2010

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (vph)	0	0	0	67	0	3	0	66	30	320	33	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Lane Util. Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Frt				1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected				0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)				1770		1583		1863	1583	1770	1863	
Flt Permitted				0.95		1.00		1.00	1.00	0.13	1.00	
Satd. Flow (perm)				1770		1583		1863	1583	248	1863	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	0	0	0	73	0	3	0	72	33	348	36	0
RTOR Reduction (vph)	0	0	0	0	0	2	0	0	30	0	0	0
Lane Group Flow (vph)	0	0	0	73	0	1	0	72	3	348	36	0
Turn Type				Prot		custom			Perm	pm+pt		
Protected Phases				6!				4		5	2!	
Permitted Phases						6			4		2	
Actuated Green, G (s)				26.1		26.1		5.2	5.2	41.8	41.8	
Effective Green, g (s)				26.1		26.1		5.2	5.2	41.8	41.8	
Actuated g/C Ratio				0.47		0.47		0.09	0.09	0.76	0.76	
Clearance Time (s)				4.0		4.0		4.0	4.0	4.0	4.0	
Vehicle Extension (s)				3.0		3.0		3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)				840		751		176	150	512	1416	
v/s Ratio Prot				0.04				c0.04		c0.14	0.02	
v/s Ratio Perm						0.00			0.00	c0.37		
v/c Ratio				0.09		0.00		0.41	0.02	0.68	0.03	
Uniform Delay, d1				7.9		7.6		23.5	22.6	13.0	1.6	
Progression Factor				1.00		1.00		1.00	1.00	1.00	1.00	
Incremental Delay, d2				0.2		0.0		1.5	0.1	3.6	0.0	
Delay (s)				8.1		7.6		25.0	22.6	16.6	1.6	
Level of Service				A		A		C	C	B	A	
Approach Delay (s)		0.0			8.1			24.3			15.2	
Approach LOS		A			A			C			B	

Intersection Summary

HCM Average Control Delay	15.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	55.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	34.9%	ICU Level of Service	A
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

5/19/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	66	30	320	33	39	23	0	210	67	0	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0		4.0	4.0		4.0
Lane Util. Factor	1.00	0.95		0.97	0.95		1.00		1.00	1.00		1.00
Frt	1.00	0.95		1.00	0.92		1.00		0.85	1.00		0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (prot)	1770	3374		3433	3254		1770		1583	1770		1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (perm)	1770	3374		3433	3254		1770		1583	1770		1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	12	75	34	364	38	44	26	0	239	76	0	3
RTOR Reduction (vph)	0	29	0	0	30	0	0	0	0	0	0	2
Lane Group Flow (vph)	12	80	0	364	52	0	26	0	239	76	0	1
Turn Type	Prot			Prot			Prot		Free	Prot		custom
Protected Phases	7	4		3	8		5			1		
Permitted Phases									Free			6
Actuated Green, G (s)	1.4	8.1		11.8	18.5		3.0		60.0	28.1		21.1
Effective Green, g (s)	1.4	8.1		11.8	18.5		3.0		60.0	28.1		21.1
Actuated g/C Ratio	0.02	0.13		0.20	0.31		0.05		1.00	0.47		0.35
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0			4.0		4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0		3.0
Lane Grp Cap (vph)	41	455		675	1003		89		1583	829		557
v/s Ratio Prot	0.01	0.02		c0.11	0.02		0.01			0.04		
v/s Ratio Perm									c0.15			0.00
v/c Ratio	0.29	0.17		0.54	0.05		0.29		0.15	0.09		0.00
Uniform Delay, d1	28.8	23.0		21.7	14.6		27.5		0.0	8.9		12.6
Progression Factor	1.00	1.00		1.00	1.00		1.00		1.00	1.00		1.00
Incremental Delay, d2	3.9	0.2		0.8	0.0		1.8		0.2	0.0		0.0
Delay (s)	32.8	23.2		22.5	14.6		29.3		0.2	8.9		12.6
Level of Service	C	C		C	B		C		A	A		B
Approach Delay (s)		24.1			21.0			3.1			9.0	
Approach LOS		C			C			A			A	

### Intersection Summary

HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	26.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔		↔	↔	
Volume (vph)	18	177	155	103	127	16	50	192	120	18	145	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.93			0.99		1.00	0.94		1.00	0.95	
Flt Protected		1.00			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3296			3433		1770	1755		1770	1762	
Flt Permitted		0.93			0.71		0.60	1.00		0.54	1.00	
Satd. Flow (perm)		3070			2479		1117	1755		1009	1762	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	20	201	176	117	144	18	57	218	136	20	165	93
RTOR Reduction (vph)	0	134	0	0	14	0	0	41	0	0	37	0
Lane Group Flow (vph)	0	263	0	0	265	0	57	313	0	20	221	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Effective Green, g (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Actuated g/C Ratio		0.24			0.24		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		737			595		626	983		565	987	
v/s Ratio Prot								c0.18				0.13
v/s Ratio Perm		0.09			c0.11		0.05			0.02		
v/c Ratio		0.36			0.45		0.09	0.32		0.04	0.22	
Uniform Delay, d1		12.6			12.9		4.1	4.7		4.0	4.4	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.5		0.3	0.9		0.1	0.5	
Delay (s)		12.9			13.5		4.4	5.6		4.1	5.0	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		12.9			13.5			5.4			4.9	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	352	1240	102	202	1235	266	74	545	203	291	476	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.40	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	736	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Effective Green, g (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Actuated g/C Ratio	0.13	0.31	1.00	0.10	0.29	1.00	0.31	0.26	1.00	0.10	0.30	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	441	1598	1583	343	1453	1583	290	910	1583	343	1062	1583
v/s Ratio Prot	c0.12	c0.28		0.07	0.28		0.02	c0.17		c0.10	0.15	
v/s Ratio Perm			0.07			0.19	0.07		0.15			c0.23
v/c Ratio	0.91	0.88	0.07	0.67	0.97	0.19	0.29	0.68	0.15	0.97	0.51	0.23
Uniform Delay, d1	30.1	22.8	0.0	30.4	24.7	0.0	17.3	23.4	0.0	31.4	20.2	0.0
Progression Factor	1.00	1.00	1.00	0.97	1.45	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	21.9	6.1	0.1	2.5	9.6	0.1	0.6	4.1	0.2	39.0	1.7	0.3
Delay (s)	52.0	28.9	0.1	31.9	45.3	0.1	17.9	27.5	0.2	70.4	22.0	0.3
Level of Service	D	C	A	C	D	A	B	C	A	E	C	A
Approach Delay (s)		31.9			36.7			19.9			28.5	
Approach LOS		C			D			B			C	

### Intersection Summary

HCM Average Control Delay	30.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖↗	↑↑↑	↖	↖↗	↑↑↑		↖↗	↑↑	↖	↖	↑↑	↖
Volume (vph)	186	1203	355	332	1299	14	347	214	164	53	223	77
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5077		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5077		3433	3539	1583	1119	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	211	1367	403	377	1476	16	394	243	186	60	253	88
RTOR Reduction (vph)	0	0	272	0	1	0	0	0	123	0	0	67
Lane Group Flow (vph)	211	1367	131	377	1491	0	394	243	63	60	253	21
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Effective Green, g (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Actuated g/C Ratio	0.07	0.29	0.29	0.11	0.33		0.13	0.34	0.34	0.28	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	245	1453	452	392	1668		441	1193	534	332	859	384
v/s Ratio Prot	0.06	0.27		c0.11	c0.29		c0.11	0.07		0.01	c0.07	
v/s Ratio Perm			0.08						0.04	0.04		0.01
v/c Ratio	0.86	0.94	0.29	0.96	0.89		0.89	0.20	0.12	0.18	0.29	0.06
Uniform Delay, d1	32.2	24.4	19.5	30.8	22.3		30.0	16.5	16.0	18.9	21.6	20.3
Progression Factor	0.85	1.77	5.59	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	15.9	7.8	0.2	35.4	6.6		19.9	0.4	0.4	0.3	0.9	0.3
Delay (s)	43.3	50.9	109.1	66.2	28.9		49.9	16.9	16.5	19.2	22.5	20.6
Level of Service	D	D	F	E	C		D	B	B	B	C	C
Approach Delay (s)		61.9			36.4			32.6			21.6	
Approach LOS		E			D			C			C	

### Intersection Summary

HCM Average Control Delay	44.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Operations Analysis Section 29





















PM 2035 Intersections, Build

Alternative 2a

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

6/29/2010

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	66	30	320	33	39	23	0	210	67	0	3
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0		4.0	4.0		4.0
Lane Util. Factor	1.00	0.95		0.97	0.95		1.00		1.00	1.00		1.00
Frt	1.00	0.95		1.00	0.92		1.00		0.85	1.00		0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (prot)	1770	3374		3433	3254		1770		1583	1770		1583
Flt Permitted	0.95	1.00		0.95	1.00		0.95		1.00	0.95		1.00
Satd. Flow (perm)	1770	3374		3433	3254		1770		1583	1770		1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	12	75	34	364	38	44	26	0	239	76	0	3
RTOR Reduction (vph)	0	29	0	0	30	0	0	0	0	0	0	2
Lane Group Flow (vph)	12	80	0	364	52	0	26	0	239	76	0	1
Turn Type	Prot			Prot			Prot		Free	Prot		custom
Protected Phases	7	4		3	8		5			1		
Permitted Phases									Free			6
Actuated Green, G (s)	1.4	8.1		11.8	18.5		3.0		60.0	28.1		21.1
Effective Green, g (s)	1.4	8.1		11.8	18.5		3.0		60.0	28.1		21.1
Actuated g/C Ratio	0.02	0.13		0.20	0.31		0.05		1.00	0.47		0.35
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0			4.0		4.0
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0			3.0		3.0
Lane Grp Cap (vph)	41	455		675	1003		89		1583	829		557
v/s Ratio Prot	0.01	0.02		c0.11	0.02		0.01			0.04		
v/s Ratio Perm									c0.15			0.00
v/c Ratio	0.29	0.17		0.54	0.05		0.29		0.15	0.09		0.00
Uniform Delay, d1	28.8	23.0		21.7	14.6		27.5		0.0	8.9		12.6
Progression Factor	1.00	1.00		1.00	1.00		1.00		1.00	1.00		1.00
Incremental Delay, d2	3.9	0.2		0.8	0.0		1.8		0.2	0.0		0.0
Delay (s)	32.8	23.2		22.5	14.6		29.3		0.2	8.9		12.6
Level of Service	C	C		C	B		C		A	A		B
Approach Delay (s)		24.1			21.0			3.1			9.0	
Approach LOS		C			C			A			A	

### Intersection Summary

HCM Average Control Delay	15.2	HCM Level of Service	B
HCM Volume to Capacity ratio	0.23		
Actuated Cycle Length (s)	60.0	Sum of lost time (s)	4.0
Intersection Capacity Utilization	26.2%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			



# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↗	↘		↗	↘	
Volume (vph)	18	177	155	103	127	16	50	192	120	18	145	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.93			0.99		1.00	0.94		1.00	0.95	
Flt Protected		1.00			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3296			3433		1770	1755		1770	1762	
Flt Permitted		0.93			0.71		0.60	1.00		0.54	1.00	
Satd. Flow (perm)		3070			2479		1117	1755		1009	1762	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	20	201	176	117	144	18	57	218	136	20	165	93
RTOR Reduction (vph)	0	134	0	0	14	0	0	41	0	0	37	0
Lane Group Flow (vph)	0	263	0	0	265	0	57	313	0	20	221	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Effective Green, g (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Actuated g/C Ratio		0.24			0.24		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		737			595		626	983		565	987	
v/s Ratio Prot								c0.18			0.13	
v/s Ratio Perm		0.09			c0.11		0.05			0.02		
v/c Ratio		0.36			0.45		0.09	0.32		0.04	0.22	
Uniform Delay, d1		12.6			12.9		4.1	4.7		4.0	4.4	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.5		0.3	0.9		0.1	0.5	
Delay (s)		12.9			13.5		4.4	5.6		4.1	5.0	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		12.9			13.5			5.4			4.9	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	352	1240	102	202	1235	266	74	545	203	291	476	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.40	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	736	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Effective Green, g (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Actuated g/C Ratio	0.13	0.31	1.00	0.10	0.29	1.00	0.31	0.26	1.00	0.10	0.30	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	441	1598	1583	343	1453	1583	290	910	1583	343	1062	1583
v/s Ratio Prot	c0.12	c0.28		0.07	0.28		0.02	c0.17		c0.10	0.15	
v/s Ratio Perm			0.07			0.19	0.07		0.15			c0.23
v/c Ratio	0.91	0.88	0.07	0.67	0.97	0.19	0.29	0.68	0.15	0.97	0.51	0.23
Uniform Delay, d1	30.1	22.8	0.0	30.4	24.7	0.0	17.3	23.4	0.0	31.4	20.2	0.0
Progression Factor	1.00	1.00	1.00	0.97	1.45	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	21.9	6.1	0.1	2.5	9.6	0.1	0.6	4.1	0.2	39.0	1.7	0.3
Delay (s)	52.0	28.9	0.1	31.9	45.3	0.1	17.9	27.5	0.2	70.4	22.0	0.3
Level of Service	D	C	A	C	D	A	B	C	A	E	C	A
Approach Delay (s)		31.9			36.7			19.9			28.5	
Approach LOS		C			D			B			C	

### Intersection Summary

HCM Average Control Delay	30.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis  
 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	186	1203	355	332	1299	14	347	214	164	53	223	77
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5077		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5077		3433	3539	1583	1119	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	211	1367	403	377	1476	16	394	243	186	60	253	88
RTOR Reduction (vph)	0	0	272	0	1	0	0	0	123	0	0	67
Lane Group Flow (vph)	211	1367	131	377	1491	0	394	243	63	60	253	21
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Effective Green, g (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Actuated g/C Ratio	0.07	0.29	0.29	0.11	0.33		0.13	0.34	0.34	0.28	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	245	1453	452	392	1668		441	1193	534	332	859	384
v/s Ratio Prot	0.06	0.27		c0.11	c0.29		c0.11	0.07		0.01	c0.07	
v/s Ratio Perm			0.08						0.04	0.04		0.01
v/c Ratio	0.86	0.94	0.29	0.96	0.89		0.89	0.20	0.12	0.18	0.29	0.06
Uniform Delay, d1	32.2	24.4	19.5	30.8	22.3		30.0	16.5	16.0	18.9	21.6	20.3
Progression Factor	0.85	1.77	5.59	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	15.9	7.8	0.2	35.4	6.6		19.9	0.4	0.4	0.3	0.9	0.3
Delay (s)	43.3	50.9	109.1	66.2	28.9		49.9	16.9	16.5	19.2	22.5	20.6
Level of Service	D	D	F	E	C		D	B	B	B	C	C
Approach Delay (s)		61.9			36.4			32.6			21.6	
Approach LOS		E			D			C			C	

Intersection Summary

HCM Average Control Delay	44.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Operations Analysis Section 30

















PM 2035 Intersections, Build

Alternative 3a

# HCM Unsignalized Intersection Capacity Analysis

## 35: Silver St. & I-190 SB

6/29/2010

												
Movement	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (veh/h)	0	0	0	67	0	3	0	66	30	0	33	0
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	0	73	0	3	0	72	33	0	36	0
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (ft)											537	
pX, platoon unblocked												
vC, conflicting volume	127	124	88	124	140	36	36			104		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	127	124	88	124	140	36	36			104		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	100	100	100	91	100	100	100			100		
cM capacity (veh/h)	844	767	970	850	751	1037	1575			1487		
<b>Direction, Lane #</b>	<b>SB 1</b>	<b>SB 2</b>	<b>SE 1</b>	<b>NW 1</b>								
Volume Total	73	3	104	36								
Volume Left	73	0	0	0								
Volume Right	0	3	33	0								
cSH	850	1037	1700	1700								
Volume to Capacity	0.09	0.00	0.06	0.02								
Queue Length 95th (ft)	7	0	0	0								
Control Delay (s)	9.6	8.5	0.0	0.0								
Lane LOS	A	A										
Approach Delay (s)	9.6		0.0	0.0								
Approach LOS	A											
<b>Intersection Summary</b>												
Average Delay			3.4									
Intersection Capacity Utilization			27.7%		ICU Level of Service					A		
Analysis Period (min)			15									

# HCM Signalized Intersection Capacity Analysis

## 24: North Street & I-190 NB

5/19/2011



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↗↗			↖↗			↖	↗			
Volume (vph)	11	122	0	0	353	39	23	0	210	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0			4.0	4.0			
Lane Util. Factor	1.00	0.95			0.95			1.00	1.00			
Frt	1.00	1.00			0.99			1.00	0.85			
Flt Protected	0.95	1.00			1.00			0.95	1.00			
Satd. Flow (prot)	1770	3539			3487			1770	1583			
Flt Permitted	0.31	1.00			1.00			0.95	1.00			
Satd. Flow (perm)	585	3539			3487			1770	1583			
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	12	139	0	0	401	44	26	0	239	0	0	0
RTOR Reduction (vph)	0	0	0	0	19	0	0	0	120	0	0	0
Lane Group Flow (vph)	12	139	0	0	426	0	0	26	120	0	0	0
Turn Type	pm+pt						Perm		Perm			
Protected Phases	7	4			8			2				
Permitted Phases	4						2		2			
Actuated Green, G (s)	17.0	17.0			11.7			25.0	25.0			
Effective Green, g (s)	17.0	17.0			11.7			25.0	25.0			
Actuated g/C Ratio	0.34	0.34			0.23			0.50	0.50			
Clearance Time (s)	4.0	4.0			4.0			4.0	4.0			
Vehicle Extension (s)	3.0	3.0			3.0			3.0	3.0			
Lane Grp Cap (vph)	230	1203			816			885	792			
v/s Ratio Prot	0.00	c0.04			c0.12							
v/s Ratio Perm	0.02							0.01	c0.08			
v/c Ratio	0.05	0.12			0.52			0.03	0.15			
Uniform Delay, d1	11.3	11.3			16.7			6.3	6.8			
Progression Factor	1.00	1.00			1.00			1.00	1.00			
Incremental Delay, d2	0.1	0.0			0.6			0.1	0.4			
Delay (s)	11.4	11.4			17.3			6.4	7.2			
Level of Service	B	B			B			A	A			
Approach Delay (s)		11.4			17.3			7.1			0.0	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	13.1	HCM Level of Service	B
HCM Volume to Capacity ratio	0.27		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	27.7%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 21: North Street & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔↔			↔↔		↔	↔		↔	↔	
Volume (vph)	18	177	155	103	127	16	50	192	120	18	145	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor		0.95			0.95		1.00	1.00		1.00	1.00	
Frt		0.93			0.99		1.00	0.94		1.00	0.95	
Flt Protected		1.00			0.98		0.95	1.00		0.95	1.00	
Satd. Flow (prot)		3296			3433		1770	1755		1770	1762	
Flt Permitted		0.93			0.71		0.60	1.00		0.54	1.00	
Satd. Flow (perm)		3070			2479		1117	1755		1009	1762	
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	20	201	176	117	144	18	57	218	136	20	165	93
RTOR Reduction (vph)	0	134	0	0	14	0	0	41	0	0	37	0
Lane Group Flow (vph)	0	263	0	0	265	0	57	313	0	20	221	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Effective Green, g (s)		9.6			9.6		22.4	22.4		22.4	22.4	
Actuated g/C Ratio		0.24			0.24		0.56	0.56		0.56	0.56	
Clearance Time (s)		4.0			4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)		737			595		626	983		565	987	
v/s Ratio Prot							c0.18				0.13	
v/s Ratio Perm		0.09			c0.11		0.05			0.02		
v/c Ratio		0.36			0.45		0.09	0.32		0.04	0.22	
Uniform Delay, d1		12.6			12.9		4.1	4.7		4.0	4.4	
Progression Factor		1.00			1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2		0.3			0.5		0.3	0.9		0.1	0.5	
Delay (s)		12.9			13.5		4.4	5.6		4.1	5.0	
Level of Service		B			B		A	A		A	A	
Approach Delay (s)		12.9			13.5			5.4			4.9	
Approach LOS		B			B			A			A	

### Intersection Summary

HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	51.5%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

# HCM Signalized Intersection Capacity Analysis

## 18: Omaha St. & West Blvd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	352	1240	102	202	1235	266	74	545	203	291	476	321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91	1.00	1.00	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5085	1583	1770	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.40	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5085	1583	736	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	400	1409	116	230	1403	302	84	619	231	331	541	365
Turn Type	Prot		Free	Prot		Free	pm+pt		Free	Prot		Free
Protected Phases	7	4		3	8		5	2		1		6
Permitted Phases			Free			Free	2		Free			Free
Actuated Green, G (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Effective Green, g (s)	9.0	22.0	70.0	7.0	20.0	70.0	22.0	18.0	70.0	7.0	21.0	70.0
Actuated g/C Ratio	0.13	0.31	1.00	0.10	0.29	1.00	0.31	0.26	1.00	0.10	0.30	1.00
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	441	1598	1583	343	1453	1583	290	910	1583	343	1062	1583
v/s Ratio Prot	c0.12	c0.28		0.07	0.28		0.02	c0.17		c0.10	0.15	
v/s Ratio Perm			0.07			0.19	0.07		0.15			c0.23
v/c Ratio	0.91	0.88	0.07	0.67	0.97	0.19	0.29	0.68	0.15	0.97	0.51	0.23
Uniform Delay, d1	30.1	22.8	0.0	30.4	24.7	0.0	17.3	23.4	0.0	31.4	20.2	0.0
Progression Factor	1.00	1.00	1.00	0.97	1.45	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	21.9	6.1	0.1	2.5	9.6	0.1	0.6	4.1	0.2	39.0	1.7	0.3
Delay (s)	52.0	28.9	0.1	31.9	45.3	0.1	17.9	27.5	0.2	70.4	22.0	0.3
Level of Service	D	C	A	C	D	A	B	C	A	E	C	A
Approach Delay (s)		31.9			36.7			19.9			28.5	
Approach LOS		C			D			B			C	

### Intersection Summary

HCM Average Control Delay	30.9	HCM Level of Service	C
HCM Volume to Capacity ratio	0.79		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	70.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			



# HCM Signalized Intersection Capacity Analysis

## 22: Omaha St. & Mt. Rushmore Rd.

6/29/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖↗	↑↑↑	↖	↖↗	↑↑↑		↖↗	↑↑	↖	↖	↑↑	↖
Volume (vph)	186	1203	355	332	1299	14	347	214	164	53	223	77
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor	0.97	0.91	1.00	0.97	0.91		0.97	0.95	1.00	1.00	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	5085	1583	3433	5077		3433	3539	1583	1770	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00		0.95	1.00	1.00	0.60	1.00	1.00
Satd. Flow (perm)	3433	5085	1583	3433	5077		3433	3539	1583	1119	3539	1583
Peak-hour factor, PHF	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Adj. Flow (vph)	211	1367	403	377	1476	16	394	243	186	60	253	88
RTOR Reduction (vph)	0	0	272	0	1	0	0	0	123	0	0	67
Lane Group Flow (vph)	211	1367	131	377	1491	0	394	243	63	60	253	21
Turn Type	Prot		Perm	Prot			Prot		Perm	pm+pt		Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases			4						2	6		6
Actuated Green, G (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Effective Green, g (s)	5.0	20.0	20.0	8.0	23.0		9.0	23.6	23.6	19.4	17.0	17.0
Actuated g/C Ratio	0.07	0.29	0.29	0.11	0.33		0.13	0.34	0.34	0.28	0.24	0.24
Clearance Time (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	245	1453	452	392	1668		441	1193	534	332	859	384
v/s Ratio Prot	0.06	0.27		c0.11	c0.29		c0.11	0.07		0.01	c0.07	
v/s Ratio Perm			0.08						0.04	0.04		0.01
v/c Ratio	0.86	0.94	0.29	0.96	0.89		0.89	0.20	0.12	0.18	0.29	0.06
Uniform Delay, d1	32.2	24.4	19.5	30.8	22.3		30.0	16.5	16.0	18.9	21.6	20.3
Progression Factor	0.85	1.77	5.59	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	15.9	7.8	0.2	35.4	6.6		19.9	0.4	0.4	0.3	0.9	0.3
Delay (s)	43.3	50.9	109.1	66.2	28.9		49.9	16.9	16.5	19.2	22.5	20.6
Level of Service	D	D	F	E	C		D	B	B	B	C	C
Approach Delay (s)		61.9			36.4			32.6			21.6	
Approach LOS		E			D			C			C	

### Intersection Summary

HCM Average Control Delay	44.6	HCM Level of Service	D
HCM Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	16.0
Intersection Capacity Utilization	62.1%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

# Evaluation & Recommendation of I-190/Silver Street Interchange Alternatives

To: Steve Gramm – SDDOT, Project Study Advisory Team

From: HDR Engineering, Inc.

Project: I-190/Silver Street Interchange

Date: 28 Oct 2011

Job No: 137390

**RE:** Evaluation & Recommendation of I-190/Silver Street Interchange Alternatives

## Introduction

The purpose of this memo is to discuss the further evaluation and findings for the I-190/Silver Street Interchange Alternatives 1 and 3a. Due to the additional traffic analysis, roadway preliminary design, and public feedback collected during the environmental and interchange justification process, HDR recommends not carrying these two build alternatives forward for further analysis.

## Evaluation of Build Alternatives

The following was considered in order to determine the benefits and the drawbacks of each alternative:

- The Purpose and Need of the Project,
- Public input,
- Interchange layout and Traffic analysis, and
- Environmental resources and potential impacts.

At the September 2011 public meeting, four interchange build alternatives were presented to the public, Alternatives 1, 1a, 2a, and 3a. Based on public feedback from that meeting, input from further engineering analysis, and Study Advisory Team input, Alternative 1 and Alternative 3a are now recommended to be eliminated from further analysis in the Draft Environmental Assessment. These build alternatives will be discussed initially in the environmental document, but will not be carried forward fully for final consideration as the feasibly preferred alternative. After eliminating these two build alternatives, the remaining two alternatives, Alternatives 1a and 2a, will continue to be analyzed and considered for the feasibly preferred alternative. The following is a discussion for each build alternative with the rationale for their elimination:

### Alternative 1

Alternative 1 is a full diamond interchange at Silver Street/North Street with I-190 shifted west (See Figure 1). This alternative shows maintaining the current cross road connection of North Street and Silver Street.

Due to the skew of I-190 to Silver Street, the southbound I-190 ramp terminal is shortened and has a fairly high degree of skew at Silver Street with subsequent sharp turning paths on some movements. Therefore, this skew would have more potential to be a safety hazard due to affecting sight views in comparison to the other build alternatives. The lengths of the mainline bridges would also need to be extended due to the skew and therefore would cost more to construct than Alternatives 1a and 2a (See Table 1).

Alternative 1 would also require additional residential property acquisitions due to the larger footprint of a diamond interchange. This larger footprint would also impact wetland areas on the northwest of the interchange. An access to the Friendship House would be required to the southwest of the interchange in an area that would require impacting the Executive Golf Course property.

Since the Rapid City Street connection in Alternative 1 would maintain the existing cross road connection of Silver Street to North Street, it was determined that this build alternative would not meet the City's Major Street Plan. The current version of that plan includes a modified city street connection from Philadelphia Street to North Street which was confirmed in meetings with City staff and their recommendation in a September 12, 2011 Memo. Therefore, Alternative 1 would not meet the purpose and need of the Project.

The primary concern for modifying the cross road connection would be to maintain existing access and traffic patterns to the neighborhood on the northwest corner of the interchange. Through further analysis presented in the Philadelphia Street Connection Alignments Memo and supported by public input, there were multiple city roadway connection options found that could feasibly provide this neighborhood access.

Therefore, HDR recommends eliminating this build alternative from further analysis since the cross road connection of Silver Street and North Street does not meet the City's Major Street Plan and the additional impacts due to the larger footprint.

### **Alternative 3a**

Alternative 3a is diamond interchange with a North Street to Philadelphia Street connection (See Figure 2). This concept is similar to Alternative 3, but with an added loop ramp connection for eastbound North Street traffic turning southbound on I-190. This would provide a free movement and eliminate a traffic signal on the west side of the interchange.

Alternative 3a would modify the existing street network connection from a North Street to Philadelphia Street connection as outlined in the latest version of Rapid City's Major Street Plan. Due to this change to access and existing traffic patterns, a city street connection from the interchange to the neighborhood on the northwest corner would need to be provided.

The primary benefit of this build alternative to the others is that the eastbound to southbound movement would be non-stop which would create an improved capacity for peak traffic from Rapid City Central High School and the Rushmore Plaza Civic Center. However, the traffic modeling and forecast results verify that Alternative 1a and 2a would also have sufficient capacity to carry the eastbound to southbound traffic through left turn signal movements. Therefore, the loop for the nonstop movement of Alternative 3a would not provide significant benefits and would not warrant increased impacts over the other alternatives.

The impacts and drawbacks associated with alternative 3a for the southbound loop include a significantly larger project footprint on the northwest side of I-190 that would require additional residential property acquisitions. There would also be added structure costs for an additional southbound I-190 lane (See Table 1). Property impacts on the southwest corner would be less than other alternatives, but it would include impacting Executive Golf Course in order to provide access to the Friendship House.

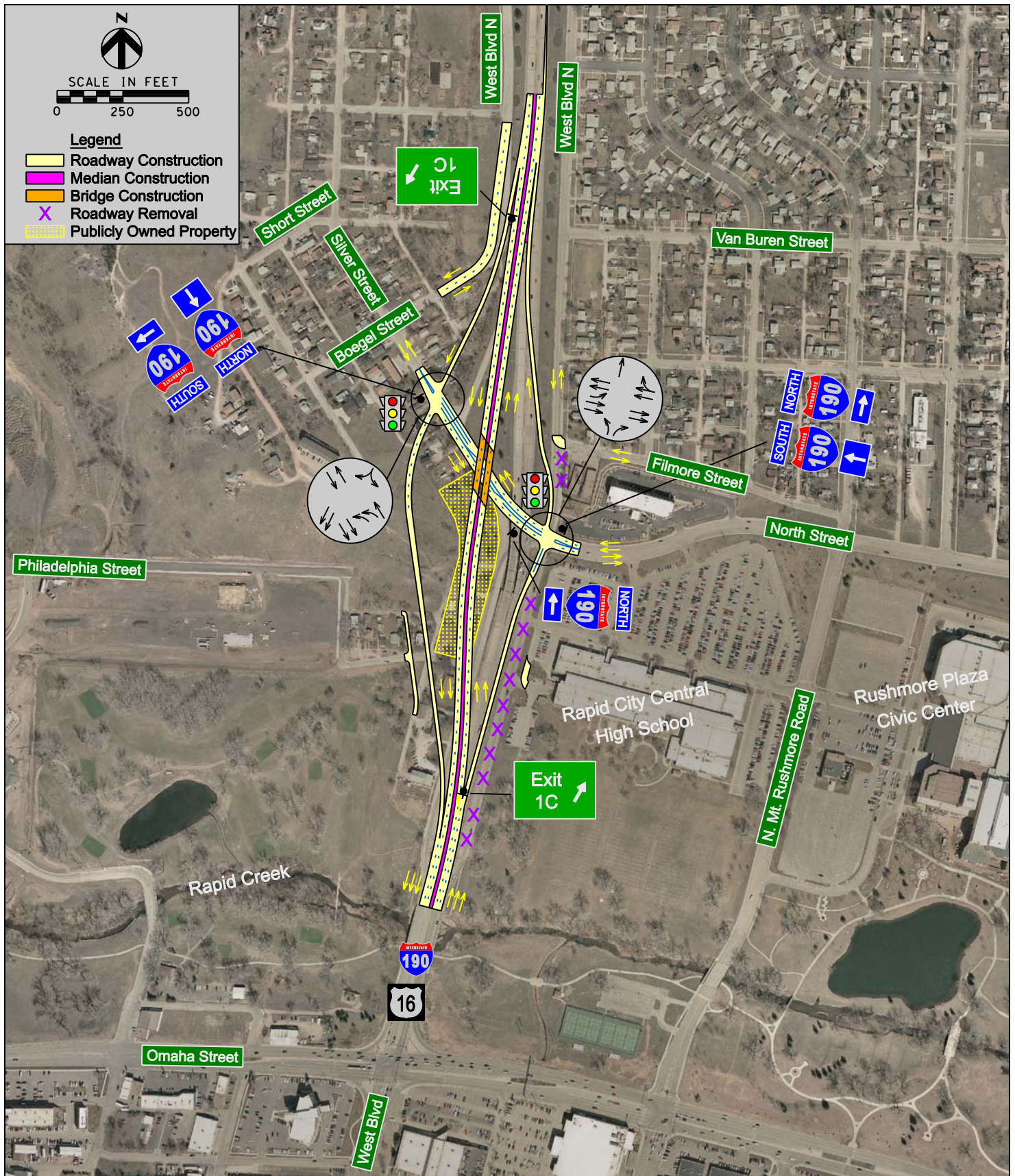
During the September 2011 public information meeting, several landowners in the area indicated that they were not in favor of this alternative due to the large area the southbound loop would require in the neighborhood. Therefore, HDR recommends eliminating this build alternative from further analysis since the added traffic capacity is not necessary and does not warrant additional impacts.

**Table 1  
Comparison of Interchange Alternatives**

Criteria	No Build Alternative	Alternative 1	Alternative 1a	Alternative 2a	Alternative 3a
Roadway cost (million \$) • Interim construction	0	6.63	6.89	6.20	6.98
Structure cost (million \$) • Steel Beam Bridge • MSE Large Panel Wall	0	2.87	2.43	2.67	2.38
Total construction cost (million \$)	0	9.50	9.32	8.86	9.36
Utility Relocation costs (million \$)	0	0.20	0.20	0.20	0.20
ROW and relocation cost (million \$)	0	2.03	2.07	1.03	3.55
15% contingencies	0	1.76	1.74	1.51	1.97
Total roadway, structure, right-of-way, utility relocation costs, (million \$)	0	13.49	13.33	11.60	15.08
<b>Right-of-way acquisitions</b>					
Open residential areas (sf @ \$2.50/sf)	0	171,500	184,200	94,800	255,900
Potential residential acquisitions (each @ 30% markup of assessed value)	0	14	14	4	13
Meets all AASHTO design criteria	N/A	Yes	Yes	Yes	Yes
Utility Conflicts					
Storm Sewer	No	Yes	Yes	Yes	Yes
Water main	No	Yes	Yes	Yes	Yes
Sanitary Sewer	No	Yes	Yes	Yes	Yes
Natural Gas	No	Yes	Yes	Yes	Yes
Electrical	No	Yes	Yes	Yes	Yes
Communication	No	Yes	Yes	Yes	Yes
Constructability	N/A	Simple	Simple	Simple	Simple
Rail crossings	0	0	0	0	0
Meets Purpose and Need of Project	No	No	Yes	Yes	Yes

## Recommendation

Due to the further analysis and public feedback, HDR recommends not carrying build alternatives 1 and 3a forward for further analysis in the draft Environmental Assessment and continuing only with build Alternatives 1a and 2a for consideration as the feasibly preferred alternative.



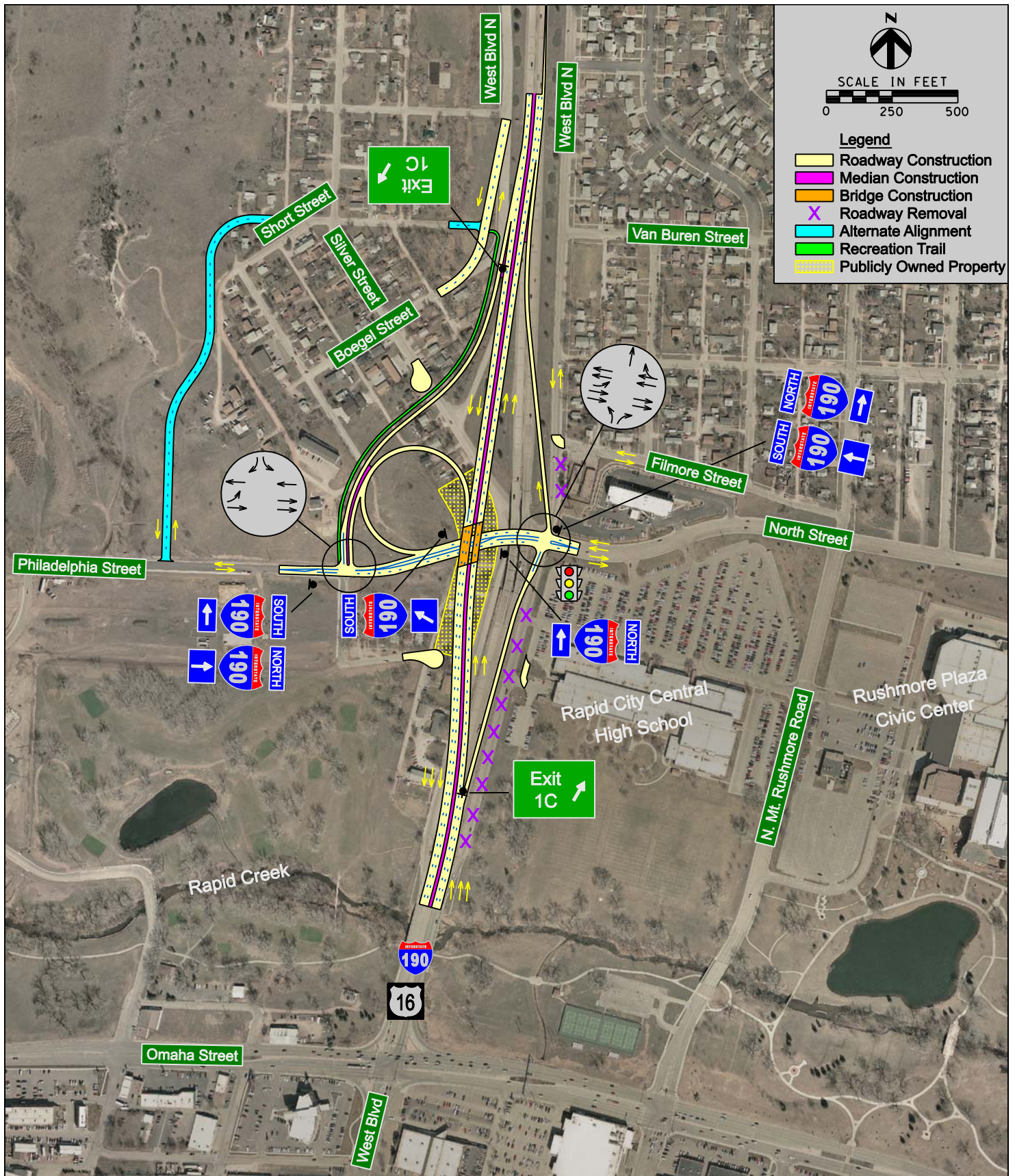
### Interchange Alternative 1

Full Diamond Interchange at Silver Street/North Street with I-190 shifted west

Interstate 190/Silver Street Interchange Study  
Rapid City, South Dakota

Oct. 2011

Figure 1



### Interchange Alternative 3a

I-190 Interchange with Loop at North Street and EB to SB access

Interstate 190/Silver Street Interchange Study  
Rapid City, South Dakota

Oct. 2011

Figure 2



# CITY OF RAPID CITY

RAPID CITY, SOUTH DAKOTA 57701-5035

## Growth Management Department

300 Sixth Street

Patsy Horton, Community Planning Coordinator  
Growth Management Department-Community Planning  
city web: [www.rcgov.org](http://www.rcgov.org)

Phone: 605-394-4120  
Fax: 605-394-6636  
e-mail: [patsy.horton@rcgov.org](mailto:patsy.horton@rcgov.org)

## MEMORANDUM

TO: Public Works Committee

FROM: Patsy Horton, Community Planning Coordinator

DATE: September 12, 2011

RE: Silver Street/I-190 Interchange Study

For the past 18-24 months, the South Dakota Department of Transportation has been studying the I-190 Corridor. Given the aging I-190 structures with low clearance at the Silver Street interchange, the South Dakota Department of Transportation has targeted the interchange for replacement. They have contracted with HDR Engineering to determine the eventual design of the replaced interchange. As part of the interchange study, HDR Engineering has proposed several potential designs. The South Dakota Department of Transportation is hosting a public meeting to be held at the Howard Johnson Hotel, 950 North Street, Rapid City, South Dakota on Wednesday, September 14, 2011, from 4:30 p.m. to 6:30 p.m. Four proposed designs will be on display to encourage participation and receive input from the neighborhood and the public.

Based on the final four designs under consideration (as attached), Public Works and Growth Management staff recommend support of the Interchange Alternative 2a as it requires the least amount of right-of-way for the interchange, ensures an east-west neighborhood connection from Philadelphia Street to East North Street, and ensures a north-south neighborhood connection from Van Buren Street to Philadelphia Street.

**STAFF RECOMMENDATION:** Staff recommends that the City Council forward public comment to the South Dakota Department of Transportation supporting the proposed I-190 Interchange Alternative 2a because it requires the least amount of right-of-way for the interchange, ensures an east-west neighborhood connection from Philadelphia Street to East North Street, and ensures a north-south neighborhood connection from Van Buren Street to Philadelphia Street.



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