Interchange Modification Justification Study

I-90/Timberline Road Interchange, Exit 402

SIOUX FALLS MPO

Technical analysis to accompany companion Environmental Assessment









Interchange Modification Justification Report

I-90/Timberline Avenue Interchange Exit 402

> Sioux Falls, South Dakota February, 2013 Updated June, 2014

> > Prepared for:



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EXECUTIVE SUMMARY

This report is part of a supplement to a previously-approved Environmental Assessment and subsequent analyses of Interstate access. The documents are being supplemented to account for alignment changes to the roadway intersecting the Interstate system. The report format has also been updated to comply with the most recent guidance. The updated EA document is being prepared in conjunction with this report.

The proposed action is a reconfiguration and realignment of the existing Timberline Avenue (Exit 402) interchange on Interstate 90 near Sioux Falls, SD. The action is proposed to provide appropriate operational capacity for a new regional arterial highway, referred to as the Eastside Corridor, which is currently under phased construction. The Eastside Corridor is part of local and state transportation plans to serve growth in the Sioux Falls metropolitan area. No adverse impacts to the Interstate highway system are forecast due to the proposed change.

The Federal policy considerations and requirements have been addressed beginning on page 36 and summary responses to the eight requirements are provided below.

- 1. The proposed action is a modification of an existing interchange to correct design deficiencies and meet planned future travel needs of the metropolitan area.
- 2. No additional Interstate capacity or additional Interchange access points are required. The need can be met by providing updated interchange configuration and additional crossroad capacity.
- 3. The ramp terminal intersections will fail with the interchange no-build option, but continue to operate acceptably with build alternatives.
- 4. The proposed action is an update of an existing full public road interchange.
- 5. The proposed action is the result of land use and transportation plans prepared within the MPO process. A companion EA accompanies this report.
- 6. A comprehensive Interstate system study has recommended improvements at this interchange.
- 7. The proposed action is part of the overall planned transportation system.
- 8. An Environmental Assessment accompanies this report.

The analysis indicates that an update of the existing interchange is necessary to address future travel demand. Previous analyses selected a single-point interchange as the preferred alternative at this location and the subsequent analysis validates this recommendation.

Alternative improvements such as slight changes at adjacent interchanges, changes to the local street system, the increased use of transit, HOV/HOT lanes, etc. were deemed not to satisfy the need for an appropriate Interstate connection for the planned new regional arterial corridor.

Analysis techniques included evaluation of operational capacity using Highway Capacity Manual 2010 techniques via HCS 2010. Highway Safety Manual techniques were used to the extent possible in this report.

INTRODUCTION

Background

SDDOT is conducting a study to evaluate the design, operations, policy and funding implications of replacing the Timberline Avenue interchange (Exit 402) on I-90 east of Sioux Falls. This existing interchange will serve as the northern terminus of the planned Sioux Falls east-side regional arterial corridor. An Environmental Assessment (EA) and two Supplements to the EA have been completed for the route. An additional EA addressing environmental impacts associated with alignment shifts for the portion of the Eastside Corridor from Madison Street to I-90 is proceeding in conjunction with this document. Phased construction of portions of the corridor included in the approved environmental documents is underway with portions of the corridor constructed and open to traffic, other portions are programmed for construction, and other portions are receiving further environmental review to address small changes in the roadway alignment or configuration. The portion of the Eastside Corridor that includes the I-90 interchange is currently undergoing an EA. Interstate access justification work for this interchange was begun, but not completed or submitted to FHWA. The current study updates the previous work with recent data and seeks to meet revised guidance for preparation of Interstate access studies. This Interchange Modification Justification Report is being prepared in conjunction with the EA and will provide traffic analysis for the selection of a preferred alternative in the EA.

Purpose

The preliminary design for the Eastside Corridor shows the intersection of the improved crossroad will remain at the existing location at Exit 402. The change of classification of the crossroad from a county highway to a regional arterial highway brings an expected significant increase in the traffic using this interchange. This study will evaluate the operational and safety effects of several interchange configurations.

Project Location

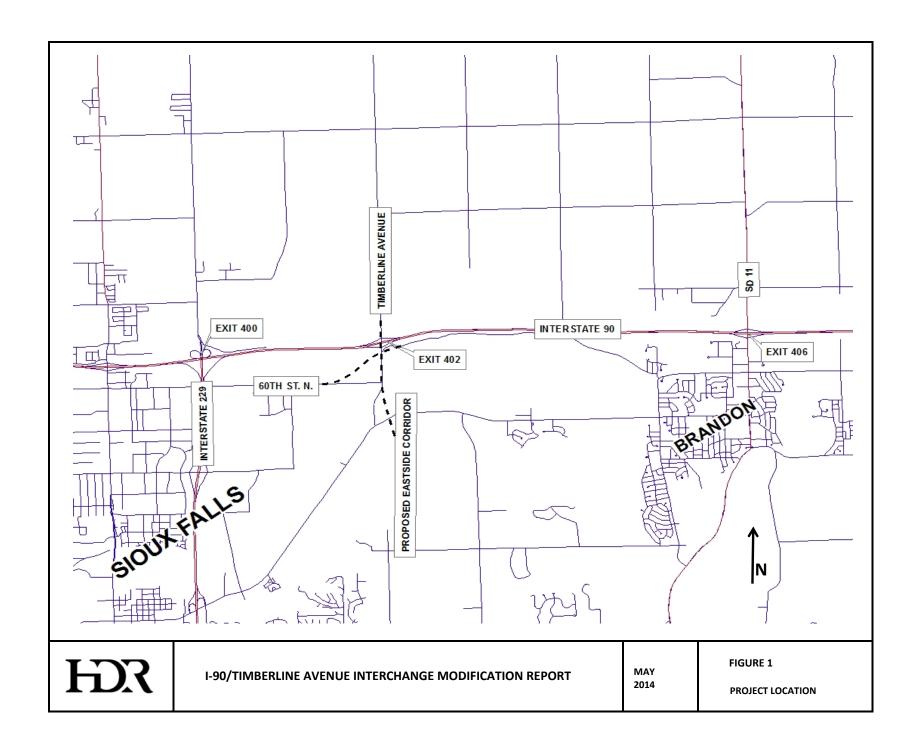
The subject interchange is at mile reference marker 402 on Interstate 90, east of Sioux Falls, SD. This location is within the Sioux Falls MPO and also within the area identified for future Sioux Falls growth by local comprehensive planning. The adjacent interchanges on I-90 are I-229 (Exit 400) and South Dakota Highway 11 (SD 11) (Exit 406). Therefore, interchange spacing is approximately 2 miles to the west of the subject interchange and 4 miles to the east of the subject interchange.

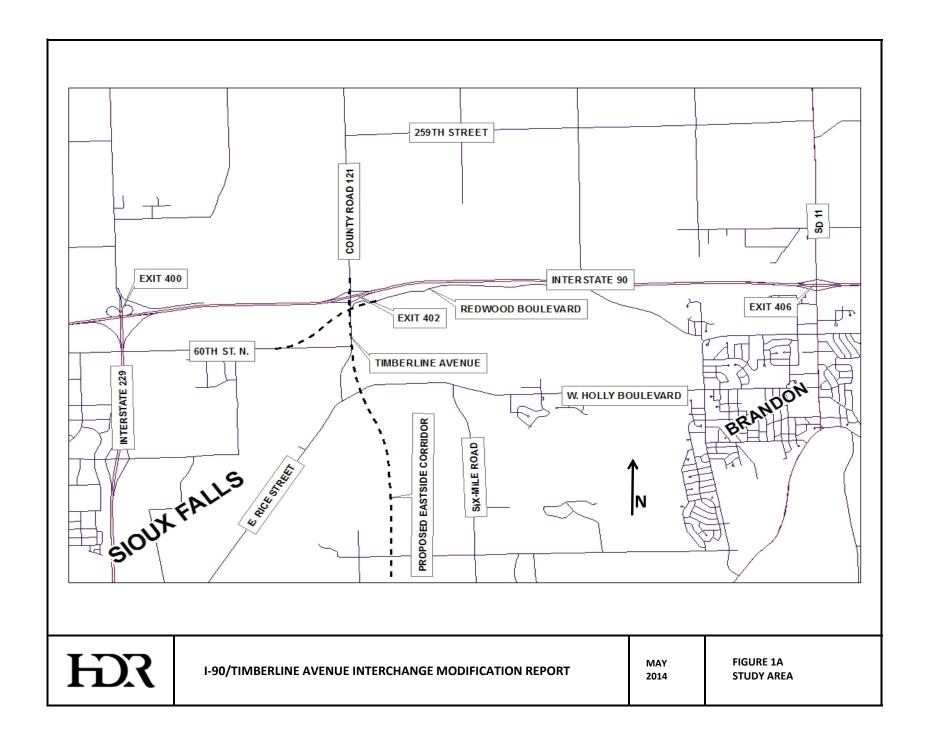
There are few local roadways in the vicinity of the interchange. The existing crossroad has been identified as Timberline Avenue and Minnehaha County Highway 121. It is an asphalt-paved two-lane roadway that provides local service between Sioux Falls and rural residences and businesses. Timberline Avenue is intersected by Redwood Boulevard, a low-volume gravel road, just to the south of the existing interchange. Approximately ½ mile south of the interchange, Timberline Avenue is intersected from the west by 60th

Street North. The closest intersecting roadway north of the interchange is 259th Street, a low-volume gravel road over 1 mile away. Currently all intersections on the crossroad are controlled by stop signs.

The Eastside Corridor is planned to terminate at Exit 402 and transition back to the existing County Highway north of the interchange. The roadway designated at 60th Street North is planned to be realigned to intersect with the Eastside Corridor and Redwood Boulevard at a common signalized intersection. Access from the Eastside Corridor to Rice Street will be provided by an at-grade intersection.

The study area, therefore, has been defined as Interstate 90, from MRM 400 to MRM 406, including Exits 400, 402, and 406, and Timberline Avenue including the interchange and the 60th Street North intersection. The study area is shown in Figure 1.





METHODOLOGY

Preparation of this report included the following work tasks:

- 1. Data gathering
- 2. Review previous Interstate access work and EA documents, including feasible alternatives and the recommended alternative.
- 3. Update existing and future operational characteristics of Interstate and local street facilities.
- 4. Estimate the safety effects of each alternative.
- 5. Prepare deliverable report

Traffic forecasts were prepared using output from the regional travel demand model maintained by the City of Sioux Falls. Traffic operations were analyzed using Highway Capacity Manual techniques using HCS 2010.

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

EXISTING CONDITIONS

Demographics

The Sioux Falls metropolitan area enjoys a robust economy and sustained measured population growth. During the period 1980 – 2000 the population grew at a steady rate of between 2% and 3% per year. Even in the face of the recent recession, the population continued to grow and the 2010 Census shows the city with a population of 153,888, while the MSA had a population of 228,261 and the market area had a population of 1,043,450. (Market area is a term used in economics and human geography describing the area surrounding a central place, from which people are attracted to use the place's goods or services.)

Generally, employment for the Sioux Falls area has grown at approximately the same rate as the population and unemployment remains very low in comparison to national figures.

The study area is currently sparsely populated, with scattered rural residences and a few businesses near the existing interchange. The study area Traffic Analysis Zones (TAZ's) currently reflect the existing sparse population with relatively small population and employment inputs. The future-year TAZ's, however, show greatly increased population and employment inputs to reflect the planned development of regional commercial and housing activities. See the following section for more information on planned land uses.

Existing Land Use

The study area is currently occupied primarily by agricultural and recreation/conservation land uses, although a few scattered rural residences exist. Small commercial enterprises occupy the land on the north side of the subject interchange. They include an agricultural implement auction, a commercial campground and two fireworks vendors.

The future land use for this area is shown in Figure 2.

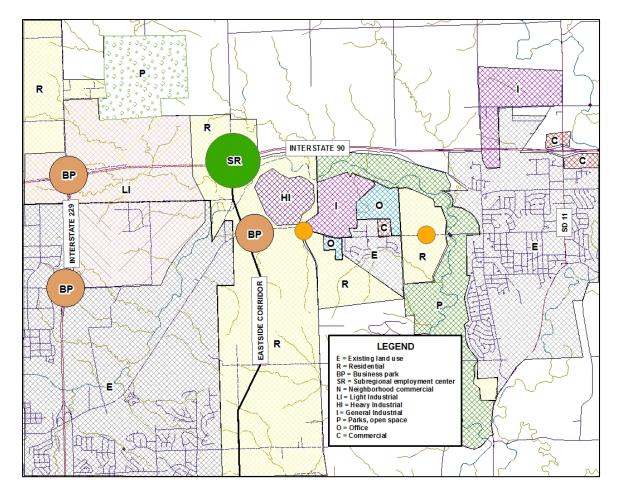


Figure 2 - Study Area Future Land Use (source Shape Sioux Falls comprehensive plan and Brandon Comprehensive Plan)

Existing Roadway Network

As previously identified, the existing roadways within the study area include:

- Interstate 90 currently two lanes in each direction
- Interstate 229 currently two lanes in each direction
- Timberline Avenue/Minnehaha County Highway 121 two lane urban collector, frequent access
- 60th Street North two lane urban collector, new access controlled by City Design Standards
- South Dakota Highway 11 three lane minor arterial north of I-90, five lane principal arterial south of I-90, access controlled by South Dakota Administrative Rule 70:09.
- Township local roads, including Redwood Boulevard and 259th Street.

Alternative Travel Modes

Travel within the study area is primarily by automobile. Pedestrian and bicycle modes are used mainly for recreation, although a small number of bicycle commuters use Rice Street on the fringe of the study area. The area is not currently served by municipal transit routes, although demand transit service exists in Brandon on the fringe of the study area.

Interchanges

Interchanges within the study area include:

- I-90/I-229 (Exit 400) a partial cloverleaf design with loops for westbound-to-southbound and northbound-to-westbound movements. Currently, I-229 terminates at this location and the mainline of I-229 feeds into an existing county highway north of the interchange. SDDOT has studied alternatives (see http://www.sddot.com/transportation/highways/planning/specialstudies/docs/IJR-I229-I90-Final%20Revised.pdf) for reconfiguration of this Interstate facility and although an updated interchange configuration has not been identified, the alternatives developed are not expected to have a configuration effect on the adjacent interchange at Exit 402. Also, portions of the Exit 400 interchange have recently been reconstructed with new surfacing.
- I-90/Timberline Avenue (Exit 402) the subject interchange is a standard diamond configuration with stop-sign controlled ramp termini. It meets current needs, but will be insufficient to carry future travel demand. Construction of the planned Eastside Corridor route would require realignment and reconfiguration of the existing interchange. The *Decennial Interstate Corridor Study (SDDOT)* has identified the following interchange deficiencies:
 - o Inslope for mainline and ramp junction
 - o Bridge section width for SD100 mainline
 - o Super-elevation rate for ramp roadway
 - o Grades on the ramp roadway
 - o Lane width and right shoulder width on ramp roadway
 - o The K value for ramp roadway
 - o On-ramp and off-ramp taper for ramp junction
- I-90/SD 11 (Exit 406) a standard diamond configuration with stop-sign controlled ramp termini. Regional growth has increased the traffic load on this interchange and will likely require future reconfiguration to provide increased capacity. SDDOT has identified the need to revise the interchange in the future, but no detailed study has been completed.

Planned interchange between Exit 402 and Exit 406 – The Sioux Falls MPO Long Range Transportation Plan has included a new interchange at Exit 404 as a potential project need beyond the 2035 planning horizon. No funding has been assigned or detailed analysis conducted for this potential project.

Aerial photos of the existing interchanges have been included in the Appendix, Part 7.

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. The data is recent and of high quality.

Operational Performance

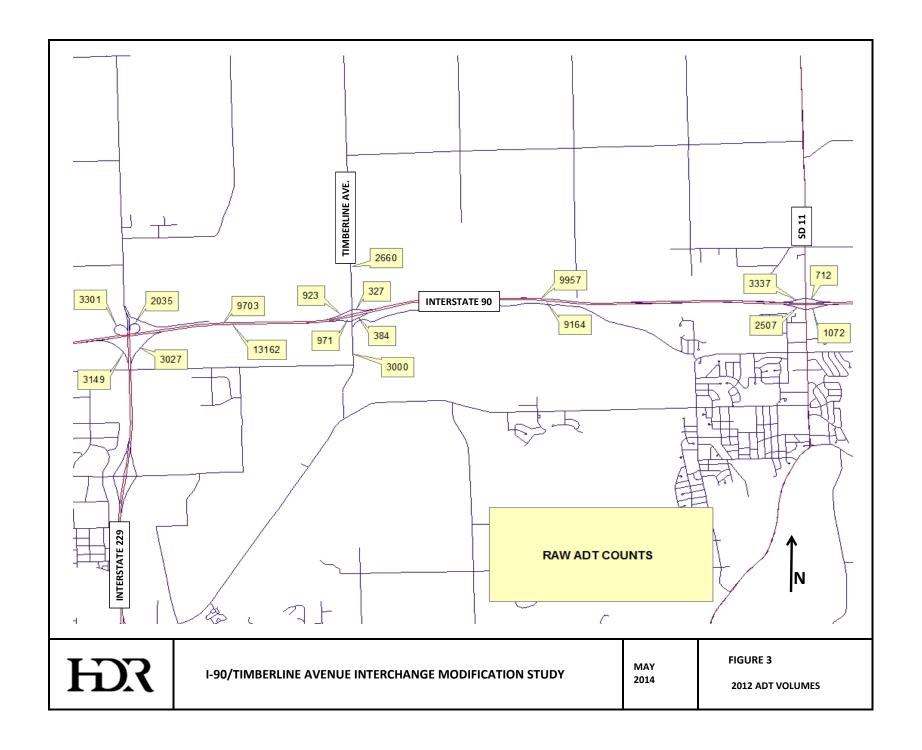
The existing study area roadways are in rural areas and performance was evaluated using techniques for Interstate highways and rural roads. Interstate 90 and Timberline Avenue both operate at acceptable levels of service under existing conditions. Traffic volumes and levels of service are summarized in Figures 3-6. Supporting analysis printouts are provided in the Appendix 1 and 2.

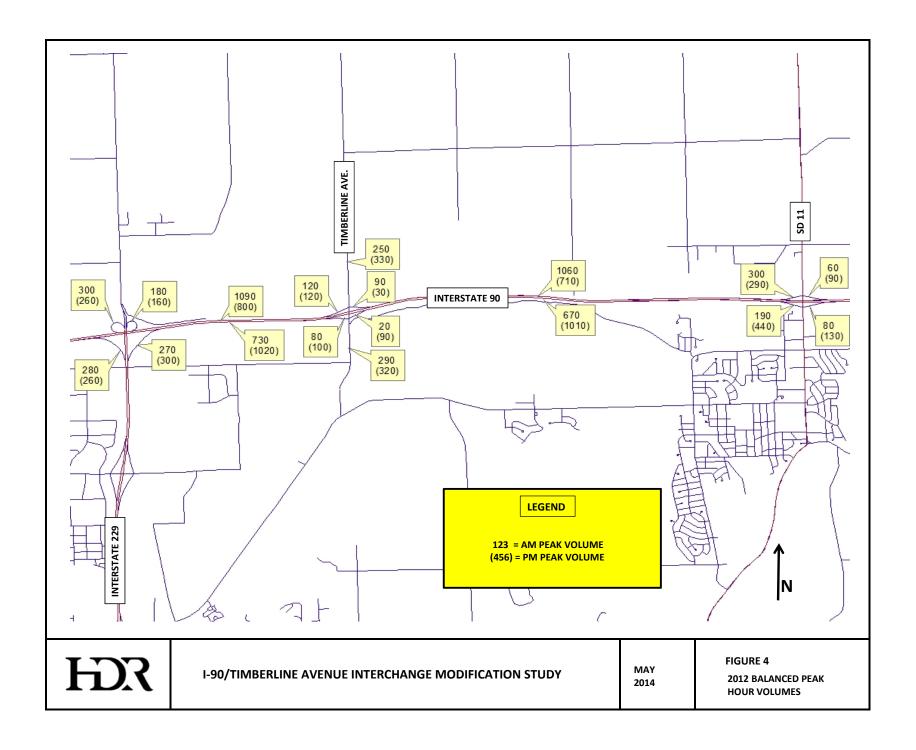
Operational performance for intersections is related to the delay experienced by drivers, as defined by the Highway Capacity Manual. The following table further outlines intersection level of service standards:

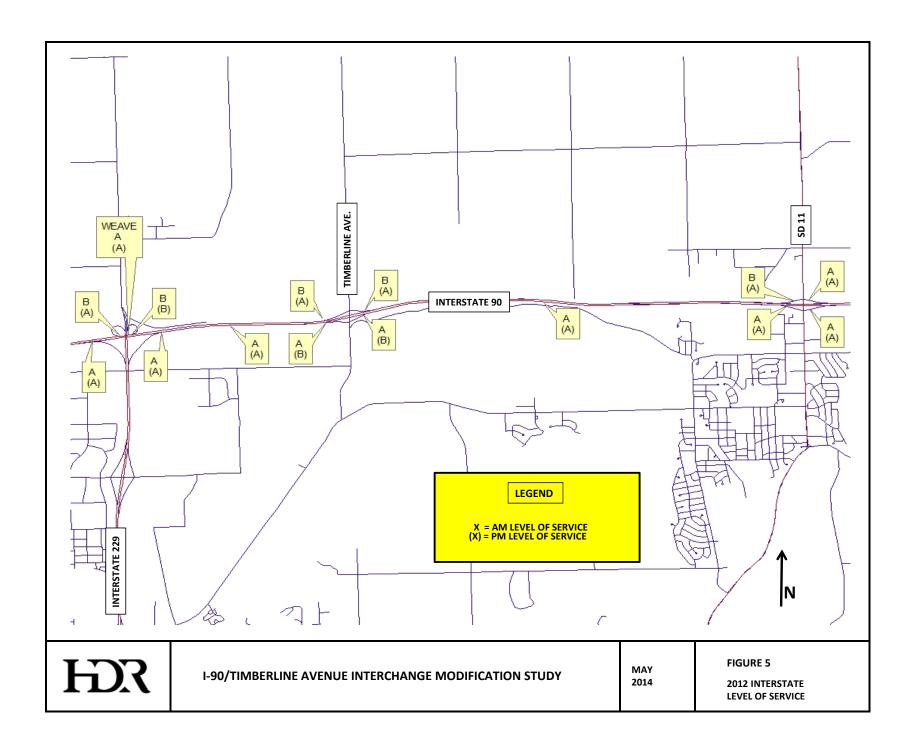
Level of Service Description

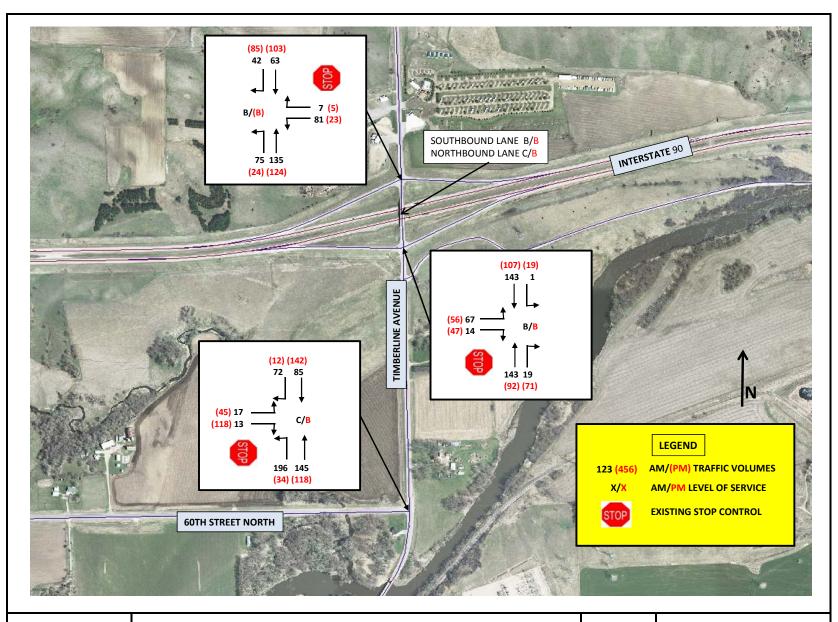
	SIGNALIZED	UNSIGNALIZED	
	Intersection	Intersection	
Level of	Control Delay	Control Delay	
Service	(sec.)	(sec.)	Intersection LOS Description
A	<=10.0	<=10.0	Free flow, insignificant delays.
В	10.1-20.0	10.1-15.0	Stable operation, minimal delays.
С	20.1-35.0	15.1-25.0	Stable operation, acceptable delays.
D	35.1-55.0	25.1-35.0	Restricted flow, regular delays.
Е	55.1-80.0	35.1-50.0	Maximum capacity, extended delays.
			Volumes at or near capacity. Long
			queues form upstream from intersection.
F	>80.0	>50.0	Forced flow, excessive delays. Represents
			jammed conditions. Intersection operates
			below capacity with low volumes. Queues
			may block upstream intersections.

Source: Highway Capacity Manual, Transportation Research Board, 2010











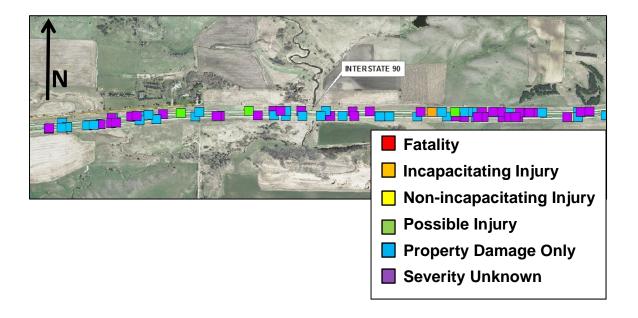
I-90/TIMBERLINE AVENUE INTERCHANGE MODIFICATION STUDY

MAY 2014 FIGURE 6

2012 INTERSECTION VOLUMES AND LEVEL OF SERVICE

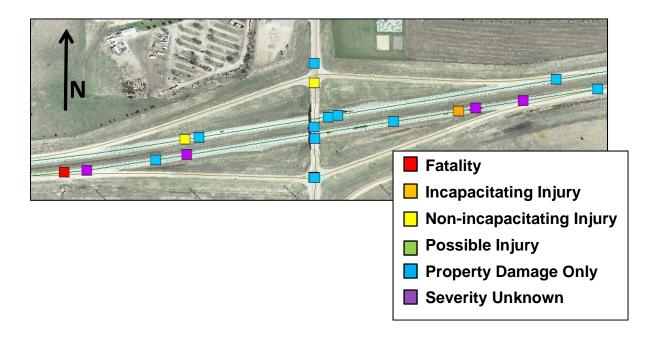
Existing Safety Conditions

The South Dakota Departments of Transportation and Public Safety make crash information available through GIS applications. GIS plots are used throughout this section to display the spatial distribution of crashes for a recent six-year period. The study corridor resides in an area that sees some of the highest frequencies of deer-related crashes in the state. Efforts are underway to reduce the deer herd and other measures have been studied to reduce the incidence of animal hits.



<u>I-90, I-229 to Timberline Avenue</u>: Potential crash trends on I-90 between the I-229 and Timberline Avenue interchange:

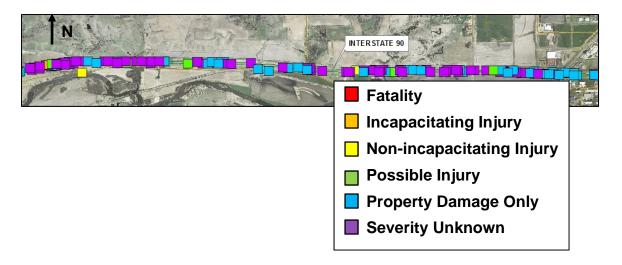
	Manner of Crash				
	Weather			Total	Documented
Year	Related	Animal	Other	Crashes	Injury
2008	8	8	2	18	1
2009	6	13	2	21	3
2010	9	13	3	25	2
2011	2	9	3	14	0
2012	1	8	1	10	0
2013	2	7	0	9	0
Total	28	58	11	97	6



<u>I-90/Timberline Avenue</u>: Potential crash trends at the I-90/Timberline Avenue interchange include:

	Manner of Crash				
	Weather			Total	Documented
Year	Related	Animal	Other	Crashes	Injury
2008	2	0	0	2	1^1
2009	3	0	0	3	1
2010	1	1	0	2	0
2011	0	1	0	1	0
2012	3	2	2	7	2
2013	4	2	1	7	0
Total	13	6	3	22	4

¹ An overturn accident resulted in a fatality.



<u>I-90 – Timberline Avenue to SD 11</u>: Potential crash trends on I-90 between Timberline Avenue and the SD 11 interchanges include:

	Manner of Crash				
	Weather			Total	Documented
Year	Related	Animal	Other	Crashes	Injury
2008	9	13	3	25	1^1
2009	4	25	3	32	2
2010	11	14	7	32	3^2
2011	2	26	1	29	3
2012	3	14	5	22	1
2013	4	16	4	24	0
Total	33	108	23	164	10

¹ A rear-end accident resulted in a fatality.

Existing Environmental Constraints

Environmental constraints are being evaluated through an EA that is being prepared simultaneously with this Interstate access report. The study area includes portions of the Big Sioux River floodplain and associated riparian and wooded areas. The previous approved 2003 EA, however, found no fatal flaws with development of the Eastside Corridor.

² An over-turn accident under slippery conditions resulted in a fatality.

PROJECT NEED

The Eastside Corridor is under development to provide regional arterial transportation service to developing areas around the east and south sides of the Sioux Falls metropolitan area. The corridor is part of extensive regional comprehensive, land use and infrastructure planning. Sections of the Eastside Corridor have been built while others are either under construction or scheduled for construction.

The northern terminus of the Eastside Corridor is the I-90 Exit 402 interchange. Additional travel demand associated with the Eastside Corridor will overwhelm the capacity of the existing rural diamond interchange (Figure 12 shows that the ramp termini level of service falls to F during the peak hours).

The interchange, therefore, needs to be rebuilt to provide additional capacity and configured to provide a useful terminus of the Eastside Corridor.

The *Decennial Interstate Corridor Study*, 2010 also identified the following geometric needs at the study interchange:

- Inslope for mainline and ramp junction
- Bridge section width for SD100 mainline
- Super-elevation rate for ramp roadway
- Grades on the ramp roadway
- Lane width and right shoulder width on ramp roadway
- The K value for ramp roadway
- On-ramp and off-ramp taper for ramp junction

ALTERNATIVES

The following interchange alternatives were developed and screened through the Environmental Assessment process:

- Alternative 1: Standard Diamond
- Alternative 2: Tight Diamond
- Alternative 3: Single Point
- No-build

Alternative 1: Standard Diamond Alternative (Figure 7):

This option is similar to the existing diamond interchange configuration. However, the spacing of the ramp intersections at the Eastside Corridor is moved further apart to accommodate signalized intersections. Due to the need for signals, the spacing between ramp intersections should be no less than 1,300 feet. In addition to the ROW impacts to the north, environmental constraints to the south caused by the Big Sioux River flood way control how far south of the proposed interchange 60^{th} Street North can be constructed. The location of the SD100/60th Street North intersection creates undesirable intersection spacing between the eastbound ramp intersection and the 60^{th} Street North intersection. The diamond interchange contains a diagonal one-way ramp in each quadrant allowing traffic to leave or enter the interstate at higher speeds.

Advantages

- o Typical interchange familiarity
- Lowest construction cost of options developed

Disadvantages

- o Increased right-of-way (ROW) needs as compared to Alternatives 2 and 3.
- o Spacing between the interchange eastbound ramp and 60th Street North/SD100 intersection is too close to provide adequate storage.

Alternative 2: Tight Diamond Alternative (Figure 8):

This type of interchange is similar to a diamond interchange in that it uses two traffic signals and typical diamond traffic movements. However, this interchange type utilizes less ROW by reducing the spacing between ramp intersections. Traffic is controlled in a similar method to a Single Point Interchange (SPI) in that the attempt is to store vehicles outside the interchange. However, two signals are utilized instead of one with a SPI.

Advantages

- Lowest ROW needs and business impacts when compared to Alternatives 1 and 3
- o Lower construction cost when compared to a SPI

Disadvantages

- o Reduced traffic capacity (major concern)
- o Difficult signal timing (major concern)
- o Driver familiarity is higher for a SPI as there are more SPI interchanges than tight diamond interchanges around Sioux Falls.

Alternative 3: Single-Point Alternative (Figure 9):

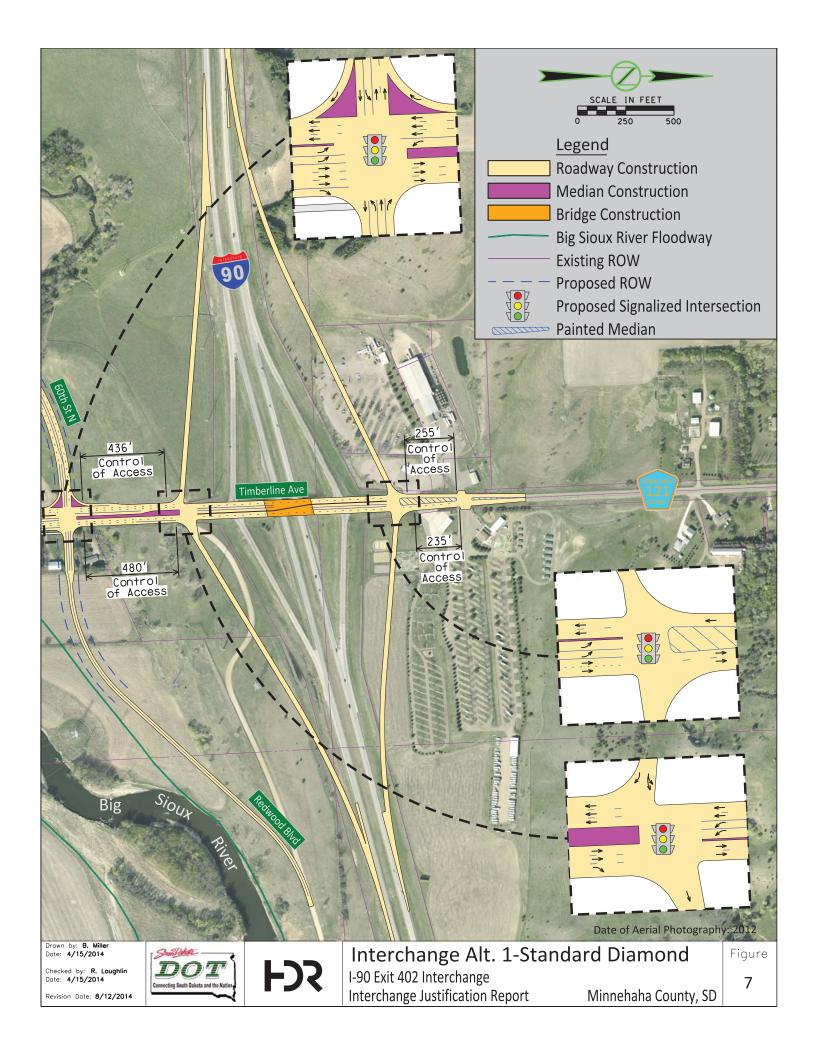
This type of interchange is best suited for areas where right-of-way availability is limited. At this location, businesses located north of the interchange are a concern for acquiring additional ROW. The Single-Point Interchange essentially combines both ramp terminals into one large intersection which accommodates all vehicular movements and is controlled by a single traffic signal. The other unique concept of the Single-Point Interchange is that opposing left turning movements are to the left of each other.

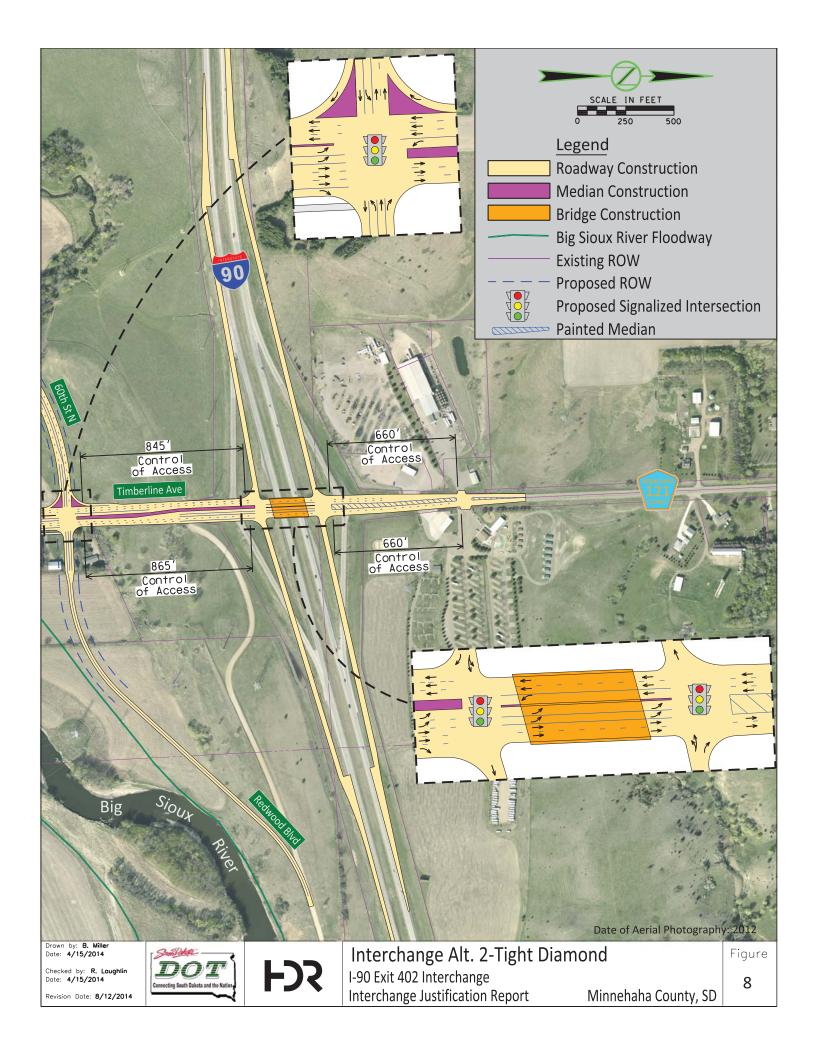
Advantages

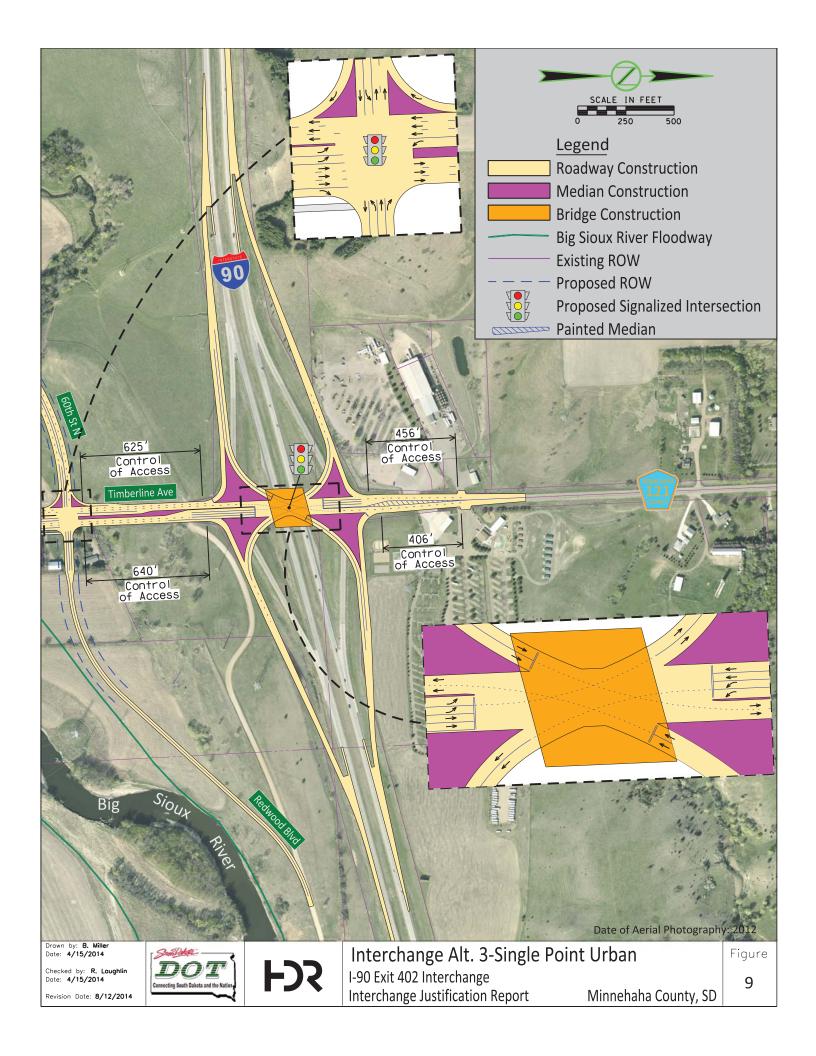
- o Reduced ROW needs and business impacts as compared to Alternative 1
- o Increased traffic capacity compared to Alternative 2
- o Driver familiarity in Sioux Falls urban area
- o Single traffic signal, reducing operating delay in interchange area
- o Increase spacing to adjacent intersections along the Eastside Corridor

Disadvantages

Higher construction cost







Improvements to adjacent interchanges and Transportation System Management alternatives were not deemed able to satisfy the need of providing an interchange with the capacity and alignment to serve the future Eastside Corridor.

FUTURE YEAR TRAFFIC

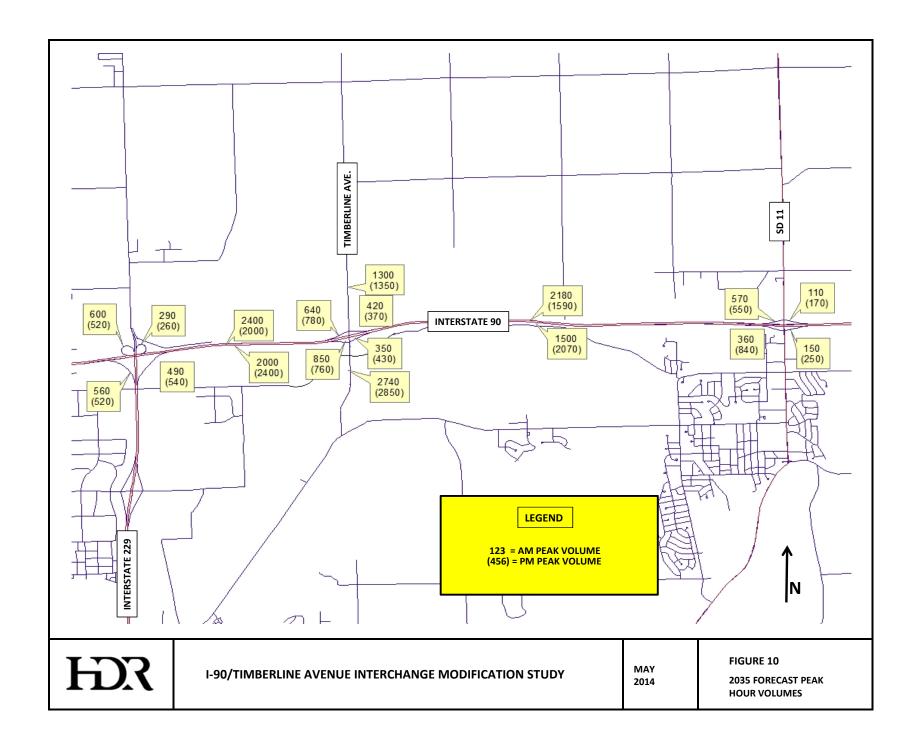
Traffic forecasts for the study area were prepared using the regional travel demand model maintained by the City of Sioux Falls and the Sioux Falls MPO. The model horizon year is 2035 and is based on local land use plans. Forecast traffic volumes are shown in Figures 10 through 14, along with the results of the operational analysis.

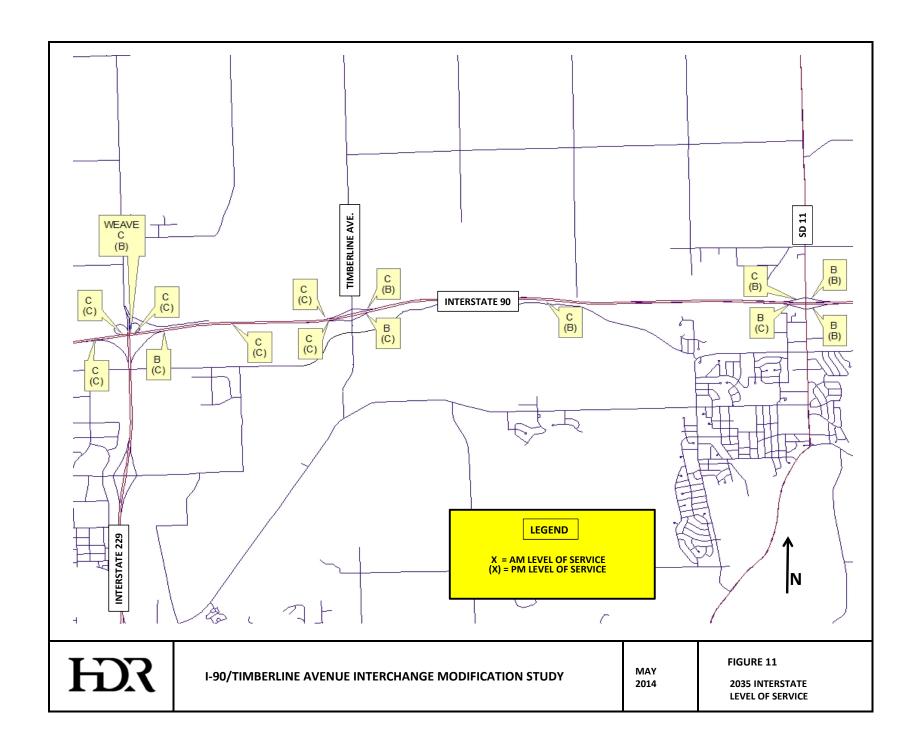
Previous analysis conducted by the SDDOT identified ramp junctions operating at or below acceptable LOS (C/D) under the current four lane interstate configuration from the I-90/I-229 (Exit 400) interchange through the I-90/Timberline (Exit 402) interchange. The study¹ recommended an auxiliary lane between Exit 400 and Exit 402 which would result in significantly improved LOS for freeway operations. It should be noted that proposed I-90/I-229 interchange alternatives in conjunction with proposed I-90/Timberline interchange alternatives do not create either configuration or operational issues to the adjacent interchange.

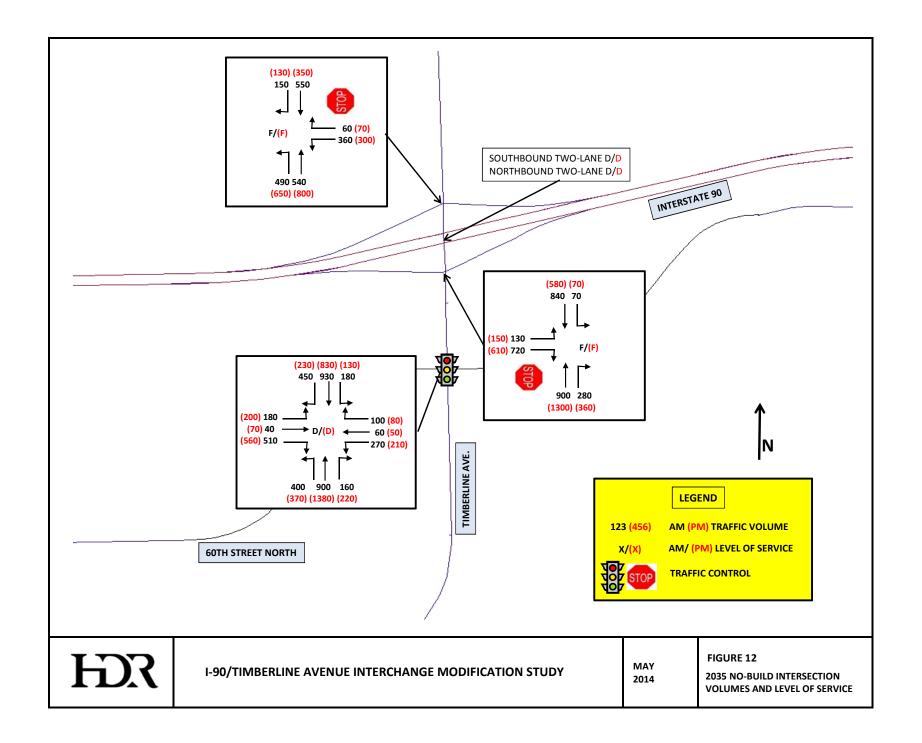
The future year traffic analysis in this report is based on the 2035 model year, which does not meet the 20-year projection requirement from planned construction. The future 20-year traffic analysis for corridor and interchange will be reviewed by SDDOT, during final design, to confirm that the 20-year traffic projection from the planned year of construction provides an acceptable level of service established for this project using the 2040 model year.

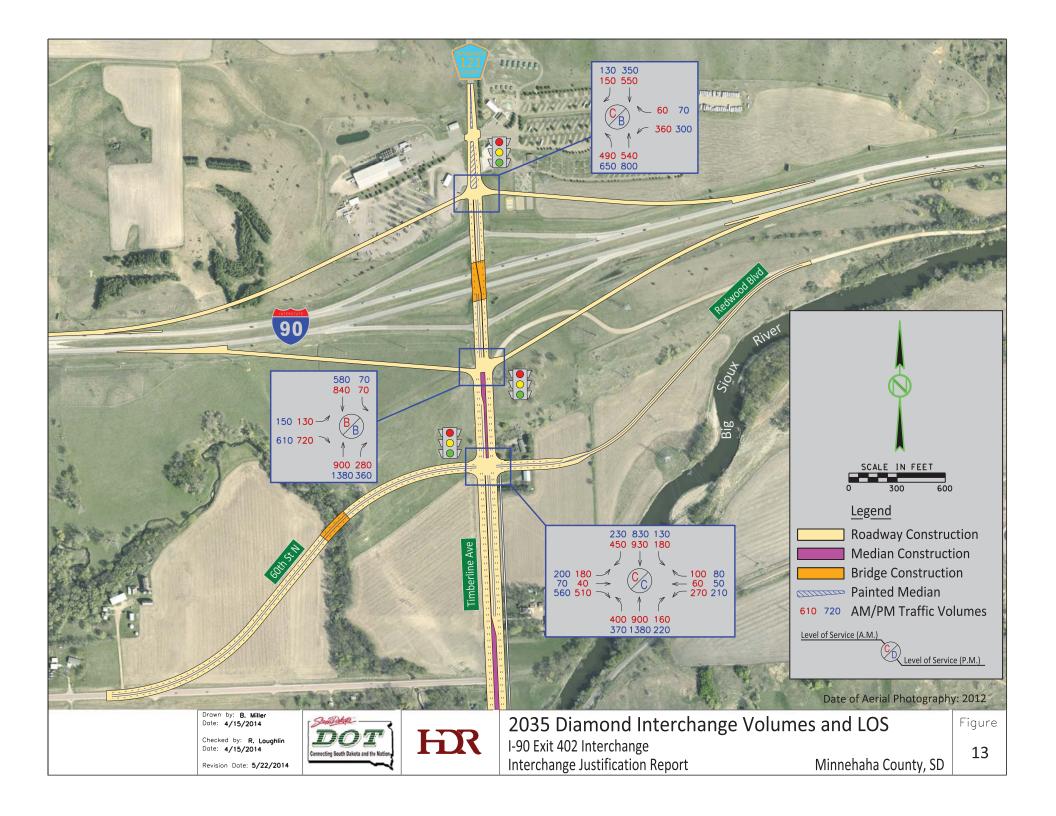
I-90/Timberline Avenue Interchange Modification Report

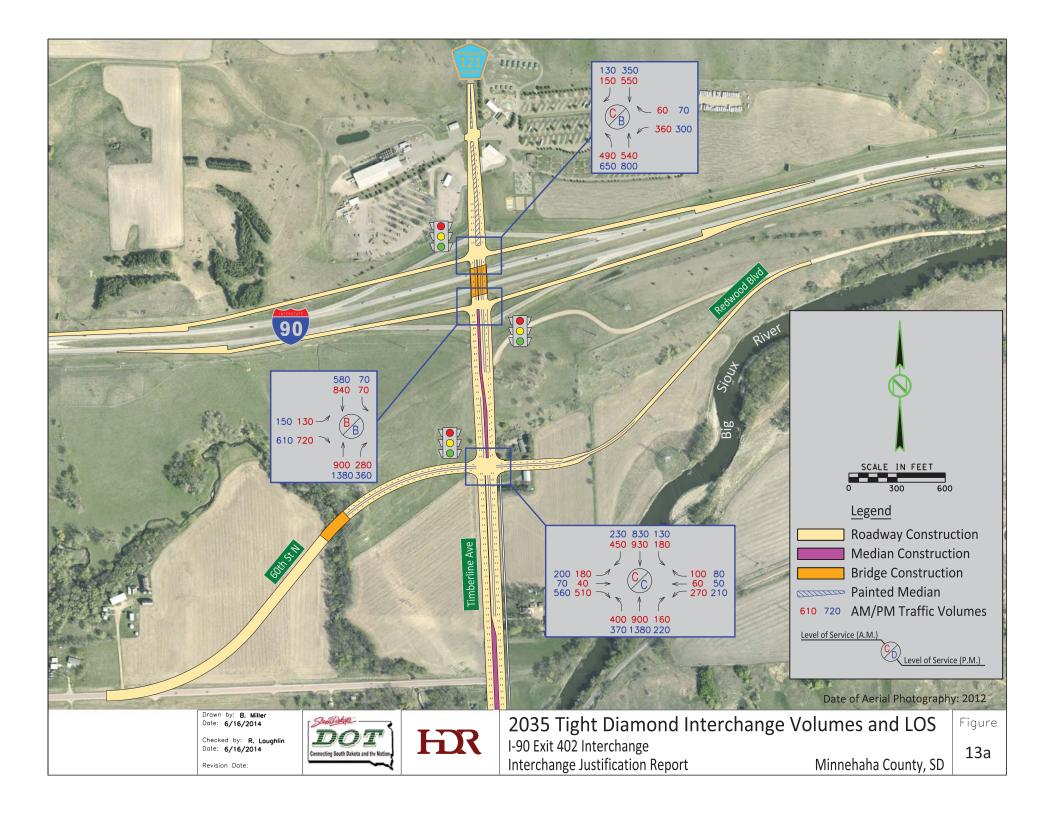
¹ The study "Interstate 90/Interstate 229 Interstate Access Modification Request" is located at: http://www.sddot.com/transportation/highways/planning/specialstudies/docs/IJR_I229-I90 Final% 20Revised.pdf

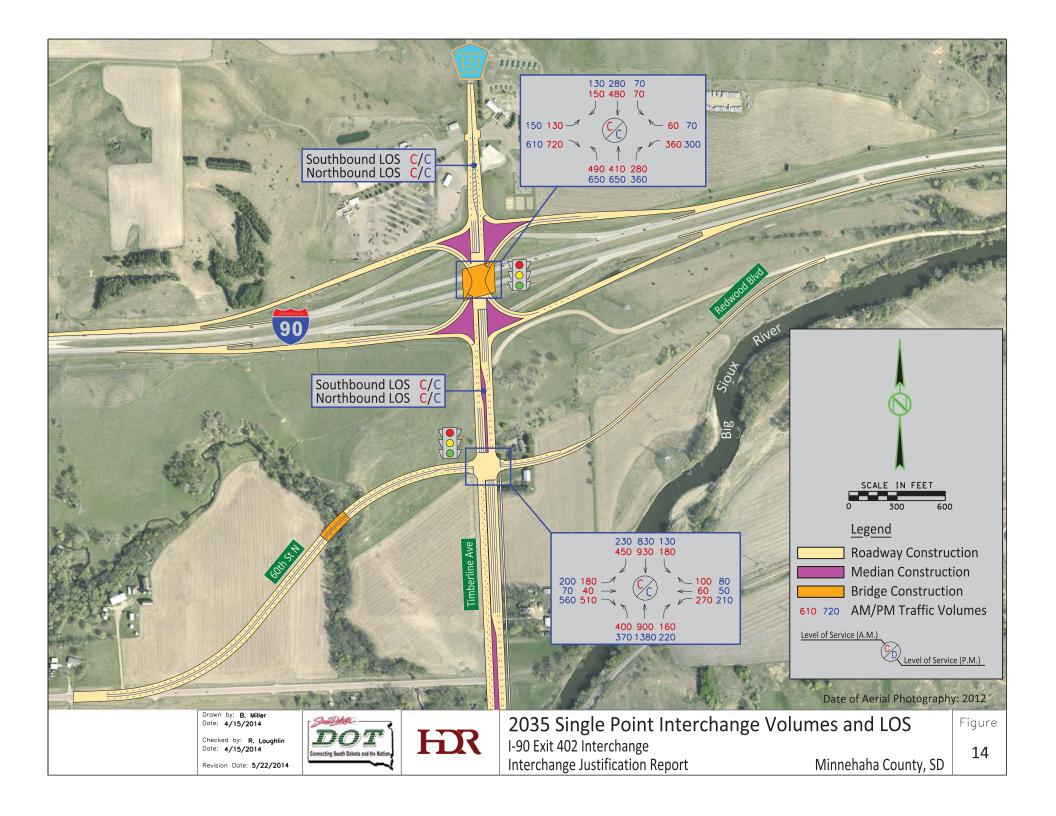












ALTERNATIVES ANALYSIS

The retained interchange improvement alternatives were analyzed and compared to determine which may be most suitable for meeting the project need. The areas of analysis and comparison are discussed in the following sections.

Conformance with Transportation Plans

Local (MPO and City) and State transportation plans have identified a need for construction of the Eastside Corridor, a regional arterial highway corridor around the east and south sides of the Sioux Falls metropolitan area. All interchange alternatives satisfy the existing transportation planning considerations.

Compliance with Policies and Engineering Standards

Each of the interchange alternatives is a standard interchange configuration. Conceptual design has used the latest guidance from AASHTO and FHWA and it appears that final design may be accomplished without conflict with geometric design standards.

One potential access management conflict is posed by the signalized intersection spacing between the interchange and the planned 60th Street North/Eastside Corridor intersection. SDDOT access management standards call for signal spacing of at least ½ mile (2,640') on roadways like the Eastside Corridor. Other guidelines and research recommends signalized intersections no closer than ¼ mile (1,320') from interchange ramp terminals.

Alternative 1 (Standard Diamond) has a center to center spacing from the nearest ramp to 60th Street of approximately 600'. Alternative 2 (Tight Diamond) has a center to center spacing of approximately 1000'. Alternative 3 (Single Point) has a center to center spacing from the central intersection to 60th Street of approximately 1200'.

Access standards for the Eastside Corridor have been established through a cooperative planning process between the SDDOT and the Sioux Falls MPO agencies, which takes precedence over regular state and local access standards under South Dakota administrative rules. That study has accepted the concept of a signalized intersection at 60th Street North. Previous analysis looked at queue spillback and interactions between adjacent traffic signals and concluded that the tight diamond and single point alternatives should operate acceptably. The standard diamond alternative, however, may experience queue interference between adjacent traffic signals.

The existing configuration and the alternatives are affected by the close proximity of existing commercial driveways on the north side of I-90. Agreements have been made with the existing businesses and a resolution by the SDDOT Transportation Commission has addressed these driveways. A driveway will be maintained for each of the existing businesses, but no other driveways will be allowed through control of access and agreement. As a result, the property access within the vicinity of the interchange will satisfy the SDDOT Road Design Manual and the AASHTO Policy standards.

Environmental Impacts

The original EA recommended that the Eastside Corridor intersect with I-90 at the existing interchange; no interchange configuration was recommended, although the previous draft Interstate access report found that a slight realignment of the crossroad and a single point interchange were the best solution for the evolving design of the Eastside Corridor. Steep slopes, floodplain, and riparian areas exist adjacent to the interchange area, but it appears that no environmentally-sensitive features are being adversely impacted by interchange configuration. The EA is being prepared concurrently with this revision of the IMJR to address recent roadway alignment changes.

Each of the Build Alternative Concepts along with the No-Build Alternative was presented at a Public Hearing on January 17, 2007. Following the Public Hearing, the alternatives were re-evaluated based on comments received and further analysis and as a result, Alternatives 1 and 2 were eliminated from further consideration. The following sections describe reasons for eliminating alternatives as well as the selection of the preferred alternative.

Preferred Alternative

Each of the alternatives developed as the potential replacement of the existing I-90 Exit 402 interchange are considered as accepted interchange configurations per the SDDOT Road Design Manual, Chapter 13. Also, except for the No-Build alternative, when performing traffic analysis, each alternative does meet acceptable traffic operations both immediately following construction and into the future. However, when comparing the alternatives to each other with respect to adjacent land impacts, long-term operations, corridor compatibility, and driver familiarity, Alternative 3 is identified as the preferred alternative.

<u>Alternative 1</u>: The larger footprint required by the Diamond Interchange configuration creates unnecessary impacts to adjacent land including negative impacts to businesses directly north of the interchange. Impacts to the Yogi Bear's Jellystone Park would require relocation of several camp amenities located directly adjacent to the interchange and Minnehaha County Road 121. The property in the northwest quadrant would lose a significant amount of their property that is currently used for consignment auctions. The loss would be significant and may require the business to relocate.

For this primary reason, it was recommended that Alternative 1 be eliminated from further consideration.

Alternative 2 & 3: The smaller footprint of the Tight Diamond Interchange (TDI) and Single Point Interchange (SPI) addresses the concerns with regards to negative impacts to adjacent land and businesses. Although an accepted interchange configuration, the TDI is not prevalent in South Dakota, which is a concern with regards to driver familiarity. Another concern is traffic operation performance of the TDI. In analysis for a research paper submitted to the Transportation Research Board (TRB), it was determined that a Single Point Interchange (SPI) provides greater traffic operations than the TDI. Over the range of tests, the SPI provided higher average travel speeds, fewer phase failures, a

lower percentage of stops and considerably higher capability to serve traffic. The results typically show that the TDI would reach capacity conditions when the SPI was operating at average conditions.

For these reasons, the Single Point Interchange is recommended as the preferred interchange configuration for the I-90 Exit 402 location. Compared to the other alternatives, Alternative 3 minimizes ROW impacts and is capable of accommodating future traffic volumes predicted to utilize this interchange. The key advantages of Alternative 3 are as follows:

- Reduced ROW needs and impacts to businesses
- Increased traffic capacity
- Driver familiarity, compared to tight diamond in Sioux Falls area
- Single traffic signal
- Increased spacing to adjacent intersections along the Eastside Corridor

While each alternative was specifically designed to meet the Project goals, only one or two drawbacks made Alternatives 1 and 2 prohibitive to construct. Alternative 1 served future capacity needs, but additional ROW and spacing issues between the eastbound ramp intersections and 60th Street North eliminated this alternative from further consideration. Alternative 2 also served future capacity needs within the planning horizon, but would experience capacity failure sooner than Alternative 3 in the period beyond 2035. For these reasons, Alternative 3 was considered superior to Alternatives 1 and 2.

Table 1
Summary of Long Term Impacts for the Interchange Alternatives

Resource	BUILD ALTERNATIVE OPTIONS				
	Alt. 1-Diamond	Alt. 2-Tight Diamond	Alt. 3-Single Point		
Air Quality	No significant	No significant	No significant		
W. O. III	impact	impact	impact		
Water Quality	No significant	No significant	No significant		
	impact	impact	impact		
Public Utility Relocations	Electrical	Electrical	Electrical		
	power lines	power lines	power lines		
Recreational Resources	No significant	No significant	No significant		
	impact	impact	impact		
Visual Impacts and Aesthetics	No significant	No significant	No significant		
-	impact	impact	impact		
Pedestrians and Bicycles	No impact	No impact	No impact		
Environmental Justice	No impact	No impact	No impact		
Noise	No significant	No significant	No significant		
	impact	impact	impact		
Threatened and Endangered	In Agency	In Agency	In Agency		
Species	Coordination	Coordination	Coordination		
Archaeological and Historical	No adverse	No adverse	No adverse		
Resources	effect	effect	effect		
Section 4(f) and 6(f) Resources	No use	No use	No use		
Regulated Materials	No significant	No significant	No significant		
	impact	impact	impact		
Land Use		-	-		
 Right-of-Way 	20.3 acres	2.57 acres	10.55 acres		
Future Land Use	Compatible	Compatible	Compatible		
Floodway	0 acres	0 acres	0 acres		
Floodplain					
• 100 year	0 acres	0 acres	0 acres		
• 500 year	0 acres	0 acres	0 acres		
Economic Resources	No significant	No significant	No significant		
Economic resources	impact	impact	impact		
Residential Relocations	None	None	None		
Business Relocations	1 permanent, 1	1 permanent, 1	1 permanent, 1		
Eddiness Refocutions	partial	partial	partial		
Habitat, Fish, and Wildlife ¹	Minor	Minor	Minor		
Wetlands and Other Waters of	1,111101	14111101	1411101		
the U.S. ²					
• Wetlands ³	1.24 acres	1.24 acres	1.24 acres		
Waters of the US	0 linear feet	0 linear feet	0 linear feet		
Waters of the OS					

Notes.

Impacts for habitat are consistent with impacts for wetlands and other waters of the U.S. Impacted wetlands would be mitigated per Section 404 of the Clean Water Act

Other waters of the U.S. identified within the Study Area for this Project include only stream channels with the presence of a definable bed and bank.

Jurisdiction is to be determined by the U.S. Army Corps of Engineers.

Safety

While there are currently no Crash Modification Factors (CMF's) to directly compare the safety effects of different interchange configurations, there is an older tool, Interchange Safety Analysis Tool (ISAT), which facilitates comparison of safety in Interchanges. Therefore, ISAT was used to estimate safety performance. The results of these model runs are estimates based on general configuration geometrics and safety performance factors and should therefore be considered only as a planning-level measure of comparison between the interchange configurations.

The ISAT model estimates the following total crashes over the period 2012 - 2035 for the alternative interchange configurations:

- Standard Diamond 895 crashes
- Tight Diamond 848 crashes
- Single Point 845 crashes

It appears, therefore, that the tight diamond and single point interchanges are expected to provide similar safety performance. The standard diamond configuration is expected to provide poorer safety performance than the other two configurations. The results of these model runs are estimates based on general configuration geometrics and safety performance factors and should therefore be considered only as a planning-level measure of comparison between the interchange configurations.

Operational Performance

The operations of the alternative interchange configurations were evaluated using appropriate level of service techniques. Performance was analyzed for forecast traffic conditions with the Eastside Corridor in place.

Interstate 90 and the Eastside Corridor both operate at acceptable levels of service under future conditions with the alternative interchanges in place. Use of the existing interchange configuration, however, results in poor interchange performance. The single-point interchange (Alternative 3) provides preferable performance because of its single signalized intersection at the interchange and better spacing to the adjacent intersection. Traffic volumes and levels of service are summarized in Figures 11-14. Supporting analysis printouts are provided in the Appendix 3 and 4.

Evaluation Matrix

Table 2 provides a comparison of the characteristics of each of the interchange alternatives. The table shows that the single-point interchange alternative provides the best technical solution to the transportation needs at this location, based on operational performance.

Table 2 – Evaluation Matrix

Alternative	Conformance with Plans	Compliance with Standards	Environmental Impacts	Safety	Operational Performance
No-Build	No	No	Didn't satisfy project need	N/A	Poor
Alt. 1 – Diamond	Yes	Yes	Extra ROW, relocation required	Good	Good
Alt. 2 – Tight Diamond	Yes	Yes	Little impact	Good	Good
Alt. 3 – Single Point	Yes	Yes	Little impact	Good	Best

Coordination

The Eastside Corridor, including its terminal interchange at Interstate 90, has been the subject of agency coordination and public involvement as part of the environmental assessment process, including public meetings. Further details are available in the Supplement to the EA. The interchange alternatives have also been the subject of review and public hearing through the regular meetings of the MPO committees.

FUNDING PLAN

The 2014-2017 Statewide Transportation Improvements Program (STIP) and the 2014—2017 MPO Transportation Improvements Program (TIP) contain projects for the further construction of the Eastside Corridor. Construction of the interchange project is currently expected in 2017 and the 2014-2017 STIP includes the funding allocations shown below. The inflated estimated cost for the overall 2017 project is \$40.658 Million.

TABLE 3 - ANTICIPATED FUNDING ALLOCATION BREAKDOWN					
State Funding	Federal	Federal Funds	State Funds	Total Funds	
Category	Funding				
	Category				
Interstate Funding	National	\$9.274 Million	\$1.416 Million	\$10.690 Million	
[IM 0909(75)402]	Highway				
	Performance				
	Program				
State Highway	National	\$21.134 Million	\$5.739 Million	\$26.873 Million	
Urban Funding	Highway				
[NH 0100(104)420]	Performance				
	Program				
Total		\$30.408 Million	\$7.155 Million	\$37.563 Million	

Note: As funding is fluid, category breakdown may be different at time of project authorization.

RECOMMENDATIONS

The Environmental Assessment and the technical analysis contained in this Interstate access report have found that the best solution for transportation needs in the study area is to build a single point interchange, Alternative 3, connecting the new Eastside Corridor route to I-90. The proposed interchange is at the site of the existing I-90/Timberline Rd. interchange (Exit 402).

The eight considerations and requirements for Interstate access are addressed below:

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.

State/local planning efforts have identified the need for a new regional arterial highway to serve growth around the east and south sides of the Sioux Falls metropolitan area. That regional arterial highway, called the Eastside Corridor, is currently under phased construction and is planned to intersect with I-90 at the existing I-90/Timberline Rd. interchange (Exit 402).

The existing interchange does not provide sufficient capacity to handle the traffic associated with the Eastside Corridor, but will serve adequately with changes to configuration and design. The Environmental Assessment and this report have identified a single-point interchange as providing the best solution to transportation needs in the study area.

The proposed change of configuration at Exit 402 will not result in any additional access points on I-90 and only a very slight change in interchange spacing.

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 with the proposed change(s) in access.

The preferred alternative involves changes to the geometric design of an existing interchange to meet the transportation needs in the study area. Future transportation demand will require additional lanes on the crossroad, but no additional lanes at the ramp merge/diverge areas, nor additional lanes on the Interstate mainline. Mass transit and HOV facilities are not planned for this portion of the MPO area within the study planning horizon.

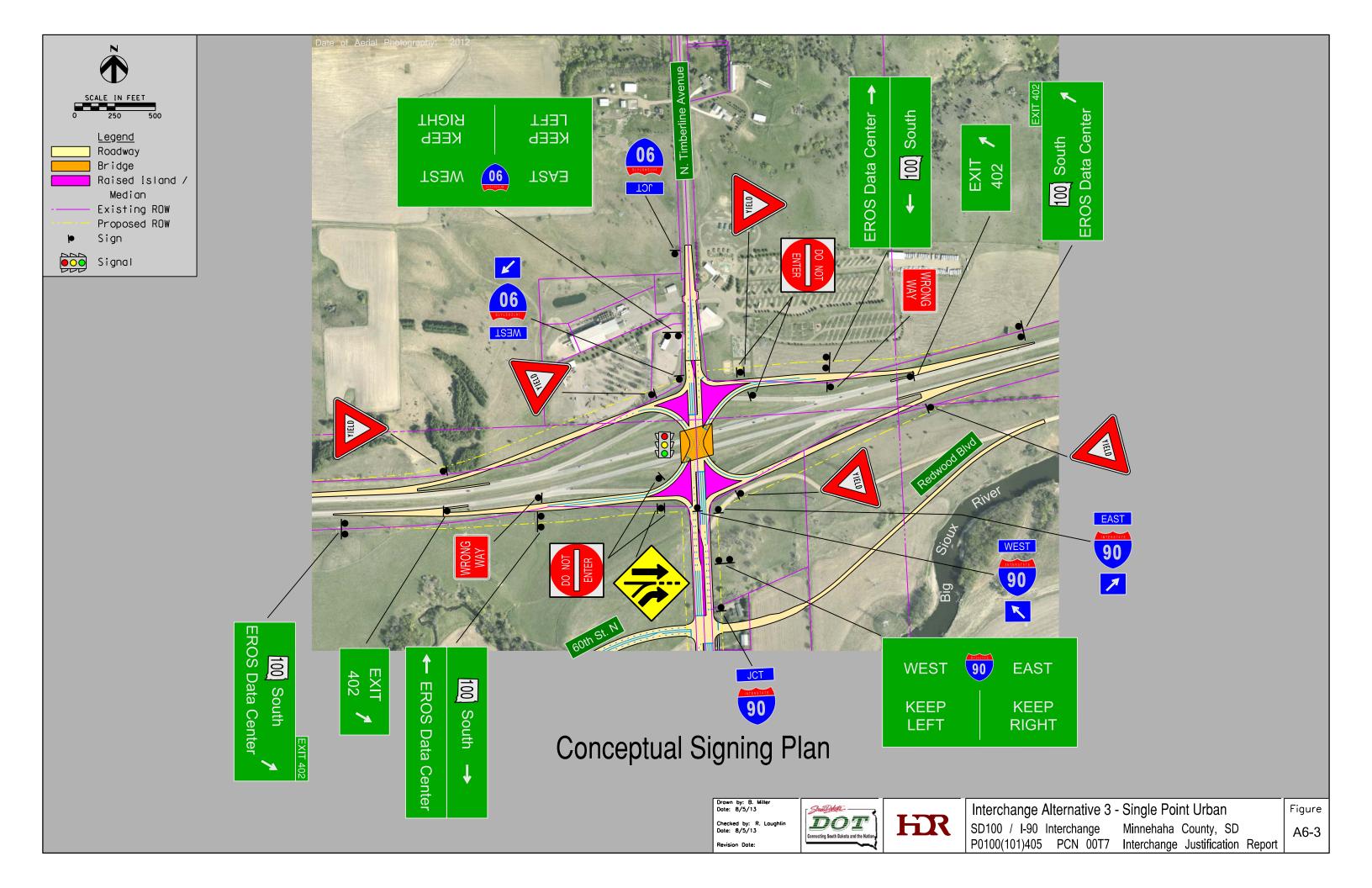
3) An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified

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, 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. 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. Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative.

The operational and safety analysis contained in this study shows that Interstate mainline and ramp facilities will continue to operate within operational and safety goals with any of the proposed alternatives. A safety analysis of recent crash records has been provided in the "Existing Safety Analysis" section on page 15. It shows that the primary crash types in the study area involve animal hits and single-vehicle crashes during inclement weather. The ramp terminal intersections, however, will fail with the No-Build alternative, but will continue to operate acceptably with the other alternatives.

The conceptual signing plan for the Single Point interchange alternative is shown in Figure A6-3. Page 39.

- 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.
 - The proposed access is a reconfiguration of an existing interchange with a county road and includes all movements. The conceptual drawings have been prepared using current standards and design using current standards is anticipated.
- 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.
 - The proposal is the result of land use and transportation plans prepared within the MPO process. This Interstate Modification Justification Report supplements a previously approved EA which has resulted in construction being programmed in the 2014 STIP and TIP.



- 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.
 - SDDOT has prepared the Decennial Interstate Corridor Study (2010), which considered all proposed additions to the Interstate Highways System within the state of South Dakota. The proposed interchange reconfiguration was addressed in the Decennial study and no other interchanges were anticipated within the study area. The Sioux Falls MPO Long Range Transportation Plan has included a new interchange at Exit 404 as a potential project need beyond the 2035 planning horizon. No funding has been assigned or detailed analysis conducted for this potential project.
- 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. 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.
 - The proposed access change results not from any particular development, but from overall growth within the metropolitan area. It is part of a planned program of transportation improvements throughout the metropolitan area to address future transportation needs.
- 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 environmental processing.
 - An original EA for the Eastside Corridor was signed on March 20, 2003. Currently, an EA for the northern segment (Madison Street north) is being prepared to address changes in alignment identified in the 2003 EA that occurred during preliminary design.

APPENDIX

1 – 2012 Interstate Level of Service 2 – 2012 Crossroad Level of Service 3 – 2035 Interstate Level of Service 4 – 2035 Crossroad Level of Service 5 – Crash Forecasts 6 – Signing Plans 7 – Interchange Area Air Photos

Appendix Part 1—2012 Interstate Level of Service

I-90/Timberline Road Interchange



Phone: E-mail:		Fax:		
	Operational Pi	lanning Analysis		
Analyst:	HDR			
-	SDDOT			
Date Performed:				
Analysis Time Period:				
Freeway/Direction:				
<u> -</u>	I-229/TIMBERLIN	IE		
	MINNEHAHA CO.			
Analysis Year:	Existing			
Description: I-90/SD 10	_			
	_Flow Inputs ar	nd Adjustments		
Annual average daily tra	ffic, AADT	20270	veh/day	
Peak-hour proportion of	AADT, K	0.09		
Peak-hour direction perc	ent, D	60	%	
Volume, DDHV		1095	veh/h	
Peak Hour factor, PHF		0.90		
Trucks and buses		11	%	
Recreational vehicles		0	%	
Terrain type:		Rolling		
Grade		-	8	
Segment length		-	mi	
Trucks and buses PCE, ET		2.5		
Recreational vehicles PC		2.0		
Heavy Vehicle adjustment Driver population factor		0.858 1.00		
Flow rate, vp	, гр	709	pc/h/ln	
riow race, vp		709	pc/11/111	
	_Speed Inputs a	and Adjustments		
Lane width		12.0	ft	
Right-side lateral clear	ance	6.0	ft	
Interchange density		1.20	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base		
FFS or BFFS		75.4	mi/h	
Lane width adjustment, f		0.0	mi/h	
Lateral clearance adjust		0.0	mi/h	
Interchange density adju	stment, fID	3.8	mi/h	
Free-flow speed		71.6	mi/h	
	_LOS and Perfor	rmance Measures		
Flow rate, vp		709	pc/h/ln	
Free-flow speed, FFS		71.6	mi/h	
Average passenger-car sp	eed, S	70.0	mi/h	
		^		

2

Number of lanes, N

Density, D Level of Service, LOS Α

10.1 pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: E-mail:		Fax:		
	Operational Pla	anning Analysis_		
	_	5 1 -		
Analyst:	HDR			
Agency or Company: Date Performed:				
Analysis Time Period:	1/2014			
Freeway/Direction:				
	I-229/TIMBERLIN	F.		
	MINNEHAHA CO.	_		
Analysis Year:				
Description: I-90/SD 1				
	Flow Inputs and	d Adjustments		
Annual average daily to	caffic, AADT	20270	veh/day	
Peak-hour proportion of		0.10		
Peak-hour direction per	cent, D	56	%	
Volume, DDHV		1135	veh/h	
Peak Hour factor, PHF		0.90		
Trucks and buses		11	%	
Recreational vehicles		0	%	
Terrain type: Grade		Rolling -	ે	
Segment length		- -	mi	
Trucks and buses PCE, F	iФ	2.5	шт	
Recreational vehicles I		2.0		
Heavy Vehicle adjustmen		0.858		
Driver population factor		1.00		
Flow rate, vp		735	pc/h/ln	
	Speed Inputs a	nd Adjustments		
Lane width		12.0	ft	
Right-side lateral clea	arance	6.0	ft	
Interchange density		1.20	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base	1. 73	
FFS or BFFS	£ 7 7.7	75.4	mi/h	
Lane width adjustment, Lateral clearance adjus		0.0	mi/h mi/h	
Interchange density adj		0.0 3.8	mi/h	
Free-flow speed	jusement, IID	71.6	mi/h	
	LOS and Perfor	mance Measures		
Flow rate, vp		735	pc/h/ln	
Free-flow speed, FFS		71.6	mi/h	
Average passenger-car s	speed. S	70.0	mi/h	
Number of lanes, N	.F 550/ 5	2	/ 11	
,				

Density, D Level of Service, LOS Α

10.5 pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: E-mail:		Fax:		
	Operational Pla	anning Analysis_		
_				
Analyst:	HDR			
Agency or Company: Date Performed:				
Analysis Time Period:	1/2014			
Freeway/Direction:				
From/To:	TIMBERLINE/SD 1	1		
	MINNEHAHA CO.	_		
Analysis Year:				
Description: I-90/SD 1				
	Flow Inputs and	d Adjustments		
Annual average daily to	raffic, AADT	17560	veh/day	
Peak-hour proportion of		0.09		
Peak-hour direction per	cent, D	60	%	
Volume, DDHV		948	veh/h	
Peak Hour factor, PHF		0.90	-	
Trucks and buses		11	8	
Recreational vehicles		0	8	
Terrain type: Grade		Rolling	ે	
Segment length		-	mi	
Trucks and buses PCE, I	יחי	2.5	шт	
Recreational vehicles		2.0		
Heavy Vehicle adjustmen		0.858		
Driver population factor		1.00		
Flow rate, vp	· ·	614	pc/h/ln	
	Speed Inputs a	nd Adjustments		
Lane width		12.0	ft	
Right-side lateral clea	arance	6.0	ft	
Interchange density		0.50	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base		
FFS or BFFS	C	75.4	mi/h	
Lane width adjustment,		0.0	mi/h	
Lateral clearance adjust Interchange density adj		0.0 1.8	mi/h mi/h	
Free-flow speed	justment, IID	73.6	mi/h	
rice flow speed			·	
	LOS and Perfor	mance Measures		
Flow rate, vp		614	pc/h/ln	
Free-flow speed, FFS		73.6	mi/h	
Average passenger-car s	speed, S	75.0	mi/h	
Number of lanes, N		2		

Density, D Level of Service, LOS 8.2 A pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: E-mail:		Fax:		
	Operational Pl	anning Analysis_		
				
Analyst:	HDR			
Agency or Company:				
	1/2014			
Analysis Time Period:				
Freeway/Direction:		1		
From/To: Jurisdiction:	TIMBERLINE/SD 1 MINNEHAHA CO.	1		
Analysis Year:				
Description: I-90/SD 1				
	Flow Inputs an	d Adjustments		
Annual average daily tr	affic, AADT	17560	veh/day	
Peak-hour proportion of	AADT, K	0.10	_	
Peak-hour direction per	cent, D	56	%	
Volume, DDHV		983	veh/h	
Peak Hour factor, PHF		0.90		
Trucks and buses		11	%	
Recreational vehicles		0	%	
Terrain type:		Rolling	•	
Grade		_	8	
Segment length	ım	- 2.5	mi	
Trucks and buses PCE, E Recreational vehicles F		2.0		
Heavy Vehicle adjustmen		0.858		
Driver population factor		1.00		
Flow rate, vp	, , , , , , , , , , , , , , , , , , ,	636	pc/h/ln	
	Speed Inputs a	nd Adjustments		
Lane width		12.0	ft	
Right-side lateral clea	rance	6.0	ft	
Interchange density		0.50	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base		
FFS or BFFS		75.4	mi/h	
Lane width adjustment,		0.0	mi/h	
Lateral clearance adjus		0.0	mi/h	
Interchange density adj	ustment, IID	1.8	mi/h mi/h	
Free-flow speed		73.6	1111/11	
	LOS and Perfor	mance Measures		
Flow rate, vp		636	pc/h/ln	
Free-flow speed, FFS		73.6	mi/h	
Average passenger-car s	speed, S	75.0	mi/h	
Number of lanes, N		2		

Density, D Level of Service, LOS 8.5 A pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: I-229 Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 66.0 mph Volume on freeway 740 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 50.0 mph Volume on ramp 280 vph Length of first accel/decel lane 610 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 270 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2930 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 740 280 270 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 206 78 75 V Trucks and buses 11 6 6 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

```
Flow rate, vp
                                   958
                                               339
                                                          327
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 958 	 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        958
                                     4720
                                                    No
     Fi F
    v = v - v
                        619
                                     4720
                                                    No
        F R
     FΟ
                        339
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
               > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 958
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    958
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 7.0 	pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.264
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 59.7
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
Space mean speed for all vehicles,
                                        S = 59.7
                                                     mph
```

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB Junction: I-229 Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 66.0 mph Volume on freeway 980 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 50.0 mph Volume on ramp 260 vph Length of first accel/decel lane 610 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 300 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2930 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 980 260 300 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 272 72 83 V Trucks and buses 11 6 6 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

```
1.00
Driver population factor, fP
                                               1.00
                                                          1.00
Flow rate, vp
                                   1269
                                               315
                                                          363
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1269 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                        Actual
                                     Maximum
                                                   LOS F?
    v = v
                        1269
                                     4720
                                                    No
     Fi F
    v = v - v
                        954
                                     4720
                                                    No
        F R
     FO
                        315
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 1269
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    1269
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 9.7 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.261
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 59.7
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
Space mean speed for all vehicles,
                                        S = 59.7
                                                     mph
```

0.917

0.917

Heavy vehicle adjustment, fHV

Phone: E-mail:		Ι	Fax:					
	D. (1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	7 7						
	Merge	Analy	/S1S					
Analyst: HDR Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: I-229 Jurisdiction: MINNEHAE Analysis Year: Existing Description: I-90/SD 100 IMJR								
	Free	way Da	ata					
Type of analysis			Merge					
Number of lanes in freeway			2					
Free-flow speed on freeway			66.0		mph			
Volume on freeway			460		vph			
	On Ra	amp Da	ata					
			D' 1.					
Side of freeway			Right					
Number of lanes in ramp			1		mmh			
Free-flow speed on ramp			55.0		mph			
Volume on ramp			270		vph			
Length of first accel/decel land Length of second accel/decel land			880		ft ft			
heligeli of second accer/decer far	ie				IL			
Adjacer	nt Ramp	Data	(if on	e exists)			
Does adjacent ramp exist?			Yes					
Volume on adjacent Ramp			280		vph			
Position of adjacent Ramp			Upstre	am	- <u>-</u>			
Type of adjacent Ramp			Off					
Distance to adjacent Ramp			2930		ft			
Conversion t	o pc/h	Undei	a Base	Conditio	ns			
Junction Components		Freev	vay	Ramp		Adjacent Ramp	Ē.	
Volume, V (vph)		460		270		280	νŗ	oh.
Peak-hour factor, PHF		0.90		0.90		0.90		
Peak 15-min volume, v15		128		75		78	V	
Trucks and buses		11		6		6	%	
Recreational vehicles		0		0		0	%	
Terrain type:		Rolli	ing	Rolling		Rolling		
Grade			%		%		8	
Length			mi		mi		mi	
Trucks and buses PCE, ET		2.5		2.5		2.5		
Recreational vehicle PCE, ER		2.0		2.0		2.0		

```
595
Flow rate, vp
                                               327
                                                          339
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 595
                                     pc/h
                 12 F FM
                     _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         922
                                      4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 595
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                          Max Desirable
                                                     Violation?
                                 4600
                    922
                                                     No
     R12
            ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 7.0 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.234
                                          S
Space mean speed in ramp influence area,
                                         S = 60.4
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 60.4

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Space mean speed for all vehicles,

Phone: E-mail:		Fax:				
	Merg	e Analysis ₋				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction:	HDR SDDOT 1/2014 PM PEAK I-90/EB I-229 MINNEHAHA CO. Existing					
	Fre	eway Data				
Type of analysis Number of lanes in freet Free-flow speed on freet Volume on freeway	_	Merg 2 66.0 720	0	mph vph		
	On	Ramp Data				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/de Length of second accel/de		Rigl 1 55.0 300 880	0	mph vph ft ft		
	Adjacent Ram	p Data (if	one exists)		
Does adjacent ramp exist Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ram	mp	Yes 260 Ups Off 2930	tream	vph ft		
Distance to adjacent kan	пр	2930	J	IL		
Conv	version to pc/	h Under Bas	se Conditio	ns		
Junction Components Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, ET		2.5	300 0.90 83 6 0 Rolling	% mi	Adjacent Ramp 260 0.90 72 6 0 Rolling	vph v % % % mi
Recreational vehicles Terrain type: Grade Length		0 Rolling	0 Rolling %	%	0 Rolling	%

```
Flow rate, vp
                                    932
                                               363
                                                          315
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 932
                                     pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1295
                                     4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 932
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                    1295
                                 4600
                                                     No
     R12
            ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 9.9 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.238
                                         S
Space mean speed in ramp influence area,
                                         S = 60.3
                                                     mph
                                         R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 60.3

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Space mean speed for all vehicles,

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB TIMBERLINE RD. Junction: Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 70.0 mph Volume on freeway 730 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph Volume on ramp 80 vph 340 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 20 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1890 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 730 80 20 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 203 22 6 V Trucks and buses 11 1 11 % 0 Recreational vehicles 0 Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

```
Flow rate, vp
                                    945
                                               90
                                                          26
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                       1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 945 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        945
                                     4800
                                                    No
     Fi F
    v = v - v
                        855
                                     4800
                                                    No
        F R
     FΟ
                        90
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
               > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 945
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    945
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 9.3 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.306
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.4
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
Space mean speed for all vehicles,
                                        S = 61.4
                                                     mph
```

1.00

0.985

1.00

0.858

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB TIMBERLINE RD. Junction: Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 1020 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 100 Volume on ramp vph Length of first accel/decel lane 340 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 90 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1890 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp 100 Volume, V (vph) 1020 90 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 283 28 25 V Trucks and buses 11 4 6 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade

2.5

2.0

Length

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

0.00 mi 0.00 mi 0.00

2.5

2.0

mi

2.5

2.0

```
1.00
Driver population factor, fP
                                              1.00
                                                         1.00
Flow rate, vp
                                   1320
                                              118
                                                         109
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1320 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks_____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        1320
                                     4800
                                                    No
     Fi F
    v = v - v
                        1202
                                     4800
                                                    No
        F R
     FO
                        118
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v 	 or v 	 > 2700 	 pc/h?
                                     No
     3 av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 1320
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    1320
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 12.5 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.309
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.4
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 61.4

mph

0.858

0.943

0.917

Heavy vehicle adjustment, fHV

Space mean speed for all vehicles,

Phone: E-mail:	Fax:				
Merge	Analysis				
Analyst: HDR Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR					
Free	way Data				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway	Merge 2 70.0 650		mph vph		
On R	amp Data				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel lane Length of second accel/decel lane	Right 1 45.0 20 760		mph vph ft ft		
Adjacent Ramp	Data (if or	ne exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp	Yes 80 Upstre Off 1890		vph ft		
Comment on the section	II. da Da	0			
Conversion to pc/h Junction Components	Under Base Freeway	Conditio:	ns	Adjacent	 E
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, ET Recreational vehicle PCE, ER	650 0.90 181 11 0 Rolling % mi 2.5 2.0	20 0.90 6 11 0 Rolling 2.5 2.0	% mi	Ramp 80 0.90 22 1 0 Rolling 2.5 2.0	vph v % % mi

```
841
Flow rate, vp
                                               26
                                                          90
                                                                   pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 841
                                     pc/h
                 12 F FM
                     _____Capacity Checks_____
                                                   LOS F?
                                      Maximum
                        Actual
                         867
                                      4800
                                                    No
    V
     FO
    v or v
                         0
                             pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                      12
     3
If yes, v = 841
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                           Max Desirable
                                                     Violation?
                                 4600
                    867
                                                     No
     R12
            ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 7.5 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.262
                                          S
Space mean speed in ramp influence area,
                                         S = 62.7
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.7

mph

0.858

1.00

0.858

1.00

0.985

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Space mean speed for all vehicles,

Phone: E-mail:	Fax:	
Merge	Analysis	
Analyst: HDR Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB Junction: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR		
Free	vay Data	
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway	Merge 2 70.0 920	mph vph
On R	amp Data	
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel lane Length of second accel/decel lane	Right 1 45.0 90 760	mph vph ft ft
Adjacent Ramp	Data (if one exist	s)
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp	Yes 100 Upstream Off 1890	vph ft
Convergion to math	IIndon Dogo Conditi	0.77
Conversion to pc/h Junction Components	Under Base Conditi Freeway Ramp	ons Adjacent
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, ET Recreational vehicle PCE, ER	920 90 0.90 0.90 256 25 11 6 0 0 Rolling Rollin % mi 2.5 2.5 2.0 2.5	Ramp 100 vph 0.90 28 v 4 % 0 % Rolling % % mi mi 2.5 2.0

```
1191
Flow rate, vp
                                               109
                                                          118
                                                                  pcph
                  _____Estimation of V12 Merge Areas____
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1191 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1300
                                      4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1191
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1300
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 10.8 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.267
                                         S
Space mean speed in ramp influence area,
                                         S = 62.5
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.5

mph

0.858

1.00

0.917

1.00

0.943

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 670 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 190 Volume on ramp vph Length of first accel/decel lane 620 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 80 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1960 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 670 190 80 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 53 22 186 V Trucks and buses 11 5 5 용 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

mi

2.5

2.0

2.5

```
Flow rate, vp
                                    867
                                               227
                                                          96
                                                                  pcph
                  _____Estimation of V12 Diverge Areas__
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                       1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 867 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                         867
                                     4800
                                                    No
     Fi F
    v = v - v
                        640
                                     4800
                                                    No
        F R
     FΟ
                         227
                                     2100
                                                    No
    V
     R
                         0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
          av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 867
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    867
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 6.1 pc/mi/ln
Density,
                                       12
                      R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.318
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.1
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
Space mean speed for all vehicles,
                                        S = 61.1
                                                     mph
```

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 1010 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 440 Volume on ramp vph Length of first accel/decel lane 620 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 130 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1960 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 440 1010 130 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 122 281 36 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
Flow rate, vp
                                    1307
                                               526
                                                          155
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1307 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                         1307
                                     4800
                                                    No
     Fi F
    v = v - v
                        781
                                     4800
                                                    No
        F R
     FΟ
                         526
                                     2100
                                                    No
    V
     R
                         0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v 	 or v 	 > 2700 	 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 1307
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    1307
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 9.9 pc/mi/ln
Density,
                                       12
                      R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.345
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 60.3
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 60.3

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		F	ax:				
	Merge	e Analy	sis				
Date performed: 1/ Analysis time period: AM Freeway/Dir of Travel: I- Junction: SD Jurisdiction: MI: Analysis Year: Ex Description: I-90/SD 100	DOT 2014 PEAK 90/EB 11 NNEHAHA CO. isting IMJR						
	Free	eway Da	ta				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway			Merge 2 70.0 480		mph vph		
	On H	Ramp Da	ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/dece Length of second accel/dec			Right 1 45.0 80 670		mph vph ft ft		
Α	djacent Ram <u>r</u>	p Data	(if one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp			Yes 190 Upstrea Off 1960	am	vph ft		
Conver	sion to pc/h	n Under	Base (Condition	ns		
Junction Components		Freew		Ramp	<u></u> -	Adjacent	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		480 0.90 133 11 0 Rolli	ng %	80 0.90 22 5 0 Rolling	୦୧	Ramp 190 0.90 53 5 0 Rolling	vph v % %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
Flow rate, vp
                                    621
                                               96
                                                          227
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 621
                                     pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                                     Maximum
                        Actual
                         717
                                      4800
                                                    No
    V
     FO
    v or v
                        0
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 621
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                          Max Desirable
                                                     Violation?
                                 4600
                    717
                                                     No
     R12
           _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 6.8 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.269
                                          S
                                         S = 62.5
Space mean speed in ramp influence area,
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.5

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		F	ax:				
	Merge	Analy	sis				
Analysis Year: Exi Description: I-90/SD 100 I	OOT 2014 PEAK 90/EB 11 INEHAHA CO. sting						
	Free	way Da	ta				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway			Merge 2 70.0 570		mph vph		
	On R	amp Da	ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel Length of second accel/dece			Right 1 45.0 130 670		mph vph ft ft		
Ad	ljacent Ramp	Data	(if one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp			Yes 440 Upstrea Off 1960	am	vph ft		
Convers	sion to pc/h	Under	Base (Condition	ns		
Junction Components	- <u>-</u> - ,	Freew		Ramp		Adjacent	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		570 0.90 158 11 0 Rolli		130 0.90 36 5 0 Rolling	୧	Ramp 440 0.90 122 5 0 Rolling	vph v % %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
Flow rate, vp
                                    738
                                               155
                                                          526
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 738 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         893
                                      4800
                                                    No
    V
     FO
    v or v
                        0
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 738
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                          Max Desirable
                                                     Violation?
                                 4600
                    893
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 8.2 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.270
                                          S
Space mean speed in ramp influence area,
                                         S = 62.4
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.4

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/WB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 70.0 mph Volume on freeway 820 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph Volume on ramp 60 vph 510 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 300 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1980 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 820 60 300 vph 0.90 0.90 Peak-hour factor, PHF 0.90 Peak 15-min volume, v15 228 17 83 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
Flow rate, vp
                                   1061
                                              72
                                                         358
                                                                  pcph
                  _____Estimation of V12 Diverge Areas__
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                       1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1061 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                        Actual
                                     Maximum
                                                   LOS F?
    v = v
                        1061
                                     4800
                                                    No
     Fi F
    v = v - v
                        989
                                     4800
                                                    No
        F R
     FΟ
                        72
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
    v or v
                > 1.5 v /2
                                     No
Is
     3
          av34
                      12
If yes, v = 1061
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                    Actual
                                 Max Desirable
                                                     Violation?
                                 4400
                    1061
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 8.8 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.304
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.5
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
Space mean speed for all vehicles,
                                        S = 61.5
                                                     mph
```

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/WB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 70.0 mph Volume on freeway 510 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 90 Volume on ramp vph Length of first accel/decel lane 510 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 290 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1980 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 510 90 290 vph 0.90 Peak-hour factor, PHF 0.90 0.90 Peak 15-min volume, v15 142 25 81 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
1.00
Driver population factor, fP
                                               1.00
                                                          1.00
                                    660
Flow rate, vp
                                               107
                                                          346
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                       1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 660 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                         660
                                     4800
                                                    No
     Fi F
    v = v - v
                        553
                                     4800
                                                    No
        F R
     FΟ
                        107
                                     2100
                                                    No
    V
     R
                         0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 660
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                    Actual
                                 Max Desirable
                                                     Violation?
                                 4400
                    660
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 5.3 pc/mi/ln
Density,
                                       12
                      R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.308
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.4
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 61.4

mph

0.858

0.930

0.930

Heavy vehicle adjustment, fHV

Phone: E-mail:		F	ax:				
	Merge	analy	sis				
Analysis Year: Exi Description: I-90/SD 100 I	OOT 2014 PEAK 90/WB 11 INEHAHA CO. sting						
	Free	eway Da	ta				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway			Merge 2 70.0 760		mph vph		
	On R	amp Da	.ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel Length of second accel/dece			Right 1 45.0 300 730		mph vph ft ft		
Ad	ljacent Ramp	Data	(if one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp			Yes 60 Upstrea Off 1980	am	vph ft		
Convers	sion to pc/h	under	Base (Condition	ns		
Junction Components	- <u>-</u> - /	Freew		Ramp		Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		760 0.90 211 11 0 Rolli	ng %	300 0.90 83 5 0 Rolling	olo	60 0.90 17 5 0 Rolling	vph v % %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
984
Flow rate, vp
                                               358
                                                          72
                                                                   pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 984
                                     pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1342
                                      4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 984
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1342
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 11.2 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.270
                                         S
Space mean speed in ramp influence area,
                                         S = 62.4
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.4

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		F	ax:				
	Merge	Analy	sis				
Analysis Year: Exi Description: I-90/SD 100 I	OT 014 PEAK 0/WB 11 NEHAHA CO. sting MJR						
	Free	way Da	ta				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway			Merge 2 70.0 420		mph vph		
	On R	amp Da	ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel Length of second accel/dece			Right 1 45.0 290 730		mph vph ft ft		
Ad	jacent Ramp	Data	(if one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp			Yes 90 Upstrea Off 1980	am	vph ft		
Convers	ion to pc/h	Under	Base (Condition	ns		
Junction Components	. 1 . 7 -	Freew		Ramp		Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		420 0.90 117 11 0 Rolli	ng %	290 0.90 81 5 0 Rolling	90	90 0.90 25 5 0 Rolling	vph v % %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
544
Flow rate, vp
                                               346
                                                          107
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 544
                                     pc/h
                 12 F FM
                     _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         890
                                      4800
                                                    No
    V
     FO
    v or v
                         0
                             pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 544
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                          Max Desirable
                                                     Violation?
                                 4600
                    890
                                                     No
     R12
            ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 7.7 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.265
                                          S
Space mean speed in ramp influence area,
                                         S = 62.6
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.6

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/WB TIMBERLINE RD. Junction: Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 1060 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 90 Volume on ramp vph Length of first accel/decel lane 530 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 120 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2020 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 1060 90 120 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 294 25 33 V Trucks and buses 11 11 2 % 0 Recreational vehicles 0 Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade

2.5

2.0

Length

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

0.00 mi 0.00 mi 0.00

2.5

2.0

mi

2.5

```
1.00
Driver population factor, fP
                                              1.00
                                                          1.00
Flow rate, vp
                                   1372
                                              117
                                                          137
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1372 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        1372
                                     4800
                                                    No
     Fi F
    v = v - v
                        1255
                                     4800
                                                    No
        F R
     FO
                        117
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
    v or v
                > 1.5 v /2
                                     No
Is
     3
          av34
                      12
If yes, v = 1372
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    1372
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 11.3 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.309
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.4
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 61.4

mph

0.858

0.858

0.971

Heavy vehicle adjustment, fHV

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/WB TIMBERLINE RD. Junction: Jurisdiction: MINNEHAHA CO. Analysis Year: Existing Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 70.0 mph Volume on freeway 710 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph Volume on ramp 30 vph 530 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 120 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2020 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp 30 Volume, V (vph) 710 120 vph 0.90 0.90 Peak-hour factor, PHF 0.90 Peak 15-min volume, v15 197 33 8 V Trucks and buses 11 8 4 % 0 0 Recreational vehicles 0 Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
Flow rate, vp
                                   919
                                              37
                                                         141
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                       1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 919 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        919
                                     4800
                                                    No
     Fi F
    v = v - v
                        882
                                     4800
                                                    No
        F R
     FΟ
                        37
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
               > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 919
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    919
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 7.4 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.301
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.6
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
Space mean speed for all vehicles,
                                        S = 61.6
                                                     mph
```

1.00

0.893

1.00

0.943

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		;	Fax:				
	Merge	Anal	ysis				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	I-90/WB TIMBERLINE RD. MINNEHAHA CO. Existing						
	Free	way D	ata				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		Merge 2 70.0 970		mph vph		
	On R	amp D	ata				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Right 1 45.0 120 680		mph vph ft ft		
	Adjacent Ramp	Data	(if on	e exists)		
Does adjacent ramp exis Volume on adjacent Ramp Position of adjacent Ra Type of adjacent Ramp Distance to adjacent Ra	mp		Yes 90 Upstre Off 2020	am	vph ft		
Con	version to pc/h	Unde	r Base	Condition	ns		
Junction Components Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length		970 0.90 269 11 0 Roll		Ramp 120 0.90 33 2 0 Rolling	% mi	Adjacent Ramp 90 0.90 25 11 0 Rolling	vph v % % mi
Trucks and buses PCE, E Recreational vehicle PC		2.5		2.5		2.5	

```
1256
Flow rate, vp
                                               137
                                                          117
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1256 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1393
                                      4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1256
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1393
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 12.0 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.276
                                         S
Space mean speed in ramp influence area,
                                         S = 62.3
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.3

mph

0.858

1.00

0.971

1.00

0.858

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		;	Fax:				
	Merge	Anal	ysis				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	I-90/WB TIMBERLINE RD. MINNEHAHA CO. Existing						
	Free	way D	ata				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		Merge 2 70.0 680		mph vph		
	On R	amp D	ata				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Right 1 45.0 120 680		mph vph ft ft		
	Adjacent Ramp	Data	(if on	e exists)		
Does adjacent ramp exis Volume on adjacent Ramp Position of adjacent Ra Type of adjacent Ramp Distance to adjacent Ra	mp		Yes 30 Upstre Off 2020	am	vph ft		
Con	version to pc/h	Unde	r Base	Conditio	ns		
Junction Components Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length		Free 680 0.90 189 11 0 Roll		Ramp 120 0.90 33 4 0 Rolling	% mi	Adjacent Ramp 30 0.90 8 8 0 Rolling	vph v % % mi
Trucks and buses PCE, E Recreational vehicle PC		2.5		2.5		2.5	

```
880
Flow rate, vp
                                               141
                                                          37
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 880 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1021
                                     4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 880
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1021
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 9.1 pc/mi/ln
Level of service for ramp-freeway junction areas of influence A
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.271
                                         S
Space mean speed in ramp influence area,
                                         S = 62.4
                                                     mph
                                         R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.4

mph

0.858

1.00

0.943

1.00

0.893

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		Fax:				
	Merge An	alysis				
Analyst: HDR Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/WE Junction: I-229 Jurisdiction: MINNEHA Analysis Year: Existin Description: I-90/SD 100 IMJR	AHA CO. Ag					
	Freeway	Data				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway		Merge 2 66.0 1090		mph vph		
	On Ramp	Data				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel lar Length of second accel/decel la		Right 1 35.0 180 740		mph vph ft ft		
Adjace	ent Ramp Da	ta (if on	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp		Yes 300 Downst Off 740	ream	vph ft		
Conversion	to pc/h Un	der Base	Condition	ns		
Junction Components	_	eeway	Ramp		Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade	0. 30 11 0		180 0.90 50 6 0 Rolling	%	300 0.90 83 6 0 Rolling	vph v % %
Length Trucks and buses PCE, ET	2.	mi 5	2.5	mi	2.5	mi

2.0

2.0

```
1411
Flow rate, vp
                                               218
                                                          363
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1411 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1629
                                     4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1411
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                          Max Desirable
                                                     Violation?
                                 4600
                    1629
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 13.4 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.289
                                         S
Space mean speed in ramp influence area,
                                         S = 59.1
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 59.1

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		Fax:				
	Merge	Analysis_				
Analysis Year: Exist Description: I-90/SD 100 IMJ	4 AK WB HAHA CO. ing R					
	Freew	ay Data				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway		Merg 2 66.0 800		mph vph		
	On Ra	mp Data				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel l Length of second accel/decel		Righ 1 35.0 160 740		mph vph ft ft		
Adja	cent Ramp	Data (if	one exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp		Yes 260 Down Off 740	stream	vph ft		
Conversio	n to pc/h	Under Bas	e Conditio	ns		
Junction Components	F - /	Freeway	Ramp		Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		800 0.90 222 11 0 Rolling %	160 0.90 44 6 0 Rolling	୦	260 0.90 72 6 0 Rolling	vph v %
Length Trucks and buses PCE, ET		m 2.5	i 2.5	mi	2.5	mi

2.0

2.0

```
1036
                                               194
Flow rate, vp
                                                          315
                                                                  pcph
                  _____Estimation of V12 Merge Areas____
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1036 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1230
                                     4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1036
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1230
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 10.3 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.283
                                         S
Space mean speed in ramp influence area,
                                         S = 59.2
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 59.2

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

HCS 2010: Freeway Weaving Release 6.50

Fax:

Phone: E-mail:

_____Operational Analysis______

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Freeway/Dir of Travel: I-90/WB

Weaving Location: I-229 ON TO I-229 OFF

Analysis Year: Existing

Description: I-90/SD 100 IMJR

_____Inputs______

Segment Type	Freeway	
Weaving configuration	One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	740	ft
Freeway free-flow speed, FFS	66	mi/h
Minimum segment speed, SMIN	40	mi/h
Freeway maximum capacity, cIFL	2350	pc/h/ln
Terrain type	Rolling	
Grade	0.00	%
Length	0.00	mi

______Conversion to pc/h Under Base Conditions_____

	Volume	Compone	nts		
	VFF	VRF	VFR	VRR	
Volume, V	790	180	300	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	219	50	83	0	
Trucks and buses	11	6	6	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	2.5	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	2.0	
Heavy vehicle adjustment, fHV	0.858	0.917	0.917	1.000)
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1023	218	363	0	pc/h

Volume ratio, VR 0.362

Configuration	Characteris	tics	
Number of maneuver lanes, NWL	2	ln	
Interchange density, ID	0.5	int/mi	
Minimum RF lane changes, LCRF	1	lc/pc	
Minimum FR lane changes, LCFR	1	lc/pc	
Minimum RR lane changes, LCRR		lc/pc	
Minimum weaving lane changes, LCMIN	581	lc/h	
Weaving lane changes, LCW	683	lc/h	
Non-weaving vehicle index, INW	38		
Non-weaving lane change, LCNW	34	lc/h	
Total lane changes, LCALL	717	lc/h	

_____Weaving and Non-Weaving Speeds______

Weaving intensity factor, W

Average non-weaving speed,	SNW	59.3	mi/h	
Weaving Segment Sp	eed, Density,	, Level of :	Service and Capa	city
Weaving segment speed, S		60.0	mi/h	
Weaving segment density, D		8.9	pc/mi/ln	
Level of service, LOS		A		
Weaving segment v/c ratio		0.277		
Weaving segment flow rate,	V	1377	veh/h	
Weaving segment capacity, c	W	4965	veh/h	
Limi	tations on We	eaving Segmo	ents	
If limit reached, see note.				
М	inimum	Maximum	Actual	Note
Weaving length (ft)	300	6261	740	a,b

mi/h

Weaving length (ft)	300	6261	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1928	С
		Maximum	Analyzed	
v/c ratio		1.00	0.277	d

Average weaving speed, SW

- a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
- Weaving segments longer than the calculated maximum length should be b. treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
- The density-based capacity exceeds the capacity of a basic freeway segment, c. under equivalent ideal conditions.
- d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax: E-mail:

______Operational Analysis_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Freeway/Dir of Travel: I-90/WB

Weaving Location: I-229 ON TO I-229 OFF

Analysis Year: Existing

Description: I-90/SD 100 IMJR

_____Inputs_____

Segment Type Weaving configuration	Freeway One-Sided	
Number of lanes, N	3	ln
Weaving segment length, LS	740	ft
Freeway free-flow speed, FFS	66	mi/h
Minimum segment speed, SMIN	40	mi/h
Freeway maximum capacity, cIFL	2350	pc/h/ln
Terrain type	Rolling	
Grade	0.00	%
Length	0.00	mi

______Conversion to pc/h Under Base Conditions_____

	Volume				
	VFF	VRF	VFR	VRR	
Volume, V	540	160	260	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	150	44	72	0	
Trucks and buses	11	6	6	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	2.5	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	2.0	
Heavy vehicle adjustment, fHV	0.858	0.917	0.917	1.00	0
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	699	194	315	0	pc/h

Volume ratio, VR 0.421

Configuration	Characteristics	3
Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.5	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	509	lc/h
Weaving lane changes, LCW	611	lc/h
Non-weaving vehicle index, INW	26	
Non-weaving lane change, LCNW	0	lc/h
Total lane changes, LCALL	611	lc/h

_____Weaving and Non-Weaving Speeds______

Weaving intensity factor, W

Average non-weaving spee	d, SNW	60.4	mi/h	
Weaving Segment	Speed, Dens:	ity, Level of S	ervice and Cap	pacity
Weaving segment speed, S		61.0	mi/h	
Weaving segment density,	D	6.6	pc/mi/ln	
Level of service, LOS		A		
Weaving segment v/c rati	0	0.215		
Weaving segment flow rat	e, v	1037	veh/h	
Weaving segment capacity	, cW	4833	veh/h	
I	imitations or	n Weaving Segme	nts	
If limit reached, see no	te.			
	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	6922	740	a,b
		Marrimum	72272200	

mi/h

	MITITIMAN	Maximum	Accuai	NOCC
Weaving length (ft)	300	6922	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1877	С
		Maximum	Analyzed	
v/c ratio		1.00	0.215	d

Notes:

Average weaving speed, SW

- a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
- b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
- c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
- d. Volumes exceed the weaving segment capacity. The level of service is F.

Phone: E-mail:		F	¹ax:				
	Diver	ge Ana	alysi	s			
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	AM PEAK I-90/WB I-229 MINNEHAHA CO. Existing						
	Free	eway Da	ata				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	-		Dive 2 66.0 1270		mph vph		
	Off R	amn Da	ı +				
Side of freeway Number of lanes in ramp Free-Flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Righ 1 35.0 300 740		mph vph ft ft		
	Adjacent Ramp	Data	(if	one exis	ts)		
Does adjacent ramp exis Volume on adjacent ramp Position of adjacent ramp Type of adjacent ramp Distance to adjacent ramp	mp		Yes 180 Upst On 740	ream	vph ft		
Con	version to pc/h	Under	· Bas	e Condit	ions		
Junction Components Volume, V (vph)	verbron to pe/i	Freev		Ramp	10116	Adjacen Ramp 180	t vph
Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		0.90 353 11 0 Rolli 0.00	ing %		ng %	0.90 50 6 0 Rolling 0.00	V % %
Length Trucks and buses PCE, E Recreational vehicle PC		0.00 2.5 2.0	m	i 0.00 2.5 2.0	mi	0.00 2.5 2.0	mi

```
1.00
                                                         1.00
Driver population factor, fP
                                              1.00
Flow rate, vp
                                   1644
                                              363
                                                         218
                                                                 pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1644 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        1644
                                     4720
                                                    No
     Fi F
    v = v - v
                        1281
                                     4720
                                                    No
        F R
     FO
                        363
                                     2000
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3 av34
    v or v
                > 1.5 v /2
                                     No
Is
     3
          av34
                      12
If yes, v = 1644
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    1644
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 11.7 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.461
Intermediate speed variable,
                                         S
Space mean speed in ramp influence area,
                                         S = 54.9
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 54.9

mph

0.858

0.917

0.917

Heavy vehicle adjustment, fHV

Phone: E-mail:		F	fax:					
	Dive	rge Ana	alys	is_				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 10	PM PEAK I-90/WB I-229 MINNEHAHA CO. Existing OO IMJR							
	Fre	eway Da	ata_					
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		Div 2 66. 960	0		mph vph		
	Off	Damp Da	1 + 2					
Side of freeway Number of lanes in ramp Free-Flow speed on ramp Volume on ramp Length of first accel/de Length of second accel/de	decel lane		Rig 1 35. 260 740	0		mph vph ft ft		
	Adjacent Ram	p Data	(if	on	e exists)		
Does adjacent ramp exist Volume on adjacent ramp Position of adjacent ramp Type of adjacent ramp Distance to adjacent ram	np		Yes 160 Ups On 740	tre	am	vph ft		
Cons	vorgion to ng/	h Undor	. Da	a 0	Condition	n a		
Junction Components	version to pc/	Freev		se	Ramp	ns	Adjacen Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, ETRECREATIONAL vehicle PCE		960 0.90 267 11 0 Rolli 0.00 0.00 2.5 2.0		% mi	260 0.90 72 6 0 Rolling 0.00 0.00 2.5 2.0	% mi	160 0.90 44 6 0 Rolling 0.00 0.00 2.5 2.0	vph v % %

```
Flow rate, vp
                                   1243
                                              315
                                                         194
                                                                 pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1243 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        1243
                                     4720
                                                    No
     Fi F
    v = v - v
                        928
                                     4720
                                                   No
        F R
     FO
                        315
                                     2000
                                                   No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3 av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 1243
                                  (Equation 13-15, 13-16, 13-18, or 13-19)
       12A
                   _Flow Entering Diverge Influence Area___
                                Max Desirable
                                                     Violation?
                   Actual
                                4400
                    1243
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                    D = 4.252 + 0.0086 v - 0.009 L = 8.3 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence A
                _____Speed Estimation_____
                                         D = 0.456
Intermediate speed variable,
                                         S
Space mean speed in ramp influence area,
                                        S = 55.0
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 55.0

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Space mean speed for all vehicles,

Appendix Part 2—2012 Crossroad Level of Service

I-90/Timberline Road Interchange



__TWO-WAY STOP CONTROL SUMMARY___

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: Existing

Project ID:

East/West Street: 60TH ST. N.
North/South Street: TIMBERLINE RD.

incersection offe	illacion.	NO		50	uuy	berro	ı (III.5	,, 1.0	O
	Vehi	.cle Volu	mes and	Adjus	tmen	.ts			
Major Street: Ap	proach	Nor	thbound			Soi	ıthbou	.nd	
Мс	vement	1	2	3		4	5	6	
		L	T	R	İ	L	T	R	
Volume		196	145				85	72	
Peak-Hour Factor,	PHF	0.68	0.68				0.83	0.83	
Hourly Flow Rate,	HFR	288	213				102	86	
Percent Heavy Veh	nicles	5							
Median Type/Stora RT Channelized?		Undivi	ded		/				
Lanes		0	1				1	0	
Configuration		LT						TR	
Upstream Signal?			No				No		
Minor Street: Ap	proach		tbound			 Еая	 stboun		
-	vement	7	8	9	1	10	11	12	
	, v cincile	L L	T	R	!	L	T	R	
Volume						 17		13	
Peak Hour Factor,	PHF					0.81		0.81	
Hourly Flow Rate,						20		16	
Percent Heavy Veh						4		4	
Percent Grade (%)			2				0		
Flared Approach:		Storage	_		/		-	No	/
Lanes	,				,	0		0	•
Configuration						· ·	LR	· ·	
			. 1						
7		ueue Ler			ET OI	Serv			
Approach	NB	SB		bound	0	1 .		tbound	1.0
Movement	1	4	7	8	9	-	10	11	12
Lane Config	LT							LR	
v (vph)	288							36	
C(m) (vph)	1368							345	
v/c	0.21							0.10	
95% queue length	0.80							0.35	
Control Delay	8.3							16.6	
LOS	A							С	
Approach Delay								16.6	
Approach LOS								С	

Phone: Fax: E-Mail: _TWO-WAY STOP CONTROL(TWSC) ANALYSIS______ Analyst: HDR Agency/Co.: SDDOT Date Performed: 1/2014 Analysis Time Period: AM PEAK Intersection: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Units: U. S. Customary Analysis Year: Existing Project ID: East/West Street: 60TH ST. N. North/South Street: TIMBERLINE RD. Intersection Orientation: NS Study period (hrs): 1.00 __Vehicle Volumes and Adjustments_ Major Street Movements 1 2 3 5 6 Т R Τ. Т R L Volume 196 145 85 72 Peak-Hour Factor, PHF 0.68 0.68 0.83 0.83 26 Peak-15 Minute Volume 72 53 22 Hourly Flow Rate, HFR 288 213 102 86 Percent Heavy Vehicles ___ Median Type/Storage Undivided RT Channelized? 1 0 Lanes Configuration LTTR Upstream Signal? No No Minor Street Movements 7 8 9 10 11 12 Т Т R $_{\rm L}$ R Τ. Volume 17 13 Peak Hour Factor, PHF 0.81 0.81 Peak-15 Minute Volume 5 4 Hourly Flow Rate, HFR 20 16 Percent Heavy Vehicles 4 Percent Grade (%) 0 Flared Approach: Exists?/Storage No RT Channelized? 0 0 Lanes Configuration LR _Pedestrian Volumes and Adjustments___ Movements 13 14 15 16

0

Flow (ped/hr)

0

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Length Speed feet vph vph sec sec mph

S2 Left-Turn Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared In volume, major th vehicles:	213	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical	Gap Cal	 culatio	 on						
Movement	_	1	4	7	8	9	10	11	12
		L	L	L	Т	R	L	Т	R
t(c,base	 	4.1					7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5					4		4
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent	Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,1t)		0.00					0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2					6.4		6.2
	2-stage								
Follow-U	Jp Time C	alculat	tions						
Movement	-	1	4	7	8	9	10	11	12
		L	L	L	T	R	L	Т	R
t(f,base	<u> </u>	2.20					3.50		3.30
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5					4		4
t(f)		2.2					3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(t) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Τ
                                                      R
                                                              L
                                                                             R
                                                                     Т
V c,x
                        188
                                                             934
                                                                            145
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

S	1500	
P(x)		
V(c,u,x)		
C(r,x)		
C(plat,x) 		
Worksheet 6-Impedance and Capacity Equation	ns	
Step 1: RT from Minor St.	9	12
Conflicting Flows		145
Potential Capacity		897
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		897
Probability of Queue free St.	1.00	0.98
Step 2: LT from Major St.	4	1
Conflicting Flows		188
Potential Capacity		1368
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1368
Probability of Queue free St.	1.00	0.79
Maj L-Shared Prob Q free St.		0.76
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.76	0.76
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		934
Potential Capacity		293
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.76	
Maj. L, Min T Adj. Imp Factor.	0.81	
Cap. Adj. factor due to Impeding mvmnt	0.80	0.79
Movement Capacity		231
Worksheet 7-Computation of the Effect of T	wo-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11
Part 1 - First Stage Conflicting Flows		

Stagel Stagel Stagel Stagel Stagel Stagel Stagel

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
Probability of Queue free St.

Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmr. Movement Capacity	ıt					
Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmr. Movement Capacity	t		.00		1.00	
Result for 2 stage process:						
y C t Probability of Queue free St.		1	.00		1.00	
Step 4: LT from Minor St.			7		10	
Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmm. Movement Capacity	ıt					
Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mymm Movement Capacity	ıt					
Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Maj. L, Min T Impedance factor Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding mymm Movement Capacity	ıt	0	.00 .76 .81		934 293 1.00 0.79 231	
Results for Two-stage process: a y						
C t					231 	
Worksheet 8-Shared Lane Calculations						
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)				20 231	345	16 897

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	Т	R
C sep				231		897
Volume				20		16
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					345	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	LT						LR	
v (vph)	288						36	
C(m) (vph)	1368						345	
v/c	0.21						0.10	
95% queue length	0.80						0.35	
Control Delay	8.3						16.6	
LOS	A						С	
Approach Delay							16.6	
Approach LOS							С	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.79	1.00
v(il), Volume for stream 2 or 5	213	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.76	
d(M,LT), Delay for stream 1 or 4	8.3	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	2.0	

__TWO-WAY STOP CONTROL SUMMARY_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year:

Project ID: I-90/SD 100 IMJR
East/West Street: 60TH ST. N.
North/South Street: TIMBERLINE RD.

Major Street:	Approach	cle Volu. Nor	thbound	_		Southh	ound		
	Movement	1	2	3	4			6	
		L	Т	R	I	Т		R	
 Volume		34	118			14	 12	12	
Peak-Hour Fact	or, PHF	0.82	0.82			0.	81	0.81	
Hourly Flow Ra	te, HFR	41	143			17	75	14	
Percent Heavy	Vehicles	5					-		
Median Type/St RT Channelized		Undivi	.ded		/				
Lanes		0	1			1	0		
Configuration		LT	•				TR		
Upstream Signa	1?		No			No)		
Minor Street:	Approach	Wes	tbound			Eastbo	und		
	Movement	7	8	9	1	0 11	-	12	
		L	Т	R	L	T		R	
 Volume					· -	5		118	
Peak Hour Fact						.61		0.61	
Hourly Flow Ra					7	3		193	
Percent Heavy					4			4	
Percent Grade			2			0			
Flared Approac	h: Exists?/	Storage			/		N	10	/
Lanes						0	0		
Configuration						LF	2		
	Delay, Q	onene Ter	ath ar	nd Leve		Service			
	_	SB	_	bound	.1 01		astbo	und	
Approach	NB	~ _					11		12
Approach Movement	NB 1	4	7	8	9	1 1 ()		•	
Movement	1	4	7	8	9	10	T.F)	
Movement Lane Config	1 LT	4	7	8	9	10	LF		
Movement Lane Config v (vph)	1 LT ————41	4	7	8	9	10	26	 66	
Movement Lane Config v (vph)	1 LT	4	7	8	9	10	26 75	 56 56	
Novement Lane Config v (vph) C(m) (vph)	1 LT ————41	4	7	8	9		26 75	 66	
Movement Lane Config v (vph) C(m) (vph) v/c	1 LT 41 1367 0.03	4	7	8	9	10	26 75 0.	 56 56	
Movement Lane Config v (vph) C(m) (vph) v/c 95% queue leng	1 LT 41 1367 0.03	4	7	8	9	10	26 75 0. 1.	56 56 35	
Movement Lane Config	1 LT 41 1367 0.03 th 0.09	4	7	8	9	10	26 75 0.	56 56 35 62	
Movement Lane Config v (vph) C(m) (vph) v/c 95% queue leng Control Delay	1 LT 41 1367 0.03 th 0.09 7.7 A	4	7	8	9	10	26 75 0. 1.	56 56 35 62	

Phone: Fax:
E-Mail:
_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS______

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year:

Project ID: I-90/SD 100 IMJR
East/West Street: 60TH ST. N.
North/South Street: TIMBERLINE RD.

	_Vehicle	Volumes	and	Adjustmen	ts		
Major Street Movements	1	2	3	4	5	6	
	L	Т	R	L	Т	R	
Volume	34	118			142	12	
Peak-Hour Factor, PHF	0.82	0.82			0.81	0.81	
Peak-15 Minute Volume	10	36			44	4	
Hourly Flow Rate, HFR	41	143			175	14	
Percent Heavy Vehicles	5						
Median Type/Storage	Und:	ivided		/			
RT Channelized?		_			_	•	
Lanes	0	1			1	0	
Configuration]	LT				TR	
Upstream Signal?		No			No		
Minor Street Movements	7	8	9	10	11	12	
	L	Т	R	L	Т	R	
Volume				45		118	
Peak Hour Factor, PHF				0.61		0.61	
Peak-15 Minute Volume				18		48	
Hourly Flow Rate, HFR				73		193	
Percent Heavy Vehicles				4		4	
Percent Grade (%)		2			0		
Flared Approach: Exist	s?/Storag	ge		/		No	/
RT Channelized?							
Lanes				0		0	
Configuration					LR		

	Pedestrian	Volumes	and Ad	djustments	
Movements	13	14	15	16	
77.					
Flow (ped/hr)	Ü	0	Ü	0	

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Length Speed feet vph vph sec sec mph

S2 Left-Turn Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared In volume, major th vehicles:	143	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical	Gap Cal									
Movement	_	1	4	7	8	9	10	11	12	
110 / 0011		L	L	L	T	R	L	T	R	
t(c,base	 e)	4.1					7.1		6.2	
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
P(hv)		5					4		4	
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10	
Percent	Grade			2.00	2.00	2.00	0.00	0.00	0.00	
t(3,1t)		0.00					0.70		0.00	
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	
t(c)	1-stage	4.2					6.4		6.2	
	2-stage									
Follow-U	Jp Time C	 alculat	tions							
Movement	_	1	4	7	8	9	10	11	12	
		L	L	L	T	R	L	T	R	
t(f,base t(f,HV) P(HV) t(f)	2)	2.20 0.90 5 2.2	0.90	0.90	0.90	0.90	3.50 0.90 4 3.5	0.90	3.30 0.90 4 3.3	

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(t) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                       9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                       R
                                                              L
                                                                     Т
                                                                             R
V c,x
                        189
                                                             407
                                                                            182
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                       10
                                                                       11
```

P(x) V(c,u,x)		
v (C, u, A)		
C(r,x)		
C(plat,x) 		
Worksheet 6-Impedance and Capacity Equati	ons	
Step 1: RT from Minor St.	9	12
Conflicting Flows		182
Potential Capacity		855
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1 00	855
Probability of Queue free St.	1.00	0.77
Step 2: LT from Major St.	4	1
Conflicting Flows		189
Potential Capacity		1367
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1367
Probability of Queue free St.	1.00	0.97
Maj L-Shared Prob Q free St.		0.97
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.97	0.97
Movement Capacity	1 00	1 00
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		407
Potential Capacity		596
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.97	
Maj. L, Min T Adj. Imp Factor.	0.97	
Cap. Adj. factor due to Impeding mvmnt	0.75	0.97
Movement Capacity		578
Worksheet 7-Computation of the Effect of	Two-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11

Stagel Stagel Stagel Stagel Stagel Stagel Stage2

Part 1 - First Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mymnt
Movement Capacity
Probability of Queue free St.

Part 2 - Second Stage						
Conflicting Flows						
Potential Capacity						
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvm	nt					
Movement Capacity	110					
Movement Capacity						
Part 3 - Single Stage						
Conflicting Flows						
Potential Capacity						
		1	.00		1.00	
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvm	nt	U	.97		0.97	
Movement Capacity						
Result for 2 stage process:						
a						
У						
Ct						
Probability of Queue free St.		1	.00		1.00	
riobability of guede free St.			.00		1.00	
Step 4: LT from Minor St.			7		10	
Part 1 - First Stage						
Conflicting Flows						
Potential Capacity						
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvm	nt					
Movement Capacity						
Part 2 - Second Stage						
Conflicting Flows						
Potential Capacity						
Pedestrian Impedance Factor						
Cap. Adj. factor due to Impeding mvm	nt					
Movement Capacity						
Part 3 - Single Stage						
Conflicting Flows					407	
Potential Capacity					596	
Pedestrian Impedance Factor			.00		1.00	
Maj. L, Min T Impedance factor		0	.97			
Maj. L, Min T Adj. Imp Factor.		0	.97			
Cap. Adj. factor due to Impeding mvm	nt	0	.75		0.97	
Movement Capacity					578	
Results for Two-stage process:						
a						
У					E = 0	
C t					578	
Worksheet 8-Shared Lane Calculations						
Movement	7	8	9	10	11	12
	L	T	R	L	T	R
						100
Volume (vph)				73 570		193
Movement Capacity (vph)				578	756	855
Shared Lane Capacity (vph)					756	

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	Т	R
C sep				578		855
Volume				73		193
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					756	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	$_{ m LT}$						LR	
v (vph)	41						266	
C(m) (vph)	1367						756	
v/c	0.03						0.35	
95% queue length	0.09						1.62	
Control Delay	7.7						12.3	
LOS	A						В	
Approach Delay							12.3	
Approach LOS							В	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.97	1.00
v(il), Volume for stream 2 or 5	143	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.97	
d(M,LT), Delay for stream 1 or 4	7.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.3	

__TWO-WAY STOP CONTROL SUMMARY___

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Incersection o.	r rentation.	110		50	Luuy	berroc	1 (III S	5). 1.0	00
	Veh	icle Volu	umes and	l Adjus	stme	nts			
Major Street:	Approach		rthbound			Sou	ıthbou	ınd	
	Movement	1	2	3		4	5	6	
		L	Т	R		L	Т	R	
Volume			143	19		1	143		
Peak-Hour Facto			0.90	0.90		0.89	0.89)	
Hourly Flow Ra			158	21		1	160		
Percent Heavy '						5			
Median Type/Sto RT Channelized	_	Undivi	ided			/			
Lanes			1 0			0	1		
Configuration			TR	-		LT			
Upstream Signa	1?		No				No		
Minor Street:	Approach	Wes	stbound			Eas	tbour	 ıd	
	Movement	7	8	9		10	11	12	
		L	Т	R		L	T	R	
 Volume						67		14	
Peak Hour Fact						0.88		0.88	3
Hourly Flow Ra	te, HFR					76		15	
Percent Heavy '	Vehicles					1		1	
Percent Grade			2				2		
Flared Approacl	h: Exists?	/Storage			/			No	/
Lanes						0		0	
Configuration							LR		
	Delay,	Queue Lei	ngth an	d Leve	۰۰۰۰۰	f Servi	ce		
Approach	NB	SB		bound				tbound	
Movement	1	4	7	8	9	1 1	10	11	12
Lane Config	_	LT	•			-	- 0	LR	
v (vph)		1						91	
C(m) (vph)		1379						673	
v/c		0.00						0.14	
95% queue leng	th	0.00						0.47	
Control Delay		7.6						11.2	
LOS		A						В	
Approach Delay								11.2	
Approach LOS								В	

Phone: Fax: E-Mail:

_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Flow (ped/hr)

Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

Major Street Movements	1	2	3	justment 4	5	6	
	L	T	R	L	T	R	
 Volume		143	19	1	143		
Peak-Hour Factor, PHF		0.90	0.90	0.89	0.89		
Peak-15 Minute Volume		40	5	0	40		
Hourly Flow Rate, HFR		158	21	1	160		
Percent Heavy Vehicles				5			
Median Type/Storage RT Channelized?	Undi	vided		/			
Lanes		1)	0	1		
Configuration		TI	3.	L:	Г		
Upstream Signal?		No			No		
Minor Street Movements		8	9	10	11	12	
	L	Т	R	L	T	R	
 Volume				67		14	
Peak Hour Factor, PHF				0.88		0.88	
Peak-15 Minute Volume				19		4	
Hourly Flow Rate, HFR				76		15	
Percent Heavy Vehicles				1		1	
Percent Grade (%)		2			2		
Flared Approach: Exist RT Channelized?	s?/Storage	e		/		No	/
Lanes				0	(0	
					LR		

0

0

______Upstream Signal Data______ Prog. Sat Arrival Green Cycle Prog. Distance

Prog. Sat Arrival Green Cycle Prog. Distance Flow Flow Type Time Length Speed to Signal vph vph sec sec mph feet

S2 Left-Turn Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5	
Shared ln volume, major th vehicles:		160	
Shared ln volume, major rt vehicles:		0	
Sat flow rate, major th vehicles:		1700	
Sat flow rate, major rt vehicles:		1700	
Number of major street through lanes:		1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical	Gap Cal	culatio	on							
Movement	-	1	4	7	8	9	10	11	12	
		L	L	L	T	R	L	T	R	
t(c,base)		4.1				7.1		6.2	
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
P(hv)			5				1		1	
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10	
Percent	Grade			2.00	2.00	2.00	2.00	2.00	2.00	
t(3,1t)			0.00				0.70		0.00	
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	
t(c)	1-stage		4.2				6.8		6.4	
	2-stage									
Follow-U	Jp Time C	alculat	tions							
Movement	-	1	4	7	8	9	10	11	12	
		L	L	L	T	R	L	Т	R	
t(f,base	 e)		2.20				3.50		3.30	
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	
P(HV)			5				1		1	

Worksheet 5-Effect of Upstream Signals

2.2

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(1,prot)$

3.5

3.3

t(f)

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                       9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                       R
                                                              L
                                                                     Т
                                                                             R
V c,x
                               179
                                                             330
                                                                            160
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                       10
                                                                       11
```

V(c,x)	1500	
P(x)		
V(c,u,x)		
C(r,x) C(plat,x)		
Worksheet 6-Impedance and Capacity Equation	S	
Step 1: RT from Minor St.	9	12
Conflicting Flows		160
Potential Capacity		880
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		880
Probability of Queue free St.	1.00	0.98
Step 2: LT from Major St.	4	1
Conflicting Flows	 179	
Potential Capacity	1379	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1379	
Probability of Queue free St.	1.00	1.00
Maj L-Shared Prob Q free St.	1.00	
Step 3: TH from Minor St.	8	11
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	1.00	1.00
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.		10
Conflicting Flows		330
Potential Capacity		643
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	
Maj. L, Min T Adj. Imp Factor.	1.00	
Cap. Adj. factor due to Impeding mvmnt	0.98	1.00
Movement Capacity		643
Worksheet 7-Computation of the Effect of Tw	o-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11
 Part 1 - First Stage		
Conflicting Flows		
Potential Capacity		

Stagel Stagel Stagel Stagel Stagel Stagel Stagel

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mymnt
Movement Capacity
Probability of Queue free St.

Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)			76 643	673	15 880
Movement 7 L	8 T	9 R	10 L	11 T	12 R
Worksheet 8-Shared Lane Calculations					
C t				643	
a Y					
Results for Two-stage process:					
Movement Capacity 					
Cap. Adj. factor due to Impeding mymnt		0.98		1.00 643	
Maj. L, Min T Adj. Imp Factor.		1.00			
Pedestrian Impedance Factor Maj. L, Min T Impedance factor		1.00		1.00	
Potential Capacity		1 00		643	
Part 3 - Single Stage Conflicting Flows				330	
Movement Capacity 					
Cap. Adj. factor due to Impeding mvmnt					
Potential Capacity Pedestrian Impedance Factor					
Conflicting Flows					
Part 2 - Second Stage					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
Potential Capacity Pedestrian Impedance Factor					
Conflicting Flows					
Part 1 - First Stage					
Step 4: LT from Minor St.		7		10	
Probability of Queue free St.		1.00		1.00	
C t		1 00		1 00	
a Y					
Result for 2 stage process:					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt		1.00		1.00	
Potential Capacity Pedestrian Impedance Factor		1.00		1.00	
Conflicting Flows					
Part 3 - Single Stage					
Movement Capacity					
Cap. Adj. factor due to Impeding mymnt					
Potential Capacity Pedestrian Impedance Factor					
- + + - 1					

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	Т	R
C sep Volume				643 76		880 15
Delay Q sep						
Q sep +1 round (Qsep +1)						
n max C sh SUM C sep					673	
n C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		1					91	
C(m) (vph)		1379					673	
v/c		0.00					0.14	
95% queue length		0.00					0.47	
Control Delay		7.6					11.2	
LOS		A					В	
Approach Delay							11.2	
Approach LOS							В	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	1.00
v(il), Volume for stream 2 or 5		160
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		1.00
d(M,LT), Delay for stream 1 or 4		7.6
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.0

__TWO-WAY STOP CONTROL SUMMARY___

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Major Street:	Approach				AdjustmentsSouthbound					
hajor bereet.	Movement	1	2	3	1	4	5	6		
	rio v Cilicire	L	T	R		L	T	R		
 Volume			92	 71		19	107			
Peak-Hour Fact	or, PHF		0.77	0.77		0.83	0.83			
Hourly Flow Ra	te, HFR		119	92		22	128			
Percent Heavy	Vehicles					5				
Median Type/St RT Channelized		Undiv	ided			/				
Lanes			1 ()		0	1			
Configuration			TF			L'				
Upstream Signa	1?		No				No			
Minor Street:	Approach	Wes	 stbound			Eas	 stboun	 .d		
	Movement	7	8	9		10	11	12		
		L	T	R	İ	L	T	R		
Volume						56		47		
Peak Hour Fact						0.76		0.76		
Hourly Flow Ra						73		61		
Percent Heavy '	Vehicles					4		4		
Percent Grade	· · /		2				2			
Flared Approac	h: Exists?	/Storage			/			No	/	
Lanes						0		0		
Configuration							LR			
	Delay	Queue Lei	ngth ar	nd Leve		f Serv	ice			
Approach	NB	SB	_	bound	0	I DOIV.		tbound		
T T	1	4	7	8	9		10	11	12	
Movement	1									
Movement Lane Config	1	LT	,			İ		LR		
Lane Config v (vph)		LT 				<u> </u>		134		
Lane Config v (vph) C(m) (vph)		22 1342				<u> </u>		134 725		
Lane Config v (vph) C(m) (vph) v/c		LT 22 1342 0.02				<u> </u>		134 725 0.18		
Lane Config v (vph) C(m) (vph) v/c 95% queue leng		22 1342 0.02 0.05				<u> </u>		134 725 0.18 0.68		
Lane Config v (vph) C(m) (vph) v/c 95% queue leng		LT 22 1342 0.02				<u> </u>		134 725 0.18 0.68 11.1		
Lane Config v (vph) C(m) (vph) v/c 95% queue leng Control Delay LOS	th	22 1342 0.02 0.05				<u> </u>		134 725 0.18 0.68 11.1		
Lane Config v (vph) C(m) (vph) v/c 95% queue leng	th	LT 22 1342 0.02 0.05 7.7				<u> </u>		134 725 0.18 0.68 11.1		

Phone: Fax:
E-Mail:
_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS______

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

L T R L T R Description Text Modern Change Morromonta		Volumes 2	3	4	5	6		
Volume 92 71 19 107 Peak-Hour Factor, PHF 0.77 0.77 0.83 0.83 Peak-15 Minute Volume 30 23 6 32 Hourly Flow Rate, HFR 119 92 22 128 Percent Heavy Vehicles 5 Median Type/Storage Undivided / RT Channelized? Lanes 1 0 0 1 Configuration TR LT Upstream Signal? No No Minor Street Movements 7 8 9 10 11 12 L T R L T R Volume 56 47 Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0 0	Major Street Movements	1	-	_	_	_		
Peak-Hour Factor, PHF 0.77 0.77 0.83 0.83 Peak-15 Minute Volume 30 23 6 32 Hourly Flow Rate, HFR 119 92 22 128 Percent Heavy Vehicles 5 Median Type/Storage Undivided / / RT Channelized? Lanes 1 0 0 1<		Ь	T	R	Ъ	T	R	
Peak-15 Minute Volume 30 23 6 32 Hourly Flow Rate, HFR 119 92 22 128 Percent Heavy Vehicles 5 Median Type/Storage Undivided / / RT Channelized? Lanes 1 0 0 1 1 0 0 1 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0<	Volume		92	71	19	107		
Hourly Flow Rate, HFR 119 92 22 128 Percent Heavy Vehicles 5 Median Type/Storage Undivided / / RT Channelized? Lanes 1 0 0 1 Configuration TR LT LT Upstream Signal? No No No Minor Street Movements 7 8 9 10 11 12 L T R L T R Volume 56 47 Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No RT Channelized? No 0 Lanes 0 0	Peak-Hour Factor, PHF		0.77	0.77	0.83	0.83		
Percent Heavy Vehicles 5 Median Type/Storage Undivided / RT Channelized? Lanes	Peak-15 Minute Volume		30	23	6	32		
Median Type/Storage Undivided / RT Channelized? 1 0 0 1 Lanes 1 0 0 1 Configuration TR LT Upstream Signal? No Minor Street Movements 7 8 9 10 11 12 L T R L T R T R Volume 56 47 Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? 0 0 Lanes 0 0	Hourly Flow Rate, HFR		119	92	22	128		
### Channelized? Lanes	Percent Heavy Vehicles				5			
### Channelized? Lanes	-	Undi	vided		/			
Configuration TR LT Upstream Signal? No No Minor Street Movements 7 8 9 10 11 12 L T R L T R Volume Volume 56 47 Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? 0 0					·			
Upstream Signal? No No Minor Street Movements 7 8 9 10 11 12 L T R L T R Volume Feak Hour Factor, PHF Peak Hour Factor, PHF Peak Hourly Flow Rate, PFR Hourly Flow Rate, HFR Percent Heavy Vehicles Percent Heavy Vehicles Percent Grade (%) Percent Grade (%) Percent Grade (%) Percent Grade Approach: Exists?/Storage RT Channelized? Lanes O O O	Lanes		1	0	0	1		
Minor Street Movements 7 8 9 10 11 12 L T R L T R Volume 56 47 Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0	Configuration		Т	R	L.	Γ		
L T R L T R L T R No. Upstream Signal?		No			No			
L T R L T R L T R No. N. Charles M. Charles M.				1.0				
Volume 56 47 Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? 0 0	Minor Street Movements	•		-	_			
Peak Hour Factor, PHF 0.76 0.76 Peak-15 Minute Volume 18 15 Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0		Ь	T	R	Ь	Т	R	
Peak-15 Minute Volume Hourly Flow Rate, HFR Percent Heavy Vehicles Percent Grade (%) Percent Grade (%) Percent Approach: Exists?/Storage RT Channelized? Lanes 18 15 61 4 73 61 7 7 0 0 0	 Volume				56		47	
Hourly Flow Rate, HFR 73 61 Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0	Peak Hour Factor, PHF				0.76		0.76	
Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0	Peak-15 Minute Volume				18		15	
Percent Heavy Vehicles 4 4 Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0	Hourly Flow Rate, HFR				73		61	
Percent Grade (%) 2 2 Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0	-				4		4	
Flared Approach: Exists?/Storage / No / RT Channelized? Lanes 0 0	-		2			2		
RT Channelized? Lanes 0 0		s?/Storac	те		/		No	/
Lanes 0 0		,	•		•		-	•
					0	(0	
Configuration LR	Configuration					LR		

	Pedestrian	Volumes	and Ad	djustments	
Movements	13	14	15	16	
Flow (ped/hr)	0	0	0	0	

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Length Speed feet vph vph sec sec mph

S2 Left-Turn

Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5	
Shared ln volume, major th vehicles:		128	
Shared ln volume, major rt vehicles:		0	
Sat flow rate, major th vehicles:		1700	
Sat flow rate, major rt vehicles:		1700	
Number of major street through lanes:		1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

	1 L	4 L	7 L	8	9	10	11	12
	L	L	т					12
			ш	T	R	L	Т	R
		4.1				7.1		6.2
-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
		5				4		4
			0.20	0.20	0.10	0.20	0.20	0.10
ade			2.00	2.00	2.00	2.00	2.00	2.00
		0.00				0.70		0.00
-stage (0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-stage (0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
-stage		4.2				6.8		6.4
-stage								
Time Cal	 lculat	ions						
	1	4	7	8	9	10	11	12
	L	L	L	Т	R	L	Т	R
		2.20				3.50		3.30
(0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
		5				4		4
		2.2				3.5		3.3
	ade -stage (-stage -stage -stage 	-stage 0.00 -stage 0.00 -stage -stage -ime Calculat	5 ade 0.00 -stage 0.00 0.00 -stage 0.00 0.00 -stage 4.2 -stage Time Calculations 1 4 L L 2.20 0.90 0.90 5	5 ade 0.20 -stage 0.00 0.00 -stage 0.00 0.00 -stage 4.2 -stage 4.2 -stage Time Calculations 1 4 7 L L L 2.20 0.90 0.90 0.90 5	5 ade 0.20 0.20 2.00 2.00 -stage 0.00 0.00 0.00 0.00 -stage 0.00 0.00 1.00 1.00 -stage 4.2 -stage Time Calculations 1 4 7 8 L L T 2.20 0.90 0.90 0.90 0.90 5	5 0.20 0.20 0.10 ade 2.00 2.00 2.00 -stage 0.00 0.00 0.00 0.00 -stage 0.00 0.00 1.00 1.00 0.00 -stage 4.2 -stage Time Calculations 1 4 7 8 9 L L L T R 2.20 0.90 0.90 0.90 0.90 0.90 0.90 5	5	5

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                       9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                       R
                                                              L
                                                                     Т
                                                                             R
V c,x
                               211
                                                             337
                                                                            128
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                       10
                                                                       11
```

V(C,x) s	1500	
P(x)		
V(c,u,x)		
C(r,x)		
C(plat,x)		
Worksheet 6-Impedance and Capacity Equation	S	
Step 1: RT from Minor St.	9	12
Conflicting Flows		128
Potential Capacity		910
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		910
Probability of Queue free St.	1.00	0.93
Step 2: LT from Major St.	4	1
Conflicting Flows	211	
Potential Capacity	1342	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	1342	
Probability of Queue free St.	0.98	1.00
Maj L-Shared Prob Q free St.	0.98	
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		337
Potential Capacity		630
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.98	
Maj. L, Min T Adj. Imp Factor.	0.99	
Cap. Adj. factor due to Impeding mvmnt	0.92	0.98
Movement Capacity		620
Worksheet 7-Computation of the Effect of Tw	o-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11
Part 1 - First Stage Conflicting Flows		

Stagel Stagel Stagel Stagel Stagel Stagel Stagel

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mymnt
Movement Capacity
Probability of Queue free St.

Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmn Movement Capacity	t					
Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmn Movement Capacity	t		.00		1.00	
Result for 2 stage process:						
y C t Probability of Queue free St.		1.	.00		1.00	
Step 4: LT from Minor St.			7		10	
Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmn Movement Capacity	t					
Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmn Movement Capacity	t					
Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Maj. L, Min T Impedance factor Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding mymn Movement Capacity	t	0 .	.00 .98 .99		337 630 1.00 0.98 620	
Results for Two-stage process:						
a Y C t					620	
Worksheet 8-Shared Lane Calculations						_
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)				73 620	725	61 910

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	Т	R
C sep Volume Delay Q sep Q sep +1 round (Qsep +1)				620 73		910 61
n max C sh SUM C sep n C act					725	

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		22					134	
C(m) (vph)		1342					725	
v/c		0.02					0.18	
95% queue length		0.05					0.68	
Control Delay		7.7					11.1	
LOS		A					В	
Approach Delay							11.1	
Approach LOS							В	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.98
v(il), Volume for stream 2 or 5		128
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.98
d(M,LT), Delay for stream 1 or 4		7.7
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		0.1

__TWO-WAY STOP CONTROL SUMMARY___

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

incersection offe	incacion.	ND		50	ady per	LIOU (III.	5,. 1.0	O
	Vehi	cle Volu	umes and	Adjus	tments_			
Major Street: Ap	proach	Noi	rthbound			Southbou	ınd	
Mc	vement	1	2	3	4	5	6	
		L	T	R	Ĺ	Т	R	
 Volume		75	135			63	42	
Peak-Hour Factor,	PHF	0.88	0.88			0.73	1 0.71	
Hourly Flow Rate,	HFR	85	153			88	59	
Percent Heavy Veh	icles	5						
Median Type/Stora RT Channelized?	ge	Undiv	ided		/			
Lanes		0	1			1	0	
Configuration		L					TR	
Upstream Signal?			No			No		
 Minor Street: Ap	proach	Wes	stbound			Eastbour	 nd	
Mc	vement	7	8	9	10	11	12	
		L	Т	R	L	Т	R	
Volume		81		7				
Peak Hour Factor,		0.71		0.71				
Hourly Flow Rate,		114		9				
Percent Heavy Veh		11		11				
Percent Grade (%)			2			0		
Flared Approach:	Exists?/	Storage		Yes	/50			/
Lanes		0	0					
Configuration			LR					
	Delay, Q	niene T.en	ngth, an	d Leve	1 of Se	ervice		
 Approach	NB	SB		bound	_ 0_ 0.		stbound	
Movement	1	4		8	9	10	11	12
Lane Config	LT			LR				12
 v (vph)	85			 123				
C(m) (vph)	1417			538				
v/c	0.06			0.23				
95% queue length	0.19			0.89				
Control Delay	7.7			14.0				
LOS	A			В				
Approach Delay				14.0				
Approach LOS				В				

Phone: Fax: E-Mail:

_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Flow (ped/hr)

Analysis Year: Existing
Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	_Vehicle '	Volumes	and Ad	justment	.s		
Major Street Movements	1	2	3	4	5	6	
	L	Т	R	L	T	R	
 Volume	75	135			63	42	
Peak-Hour Factor, PHF	0.88	0.88			0.71	0.71	
Peak-15 Minute Volume	21	38			22	15	
Hourly Flow Rate, HFR	85	153			88	59	
Percent Heavy Vehicles	5						
Median Type/Storage RT Channelized?	Undi	vided		/			
Lanes	0	1			1 ()	
Configuration	L'	Т			TH	3	
Upstream Signal?		No			No		
Minor Street Movements	7	8	9	10	11	12	
	L	Т	R	L	T	R	
 Volume	81		7				
Peak Hour Factor, PHF	0.71		0.71				
Peak-15 Minute Volume	29		2				
Hourly Flow Rate, HFR	114		9				
Percent Heavy Vehicles	11		11				
Percent Grade (%)		2			0		
Flared Approach: Exist RT Channelized?	s?/Storage	e	Yes	/50			/
Lanes	0	(0				
Configuration		LR					
P Movements	edestrian 13	Volume:	s and Ad 15	djustme 16	nts		
MO A CHIGHTOR	Τ.3	7.4	13	Τ0			

0

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Speed Length feet vph vph sec sec mph

S2 Left-Turn

Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	153	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical	L Gap Cal	 culatio	 on						
Movement	_	1	4	7	8	9	10	11	12
		L	L	L	T	R	L	T	R
t(c,base	 e)	4.1		7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5		11		11			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent	Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,1t)		0.00		0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2		6.9		6.5			
	2-stage								
Follow-U	Jp Time C	alculat	tions						
Movement	-	1	4	7	8	9	10	11	12
		L	L	L	T	R	L	T	R
t(f,base	 ∋)	2.20		3.50		3.30			
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5		11		11			
t(f)		2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                      R
                                                              L
                                                                     Т
                                                                             R
V c,x
                        147
                                       441
                                                      153
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

9 153 863 1.00 863 0.99 4	1.00 1.00 1 1 147 1417 1.00 1417 0.94 0.93
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
153 863 1.00 863 0.99	1.00 1.00 1 1 147 1417 1.00 1417 0.94
863 1.00 863 0.99 4	1.00 1 147 1417 1.00 1417 0.94
863 1.00 863 0.99 4	1.00 1 147 1417 1.00 1417 0.94
1.00 863 0.99 4	1.00 1 147 1417 1.00 1417 0.94
863 0.99 4	1.00 1 147 1417 1.00 1417 0.94
1.00	1 147 1417 1.00 1417 0.94
1.00	1 147 1417 1.00 1417 0.94
1.00	147 1417 1.00 1417 0.94
	1417 1.00 1417 0.94
	1.00 1417 0.94
	1417 0.94
1.00	1417 0.94
1.00	0.94
8	11
1.00	1.00
0.93	0.93
1 00	1 00
1.00	1.00
7	10
441	
	1.00
±.00	0.93
	0.93
0 04	
	0.94
499	
age Gap Accept	ance
8	11
	441 531 1.00 0.94 499

Stagel Stagel Stagel Stagel Stagel Stagel Stage2

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mymnt
Movement Capacity
Probability of Queue free St.

Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding movement Capacity	nvmnt					
Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding movement Capacity	nvmnt		.00		1.00	
Result for 2 stage process:						
y C t Probability of Queue free St.		1	.00		1.00	
Step 4: LT from Minor St.			7		10	
Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding m	nvmnt					
Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding m Movement Capacity	nvmnt					
Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Maj. L, Min T Impedance factor Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding m Movement Capacity	nvmnt	5 1 0	41 31 .00		1.00 0.93 0.95 0.94	
Results for Two-stage process:						
Y C t		4	99			
Worksheet 8-Shared Lane Calculation	ons					
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)	114 499	515	9 863			

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	T	R	L	T	R
C sep	499		863			
Volume	114		9			
Delay	14.3		9.2			
Q sep	0.45		0.02			
Q sep +1	1.45		1.02			
round (Qsep +1)	1		1			
n max		1				
C sh		515				
SUM C sep		538				
n		50				
Cact		538				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	$_{ m LT}$			LR				
v (vph)	85			123				
C(m) (vph)	1417			538				
v/c	0.06			0.23				
95% queue length	0.19			0.89				
Control Delay	7.7			14.0				
LOS	A			В				
Approach Delay				14.0				
Approach LOS				В				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.94	1.00
v(il), Volume for stream 2 or 5	153	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.93	
d(M,LT), Delay for stream 1 or 4	7.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	0.5	

HCS+: Unsignalized Intersections Release 5.6

__TWO-WAY STOP CONTROL SUMMARY_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year:

Project ID: I-90/Timberline IMJR East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	Vehi	icle Vol	umes an	d Adjus	stments			
Major Street:	Approach		rthboun	_		Southbou	 nd	
3	Movement	1	2	3	4	5	б	
		L	Т	R	İь	T	R	
					1			
Volume		24	 124			103	 85	
Peak-Hour Fact	or, PHF	0.88	0.88			0.77	0.77	
Hourly Flow Ra		27	140			133	110	
Percent Heavy		5						
Median Type/St		Undiv	ided		/			
RT Channelized	_				•			
Lanes	•	0	1			1	0	
Configuration		L'				-	TR	
Upstream Signa	12		No			No		
opbeream brgna	- •		110			110		
Minor Street:	Approach	We	 stbound			 Eastboun	 d	
	Movement	7	8	9	1 10	11	12	
	110 / 00110	L	T	R	L	T	R	
		_	-		1 –	-		
Volume		23		 5				
Peak Hour Fact	or, PHF	0.78		0.78				
Hourly Flow Ra	te, HFR	29		6				
Percent Heavy	Vehicles	8		8				
Percent Grade			2			0		
Flared Approac	h: Exists?	/Storage		Yes	/50			/
Lanes		0		0				
Configuration			LR					
	Delay, (el of Se			
Approach	NB	SB .		tbound			tbound	
Movement	1	4	7	8	9	10	11	12
Lane Config	$_{ m LT}$			LR				
 v (vph)				 35				
V (VpH) C(m) (vph)	1306			690				
v/c	0.02			0.05				
·								
95% queue leng				0.16				
Control Delay	7.8			11.2				
LOS	А			B				
Approach Delay				11.2				
Approach LOS				В				

Phone: Fax: E-Mail:

_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year:

Flow (ped/hr)

Project ID: I-90/Timberline IMJR East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	Vehicle '		_				
Major Street Movements	1	2	3	4	5 די	6	
	L	Т	R	L	Т	R	
Volume	24	124			103	85	
Peak-Hour Factor, PHF	0.88	0.88			0.77	0.77	
Peak-15 Minute Volume	7	35			33	28	
Hourly Flow Rate, HFR	27	140			133	110	
Percent Heavy Vehicles	5						
Median Type/Storage RT Channelized?	Undi	vided		/			
lanes	0	1			1 ()	
Configuration	L'	_			TI	-	
Jpstream Signal?	ш.	No			No	•	
ppolicum bigilai.		110			110		
Minor Street Movements	7	8	9	10	11	12	
	L	Т	R	L	T	R	
	23		5				
Peak Hour Factor, PHF	0.78		0.78				
Peak-15 Minute Volume	7		2				
Nourly Flow Rate, HFR	29		6				
Percent Heavy Vehicles	8		8				
Percent Grade (%)		2			0		
Flared Approach: Exists	?/Storag	е	Yes	/50			/
RT Channelized?							
lanes	0	(0				
Configuration		LR					
	destrian				nts		
Movements	13	14	15	16			

0 0

0

0

Lane Width (ft) 12.0 12.0 12.0 12.0 Walking Speed (ft/sec) 4.0 4.0 4.0 4.0 Percent Blockage 0 0 0 0

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Speed Length feet vph vph sec sec mph

S2 Left-Turn

Through S5 Left-Turn

Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared In volume, major th vehicles:	140	
Shared In volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

 Critical	Gap Cal	culati	 on						
Movement	_	1	4	7	8	9	10	11	12
		L	L	L	T	R	L	Т	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5		8		8			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent	Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,1t)		0.00		0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2		6.9		6.5			
	2-stage								
Follow-U	p Time Ca	alcula	tions						
Movement		1	4	7	8	9	10	11	12
		L	L	L	T	R	L	Т	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5		8		8			
t(f)		2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                      R
                                                              L
                                                                     Т
                                                                             R
V c,x
                        243
                                       382
                                                      140
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

V(c,x)		
1500		
P(x)		
V(c,u,x)		
C(r,x)		
C(plat,x)		
Worksheet 6-Impedance and Capacity Equation	ıs	
Step 1: RT from Minor St.	9	12
 Conflicting Flows	140	
Potential Capacity	885	
Potential Capacity Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	885	1.00
Probability of Queue free St.	0.99	1.00
Probability of Queue free St.	0.99	1.00
Step 2: LT from Major St.	4	1
Conflicting Flows		243
Potential Capacity		1306
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1306
Probability of Queue free St.	1.00	0.98
Maj L-Shared Prob Q free St.		0.98
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	382	
Potential Capacity	584	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	1.00	0.98
Maj. L, Min T Adj. Imp Factor.		0.98
Cap. Adj. factor due to Impeding mvmnt	0.98	0.98
Movement Capacity	572	3.70
	- · -	
Worksheet 7-Computation of the Effect of Tw	o-stage Gap Acce	ptance
Step 3: TH from Minor St.	8	11
Part 1 - First Stage Conflicting Flows		

Stagel Stagel Stagel Stagel Stagel Stagel Stage2

Part 1 - First Stage
Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
Probability of Queue free St.

Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)	29 572	609	6 885			
Movement	7 L	8 T	9 R	10 L	11 T	12 R
Worksheet 8-Shared Lane Calculatio	ons					
C t 		5	72			
a Y						
Results for Two-stage process:						
Movement Capacity		5	72			
Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding m	nvmnt		.98		0.98	
Maj. L. Min T Impedance factor					0.98 0.98	
Potential capacity Pedestrian Impedance Factor			.00		1.00	
Conflicting Flows Potential Capacity			82 84			
Part 3 - Single Stage						
Cap. Adj. factor due to Impeding m Movement Capacity	nvmri c					
Pedestrian Impedance Factor						
Potential Capacity						
Part 2 - Second Stage Conflicting Flows						
Movement Capacity						
Cap. Adj. factor due to Impeding m	mvmnt					
Potential Capacity Pedestrian Impedance Factor						
Conflicting Flows						
 Part 1 - First Stage						
Step 4: LT from Minor St.			7		10	
C t Probability of Queue free St.		1	.00		1.00	
У						
Result for 2 stage process:						
Movement Capacity						
Pedestrian Impedance Factor Cap. Adj. factor due to Impeding m	nvmnt		.00 .98		0.98	
Potential Capacity		1	0.0		1.00	
Part 3 - Single Stage Conflicting Flows						
Movement Capacity						
Cap. Adj. factor due to Impeding m	mvmnt					
Potential Capacity Pedestrian Impedance Factor						
t and in a constant						

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	T	R
C sep	572		885			
Volume	29		6			
Delay	11.6		9.1			
Q sep	0.09		0.02			
Q sep +1	1.09		1.02			
round (Qsep +1)	1		1			
n max		1				
C sh		609				
SUM C sep		690				
n		50				
Cact		690				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	$_{ m LT}$			LR				
v (vph)	27			35				
C(m) (vph)	1306			690				
v/c	0.02			0.05				
95% queue length	0.06			0.16				
Control Delay	7.8			11.2				
LOS	A			В				
Approach Delay				11.2				
Approach LOS				В				

Worksheet 11-Shared Major LT Impedance and Delay

0.98	1.00
140	
0	
1700	
1700	
0.98	
7.8	
1	
0.2	
	140 0 1700 1700 0.98 7.8

Fax:

Phone:

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E-Mail:
        _____Directional Two-Lane Highway Segment Analysis______
Analyst
                      HDR
Agency/Co.
                      SDDOT
Date Performed
Analysis Time Period
                      1/2014
                      AM PEAK
Highway
                      TIMBERLINE ROAD
                      NORTH OF I-90 TO SOUTH OF 60TH
From/To
Jurisdiction
                     MINNEHAHA CO.
Analysis Year
                      Existing
Description I-90/Timberline IMJR
                  _____Input Data_____
                                  Peak hour factor, PHF 0.88
Highway class Class 3
Shoulder width 6.0
                          ft
                                 % Trucks and buses
                                                        6
                  12.0 ft % Trucks crawling 0.0
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0
Lane width
Segment length
                                                               mi/hr
                         mi % No-passing zones 60
% Access point 3----
                  Rolling
Terrain type
                   - mi
Grade: Length
                                Access point density 13 /mi
       Up/down
Analysis direction volume, Vd 210
                                   veh/h
Opposing direction volume, Vo 144
                                   veh/h
               _____Average Travel Speed_____
Direction
                                    Analysis(d) Opposing (o)
PCE for trucks, ET
                                       2.2
                                                          2.4
PCE for RVs, ER
                                                          1.1
                                       1.1
Heavy-vehicle adj. factor,(note-5) fHV 0.933
                                                         0.923
Grade adj. factor,(note-1) fg
                                      0.78
                                                         0.72
                                       328 pc/h
Directional flow rate, (note-2) vi
                                                          246 pc/h
Free-Flow Speed from Field Measurement:
Field measured speed, (note-3) S FM
                                                    mi/h
Observed total demand, (note-3) V
                                                    veh/h
Estimated Free-Flow Speed:
Base free-flow speed,(note-3) BFFS
                                            45.0
                                                    mi/h
Adj. for lane and shoulder width, (note-3) fLS 0.0
                                                    mi/h
Adj. for access point density, (note-3) fA
                                           3.3
                                                    mi/h
Free-flow speed, FFSd
                                            41.8
                                                    mi/h
                                            2.8
                                                    mi/h
Adjustment for no-passing zones, fnp
Average travel speed, ATSd
                                            34.4
                                                    mi/h
Percent Free Flow Speed, PFFS
                                            82.5
```

Percent T	ime-Spent-Followi	.ng		
Direction	Analysis(d)	Or	pposing	(0)
PCE for trucks, ET	1.7	01	1.8	(0)
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fi			0.954	1
Grade adjustment factor, (note-1) f			0.77	ı
	_	, /b		- a / b
Directional flow rate, (note-2) vi	-	c/h	223	pc/h
Base percent time-spent-following,				
Adjustment for no-passing zones, fi	_	52.2		
Percent time-spent-following, PTSF	d	61.5 %		
Level of Service as	nd Other Performa	ance Measi	ıres	
Level of service, LOS		С		
Volume to capacity ratio, v/c		0.19		
Peak 15-min vehicle-miles of trave	l <i>VM</i> T15		veh-mi	
Peak-hour vehicle-miles of travel,	•		zeh-mi	
Peak 15-min total travel time, TT1	J		zeh-h	
Capacity from ATS, CdATS			zeh/h	
Capacity from PTSF, CdPTSF			zeh/h	
Directional Capacity		1215	/eh/h	
Passi	ng Lane Analysis_			
Total length of analysis segment,	Lt		1.5	mi
Length of two-lane highway upstream		lane, Lu	_	mi
Length of passing lane including to		,	_	mi
Average travel speed, ATSd (from all			34.4	mi/h
Percent time-spent-following, PTSF			61.5	/ 11
Level of service, LOSd (from above			C	
Level of Service, Losa (from above)		C	
Average Travel	Speed with Passi	.ng Lane		
Downstream length of two-lane high	way within effect	cive		
length of passing lane for ave:	rage travel speed	l, Lde	_	mi
Length of two-lane highway downstro	eam of effective			
length of the passing lane for		speed, Ld	_	mi
Adj. factor for the effect of pass		1 ,		
on average speed, fpl	1119 14110		_	
Average travel speed including pass	sing lane ATSpl		_	
Percent free flow speed including p		rsnl	0.0	%
referred free from speed including	passing lane, Fri	DPI	0.0	•
Percent Time-Spent	-Following with E	Passing La	ane	
Downstream length of two-lane high	way within effect	cive lengt	:h	
of passing lane for percent time			_	mi
Length of two-lane highway downstro	-		F	
the passing lane for percent t			_	mi
Adj. factor for the effect of pass.	_	.119, LU		шт
on percent time-spent-following	3, IDT		-	
Percent time-spent-following including passing lane, PTSFpl			-	%
Level of Service and Other Po	erformance Measur	es with 1	Passing	Lane
T	1			
Level of service including passing		E		
Peak 15-min total travel time, TT1	0		veh-h	
Bicycle	Level of Service	<u> </u>		

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	238.6
Effective width of outside lane, We	24.00
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	2.93
Bicycle LOS	С

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Fax:

Phone:

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E-Mail:
        _____Directional Two-Lane Highway Segment Analysis______
Analyst
                      HDR
Agency/Co.
                      SDDOT
Date Performed
Analysis Time Period
                      1/2014
                      AM PEAK
Highway
                      TIMBERLINE ROAD
                      NORTH OF I-90 TO SOUTH OF 60TH
From/To
Jurisdiction
                      MINNEHAHA CO.
Analysis Year
                      Existing
Description I-90/Timberline IMJR
                  _____Input Data_____
                                 Peak hour factor, PHF 0.88
Highway class Class 3
Shoulder width 6.0
                          ft
                                 % Trucks and buses
                                                        6
                  12.0 ft % Trucks crawling 0.0
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0
Lane width
Segment length
                                                               mi/hr
                  Rolling
                              % No-passing zones 60
Terrain type
Grade: Length
                   - mi
                                Access point density 13 /mi
       Up/down
                          %
Analysis direction volume, Vd 144
                                   veh/h
Opposing direction volume, Vo 210
                                   veh/h
               ______Average Travel Speed_____
Direction
                                   Analysis(d) Opposing (o)
PCE for trucks, ET
                                       2.4
                                                          2.2
PCE for RVs, ER
                                                          1.1
                                       1.1
Heavy-vehicle adj. factor,(note-5) fHV 0.923
                                                         0.933
                                       0.72
Grade adj. factor,(note-1) fg
                                                         0.78
                                       246 pc/h
Directional flow rate, (note-2) vi
                                                         328
                                                                pc/h
Free-Flow Speed from Field Measurement:
Field measured speed, (note-3) S FM
                                                   mi/h
Observed total demand, (note-3) V
                                                   veh/h
Estimated Free-Flow Speed:
Base free-flow speed, (note-3) BFFS
                                            45.0
                                                   mi/h
Adj. for lane and shoulder width, (note-3) fLS 0.0
                                                   mi/h
Adj. for access point density, (note-3) fA
                                           3.3
                                                   mi/h
Free-flow speed, FFSd
                                            41.8
                                                   mi/h
                                            2.4
                                                   mi/h
Adjustment for no-passing zones, fnp
Average travel speed, ATSd
                                            34.9
                                                   mi/h
Percent Free Flow Speed, PFFS
                                           83.6
```

Percent Time-Spent-Followi	ing		
Direction PCE for trucks, ET PCE for RVs, ER Heavy-vehicle adjustment factor, fHV Analysis(d) 1.8 0.954		Opposing 1.7 1.0 0.960	
Grade adjustment factor, (note-1) fg 0.77 Directional flow rate, (note-2) vi 223 pc Base percent time-spent-following, (note-4) BPTSFd Adjustment for no-passing zones, fnp Percent time-spent-following, PTSFd	26.0 52.2 48.1	0.82 303 %	pc/h
Level of Service and Other Performa	ance Me	asures	
Level of service, LOS Volume to capacity ratio, v/c Peak 15-min vehicle-miles of travel, VMT15 Peak-hour vehicle-miles of travel, VMT60 Peak 15-min total travel time, TT15 Capacity from ATS, CdATS Capacity from PTSF, CdPTSF Directional Capacity	B 0.15 61 216 1.7 1324 1395 1324	veh-mi veh-h veh/h veh/h veh/h	
Passing Lane Analysis_			
Total length of analysis segment, Lt Length of two-lane highway upstream of the passing Length of passing lane including tapers, Lpl Average travel speed, ATSd (from above) Percent time-spent-following, PTSFd (from above) Level of service, LOSd (from above)	lane,	1.5 Lu - - 34.9 48.1 B	mi mi mi mi/h
Average Travel Speed with Passi	ing Lan	ıe	
Downstream length of two-lane highway within effect length of passing lane for average travel speed Length of two-lane highway downstream of effective		-	mi
length of two fame highway downstream of circuit length of the passing lane for average travel s Adj. factor for the effect of passing lane on average speed, fpl	speed,	Ld -	mi
Average travel speed including passing lane, ATSpl Percent free flow speed including passing lane, PFF	FSpl	- 0.0	%
Percent Time-Spent-Following with F	Passing	Lane	
Downstream length of two-lane highway within effect of passing lane for percent time-spent-following Length of two-lane highway downstream of effective	ng, Lde	· –	mi
the passing lane for percent time-spent-followi Adj. factor for the effect of passing lane	_		mi
on percent time-spent-following, fpl Percent time-spent-following including passing lane, PTSFpl		-	ે
Level of Service and Other Performance Measur	res wit	h Passing	Lane
Level of service including passing lane, LOSpl Peak 15-min total travel time, TT15	E -	veh-h	
Bicycle Level of Service	e		

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	163.6
Effective width of outside lane, We	29.04
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	1.40
Bicycle LOS	A

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Fax:

Phone:

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E-Mail:
        _____Directional Two-Lane Highway Segment Analysis______
Analyst
                      HDR
Agency/Co.
                      SDDOT
Date Performed 1/2014
Analysis Time Period PM PEAK
Highway
                      TIMBERLINE ROAD
                      NORTH OF I-90 TO SOUTH OF 60TH
From/To
Jurisdiction
                     MINNEHAHA CO.
Analysis Year
                      Existing
Description I-90/Timberline IMJR
                  _____Input Data_____
                                  Peak hour factor, PHF 0.88
Highway class Class 3
Shoulder width 6.0
                          ft
                                 % Trucks and buses
                                                        6
                  12.0 ft % Trucks crawling 0.0
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0
Lane width
Segment length
                                                               mi/hr
                               % No-passing zones 60
                  Rolling
Terrain type
Grade: Length
                   - mi
                                Access point density 13 /mi
       Up/down
                          %
Analysis direction volume, Vd 148
                                   veh/h
Opposing direction volume, Vo 126
                                   veh/h
               ______Average Travel Speed_____
Direction
                                    Analysis(d) Opposing (o)
PCE for trucks, ET
                                       2.4
                                                          2.5
PCE for RVs, ER
                                                          1.1
                                       1.1
Heavy-vehicle adj. factor,(note-5) fHV 0.923
                                                         0.917
                                      0.72
Grade adj. factor,(note-1) fg
                                                         0.70
                                       253 pc/h
Directional flow rate, (note-2) vi
                                                         223
                                                                pc/h
Free-Flow Speed from Field Measurement:
Field measured speed, (note-3) S FM
                                                    mi/h
Observed total demand, (note-3) V
                                                    veh/h
Estimated Free-Flow Speed:
Base free-flow speed, (note-3) BFFS
                                            45.0
                                                    mi/h
Adj. for lane and shoulder width, (note-3) fLS 0.0
                                                    mi/h
Adj. for access point density, (note-3) fA
                                           3.3
                                                    mi/h
Free-flow speed, FFSd
                                            41.8
                                                    mi/h
                                                    mi/h
Adjustment for no-passing zones, fnp
                                            3.0
Average travel speed, ATSd
                                            35.1
                                                    mi/h
Percent Free Flow Speed, PFFS
                                            84.0
```

Percent Time-Spent-Followi	ing		
Direction PCE for trucks, ET PCE for RVs, ER Heavy-vehicle adjustment factor, fHV Grade adjustment factor, (note-1) fg Analysis(d) 1.8 1.0 0.954 0.78		Opposing 1.8 1.0 0.954 0.76	
	23.9 57.6 54.7	197	pc/h
Level of Service and Other Performa	ance Me	easures	
Level of service, LOS Volume to capacity ratio, v/c Peak 15-min vehicle-miles of travel, VMT15 Peak-hour vehicle-miles of travel, VMT60 Peak 15-min total travel time, TT15 Capacity from ATS, CdATS Capacity from PTSF, CdPTSF Directional Capacity	B 0.15 63 222 1.8 1183 1298 1183	•	
Passing Lane Analysis_			
Total length of analysis segment, Lt Length of two-lane highway upstream of the passing Length of passing lane including tapers, Lpl Average travel speed, ATSd (from above) Percent time-spent-following, PTSFd (from above) Level of service, LOSd (from above)	lane,	1.5 Lu - - 35.1 54.7 B	mi mi mi mi/h
Average Travel Speed with Passi	ing Lar	ne	
Downstream length of two-lane highway within effect length of passing lane for average travel speed Length of two-lane highway downstream of effective		-	mi
<pre>length of the passing lane for average travel s Adj. factor for the effect of passing lane on average speed, fpl</pre>	speed,	Ld -	mi
Average travel speed including passing lane, ATSpl Percent free flow speed including passing lane, PFF	Spl	0.0	%
Percent Time-Spent-Following with F	Passing	g Lane	
Downstream length of two-lane highway within effect of passing lane for percent time-spent-following Length of two-lane highway downstream of effective	ng, Lde	e –	mi
the passing lane for percent time-spent-followi Adj. factor for the effect of passing lane on percent time-spent-following, fpl	_		mi
Percent time-spent-following including passing lane, PTSFpl		-	ૄ
Level of Service and Other Performance Measur	res wit	ch Passing	Lane
Level of service including passing lane, LOSpl Peak 15-min total travel time, TT15	E -	veh-h	
Bicycle Level of Service	=		

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	168.2
Effective width of outside lane, We	28.68
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	1.52
Bicycle LOS	В

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Fax:

Phone:

Percent Free Flow Speed, PFFS

```
E-Mail:
        _____Directional Two-Lane Highway Segment Analysis______
Analyst
                      HDR
Agency/Co.
                      SDDOT
Date Performed 1/2014
Analysis Time Period PM PEAK
Highway
                      TIMBERLINE ROAD
                      NORTH OF I-90 TO SOUTH OF 60TH
From/To
Jurisdiction
                     MINNEHAHA CO.
Analysis Year
                      Existing
Description I-90/Timberline IMJR
                  _____Input Data_____
                                  Peak hour factor, PHF 0.88
Highway class Class 3
Shoulder width 6.0
                          ft
                                 % Trucks and buses
                                                        6
                  12.0 ft % Trucks crawling 0.0
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0
Lane width
Segment length
                                                               mi/hr
                              % No-passing zones 60
                  Rolling
Terrain type
Grade: Length
                   - mi
                                Access point density 13 /mi
       Up/down
                         %
Analysis direction volume, Vd 126
                                   veh/h
Opposing direction volume, Vo 148
                                   veh/h
               ______Average Travel Speed_____
Direction
                                    Analysis(d) Opposing (o)
PCE for trucks, ET
                                       2.5
                                                          2.4
PCE for RVs, ER
                                                          1.1
                                       1.1
Heavy-vehicle adj. factor,(note-5) fHV 0.917
                                                         0.923
                                       0.70
Grade adj. factor,(note-1) fg
                                                         0.72
                                       223 pc/h
Directional flow rate, (note-2) vi
                                                          253 pc/h
Free-Flow Speed from Field Measurement:
Field measured speed, (note-3) S FM
                                                    mi/h
Observed total demand, (note-3) V
                                                    veh/h
Estimated Free-Flow Speed:
Base free-flow speed, (note-3) BFFS
                                            45.0
                                                    mi/h
Adj. for lane and shoulder width, (note-3) fLS 0.0
                                                    mi/h
Adj. for access point density, (note-3) fA
                                           3.3
                                                    mi/h
Free-flow speed, FFSd
                                            41.8
                                                    mi/h
                                                    mi/h
Adjustment for no-passing zones, fnp
                                            2.8
Average travel speed, ATSd
                                            35.2
                                                    mi/h
```

84.4

Percent Time	e-Spent-Follow:	ing		
Direction	Analysis(d)	С)pposing	(0)
PCE for trucks, ET	1.8		1.8	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fHV	0.954		0.954	
Grade adjustment factor, (note-1) fg			0.78	
Directional flow rate, (note-2) vi		c/h	226	pc/h
Base percent time-spent-following, (no	-			<u> </u>
Adjustment for no-passing zones, fnp		57.6		
Percent time-spent-following, PTSFd		48.7 %	;	
Level of Service and	Other Performa	ance Meas	sures	
Level of service, LOS		В		
Volume to capacity ratio, v/c		0.13		
Peak 15-min vehicle-miles of travel,	VMT15		veh-mi	
Peak-hour vehicle-miles of travel, V			veh-mi	
Peak 15-min total travel time, TT15	0		veh-h	
Capacity from ATS, CdATS			veh/h	
Capacity from PTSF, CdPTSF			veh/h	
Directional Capacity			veh/h	
Passing	Lane Analysis			
Total length of analysis segment, Lt			1.5	mi
Length of two-lane highway upstream	of the passing	lane. Lu		mi
Length of passing lane including tap	_		_	mi
Average travel speed, ATSd (from abo	_		35.2	mi/h
Percent time-spent-following, PTSFd			48.7	/ 11
Level of service, LOSd (from above)	(110111 012010)		В	
Average Travel Sp	eed with Pass:	ing Lane		
Downstream length of two-lane highway				
length of passing lane for average	-	d, Lde	_	mi
Length of two-lane highway downstream			ī	
length of the passing lane for a		speed, La	L –	mı
Adj. factor for the effect of passing	g lane			
on average speed, fpl			_	
Average travel speed including passing		_	_	
Percent free flow speed including par	ssing lane, PF	FSpl	0.0	00
Percent Time-Spent-Fo	ollowing with 1	Passing L	ane	
Downstream length of two-lane highwa	y within effect	tive leng	ŗth	
of passing lane for percent time			_	mi
Length of two-lane highway downstream	_	_	of	
the passing lane for percent time			_	mi
Adj. factor for the effect of passing	_	J .		
on percent time-spent-following,			_	
Percent time-spent-following	-			
including passing lane, PTSFpl			-	%
Level of Service and Other Per	formance Measu	res with	Passing	Lane
Level of service including passing la	ane I.OSnl	E		
Peak 15-min total travel time, TT15	апе, поврт		veh-h	
reak 15-min cocal cravel cime, TT15		-	v ∈11-11	
Bicycle Lo	evel of Service	e		
== 0,000				

Posted speed limit, Sp	40
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	143.2
Effective width of outside lane, We	30.66
Effective speed factor, St	4.17
Bicycle LOS Score, BLOS	0.85
Bicycle LOS	A

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Appendix Part 3—2035 Interstate Level of Service

I-90/Timberline Road Interchange



Phone: E-mail:		Fax:		
	Operational Pl	anning Analysis_		
Analyst:	HDR			
Agency or Company:	SDDOT			
	1/2014			
Analysis Time Period:				
Freeway/Direction:	I-90			
From/To:	I-229/TIMBERLIN	ſΕ		
	MINNEHAHA CO.			
Analysis Year:	2035			
Description: I-90/SD 1	00 IMJR			
	Flow Inputs an	d Adjustments		
Annual average daily tr		48900	veh/day	
Peak-hour proportion of	AADT, K	0.09		
Peak-hour direction per	cent, D	55	%	
Volume, DDHV		2421	veh/h	
Peak Hour factor, PHF		0.90		
Trucks and buses		11	96	
Recreational vehicles		0	8	
Terrain type:		Rolling	96	
Grade Segment length		- -	mi	
Trucks and buses PCE, E	TT.	2.5	шт	
Recreational vehicles P		2.0		
Heavy Vehicle adjustmen		0.858		
Driver population facto		1.00		
Flow rate, vp	-,	1567	pc/h/ln	
	Speed Inputs a	nd Adjustments		
Lane width		12.0	ft	
Right-side lateral clea	rance	6.0	ft	
Interchange density		1.20	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base		
FFS or BFFS		75.4	mi/h	
Lane width adjustment,		0.0	mi/h	
Lateral clearance adjus		0.0	mi/h	
Interchange density adj	ustment, fID	3.8	mi/h	
Free-flow speed		71.6	mi/h	
	LOS and Perfor	mance Measures		
Flow rate, vp		1567	pc/h/ln	
Free-flow speed, FFS		71.6	mi/h	
Average passenger-car s	peed, S	68.4	mi/h	
Number of lanes, N		2		

Density, D Level of Service, LOS 22.9 C pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: E-mail:		Fax:	
	Operational Pl	anning Analysis_	
Analysis Time Period: Freeway/Direction: From/To:	HDR SDDOT 1/2014 PM PEAK I-90 I-229/TIMBERLIN MINNEHAHA CO. 2035		
	Flow Inputs ar	nd Adjustments	
Annual average daily tr Peak-hour proportion of		48900 0.09	veh/day
Peak-hour direction per Volume, DDHV		55 2421	% veh/h
Peak Hour factor, PHF Trucks and buses		0.90 11	8
Recreational vehicles Terrain type:		0 Rolling	8
Grade Segment length Trucks and buses PCE, E	ST.	- - 2.5	% mi
Recreational vehicles I Heavy Vehicle adjustmen	nt, fHV	2.0	
Driver population factor Flow rate, vp	or, ip	1.00 1567	pc/h/ln
	Speed Inputs a	and Adjustments	
Lane width Right-side lateral clea Interchange density Number of lanes, N	rance	12.0 6.0 1.20	ft ft ramps/mi
Free-flow speed: FFS or BFFS Lane width adjustment,	fLW	Base 75.4 0.0	mi/h mi/h
Lateral clearance adjusting Interchange density adjusting Free-flow speed	stment, fLC	0.0 3.8 71.6	mi/h mi/h mi/h
	LOS and Perfor	rmance Measures	
Flow rate, vp Free-flow speed, FFS Average passenger-car s	speed, S	1567 71.6 68.4	pc/h/ln mi/h mi/h

2

Number of lanes, N

Density, D Level of Service, LOS 22.9 C pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: E-mail:		Fax:		
	Operational Pla	anning Analysis_		
Analyst: H	DR			
-	DDOT			
Date Performed: 1				
	M PEAK			
_	-90			
_	'IMBERLINE/SD 1	1		
•	INNEHAHA CO.			
	035			
Description: I-90/SD 100				
	Flow Inputs and	d Adjustments		
Annual average daily traf	fic, AADT	40700	veh/day	
Peak-hour proportion of A	ADT, K	0.09		
Peak-hour direction perce	nt, D	57	%	
Volume, DDHV		2088	veh/h	
Peak Hour factor, PHF		0.90		
Trucks and buses		11	%	
Recreational vehicles		0	%	
Terrain type:		Rolling		
Grade		-	%	
Segment length		-	mi	
Trucks and buses PCE, ET		2.5		
Recreational vehicles PCE	, ER	2.0		
Heavy Vehicle adjustment,		0.858		
Driver population factor,	fp	1.00		
Flow rate, vp		1351	pc/h/ln	
	Speed Inputs an	nd Adjustments		
Lane width		12.0	ft	
Right-side lateral cleara	nce	6.0	ft	
Interchange density		0.50	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base		
FFS or BFFS		75.4	mi/h	
Lane width adjustment, fL	W	0.0	mi/h	
Lateral clearance adjustm		0.0	mi/h	
Interchange density adjus	tment, fID	1.8	mi/h	
Free-flow speed		73.6	mi/h	
	LOS and Perform	mance Measures		
Flow rate, vp		1351	pc/h/ln	
Free-flow speed, FFS		73.6	mi/h	
Average passenger-car spe	ed, S	73.6	mi/h	
Number of lanes, N	, ~	2		
		=		

Density, D Level of Service, LOS 18.3 C

pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: E-mail:		Fax:		
	Operational Pl	anning Analysis_		
Analyst: H	DR			
_	DDOT			
Date Performed: 1	/2014			
Analysis Time Period: P	M PEAK			
Freeway/Direction: I	-90			
	IMBERLINE/SD 1	1		
	INNEHAHA CO.			
2	035			
Description: I-90/SD 100	IMJR			
	Flow Inputs and	d Adjustments		
Annual average daily traf		40700	veh/day	
Peak-hour proportion of A		0.09		
Peak-hour direction perce	nt, D	56	%	
Volume, DDHV		2051	veh/h	
Peak Hour factor, PHF		0.90	_	
Trucks and buses		11	96	
Recreational vehicles		0	8	
Terrain type:		Rolling	•	
Grade		_	8	
Segment length		-	mi	
Trucks and buses PCE, ET		2.5		
Recreational vehicles PCE		2.0		
Heavy Vehicle adjustment,		0.858		
Driver population factor,	Гр	1.00	m a /b /l m	
Flow rate, vp		1327	pc/h/ln	
	Speed Inputs a	nd Adjustments		
Lane width		12.0	ft	
Right-side lateral cleara	nce	6.0	ft	
Interchange density		0.50	ramps/mi	
Number of lanes, N		2		
Free-flow speed:		Base		
FFS or BFFS		75.4	mi/h	
Lane width adjustment, fL		0.0	mi/h	
Lateral clearance adjustm		0.0	mi/h	
Interchange density adjus	tment, fID	1.8	mi/h	
Free-flow speed		73.6	mi/h	
	LOS and Perfor	mance Measures		
Flow rate, vp		1327	pc/h/ln	
Free-flow speed, FFS		73.6	mi/h	
Average passenger-car spe	ed, S	73.8	mi/h	
Number of lanes, N		2		

Density, D Level of Service, LOS

В

18.0- pc/mi/ln

Overall results are not computed when free-flow speed is less than 55 mph.

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: I-229 Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 66.0 mph Volume on freeway 2070 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 50.0 mph 560 Volume on ramp vph Length of first accel/decel lane 610 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 490 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2930 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 2070 560 490 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 156 136 575 V Trucks and buses 11 6 6 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

```
1.00
Driver population factor, fP
                                               1.00
                                                          1.00
Flow rate, vp
                                    2680
                                               678
                                                          593
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2680 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2680
                                     4720
                                                    No
     Fi F
    v = v - v
                        2002
                                     4720
                                                    No
        F R
     FΟ
                        678
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 2680
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2680
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 21.8 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.294
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 58.9
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 58.9

mph

0.858

0.917

0.917

Heavy vehicle adjustment, fHV

Space mean speed for all vehicles,

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB Junction: I-229 Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 66.0 Free-flow speed on freeway mph Volume on freeway 2380 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 50.0 mph 520 Volume on ramp vph Length of first accel/decel lane 610 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 540 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2930 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 2380 520 540 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 144 150 661 V Trucks and buses 11 6 6 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

```
Driver population factor, fP
                                   1.00
                                              1.00
                                                          1.00
Flow rate, vp
                                   3081
                                               630
                                                          654
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 3081 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        3081
                                     4720
                                                    No
     Fi F
    v = v - v
                        2451
                                     4720
                                                    No
        F R
     FO
                        630
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
    v or v
                > 1.5 v /2
                                     No
Is
     3
          av34
                      12
If yes, v = 3081
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                    Actual
                                 Max Desirable
                                                     Violation?
                                 4400
                    3081
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 25.3 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation____
                                         D = 0.290
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 59.0
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 59.0

mph

0.858

0.917

0.917

Heavy vehicle adjustment, fHV

Space mean speed for all vehicles,

Phone: E-mail:		Fâ	ax:								
Merge Analysis											
Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction:	I-90/EB I-229 MINNEHAHA CO. 2035 O IMJR										
Freeway Data											
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway		2	Merge 2 66.0 1510								
	On	Ramp Dat	:a								
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel lane Length of second accel/decel lane		1 5 4	Right 1 55.0 490 880								
	_Adjacent Ram	p Data (if one	e exists)						
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp		5 U	Yes 560 Upstream Off 2930		vph ft						
Conversion to pc/h Under Base Conditions											
Junction Components		Freewa		Ramp		Adjacent					
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		1510 0.90 419 11 0 Rollir	ng %	490 0.90 136 6 0 Rolling	୦୧	Ramp 560 0.90 156 6 0 Rolling	vph v % %				
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi				

2.0

2.0

2.0

Recreational vehicle PCE, ER

```
1955
Flow rate, vp
                                               593
                                                          678
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1955 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         2548
                                     4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1955
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    2548
                                                     No
     R12
           _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 19.6 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.274
                                          S
Space mean speed in ramp influence area,
                                         S = 59.4
                                                     mph
                                          R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
                                          0
```

S = 59.4

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Space mean speed for all vehicles,

Phone: E-mail:		Fá	ax:								
Merge Analysis											
Agency/Co.: S Date performed: 1 Analysis time period: P Freeway/Dir of Travel: I Junction: I Jurisdiction: M	-90/EB -229 HINNEHAHA CO. 035 HIMJR										
Freeway Data											
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway		2	Merge 2 66.0 1860								
	On	Ramp Dat	ca								
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel lane Length of second accel/decel lane] 5	Right 1 55.0 540 880								
	_Adjacent Ram	p Data ((if one	e exists)						
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp		<u>.</u> [Yes 520 Upstream Off 2930		vph ft						
Conversion to pc/h Under Base Conditions											
Junction Components	<u>-</u> - ,	Freewa		Ramp		Adjacent Ramp					
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		1860 0.90 517 11 0 Rollir	ng %	540 0.90 150 6 0 Rolling	ે	520 0.90 144 6 0 Rolling	vph v % %				
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi				

2.0

2.0

2.0

Recreational vehicle PCE, ER

```
2408
                                               654
Flow rate, vp
                                                          630
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 2408 pc/h
                 12 F FM
                     _____Capacity Checks_____
                                                   LOS F?
                         Actual
                                      Maximum
                         3062
                                      4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                      12
     3
If yes, v = 2408
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    3062
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 23.5 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.308
                                          S
Space mean speed in ramp influence area,
                                         S = 58.6
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 58.6

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 2000 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 850 Volume on ramp vph Length of first accel/decel lane 340 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 350 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1890 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 2000 850 350 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 236 97 556 V Trucks and buses 11 1 11 % 0 Recreational vehicles 0 Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
1.00
Driver population factor, fP
                                               1.00
                                                          1.00
                                   2589
Flow rate, vp
                                               959
                                                          453
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2589 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2589
                                     4800
                                                    No
     Fi F
    v = v - v
                        1630
                                     4800
                                                    No
        F R
     FΟ
                        959
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 2589
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2589
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 23.5 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.384
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 59.2
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 59.2

mph

0.858

0.985

0.858

Heavy vehicle adjustment, fHV

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB Junction: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 2400 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 760 Volume on ramp vph Length of first accel/decel lane 340 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 430 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1890 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 2400 760 430 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 211 119 667 V Trucks and buses 11 4 6 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
3107
Flow rate, vp
                                               895
                                                          521
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 3107 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                         3107
                                     4800
                                                    No
     Fi F
    v = v - v
                        2212
                                     4800
                                                    No
        F R
     FO
                        895
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v 	 or v 	 > 2700 	 pc/h?
                                     No
     3
         av34
               > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 3107
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    3107
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 27.9 pc/mi/ln
Density,
                                       12
                      R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.379
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 59.4
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 59.4

mph

0.858

1.00

0.943

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		I	₹ax:				
	Merge	Analy	/sis				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	I-90/EB TIMBERLINE RD. MINNEHAHA CO. 2035						
	Free	way Da	ata				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	-		Merge 2 70.0 1150		mph vph		
	On R	amp Da	ata				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Right 1 45.0 350 760		mph vph ft ft		
	Adjacent Ramp	Data	(if on	e exists)		
Does adjacent ramp exis Volume on adjacent Ramp Position of adjacent Ra Type of adjacent Ramp Distance to adjacent Ra	mp		Yes 850 Upstre Off 1890		vph ft		
Q		TT1	. D	Q 3			
Junction Components	version to pc/h	Unde:		Condition Ramp	ns	Adjacen	 t
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, E	T	1150 0.90 319 11 0 Roll:	ing % mi	350 0.90 97 11 0 Rolling	% mi	Ramp 850 0.90 236 1 0 Rolling	vph v % % mi
Recreational vehicle PC	E, ER	2.0		2.0		2.0	

```
1489
Flow rate, vp
                                               453
                                                          959
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1489 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                        1942
                                     4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1489
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1942
                                                     No
     R12
           _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 15.6 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.280
                                         S
Space mean speed in ramp influence area,
                                         S = 62.2
                                                     mph
                                         R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.2

mph

0.858

1.00

0.858

1.00

0.985

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:		F	'ax:				
	Merge	Analy	sis				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	I-90/EB TIMBERLINE RD. MINNEHAHA CO. 2035						
	Free	way Da	ıta				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		Merge 2 70.0 1640		mph vph		
	On R	amp Da	ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Right 1 45.0 430 760		mph vph ft ft		
	Adjacent Ramp	Data	(if on	e exists)		
Does adjacent ramp exis Volume on adjacent Ramp Position of adjacent Ra Type of adjacent Ramp Distance to adjacent Ra	mp		Yes 760 Upstre Off 1890	am	vph ft		
Con	version to pc/h	Under	Base	Condition	ns		
Junction Components Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles		Freew 1640 0.90 456 11		Ramp 430 0.90 119 6 0		Adjacent Ramp 760 0.90 211 4	vph v v %
Terrain type: Grade Length Trucks and buses PCE, E Recreational vehicle PC		2.5 2.0	.ng % mi	Rolling 2.5 2.0	% mi	Rolling 2.5 2.0	% mi

```
2123
Flow rate, vp
                                               521
                                                          895
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 2123 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                        2644
                                     4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 2123
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                    2644
                                 4600
                                                     No
     R12
           ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 21.1 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.307
                                         S
Space mean speed in ramp influence area,
                                         S = 61.4
                                                     mph
                                         R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 61.4

mph

0.858

1.00

0.917

1.00

0.943

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/EB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway Free-flow speed on freeway 70.0 mph Volume on freeway 1500 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 360 Volume on ramp vph Length of first accel/decel lane 620 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 150 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1960 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 360 1500 150 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 417 100 42 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
Driver population factor, fP
                                   1.00
                                              1.00
                                                         1.00
Flow rate, vp
                                   1942
                                              430
                                                         179
                                                                 pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1942 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks_____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        1942
                                     4800
                                                    No
     Fi F
    v = v - v
                        1512
                                     4800
                                                    No
        F R
     FO
                        430
                                     2100
                                                   No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3 av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 1942
                                  (Equation 13-15, 13-16, 13-18, or 13-19)
       12A
                   _Flow Entering Diverge Influence Area___
                                Max Desirable
                                                     Violation?
                   Actual
                                4400
                    1942
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 15.4 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.337
Intermediate speed variable,
                                         S
Space mean speed in ramp influence area,
                                        S = 60.6
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 60.6

mph

0.858

0.930

0.930

Heavy vehicle adjustment, fHV

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/EB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 2070 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph Volume on ramp 840 vph Length of first accel/decel lane 620 ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 250 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1960 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 2070 840 250 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 233 69 575 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
1.00
Driver population factor, fP
                                               1.00
                                                          1.00
Flow rate, vp
                                    2680
                                               1003
                                                          299
                                                                  pcph
                  _____Estimation of V12 Diverge Areas__
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2680 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2680
                                     4800
                                                    No
     Fi F
    v = v - v
                        1677
                                     4800
                                                    No
        F R
     FO
                        1003
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3 av34
Is
    v 	 or v 	 > 2700 	 pc/h?
                                     No
     3 av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 2680
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2680
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 21.7 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.388
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 59.1
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 59.1

mph

0.858

0.930

0.930

Heavy vehicle adjustment, fHV

Phone: E-mail:	F	Fax:					
	Mer	ge Analy	sis				
Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction:	I-90/EB SD 11 MINNEHAHA CO 2035 0 IMJR						
	Fr	eeway Da	ta				
Type of analysis Number of lanes in freewa Free-flow speed on freewa Volume on freeway	_		Merge 2 70.0 1140		mph vph		
	On	Ramp Da	ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/dec Length of second accel/de			Right 1 45.0 150 670		mph vph ft ft		
	_Adjacent Ra	mp Data	(if one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp	p		Yes 360 Upstrea Off 1960	am	vph ft		
Conve	ersion to pc	/h Under	Base (Condition	ns		
Junction Components	322 30 PC	Freew		Ramp		Adjacent	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		1140 0.90 317 11 0 Rolli	ng %	150 0.90 42 5 0 Rolling	୦୧	Ramp 360 0.90 100 5 0 Rolling	vph v % %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
1476
Flow rate, vp
                                               179
                                                          430
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1476 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         1655
                                      4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1476
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual
                          Max Desirable
                                                     Violation?
                    1655
                                 4600
                                                     No
     R12
            ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 14.1 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation___
Intermediate speed variable,
                                         M = 0.281
                                         S
Space mean speed in ramp influence area,
                                         S = 62.1
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.1

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:	I	Fax:					
	Me	rge Analy	sis				
Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction:	I-90/EB SD 11 MINNEHAHA C 2035 00 IMJR						
	F	reeway Da	ta				
Type of analysis Number of lanes in freew Free-flow speed on freew Volume on freeway	_		Merge 2 70.0 1230		mph vph		
	C	n Ramp Da	ata				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/de Length of second accel/de			Right 1 45.0 250 670		mph vph ft ft		
	Adjacent R	amp Data	(if one	e exists)		
Does adjacent ramp exist Volume on adjacent Ramp Position of adjacent Ram Type of adjacent Ramp Distance to adjacent Ram	np		Yes 840 Upstrea Off 1960	am	vph ft		
Conv	ersion to p	c/h Under	Base (Condition	ns		
Junction Components		Freev		Ramp	<u></u> -	Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		1230 0.90 342 11 0 Rolls		250 0.90 69 5 0 Rolling	୦	840 0.90 233 5 0 Rolling	vph v % %
Length Trucks and buses PCE, ET	• •	2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
1592
                                               299
Flow rate, vp
                                                          1003
                                                                  pcph
                  _____Estimation of V12 Merge Areas____
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1592 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                        1891
                                     4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1592
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    1891
                                                     No
     R12
           ____Level of Service Determination (if not F)_____
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 15.9 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.287
                                         S
Space mean speed in ramp influence area,
                                         S = 62.0
                                                     mph
                                         R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.0

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/WB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 1720 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph Volume on ramp 110 vph 510 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 570 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1980 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp 110 Volume, V (vph) 1720 570 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 478 31 158 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
1.00
Driver population factor, fP
                                              1.00
                                                         1.00
Flow rate, vp
                                   2226
                                              131
                                                         681
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2226 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2226
                                     4800
                                                    No
     Fi F
    v = v - v
                        2095
                                     4800
                                                    No
        F R
     FO
                        131
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3 av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 2226
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2226
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 18.8 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.310
Intermediate speed variable,
                                         S
Space mean speed in ramp influence area,
                                         S = 61.3
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 61.3

mph

0.858

0.930

0.930

Heavy vehicle adjustment, fHV

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014 Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/WB Junction: SD 11 Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data______ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 1210 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 170 Volume on ramp vph 510 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 550 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 1980 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp 170 Volume, V (vph) 1210 550 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 336 47 153 V Trucks and buses 11 5 5 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

mi

2.5

2.0

2.5

2.0

```
1.00
Driver population factor, fP
                                               1.00
                                                          1.00
Flow rate, vp
                                    1566
                                               203
                                                          657
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 1566 pc/h
                 12 R
                          F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        1566
                                      4800
                                                    No
     Fi F
    v = v - v
                        1363
                                     4800
                                                    No
        F R
     FO
                         203
                                     2100
                                                    No
    V
     R
                         0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v 	 or v 	 > 2700 	 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 1566
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    1566
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 13.1 pc/mi/ln
Density,
                                       12
                      R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.316
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 61.1
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 61.1

mph

0.858

0.930

0.930

Heavy vehicle adjustment, fHV

Phone: E-mail:		I	₹ax:				
	Merg	e Analy	sis				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	I-90/WB SD 11 MINNEHAHA CO. 2035						
	Fre	eway Da	ata				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		Merge 2 70.0 1610		mph vph		
	On :	Ramp Da	ata				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Right 1 45.0 570 730		mph vph ft ft		
	Adjacent Ram	p Data	(if on	e exists)		
Does adjacent ramp exis Volume on adjacent Ramp Position of adjacent Ra Type of adjacent Ramp Distance to adjacent Ra	mp		Yes 110 Upstre Off 1980		vph ft		
Q		la TT	. D	O3:-:-			
Junction Components	version to pc/	h Under Freev		Condition Ramp	ns	Adjacent	 t
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, E		1610 0.90 447 11 0 Rolls	ing % mi	570 0.90 158 5 0 Rolling	% mi	Ramp 110 0.90 31 5 0 Rolling	vph v % % mi
Recreational vehicle PC		2.0		2.0		2.0	

```
2084
Flow rate, vp
                                               681
                                                          131
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 2084 pc/h
                 12 F FM
                     _____Capacity Checks_____
                                                   LOS F?
                                      Maximum
                         Actual
                         2765
                                      4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v / 2
                                     No
Is
    v or v
     3
          av34
                      12
If yes, v = 2084
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    2765
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 22.2 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.317
                                          S
Space mean speed in ramp influence area,
                                         S = 61.1
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 61.1

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:				Fax:					
	M	erge A	Analysi	s					
Analysis time period: Freeway/Dir of Travel: Junction:	I-90/WB SD 11 MINNEHAHA 2035 OO IMJR								
		Freewa	ay Data						
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		2 70	rge .0 40		mph vph			
		On Ram	np Data						
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/de Length of second accel/de			1	.0		mph vph ft ft			
	Adjacent	Ramp D	Data (i	f on	e exists)			
Does adjacent ramp exist Volume on adjacent Ramp Position of adjacent Ram Type of adjacent Ramp Distance to adjacent Ram	mp		Ye 17 Up Of 19	0 strea f	am	vph ft			
Conv	version to	pc/h U	Jnder B	ase (Condition	ns			
Junction Components			reeway		Ramp		Adjacent		
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		0 2 1 0	.040).90 289 .1)	%	550 0.90 153 5 0 Rolling	%	Ramp 170 0.90 47 5 0 Rolling	vph v % %	
Length Trucks and buses PCE, E	Г	2	2.5	mi	2.5	mi	2.5	mi	

2.0

2.0

```
1346
Flow rate, vp
                                               657
                                                          203
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1346 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                        2003
                                     4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1346
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    2003
                                                     No
     R12
           _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 16.2 pc/mi/ln
Level of service for ramp-freeway junction areas of influence B
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.284
                                         S
Space mean speed in ramp influence area,
                                         S = 62.0
                                                     mph
                                         R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 62.0

mph

0.858

1.00

0.930

1.00

0.930

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: AM PEAK Freeway/Dir of Travel: I-90/WB Junction: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 2180 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 420 Volume on ramp vph 530 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 640 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2020 ft _____Conversion to pc/h Under Base Conditions______ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 420 2180 640 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 117 606 178 V Trucks and buses 11 11 2 % 0 Recreational vehicles 0 Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length mi

2.5

2.0

2.5

2.0

2.5

2.0

Trucks and buses PCE, ET

```
Driver population factor, fP
                                   1.00
                                              1.00
                                                         1.00
Flow rate, vp
                                   2822
                                              544
                                                         732
                                                                 pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2822 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2822
                                     4800
                                                    No
     Fi F
    v = v - v
                        2278
                                     4800
                                                    No
        F R
     FO
                        544
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3 av34
    v or v
                > 1.5 v /2
                                     No
Is
     3
          av34
                      12
If yes, v = 2822
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2822
                                                     No
    V
     12
            ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 23.8 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.347
Intermediate speed variable,
                                         S
Space mean speed in ramp influence area,
                                         S = 60.3
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 60.3

mph

0.858

0.858

0.971

Heavy vehicle adjustment, fHV

Phone: Fax: E-mail: _____Diverge Analysis_____ HDR Analyst: Agency/Co.: SDDOT Date performed: 1/2014
Analysis time period: PM PEAK Freeway/Dir of Travel: I-90/WB Junction: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO. Analysis Year: 2035 Description: I-90/SD 100 IMJR ______Freeway Data_____ Type of analysis Diverge Number of lanes in freeway 70.0 Free-flow speed on freeway mph Volume on freeway 1590 vph _____Off Ramp Data_____ Side of freeway Right Number of lanes in ramp 1 Free-Flow speed on ramp 45.0 mph 370 Volume on ramp vph 530 Length of first accel/decel lane ft Length of second accel/decel lane ft _____Adjacent Ramp Data (if one exists)_____ Does adjacent ramp exist? Yes Volume on adjacent ramp 780 vph Position of adjacent ramp Downstream Type of adjacent ramp On Distance to adjacent ramp 2020 ft _____Conversion to pc/h Under Base Conditions_____ Freeway Junction Components Ramp Adjacent Ramp Volume, V (vph) 1590 370 780 vph Peak-hour factor, PHF 0.90 0.90 0.90 Peak 15-min volume, v15 442 103 217 V Trucks and buses 11 8 4 % 0 0 Recreational vehicles Rolling Rolling Rolling Terrain type: 0.00 % 0.00 % 0.00 Grade 0.00 mi 0.00 mi 0.00 Length

2.5

2.0

Trucks and buses PCE, ET

Recreational vehicle PCE, ER

mi

2.5

2.0

2.5

2.0

```
1.00
Driver population factor, fP
                                              1.00
                                                         1.00
                                   2058
Flow rate, vp
                                               460
                                                         919
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2058 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2058
                                     4800
                                                    No
     Fi F
    v = v - v
                        1598
                                     4800
                                                    No
        F R
     FO
                        460
                                     2100
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 2058
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2058
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 17.2 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence B
                _____Speed Estimation_____
                                         D = 0.339
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 60.5
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 60.5

mph

0.858

0.893

0.943

Heavy vehicle adjustment, fHV

Phone: E-mail:		I	₹ax:				
	Merge	Analy	/sis				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	I-90/WB TIMBERLINE RD. MINNEHAHA CO. 2035						
	Free	way Da	ata				
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	-		Merge 2 70.0 1760		mph vph		
	On R	amp Da	ata				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/	ecel lane		Right 1 45.0 640 680		mph vph ft ft		
	Adjacent Ramp	Data	(if on	e exists)		
Does adjacent ramp exis Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ram	mp		Yes 420 Upstre Off 2020		vph ft		
2		TT1	. D	03:-:			
Junction Components	version to pc/h	Unde: Freev		Condition Ramp	ns	Adjacen	 t
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, E	Г	1760 0.90 489 11 0 Roll:	ing % mi	640 0.90 178 2 0 Rolling	% mi	Ramp 420 0.90 117 11 0 Rolling	vph v % % mi
Recreational vehicle PC		2.0		2.0		2.0	

```
2278
                                                          544
Flow rate, vp
                                               732
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 2278 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         3010
                                      4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 2278
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    3010
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 24.4 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.339
                                         S
                                         S = 60.5
Space mean speed in ramp influence area,
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 60.5

mph

0.858

1.00

0.971

1.00

0.858

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:	Fax:	Fax:					
	Merge	Analysis	5				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 10	I-90/WB TIMBERLINE RD. MINNEHAHA CO. 2035						
	Free	way Data_					
Type of analysis Number of lanes in freev Free-flow speed on freev Volume on freeway	_	Mer 2 70. 122	0		mph vph		
	On R	amp Data_					
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/de Length of second accel/de	Right 1 45.0 780 680			mph vph ft ft			
	Adjacent Ramp	Data (if	one	e exists)		
Does adjacent ramp exist Volume on adjacent Ramp Position of adjacent Ram Type of adjacent Ramp Distance to adjacent Ram	np	Yes 370 Ups Off 202) strea	am	vph ft		
Conv	version to pc/h	Under Ba	ıse (Condition	ns		
Junction Components		Freeway		Ramp		Adjacent	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		1220 0.90 339 11 0 Rolling	୍ଦ	780 0.90 217 4 0 Rolling	%	Ramp 370 0.90 103 8 0 Rolling	vph v % %
Length Trucks and buses PCE, E1		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
1579
Flow rate, vp
                                               919
                                                          460
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 1579 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         2498
                                     4800
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 1579
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    2498
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 20.3 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.307
                                          S
Space mean speed in ramp influence area,
                                         S = 61.4
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 61.4

mph

0.858

1.00

0.943

1.00

0.893

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:	F	Fax:					
	Merge	Analy	sis				
Date performed: 1/Analysis time period: AM Freeway/Dir of Travel: I-Junction: I-Jurisdiction: MII Analysis Year: 20 Description: I-90/SD 100	DOT 2014 PEAK 90/WB 229 NNEHAHA CO. 35 IMJR						
	Free	way Da	.ta				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway			Merge 2 66.0 2400		mph vph		
	On R	amp Da	.ta				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/dece Length of second accel/dece			Right 1 35.0 290 740		mph vph ft ft		
A	djacent Ramp	Data	(if one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp			Yes 600 Downstr Off 740	ream	vph ft		
Conver	sion to pc/h	Under	Base (Condition	ns		
Junction Components	- /	Freew		Ramp		Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		2400 0.90 667 11 0 Rolli	ng %	290 0.90 81 6 0 Rolling	୦୦	600 0.90 167 6 0 Rolling	vph v %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
3107
Flow rate, vp
                                               351
                                                          727
                                                                  pcph
                  _____Estimation of V12 Merge Areas__
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 3107 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         3458
                                      4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 3107
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                                 4600
                    3458
                                                     No
     R12
            ____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 27.6 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.393
                                          S
Space mean speed in ramp influence area,
                                         S = 56.6
                                                     mph
                                          R
                                         S = N/A
Space mean speed in outer lanes,
                                                     mph
                                          0
```

S = 56.6

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Phone: E-mail:	Fax	Fax:					
	Merge	Analysi	.s				
Analysis Year: 203 Description: I-90/SD 100 I	OOT 2014 PEAK 90/WB 229 INEHAHA CO. 35						
	Free	way Data	a				
Type of analysis Number of lanes in freeway Free-flow speed on freeway Volume on freeway		2 66	erge 5.0 000		mph vph		
	On R	amp Data	ì				
Side of freeway Number of lanes in ramp Free-flow speed on ramp Volume on ramp Length of first accel/decel Length of second accel/dece		1 35	ght 5.0 50		mph vph ft ft		
Ad	ljacent Ramp	Data (i	f one	e exists)		
Does adjacent ramp exist? Volume on adjacent Ramp Position of adjacent Ramp Type of adjacent Ramp Distance to adjacent Ramp			20 ownsti f	ream	vph ft		
Convers	sion to pc/h	Under E	Base (Condition	ns		
Junction Components	1 - 7 - 2	Freeway		Ramp		Adjacent Ramp	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade		2000 0.90 556 11 0 Rolling	J %	260 0.90 72 6 0 Rolling	୦୦	520 0.90 144 6 0 Rolling	vph v % %
Length Trucks and buses PCE, ET		2.5	mi	2.5	mi	2.5	mi

2.0

2.0

```
2589
Flow rate, vp
                                               315
                                                          630
                                                                  pcph
                  _____Estimation of V12 Merge Areas___
                L =
                               (Equation 13-6 or 13-7)
                 ΕQ
                      1.000 Using Equation 0
                 FM
                v = v (P) = 2589 pc/h
                 12 F FM
                    _____Capacity Checks_____
                                                   LOS F?
                        Actual
                                     Maximum
                         2904
                                      4720
                                                    No
    V
     FO
    v or v
                            pc/h
                                     (Equation 13-14 or 13-17)
          av34
     3
Is
    v or v
                > 2700 pc/h?
                                     No
     3
          av34
                > 1.5 v / 2
                                     No
Is
    v or v
          av34
                     12
     3
If yes, v = 2589
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                    __Flow Entering Merge Influence Area_
                    Actual Max Desirable
                                                     Violation?
                    2904
                                 4600
                                                     No
     R12
            _____Level of Service Determination (if not F)______
Density, D = 5.475 + 0.00734 v + 0.0078 v - 0.00627 L = 23.3 pc/mi/ln
Level of service for ramp-freeway junction areas of influence C
                  _____Speed Estimation____
Intermediate speed variable,
                                         M = 0.340
                                         S
Space mean speed in ramp influence area,
                                         S = 57.8
                                                     mph
                                          R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
                                          0
```

S = 57.8

mph

0.858

1.00

0.917

1.00

0.917

1.00

Heavy vehicle adjustment, fHV

Driver population factor, fP

Space mean speed for all vehicles,

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax: E-mail:

______Operational Analysis______

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK
Freeway/Dir of Travel: I-90/WB

Weaving Location: I-229 ON TO I-229 OFF

Analysis Year: 2035

Description: I-90/SD 100 IMJR

_____Inputs_____

Segment Type	Freeway		
Weaving configuration	One-Side	d	
Number of lanes, N	3	ln	
Weaving segment length, LS	740	ft	
Freeway free-flow speed, FFS	66	mi/h	
Minimum segment speed, SMIN	40	mi/h	
Freeway maximum capacity, cIFL	2350	pc/h/ln	
Terrain type	Rolling		
Grade	0.00	%	
Length	0.00	mi	

______Conversion to pc/h Under Base Conditions_____

	Volume				
	VFF	VRF	VFR	VRR	
Volume, V	1800	290	600	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	500	81	167	0	
Trucks and buses	11	6	6	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	2.5	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	2.0	
Heavy vehicle adjustment, fHV	0.858	0.917	0.917	1.00	0
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	2330	351	727	0	pc/h

Volume ratio, VR 0.316

Configuration	Characteristi	cs
Number of maneuver lanes, NWL	2	ln
Interchange density, ID	0.5	int/mi
Minimum RF lane changes, LCRF	1	lc/pc
Minimum FR lane changes, LCFR	1	lc/pc
Minimum RR lane changes, LCRR		lc/pc
Minimum weaving lane changes, LCMIN	1078	lc/h
Weaving lane changes, LCW	1180	lc/h
Non-weaving vehicle index, INW	86	
Non-weaving lane change, LCNW	303	lc/h
Total lane changes, LCALL	1483	lc/h

_____Weaving and Non-Weaving Speeds______

Weaving intensity factor, W

0.391

Average non-weaving speed, SNW	52.8	mı/h	
Weaving Segment Speed, Density	, Level of	Service and Capa	city
Weaving segment speed, S	54.5	mi/h	
Weaving segment density, D	20.8	pc/mi/ln	
Level of service, LOS	С		
Weaving segment v/c ratio	0.578		
Weaving segment flow rate, v	2926	veh/h	
Weaving segment capacity, cW	5063	veh/h	
Limitations on W	eaving Segm	ents	
If limit reached, see note.			
Minimum	Maximum	Actual	Note
Weaving length (ft) 300	5760	740	a,b
	Maximum	Analyzed	

2350

1.00

Maximum

mi/h

1966

Analyzed

0.578

d

Notes:

v/c ratio

Average weaving speed, SW

Density-based capacty,

cIWL (pc/h/ln)

- a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
- b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
- c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
- d. Volumes exceed the weaving segment capacity. The level of service is F.

HCS 2010: Freeway Weaving Release 6.50

Phone: Fax: E-mail:

______Operational Analysis______

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK
Freeway/Dir of Travel: I-90/WB

Weaving Location: I-229 ON TO I-229 OFF

Analysis Year: 2035

Description: I-90/SD 100 IMJR

_____Inputs______Inputs_____

Segment Type	Freeway		
Weaving configuration	One-Sided	1	
Number of lanes, N	3	ln	
Weaving segment length, LS	740	ft	
Freeway free-flow speed, FFS	66	mi/h	
Minimum segment speed, SMIN	40	mi/h	
Freeway maximum capacity, cIFL	2350	pc/h/ln	
Terrain type	Rolling		
Grade	0.00	%	
Length	0.00	mi	

______Conversion to pc/h Under Base Conditions_____

	Volume				
	VFF	VRF	VFR	VRR	
Volume, V	1480	260	520	0	veh/h
Peak hour factor, PHF	0.90	0.90	0.90	0.90	
Peak 15-min volume, v15	411	72	144	0	
Trucks and buses	11	6	6	0	%
Recreational vehicles	0	0	0	0	%
Trucks and buses PCE, ET	2.5	2.5	2.5	2.5	
Recreational vehicle PCE, ER	2.0	2.0	2.0	2.0	
Heavy vehicle adjustment, fHV	0.858	0.917	0.917	1.000)
Driver population adjustment, fP	1.00	1.00	1.00	1.00	
Flow rate, v	1916	315	630	0	pc/h

Volume ratio, VR 0.330

Configuration (Characterist	cics	
Number of maneuver lanes, NWL	2	ln	
Interchange density, ID	0.5	int/mi	
Minimum RF lane changes, LCRF	1	lc/pc	
Minimum FR lane changes, LCFR	1	lc/pc	
Minimum RR lane changes, LCRR		lc/pc	
Minimum weaving lane changes, LCMIN	945	lc/h	
Weaving lane changes, LCW	1047	lc/h	
Non-weaving vehicle index, INW	71		
Non-weaving lane change, LCNW	218	lc/h	
Total lane changes, LCALL	1265	lc/h	

____Weaving and Non-Weaving Speeds_____

Weaving intensity factor, W

0.345

Average non-weaving speed,	SNW	54.6	mi/h	
Weaving Segment Sp	eed, Density	, Level of S	Service and Cap	pacity
Weaving segment speed, S		56.1	mi/h	
Weaving segment density, D		17.0	pc/mi/ln	
Level of service, LOS		В		
Weaving segment v/c ratio		0.488		
Weaving segment flow rate,	V	2456	veh/h	
Weaving segment capacity, c	M	5032	veh/h	
Limi	tations on W	eaving Segme	ents	
If limit reached, see note.				
Meaving length (ft)	inimum 300	Maximum 5911	Actual 740	Note a,b

59.3

mi/h

	Minimum	Maximum	Actual	Note
Weaving length (ft)	300	5911	740	a,b
		Maximum	Analyzed	
Density-based capacty, cIWL (pc/h/ln)		2350	1954	С
		Maximum	Analyzed	
v/c ratio		1.00	0.488	d

Notes:

Average weaving speed, SW

- a. In weaving segments shorter than 300 ft, weaving vehicles are assumed to make only necessary lane changes.
- b. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments."
- c. The density-based capacity exceeds the capacity of a basic freeway segment, under equivalent ideal conditions.
- d. Volumes exceed the weaving segment capacity. The level of service is F.

Phone: E-mail:		Ι	₹ax:	:					
	Diver	rge Ana	alys	sis_					
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 1	AM PEAK I-90/WB I-229 MINNEHAHA CO. 2035 00 IMJR								
	Free	eway Da	ata_						
Type of analysis Number of lanes in free Free-flow speed on free Volume on freeway	_		2 66.	7erg .0 90		mph vph			
	Off F	Pamn Da	a + a						
Side of freeway Number of lanes in ramp Free-Flow speed on ramp Volume on ramp Length of first accel/d Length of second accel/d	ecel lane		Rig 1 35. 600 740	. 0		mph vph ft ft			
	Adjacent Ramp	Data	(if	on	e exists)			
Adjacent Ramp Does adjacent ramp exist? Volume on adjacent ramp Position of adjacent ramp Type of adjacent ramp Distance to adjacent ramp			Yes 290 Ups On 740) stre	am	vph ft			
Con	version to pc/h	n IInder	^ B=	200	Condition	na			
Junction Components	version to pc/f	Freev		ase	Ramp	ns	Adjacen Ramp	 t	
Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, E' Recreational vehicle PC		2690 0.90 747 11 0 Roll: 0.00 0.00 2.5 2.0	ing	% mi	600 0.90 167 6 0 Rolling 0.00 0.00 2.5 2.0	% mi	290 0.90 81 6 0 Rolling 0.00 0.00 2.5 2.0		vph v %

```
Driver population factor, fP
                                    1.00
                                               1.00
                                                          1.00
                                    3482
Flow rate, vp
                                               727
                                                          351
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 3482 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        3482
                                     4720
                                                    No
     Fi F
    v = v - v
                        2755
                                     4720
                                                    No
        F R
     FΟ
                        727
                                     2000
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
    v or v
                > 1.5 v /2
                                     No
Is
     3
          av34
                      12
If yes, v = 3482
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    3482
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 27.5 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.493
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 54.2
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 54.2

mph

0.858

0.917

0.917

Heavy vehicle adjustment, fHV

Space mean speed for all vehicles,

Phone: E-mail:		F	·ax	:				
	Diver	ge Ana	alys	sis_				
Analyst: Agency/Co.: Date performed: Analysis time period: Freeway/Dir of Travel: Junction: Jurisdiction: Analysis Year: Description: I-90/SD 10	PM PEAK I-90/WB I-229 MINNEHAHA CO. 2035 00 IMJR							
	Free	way Da	ata_					
Type of analysis Number of lanes in freev Free-flow speed on freev Volume on freeway	_		2 66.	7erg .0 50		mph vph		
	Off R	amp Da	. + -					
Side of freeway Number of lanes in ramp Free-Flow speed on ramp Volume on ramp Length of first accel/de Length of second accel/de	ecel lane		Ric 1 35. 520 740	ght .0)		mph vph ft ft		
Does adjacent ramp exist Volume on adjacent ramp Position of adjacent ramp Type of adjacent ramp Distance to adjacent ram	np	Under	On 740) stre)		vph ft ns		
Junction Components Volume, V (vph) Peak-hour factor, PHF Peak 15-min volume, v15 Trucks and buses Recreational vehicles Terrain type: Grade Length Trucks and buses PCE, ETR Recreational vehicle PCE		Freev 2260 0.90 628 11 0 Rolli 0.00 0.00 2.5 2.0		% mi	Ramp 520 0.90 144 6 0 Rolling 0.00 0.00 2.5 2.0	% mi	Adjacen Ramp 260 0.90 72 6 0 Rolling 0.00 0.00 2.5 2.0	vph v %

```
Driver population factor, fP
                                   1.00
                                              1.00
                                                          1.00
Flow rate, vp
                                   2925
                                               630
                                                          315
                                                                  pcph
                  _____Estimation of V12 Diverge Areas___
                               (Equation 13-12 or 13-13)
                L =
                 ΕQ
                      1.000 Using Equation 0
                 FD
                v = v + (v - v) P = 2925 pc/h
                 12 R
                         F R FD
                  _____Capacity Checks____
                                     Maximum
                                                   LOS F?
                        Actual
    v = v
                        2925
                                     4720
                                                    No
     Fi F
    v = v - v
                        2295
                                     4720
                                                    No
        F R
     FO
                        630
                                     2000
                                                    No
    V
     R
                        0 pc/h (Equation 13-14 or 13-17)
    v or v
     3
         av34
Is
    v or v
               > 2700 pc/h?
                                     No
     3
         av34
                > 1.5 v /2
    v or v
                                     No
Is
     3
          av34
                      12
If yes, v = 2925
                                   (Equation 13-15, 13-16, 13-18, or 13-19)
        12A
                   _Flow Entering Diverge Influence Area___
                                 Max Desirable
                                                     Violation?
                    Actual
                                 4400
                    2925
                                                     No
    V
     12
             ___Level of Service Determination (if not F)______
                     D = 4.252 + 0.0086 v - 0.009 L = 22.7 pc/mi/ln
Density,
                                       12
                     R
Level of service for ramp-freeway junction areas of influence C
                _____Speed Estimation_____
                                         D = 0.485
Intermediate speed variable,
                                          S
Space mean speed in ramp influence area,
                                         S = 54.4
                                                     mph
                                         R
Space mean speed in outer lanes,
                                         S = N/A
                                                     mph
```

S = 54.4

mph

0.858

0.917

0.917

Heavy vehicle adjustment, fHV

Space mean speed for all vehicles,

Appendix Part 4—2035 Crossroad Level of Service

I-90/Timberline Road Interchange



HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** SDDOT Duration, h 1.00 Agency HDR Analyst Analysis Date Jan 13, 2014 Area Type Other PHF Jurisdiction MINNEHAHA CO. Time Period AM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 60-TIMBER AM 2035.xus File Name **Project Description** 2035 AM NO-BUILD **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 400 900 180 930 Demand (v), veh/h 180 40 0 270 60 100 160 0 Signal Information Ų Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 21.0 0.0 Green 11.0 16.0 16.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 3.5 3.5 0.0 3.5 3.5 0.0 Force Mode Fixed Simult. Gap N/S On Red 0.5 0.5 0.5 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 2.0 3.0 2.0 3.0 2.0 3.0 2.0 3.0 Phase Duration, s 20.0 20.0 20.0 20.0 15.0 25.0 15.0 25.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 Change Period, (Y+Rc), s Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 9.7 3.5 14.2 6.1 12.1 10.6 Green Extension Time (g_e) , s 0.2 0.2 0.1 0.2 0.0 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 0.03 0.00 0.00 1.00 1.00 Max Out Probability 1.00 WB NB SB **Movement Group Results** EΒ Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 14 3 18 5 2 12 1 6 16 8 Adjusted Flow Rate (v), veh/h 180 40 0 270 60 90 400 900 144 180 930 0 1681 1765 1681 1765 1570 1542 1439 1617 1542 Adjusted Saturation Flow Rate (s), veh/h/ln 1496 1496 1439 7.7 2.3 0.0 Queue Service Time (gs), s 1.5 0.0 12.2 4.1 10.1 14.3 6.6 8.6 14.8 Cycle Queue Clearance Time (gc), s 7.7 1.5 0.0 12.2 2.3 4.1 10.1 14.3 6.6 8.6 14.8 0.0 Green Ratio (g/C) 0.20 0.20 0.20 0.20 0.20 0.20 0.14 0.26 0.26 0.14 0.26 0.26 378 Capacity (c), veh/h 336 353 299 336 353 299 432 1214 378 222 1214 Volume-to-Capacity Ratio (X) 0.536 0.113 0.000 0.803 0.170 0.301 0.926 0.741 0.381 0.809 0.766 0.000 Available Capacity (ca), veh/h 336 353 299 336 353 299 432 1214 378 222 1214 378 Back of Queue (Q), veh/ln (50th percentile) 2.9 0.6 0.0 5.8 0.9 1.4 5.7 5.2 2.4 4.5 5.5 0.0 Queue Storage Ratio (RQ) (50th percentile) 0.37 0.00 0.00 0.74 0.00 0.17 0.15 0.00 0.00 0.58 0.00 0.00 Uniform Delay (d1), s/veh 28.7 26.2 0.0 30.5 26.5 27.2 34.1 27.0 24.2 33.5 27.2 0.0 Incremental Delay (d2), s/veh 0.9 0.1 0.0 13.4 0.1 0.2 35.7 4.2 2.9 21.0 4.8 0.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 29.6 26.2 0.0 43.9 26.6 27.4 69.8 31.2 27.1 54.5 32.0 0.0 Level of Service (LOS) С С D С С Е С С D С 29.0 С 37.9 D 41.5 D 35.7 Approach Delay, s/veh / LOS D Intersection Delay, s/veh / LOS 38.1 D **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.4 С В 2.8 С Bicycle LOS Score / LOS 0.9 Α 1.2 Α 1.3 Α 1.1

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** SDDOT Duration, h 1.00 Agency HDR Analyst Analysis Date Jan 13, 2014 Area Type Other PHF Jurisdiction MINNEHAHA CO. Time Period PM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 60-TIMBER PM 2035.xus File Name **Project Description** 2035 PM - NO BUILD **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 210 80 Demand (v), veh/h 200 70 0 50 370 1380 220 130 830 0 Signal Information Л Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 2.0 Green 7.0 1.0 20.0 14.0 16.0 Uncoordinated No Simult. Gap E/W On Yellow 3.5 3.5 3.5 3.5 0.0 3.5 Force Mode Fixed Simult. Gap N/S On Red 0.5 0.5 0.5 0.5 0.0 0.5 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 2.0 3.0 2.0 3.0 2.0 3.0 2.0 3.0 Phase Duration, s 20.0 22.0 18.0 20.0 16.0 29.0 11.0 24.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 4.0 Change Period, (Y+Rc), s Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 10.6 4.6 11.4 5.1 11.1 8.4 Green Extension Time (g_e) , s 0.2 0.3 0.1 0.2 0.1 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 0.09 0.00 0.00 1.00 1.00 Max Out Probability 1.00 WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 14 3 18 5 2 12 1 6 16 8 Adjusted Flow Rate (v), veh/h 200 70 0 210 50 70 370 1380 204 130 830 0 Adjusted Saturation Flow Rate (s), veh/h/ln 1681 1765 1681 1765 1570 1542 1439 1617 1542 1496 1496 1439 8.6 2.6 9.4 9.1 23.4 0.0 Queue Service Time (gs), s 0.0 1.9 3.1 9.1 6.4 13.1 Cycle Queue Clearance Time (gc), s 8.6 2.6 0.0 9.4 1.9 3.1 9.1 23.4 9.1 6.4 13.1 0.0 Green Ratio (g/C) 0.20 0.22 0.22 0.18 0.20 0.20 0.15 0.31 0.31 0.09 0.25 0.25 360 Capacity (c), veh/h 336 397 336 294 353 299 471 1446 450 142 1156 Volume-to-Capacity Ratio (X) 0.595 0.176 0.000 0.714 0.142 0.234 0.785 0.955 0.454 0.919 0.718 0.000 Available Capacity (ca), veh/h 336 397 336 294 353 299 471 1446 450 142 1156 360 Back of Queue (Q), veh/ln (50th percentile) 3.4 1.0 0.0 4.1 0.7 1.1 3.7 10.5 3.2 5.5 4.8 0.0 Queue Storage Ratio (RQ) (50th percentile) 0.43 0.00 0.00 0.52 0.00 0.13 0.10 0.00 0.00 0.72 0.00 0.00 Uniform Delay (d1), s/veh 29.1 25.0 0.0 31.1 26.3 26.9 32.8 26.9 22.0 36.2 27.4 0.0 Incremental Delay (d2), s/veh 2.0 0.1 0.0 7.1 0.1 0.1 8.3 20.9 3.3 79.3 3.9 0.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 31.1 25.1 0.0 38.3 26.4 27.0 41.0 47.8 25.3 115.5 31.3 0.0 Level of Service (LOS) С С D С С D D С F С 29.5 С 34.1 С 44.2 D 42.7 Approach Delay, s/veh / LOS D Intersection Delay, s/veh / LOS 41.7 D **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.4 С В 2.8 С Bicycle LOS Score / LOS 0.9 Α 1.0 Α 1.6 Α 1.0

__TWO-WAY STOP CONTROL SUMMARY___

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: 2035

Project ID:

East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

						_			
		icle Vol		_	stme				
Major Street:	Approach		rthbound				thbour.	_	
	Movement	1	2	3		4	5	6	
		L	T	R	l	L	Т	R	
Volume			900	280		70	840		
Peak-Hour Facto	or, PHF		0.90	0.90		0.90	0.90		
Hourly Flow Rat	e, HFR		1000	311		77	933		
Percent Heavy V	<i>T</i> ehicles					5			
Median Type/Sto RT Channelized?		Undiv	ided			/			
Lanes			1 0			0	1		
Configuration			TR			LT			
Upstream Signal	2		No	•		ПТ	No		
opscream signar	- :		NO				NO		
Minor Street:	Approach	We	stbound			Eas	tbound	l	
	Movement	7	8	9		10	11	12	
		L	T	R	ĺ	L	Т	R	
Volume						130		720	
Peak Hour Facto	or, PHF					0.90		0.90	
Hourly Flow Rat						144		800	
Percent Heavy V						1		1	
Percent Grade (2				2		
Flared Approach		/Storage			/			No	/
Lanes		_				0		0	
Configuration							LR		
7		Queue Le SB			el o	f Servi			
Approach	NB 1	5B 4	west 7	bound 8	9	1	0 East	bound	12
Movement	Δ.	4 LT	/	ō	9	1	U	11 LR	12
Lane Config		тт				I		LК	
v (vph)		77						944	
C(m) (vph)		518						130	
v/c		0.15						7.26	
95% queue lengt	:h	0.52						410.45	
Control Delay		13.2						11335	
LOS		В						F	
Approach Delay								11335	
Approach LOS								F	

Phone: Fax: E-Mail:

__TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Analyst: HDR Agency/Co.: SDDOT Date Performed: 1/2014 Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD. Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary Analysis Year: 2035

Project ID:

Flow (ped/hr)

East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

Major Street Movements	1	2	3	justment 4	5	6	
	L	T	R	L	T	R	
 Volume		900	280	70	840		
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90		
Peak-15 Minute Volume		250	78	19	233		
Hourly Flow Rate, HFR		1000	311	77	933		
Percent Heavy Vehicles				5			
Median Type/Storage RT Channelized?	Undiv	ided		/			
Lanes		1	0	0	1		
Configuration		T	3.	LT			
Upstream Signal?		No			No		
Minor Street Movements	7	8	9	10	11	12	
	L	T	R	L	T	R	
 Volume				130		720	
Peak Hour Factor, PHF				0.90		0.90	
Peak-15 Minute Volume				36		200	
Hourly Flow Rate, HFR				144		800	
Percent Heavy Vehicles				1		1	
Percent Grade (%)		2			2		
Flared Approach: Exists RT Channelized?	s?/Storage			/		No	/
Lanes				0	(0	
Configuration					LR		

0

0

 Lane Width (ft)
 12.0
 12.0
 12.0
 12.0

 Walking Speed (ft/sec)
 4.0
 4.0
 4.0
 4.0

 Percent Blockage
 0
 0
 0
 0

______Upstream Signal Data______

Prog. Sat Arrival Green Cycle Prog. Distance to Signal Flow Type Time Flow Length Speed feet vph vph sec sec mph

S2 Left-Turn Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:		933
Shared ln volume, major rt vehicles:		0
Sat flow rate, major th vehicles:		1700
Sat flow rate, major rt vehicles:		1700
Number of major street through lanes:		1

Worksheet 4-Critical Gap and Follow-up Time Calculation

Movement	-	1	4	7	8	9	10	11	12
		L	L	L	T	R	L	T	R
t(c,base			4.1				7.1		6.2
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)			5				1		1
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent	Grade			2.00	2.00	2.00	2.00	2.00	2.00
t(3,1t)			0.00				0.70		0.00
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage		0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage		4.2				6.8		6.4
	2-stage								
Follow-U	Jp Time Ca	alcula	tions						
Movement	_	1	4	7	8	9	10	11	12
		L	L	L	T	R	L	T	R
t(f,base	 e)		2.20				3.50		3.30
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)			5				1		1
t(f)			2.2				3.5		3.3

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(\texttt{t}) \quad V(\texttt{1},\texttt{prot}) \quad V(\texttt{1},\texttt{prot})$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Τ
                                                      R
                                                              L
                                                                     Т
                                                                            R
V c,x
                               1311
                                                             2243
                                                                            933
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

V(c,x) s	1500	
P(x)		
V(c,u,x)		
C(r,x)		
C(plat,x)		
Worksheet 6-Impedance and Capacity Equation	S	
Step 1: RT from Minor St.	9	12
Conflicting Flows		933
Potential Capacity		308
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		308
Probability of Queue free St.	1.00	0.00
Step 2: LT from Major St.	4	1
Conflicting Flows	1311	
Potential Capacity	518	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	518	
Probability of Queue free St.	0.85	1.00
Maj L-Shared Prob Q free St.	0.67	
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.67	0.67
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		2243
Potential Capacity		36
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.67	
Maj. L, Min T Adj. Imp Factor.	0.74	
Cap. Adj. factor due to Impeding mvmnt	0.00	0.85
Movement Capacity		31
Worksheet 7-Computation of the Effect of Tw	o-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11
Don't 1 First Store		
Part 1 - First Stage		
Conflicting Flows Potential Capacity		
EULEHLIGI LANGUILV		

Stagel Stagel Stagel Stagel Stagel Stagel Stage2

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mymnt
Movement Capacity
Probability of Queue free St.

Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)			144 31	130	800 308
Movement 7 L	8 T	9 R	10 L	11 T	12 R
Worksheet 8-Shared Lane Calculations					
c t				31	
a Y					
Results for Two-stage process:					
Movement Capacity 				 ⊃⊥	
Cap. Adj. factor due to Impeding mvmnt		0.00		0.85 31	
Maj. L, Min T Adj. Imp Factor.		0.74			
Pedestrian Impedance Factor Maj. L, Min T Impedance factor		1.00 0.67		1.00	
Potential Capacity		1.00		36 1 00	
Part 3 - Single Stage Conflicting Flows				2243	
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
Potential Capacity Pedestrian Impedance Factor					
Conflicting Flows					
Part 2 - Second Stage					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
Potential Capacity Pedestrian Impedance Factor					
Conflicting Flows					
Part 1 - First Stage					
Step 4: LT from Minor St.		7		10	
C t Probability of Queue free St.		1.00		1.00	
У					
Result for 2 stage process: a					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt		0.67		0.67	
Pedestrian Impedance Factor		1.00		1.00	
Conflicting Flows Potential Capacity					
Part 3 - Single Stage					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
redestran impedance ractor					
Potential Capacity Pedestrian Impedance Factor					

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	 7	8	9	10	11	12
	L	Т	R	L	Т	R
C sep				31		308
Volume				144		800
Delay						
Q sep						
Q sep +1						
round (Qsep +1)						
n max						
C sh					130	
SUM C sep						
n						
C act						

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		77					944	
C(m) (vph)		518					130	
v/c		0.15					7.26	
95% queue length		0.52					410.4	5
Control Delay		13.2					11335	
LOS		В					F	
Approach Delay							11335	
Approach LOS							F	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.85
v(il), Volume for stream 2 or 5		933
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or 5		1700
s(i2), Saturation flow rate for stream 3 or 6		1700
P*(oj)		0.67
d(M,LT), Delay for stream 1 or 4		13.2
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		4.3

HCS+: Unsignalized Intersections Release 5.6

__TWO-WAY STOP CONTROL SUMMARY__

Analyst: HDR Agency/Co.: SDDOT

Date Performed:

Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: 2035

Project ID: I-90/Timberline IMJR East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

					-	_			
		icle Volu		_	stme				
Major Street:	Approach	_	rthbound				ıthbou		
	Movement	1	2	3	ļ	4	5	б	
		L	Т	R		L	Т	R	
Volume			1300	360		70	580		
Peak-Hour Fact	or, PHF		0.90	0.90		0.90	0.90)	
Hourly Flow Ra	ate, HFR		1444	400		77	644		
Percent Heavy	Vehicles					5			
Median Type/St		Undivi	ided			/			
Lanes	•		1 ()		0	1		
Configuration			TF			L:			
Upstream Signa	112		No	•		ш.	No		
Minor Street:	Approach		stbound			Eas	stbour		
	Movement	7	8	9	ļ	10	11	12	
		L	Т	R		L	Т	R	
Volume						150		610	
Peak Hour Fact	or, PHF					0.90		0.90	
Hourly Flow Ra	ate, HFR					166		677	
Percent Heavy	Vehicles					1		1	
Percent Grade	(%)		2				2		
Flared Approac	h: Exists?	/Storage			/			No	/
Lanes						0		0	
Configuration							LR		
	Delay,	 Queue Ler	 ngth, ar	nd Leve	 el c	of Servi	 ice		
Approach	NB	SB	West	bound			Eas	stbound	
Movement	1	4	7	8	9	:	10	11	12
Lane Config		LT						LR	
v (vph)		77						843	
C(m) (vph)		322						90	
V/C		0.24						9.37	
95% queue leng	gth .	0.94						379.83	
Control Delay		19.7						15150	
LOS		С						F	
Approach Delay	r							15150	
Approach LOS								F	

Phone: E-Mail:

_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Fax:

Analyst: HDR Agency/Co.: SDDOT

Date Performed:

Flow (ped/hr)

Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary
Analysis Year: 2035

Project ID: I-90/Timberline IMJR East/West Street: I-90 EB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	_Vehicle V			_			
Major Street Movements	1	2	3	4	5	6	
	L	Т	R	L	Т	R	
 Volume		1300	360	70	580		
Peak-Hour Factor, PHF		0.90	0.90	0.90	0.90		
Peak-15 Minute Volume		361	100	19	161		
Hourly Flow Rate, HFR		1444	400	77	644		
Percent Heavy Vehicles				5			
Median Type/Storage RT Channelized?	Undiv	ided		/			
Lanes		1	0	0	1		
Configuration			ΓR	L	T		
Upstream Signal?		No			No		
Minor Street Movements	7	8	9	10	11	12	
	L	Т	R	L	Т	R	
 Volume				150		610	
Peak Hour Factor, PHF				0.90		0.90	
Peak-15 Minute Volume				42		169	
Hourly Flow Rate, HFR				166		677	
Percent Heavy Vehicles				1		1	
Percent Grade (%)		2			2		
Flared Approach: Exist	s?/Storage			/		No	/
RT Channelized?							
Lanes				0		0	
Configuration					LR		
P Movements	edestrian 13	Vo⊥um∈ 14	es and Ad 15	djustme 16	nts		

0

0

 Lane Width (ft)
 12.0
 12.0
 12.0
 12.0

 Walking Speed (ft/sec)
 4.0
 4.0
 4.0
 4.0

 Percent Blockage
 0
 0
 0
 0

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Length Speed feet vph vph sec sec mph

S2 Left-Turn

Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5	
Shared ln volume, major th vehicles:		644	
Shared ln volume, major rt vehicles:		0	
Sat flow rate, major th vehicles:		1700	
Sat flow rate, major rt vehicles:		1700	
Number of major street through lanes:		1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical	Gap Calcula	ation							
Movement	1	4	7	8	9	10	11	12	
	L	L	L	Т	R	L	Т	R	
t(c,base)	4.	 1			7.1		6.2	
t(c,hv)	1.	00 1.	00 1.00	1.00	1.00	1.00	1.00	1.00	
P(hv)		5				1		1	
t(c,g)			0.20	0.20	0.10	0.20	0.20	0.10	
Percent	Grade		2.00	2.00	2.00	2.00	2.00	2.00	
t(3,1t)		0.	0 0			0.70		0.00	
t(c,T):	1-stage 0.	0.00	00 0.00	0.00	0.00	0.00	0.00	0.00	
	2-stage 0.	0.0	00 1.00	1.00	0.00	1.00	1.00	0.00	
t(c)	1-stage	4.	2			6.8		6.4	
	2-stage								
Follow-U	p Time Calc	 ulation	 S						
Movement	1	4	7	8	9	10	11	12	
	L	L	L	T	R	L	Т	R	
t(f,base)	2.	20			3.50		3.30	
t(f,HV)	0.9	90 0.	90 0.90	0.90	0.90	0.90	0.90	0.90	
P(HV)		5				1		1	
t(f)		2.	2			3.5		3.3	

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(t) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Τ
                                                      R
                                                              L
                                                                     Т
                                                                            R
                                                                            644
V c,x
                               1844
                                                             2442
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

V(c,x) s	1500	
P(x)		
V(c,u,x)		
C(r,x)		
C(plat,x)		
Worksheet 6-Impedance and Capacity Equati	ons	
Step 1: RT from Minor St.	9	12
Conflicting Flows		644
Potential Capacity		458
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		458
Probability of Queue free St.	1.00	0.00
Step 2: LT from Major St.	4	1
Conflicting Flows	1844	
Potential Capacity	322	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	322	
Probability of Queue free St.	0.76	1.00
Maj L-Shared Prob Q free St.	0.62	
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.62	0.62
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows		2442
Potential Capacity		27
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor	0.62	
Maj. L, Min T Adj. Imp Factor.	0.70	
Cap. Adj. factor due to Impeding mvmnt	0.00	0.76
Movement Capacity		21
Worksheet 7-Computation of the Effect of	Two-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11
Step 3: TH from Minor St. Part 1 - First Stage Conflicting Flows		

Stagel Stagel Stagel Stagel Stagel Stagel Stagel

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
Probability of Queue free St.

Volume (vph) Movement Capacity (vph) Shared Lane Capacity (vph)			166 21	90	677 458
Movement 7 L	8 T	9 R	10 L	11 T	12 R
Worksheet 8-Shared Lane Calculations					
y C t 				21	
a Y					
Results for Two-stage process:					
Cap. Adj. factor due to Impeding mvmnt Movement Capacity	0.	00		0.76 21	
Maj. L, Min T Adj. Imp Factor.	0.	70		0 77	
Maj. L, Min T Impedance factor		62		1.00	
Potential Capacity Pedestrian Impedance Factor	1	00		27 1.00	
Part 3 - Single Stage Conflicting Flows				2442	
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
Potential Capacity Pedestrian Impedance Factor					
Conflicting Flows					
Part 2 - Second Stage					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
Potential Capacity Pedestrian Impedance Factor					
Conflicting Flows					
Part 1 - First Stage					
Step 4: LT from Minor St.		7		10	
Probability of Queue free St.	1.	00		1.00	
y C t					
a					
Result for 2 stage process:					
Movement Capacity	0.	02		0.02	
Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt		00 62		1.00 0.62	
Potential Capacity					
Part 3 - Single Stage Conflicting Flows					
Movement Capacity					
Cap. Adj. factor due to Impeding mvmnt					
Pedestrian Impedance Factor					
otential Capacity					

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	T	R
C sep Volume Delay Q sep Q sep +1 round (Qsep +1)				21 166		458 677
n max C sh SUM C sep n C act					90	

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config		LT					LR	
v (vph)		77					843	
C(m) (vph)		322					90	
v/c		0.24					9.37	
95% queue length		0.94					379.8	3
Control Delay		19.7					15150	
LOS		С					F	
Approach Delay							15150	
Approach LOS							F	

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	1.00	0.76
v(il), Volume for stream 2 or 5		644
v(i2), Volume for stream 3 or 6		0
s(il), Saturation flow rate for stream 2 or	5	1700
s(i2), Saturation flow rate for stream 3 or	6	1700
P*(oj)		0.62
d(M,LT), Delay for stream 1 or 4		19.7
N, Number of major street through lanes		1
d(rank,1) Delay for stream 2 or 5		7.6

HCS+: Unsignalized Intersections Release 5.6

___TWO-WAY STOP CONTROL SUMMARY__

Analyst: HDR Agency/Co.: SDDOT

Date Performed:

Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: 2035

Project ID: I-90/Timberline IMJR
East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	veni Approach	cle Volu Not	rthbound	_	CIIIC	1100_	Southbo	und		
ajor bereee	Movement	1	2	3	ı	4	5	ana	6	
	110 V CINCIIC	L	T	R	İ	L	T		R	
		490	540				 550		150	
Peak-Hour Facto	or, PHF	0.90	0.90				0.9	0	0.90	
Hourly Flow Rat	ce, HFR	544	600				611		166	
Percent Heavy V	Vehicles	5								
Median Type/Sto RT Channelized?		Undiv	ided			/				
Lanes		0	1				1	0		
Configuration		L	Γ					TR		
Jpstream Signal	l?		No				No			
Minor Street:	Approach		stbound				Eastbou	ınd		
	Movement	7	8	9		10	11		12	
		L	Т	R		L	Т		R	
/olume		360		60						
Peak Hour Facto		0.90		0.90						
Hourly Flow Rat		400		66						
Percent Heavy V		11		11						
Percent Grade	• •		2				0			
Flared Approach	n: Exists?/	_		Yes	/	50				/
Lanes		0	(0						
Configuration			LR							
	Delay, ()ijeije T _i ei	nath.ai	nd Leve	 1 o	f Se	rvice			
Approach	NB	SB	_	tbound				stb	 ound	
Movement	1	4	7	8	9		10	1		12
Lane Config	LT		•	LR		İ			_	
v (vph)	544			466						
C(m) (vph)	826			10						
7/C	0.66			46.60						
95% queue lengt	th 5.57			231.03						
Control Delay	17.7			82811						
COS	С			F						
				00011						
Approach Delay				82811						

Phone: Fax: E-Mail:

_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Analyst: HDR Agency/Co.: SDDOT

Date Performed:

Analysis Time Period: AM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary
Analysis Year: 2035

Project ID: I-90/Timberline IMJR East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	-		-			,	
	Vehicle	Volumes	and Ad	justmen	ts		
Major Street Movements	1	2	3	4	5	6	
	L	T	R	L	Т	R	
 Volume	490	540			550	150	
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90	
Peak-15 Minute Volume	136	150			153	42	
Hourly Flow Rate, HFR	544	600			611	166	
Percent Heavy Vehicles	5						
Median Type/Storage RT Channelized?	Undi	vided		/			
Lanes	0	1			1	0	
Configuration	I	т			Т	R.	
Upstream Signal?		No			No		
Minor Street Movements	7	8	9	10	11	12	
	L	Т	R	L	Т	R	
Volume	360		60				
Peak Hour Factor, PHF	0.90		0.90				
Peak-15 Minute Volume	100		17				
Hourly Flow Rate, HFR	400		66				
Percent Heavy Vehicles	11		11				
Percent Grade (%)		2			0		
Flared Approach: Exist RT Channelized?	s?/Storag	e	Yes	/50			/
Lanes	0		0				
Configuration	J	LR	-				
P Movements	edestrian 13	. volume: 14	s and Ad 15	ıjustme 16	IIUS		
110 v Cilicia	13	1.1	1.0	± 0			
Flow (ped/hr)	0	0	0	0			

 Lane Width (ft)
 12.0
 12.0
 12.0
 12.0

 Walking Speed (ft/sec)
 4.0
 4.0
 4.0
 4.0

 Percent Blockage
 0
 0
 0
 0

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Length Speed feet vph vph sec sec mph

S2 Left-Turn

Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared In volume, major th vehicles:	600	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Critical	Gap Cal	culation	on						
Movement		1	4	7	8	9	10	11	12
		L	L	L	T	R	L	Т	R
t(c,base)	4.1		7.1		6.2			
t(c,hv)		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
P(hv)		5		11		11			
t(c,g)				0.20	0.20	0.10	0.20	0.20	0.10
Percent	Grade			2.00	2.00	2.00	0.00	0.00	0.00
t(3,1t)		0.00		0.70		0.00			
t(c,T):	1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
t(c)	1-stage	4.2		6.9		6.5			
	2-stage								
Follow-U	p Time C	alculat	tions						
Movement		1	4	7	8	9	10	11	12
		L	L	L	T	R	L	T	R
t(f,base)	2.20		3.50		3.30			
t(f,HV)		0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
P(HV)		5		11		11			
t(f)		2.2		3.6		3.4			

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1,prot) \quad V(1,prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                      R
                                                              L
                                                                     Т
                                                                             R
                        777
V c,x
                                       2382
                                                      600
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

beager beager beager beage	22 Beager Beag	cz błagei błagez
V(c,x)		
s 1500		
P(x)		
V(c,u,x)		
C(r,x)		
C(plat,x)		
Workshoot & Impedance and Conscitu Equation	n G	
Worksheet 6-Impedance and Capacity Equation	15	
Step 1: RT from Minor St.	9	12
Conflicting Flows	600	
Potential Capacity	469	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	469	1.00
Probability of Queue free St.	0.86	1.00
Transmitted of Queue Tree Sev	0.00	2.00
Step 2: LT from Major St.	4	1
Conflicting Flows		 777
Potential Capacity		826
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	2.00	826
Probability of Queue free St.	1.00	0.34
Maj L-Shared Prob Q free St.	2.00	0.00
~		
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.00	0.00
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Ohan At III from Minon Oh		1.0
Step 4: LT from Minor St.	7	10
Conflicting Flows	2382	
Potential Capacity	27	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.00
Maj. L, Min T Adj. Imp Factor.		0.00
Cap. Adj. factor due to Impeding mvmnt	0.34	0.00
Movement Capacity	9	
Worksheet 7-Computation of the Effect of Tv	vo-stage Gap Acc	eptance
Step 3: TH from Minor St.		
Part 1 - First Stage		
Conflicting Flows		

Stagel Stagel Stagel Stagel Stagel Stagel Stagel

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mvmnt
Movement Capacity
Probability of Queue free St.

Folume (vph) 400 Sovement Capacity (vph) 9 hared Lane Capacity (vph)	10	66 469			
ovement 7 L	8 T	9 R	10 L	11 T	12 R
orksheet 8-Shared Lane Calculations					
t		9			
· ·					
esults for Two-stage process:					
ovement Capacity		9			
ap. Adj. factor due to Impeding mvmnt		0.34		0.00	
aj. L, Min T Impedance factor aj. L, Min T Adj. Imp Factor.				0.00	
edestrian Impedance Factor		1.00		1.00	
otential Capacity		27			
art 3 - Single Stage onflicting Flows		2382			
ovement Capacity					
ap. Adj. factor due to Impeding mvmnt					
otential Capacity edestrian Impedance Factor					
onflicting Flows					
art 2 - Second Stage					
ovement Capacity					
ap. Adj. factor due to Impeding mvmnt					
otential Capacity edestrian Impedance Factor					
onflicting Flows					
art 1 - First Stage					
tep 4: LT from Minor St.		7		10	
robability of Queue free St.		1.00		1.00	
t		1 00		1 00	
esult for 2 stage process:					
ovement Capacity					
ap. Adj. factor due to Impeding mvmnt		0.00		0.00	
edestrian Impedance Factor		1.00		1.00	
onflicting Flows otential Capacity					
art 3 - Single Stage					
ovement Capacity					
ap. Adj. factor due to Impeding mvmnt					
otential Capacity edestrian Impedance Factor					

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	T	R
 C sep	9		469			
Volume	400		66			
Delay	79012.	1		13.9		
Q sep	8779.1	. 2		0.26		
Q sep +1	8780.1	. 2		1.26		
round (Qsep +1)	8780		1			
n max		8780				
C sh		10				
SUM C sep		10				
n		50				
C act		10				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12		
ane Config LT			LR							
v (vph)	544			466						
C(m) (vph)	826			10						
v/c	0.66			46.60						
95% queue length	5.57			231.03						
Control Delay	17.7		82811							
LOS	С			F						
Approach Delay				82811						
Approach LOS				F						

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.34	1.00
v(il), Volume for stream 2 or 5	600	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.00	
d(M,LT), Delay for stream 1 or 4	17.7	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	17.7	

HCS+: Unsignalized Intersections Release 5.6

__TWO-WAY STOP CONTROL SUMMARY_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary

Analysis Year: 2035

Project ID: I-90/Timberline IMJR East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

				20.	ady Poll	(1112)	,	
	Vehi	cle Volu	umes and	Adjust	tments			
Major Street:	Approach		thbound	_		outhbour	nd	
J	Movement	1	2	3	4	5	6	
		L	Т	R	i L	Т	R	
Volume		650	800			350	130	
Peak-Hour Fact	or, PHF	0.90	0.90			0.90	0.90	
Hourly Flow Ra	te, HFR	722	888			388	144	
Percent Heavy	Vehicles	5						
Median Type/St	orage	Undivi	ided		/			
RT Channelized								
Lanes		0	1			1	0	
Configuration		L					ΓR	
Upstream Signa	12		No			No	110	
opscicam bigna	1 ;		NO			110		
Minor Street:	Approach	Wes	stbound		E	astbound	 d	
	Movement	7	8	9	10	11	12	
		L	T	R	L	T	R	
					· 			
Volume		300		70				
Peak Hour Fact	or, PHF	0.90		0.90				
Hourly Flow Ra	te, HFR	333		77				
Percent Heavy	Vehicles	11		11				
Percent Grade	(%)		2			0		
Flared Approac		Storage		Yes	/50			/
Lanes	,	0	0		,			,
Configuration		· ·	LR					
conriguration			шк					
	Delay, Q		_		l of Ser			
Approach	NB	SB		bound			tbound	
Movement	1	4	7	8	9	10	11	12
Lane Config	LT			LR				
	722			410				
v (vph)				410				
C(m) (vph)	1020			5				
v/c	0.71			82.00				
95% queue leng				205.49				
Control Delay	16.9							
LOS	С			F				
Approach Delay								
Approach LOS				F				

Phone: Fax: E-Mail:

_____TWO-WAY STOP CONTROL(TWSC) ANALYSIS_____

Analyst: HDR
Agency/Co.: SDDOT
Date Performed: 1/2014
Analysis Time Period: PM PEAK

Intersection: TIMBERLINE RD.
Jurisdiction: MINNEHAHA CO.

Units: U. S. Customary
Analysis Year: 2035

Flow (ped/hr)

Project ID: I-90/Timberline IMJR East/West Street: I-90 WB

North/South Street: TIMBERLINE RD.

Intersection Orientation: NS Study period (hrs): 1.00

	_Vehicle	Volumes	and Ad	justment	ts		
Major Street Movements	1	2	3	4	5	6	
	L	Т	R	L	Т	R	
 Volume	650	800			350	130	
Peak-Hour Factor, PHF	0.90	0.90			0.90	0.90	
Peak-15 Minute Volume	181	222			97	36	
Hourly Flow Rate, HFR	722	888			388	144	
Percent Heavy Vehicles	5						
Median Type/Storage RT Channelized?	Undi	vided		/			
Lanes	0	1			1 ()	
Configuration	L	Т			TI	3	
Upstream Signal?		No			No		
	7	8	9	10	11	12	
	L	Т	R	L	T	R	
 Volume	300		70				
Peak Hour Factor, PHF	0.90		0.90				
Peak-15 Minute Volume	83		19				
Hourly Flow Rate, HFR	333		77				
Percent Heavy Vehicles	11		11				
Percent Grade (%)		2			0		
Flared Approach: Exist RT Channelized?	s?/Storag	е	Yes	/50			/
Lanes	0	(0				
Configuration		LR					
	edestrian			_	nts		
Movements	13	14	15	16			

0

0

 Lane Width (ft)
 12.0
 12.0
 12.0
 12.0

 Walking Speed (ft/sec)
 4.0
 4.0
 4.0
 4.0

 Percent Blockage
 0
 0
 0
 0

_Upstream Signal Data__ Prog. Sat Arrival Green Cycle Prog. Distance Time to Signal Flow Flow Type Length Speed feet vph vph sec sec mph

S2 Left-Turn

Through

S5 Left-Turn Through

Worksheet 3-Data for Computing Effect of Delay to Major Street Vehicles

	Movement 2	Movement 5
Shared ln volume, major th vehicles:	888	
Shared ln volume, major rt vehicles:	0	
Sat flow rate, major th vehicles:	1700	
Sat flow rate, major rt vehicles:	1700	
Number of major street through lanes:	1	

Worksheet 4-Critical Gap and Follow-up Time Calculation

Gap Cal	culatio	on						
	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	Т	R
)	4.1		7.1		6.2			
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	5		11		11			
			0.20	0.20	0.10	0.20	0.20	0.10
Grade			2.00	2.00	2.00	0.00	0.00	0.00
	0.00		0.70		0.00			
1-stage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-stage	0.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
1-stage	4.2		6.9		6.5			
2-stage								
p Time Ca	alculat	tions						
	1	4	7	8	9	10	11	12
	L	L	L	T	R	L	T	R
)	2.20		3.50		3.30			
	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	5		11		11			
	2.2		3.6		3.4			
	Grade 1-stage 2-stage 1-stage 2-stage 2-stage	1 L) 4.1 1.00 5 Grade 0.00 1-stage 0.00 2-stage 0.00 1-stage 4.2 2-stage p Time Calculate 1 L) 2.20 0.90 5	L L 1.00 1.00 5 Grade 0.00 1-stage 0.00 0.00 2-stage 0.00 0.00 1-stage 4.2 2-stage p Time Calculations 1 4 L L 2.20 0.90 0.90 5	1 4 7 L L 1 1.00 1.00 1.00 5 11 0.20 Grade 2.00 0.00 0.70 1-stage 0.00 0.00 0.00 2-stage 0.00 0.00 1.00 1-stage 4.2 6.9 2-stage P Time Calculations 1 4 7 L L 1 L 2.20 3.50 0.90 0.90 0.90 5 11	1 4 7 8 L L L T 1.00 1.00 1.00 1.00 1.00 5 11 0.20 0.20 2.00 2.00 0.00 0.70 1-stage 0.00 0.00 0.00 0.00 2-stage 0.00 0.00 1.00 1.00 1-stage 4.2 6.9 2-stage P Time Calculations 1 4 7 8 L L T 2.20 3.50 0.90 0.90 0.90 0.90 5 11	1 4 7 8 9 L L L T R 1.00 1.00 1.00 1.00 1.00 1.00 5 11 11 0.20 0.20 0.10 Grade 2.00 2.00 2.00 1-stage 0.00 0.00 0.00 0.00 2-stage 0.00 0.00 1.00 1.00 0.00 1-stage 4.2 6.9 6.5 2-stage P Time Calculations 1 4 7 8 9 L L L T R 2.20 3.50 3.30 0.90 0.90 0.90 0.90 0.90 5 11 11	1 4 7 8 9 10 L L L T R L 1.00 1.00 1.00 1.00 1.00 1.00 1.00 5 11 11 0.20 0.20 0.10 0.20 Grade 2.00 2.00 2.00 0.00 1-stage 0.00 0.00 0.00 0.00 0.00 2-stage 0.00 0.00 1.00 1.00 0.00 1.00 1-stage 4.2 6.9 6.5 2-stage P Time Calculations 1 4 7 8 9 10 L L T R L 1 2.20 3.50 3.30 0.90 0.90 0.90 0.90 0.90 0.90 5 11 11	1 4 7 8 9 10 11 L L L T R L T) 4.1 7.1 6.2 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00

Worksheet 5-Effect of Upstream Signals

Computation 1-Queue Clearance Time at Upstream Signal Movement 2 Movement 5 $V(t) \quad V(1, prot) \quad V(1, prot)$

```
Total Saturation Flow Rate, s (vph)
Arrival Type
Effective Green, g (sec)
Cycle Length, C (sec)
Rp (from Exhibit 16-11)
Proportion vehicles arriving on green P
g(q1)
g(q2)
g(q)
Computation 2-Proportion of TWSC Intersection Time blocked
                                              Movement 2
                                                                 Movement 5
                                                  V(l,prot) V(t) V(l,prot)
alpha
beta
Travel time, t(a) (sec)
Smoothing Factor, F
Proportion of conflicting flow, f
Max platooned flow, V(c,max)
Min platooned flow, V(c,min)
Duration of blocked period, t(p)
Proportion time blocked, p
                                                0.000
                                                                   0.000
Computation 3-Platoon Event Periods
                                          Result
p(2)
                                          0.000
                                          0.000
p(5)
p(dom)
p(subo)
Constrained or unconstrained?
Proportion
unblocked
                                             (2)
                            (1)
                                                              (3)
for minor
                        Single-stage
                                              Two-Stage Process
movements, p(x)
                          Process
                                          Stage I
                                                           Stage II
p(1)
p(4)
p(7)
(8)q
p(9)
p(10)
p(11)
p(12)
Computation 4 and 5
Single-Stage Process
                                                                    11
Movement
                         1
                                4
                                        7
                                               8
                                                      9
                                                             10
                                                                            12
                         L
                                L
                                        L
                                               Т
                                                      R
                                                              L
                                                                     Т
                                                                             R
V c,x
                        532
                                       2792
                                                      888
S
Рx
V c,u,x
Cr,x
C plat,x
Two-Stage Process
                      7
                                       8
                                                      10
                                                                       11
```

V(c,x)		
s 1500		
P(x)		
V(c,u,x)		
C(plat,x)		
Worksheet 6-Impedance and Capacity Equation	.c	
worksheet 0-impedance and capacity Equation		
Step 1: RT from Minor St.	9	12
Conflicting Flows	888	
Potential Capacity	314	
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity	314	
Probability of Queue free St.	0.75	1.00
Step 2: LT from Major St.	4	1
Conflicting Flows		532
Potential Capacity		1020
Pedestrian Impedance Factor	1.00	1.00
Movement Capacity		1020
Probability of Queue free St.	1.00	0.29
Maj L-Shared Prob Q free St.		0.00
Step 3: TH from Minor St.	8	11
Conflicting Flows		
Potential Capacity		
Pedestrian Impedance Factor	1.00	1.00
Cap. Adj. factor due to Impeding mvmnt	0.00	0.00
Movement Capacity		
Probability of Queue free St.	1.00	1.00
Step 4: LT from Minor St.	7	10
Conflicting Flows	2792	
Potential Capacity	14	
Pedestrian Impedance Factor	1.00	1.00
Maj. L, Min T Impedance factor		0.00
Maj. L, Min T Adj. Imp Factor.		0.00
Cap. Adj. factor due to Impeding mvmnt	0.29	0.00
Movement Capacity	4	
Worksheet 7-Computation of the Effect of Tw	ro-stage Gap Acce	eptance
Step 3: TH from Minor St.	8	11
Part 1 - First Stage		
Conflicting Flows Potential Capacity		
POLEILIAI CADACIEV		

Stagel Stagel Stagel Stagel Stagel Stagel Stage2

Conflicting Flows
Potential Capacity
Pedestrian Impedance Factor
Cap. Adj. factor due to Impeding mymnt
Movement Capacity
Probability of Queue free St.

Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Pactor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Result for 2 stage process: a Y C t Probability of Queue free St. Step 4: LT from Minor St. Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Part 3 - Second Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 4 - First Stage Potential Capacity Part 5 - First Stage Potential Capacity Part 5 - First Stage Potential Capacity Part 5 - First Stage Potential Capacity Part 5 - First Stage Potential Capacity Part 5 - First Stage Po							
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Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Result for 2 stage process: a Y C t Probability of Queue free St. Part 1 - First Stage Conflicting Flows Podestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Tapacity Part 3 - Single Stage Conflicting Flows Potential Tapacity Packestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Packestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 4 - Stage Potential Capacity Part 5 - Single Stage Conflicting Flows Potential Capacity Part 5 - Single Stage Potential Capacity Part 6 - Single Factor Part 7 - Singl	Pedestrian Impedance Factor						
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Conflicting Flows Potential Capacity Pedestrian Impedance Factor 1.00 1.00 Cap. Adj. factor due to Impeding mvmnt 0.00 0.00 Movement Capacity Result for 2 stage process: a y C t Probability of Queue free St. 1.00 1.00 Step 4: LT from Minor St. 7 10 Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows 2792 Potential Capacity Part 3 - Single Stage Conflicting Flows 2792 Potential Capacity 14 Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	Movement Capacity						
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Potential Capacity	Part 3 - Single Stage						
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Cap. Adj. factor due to Impeding mvmnt	Potential Capacity						
Movement Capacity Result for 2 stage process: a y C t Probability of Queue free St. 1.00 1.00 Step 4: LT from Minor St. 7 10 Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Impedance Factor 1.00 1.00 Maj. L, Min T Impedance Factor 0.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 May. Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	Pedestrian Impedance Factor		1	L.00		1.00	
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a y C t Probability of Queue free St. 1.00 1.00 Step 4: LT from Minor St. 7 10 Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a y C t 4 Worksheet 8-Shared Lane Calculations	Movement Capacity						
a y C t Probability of Queue free St. 1.00 1.00 Step 4: LT from Minor St. 7 10 Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a y C t 4 Worksheet 8-Shared Lane Calculations							
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Probability of Queue free St. 1.00 1.00 Step 4: LT from Minor St. 7 10 Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Part 3 - Single Stage Conflicting Flows 2792 Potential Capacity 14 Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance Factor 0.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	У						
Step 4: LT from Minor St. 7 10 Part 1 - First Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 2 - Second Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows 2792 Potential Capacity 14 Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	Ct						
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Potential Capacity Pedestrian Impedance Factor Cap. Adj. factor due to Impeding mvmnt Movement Capacity Part 3 - Single Stage Conflicting Flows Potential Capacity Pedestrian Impedance Factor Maj. L, Min T Impedance Factor Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding mvmnt Movement Capacity Results for Two-stage process: a y C t Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12							
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Movement Capacity Part 3 - Single Stage Conflicting Flows 2792 Potential Capacity 14 Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12							
Part 3 - Single Stage Conflicting Flows 2792 Potential Capacity 14 Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12		/ IIIII C					
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Conflicting Flows 2792 Potential Capacity 14 Pedestrian Impedance Factor 1.00 1.00 Maj. L, Min T Impedance factor 0.00 Maj. L, Min T Adj. Imp Factor. 0.00 Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	Dart 3 - Single Stage						
Potential Capacity Pedestrian Impedance Factor Maj. L, Min T Impedance factor Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding mvmnt Movement Capacity Results for Two-stage process: a Y C t Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12			•	792			
Pedestrian Impedance Factor Maj. L, Min T Impedance factor Maj. L, Min T Adj. Imp Factor. Cap. Adj. factor due to Impeding mvmnt Movement Capacity Results for Two-stage process: a Y C t Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	_						
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Cap. Adj. factor due to Impeding mvmnt 0.29 0.00 Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12							
Movement Capacity 4 Results for Two-stage process: a Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12		mn t	(20			
Results for Two-stage process: a Y C t Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12		'IIII'C				0.00	
a Y C t Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	Movement Capacity		-	i			
a Y C t Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	Results for Two-stage process:						
Y C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12							
C t 4 Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12							
Worksheet 8-Shared Lane Calculations Movement 7 8 9 10 11 12	_		4	1			
Movement 7 8 9 10 11 12							
Movement 7 8 9 10 11 12							
	Worksheet 8-Shared Lane Calculation	ıs					
	Movement	 7	 8	9	10	11	12
		•					
						- 	 -
Volume (vph) 333 77	Volume (vph)	333		77			
Movement Capacity (vph) 4 314	_						
Shared Lane Capacity (vph) 5			5				

Worksheet 9-Computation of Effect of Flared Minor Street Approaches

Movement	7	8	9	10	11	12
	L	Т	R	L	Т	R
 C sep	4		314			
Volume	333		77			
Delay	149860).4		20.2		
Q sep	13862	.09		0.43		
Q sep +1	13863	.09		1.43		
round (Qsep +1)	13863		1			
n max		13863	 3			
C sh		5				
SUM C sep		5				
n		50				
C act		5				

Worksheet 10-Delay, Queue Length, and Level of Service

Movement	1	4	7	8	9	10	11	12
Lane Config	$_{ m LT}$			LR				
v (vph)	722			410				
C(m) (vph)	1020			5				
v/c	0.71			82.00				
95% queue length	6.94			205.49				
Control Delay	16.9							
LOS	С			F				
Approach Delay								
Approach LOS				F				

Worksheet 11-Shared Major LT Impedance and Delay

	Movement 2	Movement 5
p(oj)	0.29	1.00
v(il), Volume for stream 2 or 5	888	
v(i2), Volume for stream 3 or 6	0	
s(il), Saturation flow rate for stream 2 or 5	1700	
s(i2), Saturation flow rate for stream 3 or 6	1700	
P*(oj)	0.00	
d(M,LT), Delay for stream 1 or 4	16.9	
N, Number of major street through lanes	1	
d(rank,1) Delay for stream 2 or 5	16.9	

Fax:

Phone:

E-Mail: _____Directional Two-Lane Highway Segment Analysis______ Analyst HDR Agency/Co. SDDOT Date Performed
Analysis Time Period 1/2014 AM PEAK Highway TIMBERLINE ROAD NORTH OF I-90 TO SOUTH OF 60TH From/To Jurisdiction MINNEHAHA CO. Analysis Year 2035 Description I-90/Timberline IMJR _____Input Data_____ Peak hour factor, PHF 0.88 Highway class Class 3 Shoulder width 6.0 ft % Trucks and buses 6 12.0 ft % Trucks crawling ...
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0 Lane width Segment length mi/hr Rolling Terrain type % No-passing zones 60 Grade: Length Access point density 13 /mi Up/down % Analysis direction volume, Vd 540 veh/h Opposing direction volume, Vo 840 veh/h ______Average Travel Speed_____ Direction Analysis(d) Opposing (o) PCE for trucks, ET 1.7 1.3 PCE for RVs, ER 1.1 1.1 Heavy-vehicle adj. factor,(note-5) fHV 0.960 0.982 Grade adj. factor,(note-1) fg 0.97 1.00 659 pc/h Directional flow rate, (note-2) vi 972 pc/h Free-Flow Speed from Field Measurement: Field measured speed, (note-3) S FM mi/h Observed total demand, (note-3) V veh/h Estimated Free-Flow Speed: Base free-flow speed, (note-3) BFFS 45.0 mi/h Adj. for lane and shoulder width, (note-3) fLS 0.0 mi/h Adj. for access point density, (note-3) fA 3.3 mi/h Free-flow speed, FFSd 41.8 mi/h 0.6 mi/h Adjustment for no-passing zones, fnp Average travel speed, ATSd 28.5 mi/h Percent Free Flow Speed, PFFS 68.2

Percent Time-Spent-Followi	ng		
Direction PCE for trucks, ET PCE for RVs, ER Heavy-vehicle adjustment factor, fHV Grade adjustment factor, (note-1) fg Analysis(d) 1.0 1.0 0.97		Opposing 1.0 1.0 1.000 1.000	
Directional flow rate,(note-2) vi 633 pc Base percent time-spent-following,(note-4) BPTSFd Adjustment for no-passing zones, fnp Percent time-spent-following, PTSFd	e/h 63.8 22.1 72.6	955 %	pc/h
Level of Service and Other Performa	ance Me	easures	
Level of service, LOS Volume to capacity ratio, v/c Peak 15-min vehicle-miles of travel, VMT15 Peak-hour vehicle-miles of travel, VMT60 Peak 15-min total travel time, TT15 Capacity from ATS, CdATS Capacity from PTSF, CdPTSF Directional Capacity	D 0.39 230 810 8.1 1669 1700 1669		
Passing Lane Analysis_			
Total length of analysis segment, Lt Length of two-lane highway upstream of the passing Length of passing lane including tapers, Lpl Average travel speed, ATSd (from above) Percent time-spent-following, PTSFd (from above) Level of service, LOSd (from above)	lane,	1.5 Lu - - 28.5 72.6 D	mi mi mi mi/h
Average Travel Speed with Passi	ing Lan	ne	
Downstream length of two-lane highway within effect length of passing lane for average travel speed Length of two-lane highway downstream of effective	cive		mi
length of two-lane highway downstream of effective length of the passing lane for average travel s Adj. factor for the effect of passing lane on average speed, fpl	speed,	Ld -	mi
Average travel speed including passing lane, ATSpl Percent free flow speed including passing lane, PFF	FSpl	- 0.0	%
Percent Time-Spent-Following with F	Passing	g Lane	
Downstream length of two-lane highway within effect of passing lane for percent time-spent-following Length of two-lane highway downstream of effective	ng, Lde	= -	mi
the passing lane for percent time-spent-followi Adj. factor for the effect of passing lane on percent time-spent-following, fpl	ing, Lo	d – –	mi
Percent time-spent-following including passing lane, PTSFpl		_	%
Level of Service and Other Performance Measur	res wit	ch Passing	Lane
Level of service including passing lane, LOSpl Peak 15-min total travel time, TT15	E -	veh-h	
Bicycle Level of Service	<u> </u>		

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	613.6
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.54
Bicycle LOS	D

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Phone: Fax: E-Mail: _____Directional Two-Lane Highway Segment Analysis______ Analyst HDR Agency/Co. SDDOT Date Performed 1/2014 Date Performed
Analysis Time Period PM PEAK Highway TIMBERLINE ROAD NORTH OF I-90 TO SOUTH OF 60TH From/To Jurisdiction MINNEHAHA CO. Analysis Year 2035 Description I-90/Timberline IMJR _____Input Data_____ Peak hour factor, PHF 0.88 Highway class Class 3 Shoulder width 6.0 ft % Trucks and buses 6 12.0 ft % Trucks crawling ...
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0 Lane width Segment length mi/hr Rolling Terrain type % No-passing zones 60 Grade: Length Access point density 13 Up/down /mi % Analysis direction volume, Vd 800 veh/h Opposing direction volume, Vo 580 veh/h ______Average Travel Speed_____ Direction Analysis(d) Opposing (o) PCE for trucks, ET 1.3 1.6 PCE for RVs, ER 1.1 1.1 Heavy-vehicle adj. factor,(note-5) fHV 0.982 0.965 1.00 Grade adj. factor,(note-1) fg 0.98 926 pc/h Directional flow rate, (note-2) vi 697 pc/h Free-Flow Speed from Field Measurement: Field measured speed, (note-3) S FM mi/h Observed total demand, (note-3) V veh/h Estimated Free-Flow Speed: Base free-flow speed, (note-3) BFFS 45.0 mi/h Adj. for lane and shoulder width, (note-3) fLS 0.0 mi/h Adj. for access point density, (note-3) fA 3.3 mi/h Free-flow speed, FFSd 41.8 mi/h mi/h Adjustment for no-passing zones, fnp 1.1

28.1

67.3

mi/h

Average travel speed, ATSd

Percent Free Flow Speed, PFFS

Perc	cent Time-Spent-Follow	ing		
Direction	Analysis(d)	(Opposing	(0)
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment fact			1.000	
Grade adjustment factor, (note			0.98	
Directional flow rate, (note-2	_	c/h	673	pc/h
Base percent time-spent-follo			8	
Adjustment for no-passing zon		22.7	•	
Percent time-spent-following	, PTSFa	84.7	00	
Level of Serv	vice and Other Performa	ance Mea	sures	
Level of service, LOS		D		
Volume to capacity ratio, v/o	C	0.54		
Peak 15-min vehicle-miles of	travel, VMT15	341	veh-mi	
Peak-hour vehicle-miles of to	ravel, VMT60	1200	veh-mi	
Peak 15-min total travel time		12.1	veh-h	
Capacity from ATS, CdATS		1608	veh/h	
Capacity from PTSF, CdPTSF		1666	veh/h	
Directional Capacity		1608	veh/h	
	Passing Lane Analysis			
Total length of analysis segr	ment I.t		1.5	mi
Length of two-lane highway up		lane I.		mi
Length of passing lane include		Talle, II	u – –	mi
Average travel speed, ATSd (1			28.1	mi/h
Percent time-spent-following			84.7	1111
Level of service, LOSd (from			D	
		ing Tano		
Average in	ravel Speed with Passi	ing hane.		
Downstream length of two-lane	e highway within effect	cive		
length of passing lane for	or average travel speed	d, Lde	_	mi
Length of two-lane highway do	ownstream of effective			
length of the passing lar	ne for average travel s	speed, Lo	d -	mi
Adj. factor for the effect of	f passing lane			
on average speed, fpl			_	
Average travel speed including	ng passing lane, ATSpl		_	
Percent free flow speed inclu	uding passing lane, PFI	FSpl	0.0	8
Percent Time-	-Spent-Following with I	Passing :	Lane	
December 1 and 1 a			 la	
Downstream length of two-lane			Arm	m i
of passing lane for perce Length of two-lane highway do			- o.f	mi
the passing lane for pero		_	- OT	mi
Adj. factor for the effect of	_	шу, ша	_	mi
on percent time-spent-fol	_		_	
Percent time-spent-following	rrowrng, rbr		-	
including passing lane, I	PTSFpl		-	%
Level of Service and Ot	ther Performance Measur	res with	Passing	Lane
T		_		
Level of service including pa		E	le l-	
Peak 15-min total travel time	e, TT15	_	veh-h	
B:	icycle Level of Service	<u> </u>		
	_			

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	909.1
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.74
Bicycle LOS	D

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0 Lane width Segment length mi/hr Rolling Terrain type % No-passing zones 60 Grade: Length - mi Access point density 13 /mi Up/down % Analysis direction volume, Vd 840 veh/h Opposing direction volume, Vo 540 veh/h _____Average Travel Speed_____ Direction Analysis(d) Opposing (o) PCE for trucks, ET 1.3 1.7 PCE for RVs, ER 1.1 1.1 Heavy-vehicle adj. factor,(note-5) fHV 0.982 0.960 1.00 Grade adj. factor,(note-1) fg 0.97 972 pc/h Directional flow rate, (note-2) vi 659 pc/h Free-Flow Speed from Field Measurement: Field measured speed, (note-3) S FM mi/h Observed total demand, (note-3) V veh/h Estimated Free-Flow Speed: Base free-flow speed,(note-3) BFFS 45.0 mi/h Adj. for lane and shoulder width, (note-3) fLS 0.0 mi/h Adj. for access point density, (note-3) fA 3.3 mi/h Free-flow speed, FFSd 41.8 mi/h mi/h Adjustment for no-passing zones, fnp 1.2

27.9

66.9

mi/h

Average travel speed, ATSd

Percent Free Flow Speed, PFFS

Percent Time-Spent-Followi	ing		
Direction PCE for trucks, ET 1.0 PCE for RVs, ER 1.0 Heavy-vehicle adjustment factor, fHV 1.000		Opposing 1.0 1.0	
Grade adjustment factor, (note-1) fg 1.00 Directional flow rate, (note-2) vi 955 pc Base percent time-spent-following, (note-4) BPTSFd Adjustment for no-passing zones, fnp Percent time-spent-following, PTSFd	2/h 73.1 22.1 86.4	0.97 633 %	pc/h
Level of Service and Other Performa	ance Me	easures	
·	D 0.57 358 1260 12.8 1583 1666 1583	veh/h	
Passing Lane Analysis_			
Total length of analysis segment, Lt Length of two-lane highway upstream of the passing Length of passing lane including tapers, Lpl Average travel speed, ATSd (from above) Percent time-spent-following, PTSFd (from above) Level of service, LOSd (from above)	lane,	1.5 Lu - - 27.9 86.4 D	mi mi mi mi/h
Average Travel Speed with Passi	ing Lar	ne	
Downstream length of two-lane highway within effect length of passing lane for average travel speed Length of two-lane highway downstream of effective		-	mi
length of two-lane highway downstream of effective length of the passing lane for average travel s Adj. factor for the effect of passing lane on average speed, fpl	speed,	Ld -	mi
Average travel speed including passing lane, ATSpl Percent free flow speed including passing lane, PFF	FSpl	- 0.0	%
Percent Time-Spent-Following with F	Passing	g Lane	
Downstream length of two-lane highway within effect of passing lane for percent time-spent-following Length of two-lane highway downstream of effective	ng, Lde	e –	mi
the passing lane for percent time-spent-followi Adj. factor for the effect of passing lane on percent time-spent-following, fpl	_		mi
Percent time-spent-following including passing lane, PTSFpl		-	ે
Level of Service and Other Performance Measur	res wit	ch Passing	Lane
Level of service including passing lane, LOSpl Peak 15-min total travel time, TT15	E -	veh-h	
Bicycle Level of Service	e		

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	954.5
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.77
Bicycle LOS	D

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

Fax:

Phone:

E-Mail: _____Directional Two-Lane Highway Segment Analysis______ Analyst HDR Agency/Co. SDDOT Date Performed 1/2014 Date Performed 1/2014
Analysis Time Period PM PEAK Highway TIMBERLINE ROAD NORTH OF I-90 TO SOUTH OF 60TH From/To Jurisdiction MINNEHAHA CO. Analysis Year 2035 Description I-90/Timberline IMJR _____Input Data_____ Peak hour factor, PHF 0.88 Highway class Class 3 Shoulder width 6.0 ft % Trucks and buses 6 12.0 ft % Trucks crawling ...
1.5 mi Truck crawl speed 0.0
Rolling % Recreational vehicles 0 Lane width Segment length mi/hr Rolling Terrain type % No-passing zones 60 Grade: Length Access point density 13 /mi Up/down % Analysis direction volume, Vd 580 veh/h Opposing direction volume, Vo 800 veh/h ______Average Travel Speed_____ Direction Analysis(d) Opposing (o) PCE for trucks, ET 1.3 1.6 PCE for RVs, ER 1.1 1.1 Heavy-vehicle adj. factor,(note-5) fHV 0.965 0.982 Grade adj. factor,(note-1) fg 0.98 1.00 697 pc/h Directional flow rate, (note-2) vi 926 pc/h Free-Flow Speed from Field Measurement: Field measured speed, (note-3) S FM mi/h Observed total demand, (note-3) V veh/h Estimated Free-Flow Speed: Base free-flow speed, (note-3) BFFS 45.0 mi/h Adj. for lane and shoulder width, (note-3) fLS 0.0 mi/h Adj. for access point density, (note-3) fA 3.3 mi/h Free-flow speed, FFSd 41.8 mi/h 0.7 mi/h Adjustment for no-passing zones, fnp Average travel speed, ATSd 28.5 mi/h Percent Free Flow Speed, PFFS 68.2

Percent Tir	me-Spent-Follow:	1119		
Direction	Analysis(d)		Opposing	(0)
PCE for trucks, ET	1.0		1.0	
PCE for RVs, ER	1.0		1.0	
Heavy-vehicle adjustment factor, fH	V 1.000		1.00	0
Grade adjustment factor,(note-1) fg	0.98		1.00	
Directional flow rate,(note-2) vi	673 pc	c/h	909	pc/h
Base percent time-spent-following,(1	note-4) BPTSFd	65.1	%	
Adjustment for no-passing zones, fn	ρ	22.7		
Percent time-spent-following, PTSFd		74.8	%	
Level of Service and	d Other Performa	ance Me	asures	
Level of service, LOS		D		
Volume to capacity ratio, v/c		0.41		
Peak 15-min vehicle-miles of travel	, VMT15	247	veh-mi	
Peak-hour vehicle-miles of travel, V	•	870	veh-mi	
Peak 15-min total travel time, TT15		8.7	veh-h	
Capacity from ATS, CdATS		1669	veh/h	
Capacity from PTSF, CdPTSF		1700	veh/h	
Directional Capacity		1669	veh/h	
Passing	g Lane Analysis			
Total length of analysis segment, L	t		1.5	mi
Length of two-lane highway upstream		lane.		mi
Length of passing lane including tap				mi
Average travel speed, ATSd (from abo			28.5	mi/h
Percent time-spent-following, PTSFd			74.8	/ 11
Level of service, LOSd (from above)	(22011 0120 (2)		D	
Average Travel S	peed with Pass:	ing Lan	e	
Downstream length of two-lane highwa	av within effect	tive		
length of passing lane for average	_		_	mi
Length of two-lane highway downstrea	-	a, nae	_	шт
		anood .	T d	mi
length of the passing lane for a		speed,	La -	mı
Adj. factor for the effect of passing	ng rane			
on average speed, fpl	ing lane Amonl		_	
Average travel speed including pass:		п О 1	-	0.
Percent free flow speed including pa	assing lane, PF	rSp1	0.0	%
Percent Time-Spent-l	Following with 1	Passing	Lane	
Downstream length of two-lane highwa	ay within effect	tive le	ngth	
	_			mi
of passing lane for percent time	e-spenc-rorrown	ng, Lde		
	_	_		
Length of two-lane highway downstrea	am of effective	length	of	mi
Length of two-lane highway downstrea the passing lane for percent time	am of effective me-spent-follow:	length	of	mi
Length of two-lane highway downstrea the passing lane for percent tin Adj. factor for the effect of passin	am of effective me-spent-follow: ng lane	length	of	mi
Length of two-lane highway downstrea the passing lane for percent tin Adj. factor for the effect of passing on percent time-spent-following	am of effective me-spent-follow: ng lane	length	of	mi
Length of two-lane highway downstrea the passing lane for percent tin Adj. factor for the effect of passin	am of effective me-spent-follow: ng lane	length	of	mi %
Length of two-lane highway downstreathe the passing lane for percent time. Adj. factor for the effect of passing on percent time-spent-following Percent time-spent-following	am of effective me-spent-follow ng lane , fpl	length ing, Ld	of - -	ૄ
Length of two-lane highway downstreathe the passing lane for percent time. Adj. factor for the effect of passing on percent time-spent-following. Percent time-spent-following including passing lane, PTSFpl Level of Service and Other Percent.	am of effective me-spent-follow ng lane , fpl rformance Measu	length ing, Ld	of - -	%
Length of two-lane highway downstreathe passing lane for percent time. Adj. factor for the effect of passing on percent time-spent-following encluding passing lane, PTSFpl Level of Service and Other Percent of Service including passing lane, passing la	am of effective me-spent-follow ng lane , fpl rformance Measu	length ing, Ld	of - - h Passing	%
Length of two-lane highway downstreathe the passing lane for percent time. Adj. factor for the effect of passing on percent time-spent-following Percent time-spent-following including passing lane, PTSFpl Level of Service and Other Percent Level of Service and Other Percent Level of Service and Other Percent Level of Service and Other Percent Level of Service and Other Percent Level of Service and Other Percent Level of Service and Other Percent Level Of Service and Other Percent Level Of Service and Other Percent Level Of Service and Other Percent Level Of Service and Other Percent Level Of Service and Other Percent Level Of Service and Other Percent Level Of Service Advanced Level Office Advanced Level Office Advanced Level Office Advanced Level Office Advanced Level Office Advanced Level Development Level Office Advanced Level Development Level Office Advanced Level Development Level Office Advanced Level Development Level Office Advanced Level Development Lev	am of effective me-spent-follow ng lane , fpl rformance Measu	length ing, Ld	of - -	%

Posted speed limit, Sp	45
Percent of segment with occupied on-highway parking	0
Pavement rating, P	3
Flow rate in outside lane, vOL	659.1
Effective width of outside lane, We	24.00
Effective speed factor, St	4.42
Bicycle LOS Score, BLOS	3.58
Bicycle LOS	D

Notes:

- 1. Note that the adjustment factor for level terrain is 1.00, as level terrain is one of the base conditions. For the purpose of grade adjustment, specific dewngrade segments are treated as level terrain.
- 2. If vi (vd or vo) >= 1,700 pc/h, terminate analysis-the LOS is F.
- 3. For the analysis direction only and for v>200 veh/h.
- 4. For the analysis direction only.
- 5. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analyst Analysis Date 1/20/2014 Area Type Other SIOUX FALLS PHF Jurisdiction Time Period AM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 2035 AM.xus File Name **Project Description** CORRIDOR TRAFFIC ANALYSIS **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 100 900 180 Demand (v), veh/h 180 40 270 60 400 160 930 Signal Information IJ, Cycle, s 0.08 Reference Phase 2 Offset, s 8 Reference Point Begin 0.0 Green 10.0 1.0 19.0 15.0 15.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 0.0 4.0 0.0 4.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 0.0 1.0 1.0 1.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 1.1 4.0 2.0 3.0 2.0 3.0 1.1 4.0 Phase Duration, s 20.0 20.0 20.0 20.0 16.0 25.0 15.0 24.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 8.0 3.5 14.4 6.7 6.8 6.7 Green Extension Time (g_e) , s 0.2 0.3 0.0 0.2 0.2 0.0 0.1 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 0.01 0.00 1.00 0.00 0.23 0.73 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 3 18 5 2 12 1 6 8 Adjusted Flow Rate (v), veh/h 180 40 270 60 100 202 454 81 136 704 Adjusted Saturation Flow Rate (s), veh/h/ln 1681 1765 1681 1765 1570 1542 1439 1617 1542 1496 6.0 2.3 3.5 4.7 11.6 Queue Service Time (gs), s 1.5 12.4 4.7 4.8 6.2 Cycle Queue Clearance Time (gc), s 6.0 1.5 12.4 2.3 4.7 4.8 6.2 3.5 4.7 11.6 Green Ratio (g/C) 0.38 0.19 0.19 0.19 0.19 0.14 0.25 0.25 0.36 0.24 Capacity (c), veh/h 584 331 315 331 280 432 1156 360 425 1099 Volume-to-Capacity Ratio (X) 0.308 0.121 0.857 0.181 0.357 0.467 0.392 0.224 0.321 0.641 Available Capacity (ca), veh/h 584 331 315 331 280 432 1156 360 425 1099 Back of Queue (Q), veh/ln (50th percentile) 2.1 0.6 6.7 0.9 1.6 1.7 2.1 1.2 1.6 4.6 Queue Storage Ratio (RQ) (50th percentile) 0.27 0.00 0.85 0.00 0.27 0.22 0.00 0.16 0.21 0.00 Uniform Delay (d1), s/veh 17.6 27.0 31.5 27.3 28.3 32.1 23.0 23.1 18.4 31.7 Incremental Delay (d2), s/veh 0.1 0.1 23.1 0.1 0.3 0.2 8.0 1.2 0.1 2.1 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 17.7 27.1 54.6 27.4 28.6 32.3 23.8 24.3 18.5 33.8 Level of Service (LOS) В С D С С С С С В С 19.4 В 44.7 D 26.2 С С Approach Delay, s/veh / LOS 31.3 Intersection Delay, s/veh / LOS 31.0 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.3 С В 2.7 В Bicycle LOS Score / LOS 0.9 Α 1.2 Α 1.3 Α 1.1

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analyst Analysis Date 1/20/2014 Area Type Other SIOUX FALLS PHF Jurisdiction Time Period PM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 2035 PM.xus File Name **Project Description** CORRIDOR TRAFFIC ANALYSIS **Demand Information** EΒ **WB** NB SB Approach Movement R L R L R L R 210 80 Demand (v), veh/h 200 70 50 370 1380 220 130 830 Signal Information IJ, Cycle, s 0.08 Reference Phase 2 Offset, s 5 Reference Point Begin 0.0 Green 7.0 22.0 10.0 1.0 15.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 4.0 0.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 1.0 0.0 1.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 1.1 4.0 2.0 3.0 2.0 3.0 1.1 4.0 Phase Duration, s 15.0 20.0 16.0 21.0 17.0 32.0 12.0 27.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 9.4 4.7 11.9 5.6 6.0 4.7 Green Extension Time (g_e) , s 0.0 0.2 0.0 0.2 0.2 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.00 1.00 0.00 0.02 1.00 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 3 18 5 2 12 1 6 8 Adjusted Flow Rate (v), veh/h 200 70 210 50 80 179 666 106 79 501 1681 1765 1681 1765 1570 1542 1439 1617 1542 Adjusted Saturation Flow Rate (s), veh/h/ln 1496 7.4 2.7 9.9 4.3 2.7 7.0 Queue Service Time (gs), s 1.9 3.6 4.0 8.4 Cycle Queue Clearance Time (gc), s 7.4 2.7 9.9 1.9 3.6 4.0 8.4 4.3 2.7 7.0 Green Ratio (g/C) 0.31 0.19 0.14 0.20 0.20 0.15 0.34 0.34 0.36 0.28 Capacity (c), veh/h 505 331 231 353 299 471 1561 486 384 1272 Volume-to-Capacity Ratio (X) 0.396 0.212 0.909 0.142 0.267 0.379 0.427 0.219 0.204 0.394 Available Capacity (ca), veh/h 505 331 231 353 299 471 1561 486 384 1272 Back of Queue (Q), veh/ln (50th percentile) 2.7 1.1 6.9 0.7 1.2 1.4 2.7 1.4 1.0 2.4 Queue Storage Ratio (RQ) (50th percentile) 0.34 0.00 0.88 0.00 0.21 0.19 0.00 0.19 0.13 0.00 Uniform Delay (d1), s/veh 21.5 27.5 34.0 26.3 27.0 29.8 18.8 19.4 19.0 23.5 Incremental Delay (d2), s/veh 0.2 0.1 49.6 0.1 0.2 0.1 0.7 8.0 0.1 8.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 21.7 27.6 83.6 26.4 27.2 29.9 19.4 20.2 19.1 24.3 Level of Service (LOS) С С F С С С В С В С 23.2 С Ε 21.5 С 23.6 С Approach Delay, s/veh / LOS 61.9 Intersection Delay, s/veh / LOS 28.7 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.3 С В 2.7 В Bicycle LOS Score / LOS 0.9 Α 1.0 Α 1.6 Α 1.0 Α

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HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** Agency HDR Duration, h 1.00 RL Analysis Date 1/3/2014 Analyst Area Type Other PHF 1.00 Jurisdiction Minnehaha Co. Time Period AM Intersection I-90 Eastbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline am 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 0 900 Demand (v), veh/h 130 0 280 70 840 **Signal Information** Щ Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 17.0 0.0 Green 9.0 39.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 0.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 2 1 6 Case Number 12.0 7.3 2.0 4.0 Phase Duration, s 22.0 44.0 14.0 58.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 7.6 5.2 Green Extension Time (g_e) , s 0.1 0.0 0.0 0.0 1.00 Phase Call Probability 1.00 0.00 Max Out Probability 0.30 WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R Т R L Т R L **Assigned Movement** 7 4 14 2 12 1 6 Adjusted Flow Rate (v), veh/h 130 900 280 70 840 Adjusted Saturation Flow Rate (s), veh/h/ln 1600 1645 1444 1586 1640 10.3 2.8 3.2 Queue Service Time (gs), s 5.6 15.1 2.8 Cycle Queue Clearance Time (g_c) , s 5.6 10.3 3.2 15.1 Green Ratio (g/C) 0.21 0.49 0.49 0.11 0.51 Capacity (c), veh/h 340 1604 704 178 1683 Volume-to-Capacity Ratio (X) 0.382 0.561 0.398 0.392 0.499 Available Capacity (ca), veh/h 340 1604 704 178 1683 Back of Queue (Q), veh/ln (50th percentile) 2.0 2.5 0.7 1.2 5.5 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.15 0.00 Uniform Delay (d1), s/veh 27.0 7.2 2.5 31.8 12.0 Incremental Delay (d2), s/veh 0.3 1.0 1.1 0.4 0.9 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 27.3 8.1 3.7 32.3 12.9 Level of Service (LOS) С Α Α С В 27.3 С 0.0 7.1 Α 14.4 Approach Delay, s/veh / LOS В Intersection Delay, s/veh / LOS 11.2 В **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 2.9 С 2.9 С 1.9 Α 1.3 Α Bicycle LOS Score / LOS 0.7 Α 1.5 Α 1.2 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** Agency HDR Duration, h 1.00 RL Analysis Date 1/3/2014 Analyst Area Type Other PM PHF 1.00 Jurisdiction Minnehaha Co. Time Period Intersection I-90 Eastbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline pm 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R R L R 0 Demand (v), veh/h 150 0 1300 360 70 580 **Signal Information** Щ Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 15.0 0.0 Green 6.0 44.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 0.0 0.0 0.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 2 1 6 Case Number 12.0 7.3 2.0 4.0 Phase Duration, s 20.0 49.0 11.0 60.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 8.7 5.4 Green Extension Time (g_e) , s 0.1 0.0 0.0 0.0 1.00 Phase Call Probability 1.00 0.02 Max Out Probability 1.00 WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 14 2 12 1 6 Adjusted Flow Rate (v), veh/h 150 1300 360 70 580 Adjusted Saturation Flow Rate (s), veh/h/ln 1604 1680 1456 1586 1617 6.7 13.7 2.7 3.4 Queue Service Time (gs), s 14.0 Cycle Queue Clearance Time (g_c) , s 6.7 13.7 2.7 3.4 14.0 Green Ratio (g/C) 0.19 0.55 0.55 0.08 0.43 Capacity (c), veh/h 301 1848 801 119 1382 Volume-to-Capacity Ratio (X) 0.499 0.703 0.450 0.588 0.420 Available Capacity (ca), veh/h 301 1848 801 119 1382 Back of Queue (Q), veh/ln (50th percentile) 2.4 2.3 0.6 1.4 6.4 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.17 0.00 Uniform Delay (d1), s/veh 29.1 4.8 1.6 35.2 18.8 Incremental Delay (d2), s/veh 0.5 8.0 0.6 4.6 8.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 29.6 5.6 2.2 39.8 19.6 Level of Service (LOS) С Α Α D В 29.6 С 0.0 4.8 Α С Approach Delay, s/veh / LOS 21.8 Intersection Delay, s/veh / LOS 10.8 В **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 2.9 С 2.9 С 1.9 Α 1.3 Α Bicycle LOS Score / LOS 0.7 Α 1.9 Α 1.0 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information** Intersection Information HDR Duration, h 1.00 Agency RL Analysis Date 1/3/2014 Analyst Area Type Other PHF Jurisdiction Minnehaha Co. Time Period AM 1.00 Intersection I-90 Westbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline am 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R Demand (v), veh/h 360 60 490 540 550 150 **Signal Information** Л Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 0.0 Green 22.0 25.0 18.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 0.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL WBT** NBL **NBT** SBL SBT **Assigned Phase** 8 2 5 6 Case Number 9.0 2.0 4.0 7.3 Phase Duration, s 23.0 27.0 57.0 30.0 5.0 5.0 5.0 Change Period, (Y+Rc), s 5.0 Max Allow Headway (MAH), s 3.1 3.0 0.0 0.0 Queue Clearance Time (gs), s 10.1 13.8 Green Extension Time (g_e) , s 0.6 8.0 0.0 0.0 1.00 Phase Call Probability 1.00 0.02 0.02 Max Out Probability WB **Movement Group Results** EΒ NB SB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 3 18 5 2 6 16 Adjusted Flow Rate (v), veh/h 360 60 490 540 550 150 1564 1614 1425 Adjusted Saturation Flow Rate (s), veh/h/ln 1439 1579 1615 2.7 6.5 Queue Service Time (gs), s 8.1 11.8 5.7 11.3 11.8 Cycle Queue Clearance Time (g_c) , s 8.1 2.7 5.7 11.3 6.5 Green Ratio (g/C) 0.22 0.22 0.28 0.65 0.31 0.31 Capacity (c), veh/h 704 324 868 2098 1009 445 Volume-to-Capacity Ratio (X) 0.511 0.185 0.564 0.257 0.545 0.337 Available Capacity (ca), veh/h 704 324 868 2098 1009 445 Back of Queue (Q), veh/ln (50th percentile) 2.8 0.9 4.7 1.5 4.2 2.2 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.00 0.00 0.00 Uniform Delay (d1), s/veh 27.1 25.1 31.0 6.0 22.8 21.1 Incremental Delay (d2), s/veh 0.3 0.1 0.4 0.2 2.1 2.1 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 27.4 25.2 31.5 6.3 24.9 23.2 Level of Service (LOS) С С С Α С С 0.0 27.1 С 18.3 24.5 С Approach Delay, s/veh / LOS В Intersection Delay, s/veh / LOS 22.0 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 3.0 С 2.9 С 1.9 Α 2.4 В Bicycle LOS Score / LOS 1.3 Α 1.1 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information** Intersection Information HDR Duration, h 1.00 Agency RL Analysis Date 1/3/2014 Analyst Area Type Other PM PHF Jurisdiction Minnehaha Co. Time Period 1.00 Intersection I-90 Westbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline pm 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 300 Demand (v), veh/h 70 650 800 350 130 **Signal Information** Л Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 0.0 Green 29.0 19.0 17.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 0.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL WBT** NBL **NBT** SBL SBT **Assigned Phase** 8 2 5 6 Case Number 9.0 2.0 4.0 7.3 Phase Duration, s 34.0 58.0 24.0 22.0 5.0 5.0 5.0 Change Period, (Y+Rc), s 5.0 Max Allow Headway (MAH), s 3.1 3.0 0.0 0.0 Queue Clearance Time (gs), s 8.7 16.2 Green Extension Time (g_e) , s 0.6 1.4 0.0 0.0 1.00 Phase Call Probability 1.00 0.00 Max Out Probability 0.01 WB **Movement Group Results** EΒ NB SB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 3 18 5 2 6 16 Adjusted Flow Rate (v), veh/h 300 70 650 800 350 130 1558 1598 1422 Adjusted Saturation Flow Rate (s), veh/h/ln 1433 1598 1636 3.2 7.5 6.1 Queue Service Time (gs), s 6.7 14.2 9.0 9.0 Cycle Queue Clearance Time (g_c) , s 6.7 3.2 14.2 7.5 6.1 Green Ratio (g/C) 0.21 0.21 0.36 0.66 0.24 0.24 Capacity (c), veh/h 662 305 1158 2168 759 338 Volume-to-Capacity Ratio (X) 0.453 0.230 0.561 0.369 0.461 0.385 Available Capacity (ca), veh/h 662 305 1158 2168 759 338 Back of Queue (Q), veh/ln (50th percentile) 2.3 1.0 5.4 2.3 2.8 2.2 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.00 0.00 0.00 Uniform Delay (d1), s/veh 27.4 26.1 24.5 6.3 26.1 25.6 Incremental Delay (d2), s/veh 0.2 0.1 0.3 0.3 2.0 3.3 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 27.6 26.2 24.8 28.1 28.9 6.6 Level of Service (LOS) С С С Α С С 0.0 27.4 С 14.8 28.4 С Approach Delay, s/veh / LOS В Intersection Delay, s/veh / LOS 19.6 В **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 3.0 С 2.9 С 1.9 Α 2.4 В Bicycle LOS Score / LOS 1.7 Α 0.9 Α

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Intersection	<u>1</u>		estbound			PHF		1.00				Απο	erial Di	rection		IN	lorth-South				
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Demand							EBT	ЕВ	R	WBL	W	/BT	WBR	NBL	NBT	NBF	R SB	L SBT	SBR		
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Intersection Two Demand (v), veh/h									_	360			60	490	540			550	150		
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Interchang	je Result	s																			
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В				W	BR								60			25.2		В			
С				El	3R								0			0.0		А			
D				EBL		U							130			33.5		С			
Е				NBL(IN									490			39.6		С			
F				NBR									280			8.1		А			
G				SBR							\dashv		150			23.2		В			
Н				SBL(IN							-		70			57.2		D			
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Approach [4	27.3	3	С		0.0			_	7.1		Α		1.4	В		
Intersection	n Delay, s	/veh / LOS	8		_				11.2	2							В	_			
Signalized	Intersec	tion Two	Results				EB				W	В			NB			SB			
Approach N						L	T	R		L	Т		R	L	Т	R	L	T	R		
Control Del								- `		27.4		_	25.2	31.5	6.3	-,		24.9	23.2		
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HCS 2010 Interchanges Results Summary																					
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Project Des	cription	I-90/Tir	mberline	IMJR	_	_	_	_	_		_	_	_	_	_						
Demand		Т	EBL	EBT	EBR	R W	3L	WBT	WBR	NBL	NBT	NBR	R SBI	SBT	SBR						
Intersection One Demand (v), veh/h						150	0	0						1300	360	70	580				
Intersection Two Demand (v), veh/h									30	00		70	650	800			350	130			
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Interchang	e Results																				
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В					BR							70			26.2		В				
С				E	BR							0			0.0		А				
D					- EBU						_	150			36.2		C				
E				NBL(IN								650			30.4		C				
F					(EXT)						+	360			5.6		A				
G					(EXT)							130			28.9		В				
Н				SBL(IN								70			58.0		D				
1			NP	BT(INT) -			1					650			6.6		A				
J				T(INT) -							+	280			19.6		В				
K			00		BT	. ,,						0			-		-				
L					BT							0			_						
M					BU							0			-						
N					BU							0			-						
Signalized	Intersecti	on One	Results				EB			,	WB			NB			SB				
Approach N	lovement					L	Т	R	L		Т	R	L	Т	R	L	Т	R			
Control Del	ay (<i>d</i>) , s/v	eh					29.6							5.6	2.2	39.8	19.6				
Level of Se	rvice (LOS)					С							Α	Α	D	В				
Approach D		-				29.6		С	C	.0			4.8		Α	21.8 C					
Intersection	-		3						0.8							В					
Signalized		on Two	Results				EB	_		,	WB			NB			SB				
Approach N						L	Т	R	L		Т	R	L	Т	R	L	T	R			
Control Del					\perp				27.	3		26.2	24.8	6.6			28.1	28.9			
Level of Se		•							С		\perp	С	С	Α			С	С			
Approach D	-					0.0				7.4		С	14.8		В	28	.4	С			
Intersection				1	9.6							В									

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analyst Analysis Date 1/20/2014 Area Type Other SIOUX FALLS PHF Jurisdiction Time Period AM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 2035 AM.xus File Name **Project Description** CORRIDOR TRAFFIC ANALYSIS **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 100 900 180 Demand (v), veh/h 180 40 270 60 400 160 930 Signal Information IJ, Cycle, s 0.08 Reference Phase 2 Offset, s 8 Reference Point Begin 0.0 Green 10.0 1.0 19.0 15.0 15.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 0.0 4.0 0.0 4.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 0.0 1.0 1.0 1.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 1.1 4.0 2.0 3.0 2.0 3.0 1.1 4.0 Phase Duration, s 20.0 20.0 20.0 20.0 16.0 25.0 15.0 24.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 8.0 3.5 14.4 6.7 6.8 6.7 Green Extension Time (g_e) , s 0.2 0.3 0.0 0.2 0.2 0.0 0.1 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 0.01 0.00 1.00 0.00 0.23 0.73 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 3 18 5 2 12 1 6 8 Adjusted Flow Rate (v), veh/h 180 40 270 60 100 202 454 81 136 704 Adjusted Saturation Flow Rate (s), veh/h/ln 1681 1765 1681 1765 1570 1542 1439 1617 1542 1496 6.0 2.3 3.5 4.7 11.6 Queue Service Time (gs), s 1.5 12.4 4.7 4.8 6.2 Cycle Queue Clearance Time (g_c) , s 6.0 1.5 12.4 2.3 4.7 4.8 6.2 3.5 4.7 11.6 Green Ratio (g/C) 0.38 0.19 0.19 0.19 0.19 0.14 0.25 0.25 0.36 0.24 Capacity (c), veh/h 584 331 315 331 280 432 1156 360 425 1099 Volume-to-Capacity Ratio (X) 0.308 0.121 0.857 0.181 0.357 0.467 0.392 0.224 0.321 0.641 Available Capacity (ca), veh/h 584 331 315 331 280 432 1156 360 425 1099 Back of Queue (Q), veh/ln (50th percentile) 2.1 0.6 6.7 0.9 1.6 1.7 2.1 1.2 1.6 4.6 Queue Storage Ratio (RQ) (50th percentile) 0.27 0.00 0.85 0.00 0.27 0.22 0.00 0.16 0.21 0.00 Uniform Delay (d1), s/veh 17.6 27.0 31.5 27.3 28.3 32.1 23.0 23.1 18.4 31.7 Incremental Delay (d2), s/veh 0.1 0.1 23.1 0.1 0.3 0.2 8.0 1.2 0.1 2.1 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 17.7 27.1 54.6 27.4 28.6 32.3 23.8 24.3 18.5 33.8 Level of Service (LOS) В С D С С С С С В С 19.4 В 44.7 D 26.2 С С Approach Delay, s/veh / LOS 31.3 Intersection Delay, s/veh / LOS 31.0 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.3 С В 2.7 В Bicycle LOS Score / LOS 0.9 Α 1.2 Α 1.3 Α 1.1

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analyst Analysis Date 1/20/2014 Area Type Other SIOUX FALLS PHF Jurisdiction Time Period PM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 2035 PM.xus File Name **Project Description** CORRIDOR TRAFFIC ANALYSIS **Demand Information** EΒ **WB** NB SB Approach Movement R L R L R L R 210 80 Demand (v), veh/h 200 70 50 370 1380 220 130 830 Signal Information IJ, Cycle, s 0.08 Reference Phase 2 Offset, s 5 Reference Point Begin 0.0 Green 7.0 22.0 10.0 1.0 15.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 4.0 0.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 1.0 0.0 1.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 1.1 4.0 2.0 3.0 2.0 3.0 1.1 4.0 Phase Duration, s 15.0 20.0 16.0 21.0 17.0 32.0 12.0 27.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 9.4 4.7 11.9 5.6 6.0 4.7 Green Extension Time (g_e) , s 0.0 0.2 0.0 0.2 0.2 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.00 1.00 0.00 0.02 1.00 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 3 18 5 2 12 1 6 8 Adjusted Flow Rate (v), veh/h 200 70 210 50 80 179 666 106 79 501 1681 1765 1681 1765 1570 1542 1439 1617 1542 Adjusted Saturation Flow Rate (s), veh/h/ln 1496 7.4 2.7 9.9 4.3 2.7 7.0 Queue Service Time (gs), s 1.9 3.6 4.0 8.4 Cycle Queue Clearance Time (g_c) , s 7.4 2.7 9.9 1.9 3.6 4.0 8.4 4.3 2.7 7.0 Green Ratio (g/C) 0.31 0.19 0.14 0.20 0.20 0.15 0.34 0.34 0.36 0.28 Capacity (c), veh/h 505 331 231 353 299 471 1561 486 384 1272 Volume-to-Capacity Ratio (X) 0.396 0.212 0.909 0.142 0.267 0.379 0.427 0.219 0.204 0.394 Available Capacity (ca), veh/h 505 331 231 353 299 471 1561 486 384 1272 Back of Queue (Q), veh/ln (50th percentile) 2.7 1.1 6.9 0.7 1.2 1.4 2.7 1.4 1.0 2.4 Queue Storage Ratio (RQ) (50th percentile) 0.34 0.00 0.88 0.00 0.21 0.19 0.00 0.19 0.13 0.00 Uniform Delay (d1), s/veh 21.5 27.5 34.0 26.3 27.0 29.8 18.8 19.4 19.0 23.5 Incremental Delay (d2), s/veh 0.2 0.1 49.6 0.1 0.2 0.1 0.7 8.0 0.1 8.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 21.7 27.6 83.6 26.4 27.2 29.9 19.4 20.2 19.1 24.3 Level of Service (LOS) С С F С С С В С В С 23.2 С Ε 21.5 С 23.6 С Approach Delay, s/veh / LOS 61.9 Intersection Delay, s/veh / LOS 28.7 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.3 С В 2.7 В Bicycle LOS Score / LOS 0.9 Α 1.0 Α 1.6 Α 1.0 Α

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HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** Agency HDR Duration, h 1.00 RL Analysis Date 1/3/2014 Analyst Area Type Other PHF 1.00 Jurisdiction Minnehaha Co. Time Period AM Intersection I-90 Eastbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline am 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 0 900 Demand (v), veh/h 130 0 280 70 840 **Signal Information** Щ Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 17.0 0.0 Green 9.0 39.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 0.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 2 1 6 Case Number 12.0 7.3 2.0 4.0 Phase Duration, s 22.0 44.0 14.0 58.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 7.6 5.1 Green Extension Time (g_e) , s 0.1 0.0 0.0 0.0 1.00 Phase Call Probability 1.00 0.00 0.24 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R Т R L Т R L **Assigned Movement** 7 4 14 2 12 1 6 Adjusted Flow Rate (v), veh/h 130 900 280 70 840 Adjusted Saturation Flow Rate (s), veh/h/ln 1600 1604 1444 1586 1640 11.2 3.2 3.1 Queue Service Time (gs), s 5.6 19.1 3.2 Cycle Queue Clearance Time (g_c) , s 5.6 11.2 3.1 19.1 Green Ratio (g/C) 0.21 0.49 0.49 0.11 0.51 704 Capacity (c), veh/h 340 1564 178 1683 Volume-to-Capacity Ratio (X) 0.382 0.575 0.398 0.392 0.499 Available Capacity (ca), veh/h 340 1564 704 178 1683 Back of Queue (Q), veh/ln (50th percentile) 2.0 2.7 8.0 1.1 8.5 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.14 0.00 Uniform Delay (d1), s/veh 27.0 7.8 3.0 29.5 20.1 Incremental Delay (d2), s/veh 0.3 1.0 1.1 0.4 0.9 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 27.3 8.8 4.1 29.9 21.0 Level of Service (LOS) С Α Α С С 27.3 С 0.0 7.7 Α 21.7 С Approach Delay, s/veh / LOS Intersection Delay, s/veh / LOS 14.6 В **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 2.9 С 2.9 С 1.9 Α 1.3 Α Bicycle LOS Score / LOS 0.7 Α 1.5 Α 1.2 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analysis Date 1/3/2014 Analyst Area Type Other PM PHF Jurisdiction Minnehaha Co. Time Period 1.00 Intersection I-90 Eastbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline pm 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R R L R 0 Demand (v), veh/h 150 0 1300 360 70 580 **Signal Information** Щ Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin Green 10.0 15.0 0.0 40.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 0.0 0.0 0.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 2 1 6 Case Number 12.0 7.3 2.0 4.0 Phase Duration, s 20.0 45.0 15.0 60.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 8.7 9.4 Green Extension Time (g_e) , s 0.1 0.0 0.0 0.0 1.00 Phase Call Probability 1.00 0.02 Max Out Probability 1.00 WB SB **Movement Group Results** EΒ NB Approach Movement L Т R Т R Т R L Т R L L **Assigned Movement** 7 4 14 2 12 1 6 Adjusted Flow Rate (v), veh/h 150 1300 360 70 580 Adjusted Saturation Flow Rate (s), veh/h/ln 1604 1456 1586 1617 1646 20.4 Queue Service Time (gs), s 6.7 5.8 3.1 13.8 Cycle Queue Clearance Time (g_c) , s 6.7 20.4 5.8 3.1 13.8 Green Ratio (g/C) 0.13 0.50 0.50 0.07 0.48 Capacity (c), veh/h 215 1646 728 113 1544 Volume-to-Capacity Ratio (X) 0.699 0.790 0.494 0.619 0.376 Available Capacity (ca), veh/h 301 1646 728 113 1544 Back of Queue (Q), veh/ln (50th percentile) 2.5 3.8 1.2 1.2 6.2 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.15 0.00 29.1 Uniform Delay (d1), s/veh 8.3 3.9 28.3 18.3 Incremental Delay (d2), s/veh 1.6 1.4 0.8 6.8 0.6 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 30.7 9.7 4.8 35.2 18.9 Level of Service (LOS) С Α Α D В 30.7 С 0.0 8.7 Α 20.6 С Approach Delay, s/veh / LOS Intersection Delay, s/veh / LOS 13.2 В **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 2.9 С 2.9 С 1.9 Α 1.3 Α Bicycle LOS Score / LOS 0.7 Α 1.9 Α 1.0 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information** Intersection Information HDR Duration, h 1.00 Agency RL Analysis Date 1/3/2014 Analyst Area Type Other PHF Jurisdiction Minnehaha Co. Time Period AM 1.00 Intersection I-90 Westbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline am 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R Demand (v), veh/h 360 60 490 540 550 150 **Signal Information** Л Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 0.0 Green 22.0 25.0 18.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 0.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL WBT** NBL **NBT** SBL SBT **Assigned Phase** 8 2 5 6 Case Number 9.0 2.0 4.0 7.3 Phase Duration, s 23.0 27.0 57.0 30.0 5.0 5.0 5.0 Change Period, (Y+Rc), s 5.0 Max Allow Headway (MAH), s 3.1 3.0 0.0 0.0 Queue Clearance Time (gs), s 10.1 12.9 Green Extension Time (g_e) , s 0.6 0.9 0.0 0.0 1.00 Phase Call Probability 1.00 0.02 Max Out Probability 0.01 WB **Movement Group Results** EΒ NB SB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 3 18 5 2 6 16 Adjusted Flow Rate (v), veh/h 360 60 490 540 550 150 1564 1614 1648 1425 Adjusted Saturation Flow Rate (s), veh/h/ln 1439 1579 2.7 6.5 Queue Service Time (gs), s 8.1 10.9 4.7 11.0 10.9 Cycle Queue Clearance Time (g_c) , s 8.1 2.7 4.7 11.0 6.5 Green Ratio (g/C) 0.22 0.22 0.28 0.65 0.31 0.31 Capacity (c), veh/h 704 324 868 2098 1030 445 Volume-to-Capacity Ratio (X) 0.511 0.185 0.564 0.257 0.534 0.337 Available Capacity (ca), veh/h 704 324 868 2098 1030 445 Back of Queue (Q), veh/ln (50th percentile) 2.8 0.9 3.9 1.2 4.1 2.2 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.00 0.00 0.00 Uniform Delay (d1), s/veh 27.1 25.1 26.1 4.7 22.7 21.1 Incremental Delay (d2), s/veh 0.3 0.1 0.4 0.2 2.0 2.1 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 27.4 25.2 26.5 4.9 24.7 23.2 Level of Service (LOS) С С С Α С С 0.0 27.1 С 15.2 24.4 С Approach Delay, s/veh / LOS В Intersection Delay, s/veh / LOS 20.5 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 3.0 С 2.9 С 1.9 Α 2.4 В Bicycle LOS Score / LOS 1.3 Α 1.1 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analysis Date 1/3/2014 Analyst Area Type Other PM PHF Jurisdiction Minnehaha Co. Time Period 1.00 Intersection I-90 Westbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline pm 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 300 Demand (v), veh/h 70 650 800 350 130 **Signal Information** Л Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 0.0 Green 29.0 19.0 17.0 0.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 0.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 0.0 0.0 0.0 **Timer Results EBL EBT WBL WBT** NBL **NBT** SBL SBT **Assigned Phase** 8 2 5 6 Case Number 9.0 2.0 4.0 7.3 Phase Duration, s 34.0 58.0 24.0 22.0 5.0 5.0 Change Period, (Y+Rc), s 5.0 5.0 Max Allow Headway (MAH), s 3.1 3.0 0.0 0.0 Queue Clearance Time (gs), s 8.7 14.5 Green Extension Time (g_e) , s 0.6 1.4 0.0 0.0 1.00 Phase Call Probability 1.00 0.00 Max Out Probability 0.01 WB **Movement Group Results** EΒ NB SB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 3 18 5 2 6 16 Adjusted Flow Rate (v), veh/h 300 70 650 800 350 130 Adjusted Saturation Flow Rate (s), veh/h/ln 1558 1636 1631 1422 1433 1598 3.2 7.3 Queue Service Time (gs), s 6.7 12.5 6.2 6.1 Cycle Queue Clearance Time (g_c) , s 6.7 3.2 12.5 6.2 7.3 6.1 Green Ratio (g/C) 0.21 0.21 0.36 0.66 0.24 0.24 Capacity (c), veh/h 662 305 1158 2168 775 338 Volume-to-Capacity Ratio (X) 0.453 0.230 0.561 0.369 0.452 0.385 Available Capacity (ca), veh/h 662 305 1158 2168 775 338 Back of Queue (Q), veh/ln (50th percentile) 2.3 1.0 4.0 1.3 2.8 2.2 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.00 0.00 0.00 Uniform Delay (d1), s/veh 27.4 26.1 18.8 3.8 26.1 25.6 Incremental Delay (d2), s/veh 0.2 0.1 0.2 0.3 1.9 3.3 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 27.6 26.2 19.0 4.0 28.0 28.9 Level of Service (LOS) С С В Α С С 0.0 27.4 С 28.2 С Approach Delay, s/veh / LOS 10.8 В Intersection Delay, s/veh / LOS 17.1 В **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 3.0 С 2.9 С 1.9 Α 2.4 В Bicycle LOS Score / LOS 1.7 Α 0.9 Α

HCS 2010 Interchanges Results Summary																					
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D					- EBL	J						130			32.2		С				
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HCS 2010 Interchanges Results Summary																					
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Cycle, s	_	0.0	-	51	†							1	2		3	4	4				
Offset, s	_	0	Green	29.0	19.0	17.0	0.0		0.0	0.0			1		,	<	4		=		
Uncoordina		No	Yellow		4.0	4.0	0.0		0.0	0.0		\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	4		1	_	B	55++	2		
Force Mode	· Fi	xed	Red	1.0	1.0	1.0	0.0) (0.0	0.0		5	6		7	8		141441	- 11		
Interchange Results																					
O-D			O-D	Demand	Mover	ments	3				Dei	mand (v	eh/h)	De	lay (s)			LOS			
А	WBL - WBU											300			46.5			С			
В				WE								70	26.2			В					
С				EB								0			0.0		А				
D				EBL -								150		34.7				С			
Е				NBL(INT) - EBL	J						650		28.8			В				
F				NBR(<u> </u>							360			9.7		А				
G				SBR(130			28.9			В			
Н				SBL(INT		U						70	33.1		D						
ı			NB	T(INT) -								650			4.0			А			
J				T(INT) - V								280			18.9			В			
K				WE								0			-						
L				EB	Т							0			-			-			
М				WE	SU							0			-			-			
N				EB	U							0			-						
Signalized	Intorcocti	on One	Poculto		-		EB			\/	VB			NB				SB			
Approach M		JII ONE	ive sull S		+		Т	R	L		vь T	R	L	Т	R		L	T	R		
Control Dela		2h			_	_	30.7					-11		9.7	4.8	+	5.2	18.9	11		
Level of Ser					_		C			+	_			Α	A	_).2	В			
Approach D					2	30.7		С	0	0			8.7		A	_			С		
Intersection			3		1	30.1			3.2				0.1		, v	20.6 C					
Signalized		on Two	Results		-		EB			-	VB		, '	NB				SB			
Approach M							Т	R	L	_	T	R	L	T	R	-		T	R		
Control Dela									27.6	j		26.2	19.0	4.0				28.0	28.9		
Level of Sei					_		\blacksquare		С			С	В	A		-		С	С		
Approach D			`		-	0.0 27.4						С	10.8						С		
Intersection				1	7.1			1			В										

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analyst Analysis Date 1/20/2014 Area Type Other SIOUX FALLS PHF Jurisdiction Time Period AM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 2035 AM.xus File Name **Project Description** CORRIDOR TRAFFIC ANALYSIS **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 100 900 180 Demand (v), veh/h 180 40 270 60 400 160 930 Signal Information IJ, Cycle, s 0.08 Reference Phase 2 Offset, s 8 Reference Point Begin 0.0 Green 10.0 1.0 19.0 15.0 15.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 0.0 4.0 0.0 4.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 0.0 1.0 1.0 1.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 1.1 4.0 2.0 3.0 2.0 3.0 1.1 4.0 Phase Duration, s 20.0 20.0 20.0 20.0 16.0 25.0 15.0 24.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 8.0 3.5 14.4 6.7 6.8 6.7 Green Extension Time (g_e) , s 0.2 0.3 0.0 0.2 0.2 0.0 0.1 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 0.01 0.00 1.00 0.00 0.23 0.73 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 3 18 5 2 12 1 6 8 Adjusted Flow Rate (v), veh/h 180 40 270 60 100 202 454 81 136 704 Adjusted Saturation Flow Rate (s), veh/h/ln 1681 1765 1681 1765 1570 1542 1439 1617 1542 1496 6.0 2.3 3.5 4.7 11.6 Queue Service Time (gs), s 1.5 12.4 4.7 4.8 6.2 Cycle Queue Clearance Time (g_c) , s 6.0 1.5 12.4 2.3 4.7 4.8 6.2 3.5 4.7 11.6 Green Ratio (g/C) 0.38 0.19 0.19 0.19 0.19 0.14 0.25 0.25 0.36 0.24 Capacity (c), veh/h 584 331 315 331 280 432 1156 360 425 1099 Volume-to-Capacity Ratio (X) 0.308 0.121 0.857 0.181 0.357 0.467 0.392 0.224 0.321 0.641 Available Capacity (ca), veh/h 584 331 315 331 280 432 1156 360 425 1099 Back of Queue (Q), veh/ln (50th percentile) 2.1 0.6 6.7 0.9 1.6 1.7 2.1 1.2 1.6 4.6 Queue Storage Ratio (RQ) (50th percentile) 0.27 0.00 0.85 0.00 0.27 0.22 0.00 0.16 0.21 0.00 Uniform Delay (d1), s/veh 17.6 27.0 31.5 27.3 28.3 32.1 23.0 23.1 18.4 31.7 Incremental Delay (d2), s/veh 0.1 0.1 23.1 0.1 0.3 0.2 8.0 1.2 0.1 2.1 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 17.7 27.1 54.6 27.4 28.6 32.3 23.8 24.3 18.5 33.8 Level of Service (LOS) В С D С С С С С В С 19.4 В 44.7 D 26.2 С С Approach Delay, s/veh / LOS 31.3 Intersection Delay, s/veh / LOS 31.0 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.3 С В 2.7 В Bicycle LOS Score / LOS 0.9 Α 1.2 Α 1.3 Α 1.1

HCS 2010 Signalized Intersection Results Summary 147季1767 **General Information Intersection Information** HDR Duration, h 1.00 Agency RL Analyst Analysis Date 1/20/2014 Area Type Other SIOUX FALLS PHF Jurisdiction Time Period PM PEAK 1.00 Intersection 60TH ST. N. Analysis Year 2035 **Analysis Period** 1>7:00 2035 PM.xus File Name **Project Description** CORRIDOR TRAFFIC ANALYSIS **Demand Information** EΒ **WB** NB SB Approach Movement R L R L R L R 210 80 Demand (v), veh/h 200 70 50 370 1380 220 130 830 Signal Information IJ, Cycle, s 0.08 Reference Phase 2 Offset, s 5 Reference Point Begin 0.0 Green 7.0 22.0 10.0 1.0 15.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 4.0 0.0 4.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 1.0 0.0 1.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 3 8 2 7 5 1 6 Case Number 1.1 4.0 2.0 3.0 2.0 3.0 1.1 4.0 Phase Duration, s 15.0 20.0 16.0 21.0 17.0 32.0 12.0 27.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.1 3.0 3.1 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 9.4 4.7 11.9 5.6 6.0 4.7 Green Extension Time (g_e) , s 0.0 0.2 0.0 0.2 0.2 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 1.00 1.00 1.00 0.00 1.00 0.00 0.02 1.00 Max Out Probability WB SB **Movement Group Results** EΒ NB Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 3 18 5 2 12 1 6 8 Adjusted Flow Rate (v), veh/h 200 70 210 50 80 179 666 106 79 501 1681 1765 1681 1765 1570 1542 1439 1617 1542 Adjusted Saturation Flow Rate (s), veh/h/ln 1496 7.4 2.7 9.9 4.3 2.7 7.0 Queue Service Time (gs), s 1.9 3.6 4.0 8.4 Cycle Queue Clearance Time (g_c) , s 7.4 2.7 9.9 1.9 3.6 4.0 8.4 4.3 2.7 7.0 Green Ratio (g/C) 0.31 0.19 0.14 0.20 0.20 0.15 0.34 0.34 0.36 0.28 Capacity (c), veh/h 505 331 231 353 299 471 1561 486 384 1272 Volume-to-Capacity Ratio (X) 0.396 0.212 0.909 0.142 0.267 0.379 0.427 0.219 0.204 0.394 Available Capacity (ca), veh/h 505 331 231 353 299 471 1561 486 384 1272 Back of Queue (Q), veh/ln (50th percentile) 2.7 1.1 6.9 0.7 1.2 1.4 2.7 1.4 1.0 2.4 Queue Storage Ratio (RQ) (50th percentile) 0.34 0.00 0.88 0.00 0.21 0.19 0.00 0.19 0.13 0.00 Uniform Delay (d1), s/veh 21.5 27.5 34.0 26.3 27.0 29.8 18.8 19.4 19.0 23.5 Incremental Delay (d2), s/veh 0.2 0.1 49.6 0.1 0.2 0.1 0.7 8.0 0.1 8.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 21.7 27.6 83.6 26.4 27.2 29.9 19.4 20.2 19.1 24.3 Level of Service (LOS) С С F С С С В С В С 23.2 С Ε 21.5 С 23.6 С Approach Delay, s/veh / LOS 61.9 Intersection Delay, s/veh / LOS 28.7 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS С 2.4 3.5 3.3 С В 2.7 В Bicycle LOS Score / LOS 0.9 Α 1.0 Α 1.6 Α 1.0 Α

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HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** Agency HDR Duration, h 1.00 RL Analysis Date 1/3/2014 Analyst Area Type Other PHF 1.00 Jurisdiction Minnehaha Co. Time Period AM Intersection I-90 Eastbound Analysis Year 2035 **Analysis Period** 1>7:00 timberline am 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R L R 360 480 Demand (v), veh/h 130 0 0 0 0 490 410 70 Signal Information 3 Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 5.0 27.0 0.0 Green 9.0 19.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 4.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 1.0 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 8 2 5 1 6 Case Number 8.0 8.0 2.0 4.0 2.0 4.0 Phase Duration, s 32.0 32.0 24.0 34.0 14.0 24.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.0 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 6.4 19.0 18.0 5.3 Green Extension Time (g_e) , s 0.8 0.6 0.2 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 0.00 0.34 Max Out Probability 0.04 1.00 WB NB SB **Movement Group Results** EΒ Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 14 3 8 18 5 2 1 6 Adjusted Flow Rate (v), veh/h 130 360 642 538 70 480 Adjusted Saturation Flow Rate (s), veh/h/ln 1505 1442 1597 1614 1586 1609 12.9 3.3 Queue Service Time (gs), s 0.0 16.0 10.5 10.7 Cycle Queue Clearance Time (g_c) , s 4.4 17.0 16.0 10.5 3.3 10.7 Green Ratio (g/C) 0.34 0.34 0.24 0.36 0.11 0.24 Capacity (c), veh/h 598 577 758 1170 178 764 Volume-to-Capacity Ratio (X) 0.217 0.624 0.847 0.459 0.392 0.628 Available Capacity (ca), veh/h 598 577 758 1170 178 764 Back of Queue (Q), veh/ln (50th percentile) 1.6 5.5 7.5 3.7 1.2 4.2 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.00 0.15 0.00 22.9 Uniform Delay (d1), s/veh 19.0 36.4 20.6 33.0 27.3 Incremental Delay (d2), s/veh 0.1 1.6 6.2 0.9 0.5 4.0 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 19.1 24.5 42.6 21.4 33.5 31.3 Level of Service (LOS) В С D С С С 19.1 В 24.5 С 32.9 С С Approach Delay, s/veh / LOS 31.6 Intersection Delay, s/veh / LOS 30.4 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 2.9 С 2.8 С 2.1 В 2.6 В Bicycle LOS Score / LOS 0.7 Α 1.1 Α 1.2 Α 0.9 Α

HCS 2010 Signalized Intersection Results Summary 141季1167 **General Information Intersection Information** Agency HDR Duration, h 1.00 RL Analysis Date 1/3/2014 Analyst Area Type Other PM PHF 1.00 Jurisdiction Minnehaha Co. Time Period Intersection I-90 Analysis Year 2035 **Analysis Period** 1>7:00 timberline pm 2035.xus File Name **Project Description** I-90/Timberline IMJR **Demand Information** EΒ **WB** NB SB Approach Movement L R L R L R R 300 Demand (v), veh/h 150 0 0 0 0 650 650 70 280 Signal Information Cycle, s 0.08 Reference Phase 2 Offset, s 0 Reference Point Begin 0.0 Green 9.0 10.0 17.0 24.0 0.0 Uncoordinated No Simult. Gap E/W On Yellow 4.0 4.0 4.0 0.0 4.0 0.0 Force Mode Fixed Simult. Gap N/S On Red 1.0 1.0 1.0 1.0 0.0 0.0 **Timer Results EBL EBT WBL** WBT NBL **NBT** SBL SBT **Assigned Phase** 4 8 2 5 1 6 Case Number 8.0 8.0 2.0 4.0 2.0 4.0 Phase Duration, s 29.0 29.0 29.0 37.0 14.0 22.0 Change Period, (Y+Rc), s 5.0 5.0 5.0 5.0 5.0 5.0 Max Allow Headway (MAH), s 3.0 3.0 3.0 0.0 3.0 0.0 Queue Clearance Time (gs), s 7.5 15.8 22.4 5.3 Green Extension Time (g_e) , s 0.7 0.6 0.5 0.0 0.0 0.0 Phase Call Probability 1.00 1.00 1.00 1.00 0.00 0.34 Max Out Probability 0.03 1.00 WB NB SB **Movement Group Results** EΒ Approach Movement L Т R L Т R L Т R L Т R **Assigned Movement** 7 4 14 3 8 18 5 2 1 6 Adjusted Flow Rate (v), veh/h 150 300 830 830 70 280 Adjusted Saturation Flow Rate (s), veh/h/ln 1446 1586 1593 1498 1619 1639 17.3 3.3 Queue Service Time (gs), s 0.0 8.6 20.4 6.1 Cycle Queue Clearance Time (g_c) , s 5.5 13.8 20.4 17.3 3.3 6.1 Green Ratio (g/C) 0.30 0.30 0.30 0.40 0.11 0.21 Capacity (c), veh/h 539 524 971 1311 178 677 Volume-to-Capacity Ratio (X) 0.278 0.573 0.855 0.633 0.392 0.414 Available Capacity (ca), veh/h 539 524 971 1311 178 677 Back of Queue (Q), veh/ln (50th percentile) 2.0 4.6 9.3 6.5 1.2 2.3 Queue Storage Ratio (RQ) (50th percentile) 0.00 0.00 0.00 0.00 0.15 0.00 24.2 Uniform Delay (d1), s/veh 21.5 36.8 22.3 33.0 27.2 Incremental Delay (d2), s/veh 0.1 1.0 2.7 8.0 0.5 1.9 Initial Queue Delay (d3), s/veh 0.0 0.0 0.0 0.0 0.0 0.0 Control Delay (d), s/veh 21.6 25.2 39.5 23.1 33.5 29.1 Level of Service (LOS) С С D С С С 21.6 С 25.2 С 31.3 С 30.0 С Approach Delay, s/veh / LOS Intersection Delay, s/veh / LOS 29.8 С **Multimodal Results** ΕB WB NB Pedestrian LOS Score / LOS 2.9 С 2.8 С 2.1 В 2.6 В Bicycle LOS Score / LOS 0.7 Α 1.0 Α 1.6 Α 0.8 Α

				HCS	201	10 In	terch	ang	es F	Resu	ults	Sumn	nary						
General Inf	formation											Intercha	ange In	ormatio	n				
Agency		HDR										Intercha	nge Typ	е	5	SPUI			
Analyst		RL				Analys	is Date	1/3/	2014			Segmen	t Distan	ce, ft					
Jurisdiction		Minneh	aha Co.			Durati	on,h	1.00)			Freeway	/ Directi	on	E	East-V	Vest		
Intersection	ı	I-90 Ea	stbound			PHF		1.00)			Arterial	Directio	า	1	lorth-	Sout	n	
File Name		timberli	ne am 2	035.xus															
Project Des	cription	I-90/Tin	nberline	IMJR															
Demand					Т	EBL	EBT	EB	R \	WBL	WE	BT WBF	R NBL	. NBT	NBI	₹ S	BL	SBT	SBR
Intersection	Demand (v), veh/	'n			130	0	0		360	0	0	490	410			70	480	
Signal Info	rmation						.	5_										↓↓↓	10
Cycle, s		0.0	1	K	- N	, L ,	↑ 🛱	7 27				\	1		4	→			N.
Offset, s		0	Croon	9.0	5.0	19		7.0	0.0	0.		1		2	3	4	÷		> -
Uncoordina	ted N	No.	Green Yellow	-	4.0	4.0			0.0	0.		~				>	14		2
Force Mode	e Fi	xed	Red	1.0	1.0	1.0			0.0	0.		5		6	7	8		1111	-10
Interchange	e Results																		
O-D			O-D	Deman	d Mo	vemer	nts				1	Demand	(veh/h)	De	lay (s)			LOS	
А				V	/BL							36)		0.0			Α	
В				W	'BR							0			0.0			Α	
С				Е	BR							0			0.0			Α	
D				Е	BL							130)		0.0			Α	
E				N	BL							64:	2	4	42.6			С	
F				N	BR							0			0.0			Α	
G				S	BR							0			0.0			Α	
Н				S	BL							70		;	33.5			С	
I				N	вт							53	3		21.4			В	
J				S	вт							48)	;	31.3			С	
K				W	/BT							0			-			-	
L				E	вт							0			-			-	
M												0			-			-	
N												0			-			-	
Signalized	Intersection	on Resu	lts				EB		T		WB			NB				SB	
Approach M						L	Т	R		L	Т	R	L	Т	R	L	- T	Т	R
Control Dela		eh					19.1				24.5		42.6	21.4		33	3.5	31.3	
Level of Ser							В				С		D	С			2	С	
Approach D						19.1		В		24.5	-	С	32.		С	_	31.6	T '	С
Intersection	Delay, s/ve	eh / LOS							30.4							С			

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				HCS	201	10 Ir	nterch	ang	es	Re	sult	s S	Summa	ary						
General Inf	formation	1										_	nterchan							
Agency		HDR											nterchan				SPUI			
Analyst		RL			_		sis Date	_		14		_	egment							
Jurisdiction		+	aha Co.			Durat	ion,h	1.00					reeway I			_	East-			
Intersection	1	I-90				PHF		1.00	0			A	rterial Di	irection	<u> </u>	1	North	-Sout	h	
File Name			ine pm 2		<u> </u>															
Project Des	scription	I-90/Tin	nberline	IMJR	_		-	_			_	-	-	-	-	_	-	-	-	
Demand						EBL	EBT	E	3R	WB	BL V	VBT	WBR	NBL	NBT	NB	R	SBL	SBT	SBR
Intersection	Demand (v), veh/	⁄h			150	0	()	30	0	0	0	650	650			70	280	
Signal Info	rmation							ķ											JAMES II.	-14
Cycle, s		0.0	1	K	8	, [` , 📙	a ⊊	1					Î		_4	4			N. N.
Offset, s		0	Green	9.0	10.0			4.0	0.0	_	0.0		1	- 1 :	2	3	4	÷		*
Uncoordina	ted 1	No	Yellow		4.0	4.		.0	0.		0.0	-1	~	1		•	\rightarrow	8		V.
Force Mode	e Fi	xed	Red	1.0	1.0	1.		.0	0.		0.0		5	•	6	7	8		1111	310
Interchange	e Results																			
O-D			O-D	Deman	d Mo	veme	nts					De	emand (v	/eh/h)	De	lay (s)		LOS	
А				V	/BL								300			0.0			Α	
В				W	/BR								0			0.0			А	
С				Е	BR								0			0.0			А	
D				Е	BL								150			0.0			Α	
E				N	IBL								830		(39.5			С	
F				N	IBR								0			0.0			Α	
G				S	BR								0			0.0			А	
Н				S	BL								70		(33.5			С	
I				N	IBT								830			23.1			В	
J				S	вт								280			29.1			В	
K				V	/BT								0			-			-	
L				E	ВТ								0			-			-	
M													0			-			-	
N													0			-			-	
Signalized	Intersection	on Resu	Its				EB				V	/B			NB				SB	
Approach M						L	Т	R	7	L	1	Г	R	L	Т	R		L	Т	R
Control Dela	ay (<i>d</i>) , s/ve	eh					21.6		T		25	5.2		39.5	23.1		3	3.5	29.1	
Level of Sei	rvice (LOS))					С		7			2		D	С			С	С	
Approach D	Delay, s/veh	/LOS				21.	6	С		25	.2		С	31.3	3	С		30.0		С
Intersection	Delay, s/v	eh / LOS	3						29	.8							С			

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Appendix Part 5—Crash Forecasts

I-90/Timberline Road Interchange



Interchange Safety Analysis Tool

General Output Data

General Interchange Information

Project description:	STD. DIAMOND			
Analyst:	HDR			
Date:	9/4/2012			
Area type:	Rural			
Beginning year of analysis period: 2012	2012			
Ending year of analysis period:	2035			
	veweent ealaieM		Crossroad ramp	Crossroad
	iviali illi o il eeway	Ramne	terminals and	Clossicad
	segments		intersections	segments
Crash data available:	>	>	7	\
Beginning year of crash data:	2007	2007	2007	2007
Ending year of crash data:	2009	2009	2009	2009

Number of Predicted Crashes for Entire Interchange Area

Number of predic	umber of predicted crashes during analysis period	g analysis period	Average numb	Average number of predicted crashes per year	ashes per year
			d dr	during analysis period	po
Total	Ī	PDO	Total	Ы	PDO
894.6	249.3	645.2	37.3	10.4	56.9

Number of Predicted Crashes by Interchange Element Type

		Number of predic	of predicted crashes during analysis period	g analysis period			Crash rate
Interchange element type	Number of sites	Total	H	PDO	MVMT	MEV	(per MVMT or MEV)
Mainline freeway segments	10	827.3	232.9	594.3	1,101.840		0.751
Ramps	4	6.1	1.1	2.0	7.398		0.826
Crossroad ramp terminals & ints	2	4.9	2.2	2.7		20.590	0.237
Crossroad segments	9	26.3	13.1	43.2	9.300		6.054
Total	22	894.6	249.3	645.2	1,118.538		0.800

Number of Predicted Crashes by Year

	Total	2012	2013	2014	2015	2016	2017	2018	2019
Total Crashes	894.6	41.2	41.6	42.0	42.3	42.7	43.0	43.4	43.8
FI Crashes	249.3	11.4	11.5	11.6	11.7	11.9	12.0	12.1	12.2
PDO Crashes	645.2	29.8	30.1	8.08	9.08	30.8	31.1	31.3	31.6

2021 44.5 12.4 32.1

2020 44.1 12.3 31.8

Number of Predicted Crashes by Collision Type

		Namber and	Jeiceillage of pret	Number and percentage of predicted crashes by comision type	COMPONITE LYPE	
	Total	al	H		OQd	00
Collision type	No.	%	No.	%	No.	%
All collision types	894.6	100.0%	249.3	100.0%	645.2	100.0%
Single vehicle	631.6	%9:02	174.5	20.0%	457.1	20.8%
Fixed object	187.8	21.0%	52.3	21.0%	135.6	21.0%
Animal	145.0	16.2%	38.9	15.6%	106.1	16.4%
Pedestrian	0.7	0.1%	0.2	0.1%	0.5	0.1%
Bicyclist	0.0	%0.0	0.0	%0.0	0.0	%0.0
Parked car	9.7	%8.0	2.1	0.8%	5.5	%6.0
Noncollision	199.8	22.3%	55.3	22.2%	144.5	22.4%
Other single-vehicle	2.06	10.1%	25.7	10.3%	0.59	10.1%
Multiple vehicle	263.0	29.4%	74.9	30.0%	188.1	29.5%
Rear-end	131.0	14.6%	37.1	14.9%	94.0	14.6%
Head-on	6.2	%2'0	1.7	%2'0	4.5	%2'0
Angle	15.6	1.7%	4.7	1.9%	10.8	1.7%
Sideswipe, same direction	9.69	%2'9	17.0	%8'9	42.6	%9.9

Sideswipe, opposite direction	4.8	0.5%	1.3	0.5%	3.5	0.5%
Other multiple-vehicle	45.7	5.1%	13.0	5.2%	32.7	5.1%

2034	11.7	30.2	645.2
2033	11.5	30.0	250.2
2032	11.4	29.7	895.4
2031	48.5	13.6	34.8
2030	48.0	13.5	34.5
2029	47.6	13.4	34.3
2028	47.2	13.3	34.0
2027	46.8	13.1	33.7
2026	46.4	13.0	33.4
2025	46.0	12.9	33.2
2024	45.7	12.8	32.9
2023	45.3	12.7	32.6
2022	44.9	12.5	32.4
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Interchange Safety Analysis Tool

General Output Data

General Interchange Information

Project description:	TIGHT DIAMOND			
Analyst:	HDR			
Date:	9/4/2012			
Area type:	Rural			
Beginning year of analysis period: 2012	2012			
Ending year of analysis period:	2035			
	Majaliao frontina		Crossroad ramp	Crosson
	Mail illine il eeway	Ramps	terminals and	Clussidad
	Segments		intersections	Segments
Crash data available:	Υ	>	Ь	Υ
Beginning year of crash data:	2007	2007	2007	2007
Ending year of crash data:	2009	2009	2009	2009

Number of Predicted Crashes for Entire Interchange Area

Number of predic	umber of predicted crashes during analysis period	g analysis period	Average numb	number of predicted crashes per year	ashes per year
Total	Ē	PDO	Total	FI	PDO
848.0	234.5	613.5	35.3	9.8	25.6

Number of Predicted Crashes by Interchange Element Type

		Number of predic	of predicted crashes during analysis period	l analysis period			Crash rate
Interchange element type	Number of sites	Total	FI	PDO	MVMT	MEV	(per MVMT or MEV)
Mainline freeway segments	10	780.7	218.0	562.7	978.600		0.798
Ramps	4	5.3	1.0	4.2	5.773		0.911
Crossroad ramp terminals & ints	2	4.9	2.2	2.7		20.590	0.237
Crossroad segments	9	57.2	13.3	44.0	9.350		6.120
Total	22	848.0	234.5	613.5	993.723		0.853

Number of Predicted Crashes by Year

	Total	2012	2013	2014	2015	2016	2017	2018	2019
Total Crashes	848.0	39.2	39.5	39.8	40.1	40.5	40.8	41.2	41.5
FI Crashes	234.5	10.7	10.8	10.9	11.0	11.2	11.3	11.4	11.5
PDO Crashes	613.5	28.4	28.6	28.9	29.1	29.3	29.6	29.8	30.0

2021 42.2 11.7 30.5

2020 41.9 11.6 30.3

Number of Predicted Crashes by Collision Type

		Number and	percernage or pre	Number and percentage of predicted clashes by collision type	collision type	
	Total	tal		FI	OQd	0
Collision type	No.	%	No.	%	No.	%
All collision types	848.0	100.0%	234.5	100.0%	613.5	100.0%
Single vehicle	613.1	72.3%	168.2	71.7%	444.9	72.5%
Fixed object	173.1	20.4%	47.7	20.3%	125.4	20.4%
Animal	149.7	17.7%	40.2	17.1%	109.6	17.9%
Pedestrian	0.7	0.1%	0.2	0.1%	0.5	0.1%
Bicyclist	0.0	%0.0	0.0	%0:0	0.0	%0.0
Parked car	7.9	%6:0	2.2	%6:0	8.3	%6.0
Noncollision	199.8	23.6%	55.1	23.5%	144.7	23.6%
Other single-vehicle	81.9	%2'6	23.0	%8'6	6.83	%9.6
Multiple vehicle	234.9	27.7%	66.3	28.3%	168.7	27.5%
Rear-end	117.4	13.8%	32.9	14.0%	84.5	13.8%
Head-on	6.9	0.7%	1.6	%2'0	4.3	%2'0
Angle	14.4	1.7%	4.4	1.9%	10.0	1.6%
Sideswipe, same direction	52.6	6.2%	14.9	6.3%	37.7	6.2%

Sideswipe, opposite direction	4.7	%9.0	1.2	0.5%	3.4	%9:0
Other multiple-vehicle	39.9	4.7%	11.2	4.8%	28.6	4.7%

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2034	11.0	28.7	613.5
2033	10.9	28.5	235.5
2032	10.8	28.3	849.0
2031	45.9	12.8	33.1
2030	45.5	12.7	32.8
2029	45.1	12.6	32.5
2028	44.7	12.5	32.3
2027	44.4	12.4	32.0
2026	44.0	12.2	31.8
2025	43.6	12.1	31.5
2024	43.3	12.0	31.3
2023	42.9	11.9	31.0
2022	42.6	11.8	30.8
	_		

Interchange Safety Analysis Tool

General Output Data

General Interchange Information

Project description:	SINGLE POINT			
Analyst:	HDR			
Date:	9/4/2012			
Area type:	Rural			
Beginning year of analysis period: 2012	2012			
Ending year of analysis period:	2035			
	Majalian from		Crossroad ramp	Crosson
	Mallille Heeway	Ramne	terminals and	Clossidad
	seaments	raiibs	tellilliais alla	segments
	369116116		intersections	3691161163
Crash data available:	Ь	>	Τ	\
Beginning year of crash data:	2007	2007	2002	2007
Ending year of crash data:	2009	2009	6007	2009

Number of Predicted Crashes for Entire Interchange Area

Number of predic	f predicted crashes during analysis period	g analysis period	Average numb	Average number of predicted crashes per year	ashes per year
			dı	during analysis period	po
Total	FI	OQA	Total	Ы	PDO
844.6	233.3	611.4	35.2	2.6	25.5

Number of Predicted Crashes by Interchange Element Type

		Number of predic	of predicted crashes during analysis period	l analysis period			Crash rate
Interchange element type	Number of sites	Total	FI	PDO	MVMT	MEV	(per MVMT or MEV)
Mainline freeway segments	10	775.1	216.3	558.8	957.525		0.810
Ramps	4	5.5	1.1	4.5	6.296		0.880
Crossroad ramp terminals & ints	2	4.9	2.2	2.7		20.590	0.237
Crossroad segments	9	59.1	13.7	45.4	9.785		6.037
Total	22	844.6	233.3	611.4	973.605		898'0

Number of Predicted Crashes by Year

	Olai	2012	2013	4107	2013	2010	7107	2010	8102	
Total Crashes	844.6	39.0	39.3	236.7	40.0	40.3	40.7	41.0	41.3	
FI Crashes	233.3	10.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	
PDO Crashes	611.4	28.3	28.5	28.8	29.0	29.2	29.5	29.7	29.9	

2021 42.0 11.6 30.4

2020 41.7 11.5 30.2

Number of Predicted Crashes by Collision Type

		Number and	percentage or prec	Number and percentage of predicted crasnes by collision type	collision type	
	Total	al	H		PDO	0
Collision type	No.	%	No.	%	No.	%
All collision types	844.6	100.0%	233.3	100.0%	611.4	100.0%
Single vehicle	611.4	72.4%	167.6	71.8%	443.9	72.6%
Fixed object	172.5	20.4%	47.4	20.3%	125.1	20.5%
Animal	150.1	17.8%	40.2	17.2%	109.9	18.0%
Pedestrian	0.7	0.1%	0.2	0.1%	0.5	0.1%
Bicyclist	0.0	%0.0	0.0	%0.0	0.0	%0.0
Parked car	6.7	%6:0	2.2	%6.0	2.7	%6:0
Noncollision	199.0	23.6%	54.8	23.5%	144.2	23.6%
Other single-vehicle	81.2	%9.6	22.8	8.6	58.4	%9.6
Multiple vehicle	233.2	27.6%	2.59	28.2%	167.5	27.4%
Rear-end	116.5	13.8%	32.6	14.0%	83.9	13.7%
Head-on	0.9	0.7%	1.6	0.7%	4.3	%2'0
Angle	14.3	1.7%	4.4	1.9%	10.0	1.6%
Sideswipe, same direction	52.1	6.2%	14.7	6.3%	37.4	6.1%

Sideswipe, opposite direction	4.7	%9:0	1.3	0.5%	3.5	%9.0
Other multiple-vehicle	39.5	4.7%	11.1	4.8%	28.4	4.6%

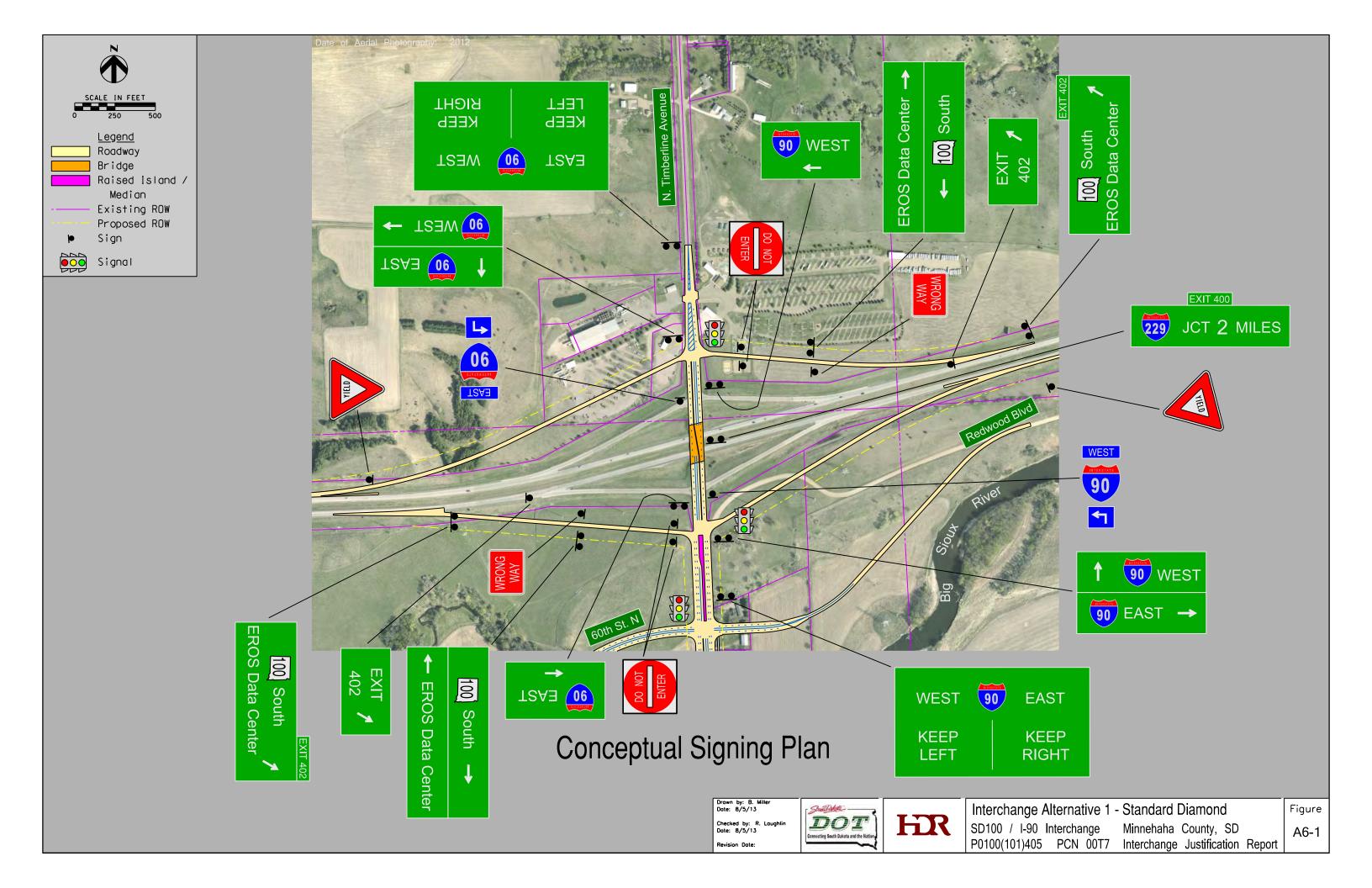
	2034	10.9	28.7	611.4
	2033	10.8	28.5	233.9
	2032	10.7	28.2	845.3
	2031	45.7	12.8	32.9
	2030	45.3	12.6	32.7
	2029	44.9	12.5	32.4
	2028	44.6	12.4	32.2
	2027	44.2	12.3	31.9
	2026	43.8	12.2	31.7
	2025	43.5	12.1	31.4
	2024	43.1	12.0	31.2
	2023	42.7	11.8	30.9
	2022	42.4	11.7	30.7
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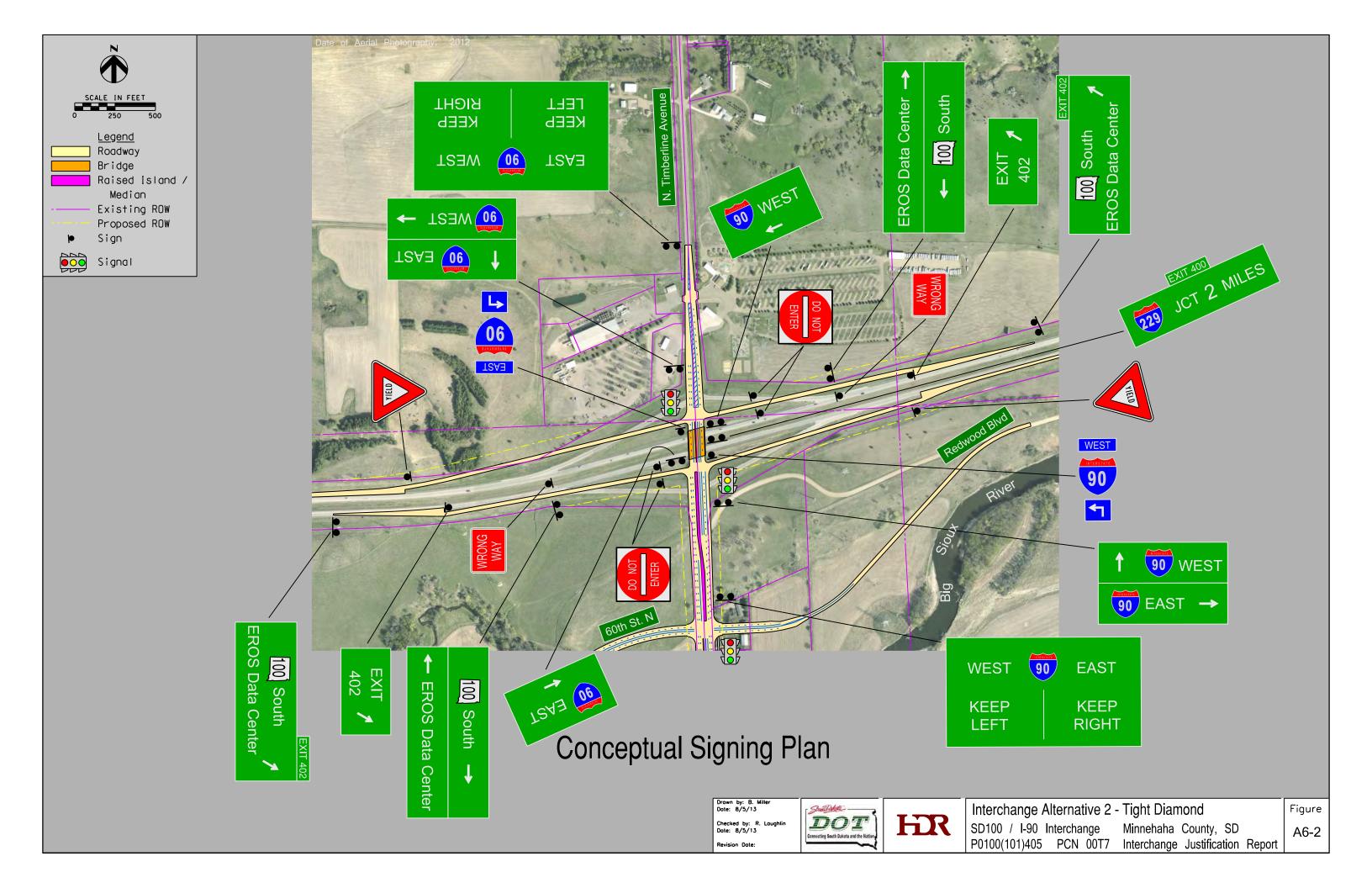
Appendix Part 6—Signing Plans

I-90/Timberline Road Interchange









Appendix Part 7— Interchange Area Air Photos

I-90/Timberline Road Interchange







