



South Dakota

I-90 EXIT 406

SD11/SPLITROCK BOULEVARD INTERCHANGE MODIFICATION JUSTIFICATION REPORT

I-90 Exit 406 Interchange Modification Justification Report for Interstate 90 Exit 406 (SD11/Splitrock Boulevard) Interchange

Brandon, South Dakota

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Prepared for:



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Executive Summary

The South Dakota Department of Transportation (SDDOT) initiated a study of the I-90 Exit 406 Interchange and SD11/Splitrock Boulevard corridor in order to develop and evaluate potential improvements within the study area. As part of the study, this Interchange Modification Justification Report (IMJR) was developed to provide a technical evaluation of the operational feasibility of the proposed improvements. This document also determines whether the proposed I-90 Exit 406 Interchange and SD11/Splitrock Boulevard corridor improvements satisfy requirements established by the Federal Highway Administration's (FHWA) policy concerning additional or revised access to the Eisenhower Interstate Highway System.

This IMJR document was developed using the methodology and approach outlined in Figure 3 of Section 3.5 of the *Interstate System Access Information Guide*. This IMJR was developed concurrently with the Environmental Assessment (EA) process.

Based on the analysis contained herein, the IMJR-recommended alternative that best meets the established transportation needs within the study area is as follows:

- Interchange Build Alternative 11-5: Diverging Diamond Interchange (DDI).
- Corridor Build Alternative A: SD11/Splitrock Boulevard – 5-Lane Undivided (south of I-90).
- Corridor Build Alternative F: SD11/Splitrock Boulevard – 3-Lane Undivided (north of I-90).

This modification request is to modify the existing I-90 Exit 406 Interchange. No additional access to the Interstate system is being requested.

The technical analysis contained herein demonstrates that the eight policy requirements for new or revised access points to the existing Interstate system, published in the Federal Register Volume 74 Number 165, August 27, 2009, have been met. The following summarizes responses provided in more detail in Chapter 10 Recommendations.

Policy Statement #1

Through a compilation of previous studies and findings as part of this study, four overarching needs have been established as the basis for the proposed improvements:

- Geometric deficiencies.
- Transportation demand.
- Access.
- Safety.

Three of the primary causal factors of these needs are: A) geometric deficiencies, B) the interchange was not designed to handle current and forecasted travel demand, and C) the existing bridge prohibits expansion of SD11/Splitrock Boulevard through the interchange.

It can be concluded that the I-90 Exit 406 interchange needs cannot be adequately satisfied by existing interchanges to I-90 and the local street network can neither provide the desired access, nor can they be reasonably improved to satisfactorily accommodate the Design Year traffic demands. A comprehensive approach to interchange improvement is needed to address the four overarching needs, which establishes the basis for an interchange reconstruction Build condition to address these needs instead of maintaining a No-Build condition. The proposed DDI improvements, represented by DDI Build Alternative 11-5, address these needs and satisfactorily accommodate the Design Year traffic demands.

Policy Statement #2

The recommended improvements as part of this IMJR incorporate changes in geometric design of the existing I-90 Exit 406 Standard Diamond interchange to address the established needs. The development and screening process of proposed alternatives involved the following:

- A. Development of interchange and corridor concepts.
- B. Screening of interchange and corridor concepts.
- C. Refinement of concepts carried forward as Build Alternatives.
 - a. Development of Build Alternative sub-alternatives.
 - b. Identification of transportation system management alternatives.
 - c. Identification of improvements to alternate interchanges.
- D. Screening of Build Alternatives to select a single interchange and corridor type.
- E. Build-out of selected interchange Build Alternative type (DDI) to meet long-term design and operations goals that align with the bridge design life.
- F. Screening of Build Alternative to select IMJR-recommended interchange configuration.

The recommended Build Alternative in this IMJR is the DDI Build Alternative 11-5, based on the following key differentiators when compared to the other DDI build-out configurations:

- Provides the best cross-sectional continuity with SD11/Splitrock Boulevard north and south of interchange.
 - Build Alternative 11-5 is the only Build Alternative that extends two continuous through lanes through both crossover intersections.
- Because of the cross-sectional continuity through the interchange, Build Alternative 11-5 also provides the best flexibility in meeting traffic growth and changes to traffic patterns within the bridge design life.
- Provides a signal-controlled pedestrian crossing across the high demand eastbound I-90 off-ramp right-turn lanes.
- Best minimizes vehicle-bicycle conflicts south of the southern crossover intersection.
- Best addresses weave movement conflicts between the eastbound I-90 right-turning traffic and southbound through traffic, between southern crossover intersection and Ash Street.
- While Build Alternative 11-5 does not provide the traffic operational benefits of a free right-turn for the high-volume eastbound off-ramp to southbound SD11/Splitrock Boulevard movement, it manages operations acceptably in terms of both delay and queue length.
- 11-5 allows for the two business accesses on SD11/Splitrock Boulevard to remain as right-in/right-out accesses.

Policy Statement #3

The traffic operations analysis of the study area freeway segments demonstrated that the proposed improvements do not have an adverse impact to the safety and operation of I-90 through the study area. The proposed modifications are expected to improve I-90 operations through a design that is consistent with current design standards and meet future traffic projections. Modifications to the two ramp terminals, in particular, are expected to improve intersection operations and safety and reduce the risk of queue spillback onto I-90 mainline that has been observed in current operations.

While no changes in access are proposed at SD11/Splitrock Boulevard intersections with public streets, consolidation and removal to private access is proposed at select private access locations to improve SD11/Splitrock Boulevard safety and operations. Properties impacted by proposed access modifications between I-90 and Ash Street are accommodated through new access via Express Avenue.

A conceptual signing plan for the IMJR-recommended DDI Build Alternative 11-5 is provided in Figure 32.

Policy Statement #4

The proposed interchange modifications at I-90 Exit 406 will provide for all traffic movements through a DDI configuration. The proposed modifications will meet or exceed current design standards.

Policy Statement #5

A need for interchange improvements was originally identified in the 2010 Decennial Interstate Corridor Study, which is a tool used by the SDDOT to assess and plan for improvements throughout the statewide Interstate network. Interchange improvements have been identified and incorporated into the Go Sioux Falls 2040 LRTP, which is prepared as part the Sioux Falls MPO planning process.

Many of the traffic-related considerations that drove design decisions were based on regional traffic demand and surrounding land use. This included the propensity for directional commuter traffic from Brandon to Sioux Falls in the morning and back to Brandon in the evening. High truck demand, particularly those longer than a common semi-truck (WB-67), originates both north and south of I-90 throughout the day and relies on the I-90 interchange for regional connectivity. Locally, SD11/Splitrock Boulevard offers the only crossing of I-90 within the City of Brandon. The next adjacent crossing is two miles to the east along 484th Avenue.

The proposed interchange improvements have been identified in the 2022-2025 Developmental STIP as PCN 4433. SD11/Splitrock Boulevard corridor improvements, outside of the control of access limits, associated with this project are identified as PCN 062V within the same 2022-2025 Developmental STIP.

Policy Statement #6

The 2010 Decennial Interstate Corridor Study does not indicate a need for any future additional interchanges along I-90 between Exit 402 and Exit 410. Improvements are planned to the I-90 Exit 402 Interchange to improve capacity and connectivity with the new Veterans Parkway.

Policy Statement #7

The proposed interchange improvements were developed based on the overarching needs established for this project, which include current geometric deficiencies, transportation demand, access, and safety. Several of these needs were identified in the 2010 Decennial Interstate Corridor Study, which has been the impetus for development of this IMJR document.

One of the needs established for this project is future-year traffic demand. Both the Sioux Falls metropolitan area and City of Brandon have experienced notable growth within the last decade. It is expected that this area will continue substantial, sustained growth and drives the importance for coordinated long-range planning of transportation improvements between the jurisdictions.

Specific to modifications at I-90 Exit 406, further planning efforts have identified proposed improvement projects within the 2010 Decennial Interstate Corridor Study, the Go Sioux Falls 2040 LRTP, and the 2022-2025 Developmental STIP.

The overarching study that developed this IMJR and the companion EA document verified already established needs and identified additional needs within the study area. A Study Advisory Team made up of FHWA, SDDOT, Sioux Falls MPO, and City of Brandon representatives helped guide the development and screening of interchange and corridor alternatives.

Policy Statement #8

The proposed improvements/alternatives will be included and evaluated in the EA. The EA document will be the basis for approval of the selected alternative.

1. Introduction

The South Dakota Department of Transportation (SDDOT) initiated a study of the I-90 Exit 406 Interchange and SD11/Splitrock Boulevard corridor in order to develop and evaluate potential improvements within the study area. As part of the study, this Interchange Modification Justification Report (IMJR) was developed to help determine if the proposed interchange improvements satisfy requirements established by the Federal Highway Administration's (FHWA) policy concerning additional or revised access to the Eisenhower Interstate Highway System. This IMJR was developed concurrently with the Environmental Assessment (EA) process.

This document was developed on behalf of the SDDOT, for submittal to FHWA as a request to modify Interstate access at the I-90 Exit 406 Interchange.

1.1. Background

Future improvement needs were identified for the I-90 Exit 406 Interchange as early as the 2000 Decennial Interstate Corridor Study. While the 2000 Decennial Interstate Corridor Study did not indicate 20-year traffic needs, it noted future geometric improvements such as widening the bridge to match cross-sections to the north and south of I-90. The study developed Standard Diamond and Partial Cloverleaf interchange concepts to address the identified needs.

In the 2010 Decennial Interstate Corridor Study, traffic demand and congestion needs were noted in the future-year analysis along with the aforementioned existing geometric concerns. The study developed two interchange concepts, a Standard Diamond and Single Point Urban Interchange, and evaluated through a high-level conceptual design assessment.

Since completion of the 2010 Decennial Interstate Corridor Study, the Sioux Falls Metropolitan Planning Organization (Sioux Falls MPO) updated their 2045 Travel Demand Model (Sioux Falls 2045 TDM) that included updated growth projects and future projects notably affecting traffic patterns. The revised traffic demand around the I-90 Exit 406 area was significant enough that the initial recommendations from the 2010 Decennial Interstate Corridor Study would not meet the forecasted demand in the 2040 Design Year. Therefore, the SDDOT desired an evaluation of additional interchange alternatives and the I-90 Exit 406 IMJR and EA project was initiated. Interchange improvements at I-90 Exit 406 have been identified in the Go Sioux Falls 2040 Long Range Transportation Plan¹ (Go Sioux Falls 2040 LRTP) between the 2021 and 2025 timeframe.

1.2. Purpose

The I-90 Exit 406 Interchange was constructed in 1960. While the SD11/Splitrock Boulevard bridge crossing I-90 is not considered structurally deficient at this time, the bridge has been determined by the SDDOT Office of Bridge Design to be nearing the end of its service life and replacement of the bridge is being pursued before any major rehabilitation work is necessary.

¹ *Go Sioux Falls 2040 Long-Range Transportation Plan*, Sioux Falls Metropolitan Planning Organization, November 2015.

The purpose of this project is to reconstruct the I-90 Exit 406 Interchange to meet current design standards, improve safety, and increase the efficiency of the transportation system along the I-90 and SD11/Splitrock Boulevard corridors. The interchange improvements contained herein will also address a priority improvement project identified by the 2010 Decennial Interstate Corridor Study.

1.3. Project Location

The existing I-90 Exit 406 Diamond Interchange is located along the northern edge of the City of Brandon in Minnehaha County, South Dakota. The interchange is approximately nine miles northeast of downtown Sioux Falls and serves as an important regional transportation gateway for the Brandon area. While the Brandon corporate limits only encapsulate the SD11/Splitrock Boulevard corridor south of I-90, the entire study is within their growth area, and the corporate limits do extend in the industrial area north of I-90. The entire IMJR study area, shown in Figure 1, is within the Sioux Falls MPO planning boundary and encompasses the following limits:

- I-90 corridor:
 - From: The western merge/diverge segment of the I-90 Exit 402 Interchange located four miles to the west of the I-90 Exit 406 Interchange.
 - To: The eastern merge/diverge segment of the I-90 Exit 410 Interchange located four miles to the east of the I-90 Exit 406 Interchange.
 - Includes ramp terminal intersections at both Exit 402 (Timberline Road/478th Avenue) and Exit 410 (486th Avenue).
- SD11/Splitrock Boulevard corridor:
 - From: The Redwood Boulevard intersection, approximately 0.45 miles south of I-90.
 - To: The Hemlock Boulevard intersection, approximately 0.55 miles north of I-90.
- Timberline Road/478th Avenue includes both I-90 Exit 402 ramp terminal intersections.
- 486th Avenue includes both I-90 Exit 410 ramp terminal intersections.

Within the IMJR study area, the following SD11/Splitrock Boulevard corridor intersections were analyzed as part of this study (existing traffic control):

- Redwood Boulevard (signalized intersection).
- Birch Street (west) (stop-controlled from minor street approach).
- Birch Street (east) (stop-controlled from minor street approach).
- Ash Street (stop-controlled from minor street approach).
- Eastbound I-90 ramp terminal intersection (stop-controlled from off-ramp approach).
- Westbound I-90 ramp terminal intersection (stop-controlled from off-ramp approach).
- Hemlock Boulevard (stop-controlled from minor street approach).

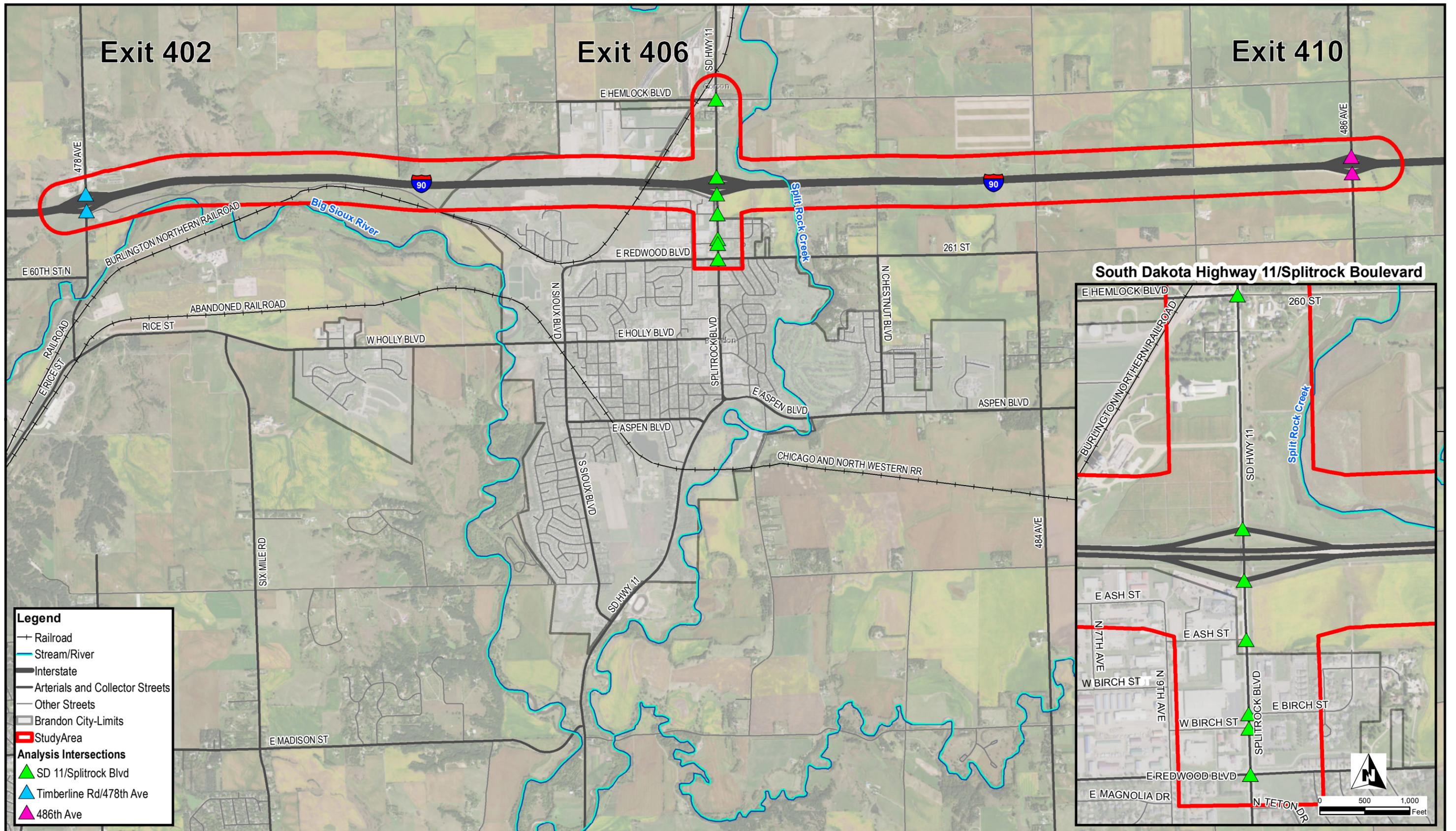
The following projects are currently under construction or are planned for construction within the study area:

- Reconstruction of eastbound and westbound I-90 Split Rock Creek bridges (PCN 021X):
 - Construction began in 2017.

- Eastbound bridge includes wider bridge deck to accommodate acceleration lane/taper.
- Concepts and Build Alternatives developed for this study incorporated the new bridges.
- I-90 mainline preservation and asphaltic concrete overlay (PCN 04DD):
 - Construction began in 2017.
- Reconstruction of I-90 Exit 402 Interchange:
 - Letting in 2017 (2018-2021 Statewide Transportation Improvement Program (STIP)²).
 - 2014 IMJR identified a Single Point Urban Interchange as the preferred alternative, connecting Veterans Parkway and I-90.
 - Single Point Urban Interchange configuration was incorporated in all future-year Build and No-Build analyses within this study.
- ADA Curb Ramp Upgrades, SD11 through Brandon (PCN 04PE)
 - Identified for 2019 fiscal year (2018-2021 STIP)
- Reconstruction of eastbound and westbound I-90 bridges over BNSF railroad tracks (PCN 4433):
 - Identified in Statewide Developmental Program 2022-2025 (2018-2021 STIP)
 - Bridge width needs identified from this project will be incorporated into future bridge design.

The existing I-90 Exit 406 Interchange is a diamond-type interchange configuration as shown in Figure 2. The proposed improvements would reconstruct this interchange to a Diverging Diamond Interchange (DDI) configuration to meet current design standards, improve safety, and increase the efficiency of the transportation system along the I-90 Interstate and SD11/Splitrock Boulevard corridors.

² South Dakota Department of Transportation 2018-2021 Statewide Transportation Improvement Program (STIP).



IMJR Study Area and Analysis Intersections

I-90 Exit 406 Interchange Modification Study
Brandon, South Dakota



NOV 2017

FIGURE 1



Existing I-90 Exit 406 Interchange
 I-90 Exit 406 Interchange Modification Study
 Brandon, South Dakota



JUL 2017

FIGURE 2

2. Methodology

This IMJR document was developed using the methodology and approach outlined in the *Interstate System Access Information Guide*³, following the outline presented in Figure 3 of Section 3.5. The general IMJR study process entailed:

1. Establishment of project Methods and Assumptions document.
2. Collection of current data.
3. Identification and evaluation of existing and future needs within the study area.
4. Development of interchange and arterial corridor concepts to address established needs.
5. High-level analysis and screening of initial concepts.
6. Refinement of concepts carried forward to establish study interchange and corridor Build Alternatives.
7. Analysis and screening of Build Alternatives.
8. Development of IMJR and EA documents.
9. Identification of a Preferred Alternative.

The IMJR document is prepared in conjunction with the development of the EA document. The EA document establishes the overall project purpose and need and provides the overarching discussion and evaluation of alternatives, environmental resources, and impacts of the proposed action with appropriate mitigation measures. The IMJR provides technical evaluation support of the alternatives to the EA document and is the SDDOT’s formal request for modifying access to the Interstate system.

3. Existing Conditions

3.1. Demographics

The Sioux Falls Metropolitan Statistical Area, which includes Brandon, has seen quick, yet steady growth over the last several decades illustrated in Table 1. The City of Brandon has seen growth at an even quicker rate, expecting to cross the 10,000-population mark before the proposed interchange improvements are constructed. Population growth in both the Sioux Falls Metropolitan Statistical Area (37 percent) and the City of Brandon (74 percent) has outpaced the statewide growth rate (15 percent) between 2000 and 2016.

Table 1: Population History

	2000	2010	2016 (estimate)	2000-2016 Percent Increase
Sioux Falls Statistical Area	187,093	228,261	255,729	37%
City of Brandon	5,693	8,785	9,923	74%
South Dakota	754,844	814,180	865,454	15%

United States Census Bureau (<https://www.census.gov/>).

³ *Interstate System Access Informational Guide*. August 2010. U.S. Department of Transportation, Federal Highway Administration, and Office of Infrastructure.

Employment within the statistical area has grown along with the population. Unemployment rates within the Sioux Falls metropolitan area and the State of South Dakota were 2.5 percent and 2.9 percent, respectively, in May 2017⁴.

Traffic analysis zones (TAZ) within the study area were extracted from the Sioux Falls 2045 TDM, shown in Figure 3. Model year 2013 and 2045 household, retail job, and total job estimates are shown within the respective TAZ. Future-year household estimates in the Sioux Falls 2045 TDM are projected to stay relatively stable within the study area. The number of jobs is expected to increase annually by approximately 1.0 percent throughout the study area. The most notable job growth is north of I-90 in the industrial area.

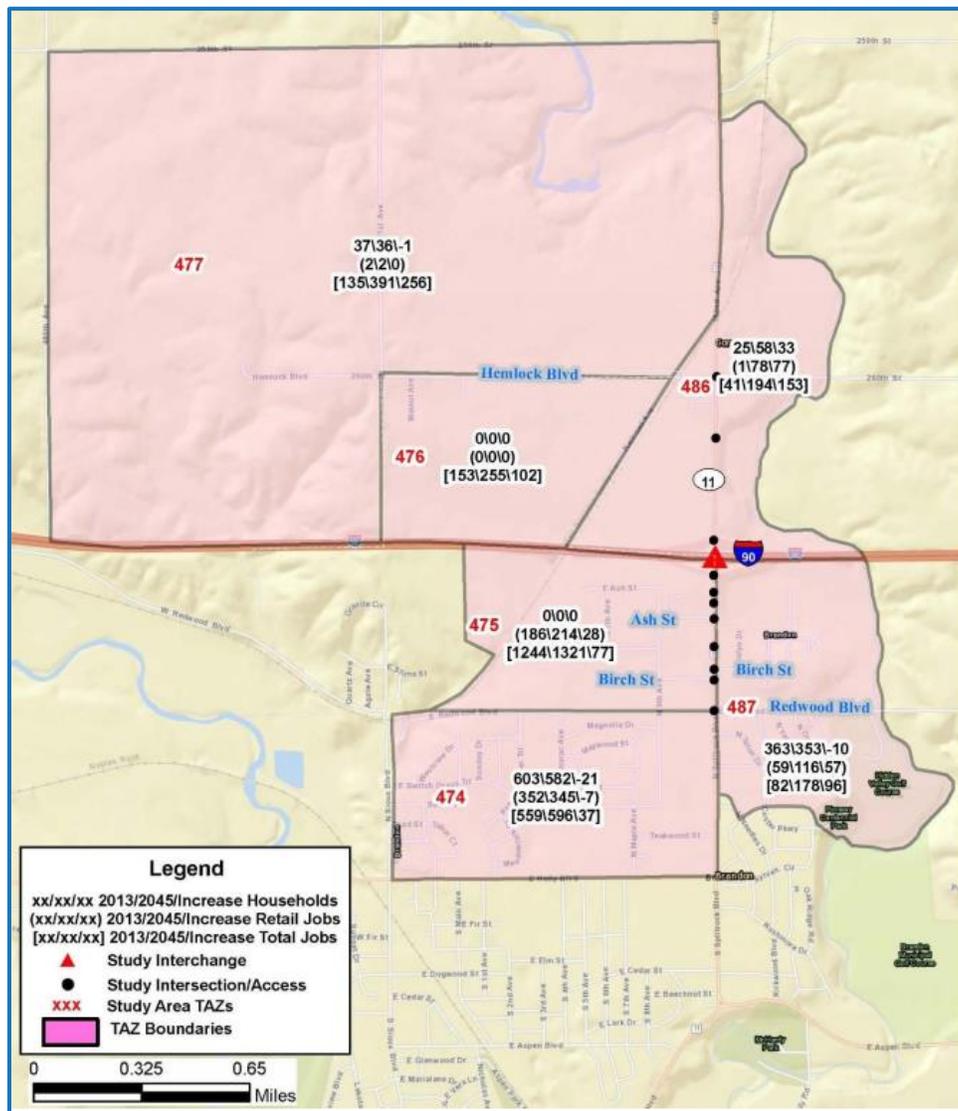


Figure 3: Study Area Traffic Analysis Zones and Land Use Data

⁴ Bureau of Labor Statistics, United States Department of Labor. <https://www.bls.gov/eag/eag.sd.htm> (retrieved July 13, 2017).

3.2. Existing Land Use

The study area comprises a mix of residential, commercial, industrial and agricultural uses. Figure 4 illustrates 2017 City of Brandon zoning within the study area.

South of I-90, SD11/Splitrock Boulevard is lined by a variety of land uses, many of which are commercial-based due to the proximity to the I-90 Exit 406 Interchange and being a primary north/south arterial highway through Brandon. An industrial area with limited space for new development is located on the west side of SD11/Splitrock Boulevard with some frontage to the highway (TAZ 475). Land use is primarily residential, with a mix of commercial and church, to the east of SD11/Splitrock Boulevard (TAZ 487) and to the southwest of the Redwood Boulevard intersection (TAZ 474). A large undeveloped parcel that partially lies in the floodplain is located along the southeast quadrant of the interchange.

North of I-90, there is a mix of industrial, agricultural, and residential land use. A growing industrial park is located on the west side of SD11 (TAZ 476 and 477) with agricultural land use throughout the undeveloped areas. Industrial facilities north of I-90 generate a high number of heavy vehicle trips, with vehicles and vehicle combinations that often exceed a standard WB-67 truck. A summary of these industries are as follows:

- Marmen Energy – Manufactures wind tower base segments. Uses Double Schnabel configurations with total vehicle lengths upwards of 195 feet.
- CHS/Eastern Farmers Coop – Grain handling facility with high seasonal demand, particularly during fall harvest. Variety of heavy vehicle configurations up to WB-67 trucks.
- Jebro – Asphalt distribution facility with heavy vehicle configurations of dual trailers plus tractor.
- Concrete Materials – Current gravel and concrete facility with a planned facility expansion to include quarry operations. This expansion is expected to increase frequency of dual trailer plus tractor configurations.

On the east side of SD11, challenging topography from the Split Rock Creek river valley has limited development to agriculture and a few residences (TAZ 486). The Village of Corson is located around the intersection of SD11 and Hemlock Boulevard at the northern study area limits.

The City of Brandon 2035 Comprehensive Plan identifies commercial development along the SD11/Splitrock Boulevard corridor north of I-90 and continued build-out of the industrial area to the northwest of the interchange⁵.

⁵ Brandon 2035 Comprehensive Plan. http://cityofbrandon.org/index.asp?SEC=71E0B6E1-1D8B-4884-934B-8AE2BBF4D902&Type=B_BASIC.

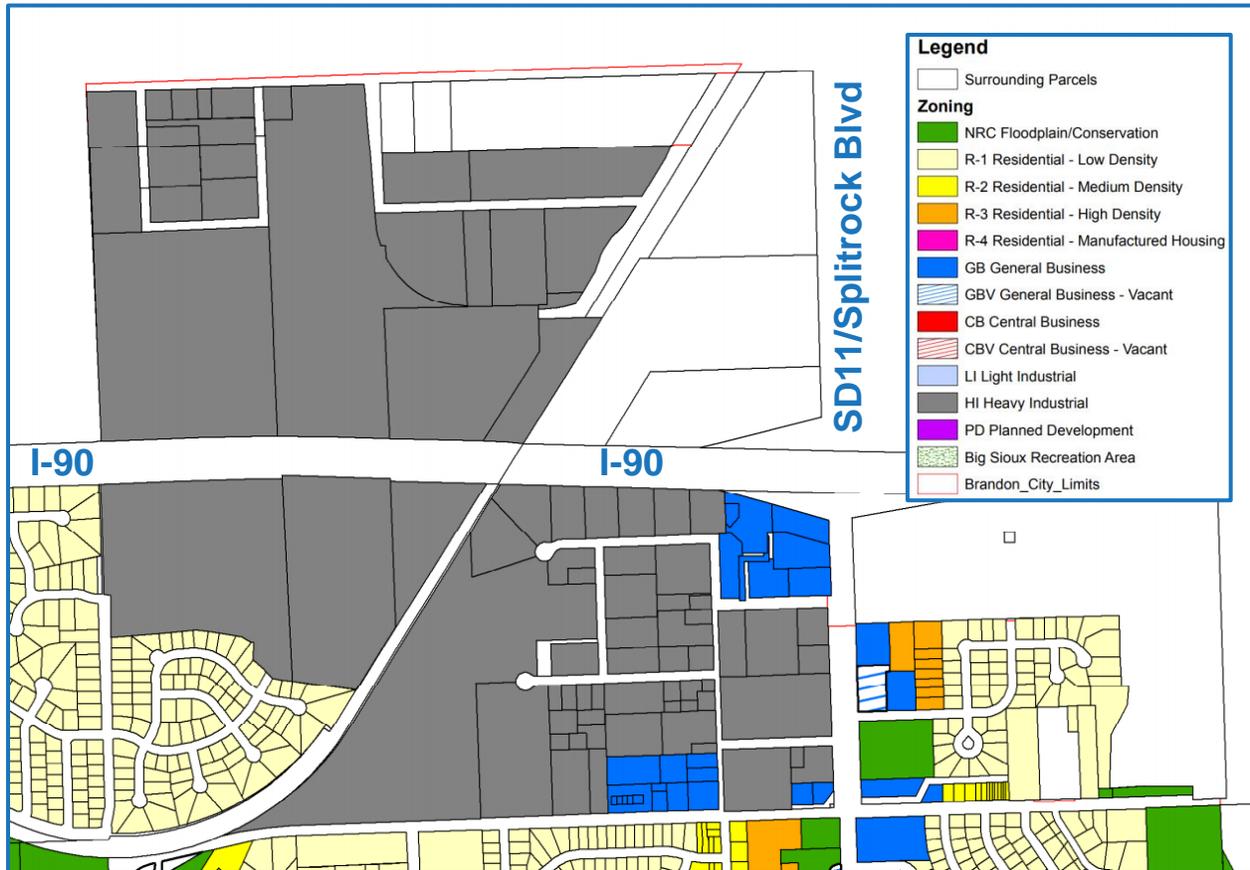


Figure 4: Existing City of Brandon Zoning

(Adapted from City of Brandon Zoning Map dated 11/1/16)

3.3. Existing Roadway Network

The major streets within the study area, as illustrated in Figure 5, are as follows:

Interstate 90

- West of SD11/Splitrock Boulevard: Rural Interstate:
 - SDDOT access classification: Interstate.
 - 2 lanes eastbound and southbound through study area, separated by a depressed turf median.
 - Last major improvement: Continuous reinforced concrete surface constructed in 1998 (eastbound) and 1997 (westbound).
- East of SD11/Splitrock Boulevard: Urban Interstate:
 - SDDOT access classification: Interstate.
 - 2 lanes eastbound and southbound through study area, separated by a depressed turf median.
 - Last major improvement: Continuous reinforced concrete surface constructed in 1998 (eastbound) and 1997 (westbound).

SD11/Splitrock Boulevard

- South of I-90: Urban Other Principal Arterial:
 - SDDOT access classification: Intermediate Urban.
 - 5-lane cross-section with two lanes in each direction and center-turn lane between Ash Street and Redwood Boulevard.
 - 4-lane cross-section with two lanes in each direction between Ash Street and eastbound I-90 ramp terminal intersection.
 - 2-lane cross-section with one lane in each direction between I-90 ramp terminal intersections.
 - Last major improvement: doweled concrete pavement surface constructed in 1990 south of Ash Street. Plain jointed concrete pavement surface constructed in 1986 north of Ash Street.
- North of I-90: Urban Minor Arterial:
 - SDDOT access classification: Intermediate Urban.
 - Constructed as 5-lane cross-section for up to two lanes in each direction and center-turn lane between eastbound I-90 ramp terminal intersection and Hemlock Boulevard.
 - Currently striped for a single lane in each direction with parking permitted within the Village of Corson.
 - Last major improvement: 8.5-inch doweled concrete pavement surface constructed in 1996.

Redwood Boulevard

- Urban Major Collector.
- One lane in each direction with left-turn lanes at major intersections.

Hemlock Boulevard

- West of SD11/Splitrock Boulevard: Urban Major Collector:
 - One lane in each direction.
- East of SD11/Splitrock Boulevard: Urban Local Street:
 - One lane in each direction.
 - Gravel roadway.

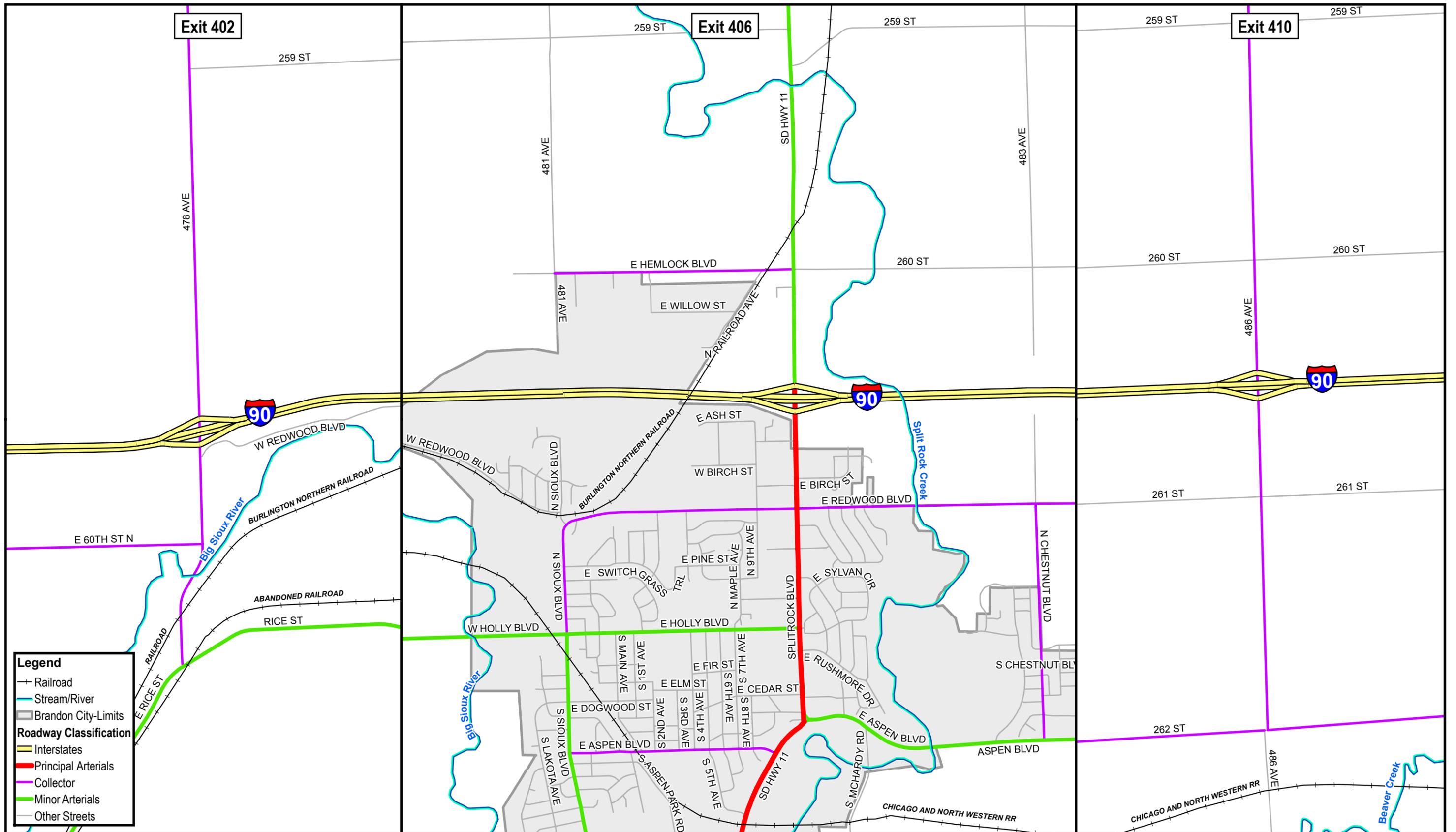
Other public streets of note within the study area include analyzed SD11/Splitrock Boulevard intersections with local streets and adjacent interchange crossroads:

Local Analyzed Streets

- Birch Street (west): Urban Local Street.
- Birch Street (east): Urban Local Street.
- Ash Street: Urban Local Street.

Adjacent Interchange Crossroads

- Timberline Avenue/478th Avenue (Exit 402): Urban Major Collector.
- 486th Avenue (Exit 410): Rural Major Collector.



Existing Roadway Network

I-90 Exit 406 Interchange Modification Study
Brandon, South Dakota



JUL 2017

FIGURE 5

3.4. Alternative Travel Modes

Travel along the existing transportation network within and around the study area is primarily by automobile. However, other forms are present:

Bicycle and Pedestrian Facilities

Pedestrian and bicycle facilities are limited within the study area, particularly south of I-90 and across the bridge. A sidewalk is provided on the east side of SD11/Splitrock Boulevard between Redwood Boulevard and Birch Street (east); otherwise, there are no shoulders or sidewalk south of the westbound I-90 ramp terminal intersection. The narrow width of the bridge deck, in particular, restricts to bicycle and pedestrian mobility along the corridor. To the north of I-90, the current 5-lane section provides a 12-foot shoulder (future lane) on both sides for bicycle and pedestrian accommodations. Sidewalk is also provided within the Village of Corson.

Transit

Fixed-route transit within the Sioux Falls metropolitan area is served by the Sioux Area Metro. However, routes do not currently extend to the Brandon area at this time. Brandon City Transit, Inc. provides on-call door-to-door service that traverse through the study area depending on passenger destinations.

Jefferson Lines provides regional bus transportation along I-90 through the interchange, providing connectivity between prime transfer points of Sioux Falls and Minneapolis or Albert Lee. Jefferson Lines does not provide a bus stop in Brandon and, therefore, does not routinely use the interchange.

Airports

The nearest commercial airport is the Sioux Falls Regional Airport located approximately nine miles west of the I-90 Exit 406 Interchange. The eastern I-90 interchange with access towards the airport is the Cliff Avenue Exit (Exit 399).

Railroad

No passenger rail lines run through the study area. However, a BNSF line traverses under I-90 west of the I-90 Exit 406 Interchange and crosses SD11/Splitrock Boulevard on the north side of Corson.

3.5. Interchanges

Three interchanges are located within the study area, Exit 402, 406, and 410, and are further described in the following subsections.

I-90 Exit 406

The existing interchange at Exit 406 is a Standard Diamond configuration with approximately 585-foot separation between ramp terminal intersections as shown in Figure 6. Each ramp terminal is stop-controlled from the off-ramp approach. Diagonal ramps in all four quadrants are single lane.

Through a review of construction plans and previous studies, the following elements of the existing interchange design do not meet current design standards:

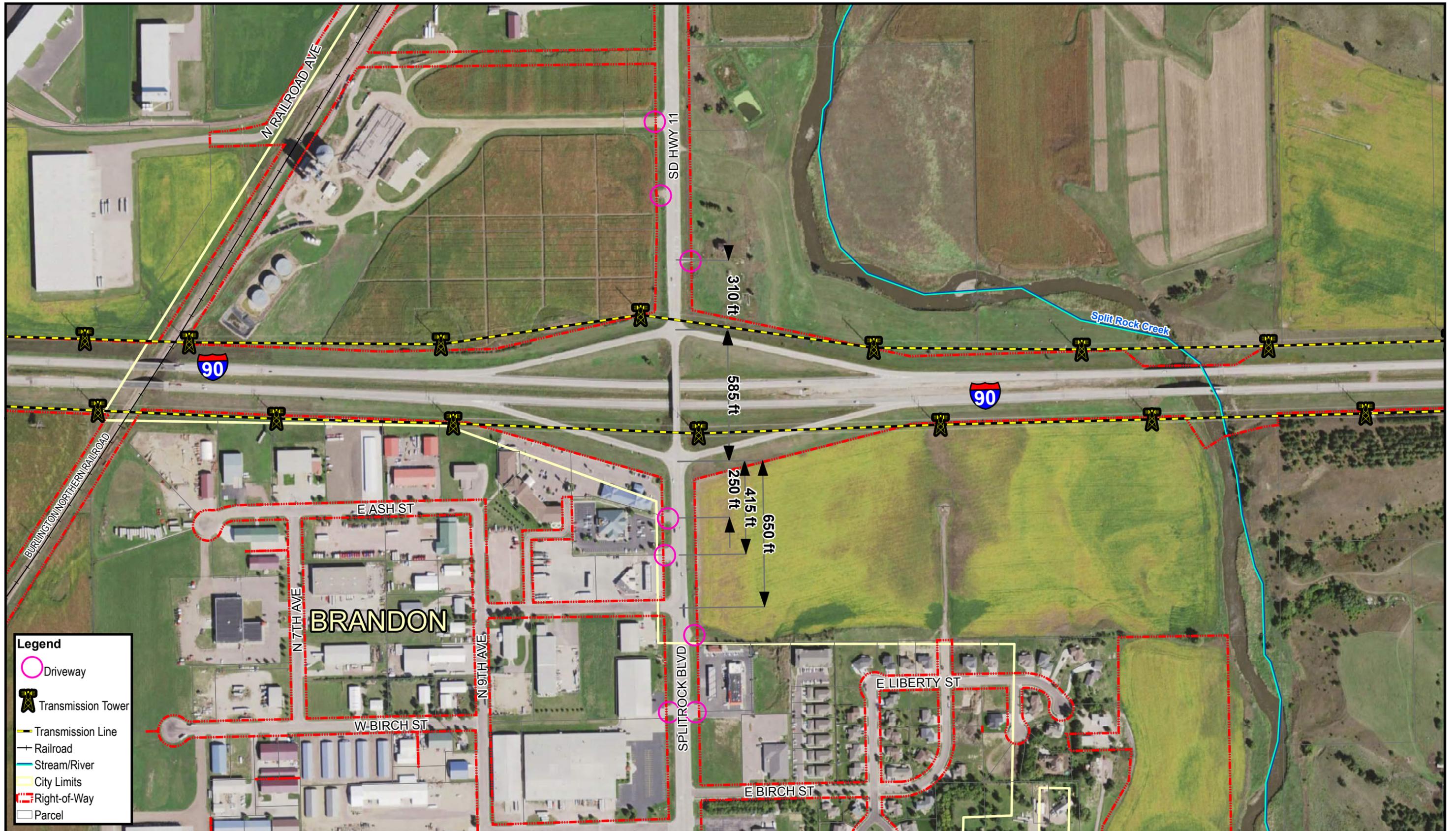
- Ramps on the east side of the interchange are too steep with segments exceeding the maximum 5 percent grade (5.2 on percent eastbound on-ramp and 6 percent on westbound off-ramp).
- Ramp surfacing width is 24 feet, less than the standard 25-foot width.
- Ramp clear zone is less than the minimum 30-foot standard from edge of travel lane.
- Slopes adjacent to the roadway shoulders are too steep; existing slopes are 4:1 and current design guidance is for a 6:1 slope to the clear zone.
- Ramp intersections with I-90 are less than 300 feet from the centerline of I-90; the design standard is for that distance to be 550 feet. As a result, off-ramp storage capacity is too short for projected traffic volumes; risk of compounding impacts that can lead to traffic backing up onto the I-90 mainline.
- On-ramp entrance taper rates are 29:1 and 30:1. Parallel type on-ramps are preferred with a 50:1 entrance taper.

The existing structure over I-90 has a total bridge roadway width of 30 feet, restricting the ability to accommodate increasing travel demand and multi-modal mobility. With 5-lane cross-sections to the north and south, though the north is currently striped as a 3-lane roadway section, the 2-lane bridge serves as a bottleneck along the study area corridor. This limited bridge width also negates the opportunity to develop left-turn lanes across the bridge for I-90 on-ramps. In addition, the current bridge deck does not provide adequate clear zone space between travel lanes and the bridge railing, and separate pedestrian/bicycle facilities are not provided.

Two transmission line alignments run through the study area, one along the northern I-90 right-of-way (ROW) line and one along the southern I-90 ROW line. Towers along both alignments constrain potential design options without necessitating tower relocation. The tower in the southeast quadrant is of particular concern for the SD11/Splitrock Boulevard alignment, interchange types that require a large footprint, and constructability options for maintaining traffic.

The first public roadway intersection south of the interchange is Ash Street, located approximately 650 feet south (measured center-of-intersection to center-of-intersection) of the eastbound I-90 ramp terminal intersection. A four-lane segment is present between the two intersections, with a northbound lane drop and southbound lane-add at the eastbound I-90 ramp terminal intersection. Two existing full-access driveways into commercial property are located on the west side of SD11/Splitrock Boulevard, approximately 250 feet and 415 feet to the south of the eastbound I-90 ramp terminal.

To the north of the interchange, the first access break is to an undeveloped property on the east side of SD11/Splitrock Boulevard, approximately 300 feet north of the westbound I-90 ramp terminal intersection. The first major developed driveway is the CHS/Eastern Farmers Coop driveway located approximately 915 feet north of the interchange.



Existing I-90 Exit 406 Interchange Configuration

I-90 Exit 406 Interchange Modification Study
Brandon, South Dakota



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FIGURE 6

I-90 Exit 402

The I-90 Exit 402 Interchange, shown in Figure 7, exhibits many of the same characteristics as the Exit 406 design. The Standard Diamond configuration includes a single lane in each direction on the crossroad (Timberline Avenue/478th Avenue) through the interchange. Each diagonal ramp exhibits a single lane and ramp terminal intersections are stop-controlled from the off-ramp approach.

This interchange is planned for reconstruction beginning in 2017 as part of the Veterans Parkway project. The Final IMJR, dated June 2014, selected a Single Point Urban Interchange (SPUI) as the preferred alternative. The configuration, shown in Figure 8, carries two through lanes northbound and southbound through the signalized single point and includes dual left-turn lanes for all movements. Off-ramp right-turn lanes are single lanes and all ramp junctions are single-lane merge or diverge, as applicable.

I-90 Exit 410

The I-90 Exit 410 Interchange is also a similar configuration as the other study area interchanges and is shown in Figure 9. The Standard Diamond-type interchange accommodates a single northbound and southbound lane in each direction across I-90. Each diagonal ramp is a single lane and the ramp terminal intersections are stop-controlled from the off-ramp approach.

Elements of this interchange that do not meet current design standards, as identified in the 2010 Decennial Interstate Corridor Study include:

- Right shoulder width of 2 feet is less than the 8-foot minimum.
- Inslope of 4:1 is steeper than minimum of 6:1.
- Existing on-ramp taper is 29:1, less than the minimum of 50:1.
- Ramp terminal intersection sight distance is less than the minimum of 425 feet.

This interchange is in a rural setting approximately 2 miles west of the Minnesota/South Dakota border and 1.5 miles west of an eastbound/westbound I-90 rest area and westbound Port of Entry.



Legend:
 — Stream/River

**Existing I-90 Exit 402
 Interchange Configuration**

I-90 Exit 406
 Interchange Modification Study
 Brandon, South Dakota



JUL 2017

FIGURE 7

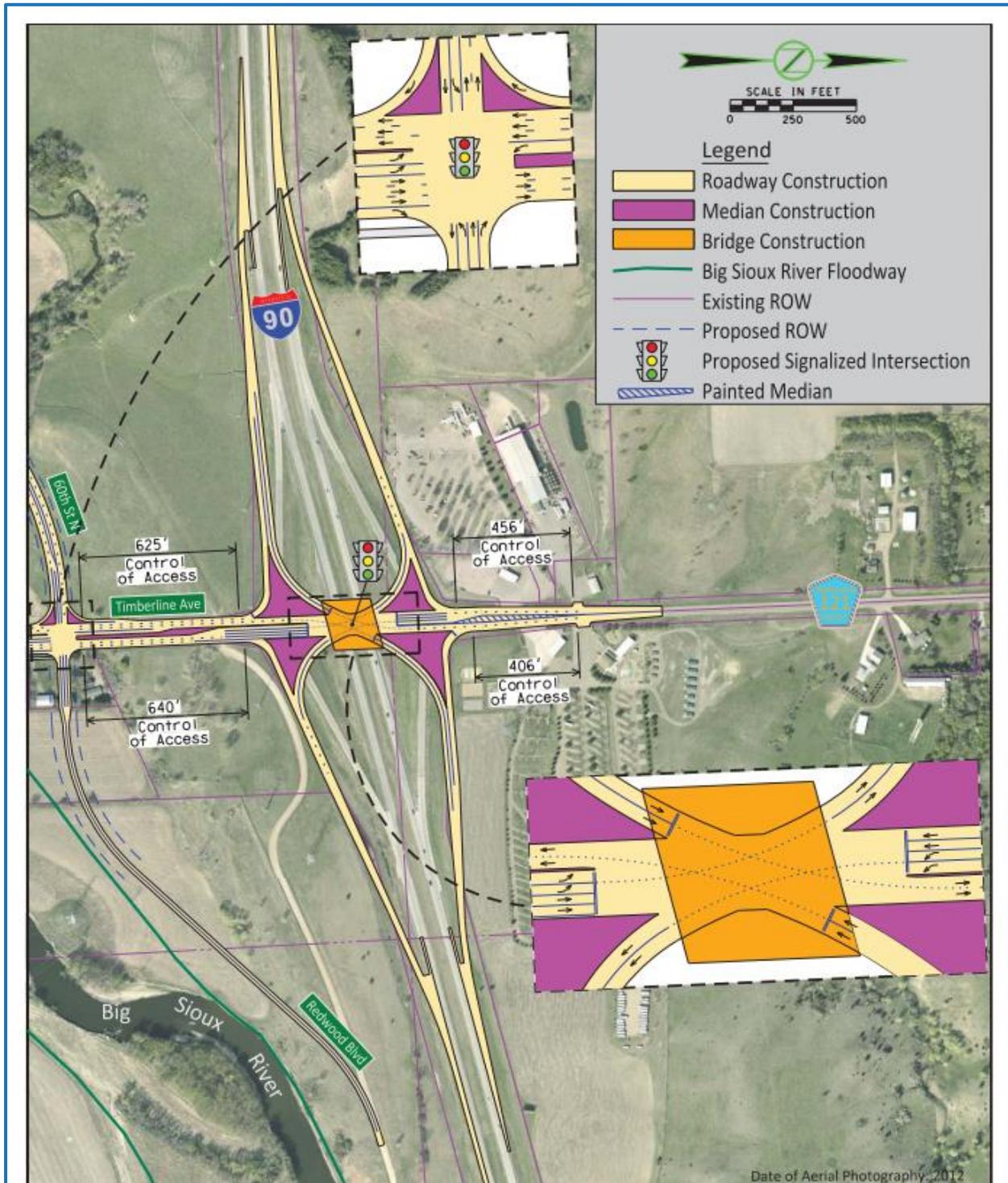
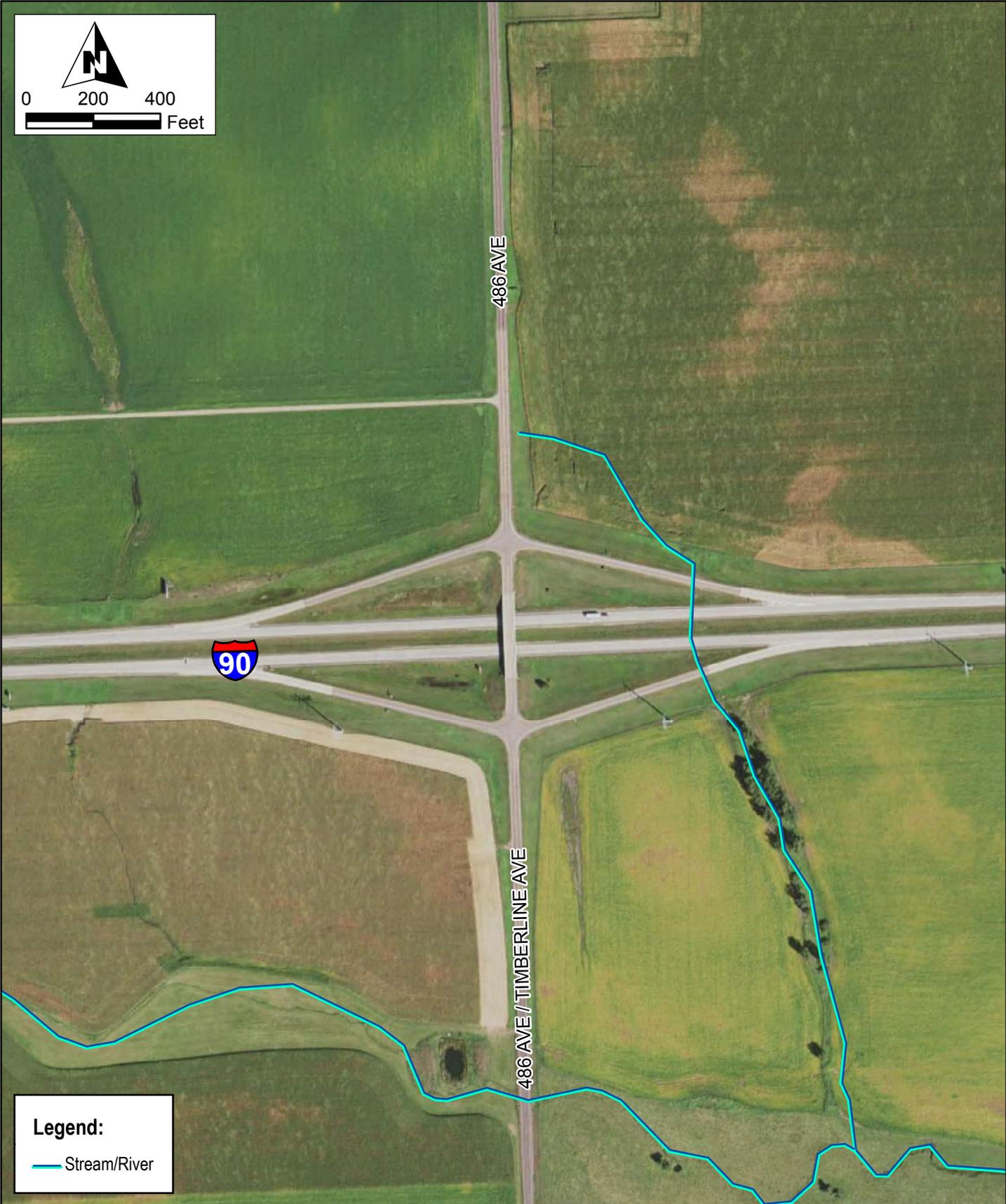


Figure 8: Planned I-90 Exit 402 Interchange Configuration

(Figure 9 from I-90/Timberline Road Interchange, Exit 402, Interchange Modification Study, June 2014)

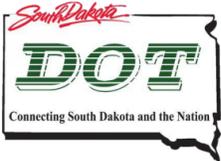


**Existing I-90 Exit 410
Interchange Configuration**

I-90 Exit 406
Interchange Modification Study
Brandon, South Dakota



U.S. Department
of Transportation
**Federal Highway
Administration**



JUL 2017

FIGURE 9

3.6. Existing Data

Existing data was collected at the onset of the study and updated as needed to fulfill the study objectives. The source of data was identified in the project Methods and Assumptions document, which was agreed upon through the signing of that document by FHWA and SDDOT. The data obtained for this project is of high quality.

Traffic Data

Existing traffic data was collected over the course of three years between 2014 and 2016, summarized in the following table. Peak hour volumes and heavy vehicle percentages were extracted from the data to develop a balanced Existing Conditions traffic data set of AM and PM peak hour traffic volumes.

Table 2: Traffic Data Collection Summary

	Intersection	Segment	Type of Data Collected	Year Collected
SD11/ Splitrock Boulevard Corridor	Hemlock Boulevard	-	Intersection TMC	2016
	CHS Access	-	Intersection TMC	2014
	Eastern Farmers Access	-	Intersection TMC	2014
	I-90 WB Ramp Terminal		Intersection TMC	2016
	I-90 EB Ramp Terminal		Intersection TMC	2016
	Hotel Access	-	Intersection TMC	2014
	BP Access	-	Intersection TMC	2014/2016
	Ash Street	-	Intersection TMC	2014/2016
	McDonald's/Holiday Access	-	Intersection TMC	2014
	Birch Street (east)	-	Intersection TMC	2014/2016
	Birch Street (west)	-	Intersection TMC	2014/2016
	Redwood Boulevard	-	Intersection TMC	2014
	-	Mainline	Segment Volume and Speed	2016
I-90 Mainline	-	Mainline	Interstate Volume and Speed	2016
I-90 Exit 402	Timberline Avenue/478 th Avenue Ramp Terminals	-	**	**
	-	Ramps	**	**
I-90 Exit 406	-	Ramps	Ramp Volume	2014
I-90 Exit 410	486 th Avenue Ramp Terminals	-	Intersection TMC	2016
	-	Ramps	Ramp Volume	2014

*Turning Movement Counts (TMC).

** Volumes obtained from I-90/Timberline Road Interchange, Exit 402 IMJR.

Future-Year Traffic Data

The development of future-year traffic volumes were based on the existing traffic counts and traffic forecasts from the Sioux Falls 2045 TDM. The Sioux Falls MPO provided the most current version of the Sioux Falls 2045 TDM for this study.

Crash Data

The SDDOT provided a GIS database of reported crashes within the study over a 5-year period between 2010 and 2014. Crash data, including crash information such as severity, manner of collision, location and contributing circumstances, was reviewable in tabular and spatial format.

Geometric Data

Geometric data review of existing conditions was based on construction plans provided by the SDDOT.

For conceptual design and refinement of Build Alternatives, the SDDOT provided topographic survey files for the interchange area and along the SD11/Splitrock Boulevard corridor.

3.7. Operational Performance

Existing Traffic Operations

Traffic operations for all roadway elements within the study area were evaluated using methodology described in the 2010 version of the Highway Capacity Manual (HCM 2010). The 2010 Highway Capacity Software (HCS 2010), version 6.65 (freeway) and 6.8 (intersections), was used in the analysis of traffic operations at freeway mainline, merge, and diverge segments, two-way stop-controlled intersections (minor crossroad and ramp-terminal intersection), and signalized intersections. HCS 2010 measures average control delay in terms of seconds of delay per vehicle (sec/veh) at two-way stop-control and signalized intersections. It measures density in terms of passenger cars per mile per lane (pc/mi/ln) on freeway segments. Level of Service (LOS) values were applied to these measures in accordance with methodologies outlined in the HCM 2010.

A weighted average approach was also used to present an alternative average delay measure at minor two-way stop-controlled intersections with SD11/Splitrock Boulevard (Hemlock Boulevard, Ash Street, and both Birch Street). This methodology uses average control delay values for the stop-controlled approach calculated in the HCM 2010 two-way stop-control analysis and assumes zero delay for the major street through and right-turn vehicles to calculate an average delay for all vehicles entering the intersection. A LOS measure was applied to the weighted average delay using HCM 2010 all-way stop-control thresholds for intersection delay and LOS.

Table 3 and Table 4 present the LOS thresholds used to evaluate operations along freeway elements and at intersections within the study area.

Table 3: Freeway Level of Service Thresholds

Level of Service (LOS)	Segment Density (pc/mi/ln)		
	Merge and Diverge Segment	Freeway Weaving Segment	Basic Freeway Segment
A	0 – 10	0 – 10	0 – 11
B	> 10 – 20	> 10 – 20	> 11 – 18
C	> 20 – 28	> 20 – 28	> 18 – 26
D	> 28 – 35	> 28 – 35	> 26 – 35
E	> 35	> 35	> 35 – 45
F	Demand exceeds capacity	Demand exceeds capacity	Demand exceeds capacity; > 45

Source: Transportation Research Board, Highway Capacity Manual, 2010.

Table 4: Intersection Level of Service Thresholds

Level of Service (LOS)	Intersection Delay (sec/veh)	
	Signalized Intersections	Two-Way Stop-Control*, All-Way Stop-Control, Roundabouts
A	0 – 10	0 – 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	Demand exceeds capacity; > 80	Demand exceeds capacity; > 50

Source: Transportation Research Board, Highway Capacity Manual, 2010.

The following LOS thresholds represent the minimum allowable LOS measures for future-year Build concepts to be carried forward and considered for a preferred Build alternative. For the analysis contained within this memorandum, these LOS thresholds will also be applied to identify areas with current and future-year concerns in the No-Build Conditions.

- Ramp Terminal Intersections:
 - Intersection: LOS C.
 - Individual Movements: LOS D with overall intersection at LOS C or better.
- Signalized Non-Ramp Terminal Intersections (modified by project):
 - Intersection: LOS D.
 - Individual Movements: LOS E with overall intersection at LOS D or better.
- Other Non-Ramp Terminal Intersections (modified by project):
 - Intersection: LOS D.
 - Individual Movements: LOS E or F with overall intersection at LOS D or better.
- Intersections Not Modified by Project:
 - Intersection: LOS D.
 - Individual Movements: LOS E or F with overall intersection at LOS D or better.

The AM and PM peak hour traffic volumes representative of the Existing Conditions (2016) dataset is shown in Figure 10. The LOS results are summarized in Figure 11 and shown in Tables 5-8. HCS 2010 reports are provided in Appendix A.

Table 5: SD11/Splitrock Boulevard Intersection Traffic Operations – Existing Conditions

SD11/Splitrock Boulevard Intersection	Intersection Control Type	AM Peak Period		PM Peak Period	
		Avg. Delay LOS	Local Street Weighted Avg. Delay LOS	Avg. Delay LOS	Local Street Weighted Avg. Delay LOS
Hemlock Boulevard	TWSC	C	A	C	A
I-90 WB Ramp Terminal	TWSC	F	-	F*	-
I-90 EB Ramp Terminal	TWSC	C	-	F*	-
Ash Street	TWSC	C	A	F*	C
Birch Street (East)	TWSC	D	A	D	A
Birch Street (West)	TWSC	C	A	E	A
Redwood Boulevard	Signal	B	-	B	-

* Demand exceeds capacity, volume/capacity (v/c) ratio greater than 1.0.

Table 6: I-90 Exit 406 Ramp Terminal 95th Percentile Queue Lengths – Existing Conditions

Stop-Controlled Off-Ramp Approach	AM Peak Period	PM Peak Period
	95 th % Queue (veh)	95 th % Queue (veh)
Eastbound Off-Ramp	4.5	28.8
Westbound Off-Ramp	2.9	12.1

Table 7: I-90 Exit 402 and 410 Ramp Terminal Traffic Operations – Existing Conditions

SD11/Splitrock Boulevard Intersection	Intersection Control Type	AM Peak Period		PM Peak Period	
		Avg. Delay LOS	Local Street Weighted Avg. Delay LOS	Avg. Delay LOS	Local Street Weighted Avg. Delay LOS
Exit 402 / Timberline Road					
I-90 WB Ramp Terminal	TWSC	C	-	B	-
I-90 EB Ramp Terminal	TWSC	B	-	A	-
Exit 410 / 486th Ave					
I-90 WB Ramp Terminal	TWSC	A	-	A	-
I-90 EB Ramp Terminal	TWSC	A	-	A	-

Table 8: I-90 Freeway Segment Traffic Operations – Existing Conditions

Freeway Segment	AM Peak Period	PM Peak Period
	LOS	LOS
Eastbound I-90		
Basic, 2-lane mainline to Exit 402	A	B
Diverge, to Timberline Ave	A	B
Basic, 2-lane mainline within Exit 402	A	B
Merge, from Timberline Ave	A	B
Basic, 2-lane mainline between Exit 402 and Exit 406	A	B
Diverge, to SD11/Splitrock Blvd	A	B
Basic, 2-lane mainline within Exit 406	A	A
Merge, from SD11/Splitrock Blvd	A	B
Basic, 2-lane mainline between Exit 406 and Exit 410	A	A
Diverge, to 486 th Ave	A	B
Basic, 2-lane mainline within Exit 410	A	A
Merge, from 486 th Ave	A	B
Basic, 2-lane mainline from Exit 410	A	A
Westbound I-90		
Basic, 2-lane mainline to Exit 410	A	A
Diverge, to 486 th Ave	A	A
Basic, 2-lane mainline within Exit 410	A	A
Merge, from 486 th Ave	A	A
Basic, 2-lane mainline between Exit 410 and Exit 406	A	A
Diverge, to SD11/Splitrock Blvd	A	A
Basic, 2-lane mainline within Exit 406	A	A
Merge, from SD11/Splitrock Blvd	B	A
Basic, 2-lane mainline between Exit 406 and Exit 402	B	A
Diverge, to Timberline Ave	B	A
Basic, 2-lane mainline within Exit 402	A	A
Merge, from Timberline Ave	B	B
Basic, 2-lane mainline to Exit 402	B	A

The Existing Conditions analysis notes capacity constraints already present at the two I-90 Exit 406 ramp terminal intersections. The eastbound ramp terminal intersection stop-controlled off-ramp approach is operating at LOS F in the PM peak hour. The measured 95th percentile queue length during this period is 28.8, representing approximately a 720-foot queue at 25 feet per vehicle. While this queue does not extend the length of the existing ramp, measuring approximately 930 feet from the stop location to the tip of the painted diverge gore point, it

would be expected to impact I-90 mainline traffic because exiting vehicles would need to slow down on I-90 in order to stop at the back of the queue. The westbound ramp terminal stop-controlled off-ramp approach is operating at LOS F in both the AM and PM peak hours, though queue lengths are considerably less than those on the eastbound off-ramp.

It is expected that these operations will continue to deteriorate as the Brandon area continues to grow and traffic demand at this interchange increases.

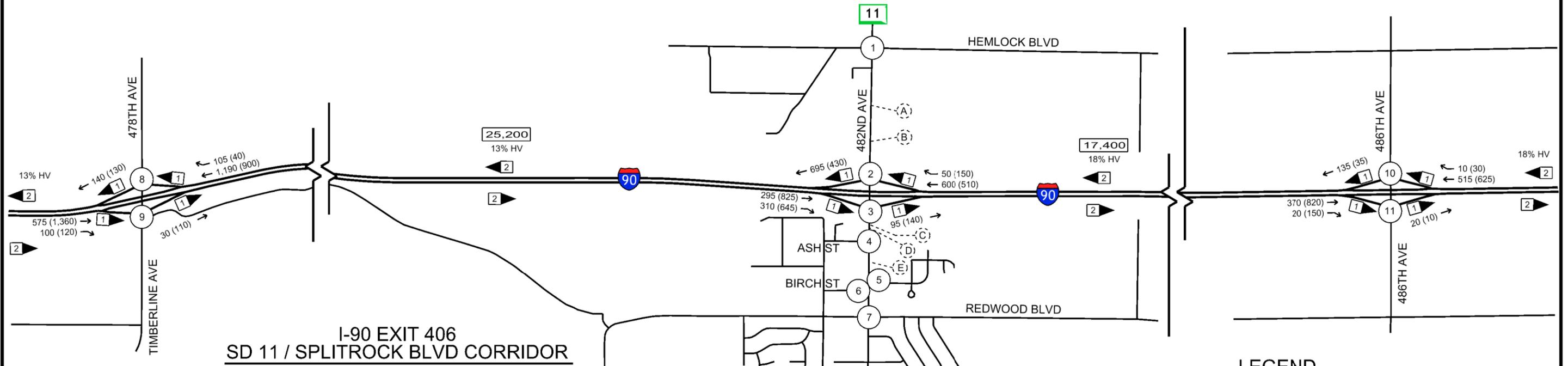
At local network intersections along SD11/Splitrock Boulevard, worst-case two-way stop-control approaches measured LOS D, E and F at the Ash Street and both Birch Street intersections. However, when looking at the weighted intersection delay (that accounts for the benefits provided from a free through movement on the high-volume, major road), these intersections measured LOS A or B.

Along I-90, all analyzed freeway segments measured LOS B or better indicating adequate capacity for the demand reflected in the Existing Conditions.

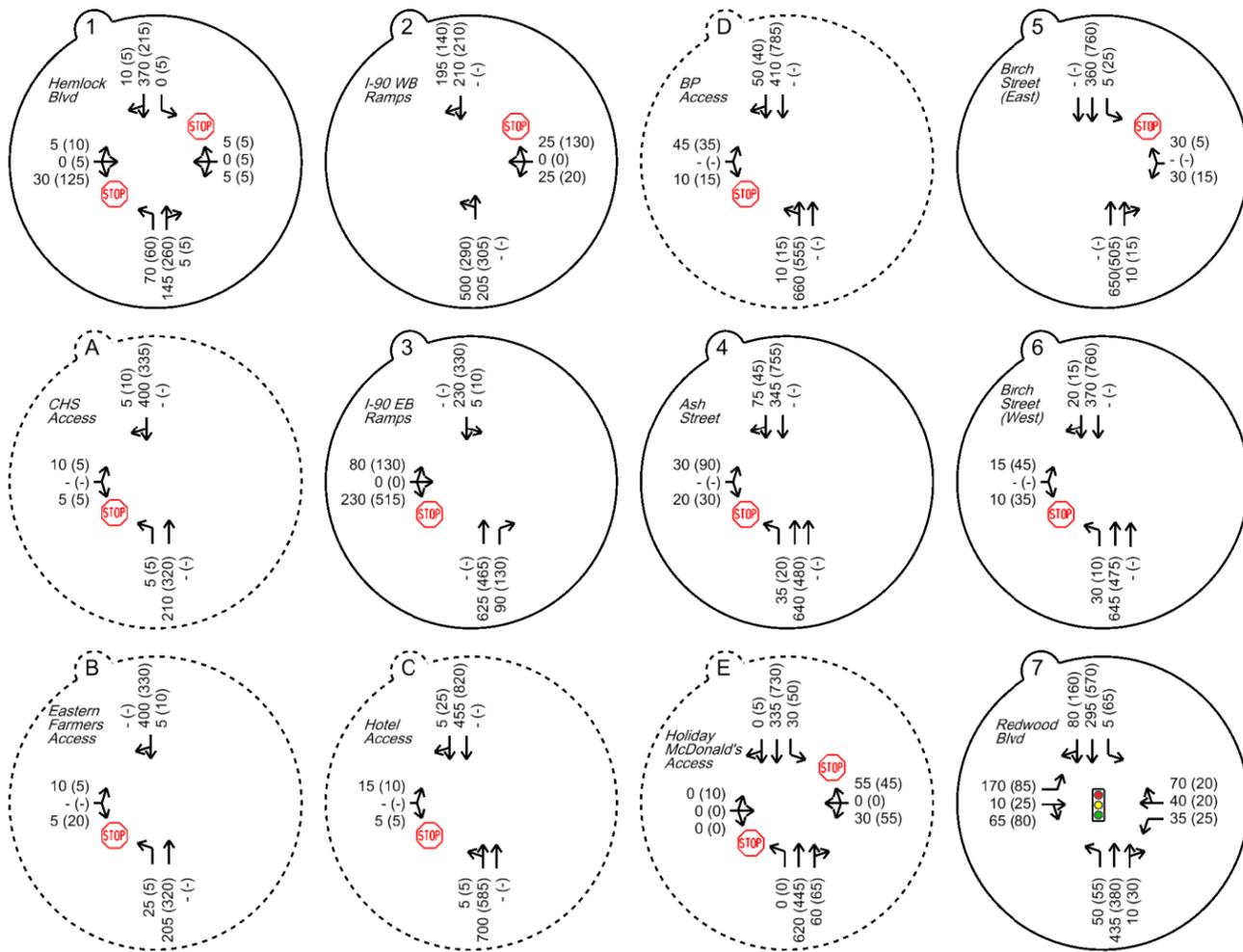
EXIT 402

EXIT 406

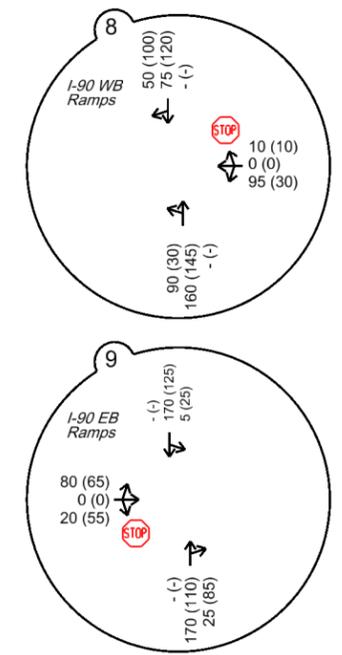
EXIT 410



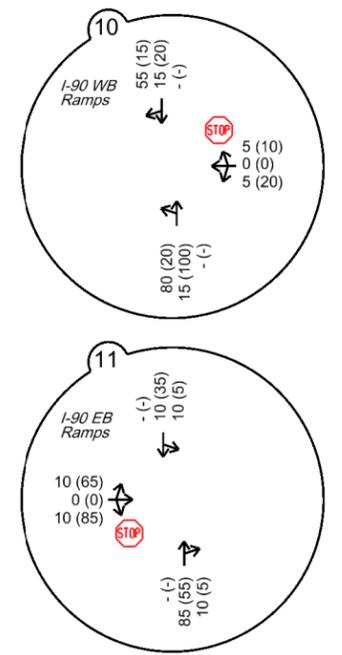
I-90 EXIT 406
SD 11 / SPLITROCK BLVD CORRIDOR



I-90 EXIT 402/TIMBERLINE RD



I-90 EXIT 410/486TH AVE



LEGEND

- xx,xxx AVERAGE DAILY TRAFFIC VOLUME (ADT)
- xxx (xxx) AM (PM) PEAK HOUR VOLUME
- Number of lanes and flow direction
- INTERSECTION FOR ANALYSIS
- DRIVEWAY ACCESS
- TRAFFIC SIGNAL CONTROL
- STOP CONTROL

EXISTING CONDITIONS



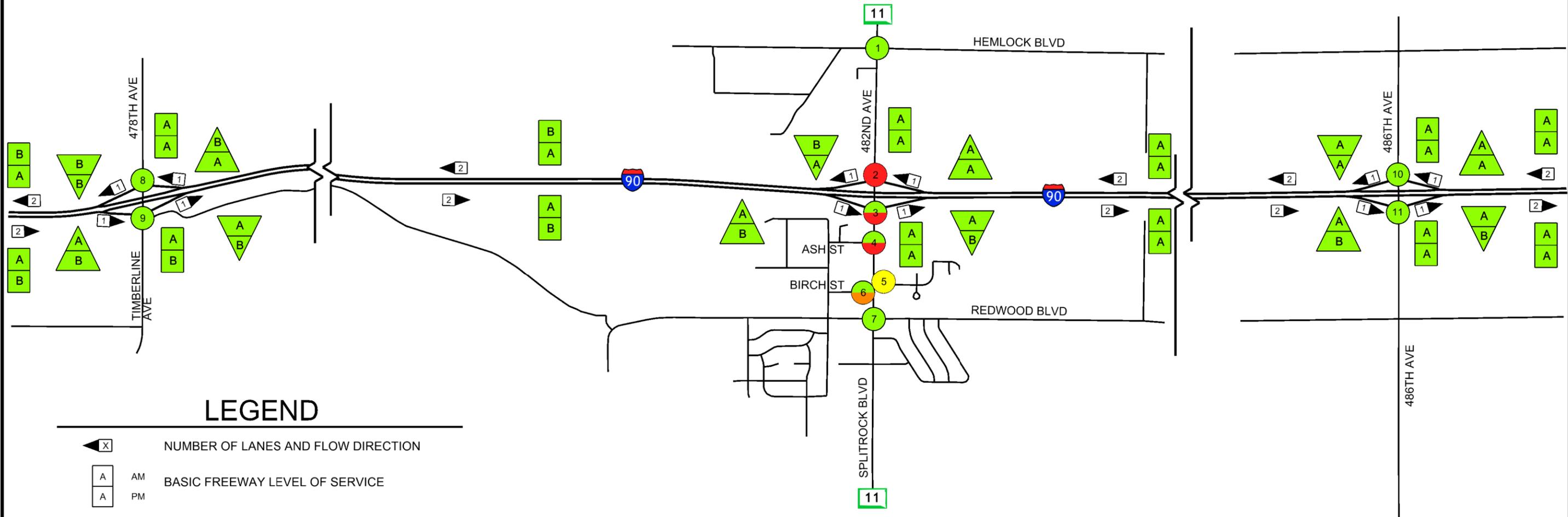
IMJR TRAFFIC VOLUMES
I-90 EXIT 406 INTERCHANGE
MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
FIGURE 10

EXIT 402

EXIT 406

EXIT 410



LEGEND

- NUMBER OF LANES AND FLOW DIRECTION
 - AM BASIC FREEWAY LEVEL OF SERVICE
PM
 - AM RAMP MERGE LEVEL OF SERVICE
PM
 - AM RAMP DIVERGE LEVEL OF SERVICE
PM
 - AM INTERSECTION LEVEL OF SERVICE
PM
- A
B
C
D
E
F

ANALYSIS ASSUMPTIONS

PHF = VARIED (FIELD MEASURED)
 TERRAIN = LEVEL
 fp = 1.00
 MAINLINE BFFS = VARIED (FIELD MEASURED)
 DIAGONAL RAMP FFS = 55.0 MPH
 TRUCK % = VARIED (FIELD MEASURED)

INTERSECTION PEAK HOUR OPERATIONS

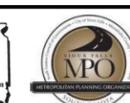
ID	CORRIDORS	CONTROL TYPE		HCM 2010 LEVEL OF SERVICE		LOCAL STREET WEIGHTED AVERAGE LEVEL OF SERVICE	
		SIGNAL	STOP	AM	PM	AM	PM
SD11/Splitrock Blvd							
1	SD11 & Hemlock Boulevard		X	C	C	A	A
2	SD11 & I-90 WB Ramp Terminal		X	F	F*	-	-
3	SD11 & I-90 EB Ramp Terminal		X	C	F*	-	-
4	SD11 & Ash Street		X	C	F*	A	C
5	SD11 & Birch Street (East)		X	D	D	A	A
6	SD11 & Birch Street (West)		X	C	E	A	A
7	SD11 & Redwood Boulevard	X		B	B	-	-
478th Ave/Timberline Ave							
8	Timberline Ave & I-90 WB Ramp Terminal		X	C	B	-	-
9	Timberline Ave & I-90 EB Ramp Terminal		X	B	A	-	-
486th Ave							
10	486th Ave & I-90 WB Ramp Terminal		X	A	A	-	-
11	486th Ave & I-90 EB Ramp Terminal		X	A	A	-	-

NOTES:
 WEIGHTED AVERAGE LOS DERIVED FROM HCM 2010 AWSC LOS CRITERIA
 * DENOTES V/C RATIO > 1

EXISTING CONDITIONS



NOT TO SCALE



IMJR TRAFFIC OPERATIONS ANALYSIS
 I-90 EXIT 406 INTERCHANGE
 MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
 FIGURE 11

Existing Bicycle and Pedestrian (Nonautomobile Mode) Facility Evaluation

The Streets Module in HCS 2010 was used to analyze pedestrian and bicycle facilities, when applicable. HCM 2010 Chapters 16, 17, and 18 provides a nonautomobile mode LOS criteria for pedestrian and bicycle modes at and through signalized intersections. The quality of service-based LOS score measures a combination of factors that describe performance measures and intersection character. The LOS score criteria are provided in Table 9.

Table 9: Pedestrian and Bicycle Modes Level of Service Criteria

Level of Service (LOS)	Level of Service Score
A	≤ 2.00
B	> 2.00-2.75
C	> 2.75-3.50
D	> 3.50-4.25
E	> 4.25-5.00
F	> 5.00

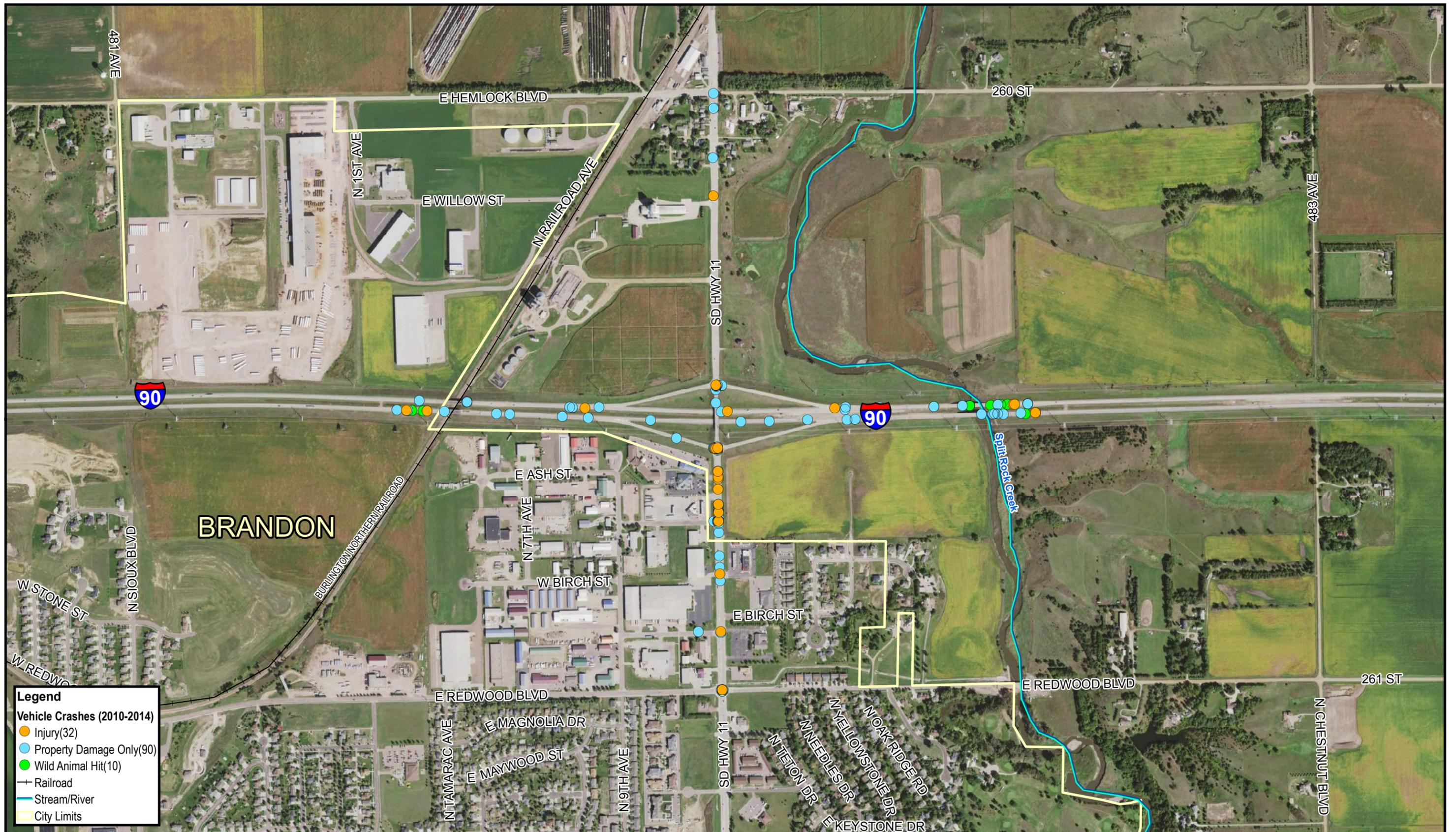
Source: Transportation Research Board, Highway Capacity Manual, 2010.

SD11/Splitrock Boulevard corridor segments through the study area were not analyzed as part of the Existing Conditions analysis due to lack of facilities (lack of shoulders and/or sidewalk south of I-90 and bridge width restrictions across I-90), multi-modal accommodations, and limitations in the HCS 2010 Streets Module software. It should be noted; however, that the Build Alternatives were developed to provide improvements to both pedestrian and bicycle mobility throughout the corridor when compared to the Existing Conditions.

3.8. Existing Safety Conditions

A review of crash data was completed for the I-90 Exit 406 study area to identify potential trends or safety concerns within the study area. 111 reported crashes occurred over a 5-year period (2010-2014) within the analyzed area along both the I-90 and SD11/Splitrock Boulevard corridors. These crashes are spatially depicted in Figure 12. Crash rates were developed based on obtained 2014 Average Annual Daily Traffic volumes and compared to calculated critical crash rates when data was available.

The following subsections summarize the review of crashes along I-90 freeway segments, at SD11/Splitrock Boulevard intersections and along SD11/Splitrock Boulevard corridor segments between each analyzed intersection. More details regarding the crash history may be found in the Crash Summary memorandum located in Appendix B.



Legend

Vehicle Crashes (2010-2014)

- Injury(32)
- Property Damage Only(90)
- Wild Animal Hit(10)
- +— Railroad
- Stream/River
- City Limits

Study Area Crash History (2010-2014)

I-90 Exit 406 Interchange Modification Study
 Brandon, South Dakota



AUG 2017

FIGURE 12

I-90 Freeway Segments

I-90 was segmented into mainline and interchange-related segments within the study area as shown in Figure 13. A summary of crashes based on this segmentation, color-coded to reference the spatial representation shown in Figure 13, is provided in Table 10.

Figure 13: I-90 Crash Evaluation Segmentation Limits



Table 10: I-90 Freeway and Exit 406 Ramp Segment Crash Summary

From	To	Total Crashes	Injury Crashes	Crash Rate	Manner of Collision			
					Rear End	Angle	Side Swipe	No Collision
Eastbound								
3,000 ft. west of SD11	Approaching Diverge	7	1	2.14	0	1	0	4
SD11 Diverge Area	SD11 Diverge	3	0	0.92	1	0	1	1
SD11 Off-Ramp	-	1	0	1.09	0	0	0	1
SD11 Diverge	SD11 Merge	4	0	1.04	1	0	0	3
SD11 Merge	SD11 Merge Area	2	0	0.88	0	0	0	1
SD11 Merge Area	3,000 ft. east of SD11	7	2	3.26*	0	0	0	7
Westbound								
3,000 ft. east of SD11	Approaching Diverge	11	1	5.23*	1	0	1	9
SD11 Diverge Area	SD11 Diverge	3	1	1.33	0	0	0	3
SD11 Diverge	SD11 Merge	2	1	0.52	0	0	0	2
SD11 Merge	SD Merge Area	3	0	0.92	0	0	1	2
SD11 Merge Area	3,000 ft. west of SD11	3	0	0.89	0	0	0	3
Totals		46	6	-	3	1	3	36

Segment crash rate expressed in crashes per million vehicle miles (MVM) traveled.

Calculated critical crash rates based on South Dakota average crash rates by facility type (2015 data).

* Exceeds calculated critical crash rate.

Overall, there were 46 I-90 mainline and I-90 Exit 406 ramp segment crashes. 36 of these were single-vehicle crashes (no collision between two vehicles). Two I-90 mainline segments east of the interchange exhibit crash rates that exceed the calculated critical crash rates:

- Eastbound I-90 segment crash rate calculated at 3.26 crashes/MVM, slightly higher than the critical crash rate of 3.08 crashes/MVM.
 - All seven crashes involved wet or icy roadway conditions and six of those were on or ending on the Split Rock Creek Bridge.
- Westbound I-90 segment crash rate calculated at 5.23 crashes/MVM is notably higher than the critical crash rate of 3.11 crashes/MVM traveled.
 - Seven of the 11 crashes due to vehicle-animal collisions.

SD11/Splitrock Boulevard Intersections

Intersection-related crashes, those occurring within a 150-foot radius of the intersection, were evaluated at each SD11/Splitrock Boulevard study area analysis intersection. Table 11 summarizes these crashes along the study area analysis intersections.

Table 11: SD11/Splitrock Boulevard Corridor Intersection Crash History (2010-2014)

SD11/Splitrock Boulevard Intersection	Total Crashes	Injury Crashes	Crash Rate	Manner of Collision		
				Rear End	Angle	No Collision
Hemlock Boulevard	1	0	0.08	0	1	0
I-90 WB Ramp Terminal	9	3	0.52	6	3	0
I-90 EB Ramp Terminal	21	6	0.76*	9	10	2
Ash Street	8	1	0.33	3	4	1
Birch Street (east)	0	0	0.00	0	0	0
Birch Street (west)	2	1	0.09	1	1	0
Redwood Boulevard	4	0	0.15	1	3	0
Totals	45	11	-	20	22	3

Intersection crash rate expressed in crashes per million entering vehicles (MEV).

Calculated critical crash rates based on Sioux Falls average crash rates by intersection type (2015).

** Exceeds critical crash rate.*

The eastbound I-90 ramp terminal intersection was the lone intersection that exhibited a 5-year crash rate that exceeded the critical crash rate (calculated crash rate of 0.76 crashes/MEV compared to a critical crash rate of 0.56 crashes/MEV). 21 crashes occurred at this intersection between 2010 and 2014, 6 of those being injury crashes. 16 of the 21 crashes involved eastbound I-90 off-ramp vehicles. Manner of Collision was evenly split between rear-end and angle crashes, indicative of long or unexpected queues, vehicles pulling into crossroad traffic from the off-ramp two-way stop-control intersection approach, and sight distance concerns.

SD11/Splitrock Boulevard Corridor Segments

Crash history between SD11/Splitrock Boulevard corridor segments between each of the aforementioned intersections was also evaluated, shown in Table 12. Crashes in this analysis do not include intersection crashes summarized in Table 11.

Table 12: SD11/Splitrock Boulevard Corridor Segment Crash History (2010-2014)

From	To	Total Crashes	Injury Crashes	Crash Rate	Manner of Collision			
					Rear End	Angle	Side Swipe	No Collision
Hemlock Boulevard	I-90 WB Ramp Terminal	2	1	0.37	0	0	0	2
I-90 WB Ramp Terminal	I-90 EB Ramp Terminal	0	0	0.00	0	0	0	0
I-90 EB Ramp Terminal	Ash Street	14	6	6.58*	5	6	3	0
Ash Street	Redwood Boulevard	4	0	0.89	1	3	0	0
Totals		20	7	-	6	9	3	2

Segment crash rate expressed in crashes per million vehicle miles (MVM) traveled.

Calculated critical crash rates based on South Dakota average crash rates by facility type (2015 data).

** Exceeds calculated critical crash rate.*

The segment between eastbound I-90 ramp terminal intersection and Ash Street stands out amongst the other segments, with a calculated segment crash rate of 6.58 crashes/MVM that exceeds the critical crash rate of 4.73 crashes/MVM. This segment represents a distance of approximately 350 feet in front of two driveways on the west side of SD11/Splitrock Boulevard. Six of the 14 reported crashes were injury crashes. Eight crashes involved vehicles traveling in the southbound direction and six involved northbound travel.

In the southbound direction, the lane-add from the eastbound I-90 ramp terminal intersection and/or presence of driveways within close proximity of the interchange were contributing factors in several of the reported crashes. Four crashes involved a vehicle making a right-turn from the inside of the two southbound lanes; all citing they did not see the other vehicle on the outside lane. Three other crashes involved proper lane changes and resulted in side-swipe crashes; again, all three citing they did not see the other vehicle. It is likely that the off-ramp right-turn movement often operating similar to a free right-turn situation may have contributed to the drivers not seeing a vehicle prior to making a lane change.

In the northbound direction, turning left into the driveways from a through lane and long or unexpected queues were the primary contributing factors. Two rear-end crashes involved the first vehicle stopped in a through lane to make a left-turn into the driveways north of Ash Street. Three other rear-end crashes involved following too close and driver inattention, likely due to unexpected queues.

3.9. Existing Environmental Constraints

The environmental constraints and subsequent impacts of proposed alternatives are being identified in the EA. Within the study area, the following constraints are known and described in more detail within the EA document.

- Farmland
- Split Rock Creek floodplain

- Wetlands/Waters of the U.S.
- Historic and Archaeological Resources
- Section 4(f) Historic Resources
- Land Use/ROW Impacts
- Social/Community Resources (for example, provision of emergency services and the maintenance of traffic during construction)
- Bicyclists and Pedestrians Route Accommodation (existing and planned)
- Utilities
- Noise
- Hazardous Materials
- Cumulative Impacts

The project area is adjacent to the Split Rock Creek floodplain and is also on the northern border of Brandon. These two features explain some of the environmental features and potential constraints of this project. For instance, river areas are often the location of archaeological resources, wetlands, and floodplains. The land uses in this project area also reflect city limits and explain why some of the more historic land uses (agricultural and even some historic properties) remain in place. Additionally, there is a cluster of development adjacent to the study corridor on the north end of the study area (Corson). Environmental conditions such as these can be limiting factors for the development of alternatives. However, if the project does not require new right-of-way and construction impacts can be minimized, these constraints are generally manageable issues.

Figure 14 illustrates the location of some of these features.

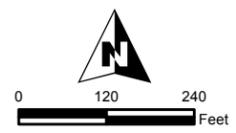


Legend

- Phase I ESA REC Parcels
- 100-Year Flood Plain
- Delineated Wetlands
- Railroad
- Stream/River

Environmental Constraints Identified in NEPA Process

I-90 Exit 406 Interchange Modification Study
 Brandon, South Dakota



SEP 2017

FIGURE 14

4. Need

4.1. Geometric Deficiencies

Geometric deficiencies at the I-90 Exit 406 Interchange have been documented in previous studies, including the 2000 and 2010 Decennial Interstate Corridor Studies. Based on the current SDDOT design standards, deficiencies with the interchange include:

- Ramps on the east side of the interchange are too steep with segments exceeding the maximum 5 percent grade (5.2 percent on eastbound on-ramp and 6 percent on westbound off-ramp).
- Ramp surfacing width is 24 feet, less than the standard 25-foot width.
- Slopes adjacent to the roadway shoulders are too steep; existing slopes are 4:1 and current design guidance is for a 6:1 slope to the clear zone.
- Interchange ramp terminals are located less than 300 feet from the I-90 centerline; current design standard for a diamond interchange is a 550-foot distance between Interstate mainline and a ramp terminal. As a result, off-ramp storage capacity is too short for projected traffic volumes; risk of compounding impacts that can lead to traffic backing up onto the I-90 mainline.
- On-ramp entrance taper rates are 29:1 and 30:1. Parallel type on-ramps are preferred with a 50:1 entrance taper.

The existing structure over I-90 has a total bridge roadway width of 30 feet and restricts the ability to accommodate both existing and increasing travel demand as well as multi-modal mobility. This 2-lane segment, single lane in each direction, serves as a bottleneck in the corridor for both through and turning traffic at each ramp terminal intersection. SD11/Splitrock Boulevard corridor cross-sections can accommodate up to a 5-lane section south of Ash Street and north of the interchange. The limited bridge width also negates the opportunity to develop left-turn lanes across the bridge for I-90 on-ramps. In addition, the current bridge deck does not provide adequate clear zone space between travel lanes and the bridge railing, and separate pedestrian/bicycle facilities are not provided.

While the current umbrella-type structure is not considered structurally deficient at this time, it was constructed in 1960 and the next major investment is either major rehabilitation of the existing structure or replacement. Because an umbrella-type structure is unable to be widened, replacement is the preferred option in lieu of any major rehabilitation work when the next major investment need arises.

4.2. Transportation Demand

Average Daily Traffic (ADT) volumes were measured along I-90 in July 2016, at 25,200 vehicles between Exits 402 and 406 and 17,400 between Exits 406 and 410. Through the 2045 Planning Year, the Sioux Falls MPO TDM forecasts volumes to increase to 47,300 and 29,700 west and east of Exit 406, respectively.

Traffic volumes are also expected to increase along the SD11/Splitrock Boulevard corridor due to the rapid growth in and around Brandon. Current (2016) corridor volume between I-90 and

Redwood Boulevard is approximately 13,300 vehicles per day and expected to exceed 23,000 by 2045 (Sioux Falls MPO TDM). Existing volume between I-90 and Hemlock Boulevard is approximately 6,400 vehicles per day and forecasted to be 11,900 by 2045 (Sioux Falls TDM).

Traffic operations for the I-90 and SD11/Splitrock Boulevard corridors in this study area have been evaluated for LOS based on existing and forecasted volumes. LOS F is currently experienced in both the AM and PM peak periods at the westbound ramp terminal intersection and in the PM peak period at the eastbound ramp terminal intersection. Based on forecasted growth through the 2045 Planning Year on both the I-90 and Splitrock Boulevard corridor, operations are expected to continue to degrade at both ramp terminal intersections.

The current SD11/Splitrock Boulevard corridor provides only segmented accommodations for non-motorized modes of travel, such as bicycles and pedestrians, and thus does not meet the needs for multi-modal demand along the corridor. Shoulders and sidewalk are not provided continuously through the corridor. A noteworthy impediment to multi-modal uses through the Splitrock Boulevard corridor is the narrow bridge over I-90, which has one travel lane and a narrow shoulder in each direction. No sidewalk is available for pedestrian use on the bridge, and bicyclists need to enter the lone travel lane in either direction to cross I-90.

4.3. Access

The current control of access extending along the crossroad is primarily limited to the interchange area, as shown in Figure 15. There is one H-lot that extends across the first parcel north of the interchange.

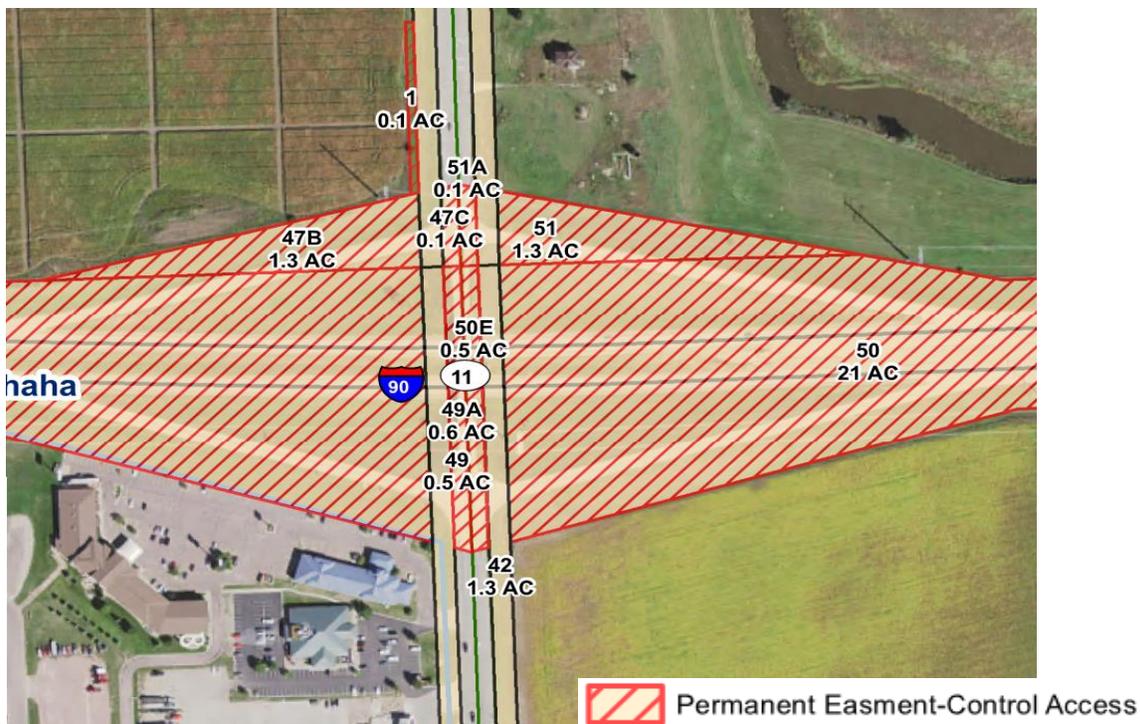


Figure 15: Existing I-90 Exit 406 Interchange Control of Access Limits

(Adapted from SDDOT ROW GIS map)

Multiple private commercial and residential drives directly access SD11/Splitrock Boulevard corridor throughout the study area, all of which are currently outside of the interchange control of access limits. The segment between the eastbound I-90 ramp terminal and Ash Street is an example of where access proximity to the interchange and density is problematic due to the propensity of turning and slowing vehicles and the subsequent impact to operations and safety through the interchange area. The SDDOT Road Design Manual identifies 660 feet as the minimum control of access extending along the crossroad away from a ramp terminal intersection for a new interchange. Within 650 feet south of the eastbound I-90 ramp terminal intersection, center-of-intersection to center-of-intersection, there are two full access driveway locations and a full access Ash Street intersection.

The cross-section of this SD11/Splitrock Boulevard segment is four lanes (two in each direction), with one northbound lane dropping at the right turn to the eastbound I-90 ramp, and one southbound added at the right turn from the eastbound I-90 ramp. This configuration of lanes can result in some operational and safety challenges in the segment of SD11/Splitrock Boulevard between Ash Street and the I-90 bridge. For instance, the inside northbound lane on SD11/Splitrock Boulevard acts as the “through” lane for traffic going across the interchange bridge. This lane is also the departure lane for left-turning vehicles. If the left-turning vehicles are delayed in making a turn due to the lack of gaps in southbound traffic, there is a risk for traffic back-ups or crashes to occur.

In the southbound direction, weaving traffic between the eastbound I-90 ramp terminal intersection and Ash Street is also problematic. The proximity of the two private driveways to both Ash Street and the eastbound I-90 ramp terminal intersection exacerbate the concern associated with a high frequency of lane changes and turning movements within this short distance.

*SD11/Splitrock Boulevard Driveways on West Side, South of I-90
(Looking south from eastbound ramp terminal;
Southbound lane add pavement markings in photo)*



4.4. Safety

A review of reported crashes between 2010 and 2014, I-90 Exit 406 Interchange and SD11/Splitrock Boulevard corridor construction plans, and public and stakeholder input identified multiple locations that are of safety concern for transportation users. Examples of these locations along the SD11/Splitrock Boulevard corridor include:

- Existing traffic control (stop-control from the off-ramp approach) and intersection sight distance limitations at the eastbound and westbound ramp terminal intersections.
 - Calculated crash rate at the eastbound ramp terminal intersection exceeds critical crash rate.
- The location and density of full access intersections, particularly south of the interchange
 - Calculated crash rate exceeds critical crash rate along the SD11/Splitrock Boulevard segment between the eastbound ramp terminal and Ash Street.
- The northbound lane drop and southbound lane addition at the eastbound ramp terminal intersection and discontinuity of a continuous cross-section through interchange.
- Lack of a center-turn lane between the interchange and Ash Street, where northbound left-turning vehicles must currently initiate their left-turn from the inside through lane north of Ash Street.
- Lack of continuous multi-modal facilities along SD11 (Splitrock Boulevard corridor).

5. Alternatives

The following outlines the development and screening process for interchange and corridor alternatives within the study area. Consistent with guidance provided in the *Interstate System Access Information Guide*, these alternatives include:

- No-Build Alternative.
- Build Alternatives (Alternatives that provide a change in access).
- Improvements to Alternate Interchanges.
- Transportation System Management (TSM) Alternative.
- Alternative Transportation Modes.
- Build Alternative, which Incorporate TSM and Alternative Modes.

The initial series of I-90 Exit 406 Interchange and SD11/Splitrock Boulevard corridor concepts were developed following the first set of stakeholder and public meetings on August 9, 2016. The goal of this initial design was to develop a comprehensive set of concepts to address the established needs and fulfill the project purpose as well as reevaluate the two proposed alternatives developed as part of the 2010 Decennial Interstate Corridor Study.

Following the development of the interchange and corridor concepts, the Study Advisory Team screened many of these concepts from further consideration and identified a series of Build Alternatives to be carried forward for additional refinement and analysis. The screening process and identified Build Alternatives were presented for public and stakeholder feedback on January 23, 2017.

5.1. Initial Interchange and Corridor Concept Development and Screening

The following is a summary of the No-Build alternative, which is carried throughout the screening process, and initial interchange and corridor concepts developed following the first public involvement opportunity. Figures representative of each concept are provided in Appendix C. Each concept summary concludes with the determination to whether the concept was carried forward as a Build Alternative or eliminated from further consideration based on established screening criteria. Additional information on this screening process is provided in Appendix D, Concepts Screening Evaluation Memorandum.

I-90 Exit 406 Interchange Concept Development and Screening Summary

No-Build – This alternative does not modify the existing Standard Diamond layout or SD11/Splitrock Boulevard corridor through the interchange other than typical maintenance and preservation activities.

- *No-Build Alternative is carried forward throughout study process.*

Concept 1: Standard Diamond – This concept expands upon the ‘most feasible interchange concept’ identified in the 2010 Decennial Interstate Corridor Study. It replaces the existing interchange (also a Standard Diamond) in place, maintaining the existing SD11/Splitrock Boulevard alignment. Traffic would not be maintained across I-90 during construction without the use of a temporary bridge and/or detours.

The initial Standard Diamond configuration reviewed was simply signaling the existing configuration, where the bridge would not be widened to accommodate additional through or new left-turn lanes. No layout was developed for this configuration, as it was an exploratory analysis to begin the Standard Diamond concept development process. It was found that while signaling the existing ramp terminal intersections does not meet many of the needs identified for the interchange, such as geometric deficiencies or access, it provides context to the traffic demand needs for a Standard Diamond interchange. Table 13 provides a summary of 2045 Build Conditions traffic operations analysis (see Chapter 6 for discussion regarding development of future-year traffic volumes) results of simply signaling the two existing ramp terminal intersections with no turn lane modifications.

Table 13: Signaling Existing I-90 Exit 406 Ramp Terminal Intersections – 2045 Build Conditions

I-90 Exit 406 Ramp Terminal Intersection	Intersection Control Type	LOS		Approach	95 th Percentile Queue (ft.)	
		AM	PM		AM	PM
I-90 WB Ramp Terminal	Signal	F	E	WB Off-Ramp	92	474
				Northbound	1,478	991
				Southbound	199	198
I-90 EB Ramp Terminal	Signal	F	F	EB Off-Ramp	704	2,434
				Northbound	3,222	2,537
				Southbound	752	1,404

It was concluded that signaling the existing interchange configuration does not meet traffic operational goals at the interchange due to the significant delay and queue lengths measured in the 2045 Build Conditions. Signaling the westbound ramp terminal intersection does little to improve operations for northbound to westbound left-turning traffic. In permitted phasing, it actually allows less time for vehicles to turn as it gives a red indication for SD11/Splitrock Boulevard traffic while allowing turns from the off-ramp. Similar to the existing traffic control, it only takes one vehicle waiting to turn left to stop the entire stream of turning and through traffic. Split phasing would allow even less time for this movement as traffic would be prohibited from turning during both off-ramp and southbound phases. Signaling the eastbound ramp terminal intersection does not improve eastbound off-ramp queues. The demand exceeds allowable green time for this movement, resulting in significant delay and queues that would impact I-90 mainline.

The Standard Diamond concept developed for the screening process, shown in Appendix C, incorporated improvements to the SD11/Splitrock Boulevard corridor and ramps to meet operational goals for this study and address other established needs for the interchange.

- *Conclusion: Carried forward as Build Alternative.*

Concept 2: Standard Diamond (shifted west) – The conceptual geometrics and overall footprint of this layout are nearly identical to the Standard Diamond concept, except that the SD11/Splitrock Boulevard alignment shifts west in order to maintain traffic on the existing bridge while half of the new bridge is constructed. Traffic could then be maintained on the first half of the new bridge while the existing bridge is removed and the remaining sections of the new bridge are constructed.

- *Conclusion: Carried forward as Build Alternative.*

Concept 3: Standard Diamond with Roundabouts – This layout mirrors Concept 1 Standard Diamond except that a roundabout is incorporated at each ramp terminal intersection instead of a signalized intersection. Similar to Concept 1, traffic would need to be maintained across I-90 during construction via a temporary bridge and/or detour routes. The public and stakeholder involvement process noted concern regarding motorist unfamiliarity of ramp terminal intersection roundabouts, unfamiliarity of multi-lane roundabouts, and navigating large trucks that frequently use the existing interchange through the roundabouts. However, because of the operational and safety benefits of roundabouts at this location, it was determined that ramp terminal intersection roundabouts were a feasible option. This concept was eliminated from consideration, in favor of Concept 4, because of the expected impact to the transmission tower in the southeast quadrant.

- *Conclusion: Eliminated from further consideration.*

Concept 4: Standard Diamond with Roundabouts (shifted west) – This layout mirrors Concept 2 Standard Diamond (shifted west) except that a roundabout is incorporated at each ramp terminal intersection instead of a signalized intersection. Traffic could be maintained on the existing bridge during construction of the initial half of the new bridge. Similar public and stakeholder concerns identified in Concept 3 with regard to the roundabouts apply here;

however, this concept does not impact the transmission tower in the southeast quadrant and was therefore carried forward over Concept 3.

- *Conclusion: Carried forward as Build Alternative.*

Concept 5: Folded Diamond (A) – Diamond-type interchange that includes a loop ramp in the northeast quadrant instead of a diagonal ramp in the northwest quadrant. This creates a free right-turn for the major morning commute movement heading west toward Sioux Falls. Because the diagonal ramp is eliminated in the northwest quadrant, southbound to westbound movements must turn left onto the loop ramp to head westbound on I-90. The addition of the loop ramp pushes the westbound off-ramp and ramp terminal intersection farther north, which results in greater impact to the property in the northwest quadrant than other concepts. This concept was eliminated due to potential cultural resource impacts, transmission tower impacts, right-of-way needs, and floodplain impacts, all in the northeast quadrant.

- *Conclusion: Eliminated from further consideration.*

Concept 6: Folded Diamond Variation (B) – Identical layout to Concept 5 except a diagonal ramp is added in the northwest quadrant. Southbound to westbound movement can turn right onto the diagonal ramp instead of needing to turn left onto the loop ramp in Concept 5. This concept was eliminated due to potential cultural resource impacts, transmission tower impacts, right-of-way needs, and floodplain impacts, all in the northeast quadrant. The diagonal ramp in the northwest quadrant requires additional right-of-way and will impact wetlands. The total cost of this interchange concept is also considerably greater than many of the other concepts.

- *Conclusion: Eliminated from further consideration.*

Concept 7: Single Point Urban Interchange – SPUI concept with the single point intersection centered over the I-90 mainline. Compared to the Standard Diamond-type interchanges, the SPUI improves separation between ramp terminal intersections and Ash Street and consolidates two ramp terminals into a single location. The SPUI concept requires a greater bridge deck area than the diamond-type interchanges. The overall footprint impacts the transmission tower in the southeast quadrant of the interchange. The cost for this concept is also considerably greater than many of the other concepts and is eliminated from consideration.

- *Conclusion: Eliminated from further consideration.*

Concept 8: Single Point Urban Interchange Offset – Similar idea to Concept 7 with a single-ramp terminal, but in this instance, the single point intersection is offset to the north near the current westbound I-90 ramp terminal intersection. This concept provides the greatest separation between the ramp terminal and Ash Street; however, it requires two additional bridges for ramp crossings of the I-90 mainline. This concept was eliminated from consideration due to eastbound on-ramp floodplain impacts, total bridge area with the additional bridges, and total cost that was considerably greater than many other concepts.

- *Conclusion: Eliminated from further consideration.*

Concept 9: Single Point Urban Interchange Offset with Roundabouts (A) – Similar layout to Concept 8 except that this concept adds a roundabout in place of the hotel/restaurant access (see Figure 6) in order to create a second prominent intersection for commercial businesses to

the west. This concept was eliminated for the same reasons as Concept 8 in addition to concerns regarding roundabout ramp terminal intersections and large truck demand initially presented in Concept 3.

- *Conclusion: Eliminated from further consideration.*

Concept 10: Single Point Urban Interchange Offset with Roundabouts (B) – Same layout as Concept 9 except in this layout the roundabout intersection for the businesses on the west side is shifted north, near the existing eastbound I-90 ramp terminal intersection in order to provide additional separation between the intersection and Ash Street. This concept was eliminated based on the same reasons as presented for Concept 9.

- *Conclusion: Eliminated from further consideration.*

Concept 11: Diverging Diamond Interchange – Concept is very similar to a Standard Diamond-type interchange footprint; however, this interchange type crosses over travel lanes through the interchange to eliminate left-turn movements across traffic at the ramp terminals. Lanes are crossed over (northbound lanes are on the west side of the roadway and southbound lanes are on the east side) at the two crossover intersections. This concept provides a free left-turn movement for the high northbound to westbound movement.

- *Conclusion: Carried forward as Build Alternative.*

SD11/Splitrock Boulevard Corridor Concept Development and Screening Summary

No-Build – This alternative does not modify the SD11/Splitrock Boulevard corridor outside of the interchange footprint. Typical maintenance and preservation activities are still assumed to occur.

- *No-Build Alternative is carried forward throughout study process.*

Concept A: SD11/Splitrock Boulevard – 5-Lane Undivided (South of I-90) – This concept is similar to the existing cross-section, two lanes in each direction plus a center turn lane, but incorporates an urban cross-section with sidewalk, curb and gutter and extra lane width in the outer lane for bicycles. Potential access modifications are also identified.

- *Conclusion: Carried forward as Build Alternative.*

Concept B: SD11/Splitrock Boulevard – 4-Lane Divided (South of I-90) – This concept constructs a 4-lane section with similar urban cross-sectional elements as Concept A such as sidewalk, curb and gutter, and extra lane width in the outer lane for bicycles. The main difference is that instead of a center-turn lane, a raised median is constructed to limit the number of conflict points through the corridor. U-turn opportunities are incorporated in the median breaks, where applicable. Intersections with local, public streets are $\frac{3}{4}$ access to where traffic cannot turn left from a minor street approach and intersections with driveways are limited to right-in/right-out. Because large trucks have difficulties making U-turns, potential improvements at the 9th Avenue and Redwood Avenue intersection are a way for trucks to leave the industrial area and head north on SD11/Splitrock Boulevard.

- *Conclusion: Carried forward as Build Alternative.*

Concept C: SD11/Splitrock Boulevard – 4-Lane Divided with Frontage Road (South of I-90) – Layout reflects a similar SD11/Splitrock Boulevard cross-section as Concept B except that the

alignment bows out to the east around the Ash Street intersection. This accommodates a frontage road on the west side of SD11/Splitrock Boulevard, east of the businesses, north of Ash Street. This concept results in significant property impacts, requiring multiple full acquisitions and demolition of existing structures, and constructability issues. Therefore, it was eliminated from further consideration.

- *Conclusion: Eliminated from further consideration.*

Concept D: Direct Backage Road Connection (Corridor Sub-Alternative) – This concept was developed as a sub-alternative to the SD11/Splitrock Boulevard corridors that close one or both driveway access to the fuel stop, restaurant, and hotel north of Ash Street (hotel/restaurant access and fuel stop/restaurant access locations shown in Figure 6). The restaurant currently does not have alternate access, thus necessitating backage access via Express Avenue. This concept realigns Express Avenue through the truck/diesel area of the fuel station. While it provides a more prominent, direct connection to the hotels and restaurant, it creates several impacts to the fuel station that would likely have a notable impact to operations. Due to these impacts, Concept D was eliminated from further consideration.

- *Conclusion: Eliminated from further consideration.*

Concept E: Express Avenue Backage Road Improvements (Corridor Sub-Alternative) – Driven by the same need as Concept D, this concept provides restaurant access via the existing or an improved Express Avenue roadway.

- *Conclusion: Carried forward as Build Alternative.*

Concept F: SD11/Splitrock Boulevard 3-Lane Undivided (north to Hemlock Boulevard) – Due to the existing pavement condition and constructed cross-section, this alternative does not incorporate any changes to the existing roadway pavement. However, this concept identifies a couple of access modifications. This concept eliminates the existing field access on the west side of SD11/Splitrock Boulevard to extend the control of access northward to the first major driveway serving the grain handling facility. Access to the affected field would be accommodated from the grain handling facility driveway. On the east side of SD11/Splitrock Boulevard, the existing parcel access is proposed to be relocated north, further away from the interchange to provide additional control of access distance away from the ramp terminal intersection. A potential shared-use path on the west side of SD11/Splitrock Boulevard, between the interchange and Corson, was also identified to remove pedestrians and bicyclists away from the vehicular travel way.

- *Conclusion: Carried Concept F forward as Build Alternative*

Concept F: SD11/Splitrock Boulevard and Hemlock Boulevard Intersection (Corridor Sub-Alternatives) – At the Hemlock Boulevard intersection, a series of concepts were developed to help minimize conflict for loaded eastbound to southbound Marmen trucks with northbound traffic (Concepts F1 through F5). Following additional analysis, it was found that future-year traffic volumes do not meet warrants for installation of a traffic signal. Further, the current intersection control meets future-year operational goals for this study. Because Marmen trucks can currently complete the turn with the aid of pilot car(s) stopping traffic and forecasted volumes do not necessitate modifications to the intersection, it was concluded that additional

improvements to address the current Marmen truck-turning conflicts be considered as part of a separate study. Therefore, Concepts F1 through F5 were eliminated from further consideration.

- *Conclusion: Eliminated Concepts F1 through F5 from further consideration.*

5.2. Interchange and Corridor Build Alternative Refinement and Screening

Build Alternatives carried through for further refinement and analysis include the following (with Build Alternative number). Graphical depictions of each layout are included in Appendix E. Potential signing plans for each Interchange Build Alternative are located in Appendix G.

Interchange Build Alternatives

No-Build.

1. Standard Diamond.
2. Standard Diamond (shifted west).
4. Standard Diamond with Roundabouts (shifted west).
11. Diverging Diamond Interchange.

SD11/Splitrock Boulevard Corridor Build Alternatives

No-Build.

- A. SD11/Splitrock Boulevard – 5-Lane Undivided (south of I-90).
- B. SD11/Splitrock Boulevard – 4-Lane Divided (south of I-90).
- F. SD11/Splitrock Boulevard – 3-Lane Undivided (north of I-90).

An Express Avenue backage connection to the restaurant parcel and access easement to the eastern hotel parcel, previously identified as Concept E, is included with both Corridor Build Alternative A and B. From this point forward, Corridor Concept E is considered a part of any Build Alternative that closes or restricts access in this location.

Build Alternative Refinement – Sub-Alternative Development

A frequently identified concern throughout the public and stakeholder involvement process was the lack of full access SD11/Splitrock Boulevard intersections at the Birch Street (east) and Ash Street intersections in Corridor Build Alternative B. Based on this feedback, additional Build Alternatives were developed for Corridor Build Alternative B:

- B-1. SD11/Splitrock Boulevard – 4-Lane Divided with Birch (east) full access and Ash Street $\frac{3}{4}$ access.
- B-2. SD11/Splitrock Boulevard – 4-Lane Divided with Birch Street (east) $\frac{3}{4}$ access and Ash Street full access.
- B-3. SD11/Splitrock Boulevard – 4-Lane Divided with Birch Street (east) full access and Ash Street full access.

Build Alternative Screening Overview

The second phase of the alternative development and screening process evaluated the remaining Build Alternatives to select a single interchange type and corridor type to assess potential environmental impacts, operational sufficiency, and safety. The following summarizes the key differentiators within the Build Alternative screening process. Additional information on

this screening process can be found in Appendix F, Environmental Assessment Alternatives Screening Matrix Memorandum, and the EA document.

I-90 Exit 406 Interchange Build Alternative Screening Summary

Traffic Operations

2045 Conditions traffic operations were reviewed at both ramp terminal intersections for the No-Build and Build Alternatives. A summary of the measured ramp terminal intersection LOS is provided in Table 14.

The No-Build alternative does not meet the operational needs at both ramp terminal intersections. LOS F was measured at both off-ramp approaches in the AM and PM peak periods in 2045 Conditions.

All interchange Build Alternatives meet the ramp terminal intersection operational goals of this study. Differences between each were minimal, ranging between LOS A and LOS C.

Table 14: I-90 Exit 406 Ramp Terminal Intersection Operations – 2045 Conditions

Ramp Terminal Intersection	No-Build	1 & 2. Standard Diamond & Standard Diamond (shifted west)	4: Standard Diamond with Roundabouts (shifted west)	11: DDI
	LOS AM/PM	LOS AM/PM	LOS AM/PM	LOS AM/PM
I-90 WB Ramp Terminal Intersection	F*/F*	C/C	C/C	B/B
I-90 EB Ramp Terminal Intersection	F*/F*	A/A	B/B	B/B

* Demand exceeds capacity, volume/capacity (v/c) ratio greater than 1.0.

While the ramp terminal intersection LOS does not provide discernable differentiation amongst the interchange Build Alternatives, subtle nuances between Standard Diamond and DDI provide operational elements that differentiate between the two interchange types. The DDI offers an operational advantage compared to the Standard Diamond variations in that the high-volume northbound to westbound left-turn movement is a free movement. This results in improved traffic operations compared to the signal-controlled dual left-turns in a Standard Diamond.

Truck Mobility

Build Alternatives 1, 2, and 11 are more advantageous to accommodating large trucks, many of which are larger than a typical WB-67 truck. The ease at which large trucks can proceed through multiple roundabouts and/or turn between SD11/Splitrock Boulevard and the interchange ramps were notable concerns from the stakeholders and public. The turning envelope of these large trucks over the southern roundabout ramp terminal, in particular, would have required nearly the entire center island to be mountable.

Predicted Safety

A predictive safety analysis was completed for the No-Build and Build Alternatives using FHWA’s Interactive Highway Safety Design Model (IHSDM). The IHSDM is based on methodology outlined in Part C of the Highway Safety Manual (HSM). It uses a variety of factors derived from the respective alternative to predict crashes over a specific timeframe.

It was found that the DDI offers better safety performance in terms of predicted reduction in crashes between the 2022 Base Year and 2045 Planning Year than the Standard Diamond variations and Standard Diamond with Roundabouts (shifted west). A summary of the predicted crashes for each interchange Build Alternative is shown in Table 15. The extent of interchange improvements in this analysis extend from the northern radius returns of the Ash Street intersection northward to where the interchange configuration ties back into existing pavement on the north side of I-90.

Table 15: I-90 Exit 406 Ramp Terminal Intersection Predicted Total Crashes – 2022-2045

Ramp Terminal Intersection	No-Build	1 & 2. Standard Diamond & Standard Diamond (shifted west)	4. Standard Diamond with Roundabouts (shifted west)	11. DDI
	Baseline	Difference	Difference	Difference
Total Crashes (2022-2045)	158 crashes	25 fewer crashes than No-Build	94 fewer crashes than No-Build	100 fewer crashes than No-Build

Constructability

Constructability of each interchange Build Alternative was evaluated with regard to schedule, foreseeable issues during construction, and maintenance of traffic. Because each interchange Build Alternative is a variation of a Diamond-type interchange with comparable footprints, construction timeline and foreseeable issues during construction were very similar. In each instance, the interchange would likely be constructed over the course of two years. Preliminary grading and bridge work would begin the first year. Construction considerations, such as fill needs or transmission tower impacts, are expected to be similar across each interchange Build Alternative.

The primary constructability difference between the interchange Build Alternatives is maintenance of traffic across I-90 during construction. This was of notable concern throughout the public involvement process. Interchange Build Alternative 1, Standard Diamond, was developed on existing alignment, thus requiring the existing bridge to be removed at the onset of bridge construction. Maintenance of traffic across I-90 would be via a temporary or detour routes to next adjacent crossings, neither of which were desirable options for the public, stakeholders, or SDDOT. Interchange Build Alternatives 2, 4, and 11 all introduce an offset alignment of SD11/Splitrock Boulevard to where a portion of the new bridge could be constructed to the west of the existing bridge. This allows traffic to be maintained on the existing bridge during the initial stages of construction prior to being shifted over onto the partially completed new bridge.

Environmental Impacts

Each of the proposed interchange Build Alternatives were some variation of a Diamond-type interchange configuration, thus occupying a very similar footprint. Environmental impacts are subsequently similar across each Build Alternative with no discernable difference between a DDI and Standard Diamond-type interchange.

Interchange Build Alternatives Screening

In conclusion, while there are numerous similarities between each of the diamond-type Build Alternatives, the key differentiators that facilitated screening down to a single interchange type to be carried forward are as follows:

- No-Build: Carried forward.
- Standard Diamond with Roundabouts (shifted west) (Build Alternative 4): Eliminated due to poor accommodation of large truck turning movements and community acceptance.
- Standard Diamond (Build Alternative 1): Build Alternative 1 was eliminated due to need of constructing a temporary bridge to provide SD11/Splitrock Boulevard access across I-90 during construction.
- Standard Diamond (shifted west) (Build Alternative 2): Eliminated based on the traffic operations and safety benefits provided by the DDI.
- DDI (Build Alternative 11): Carried forward based on the ability to accommodate existing and future directional traffic patterns and safety benefits shown in the predicted reduction in crashes.

SD11/Splitrock Boulevard Corridor Build Alternative Screening Summary

The SD11/Splitrock Boulevard Corridor Build Alternative A was selected as the build alternative south of I-90, representative of an undivided 5-lane cross-section with driveway access modifications and multi-modal improvements. The actual reconstruction of the roadway pavement south of Ash Street will be deferred to a later date based on condition of the existing pavement and the recent pavement repair project. This stretch was constructed in 1990, and the extent of that project extends through Brandon. The SDDOT has determined that they would like to keep paving sections similar and not reconstruct pavement that is anticipated to be in good condition at the time of interchange improvement. The Redwood Boulevard intersection shows no operational deficiencies in the 2045 Planning Year given the current configuration. The crash history does not indicate any crash trends or safety concerns at this time.

Corridor Build Alternative B was eliminated from consideration due to the extent of improvements required to provide a raised median between Ash Street and Redwood Boulevard. Partial reconstruction to include a median would initiate disjointed pavement timelines through this segment, which is not desired by the SDDOT.

Corridor Build Alternative A will incorporate access modifications and multi-modal improvements to address established needs. Driveway closures and consolidations to shared driveways are carried forward. A sidewalk is planned on the west side of SD11/Splitrock Boulevard to tie the planned multi-modal improvements within the interchange to the curb ramps and sidewalk at the Redwood Boulevard intersection. Bicycles will be accommodated on the sidewalk, on the existing four-foot shoulder, or within the travel lanes.

North of I-90 through Corson, the current cross-section was constructed in 1996 for five lanes, but striped for three, and adequately handles future traffic volumes. It is anticipated that this section will be in good condition at the time of proposed interchange improvement. Bicycles and pedestrians are accommodated through this segment as they are today, on the 12-foot shoulder between the interchange and Corson. Within Corson, sidewalk is provided on the east and west sides of SD11. As the operational goals are accommodated within the current cross-section and the pavement is expected to be in good condition, Corridor Build Alternative F is carried forward north of the interchange.

Along with SD11/Splitrock Boulevard Corridor Build Alternative A and Corridor Build Alternative F, the corridor No-Build Alternative was also carried forward.

5.3. Improvements to Alternate Interchanges

I-90 Exit 402 – Interchange improvements are currently planned for this interchange as part of Veterans Parkway project. The planned SPUI and corridor projects were included in the Sioux Falls MPO TDM used to develop future-year traffic volumes and the subsequent traffic operations analysis for this study. While the planned I-90 Exit 402 SPUI project will improve interchange capacity and will likely draw some traffic from I-90 Exit 406, that project does not address geometric and safety concerns at Exit 406 and would have only marginal impact to traffic patterns using the interchange. Due to projected growth in and around the City of Brandon, it is expected that demand will continue to grow at Exit 406 and the adjacent interchanges.

I-90 Exit 410 - The current interchange configuration is able to accommodate existing and future-year traffic demand. Improvements to this interchange would do little to draw demand away from the I-90 Exit 406 Interchange, as the high volume movements through that interchange are toward Sioux Falls or on the SD11/Splitrock Boulevard corridor. Further, improvements to Exit 410 would not address geometric and safety concerns at Exit 406.

5.4. Transportation System Management Alternative

Ramp metering is a TSM strategy that is used on high-volume ramps and congested corridors to improve traffic flows and safety conditions. High occupancy vehicle (HOV) facilities are another TSM strategy to help improve congested corridors. The forecasted demand at the interchange and along the I-90 mainline do not indicate ramp metering would be needed as the I-90 corridor is not expected to be congested within this study's analysis timeframe.

There are no areas within the State of South Dakota that will consistently experience congestion levels extreme enough to make ramp metering or HOV facilities economically feasible in the foreseeable future.

5.5. Alternative Transportation Modes

Alternative transportation modes will not address the needs established at this interchange. Currently, there is no fixed-route transit service within the City of Brandon. A regional bus line, Jefferson Lines, traverses through the interchange on I-90, but does not stop in Brandon. There

are currently no plans for transit or special use lanes within the interchange area in long-range City of Brandon or Sioux Falls MPO planning studies.

All concepts and alternatives developed as part of this project include pedestrian and bicycle improvements through the interchange. This includes improving pedestrian and bicycle connectivity along SD11/Splitrock Boulevard between existing pedestrian facilities south of Redwood Boulevard and the 12-foot shoulder north of the interchange.

Each concept and alternative developed also accommodates bus transit routes through the interchange in the future if deemed necessary through subsequent planning studies.

5.6. Build Alternative, which Incorporate TSM and Alternative Modes

As noted in the previous sections, TSM alternatives and alternative transportation modes do not address the needs for this project. However, pedestrian and bicycle connectivity through the interchange area is being improved in each of the Build Alternatives developed for this project.

5.7. Alternatives Carried Forward in IMJR

The following alternatives are carried forward to Chapter 8 Alternatives Analysis for further evaluation as part of this IMJR document.

- No-Build Alternatives.
- Interchange Build Alternative 11: Diverging Diamond Interchange.
- Corridor Build Alternative A: SD11/Splitrock Boulevard – 5-Lane Undivided (south of I-90).
- Corridor Build Alternative F: SD11/Splitrock Boulevard – 3-Lane Undivided (north of I-90).

6. Future Year Traffic

6.1. Development of Future-Year Traffic Volumes

Future-year traffic volumes for the 2022 Base Year and 2045 Planning Year are based on the balanced set of Existing Conditions AM and PM peak hour traffic volumes and the Sioux Falls MPO 2045 TDM forecasts. The 2045 TDM was most recently updated in 2015 to include projects in the MPO's long-range plan and planned land uses out to year 2045 within the MPO boundary. This includes the SPUI connection of Veterans Parkway with I-90 at Exit 402. Land use projections to year 2045, including household and employment information, were described earlier in the IMJR.

While the Sioux Falls MPO 2045 TDM was validated and calibrated at the regional level during model development, this study provided an opportunity to further validate the model traffic volumes within the study area through a comparison of collected daily traffic counts and the base 2013 model daily volume. Table 16 shows a comparison of these two volumes on select roadways. The difference between the respective comparative volumes was less than 10 percent, confirming the model is valid within the study area.

Table 16: Comparison of Sioux Falls MPO 2045 TDM Volumes and Existing Counts

Major Roadway	Cutline Location	Traffic Count	2013 Base Year Model Volume	Difference (%)
I-90	West of SD11	18,700	17,745	-5%
SD11/Splitrock Boulevard	South of I-90	10,814	10,293	-5%

The following AM and PM peak hour scenarios were developed for this study representative of 2022 Base Year and 2045 Planning Year traffic volumes:

- 2022 No-Build Conditions (Figure 16).
- 2045 No-Build Conditions (Figure 17).
- 2022 Build Conditions (Figure 18).
- 2045 Build Conditions (Figure 19).

The No-Build Conditions are representative of the 2045 model with no improvements to the existing interchange. The Build Conditions were developed using a built-out Standard Diamond configuration at the interchange, providing additional capacity within the interchange. This additional capacity had a minor affect to traffic patterns within the study area, typically an increase when compared to the No-Build Conditions, illustrated by the following differences in daily traffic volumes.

Table 17: Existing Conditions and 2045 Planning Year Daily Traffic Volumes

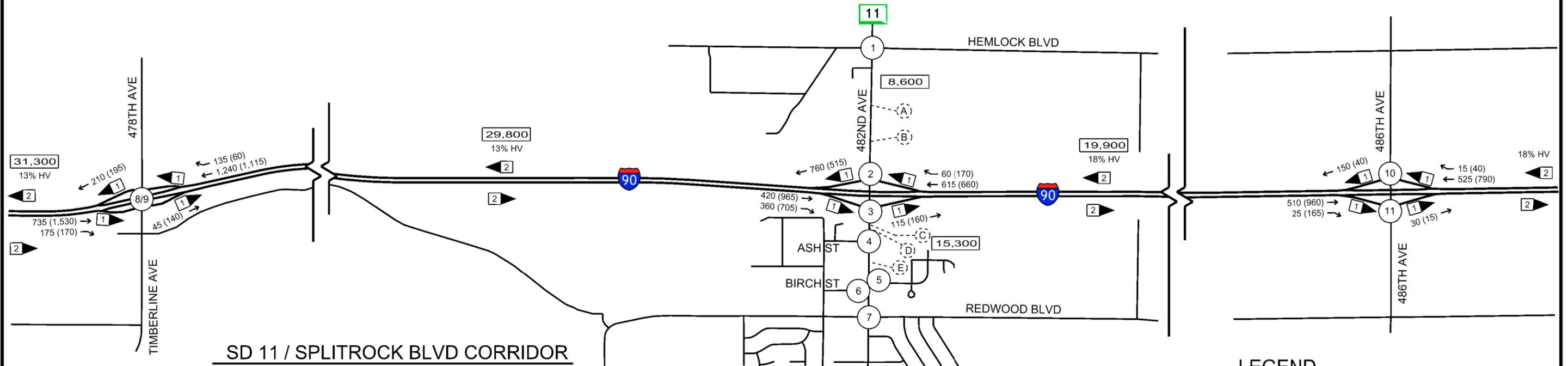
Location	Existing Conditions	2045 No-Build	2045 Build	No-Build/ Build Difference (%)
I-90 West of Exit 406	25,200	47,300	48,800	2%
I-90 East of Exit 406	17,400	29,700	29,500	-0.7%
SD11/Splitrock Boulevard North of I-90	7,800	11,900	12,200	2.5%
SD11/Splitrock Boulevard South of I-90	13,300	23,100	24,400	5.6%

Additional information regarding the development of future-year traffic volumes is provided in the Traffic Forecasts Memorandum in Appendix H.

EXIT 402

EXIT 406

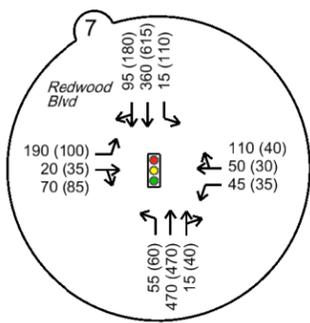
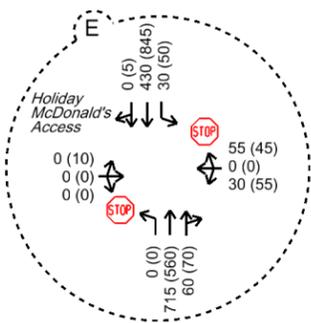
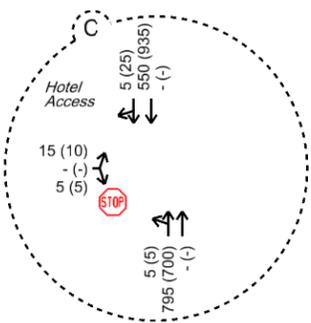
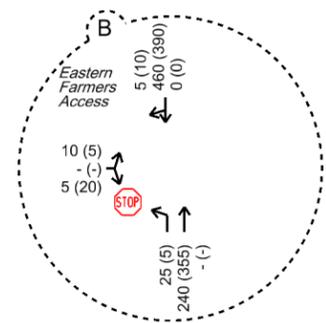
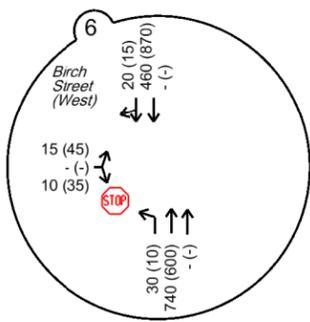
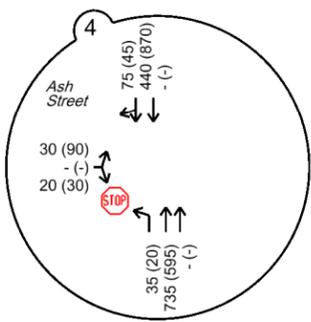
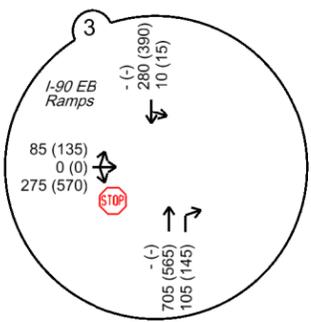
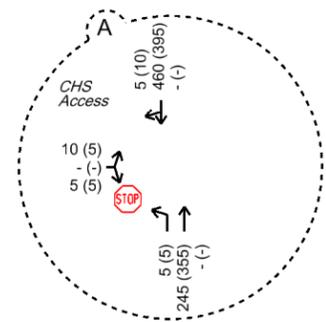
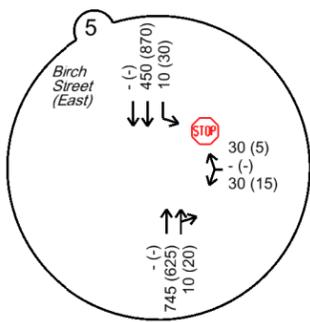
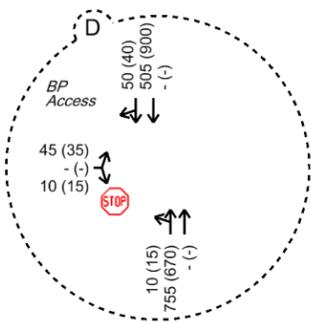
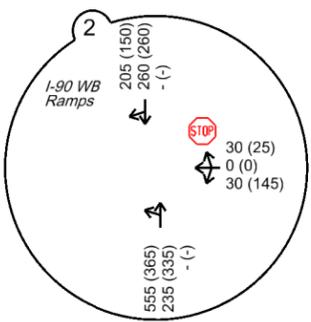
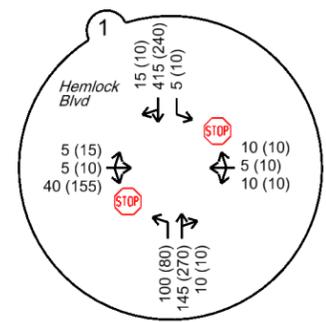
EXIT 410



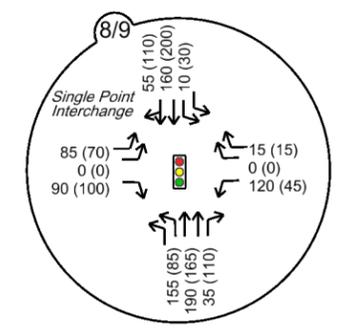
SD 11 / SPLITROCK BLVD CORRIDOR

LEGEND

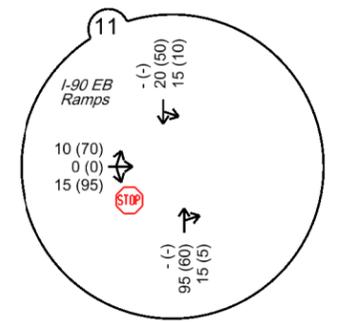
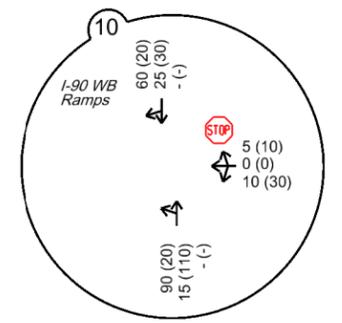
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- xxx (xxx) AM (PM) PEAK HOUR VOLUME
- Number of lanes and flow direction
- Intersection for analysis
- Driveway access
- Traffic signal control
- Stop control



I-90 EXIT 402/TIMBERLINE RD



I-90 EXIT 410/486TH AVE



2022 NO-BUILD CONDITIONS



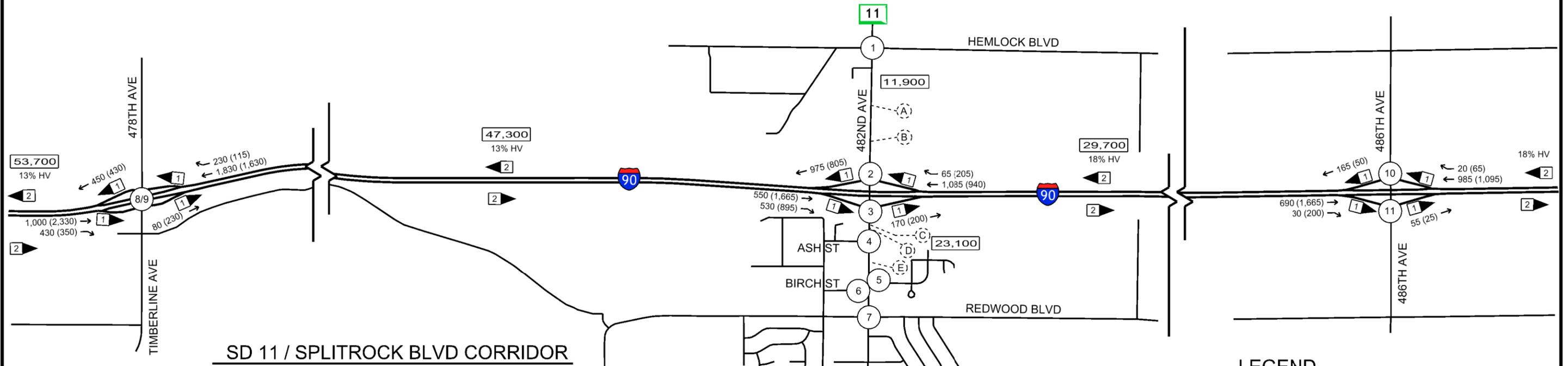
IMJR TRAFFIC VOLUMES
 I-90 EXIT 406 INTERCHANGE
 MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
 FIGURE 16

EXIT 402

EXIT 406

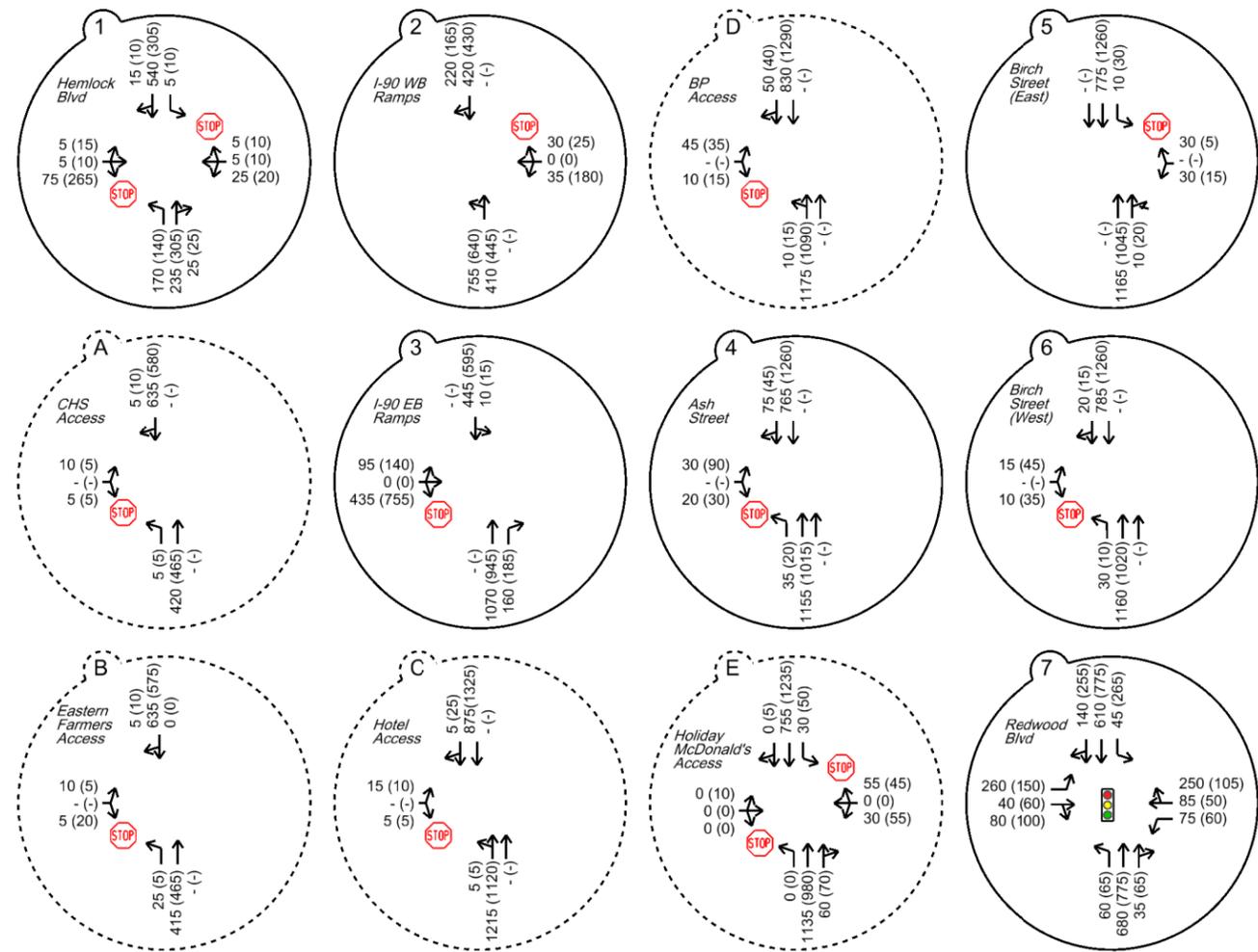
EXIT 410



SD 11 / SPLITROCK BLVD CORRIDOR

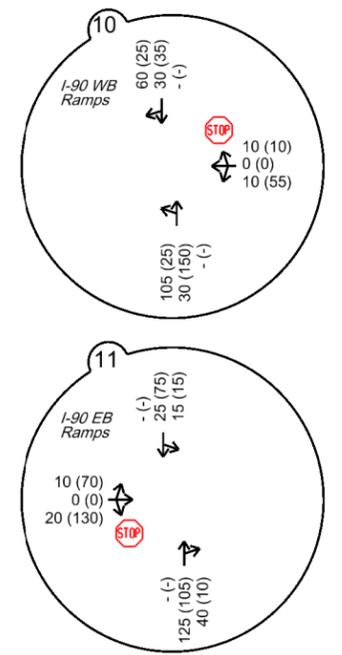
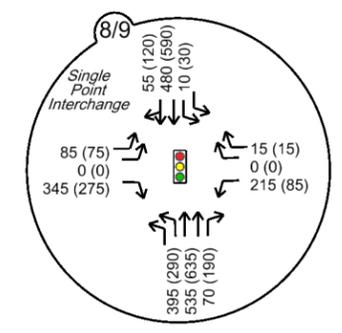
LEGEND

- xx,xxx AVERAGE DAILY TRAFFIC VOLUME (ADT)
- xxx (xxx) AM (PM) PEAK HOUR VOLUME
- Number of lanes and flow direction
- Intersection for analysis
- Driveway access
- Traffic signal control
- Stop control



11 I-90 EXIT 402/TIMBERLINE RD

I-90 EXIT 410/486TH AVE



2045 NO-BUILD CONDITIONS



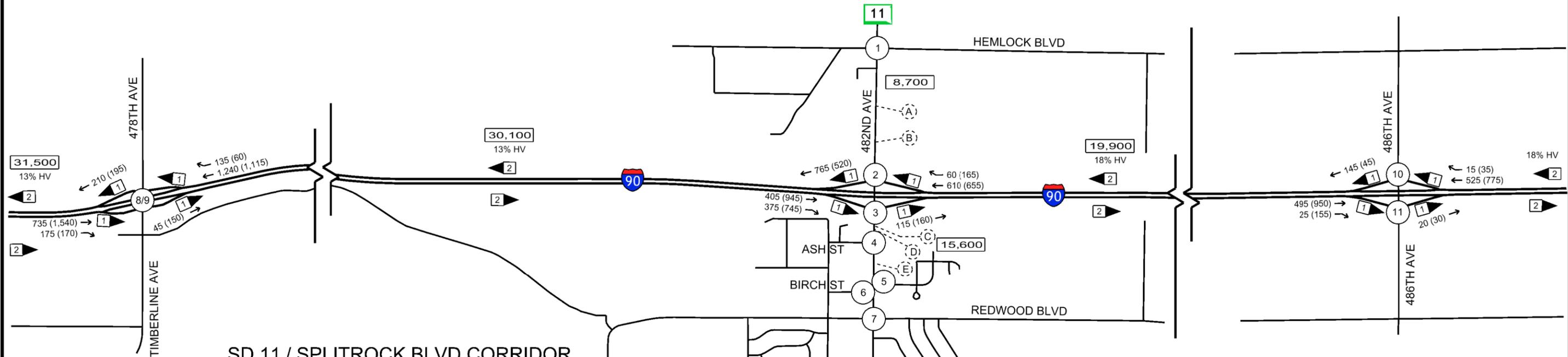
IMJR TRAFFIC VOLUMES
 I-90 EXIT 406 INTERCHANGE
 MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
 FIGURE 17

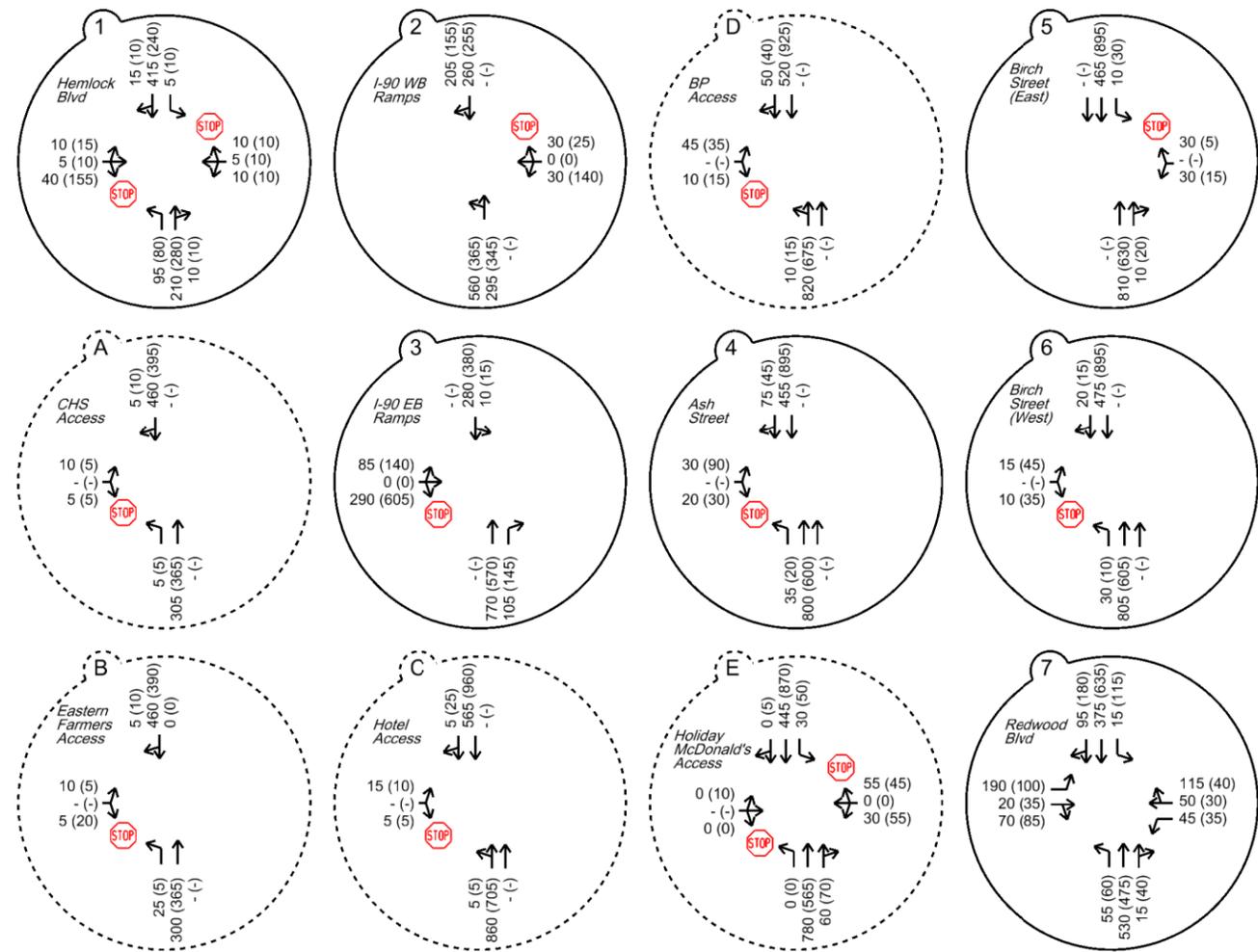
EXIT 402

EXIT 406

EXIT 410



SD 11 / SPLITROCK BLVD CORRIDOR

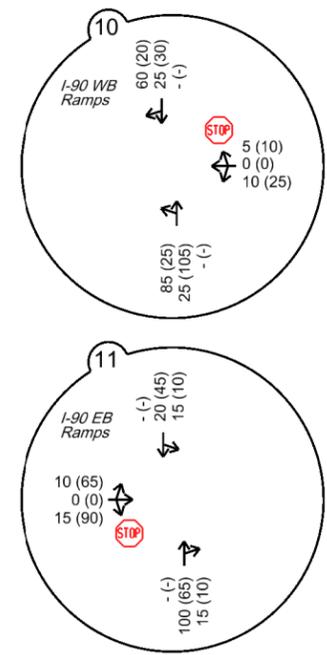
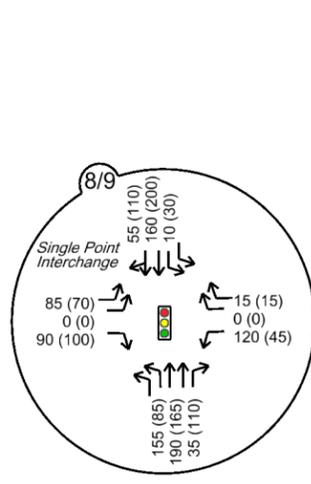


LEGEND

- xx,xxx AVERAGE DAILY TRAFFIC VOLUME (ADT)
- xxx (xxx) AM (PM) PEAK HOUR VOLUME
- Number of lanes and flow direction
- INTERSECTION FOR ANALYSIS
- DRIVEWAY ACCESS
- TRAFFIC SIGNAL CONTROL
- STOP CONTROL

I-90 EXIT 402/TIMBERLINE RD

I-90 EXIT 410/486TH AVE



2022 BUILD CONDITIONS

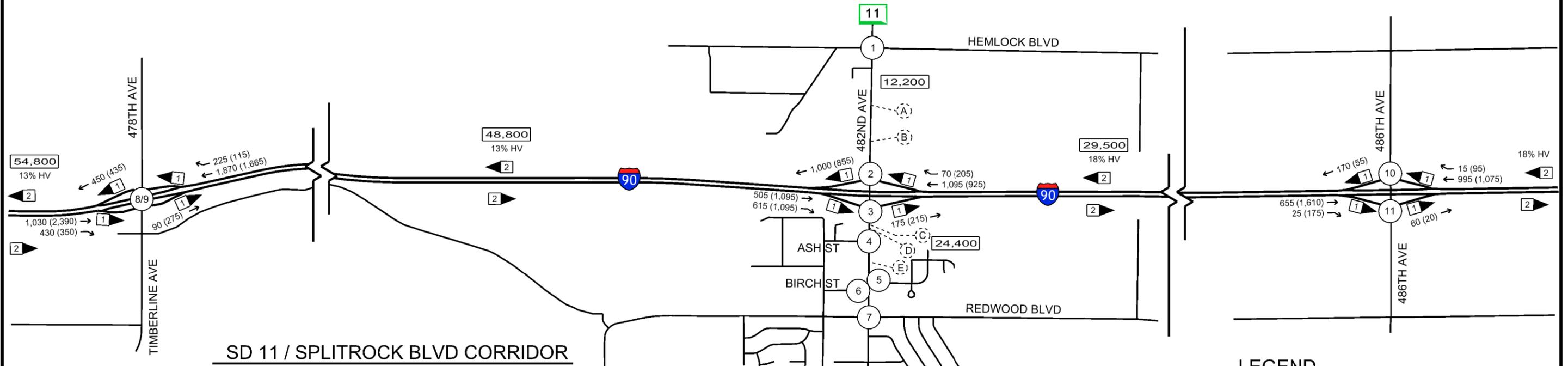
Note: Standard Diamond interchange lane designations shown at intersections #2 and #3 for illustrative depiction of ramp terminals.



EXIT 402

EXIT 406

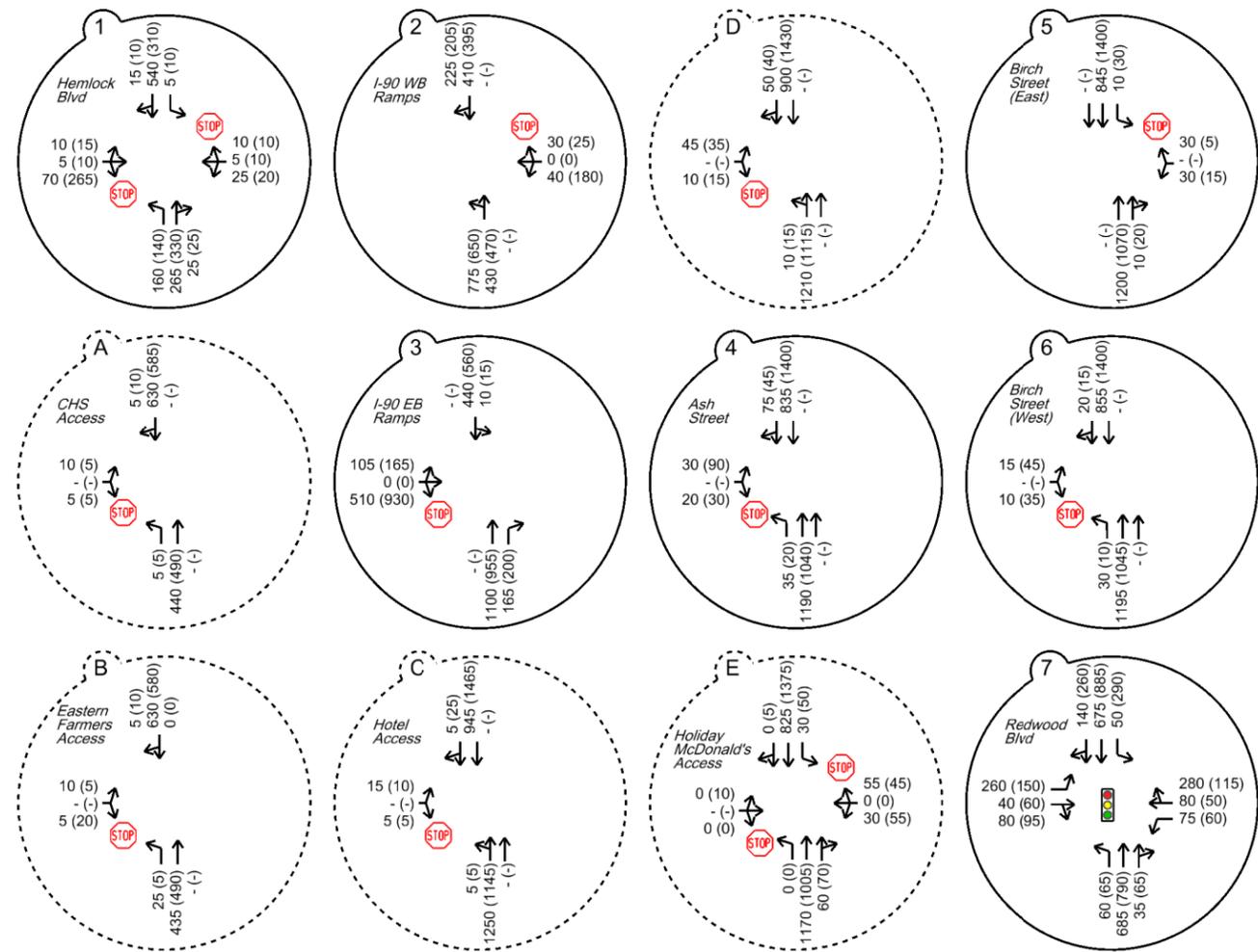
EXIT 410



SD 11 / SPLITROCK BLVD CORRIDOR

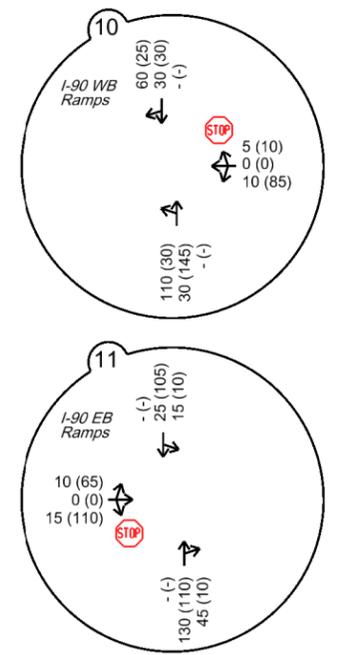
LEGEND

- xx,xxx AVERAGE DAILY TRAFFIC VOLUME (ADT)
- xxx (xxx) AM (PM) PEAK HOUR VOLUME
- Number of lanes and flow direction
- INTERSECTION FOR ANALYSIS
- DRIVEWAY ACCESS
- TRAFFIC SIGNAL CONTROL
- STOP CONTROL



I-90 EXIT 402/TIMBERLINE RD

I-90 EXIT 410/486TH AVE



2045 BUILD CONDITIONS

Note: Standard Diamond interchange lane designations shown at intersections #2 and #3 for illustrative depiction of ramp terminals.



6.2. 2022 No-Build Condition Traffic Operations

The 2022 No-Build Conditions LOS results are summarized in Figure 20 and Tables 18-21. For the local road stop-controlled approaches along SD11/Splitrock Boulevard, measured LOS values reflective of the worst-case stop-controlled approach delay and weighted average intersection delay. HCS 2010 reports are provided in Appendix I.

The signal timings at the SD11/Splitrock Boulevard and Redwood Boulevard intersection were revised to include updated red, yellow, and pedestrian clearance intervals.

Table 18: SD11/Splitrock Boulevard Intersection Traffic Operations – 2022 No-Build Conditions

SD11/Splitrock Boulevard Intersection	Intersection Control Type	AM Peak Period		PM Peak Period	
		Avg. Delay LOS	Local Street Weighted Avg. Delay LOS	Avg. Delay LOS	Local Street Weighted Avg. Delay LOS
Hemlock Boulevard	TWSC	C	A	C	A
I-90 WB Ramp Terminal	TWSC	F	-	F*	-
I-90 EB Ramp Terminal	TWSC	F	-	F*	-
Ash Street	TWSC	D	A	F*	C
Birch Street (East)	TWSC	D	A	E	A
Birch Street (West)	TWSC	C	A	F	A
Redwood Boulevard	Signal	B	-	B	-

* Demand exceeds capacity, volume/capacity (v/c) ratio greater than 1.0.

Table 19: I-90 Exit 406 Ramp Terminal 95th Percentile Queue Lengths – 2022 No-Build Conditions

Stop-Controlled Off-Ramp Approach	AM Peak Period	PM Peak Period
	95 th % Queue (veh)	95 th % Queue (veh)
Eastbound Off-Ramp	10.2	48.6
Westbound Off-Ramp	2.9	14.5

Table 20: I-90 Exit 402 and 410 Ramp Terminal Traffic Operations – 2022 No-Build Conditions

SD11/Splitrock Boulevard Intersection	Intersection Control Type	AM Peak Period		PM Peak Period	
		Avg. Delay LOS	Local Street Weighted Avg. Delay LOS	Avg. Delay LOS	Local Street Weighted Avg. Delay LOS
Exit 402 / Timberline Road					
I-90 SPUI	Signal	C	-	C	-
Exit 410 / 486th Ave					
I-90 WB Ramp Terminal	TWSC	A	-	A	-
I-90 EB Ramp Terminal	TWSC	A	-	A	-

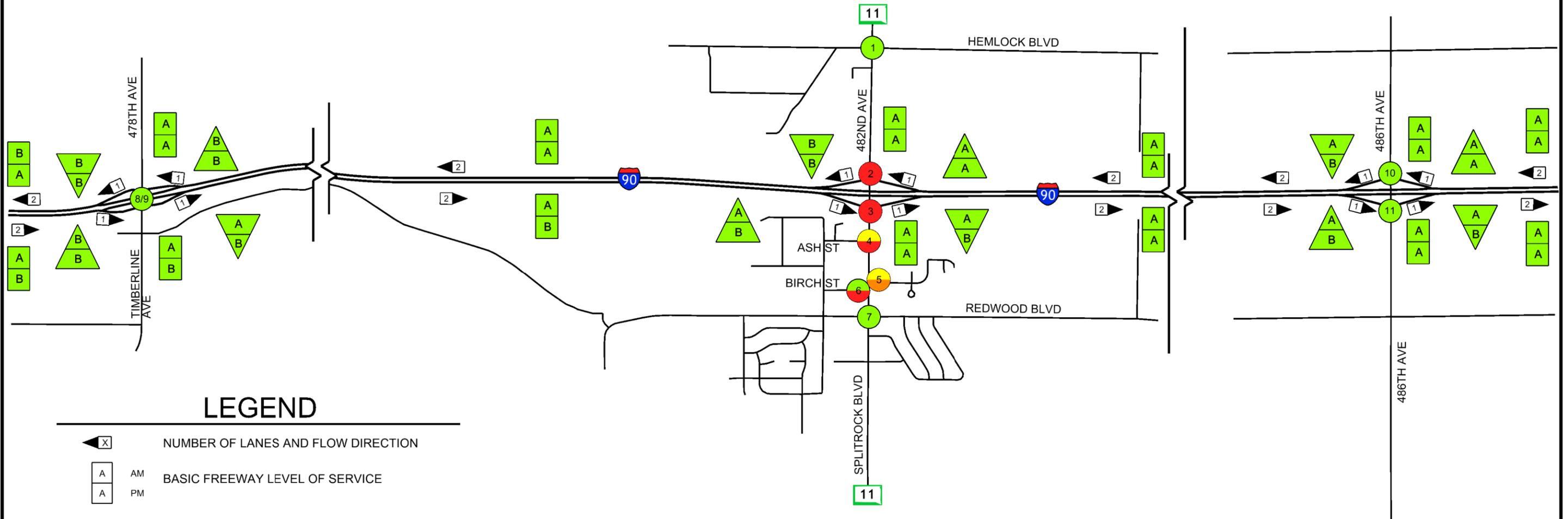
Table 21: I-90 Freeway Segment Traffic Operations – 2022 No-Build Conditions

Freeway Segment	AM Peak Period	PM Peak Period
	LOS	LOS
Eastbound I-90		
Basic, 2-lane mainline to Exit 402	A	B
Diverge, to Timberline Ave	B	B
Basic, 2-lane mainline within Exit 402	A	B
Merge, from Timberline Ave	A	B
Basic, 2-lane mainline between Exit 402 and Exit 406	A	B
Diverge, to SD11/Splitrock Blvd	A	B
Basic, 2-lane mainline within Exit 406	A	A
Merge, from SD11/Splitrock Blvd	A	B
Basic, 2-lane mainline between Exit 406 and Exit 410	A	A
Diverge, to 486 th Ave	A	B
Basic, 2-lane mainline within Exit 410	A	A
Merge, from 486 th Ave	A	B
Basic, 2-lane mainline from Exit 410	A	A
Westbound I-90		
Basic, 2-lane mainline to Exit 410	A	A
Diverge, to 486 th Ave	A	A
Basic, 2-lane mainline within Exit 410	A	A
Merge, from 486 th Ave	A	B
Basic, 2-lane mainline between Exit 410 and Exit 406	A	A
Diverge, to SD11/Splitrock Blvd	A	A
Basic, 2-lane mainline within Exit 406	A	A
Merge, from SD11/Splitrock Blvd	B	B
Basic, 2-lane mainline between Exit 406 and Exit 402	A	A
Diverge, to Timberline Ave	B	B
Basic, 2-lane mainline within Exit 402	A	A
Merge, from Timberline Ave	B	B
Basic, 2-lane mainline to Exit 402	B	A

EXIT 402

EXIT 406

EXIT 410



LEGEND

- NUMBER OF LANES AND FLOW DIRECTION
 - AM BASIC FREEWAY LEVEL OF SERVICE
PM
 - AM RAMP MERGE LEVEL OF SERVICE
PM
 - AM RAMP DIVERGE LEVEL OF SERVICE
PM
 - AM INTERSECTION LEVEL OF SERVICE
PM
- A
B
C
D
E
F

ANALYSIS ASSUMPTIONS

PHF = VARIED (FIELD MEASURED)
 TERRAIN = LEVEL
 fp = 1.00
 MAINLINE BFFS = VARIED (FIELD MEASURED)
 DIAGONAL RAMP FFS = 55.0 MPH
 TRUCK % = VARIED (FIELD MEASURED)

INTERSECTION PEAK HOUR OPERATIONS

ID	CORRIDORS	CONTROL TYPE		HCM 2010 LEVEL OF SERVICE		LOCAL STREET WEIGHTED AVERAGE LEVEL OF SERVICE	
		SIGNAL	STOP	AM	PM	AM	PM
SD11/Splitrock Blvd							
1	SD11 & Hemlock Boulevard		X	C	C	A	A
2	SD11 & I-90 WB Ramp Terminal		X	F	F*	-	-
3	SD11 & I-90 EB Ramp Terminal		X	F	F*	-	-
4	SD11 & Ash Street		X	D	F*	A	C
5	SD11 & Birch Street (East)		X	D	E	A	A
6	SD11 & Birch Street (West)		X	C	F	A	A
7	SD11 & Redwood Boulevard	X		B	B	-	-
478th Ave/Timberline Ave							
8/9	Timberline Ave & I-90 Single Point Interchange	X		C	C	-	-
486th Ave							
10	486th Ave & I-90 WB Ramp Terminal		X	A	A	-	-
11	486th Ave & I-90 EB Ramp Terminal		X	A	A	-	-

NOTES:
 WEIGHTED AVERAGE LOS DERIVED FROM HCM 2010 AWSC LOS CRITERIA
 * DENOTES V/C RATIO > 1



NOT TO SCALE



2022 NO-BUILD CONDITIONS

IMJR TRAFFIC OPERATIONS ANALYSIS
 I-90 EXIT 406 INTERCHANGE
 MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
 FIGURE 20

6.3. 2045 No-Build Condition Traffic Operations

The 2045 Planning Year No-Build Conditions LOS results are summarized in Figure 21 and shown with respective density and average control delay values in Tables 22-25. Measured LOS values reflective of the worst-case stop-controlled approach delay and weighted average intersection delay are reported for each stop-controlled local road intersection. HCS 2010 reports are provided in Appendix J.

The signal timings at the SD11/Splitrock Boulevard and Redwood Boulevard intersection were the same as used for the 2022 No-Build Condition. It was assumed that the SD11/Splitrock Boulevard speed limit would be decreased to 35 mph due to an expected increase in roadside development, compared to the 45 mph in Existing and 2022 No-Build Conditions.

Table 22: SD11/Splitrock Boulevard Intersection Traffic Operations – 2045 No-Build Conditions

SD11/Splitrock Boulevard Intersection	Intersection Control Type	AM Peak Period		PM Peak Period	
		Avg. Delay LOS	Local Street Weighted Avg. Delay LOS	Avg. Delay LOS	Local Street Weighted Avg. Delay LOS
Hemlock Boulevard	TWSC	F	A	F	A
I-90 WB Ramp Terminal	TWSC	F*	-	F*	-
I-90 EB Ramp Terminal	TWSC	F*	-	F*	-
Ash Street	TWSC	F	A	F*	F
Birch Street (East)	TWSC	F	A	F	A
Birch Street (West)	TWSC	F	A	F*	B
Redwood Boulevard	Signal	C	-	B	-

* Demand exceeds capacity, volume/capacity (v/c) ratio greater than 1.0.

Table 23: I-90 Exit 406 Ramp Terminal 95th Percentile Queue Lengths – 2045 No-Build Conditions

Stop-Controlled Off-Ramp Approach	AM Peak Period	PM Peak Period
	95 th % Queue (veh)	95 th % Queue (veh)
Eastbound Off-Ramp	45.2	96.5
Westbound Off-Ramp	Exceeded HCS calculation range	Exceeded HCS calculation range

Table 24: I-90 Exit 402 and 410 Ramp Terminal Traffic Operations – 2045 No-Build Conditions

SD11/Splitrock Boulevard Intersection	Intersection Control Type	AM Peak Period		PM Peak Period	
		Avg. Delay LOS	Local Street Weighted Avg. Delay LOS	Avg. Delay LOS	Local Street Weighted Avg. Delay LOS
Exit 402 / Timberline Road					
I-90 SPU1	Signal	C	-	C	-
Exit 410 / 486th Ave					
I-90 WB Ramp Terminal	TWSC	A	-	B	-
I-90 EB Ramp Terminal	TWSC	A	-	A	-

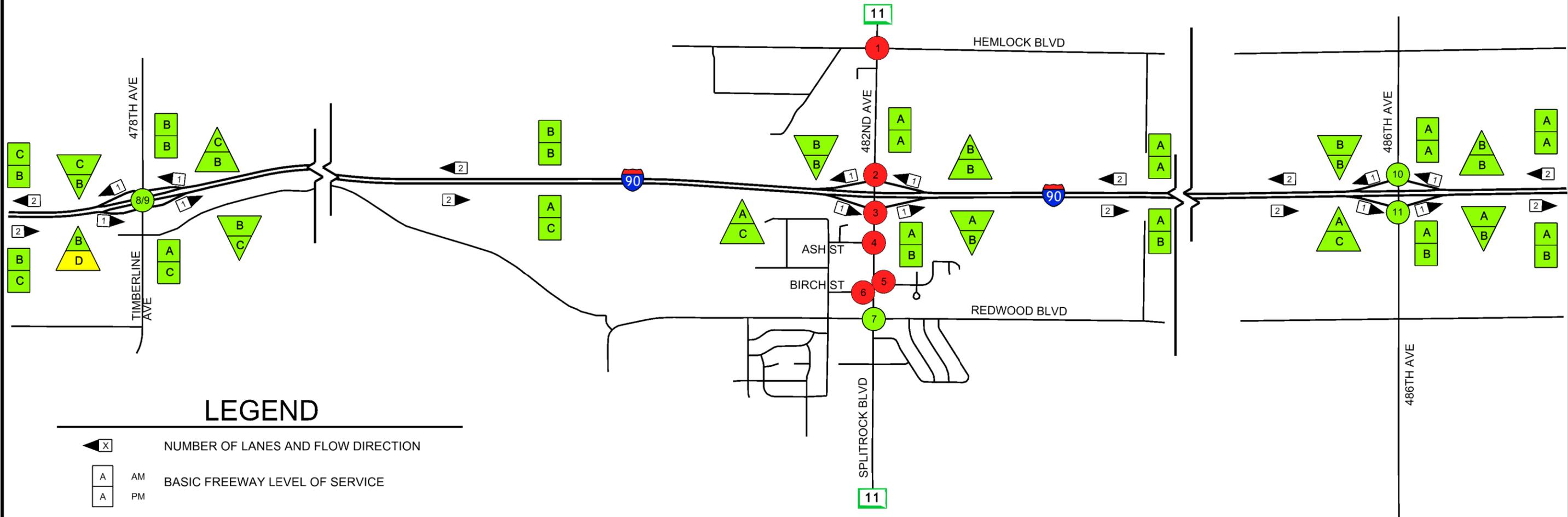
Table 25: I-90 Freeway Segment Traffic Operations – 2045 No-Build Conditions

Freeway Segment	AM Peak Period	PM Peak Period
	LOS	LOS
Eastbound I-90		
Basic, 2-lane mainline to Exit 402	B	C
Diverge, to Timberline Ave	B	D
Basic, 2-lane mainline within Exit 402	A	C
Merge, from Timberline Ave	B	C
Basic, 2-lane mainline between Exit 402 and Exit 406	A	C
Diverge, to SD11/Splitrock Blvd	A	C
Basic, 2-lane mainline within Exit 406	A	B
Merge, from SD11/Splitrock Blvd	A	B
Basic, 2-lane mainline between Exit 406 and Exit 410	A	B
Diverge, to 486 th Ave	A	C
Basic, 2-lane mainline within Exit 410	A	B
Merge, from 486 th Ave	A	B
Basic, 2-lane mainline from Exit 410	A	B
Westbound I-90		
Basic, 2-lane mainline to Exit 410	A	A
Diverge, to 486 th Ave	B	B
Basic, 2-lane mainline within Exit 410	A	A
Merge, from 486 th Ave	B	B
Basic, 2-lane mainline between Exit 410 and Exit 406	A	A
Diverge, to SD11/Splitrock Blvd	B	B
Basic, 2-lane mainline within Exit 406	A	A
Merge, from SD11/Splitrock Blvd	B	B
Basic, 2-lane mainline between Exit 406 and Exit 402	B	B
Diverge, to Timberline Ave	C	B
Basic, 2-lane mainline within Exit 402	B	B
Merge, from Timberline Ave	C	B
Basic, 2-lane mainline to Exit 402	C	B

EXIT 402

EXIT 406

EXIT 410



LEGEND

- NUMBER OF LANES AND FLOW DIRECTION
 - AM BASIC FREEWAY LEVEL OF SERVICE
PM
 - AM RAMP MERGE LEVEL OF SERVICE
PM
 - AM RAMP DIVERGE LEVEL OF SERVICE
PM
 - AM INTERSECTION LEVEL OF SERVICE
PM
- A
B
C
D
E
F

ANALYSIS ASSUMPTIONS

PHF = 0.9
 TERRAIN = LEVEL
 fp = 1.00
 MAINLINE BFFS = VARIED (FIELD MEASURED)
 DIAGONAL RAMP FFS = 55.0 MPH
 TRUCK % = VARIED (FIELD MEASURED)

INTERSECTION PEAK HOUR OPERATIONS

ID	CORRIDORS	CONTROL TYPE		HCM 2010 LEVEL OF SERVICE		LOCAL STREET WEIGHTED AVERAGE LEVEL OF SERVICE	
		SIGNAL	STOP	AM	PM	AM	PM
SD11/Splitrock Blvd							
1	SD11 & Hemlock Boulevard		X	F	F	A	A
2	SD11 & I-90 WB Ramp Terminal		X	F*	F*	-	-
3	SD11 & I-90 EB Ramp Terminal		X	F*	F*	-	-
4	SD11 & Ash Street		X	F	F*	A	F
5	SD11 & Birch Street (East)		X	F	F	A	A
6	SD11 & Birch Street (West)		X	F	F*	A	B
7	SD11 & Redwood Boulevard	X		C	B	-	-
478th Ave/Timberline Ave							
8/9	Timberline Ave & I-90 Single Point Interchange	X		C	C	-	-
486th Ave							
10	486th Ave & I-90 WB Ramp Terminal		X	A	B	-	-
11	486th Ave & I-90 EB Ramp Terminal		X	A	A	-	-

NOTES:
 WEIGHTED AVERAGE LOS DERIVED FROM HCM 2010 AWSC LOS CRITERIA
 * DENOTES V/C RATIO > 1

2045 NO-BUILD CONDITIONS



IMJR TRAFFIC OPERATIONS ANALYSIS
 I-90 EXIT 406 INTERCHANGE
 MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
 FIGURE 21

6.4. Future Year No-Build Traffic Operations Conclusions

The Existing Conditions analysis notes capacity constraints that are already present at the two Exit 406 ramp terminal intersections. As volumes are projected to increase towards years 2022 and 2045, the future-year No-Build analyses demonstrate a continued degradation in ramp terminal intersection operations. The westbound ramp terminal stop-controlled off-ramp approach is operating at LOS F in both the AM and PM peak hours. The eastbound ramp terminal intersection stop-controlled off-ramp approach is operating at LOS F in the PM peak hour. Measured 95th percentile queue lengths also continue to grow as motorists have increasing difficulty finding adequate gaps for turns. The eastbound off-ramp queue in the 2022 PM peak period extends onto I-90 mainline. By 2045, off-ramp queue impacts would be expected on both off-ramps in the AM and PM peak period.

Throughout the remainder of the corridor, the four local street (Hemlock Boulevard, Ash Street, Birch Street to the east, and Birch Street to the west) stop-controlled approaches also continue to degrade as corridor traffic volumes increase from the Existing Conditions. In 2045 No-Build Conditions, the worst-case stop-controlled approaches at two-way stop-controlled intersection all exhibit LOS E or F in both AM and PM peak hours.

The weighted average delay at the four local street stop-controlled intersections is typically less than 10 seconds per vehicle across all three analysis scenarios. When compared to LOS thresholds for an all-way stop-controlled intersection, LOS A was typically noted through year 2045. The lone exception was LOS F at the Ash Street intersection in the PM peak period 2045 No-Build Conditions. It should be noted, however, that a redistribution of traffic to other access locations or alteration of traffic patterns within and around the industrial area to intersections with greater capacity would be expected to some extent due to experienced delay on the Ash Street approach. The signalized intersection of Redwood Boulevard and SD11/Splitrock Boulevard, for example, has ample capacity to accommodate greater turning demand into and out of the industrial area. Overall, this redistribution or alteration of traffic patterns would result in lower volumes, less delay, and improved LOS on the high delay stop-controlled approaches.

Along I-90, all analyzed freeway segments within the Existing Conditions, 2022 No-Build Conditions, and 2045 No-Build Conditions resulted in LOS C or better except the eastbound diverge to Exit 402 that was measured as a LOS D.

7. Alternatives Analysis

Chapter 6, Alternatives, summarized the development and screening process for potential interchange and corridor concepts and Build Alternatives. The following interchange and corridor Build Alternatives were carried forward (from Chapter 6) for further analysis in this chapter:

- No-Build.
- Interchange Build Alternative 11: Diverging Diamond Interchange.
- Corridor Build Alternative A: SD11/Splitrock Boulevard – 5-Lane Undivided (south of I-90).
- Corridor Build Alternative F: SD11/Splitrock Boulevard – 3-Lane Undivided (north of I-90).

This chapter investigates potential build-out alternatives of DDI Build Alternative 11, tailoring nuances of each layout to meet the long-term operational, safety, and design goals of the interchange as identified by the study team. Following the evolution of potential build-out alternatives, they are compared to the No-Build alternative as part of the Alternatives Analysis.

7.1. Build-out of DDI Configuration

The build-out of potential DDI configurations focused on four primary areas for further investigation and refinement within or adjacent to the interchange footprint:

- Bridge Design Life and Typical Cross-Section.
- Eastbound I-90 Ramp Terminal – Eastbound to Southbound Right-Turn Traffic Control.
- Ash Street Intersection Traffic Control.
- Control of Access.

Bridge Design Life and Typical Cross-Section

This study forecasts traffic volumes out to the 2045 Planning Year. Those volumes were used to develop the set of concepts and Build Alternatives that met operational (LOS) acceptability per the objectives of this project. In many instances, 2045 forecast volumes necessitated only a single through lane in one or both directions through the interchange to address the established operational need. However, the SDDOT designs bridges out to a 75-year design life, equivalent to another 55+/- years beyond this study's forecasts. Expansion from a single lane to two lanes in both directions provides capacity beyond the 2045 study horizon and minimizes the need to come back and expand the bridge in the future.

The bridge cross-section should also consider existing and future roadway cross-sections to the north and south of the interchange. Currently, the SD11/Splitrock Boulevard corridor is a 5-lane cross-section, with two through lanes in each direction, south of Ash Street through Brandon. The majority of existing and future-year traffic using the interchange originates or is destined for the greater Brandon area south of I-90. Thus, two travel lanes in each direction south of the interchange is an established cross-section to accommodate existing and future demand. To the north of I-90, even though the current lane configuration is striped as a 3-lane roadway, the current cross-section is representative of a 5-lane paving section with 5-12 foot lanes extending from north of the interchange through Corson. This section could quickly be converted to a 5-

lane roadway with the addition of shoulders or curb and gutter when traffic demand warrants conversion.

Eastbound Ramp Terminal – Eastbound to Southbound Right-Turn Traffic Control

Another consideration within the DDI Build Alternative configuration is the proposed traffic control for eastbound to southbound right-turning traffic at the eastbound I-90 ramp terminal intersection. In the PM peak period, this movement exhibits high volumes as Brandon area residents are returning from work in Sioux Falls and other areas to the west. Providing a free right-turn movement at this location would allow traffic to progress through the ramp terminal and continue southbound without stopping. A single right-turn lane would be provided on the ramp with a lane-add to the south on SD11/Splitrock Boulevard, so the turning vehicles will be able to continue the turn into their own lane and not need to yield to oncoming through traffic. Ultimately, this right-turn treatment reduces the risk of a stopped queue on the eastbound off-ramp.

A drawback of a free-right turn movement into an added lane on SD11/Splitrock Boulevard is that it creates an uncontrolled crossing for pedestrians and bicyclists. Pedestrians would be required to find a gap in traffic in order to cross the free right movement, which is expected to be difficult in the afternoon peak hours when there is an almost continuous stream of traffic exiting and turning south on SD11/Splitrock Boulevard.

For bicyclists heading southbound within a widened travel lane or bicycle lane, this widened area would be situated between the inside through lane and the lane-add from the free-right turn movement. Similar to the concern of pedestrians finding a gap in an almost continuous stream of traffic to cross the free right-turn lane, bicyclists would also be required to find a gap in this same flow of traffic to weave across the lane-add over to the widened lane or bicycle lane on the outside of the SD11/Splitrock Boulevard cross-section.

A second traffic control option for this eastbound to southbound right-turn movement is signalization. From a geometrics standpoint, DDI Build Alternatives that incorporate dual right-turns were designed with sight lines that are adequate to permit right-turn on red. However, these Build Alternatives were designed to accommodate demand where right-turn on red is prohibited.

Benefits to signalizing the dual right-turn lanes include the additional control of movements at the intersection, providing a controlled opportunity for pedestrians to cross, and addressing the potential weave conflict between southbound through traffic and right-turning traffic entering the corridor in an added lane. Two continuous southbound lanes could be carried through the DDI, instead of dropping one lane as a left-turn to the eastbound off-ramp in order to add a lane from the eastbound on-ramp free right-turn. Another benefit is realized for bicyclists within the southbound widened lane or bicycle lane. They can continue southbound through the crossover intersection on the outside of a through lane with southbound through traffic and not need to weave across the off-ramp right-turn traffic.

There are, however, operational and safety drawbacks to signalized control of this right-turn movement. In the Build Alternatives refinement phase, preliminary investigation of this operation indicated that two right-turn lanes would be required to manage ramp queues and minimize risk of queue spillback onto or near the I-90 mainline. Even with two lanes and an overlap to the northbound crossover phase, a considerable amount of green time is needed to serve the off-ramp right-turn demand. Compared to the signal timings used in the free right-turn DDI Build Alternatives analysis, signalizing the right-turn movement (overlapped to northbound through) requires reducing the green time for southbound through within the same cycle length or increasing the cycle length to accommodate a longer off-ramp right-turn green (overlapped to northbound through). In both instances, increased delay is experienced on at least one movement within the DDI as traffic cannot be served as quickly.

Ash Street Intersection Traffic Control

IMJR analysis areas typically encompass the next major intersection along the interchange crossroad. In this case, the next major intersections are Redwood Boulevard to the south and Hemlock Boulevard to the north. The Redwood Boulevard intersection is the only signalized intersection in the study area. In addition to discussions as a study team, several comments were received regarding further study of signalizing the Ash Street intersection to improve 'access' and safety for vehicles and trucks turning into and out of the Ash Street approach.

From an operations standpoint, a signal would improve average intersection delay. However, it would degrade operations along the entire corridor in terms of average travel speed due to creating another opportunity to stop the significantly higher through traffic volumes.

A traffic signal warrant was conducted at the intersection and concluded that the current volumes do not meet warrants for installation of a traffic signal (Appendix K). Forecasts to years 2022 and 2045 indicate that a signal may be warranted by year 2022 with this study's analysis assumptions, input variables, and traffic forecasts. However, because traffic patterns change over time and projected development does not always come to fruition, the analysis concluded that the intersection be reevaluated with updated traffic volumes before making a decision to install a signal.

A third consideration is the SD11/Splitrock Boulevard access classification of Intermediate Urban, which requires a minimum signal spacing of ½ mile between signalized intersections. If the eastbound ramp terminal intersection is signalized, as proposed in the DDI Build Alternative, signal spacing between the interchange crossover intersection and Redwood Boulevard would be approximately 2,150 feet. Therefore, a traffic signal will not be permitted at the Ash Street intersection given the current Intermediate Urban access classification.

DDI Build Alternatives

Due to the need for accommodating traffic volumes that are forecast to keep growing after year 2045, the DDI configuration was built-out to preemptively address these increases shown in the development of Build Alternatives 11-2, 11-3, 11-4, and 11-5. Each build-out alternative incorporates the same ramp junctions with the I-90 mainline. The primary differences occur

along the SD11/Splitrock Boulevard corridor up to and through the ramp terminals and crossover intersections.

Build Alternative 11-1 – Reflects initial DDI configuration carried forward from EA screening process (known as Build Alternative 11). This Build Alternative carries a single lane of through traffic in both directions through the interchange. A second lane is dropped as a left-turn onto the eastbound and westbound I-90 on-ramps. (Figure 22)

Build Alternative 11-2 – Layout builds upon Build Alternative 11-1 and addresses lane utilization concerns in the northbound direction. Because of the single left-turn lane, concern was noted regarding vehicles beginning to occupy the inside lane well in advance of the southern crossover and lead to delays and lane change concerns between the crossover intersection. (Figure 23)

- *Change from 11-1: At the northern crossover, the approaching northbound travel lane configuration exhibits a left-turn and shared left-turn/through.*

Build Alternative 11-3 – Layout builds upon Build Alternative 11-2 and provides a second, continuous northbound lane through the two crossover intersections. (Figure 24)

- *Change from 11-2: 2 northbound through lanes carried through both crossover intersections.*

Build Alternative 11-4 – Layout builds upon Build Alternative 11-3 and signalizes the eastbound to southbound right-turn movement at the eastbound I-90 ramp terminal intersection. This necessitates dual right-turn lanes on the off-ramp approach. A lane is added between this ramp terminal and Ash Street, dropping as a right-turn-only lane into Ash Street. Two southbound through lanes are carried through the interchange. (Figure 25)

- *Changes from 11-3: Dual eastbound right-turn lanes at eastbound ramp terminal intersection (signal control); 2 southbound through lanes carried through both crossover intersections.*

Build Alternative 11-5 – Layout builds upon Build Alternative 11-3 and signalizes the eastbound to southbound right-turn movement at the eastbound I-90 ramp terminal intersection. This necessitates dual right-turn lanes on the off-ramp approach both of which feed directly into dual southbound through lanes that are carried through both crossover intersections. This Build Alternative is the lone alternative that provides two continuous northbound and southbound lanes through the interchange. (Figure 26)

- *Changes from 11-3: Dual eastbound right-turn lanes at eastbound ramp terminal intersection (signal control); 2 southbound through lanes carried through both crossover intersections.*

Control of single lane off-ramp approaches that are a merge movement into a northbound/southbound SD11/Splitrock Boulevard lane was modified in the build-out and refinement process. It was determined that yield control for these movements is a practical control for low to moderate traffic volumes, which are expected for these movements. Further, there are no pedestrian conflicts for off-ramp left-turn movements. Free movements were

maintained as free turning movements into their own lane, as applicable in 11-1, 11-2, and 11-3. The following single lane off-ramp movements were modified to yield control, where applicable within the respective DDI Build Alternative:

- Eastbound off-ramp single lane left-turn (11-1, 11-2, 11-3, 11-4, and 11-5)
- Westbound off-ramp single lane right-turn (11-3, 11-4, and 11-5)
- Westbound off-ramp single lane left-turn (11-1, 11-2, 11-3, 11-4, and 11-5)

A southbound left-turn lane to Ash Street shown in previously developed concepts was removed in the Build Alternative refinement. Future development in the southeast interchange quadrant and subsequent traffic impact study will determine this need.

For DDI Build Alternatives with proposed SD11/Splitrock Boulevard access closures between I-90 and Ash Street, the following access accommodations are provided:

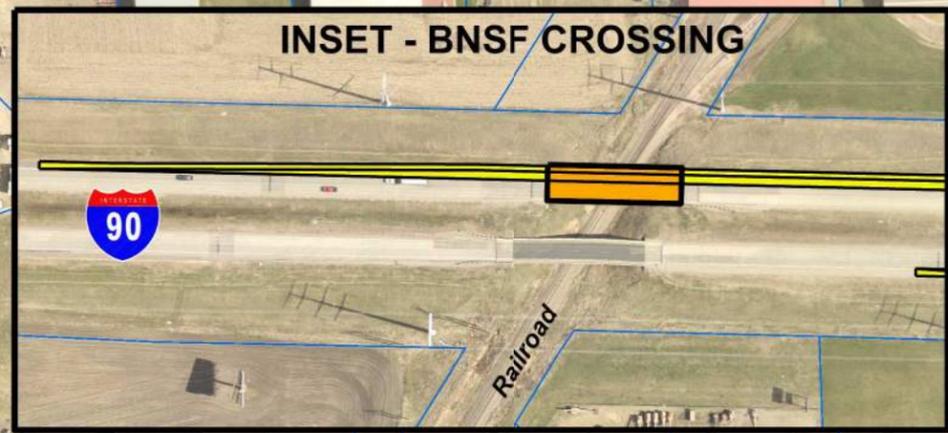
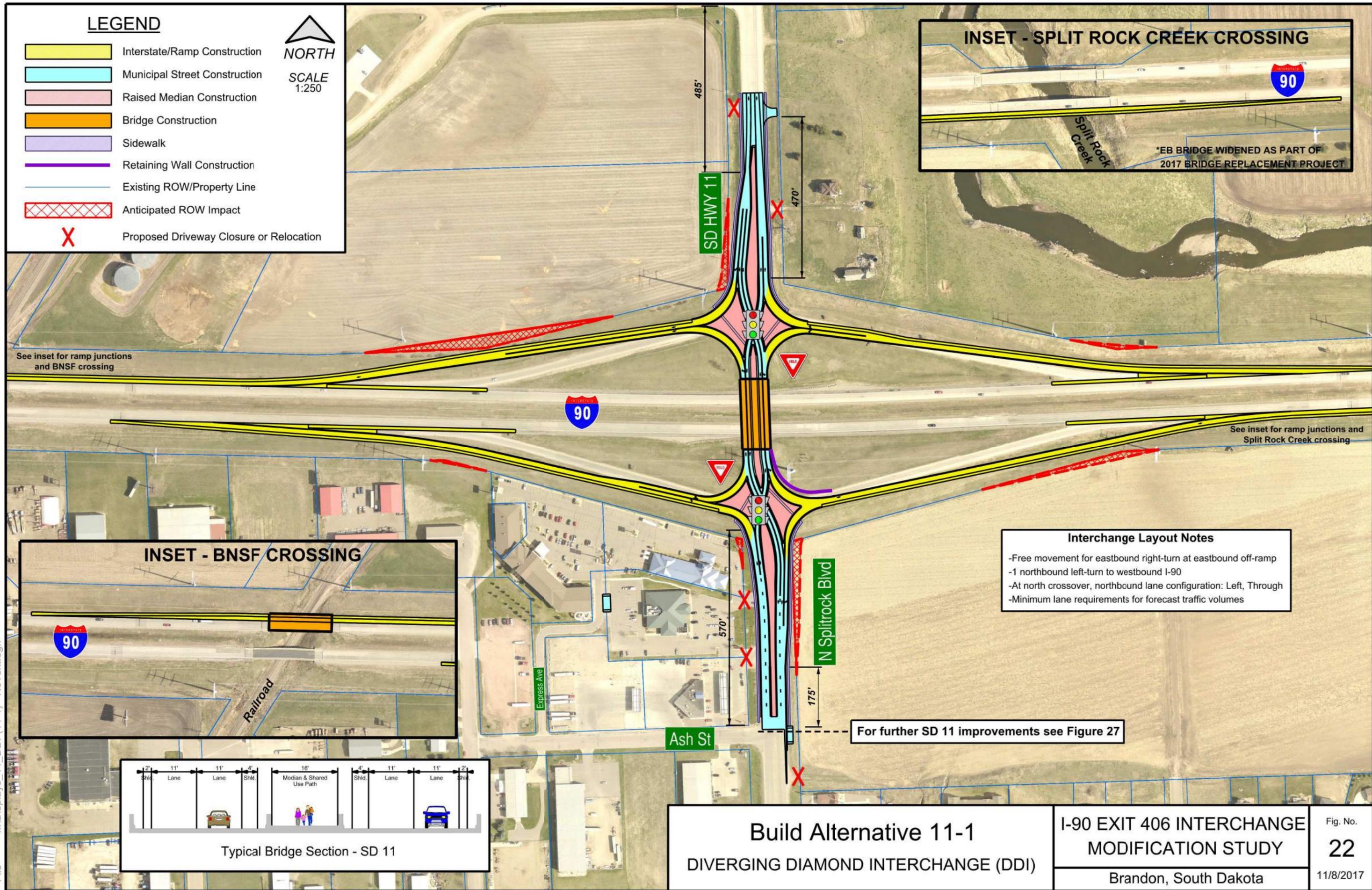
- Closed hotel access
 - New access provided via Express Avenue and an access easement across existing hotel parking lot.
- Closed restaurant/gas station access
 - New access provided to restaurant parcel via Express Avenue and a new driveway.
 - Access to gas station maintained via Ash Street and existing driveways.

The Corridor Build Alternative A limits were adjusted through the interchange build-out process. All improvements between the eastbound I-90 ramp terminal intersection and Ash Street are tied to the interchange improvements due to control of access considerations. Figure 27 depicts the proposed limits of Corridor Build Alternative A, multi-modal improvements on the west side of SD11/Splitrock Boulevard, and access modifications. Figure 28 depicts the proposed Corridor Build Alternative F limits and access modifications.

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation

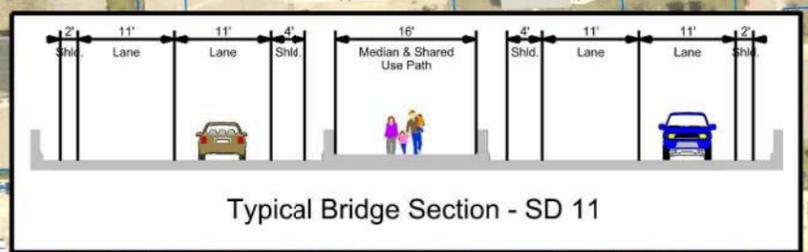
NORTH
SCALE
1:250



Interchange Layout Notes

- Free movement for eastbound right-turn at eastbound off-ramp
- 1 northbound left-turn to westbound I-90
- At north crossover, northbound lane configuration: Left, Through
- Minimum lane requirements for forecast traffic volumes

For further SD 11 improvements see Figure 27

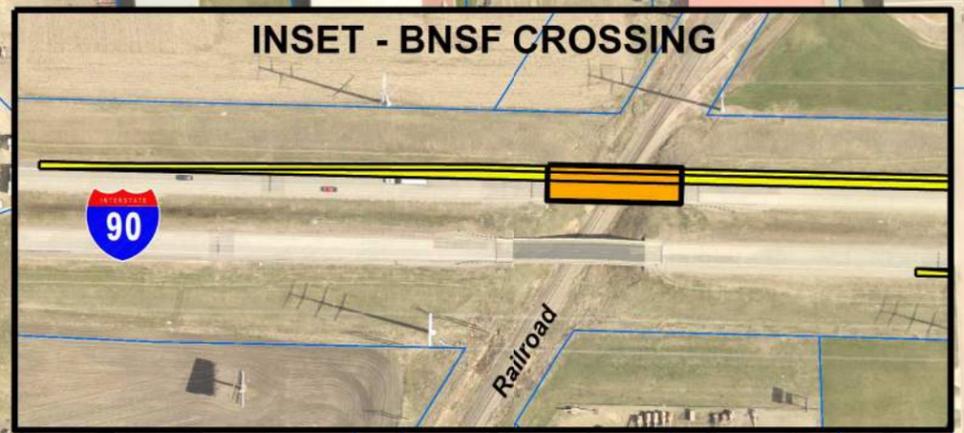
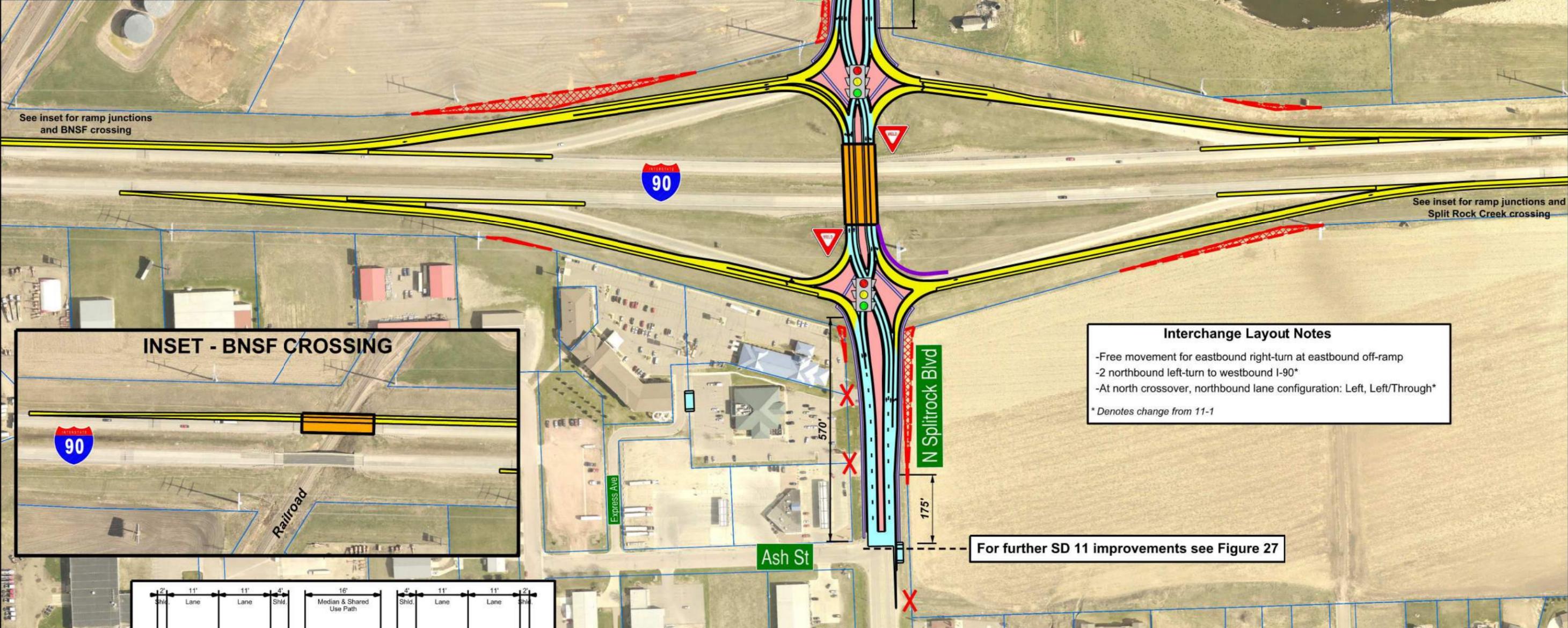


<p>Build Alternative 11-1 DIVERGING DIAMOND INTERCHANGE (DDI)</p>	<p>I-90 EXIT 406 INTERCHANGE MODIFICATION STUDY</p>	<p>Fig. No. 22</p>
<p>Brandon, South Dakota</p>		<p>11/8/2017</p>

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation

NORTH
SCALE
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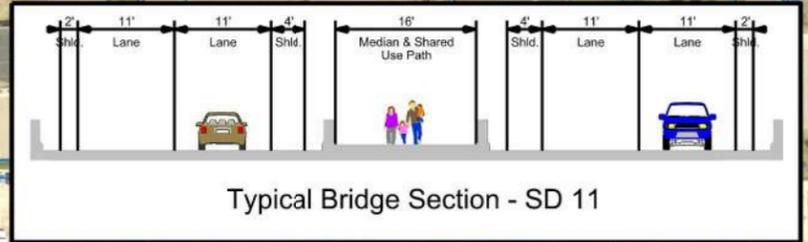


Interchange Layout Notes

- Free movement for eastbound right-turn at eastbound off-ramp
- 2 northbound left-turn to westbound I-90*
- At north crossover, northbound lane configuration: Left, Left/Through*

* Denotes change from 11-1

For further SD 11 improvements see Figure 27

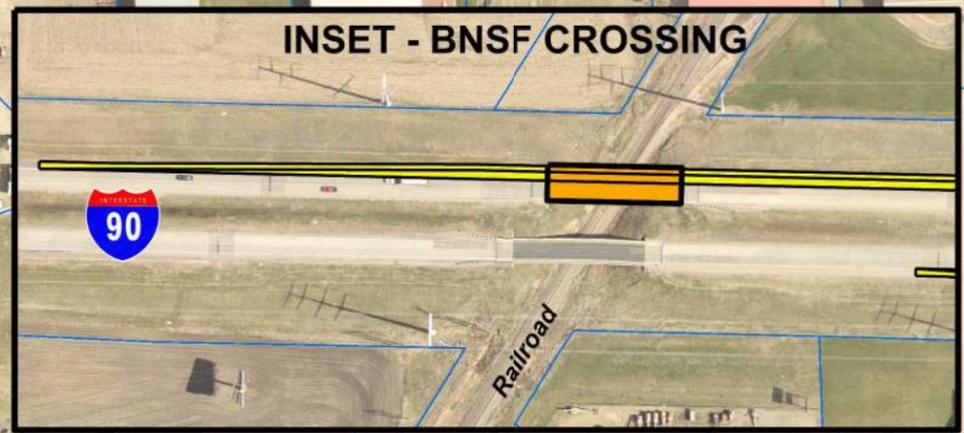
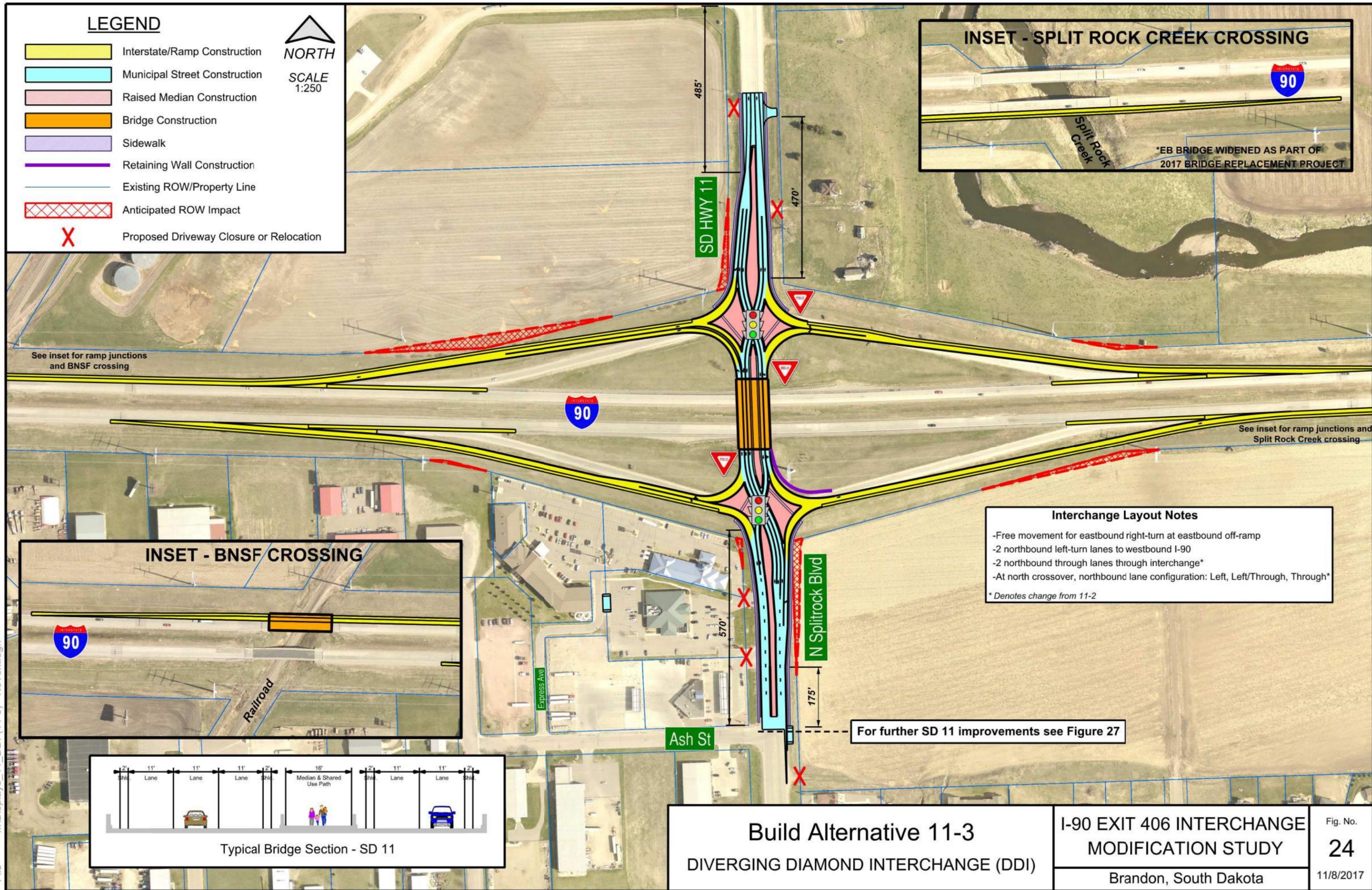
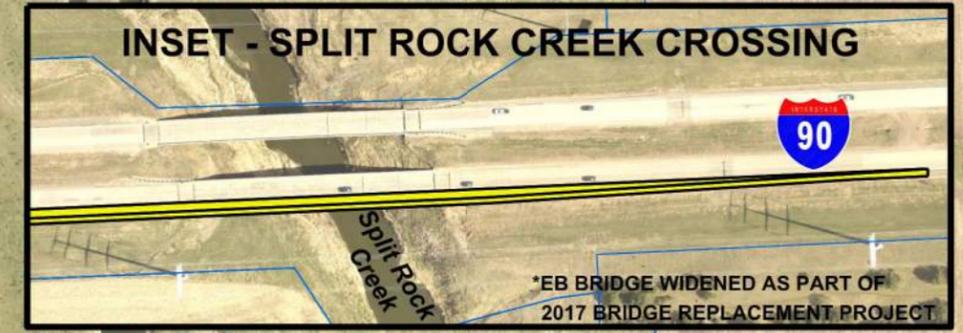


<p>Build Alternative 11-2 DIVERGING DIAMOND INTERCHANGE (DDI)</p>	<p>I-90 EXIT 406 INTERCHANGE MODIFICATION STUDY</p>	<p>Fig. No. 23 11/8/2017</p>
<p>Brandon, South Dakota</p>		

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation

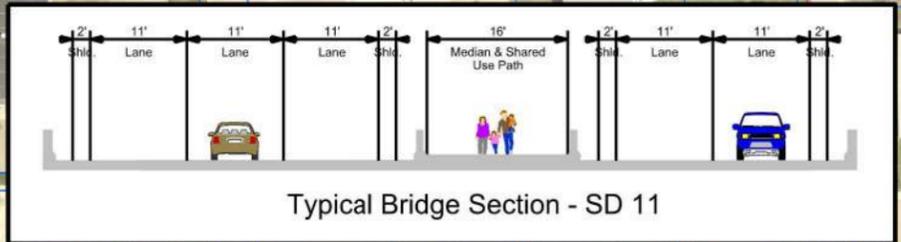
NORTH
SCALE
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Interchange Layout Notes

- Free movement for eastbound right-turn at eastbound off-ramp
- 2 northbound left-turn lanes to westbound I-90
- 2 northbound through lanes through interchange*
- At north crossover, northbound lane configuration: Left, Left/Through, Through*

* Denotes change from 11-2

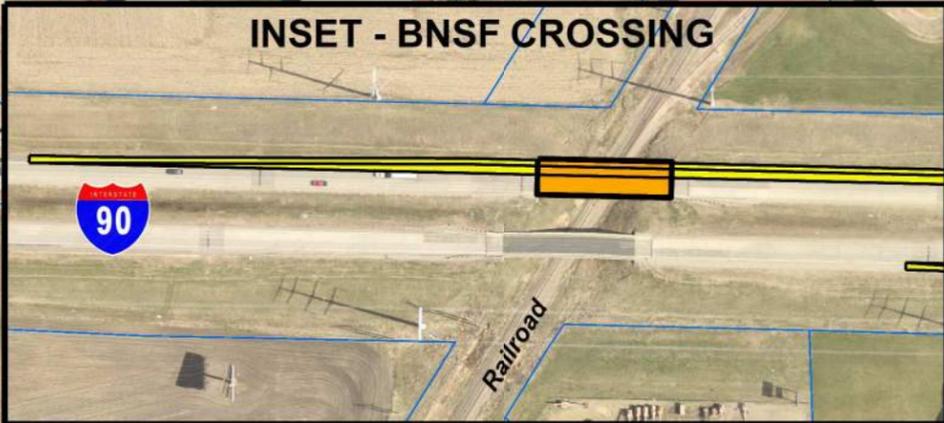
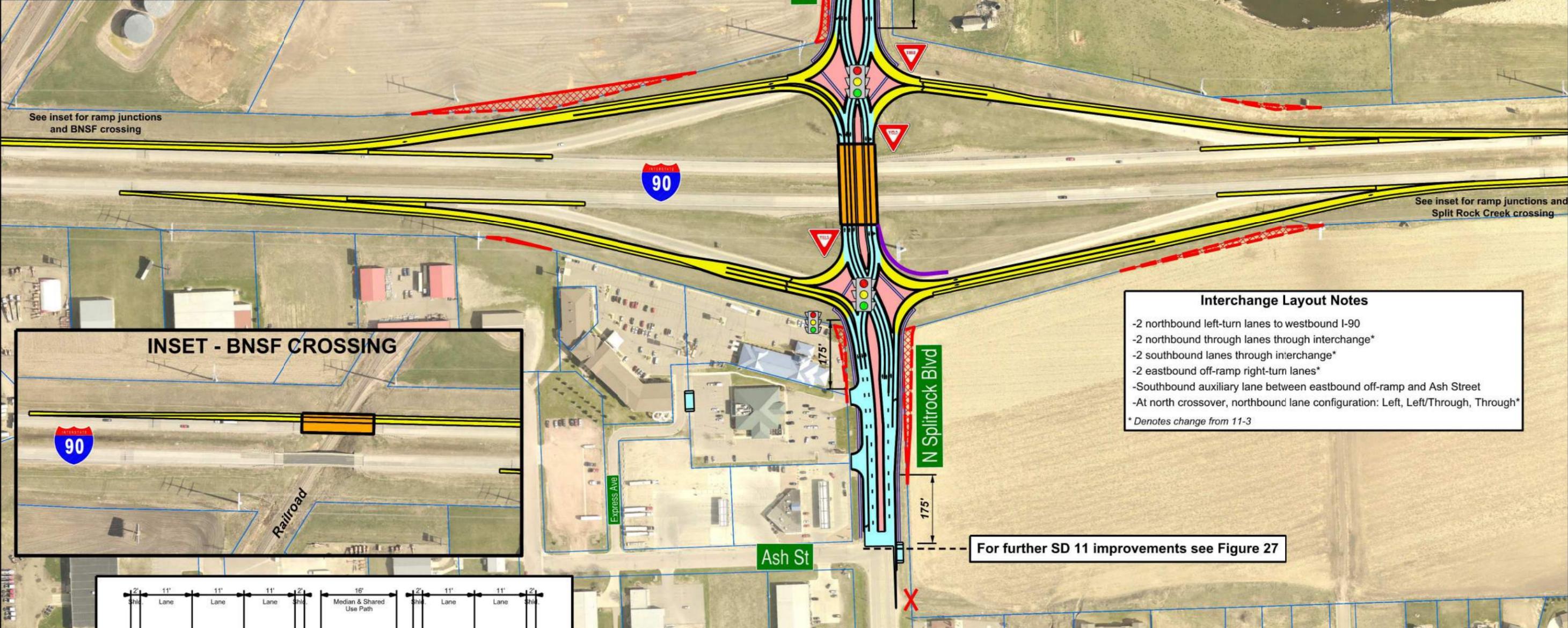


<p>Build Alternative 11-3 DIVERGING DIAMOND INTERCHANGE (DDI)</p>	<p>I-90 EXIT 406 INTERCHANGE MODIFICATION STUDY</p>	<p>Fig. No. 24 11/8/2017</p>
<p>Brandon, South Dakota</p>		

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation

NORTH
SCALE
1:250

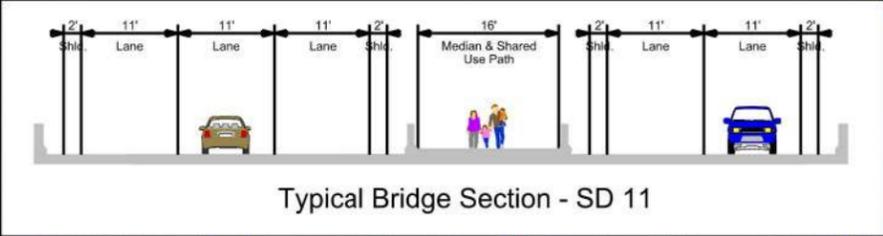


Interchange Layout Notes

- 2 northbound left-turn lanes to westbound I-90
- 2 northbound through lanes through interchange*
- 2 southbound lanes through interchange*
- 2 eastbound off-ramp right-turn lanes*
- Southbound auxiliary lane between eastbound off-ramp and Ash Street
- At north crossover, northbound lane configuration: Left, Left/Through, Through*

* Denotes change from 11-3

For further SD 11 improvements see Figure 27

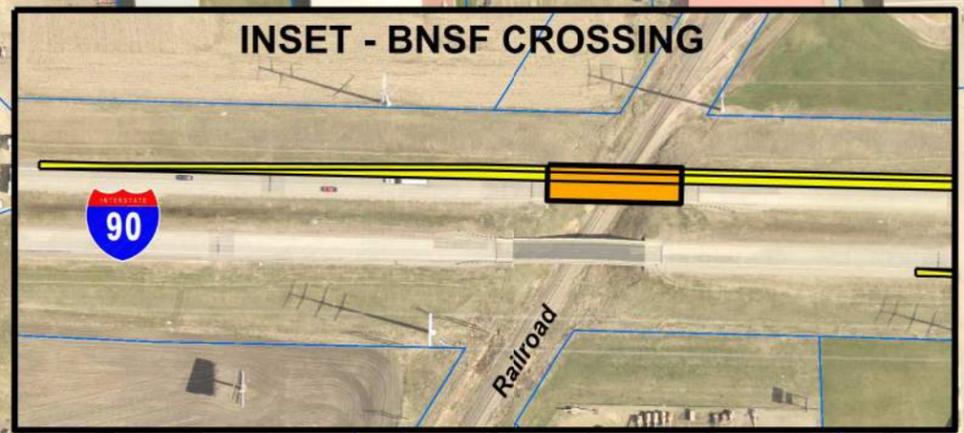
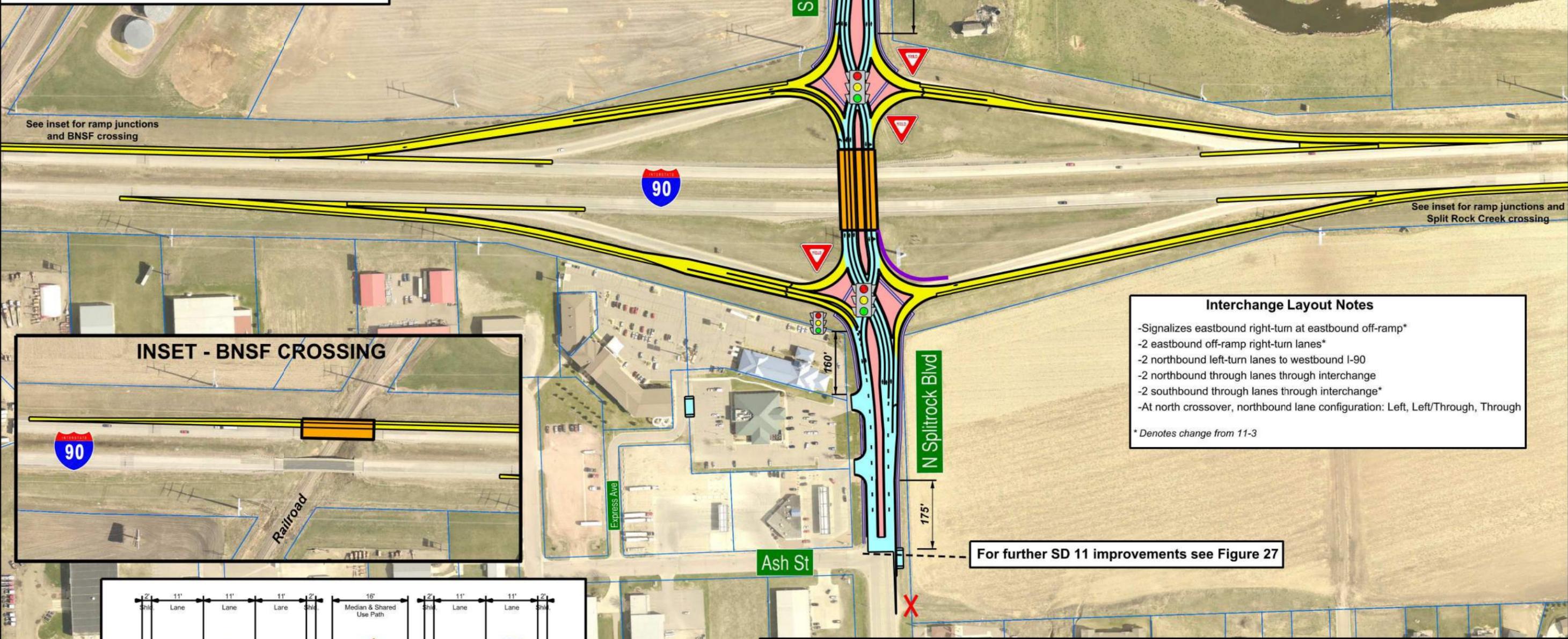


<p>Build Alternative 11-4 DIVERGING DIAMOND INTERCHANGE (DDI)</p>	<p>I-90 EXIT 406 INTERCHANGE MODIFICATION STUDY</p>	<p>Fig. No. 25 11/8/2017</p>
<p>Brandon, South Dakota</p>		

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation

NORTH
SCALE
1:250

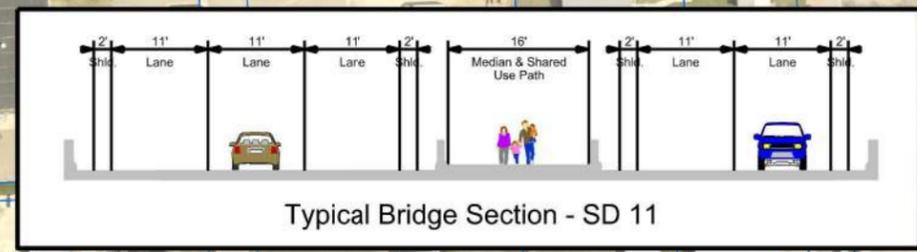


Interchange Layout Notes

- Signalizes eastbound right-turn at eastbound off-ramp*
- 2 eastbound off-ramp right-turn lanes*
- 2 northbound left-turn lanes to westbound I-90
- 2 northbound through lanes through interchange
- 2 southbound through lanes through interchange*
- At north crossover, northbound lane configuration: Left, Left/Through, Through

* Denotes change from 11-3

For further SD 11 improvements see Figure 27

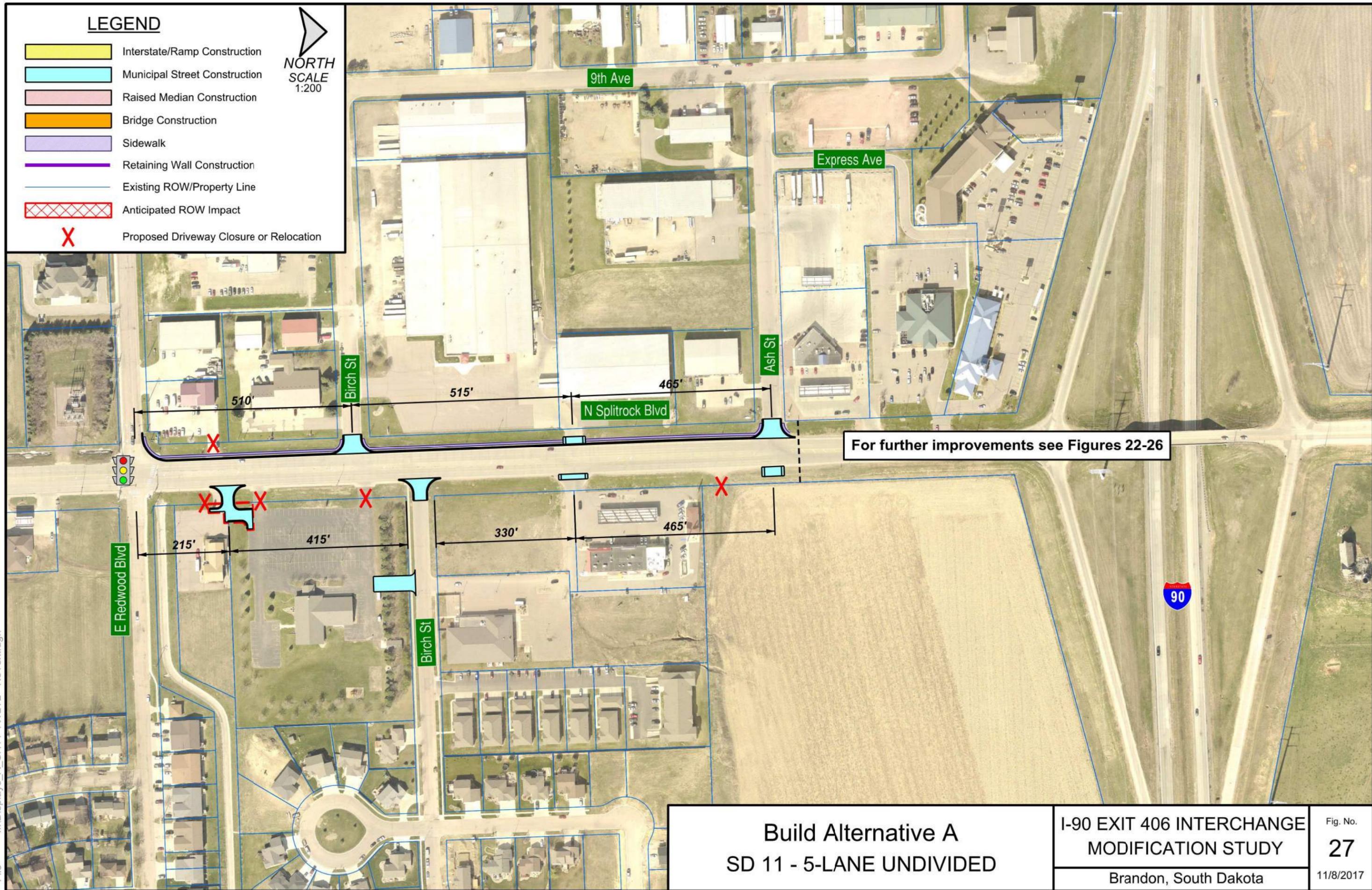


<p>Build Alternative 11-5 DIVERGING DIAMOND INTERCHANGE (DDI)</p>	<p>I-90 EXIT 406 INTERCHANGE MODIFICATION STUDY</p>	<p>Fig. No. 26 11/8/2017</p>
<p>Brandon, South Dakota</p>		

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation

NORTH
SCALE
1:200



For further improvements see Figures 22-26

Build Alternative A
SD 11 - 5-LANE UNDIVIDED

I-90 EXIT 406 INTERCHANGE
MODIFICATION STUDY

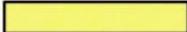
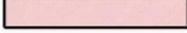
Brandon, South Dakota

Fig. No.

27

11/8/2017

LEGEND

-  Interstate/Ramp Construction
-  Municipal Street Construction
-  Raised Median Construction
-  Bridge Construction
-  Sidewalk
-  Retaining Wall Construction
-  Existing ROW/Property Line
-  Anticipated ROW Impact
-  Proposed Driveway Closure or Relocation

NORTH
SCALE
1:200

For further improvements see Figures 22-26

SD HWY 11

Hemlock Blvd

90



**Build Alternative F
SD11 - 3-LANE UNDIVIDED**

**I-90 EXIT 406 INTERCHANGE
MODIFICATION STUDY**

Brandon, South Dakota

Fig. No.
28
11/8/2017

Control of Access

Control of access (COA) along the SD11/Splitrock Boulevard corridor is an important consideration into the long-term operational and safety performance of the interchange. FHWA has established COA requirements along the crossroad corridor upstream and downstream of the interchange. Distances are measured in accordance with Figure 13-12 in the *SDDOT Road Design Manual*⁶. The minimum COA, as noted in the *SDDOT Road Design Manual*, is shown in the following table.

Table 26: Minimum Control of Access along Crossroad

Location	Urban (ft.)	Rural (ft.)
Reconstruction of Existing Interchange	100	300
Construction of New Interchange	660	660

SDDOT Road Design Manual (obtained September 2017).

The SDDOT Road Design Manual notes that these are minimum distances as established by AASHTO’s *A Policy on Design Standards Interstate System*⁷. The manual also recommends additional control for existing interchanges with established safety and operational concerns or if it is feasible to meet South Dakota Access Location Criteria.

The following summarizes proposed access locations and their relation to COA requirements for the DDI Build Alternatives.

The SDDOT has already purchased COA in the northwest quadrant along the frontage of the first parcel, extending approximately half of the existing farm field. For each DDI Build Alternative, this project proposes to extend the COA north to the existing CHS driveway and closing the existing field access as part of the acquisition. This results in approximately 485 feet from the beginning of the right-turn lane taper upstream to the CHS driveway. Access to the field would be accommodated by the existing CHS driveway.

In the northeast quadrant, the proposed COA extends approximately 470 feet from the controlled westbound off-ramp right-turn radius to a proposed new driveway between two existing field access drives. The existing access south of the new driveway would be removed as part of the COA acquisition. The location of the proposed new driveway access in all DDI Build Alternatives was based on two important considerations:

- Terrain – Challenging terrain on the east side of SD11/Splitrock Boulevard limits feasibility of an access directly across from the existing CHS driveway. Further, an access easement would be needed to access the parcel in the northeast quadrant of the interchange.
- Left-turn conflict – The proposed driveway location provides approximately 275 feet of separation from edge-of-drive to edge-of-drive to minimize potential head-to-head left-

⁶ *South Dakota Department of Transportation Road Design Manual*. Accessed September 2017. <http://sddot.com/business/design/forms/roaddesign/Default.aspx>

⁷ *A Policy on Design Standards Interstate System*. American Association of State Highway and Transportation Officials. January 2016.

turn conflicts inside the two-way left-turn lane. The CHS driveway experiences high demand in the fall harvest seasons and maintaining separation to allow multiple WB-67 size vehicles to stack within the two-way left-turn lane, limits this left-turn conflict.

In the southeast quadrant, the existing field access is relocated north approximately 100 feet to the Ash Street intersection. This results in a COA distance of approximately 175 feet between the field access and the start of the northbound right-turn lane. It should be noted that the undeveloped field, much of which lies in a floodplain, is also accessible via Birch Street.

In the southwest quadrant, two existing commercial driveways are located between I-90 and Ash Street. Distances from the end of eastbound I-90 ramp terminal intersection return to the two intersections are as follows:

- To hotel driveway: 125 ft.
- To gas station driveway: 290 ft.
- To Ash Street ROW: 500 ft.

A free movement into an added lane, such as a free eastbound to southbound right-turn from the off-ramp in 11-1, 11-2, and 11-3, has slightly different COA requirements than those that are controlled. The COA is measured from where the vehicle from right turn reaches the design speed of the crossroad (Figure 13-12 of SDDOT Road Design Manual). Design speeds used for the development of alternatives in this study were 45 mph (posted speed of 40 mph) and 40 mph (35 mph posted speed). Based on either of these two design speeds, the required COA is 490 ft. and 300 ft., respectively. Therefore, both driveway access locations are shown as closed, and a design variance would need to be requested from FHWA to maintain access to Ash Street.

In DDI Build Alternatives 11-4 and 11-5, the eastbound I-90 off-ramp right-turn movement is signal-controlled and the minimum COA distance aligns with Table 26. The first driveway south of I-90 is located outside of this minimum distance.

DDI Build Alternatives Carried Forward

DDI Build Alternatives 11-1, 11-2, 11-3, and 11-5 were carried forward in the Alternatives Analysis with the No-Build Alternative. 11-4 is the lone DDI build-out configuration not carried forward for further consideration due to the southbound lane-addition between the ramp terminal and Ash Street. This additional lane would serve a low-demand movement, create undesirable weave conflicts, and require lane change(s) for high-volume movements. 11-4 is also the lone configuration that notably affects the SD11/Splitrock Boulevard and Ash Street intersection. The other four DDI Build Alternatives tie into the intersection radius returns with slight widening along the east edge of pavement.

7.2. Conformance with Transportation Plans

The proposed interchange improvements conform to both state and local plans. Geometric deficiencies were first identified in the 2000 Decennial Interstate Corridor Study, and a traffic need was added in the 2010 Decennial Interstate Corridor Study. The I-90 Exit 406 Interchange and SD11/Splitrock Boulevard improvements have been identified in the Go Sioux Falls 2040

L RTP. The improvements are also identified as developmental projects, those outside of the four-year STIP outlay but within the SDDOT's eight-year program.

7.3. Compliance with Policies and Engineering Studies

The interchange No-Build alternative does not meet the project need of addressing geometric deficiencies through the existing interchange footprint. Therefore, if the interchange No-Build alternative was carried forward and the bridge would undergo a major rehabilitation, the interchange would not comply with current guidelines in the SDDOT Road Design Manual:

- Westbound off-ramp and eastbound on-ramp grade exceeds maximum at 6 percent and 5.2 percent, respectively (*5 percent maximum standard*).
- Ramp surfacing width is 24 feet (*25-foot ramp surfacing width standard: 2-foot inside shoulder, 8-foot outside shoulder, and 15-foot lane*).
- Existing slopes adjacent to roadway shoulders are 4:1 (*6:1 slope to clear zone standard*).
- Ramp clear zone less than 30 feet (*30-foot minimum standard*).
- Ramp terminal intersections are less 300 feet from I-90 centerline, limiting storage capacity for Diamond-type interchange (*550-foot offset from Interstate centerline standard for Diamond-type interchange*).
- Current SD11/Splitrock Boulevard bridge over I-90 does not provide accommodations for multi-modal accessibility across I-90.
- Bridge width (30 feet) limits functionality in terms of SDDOT operational goals for an urban interchange.
- On-ramp entrance taper rates are 29:1 or 30:1 (*Parallel-type on-ramps are preferred with a minimum 50:1 entrance taper*).

The improvements as part of the DDI Build Alternatives 11-1, 11-2, 11-3, and 11-5 were designed in accordance with the latest version of the SDDOT Road Design Manual.

7.4. Environmental Impacts

The EA document compares the No-Build alternative (referred to as the No Action Alternative) with DDI Build Alternative 11-5 (referred to as the Proposed Action). A summary of this comparison is provided in Table 23. Refer to the Environmental Impacts of the No Action Alternative and Propose Action table (EA document Table 2) in the EA document for additional information on this evaluation. Resources identified within the study area that will not be impacted are not shown.

Table 27: No Action Alternative and Proposed Action Summary of Environmental Impacts

Resource	No Action Alternative	Proposed Action
Air Quality	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: No permanent impacts to air quality would occur.</p> <p>Permanent Impacts: Neighboring areas could be exposed to construction-related fugitive dust and construction equipment emissions during construction. SDDOT Best Management Practices (BMPs) are implemented on all construction projects to minimize impacts to air quality. No sensitive receptors are located adjacent to the project area.</p>
Farmlands	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts Approximately 0.66 acres of farmland would be impacted by the project. Of this area, 0.38 acres is within soil map units identified as prime farmland and 0.28 acres is within soil map units identified as not prime farmland. Farmland would be impacted from minor ROW expansions in the northwest, northeast, and southeast quadrants of the study area.</p> <p>Temporary Impacts Additional farmland may be impacted by construction staging. The areas would be returned to farmland after construction is complete.</p>
Floodplains	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts Permanent fill of 2.1 acres of 100-year floodplain would occur adjacent to the eastbound onramp to I-90. The floodplain impacts are to mapped Zone A and Zone AE floodplains. The floodplain is a base flow area of Split Rock Creek and does not carry active floodway. Impacts will be confined to a single parcel in the southeast quadrant of the interchange. The parcel is zone A1-General Agricultural and is located in Minnehaha County outside of the Brandon Corporate limit. The Proposed Action would have no impact to the floodway.</p> <p>Temporary Impacts Temporary impacts from materials or construction staging within the floodplain and would be minimal. Materials and construction equipment would likely be moved prior to a flood event.</p>
Water Quality	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: The Proposed Action will result in a net increase in impervious surface of 178,000 square feet (4.1 acres), a 45% increase in impervious surface in the study area, due to expanded bridge lanes, creation of medians, longer ramps, sidewalks, curb, and gutter. The project design will include stabilization and drainage design in conformance with the SDDOT Road Design Manual.</p> <p>Temporary Impacts: Temporary impacts to water quality could occur from ground disturbance, potential spills from equipment, and runoff not contained by BMPs.</p>
Wetlands/ Waters of the U.S.	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts Permanent impacts to 0.325 acres of wetlands would occur. The impacted wetlands include impacts to 0.195 acres of ditch wetlands and 0.130 acres of prairie pothole wetland.</p> <p>Temporary Impacts Temporary impacts to farmed prairie pothole wetlands would occur adjacent to fill areas.</p>
Historical and Archaeologic al Resources	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts A review of the Level III survey by the South Dakota State Historic Preservation Officer (SHPO) concurred with the no historic properties affected determination.</p> <p>Temporary Impacts Temporary impacts to historic or archaeological resources would occur adjacent to fill areas.</p>
Right-of- Way	<p>Permanent Impacts: No ROW changes, therefore no permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: A total of approximately 0.69 acres of new ROW would be required through partial acquisitions of five parcels. The largest parcel acquisition is 0.39 acres of a 16.05-acre agricultural parcel.</p> <p>Temporary Impacts: No temporary ROW is expected except for construction easements to construct the project.</p>

Table 23: No Action Alternative and Proposed Action Summary of Environmental Impacts (Cont.)

Resource	No Action Alternative	Proposed Action
Land Use	<p>Permanent Impacts: No permanent impacts to land use would occur. Indirectly, anticipated congestion may be a limiting factor in land use plan implementation.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: Minor land use impacts would occur from conversion of approximately 0.66 acres of farmland to maintained ROW.</p> <p>Temporary Impacts: No temporary impacts to land use would occur.</p>
Bicyclists and Pedestrians	<p>Permanent Impacts: No bicycle or pedestrian facilities are present and therefore no permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts Bicycle and Pedestrian facilities would be improved from the construction of a walkable median on the new bridge. Pedestrian signals would be present at the interchange intersections. New sidewalk would be constructed on the west side SD11 south of the interchange to Redwood Blvd.</p> <p>Temporary Impacts Temporary lane closers, narrow lanes, staged construction equipment, and construction dust and noise may prevent or severely limit bicycle and pedestrian traffic through the study area during construction.</p>
Economic Resources	<p>Permanent Impacts: Anticipated increase in congestion may diminish desirability for commercial businesses.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: No permanent impacts would occur. Access from a public street will be maintained to all existing businesses. Access points will change for some businesses.</p> <p>Temporary Impacts: Access to all existing businesses will be maintained during construction.</p>
Utilities	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: Temporary impacts to public utilities may occur during construction due to normal construction activities and relocations, but no disruption of services is expected to occur.</p>
Public Facilities and Services	<p>Permanent Impacts: No permanent impacts would occur; though increased congestion could harm emergency services.</p> <p>Temporary Impacts: No temporary impacts would occur, though a future bridge repair would require closure of SD11.</p>	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur. SD11 bridge would remain open during construction.</p>
Noise	<p>Permanent Impacts: Traffic noise levels are predicted to increase with an increase in traffic volumes.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: Traffic noise analysis determined no receivers would be considered impacted by increases in traffic noise.</p> <p>Temporary Impacts: Temporary increases would occur from road and bridge construction and equipment.</p>
Hazardous Materials	<p>Permanent Impacts: No permanent impacts would occur.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>	<p>Permanent Impacts: One recognized environmental condition is within a work area (driveway closure). No permanent impacts to hazardous materials are anticipated.</p> <p>Temporary Impacts: No temporary impacts would occur.</p>

7.5. Safety

The Build Alternatives are expected to show a safety benefit when compared to the No-Build corridor. The following table summarizes this benefit in relation to predicted crashes as calculated in the IHSDM developed for this study. The IHSDM, developed by FHWA, is an implementation of crash prediction methods documented in Part C of the HSM. IHSDM output sheets are provided in Appendix L.

Table 28: Study Area Predicted Crashes (2022-2045)

Alternative	Total Crashes (2022-2045)	Freeway	Ramps	Interchange	SD11 Corridor
No-Build Total	637.5	141.3	21.0	158.0	317.2
Build Alternative Total	510.9				
<i>Interchange Build Alternative 11 (DDI)</i>		125.6	30.2	57.7	
<i>Corridor Build Alternative A*</i>					296.3 / 297.4 / 297.7
Difference between No-Build and Build Alternatives	-126.7	-15.8	+9.2	-100.3	-20.9 / -19.8 / -19.5

* Differences in Corridor Build Alternative A based on treatment of the two existing commercial driveway locations between I-90 and Ash Street: Both Closed / 1 RIRO and 1 Closed / Both RIRO.

The following summarizes the findings of the predicted crashes in the Build Alternative vs. the No-Build Alternative. The Build Alternative results in:

- Freeway – 15.8 decrease in number of predicted crashes primarily due to the longer acceleration lanes and greater spacing between ramp junctions.
- Ramps – 9.2 increase in number of predicted crashes due to additional lanes along ramps (receiving and ramp terminal approach).
- Interchange – 100.3 decrease in number of predicted crashes based on a DDI crash modification factor of 0.43 compared to the TWSC ramp terminals of the No-Build Alternative.
- SD11 Corridor – Predicted decrease in crashes along corridor with proposed access modifications. Three scenarios were developed based on the type of treatment to existing commercial driveways between I-90 and Ash Street:
 - 20.9 decrease in predicted crashes if both access locations closed.
 - 19.8 decrease if the hotel access is closed and second access is maintained as right-in/right-out.
 - 19.5 decrease if both existing access locations maintained as right-in/right-out.

Between the DDI Build Alternatives, discernable safety differences were identified for vehicles, pedestrians, and bicyclists. The following provides a summary of four safety considerations reflective of differences between the DDI Build Alternatives.

Eastbound Off-Ramp Pedestrian Crossing – Right-Turn Lane Control

The first safety consideration describes whether the pedestrian crossing of the eastbound I-90 off-ramp right-turn lanes is uncontrolled (free) or signal-controlled.

A. Uncontrolled (free right-turn) pedestrian crossing

- Build Alternatives 11-1, 11-2, and 11-3
- Safety benefits:
 - Vehicular traffic operations and management of off-ramp queue length.
 - Shorter crossing distance for pedestrians.
- Drawbacks:
 - Risk of uncontrolled vehicle-pedestrian conflicts, which often leads to high-severity crashes for pedestrians.
 - May be difficult for pedestrians to find acceptable gaps in traffic during peak periods.

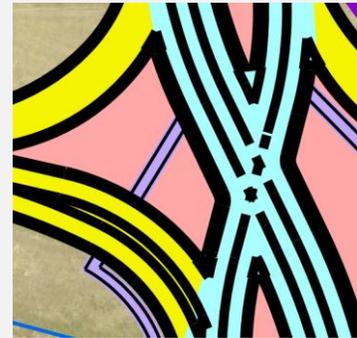
B. Signal-controlled pedestrian crossing

- Build Alternative 11-5
- Safety benefits:
 - Signal control reduces risk of vehicle-pedestrian conflicts.
 - Provides signal-controlled gap in traffic for pedestrians.
- Drawbacks:
 - Potential for higher frequency of rear-end crashes on-ramp, which are typically less severe than vehicle-pedestrian crashes.
 - Longer pedestrian crossing distance (2 lanes vs. 1 lane).

A. Uncontrolled Pedestrian Crossing (11-1, 11-2, and 11-3)



B. Signal-Controlled Pedestrian Crossing (11-5)



Vehicle-Bicycle Weave Conflict – Southbound SD11/Splitrock Boulevard (south of eastbound ramp terminal)

This safety consideration describes the weave conflict that may be present between the eastbound ramp terminal and Ash Street if a widened outer lane is carried southbound through the DDI for bicyclists. In the DDI Build Alternatives with a free right-turn movement, this widened lane for bicyclists will continue southbound through the southern crossover intersection and enter the SD11/Splitrock Boulevard corridor typical section between two southbound through lanes. While this is a typical design for DDIs, it creates a weave area for bicyclists that can be a concern during periods with higher volumes of turning vehicular traffic.

In Build Alternative 11-5, this southbound widened lane is carried through the southern crossover intersection and the signalized off-ramp right-turn lanes. This eliminates the weave

requirement and bicyclists may progress through the intersection with southbound vehicular traffic.

A. Bicycle lane between southbound through lane and southbound lane addition

- Build Alternatives 11-1, 11-2, and 11-3
- Drawbacks:
 - Vehicle-bicycle weave conflict.
 - SB bicyclists required to weave across off-ramp right-turning traffic that enters into SB SD11 lane addition.
 - Free right-turn allows for continuous stream of traffic, which may make it difficult for bicyclists to find a safe gap in traffic to weave over to widened lane beyond interchange.

B. Bicycle lane continuous on outside of travel lanes

- Build Alternative 11-5
- Safety benefits:
 - SB widened lane continuous on outside travel lane through and south of DDI.
 - Bicyclists not required to weave across traffic.
 - Bicyclists travel with southbound progression of traffic (off-ramp right-turn stopped during SB through traffic progression).
- Drawbacks:
 - If right-turn on red were allowed, this would be a potential conflict.

A. Bicycle lane between SB through lane and SB lane addition (11-1, 11-2, and 11-3)



B. Bicycle lane continuous on outside of travel lanes (11-5)



Vehicle-Vehicle Weave Conflict – Southbound SD11/Splitrock Boulevard (south of eastbound ramp terminal)

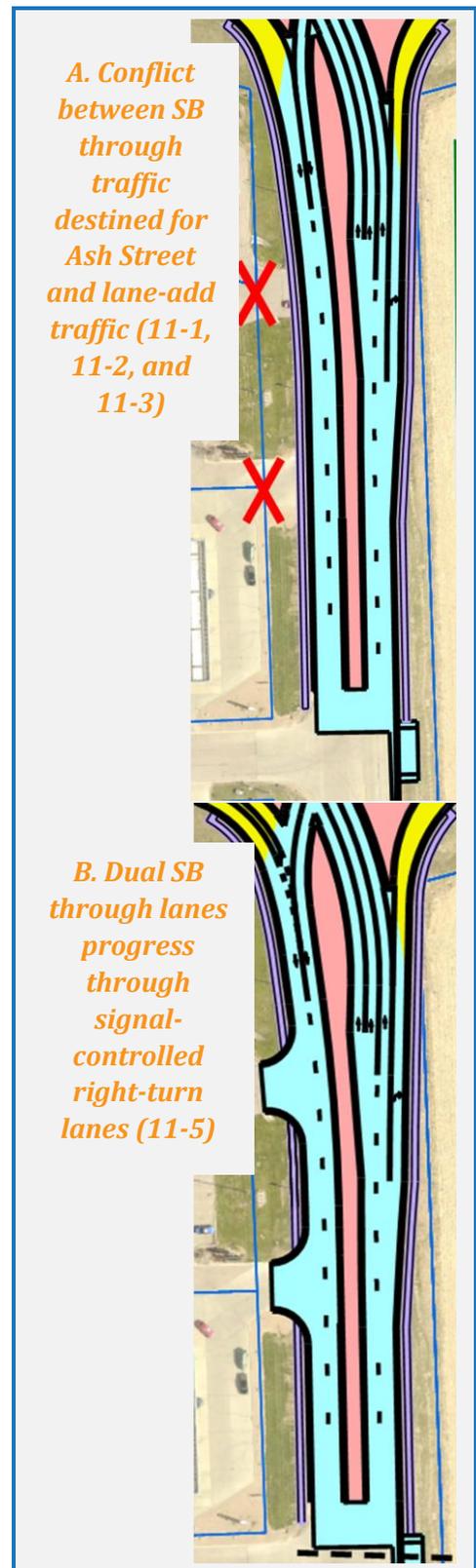
This safety consideration describes a vehicle-vehicle weave conflict between the eastbound ramp terminal and Ash Street. In the free right-turn DDI Build Alternatives, the eastbound I-90 off-ramp right-turning traffic would enter onto SD11/Splitrock Boulevard at the same time as the southbound traffic progression. This could create a similar safety concern to what is currently exhibited by the existing configuration and documented in the crash history. Southbound traffic would have to compete with the add-lane traffic to safely maneuver over to the outside lane in order to turn right onto Ash Street. While this is a typical design for DDIs, the high volume of turning vehicles and close proximity of Ash Street (less than 550 feet to complete the lane change) leads to the safety concern in the free right-turn Build Alternatives. In Build Alternative 11-5, progressed southbound SD11/Splitrock Boulevard traffic would be able to continue southbound in two lanes while the off-ramp right-turn traffic is signal-controlled.

A. Potential weave conflict between southbound interchange traffic destined for Ash Street and southbound lane-add traffic

- Build Alternatives 11-1, 11-2, and 11-3
- Drawbacks:
 - All SB interchange traffic destined for Ash Street would have to weave into add-lane, with potential conflict of free right-turn traffic.
 - This movement would operate poorly during the peak periods with a constant stream of free right-turn traffic.

B. Dual southbound through lanes progress through signal-controlled right-turn lanes

- Build Alternative 11-5
- Safety benefits:
 - Addresses existing safety need (see historical crash analysis).
 - Motorists can position themselves in advance of their intended maneuver.
 - EB to SB right-turn traffic does not compete with SB through traffic (and vice versa) in lane change maneuvers due to signal control.



Lane Continuity –Lane Drops between Crossover Intersections

The fourth safety consideration discusses lane drops between the DDI crossover intersections and through lane continuity along SD11/Splitrock Boulevard through the study area.

In the southbound direction, the inclusion of a lane drop is dependent upon whether the eastbound I-90 off-ramp right-turn is unsignalized, to facilitate a free right-turn, or signalized. Compared to the southbound through movement, the southbound to eastbound left-turn movement traffic volume is significantly less than the southbound through movement (2045 Build Conditions PM through volume: 560 vehicles; left-turn volume: 15 vehicles).

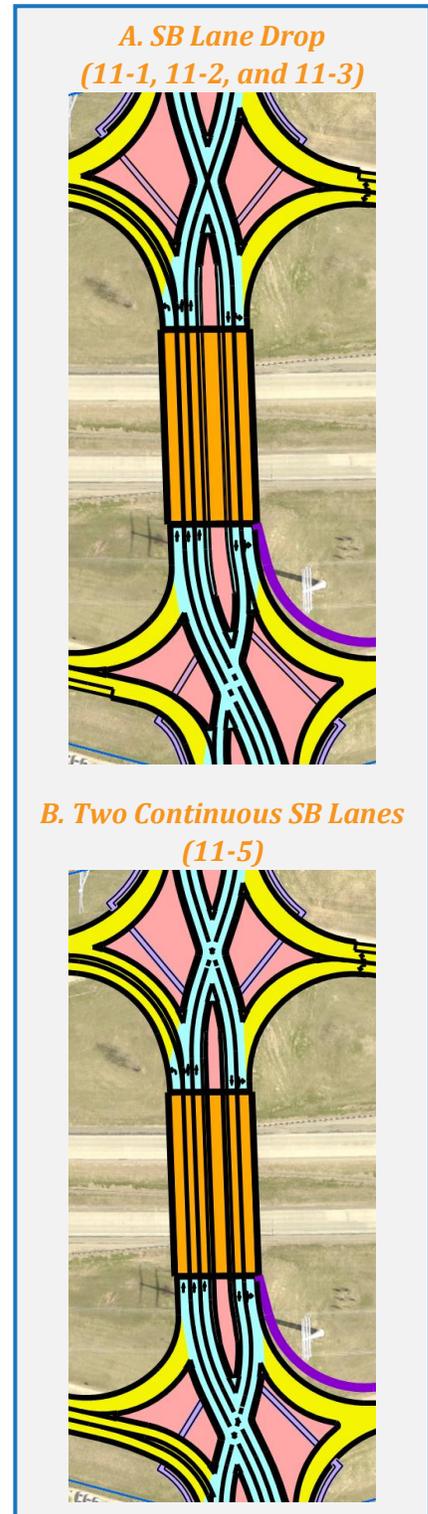
A. Southbound through lane dropped as left-turn to eastbound I-90 on-ramp in order to accommodate downstream lane addition

- Build Alternatives 11-1, 11-2, and 11-3
- Safety benefits:
 - SB turning and through traffic channelized in designated lane.
- Drawbacks:
 - May increase frequency of weave movements within interchange.
 - SB left-turn demand is very low, which could lead to unbalanced lane utilization in SB direction at northern crossover intersection.

B. Two continuous southbound lanes through interchange

- Build Alternative 11-5
- Safety benefits:
 - Reduces propensity for weave maneuvers within interchange.
 - Route continuity by carrying two through lanes through interchange.
- Drawbacks:
 - Longer pedestrian crossing distance at one crossover intersection crossing.

In the northbound direction, Build Alternatives 11-3 and 11-5 incorporate two continuous through lanes northbound through both crossover intersections. 11-1 and 11-2 includes a single northbound through lane through the northern crossover intersection. Similar benefits and drawbacks to what was noted in the southbound direction apply here as well. The most notable drawback is the lack of northbound lane continuity in 11-1 and 11-2 where only a single through lane is carried through the northern crossover intersection. The left traffic lane is dropped as a left-turn to the westbound on-ramp.



7.6. Operational Performance

The operational performance of each DDI Build Alternative was assessed in conjunction with the SD11/Splitrock Boulevard Corridor Build Alternatives A and F. Traffic volumes in this assessment are representative of 2045 Planning Year No-Build Conditions for the No-Build alternative and 2045 Planning Year Build Conditions for the DDI Build Alternatives. A summary of measured operations is depicted in Figure 29. HCS 2010 reports are provided in Appendix M.

I-90 Exit 406 Interchange

Table 29 presents the measured ramp terminal intersection LOS for the No-Build and DDI Build Alternatives.

Table 29: I-90 Exit 406 Ramp Terminal Intersection Operations – 2045 Conditions

Ramp Terminal Intersection	No-Build	11-1	11-2	11-3	11-5
	LOS AM/PM				
I-90 WB Ramp Terminal Intersection	F*/F*	B/B	B/B	B/B	B/B
I-90 EB Ramp Terminal Intersection	F*/F*	B/B	B/B	B/B	B/B

** Demand exceeds capacity, volume/capacity (v/c) ratio greater than 1.0.
See Figure 21 for No-Build Conditions summary.*

All DDI Build Alternatives achieve a notable improvement in 2045 Planning Year traffic operations when compared to the No-Build alternative. Amongst the DDI Build Alternatives, they all resulted in measured delay representative of LOS B. However, LOS measures alone do not discern the varying levels of capacity and flexibility to accommodate additional traffic growth beyond what is presented in this IMJR.

Build Alternatives 11-3 and 11-5 provide greater capacity than 11-1 and 11-2 as additional lanes are carried through each of the crossover intersections. These two Build Alternatives meet the SDDOT goals of accommodating future-year traffic through the design life of the bridge. In 11-3 and 11-5, two continuous northbound through movement opportunities are provided through the interchange. The additional through lane will be particularly advantageous to traffic operations with the continual growth of the industrial area north of I-90. The measured intersection delay shows some betterment in 11-3 and 11-5, typically in the range of 1-5 seconds at each ramp terminal compared to 11-1 and 11-2. HCS 2010 output sheets detailing these measures are included in Appendix M.

The notable geometric difference between 11-1/11-2/11-3 and 11-5 is two continuous lanes are carried southbound through both crossover intersections in 11-5. This second southbound lane increases capacity of the interchange, improves cross-sectional continuity, and signals the eastbound to southbound right-turn movement at the eastbound I-90 ramp terminal. The impact this signalization has on measured 95th percentile queue lengths in the PM peak period

(reflective of the analysis period with the highest eastbound I-90 off-ramp right-turn volume) is illustrated in Table 30.

Table 30: Eastbound I-90 Ramp Terminal 95th Percentile Queues – 2045 PM Peak Period

Eastbound I-90 Ramp Terminal Movement	11-1	11-2	11-3	11-5
	95 th % Queue (ft.)			
Eastbound Right-Turn	Free	Free	Free	346
Northbound Through	303	303	230	200
Southbound Through	248	248	185	132

The 95th percentile queue of a signalized right-turn movement measures approximately 346 feet in the PM peak period. So while the measured queue does not impact I-90 mainline operations in the study model, it still creates a risk of longer queues, greater delay, and stop and go traffic when compared to a free right-turn movement through the ramp terminal. Conversely, one of the ancillary benefits of signaling the right-turn movement is the need for an extended green time to handle this high-volume movement. This results in a lower northbound through-movement queue when compared to 11-1, 11-2, and 11-3.

The interchange origin-destination (O-D) delay measures were also computed for the DDI Build Alternatives. This approach accounts for the total delay that a motorist may encounter at one or both ramp terminals, depending on the route, when traversing through an interchange. A schematic of the HCM 2010 methodology O-D paths for a Diamond-type interchange is provided in the inset. This schematic was adapted for each DDI configuration and applied to determine O-D path delays a vehicle may experience within each respective analysis condition.

No significant differences were noted between the four DDI Build Alternatives, as shown in Table 31. The worst measured LOS of an O-D path is LOS C, though most movements operate at LOS A or B. Detailed results are included in Appendix M.

Interchange Origin-Destination Level of Service

Level of Service (LOS)	Control Delay (sec/veh)
	Signalized Ramp Terminals
A	≤ 15
B	> 15 – 30
C	> 30 – 55
D	> 55 – 85
E	> 85 – 120
F	Demand exceeds capacity; > 120

HCM 2010 Notation of Origin-Destination Demands at Diamond Interchange (Adapted from Exhibit 22-6, HCM 2010)

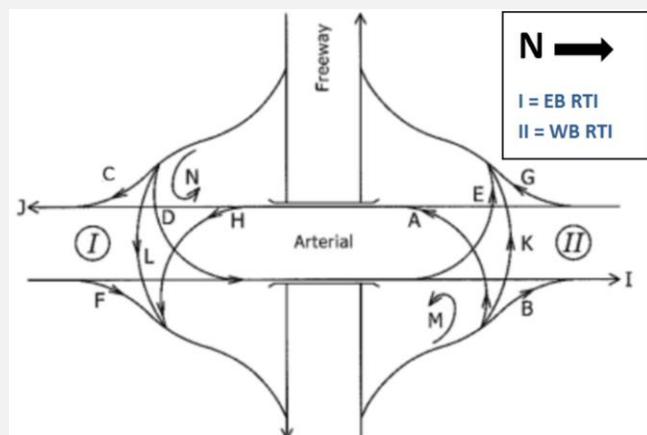


Table 31: I-90 Exit 406 Interchange Origin-Destination LOS – 2045 Conditions

Origin-Destination Notation for Diamond Interchange	11-1	11-2	11-3	11-5
	O-D LOS AM/PM	O-D LOS AM/PM	O-D LOS AM/PM	O-D LOS AM/PM
A	B/B	B/B	B/B	A/B
B	B/B	B/B	B/B	B/B
C	A/A	A/A	A/A	B/B
D	B/B	BB	B/B	B/B
E	B/B	B/B	B/C	B/B
F	B/B	B/B	B/B	B/B
G	C/B	C/B	C/B	C/B
H	C/B	C/B	C/B	C/C
I	B/C	B/C	B/C	B/B
J	C/C	C/C	C/C	C/C
K,L,M,N	-/-	-/-	-/-	-/-

SD11/Splitrock Boulevard Corridor Intersections

Table 32 presents traffic operations at the other SD11/Splitrock Boulevard corridor intersections. For the two-way stop-controlled intersections, a weighted average of entering traffic was calculated to account for the travel time benefits of a free through movement along the major highway.

Table 32: SD11/Splitrock Boulevard Corridor Intersection Operations – 2045 Conditions

SD11/Splitrock Blvd Intersection	Intersection Control Type	No-Build Alternative		DDI Build Alternatives 11-1, 11-2, 11-3, 11-5	
		Avg. Delay LOS AM/PM	Local Street Weighted Avg. Delay LOS AM/PM	Avg. Delay LOS AM/PM	Local Street Weighted Avg. Delay LOS AM/PM
Hemlock Boulevard	TWSC	F/F	A/A	F/F	A/A
Ash Street	TWSC	F/F*	A/F	F*/F*	11-1,11-2,11-3: E/F 11-5: D/F
Birch Street (east)	TWSC	F/F	A/A	F/F	A/A
Birch Street (west)	TWSC	F/F*	A/B	F/F*	A/C
Redwood Boulevard	Signal	C/B	-/-	C/B	-/-

* Demand exceeds capacity, volume/capacity (v/c) ratio greater than 1.0.
See Figure 21 for No-Build Conditions summary.

As each intersection is outside of the interchange footprint, the resulting intersection measures are applicable across each Build Alternative. The primary difference that affects TWSC

operations between the No-Build and Build Alternatives is the closure (11-1, 11-2, and 11-3) or restriction of left-turn movements (11-5) into and out of the two driveway access locations between I-90 and Ash Street. Affected traffic from movement restrictions at these two driveways was redistributed to the Ash Street intersection. The resulting TWSC LOS was the same across each DDI Build Alternative, regardless of driveway access between I-90 and Ash Street.

In the No-Build and Build Alternatives, the worst-case stop-controlled approach at each analyzed local network intersection with SD11/Splitrock Boulevard results in LOS F measure of delay. A weighted intersection average delay of LOS F occurs in the PM peak period at the Ash Street intersection. The signalized intersection at Redwood Boulevard demonstrates ample capacity within the current configuration and signal timing updates.

One consideration to the TWSC results, particularly at Ash Street, is that the analysis did not redistribute trips across the various access points into and out of the industrial area to the west of SD11/Splitrock Boulevard, south of I-90. This would be expected to occur to some degree as motorists gravitate towards intersections with less minor-street delay and/or signalized intersections. 9th Avenue is the primary north/south roadway through this industrial area and has access to Redwood Boulevard. The Redwood Boulevard and SD11/Splitrock Boulevard is approximately 850 feet east and has ample capacity to accommodate industrial area vehicles desiring a signalized intersection to complete their movement off of or onto SD11/Splitrock Boulevard.

A second consideration to the TWSC results is that the Redwood Boulevard traffic signal was assumed uncoordinated with the DDI crossover intersection signals in this analysis. As demand grows within the SD11/Splitrock Boulevard and Redwood Boulevard intersection grows, the number of phases within the cycle will likely increase from the current 2-phase pattern to include protected left-turn movements. This increases difficulty in coordinating with the short cycle lengths of DDI crossover intersections. If coordination is feasible between these signals, there would likely be an improvement in projected minor-street approach TWSC delay.

[SD11/Splitrock Boulevard Corridor Segments](#)

Another consideration to corridor operations is the segment and overall facility operations, in terms of travel speed. The benefits of maintaining travel speed and minimizing stops along the priority corridor are not readily apparent in a TWSC evaluation. The analyzed components of the corridor include:

- Segment 1: Redwood Boulevard to eastbound ramp terminal
- Segment 2: Between ramp terminals
- Facility: Redwood Boulevard to westbound ramp terminal

Table 33 illustrates the negligible effect each DDI Build Alternative variation has on the facility operations in terms of LOS representative of measured travel speed through the corridor with respect to the base free flow speed (see inset). The lone difference occurs in the PM peak period northbound/southbound segment between the ramp terminals which goes from a LOS

D/E in 11-1 and 11-2 to a LOS C/D in 11-3 and 11-5 due to the additional capacity and flexibility in accommodating demand that is less directional and a mix of mainline and ramp movements.

In this case, the No-Build corridor was not calculated due to the two-way stop-controlled ramp terminal intersections and limitations with the HCS 2010 software. In uncongested conditions, the No-Build alternative allows northbound/southbound vehicle are able to traverse through the study area unimpeded by traffic signals outside of the Redwood Boulevard intersection. However, geometric constraints at the ramp terminal intersections lead to lengthy delay and queues during the peak periods, particularly in the northbound direction in the AM peak period. It is expected that any of the proposed DDI Build Alternative would be an improvement to corridor travel time reliability.

Level of Service (LOS)	Travel Speed as a Percent of Base Free-Flow Speed (%)
A	> 85
B	> 67 – 85
C	> 50 – 67
D	> 40 – 50
E	> 30 – 40
F	Demand exceeds capacity; ≤ 30

Table 33: SD11/Splitrock Boulevard Corridor Segment Operations – 2045 Build Conditions

SD11/Splitrock Boulevard Corridor Segments	DDI Build Alternatives							
	11-1		11-2		11-3		11-5	
	AM NB/SB	PM NB/SB	AM NB/SB	PM NB/SB	AM NB/SB	PM NB/SB	AM NB/SB	PM NB/SB
Segment 2: Between ramp terminals	C/D	D/E	C/D	D/E	C/D	C/D	C/D	C/D
Segment 1: Redwood Blvd to EB ramp terminal	C/C	C/B	C/C	C/B	C/C	C/B	C/C	C/B
Facility	C/C	C/C	C/C	C/C	C/C	C/C	C/C	C/C

SD11/Splitrock Boulevard Corridor Multi-Modal LOS

All DDI Build Alternatives provide an improvement to multi-modal operations and safety through the corridor. The existing bridge does not accommodate pedestrian travel or bicycle travel outside of the through lane due to width, thus is often a barrier to multi-modal travel along the SD11/Splitrock Boulevard corridor. Limited pedestrian facilities are also present south of I-90.

Each DDI Build Alternative provides a shared-use path between the crossover intersections and sidewalks and widened outer lanes beyond each crossover intersection. Future SD11/Splitrock Boulevard projects will be able to tie into these accommodations.

In addition to the interchange improvements, a sidewalk is planned on the west side of SD11/Splitrock Boulevard to connect the DDI multi-modal improvements with existing curb ramps and sidewalk at the Redwood Boulevard intersection. Bicycles are accommodated on

the 12-foot shoulders to the north I-90 and either on the planned sidewalk or existing 4-foot shoulder south of I-90.

The primary differences in pedestrian accommodations between the DDI Build Alternatives are the number of lanes at each pedestrian crossing at the crossover intersections and whether the eastbound I-90 ramp terminal right-turn movement is signalized or traffic is accommodated via a free movement. The multi-modal safety benefits and drawbacks associated with each DDI configuration were discussed in previous sections of this report.

Overall, these features had negligible effect on the overall bicycle and pedestrian facility LOS score, resulting in a LOS D between Redwood Boulevard and the westbound ramp terminal.

I-90 Freeway Segments

Table 34 summarizes the I-90 mainline traffic operations in future-year 2045 traffic conditions. As previously noted, each of the DDI Build Alternatives incorporates the same ramp junction with I-90 mainline. All freeway measures are LOS C or better for the DDI Build Alternatives.

Table 34: I-90 Freeway Segment Traffic Operations – 2045 No-Build and Build Conditions

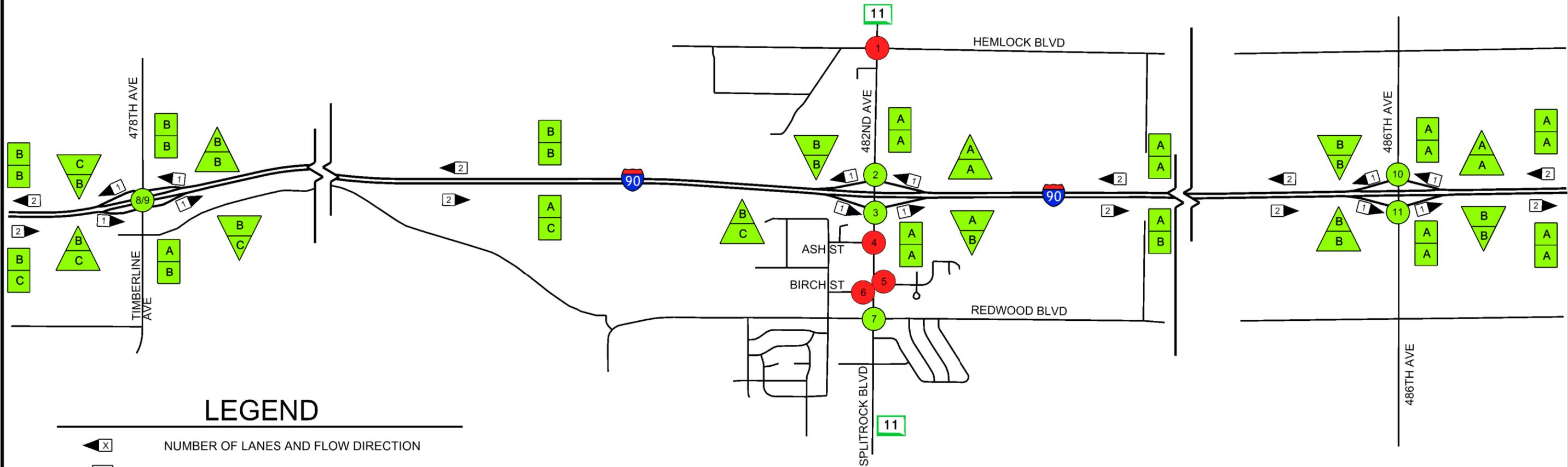
Freeway Segment	No-Build Alternative		DDI Build Alternatives 11-1, 11-2, 11-3, 11-5	
	AM Peak Period	PM Peak Period	AM Peak Period	PM Peak Period
	LOS	LOS	LOS	LOS
Eastbound I-90				
Basic, 2-lane mainline to Exit 402	B	C	B	C
Diverge, to Timberline Ave	B	D	B	C
Basic, 2-lane mainline within Exit 402	A	C	A	B
Merge, from Timberline Ave	B	C	B	C
Basic, 2-lane mainline between Exit 402 and Exit 406	A	C	A	C
Diverge, to SD11/Splitrock Blvd (Exit 406)	A	C	B	C
Basic, 2-lane mainline within Exit 406	A	B	A	A
Merge, from SD11/Splitrock Blvd (Exit 406)	A	B	A	B
Basic, 2-lane mainline between Exit 406 and Exit 410	A	B	A	B
Diverge, to 486 th Ave	A	C	B	B
Basic, 2-lane mainline within Exit 410	A	B	A	A
Merge, from 486 th Ave	A	B	B	B
Basic, 2-lane mainline from Exit 410	A	B	A	A
Westbound I-90				
Basic, 2-lane mainline to Exit 410	A	A	A	A
Diverge, to 486 th Ave	B	B	A	A
Basic, 2-lane mainline within Exit 410	A	A	A	A
Merge, from 486 th Ave	B	B	B	B
Basic, 2-lane mainline between Exit 410 and Exit 406	A	A	A	A
Diverge, to SD11/Splitrock Blvd (Exit 406)	B	B	A	A
Basic, 2-lane mainline within Exit 406	A	A	A	A
Merge, from SD11/Splitrock Blvd (Exit 406)	B	B	B	B
Basic, 2-lane mainline between Exit 406 and Exit 402	B	B	B	B
Diverge, to Timberline Ave	C	B	B	B
Basic, 2-lane mainline within Exit 402	B	B	B	B
Merge, from Timberline Ave	C	B	C	B
Basic, 2-lane mainline to Exit 402	C	B	B	B

See Figure 21 for No-Build Conditions summary.

EXIT 402

EXIT 406

EXIT 410



LEGEND

- NUMBER OF LANES AND FLOW DIRECTION
 - AM BASIC FREEWAY LEVEL OF SERVICE
 - PM BASIC FREEWAY LEVEL OF SERVICE
 - AM RAMP MERGE LEVEL OF SERVICE
 - PM RAMP MERGE LEVEL OF SERVICE
 - AM RAMP DIVERGE LEVEL OF SERVICE
 - PM RAMP DIVERGE LEVEL OF SERVICE
 - AM INTERSECTION LEVEL OF SERVICE
 - PM INTERSECTION LEVEL OF SERVICE
- A
B
C
D
E
F

INTERSECTION PEAK HOUR OPERATIONS
DDI BUILD ALTERNATIVES 11-1, 11-2, 11-3, 11-5

ID	CORRIDORS	CONTROL TYPE		HCM 2010 LEVEL OF SERVICE		LOCAL STREET WEIGHTED AVERAGE LEVEL OF SERVICE	
		SIGNAL	STOP	AM	PM	AM	PM
SD11/Splitrock Blvd							
1	SD11 & Hemlock Boulevard		X	F	F	A	A
2	SD11 & I-90 WB Ramp Terminal	X		B	B	-	-
3	SD11 & I-90 EB Ramp Terminal	X		B	B	-	-
4	SD11 & Ash Street		X	F*	F*	11-1,2,3: E 11-5: D	F
5	SD11 & Birch Street (East)		X	F	F	A	A
6	SD11 & Birch Street (West)		X	F	F*	A	C
7	SD11 & Redwood Boulevard	X		C	B	-	-
478th Ave/Timberline Ave							
8/9	Timberline Ave & I-90 Single Point Interchange	X		C	C	-	-
486th Ave							
10	486th Ave & I-90 WB Ramp Terminal		X	A	B	-	-
11	486th Ave & I-90 EB Ramp Terminal		X	A	A	-	-

NOTES:
WEIGHTED AVERAGE LOS DERIVED FROM HCM 2010 AWSC LOS CRITERIA
* DENOTES V/C RATIO > 1

ANALYSIS ASSUMPTIONS

PHF = 0.9
TERRAIN = LEVEL
fp = 1.00
MAINLINE BFFS = VARIED (FIELD MEASURED)
DIAGONAL RAMP FFS = 55.0 MPH
TRUCK % = VARIED (FIELD MEASURED)

2045 BUILD CONDITIONS



NOT TO SCALE



IMJR TRAFFIC OPERATIONS ANALYSIS
I-90 EXIT 406 INTERCHANGE
MINNEHAHA COUNTY, SOUTH DAKOTA

NOVEMBER 2017
FIGURE 29

7.7. Evaluation Matrix

Table 35 provides a comparison of the No-Build and Build Alternatives 11-1, 11-2, 11-3, and 11-5. Evaluation criteria were established from the project Purpose and Need and feeds into the EA document screening process. Ratings for each of the criterion are based on Poor/Good/Best or Yes/No. Key differentiators described in the previous sections are highlighted in blue.

Based on the results of the operational matrix, Build Alternative 11-5 provides the best operational and safety performance to meet the established needs of the I-90 Exit 406 Interchange.

Table 35: Alternatives Evaluation Matrix

	No-Build	DDI 11-1	DDI 11-2	DDI 11-3	DDI 11-5
Meets Current Design Standards	No	Yes	Yes	Yes	Yes
<i>Provides cross-sectional continuity with SD11 north and south of interchange</i>	Poor	Good	Good	Good	Best
<i>Flexibility in meeting traffic growth and patterns within bridge design life</i>	Poor	Good	Good	Best	Best
Meets Traffic Operation Objectives	No	Yes	Yes	Yes	Yes
<i>Ramp Terminal Intersection LOS</i>	F/F	B/B	B/B	B/B	B/B
<i>Analysis-measured eastbound off-ramp 95th % queue in 2045 PM peak period</i>	Spillback onto I-90 mainline	Free movement	Free movement	Free movement	346 ft.
Provides Continuous Bicycle and Pedestrian Facilities	No	Yes	Yes	Yes	Yes
<i>Signal-controlled pedestrian crossings at high-volume movements through interchange</i>	No	No	No	No	Yes
<i>Minimize Bicycle conflicts</i>	Poor	Good	Good	Good	Best
Meets Control of Access Requirements	Yes	Yes	Yes	Yes	Yes
Address Existing Safety Concerns	No	Good	Good	Good	Best
<i>Address weave movement between EB RTI and Ash Street</i>	No	Good	Good	Good	Best
Avoid Environmental Impacts	n/a (Baseline)	Good	Good	Good	Good
Avoid Utility Impacts	n/a (Baseline)	Good	Good	Good	Good
Avoid Right-of-Way Impacts	n/a (Baseline)	Good	Good	Good	Good
Constructability	n/a	Maintain traffic on existing bridge			

7.8. Commercial Development Supplemental Analysis

During the IMJR review process, a large commercial development was proposed in the southeast quadrant of the interchange. This development would represent a notable change in land use, deviating from the Sioux Falls MPO land use plans and subsequent travel demand model traffic forecasts. Therefore, it was determined that a supplemental analysis be conducted to assess the affect this development may have on the proposed improvements of Build Alternative 11-5. The supplemental analysis memorandum, which also includes a memorandum documenting updated traffic forecasts with the proposed development, is included in Appendix N.

It was found that the Build Alternative 11-5 improvements have adequate capacity to accommodate the expected additional traffic generated by the proposed commercial development in year 2045. With the mix of proposed development, much of the generated traffic travels to the development from the south, returns to the south, and never goes through the interchange. Therefore, the intersection delay, intersection queues, and freeway segment merge/diverge density measures for Build Alternative 11-5 in the commercial development scenario were very similar to those exhibited within this IMJR analysis.

Careful attention will be needed at the Ash Street intersection if it is the primary access point into and out of the development. The supplemental analysis demonstrated that the impact to SD11/Splitrock Boulevard corridor operations due to a high volume Ash Street approach out of the development coupled with signaling the intersection might be significant. The number of access locations into/out of the development, their proximity to the interchange, and intensity of the development will all have an impact on the SD11/Splitrock Boulevard corridor operations. This will be further analyzed and mitigated appropriately as part of a SDDOT access permit process if the proposed development comes to fruition through a Traffic Impact Study.

Based on the findings from this supplemental analysis, it can be concluded that the additional traffic generated by the proposed commercial development and subsequent improvement to the Ash Street and Redwood Boulevard intersections would not adversely impact the proposed Build Alternative 11-5 operations.

8. Coordination

Stakeholder and public involvement are centered on three major milestones within the IMJR and EA study components:

- Stakeholder and Public Meeting #1: Gather feedback on study area issues and needs.
- Stakeholder and Public Meeting #2: Gather feedback on proposed Build Alternatives for further refinement and analysis.
- Public Meeting #3: As part of the publication of EA document, requesting public comment on the preferred alternative and environmental impacts.

Project stakeholders were invited to take part in smaller, group discussion meetings prior to each public meeting. This allowed for small-group discussions with the Study Advisory Team. Stakeholders consisted of property and business owners and managers along the SD11/Splitrock

Stakeholders consisted of property and business owners and managers along the SD11/Splitrock Boulevard corridor, emergency responders, government representatives, and others identified to have a strong transportation interest along the corridor.

At the initial set of public and stakeholder meetings held August 9, 2016, the study team gathered feedback from the public regarding the issues and needs they see within and around the I-90 Exit 406 Interchange. Many of the comments focused on traffic operations and safety at both ramp terminals and the subsequent upstream impacts along both the SD11/Splitrock Boulevard corridor and I-90 mainline. There were also several comments regarding the importance of maintaining access across I-90 along SD11/Splitrock Boulevard.

The second set of stakeholder and public meetings held January 23, 2017, presented the proposed interchange and corridor Build Alternatives developed for the study area for comment and feedback. Overall, there was notable support for both the Standard Diamond (shifted west) and DDI Build Alternatives. While many understood the safety benefits of roundabouts at ramp terminals, the consensus from the public and businesses was that this location was not a good fit due to the high number of large trucks that use the interchange. There was also preference for the Standard Diamond (shifted west) over the Standard Diamond interchange because the shifted west variation maintains traffic across the existing bridge. Along the corridor, comments were mixed in preference to a corridor with a restrictive median or a continuous two-way center left-turn lane. Degree of access, such as full, $\frac{3}{4}$ or right-in/right-out, at Ash Street and Birch Street (east) was of particular concern.

The third public meeting will be held in conjunction with the publication of the EA document, requesting feedback from the public on the proposed preferred alternative and the identified impacts.

Project information has been disseminated to the public through the project website at <http://www.sehinc.com/online/406>. The website provides links to study materials such as concept and Build Alternative figures, evaluation summaries, and public information meeting material. The website also provides study contact information for SDDOT and consultant project managers. Viewers of the website have the opportunity to submit comments and questions directly from the website.

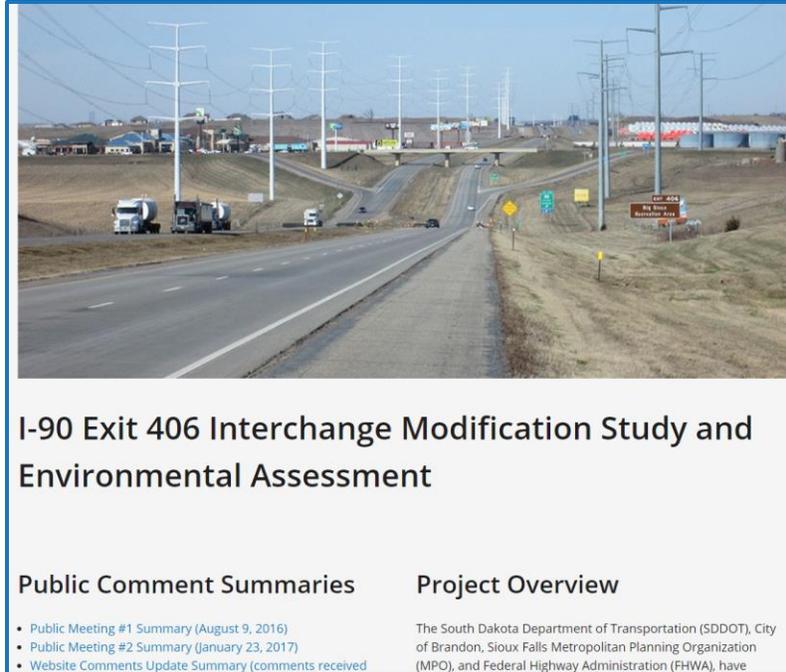


Figure 30: I-90 Exit 406 Study Website

(www.sehinc.com/online/406)

9. Funding Plan

The following table provides the two planned projects that will include the proposed improvements identified as part of this IMJR. The Interstate project costs include the reconstruction of both bridges over the BNSF railroad tracks, the I-90 Exit 406 interchange, and I-90 mainline from just west of the BNSF bridges to just west of the Split Rock Creek bridges.

Table 36: Anticipated Funding Allocation (2017 dollars)

Project Number	State Funding Category	Federal Funding Category	Federal Funds (\$ million)	State Funds (\$ million)	Other Funds (\$ million)	Total Funds (\$ million)
IM-NH 0909(46)406	Interstate	National Highway Performance	\$24.475	\$3.733	\$0.000	\$28.280
NH 0011(118)80	State Highway Urban	National Highway Performance	\$3.852	\$0.849	\$0.000	\$4.701
TOTAL:			\$28.327	\$4.582	\$0.000	\$32.909

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

Inflated costs to year of implementation are calculated at \$36.332 million.

10. Recommendations

Based on the analysis contained herein, the IMJR-recommended alternative that best meets the established transportation needs within the study area is as follows:

- Interchange Build Alternative 11-5: Diverging Diamond Interchange.
- Corridor Build Alternative A: SD11/Splitrock Boulevard – 5-Lane Undivided (south of I-90).
- Corridor Build Alternative F: SD11/Splitrock Boulevard – 3-Lane Undivided (north of I-90).

This modification request is to modify the existing I-90 Exit 406 Interchange. No additional access to the Interstate system is being requested.

Based on this recommendation, the proposed control of access is provided in Figure 31.

The technical analysis contained herein demonstrates that the eight policy requirements for new or revised access points to the existing Interstate system, published in the Federal Register Volume 74 Number 165, August 27, 2009, have been met.

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

A review of previous studies, interchange construction plans, and findings as part of this study has established four overarching needs as the basis for the proposed improvements:

- Geometric deficiencies.
- Transportation demand.
- Access.
- Safety.

Three of the primary causal factors of these needs are: A) geometric deficiencies, B) the interchange was not designed to handle current and forecasted travel demand, and C) the existing bridge prohibits expansion of SD11/Splitrock Boulevard through the interchange. The following describes each of these needs with regard to requirements of Policy Point #1.

Geometric Deficiencies

The interchange was constructed in 1960 and incorporated design standards current to that era. Existing interchange geometrics within the interchange area that do not meet current SDDOT Road Design Manual guidelines include:

- Westbound off-ramp and eastbound on-ramp grade exceeds maximum at 6 percent and 5.2 percent, respectively (*5 percent maximum standard*).
- Ramp surfacing width is 24 feet (*25-foot ramp surfacing width standard: 2-foot inside shoulder, 8-foot outside shoulder, and 15-foot lane*).
- Existing slopes adjacent to roadway shoulders are 4:1 (*6:1 slope to clear zone standard*).
- Ramp clear zone less than 30 feet (*30-foot minimum standard*).
- Ramp terminal intersections are less 300 feet from I-90 centerline, limiting storage capacity for Diamond-type interchange (*550-foot offset from Interstate centerline standard for Diamond-type interchange*).
- Current SD11/Splitrock Boulevard bridge over I-90 does not provide accommodations for multi-modal accessibility across I-90.
- Bridge width (30 feet) limits functionality in terms of SDDOT operational goals for an urban interchange.
- On-ramp entrance taper rates are 29:1 or 30:1 (*Parallel type on-ramps are preferred with a minimum 50:1 entrance taper*).

The current bridge has been a limiting factor to implementing incremental improvements that address growing demand within the existing interchange. Due to the bridge type, commonly known as an umbrella-type structure, it cannot be widened. This prohibits additional northbound/southbound through lanes or left-turn lanes to the interchange on-ramps without bridge reconstruction. The narrow bridge width also creates an impediment in the multi-modal connectivity along the SD11/Splitrock Boulevard corridor. The lack of separate pedestrian or bicycle facilities makes it difficult to cross I-90 on the bridge safely.

Because these deficiencies are throughout the interchange area, isolated or singular improvements neither fully address this need nor the other identified needs. The proposed DDI improvements to reconstruct the current I-90 Exit 406 interchange address these geometric deficiencies.

Transportation Demand

The transportation demand need is primarily related to the projected continual degradation of traffic operations at both ramp terminal intersections. Existing and future-year No-Build Conditions analyses illustrate this need due to the existing interchange configuration and forecasted increases in traffic demand on both the SD11/Splitrock Boulevard corridor and interchange ramps.

The future-year No-Build and Build Conditions analyses found no freeway segment operational issues around the I-90 Exit 406 interchange. However, the degradation and ultimate failure of operations at both ramp terminals is expected to impact I-90 mainline operations through queue spillback. Further, it was found that simply signaling the existing layout does not meet operational goals in 2045 Build Conditions due to lengthy delay and queues affecting both I-90 mainline and SD11/Splitrock Boulevard operations.

The primary impediment to accommodating future-year demand is the existing bridge width and need for reconstruction in order to add lanes on SD11/Splitrock Boulevard. The current configuration is a single lane in both directions and left-turns to the on-ramps are accommodated from this shared through/left-turn lane. This leads to significant delay and queues in the northbound direction in both the AM and PM peak periods. Signalizing this ramp terminal does not provide operational improvements to meet study goals as a standalone improvement.

Adding turn lanes to off-ramp approaches would be feasible and provide a benefit to operations, particularly for the eastbound off-ramp approach. However, that improvement alone does not meet the operational needs at the interchange. The bridge needs to be widened to accommodate additional lanes in order to serve existing and forecasted demand at the westbound ramp terminal intersection.

The study also evaluated adjacent interchanges and described the interrelationship each has, or does not have, with regard to study area traffic demand. I-90 Exit 406 serves as the City of Brandon's primary access to I-90 as the next adjacent interchanges are four miles to the east or west (Exit 402 and Exit 410). The Sioux Falls MPO TDM demonstrates the importance of Exit 406 and subsequent traffic demand for the Brandon area. The incorporation of planned Exit 402 and Veterans Parkway improvements do not draw a significant amount of traffic demand away from Exit 406.

Programmed improvements to the I-90 Exit 402 Interchange were accounted for in the traffic forecast and analysis of future-year travel demand. However, because I-90 Exit 406 is the primary I-90 access to/from the heart of Brandon, improvements at I-90 Exit 402, four miles to the west of Brandon, will only have a limited impact on drawing traffic demand away from Exit 406. Further, those improvements do not address the existing geometric deficiencies, access deficiencies, and safety concerns at I-90 Exit 406.

All interchange concepts were developed and refined to meet operational goals with regard to future-year demand. Each concept included a new bridge to provide additional travel lanes across I-90. From there, each concept incorporated a comprehensive approach to address Design Year traffic needs, such as ramp terminal intersection lane channelization, storage, and traffic control were tailored to each respective interchange.

Advantages to the proposed DDI improvements that align with existing and future-year traffic conditions include:

- Provides free left-turns from the crossroad to on-ramps.
 - Benefit to northbound to westbound high-volume movement.
 - Benefit to southbound through traffic at northern crossover intersection.
- Crossover intersections and benefits of a two-phase signal.
 - More than two phases likely required in other signalized interchange alternatives, which can increase overall interchange delay.

Access

Established access needs along the SD11/Splitrock Boulevard corridor could be addressed as a single project through the closure, relocation, or restriction of access at each location. However, addressing this need alone does not adequately satisfy the entirety of needs that includes geometric deficiencies, traffic demand, and safety at this interchange.

Therefore, each interchange concept that was developed incorporated access improvements to address this need as part of the overall project. The refinement process further tailored these access improvements to meet goals for this study and compliment elements that address the other interchange needs.

Access improvements incorporated into the proposed DDI Build Alternative include:

- Construct a median between the eastbound ramp terminal intersection and Ash Street to prohibit left-turns into and out of existing commercial driveways.
- Extension of control of access along SD11/Splitrock Boulevard through:
 - Field access closure in northwest quadrant of interchange.
 - Moving access further away from interchange in northeast quadrant of interchange.
 - Aligning field access with Ash Street intersection in southeast quadrant of interchange.
- Proposed access modifications south of Ash Street to reduce number of conflict points.

Safety

The crash history review identified several locations of safety concern for transportation users. Examples of these locations along the SD11/Splitrock Boulevard corridor include:

- Ramp terminal intersections.
 - Existing traffic control (stop-control from the off-ramp approach) and intersection sight distance limitations.
 - Calculated crash rate at the eastbound ramp terminal intersection exceeds critical crash rate.
- SD11/Splitrock Boulevard segment between eastbound ramp terminal intersection and Ash Street.
 - Access density and proximity to interchange.
 - Northbound lane drop and southbound lane addition at the eastbound ramp terminal intersection.
 - Lack of a center-turn lane; northbound left-turns to commercial driveways are initiated from inside through lane.
 - Calculated segment crash rate exceeds critical crash rate.
- SD11/Splitrock Boulevard lane continuity.
- Lack of continuous multi-modal facilities along SD11/Splitrock Boulevard corridor.

At the ramp terminal intersections, safety concerns are related to geometric deficiencies, traffic demand, and traffic control. Reconstruction of the bridge over I-90 is needed to adequately address these needs.

The predictive safety analysis of the Build Alternatives identified a significant safety benefit of DDIs. Compared to other interchange types, the DDI reduces the number of conflict points and potential for right-angle crashes that have a propensity of resulting in more severe crashes. In the crash history analysis, 10 of the 21 crashes at the eastbound ramp terminal intersection were angle crashes, 7 of which involved a vehicle pulling out of the off-ramp approach. Six of these 21 crashes resulted in injuries. The DDI eliminates left-turn maneuvers across traffic, providing a free left-turn onto both on-ramps. Left-turns from the off-ramps also do not cross traffic, rather merge into a traffic lane from a yield condition.

The speed reduction also associated with DDIs helps reduce severity when drivers do make errors that result in crashes. Coupled with the reduction in conflict points, particularly right-angle conflicts, traffic operational benefits, and addressing other established needs for the project, the DDI demonstrates a safety improvement to not only the existing conditions but also in comparison to the other developed interchange improvements.

There are multiple safety concerns along the SD11/Splitrock Boulevard corridor between I-90 and Ash Street and requires a multi-faceted approach to design geometrics, traffic control, and access. Many of these items could be addressed individually and deliver safety benefits to the segment, but alone, they do not address the interchange needs.

These elements were incorporated into each of the developed concepts and refined through the study. Safety improvements incorporated into the proposed DDI Build Alternative include:

- Construct a median between the eastbound ramp terminal intersection and Ash Street to prohibit left-turns into and out of existing commercial driveways.
- Carry two lanes northbound and southbound through the interchange.
- Signalize dual right-turn lanes on eastbound off-ramp to minimize southbound vehicle-vehicle and vehicle-bicycle weave conflicts.
- Add northbound right-turn lane at northbound ramp terminal intersection.

The existing bridge width does not accommodate separate bicycle and pedestrian facilities and creates a barrier for multi-modal mobility across I-90. Greater bridge width, or a separate structure, is required in order to provide separate facilities such as a sidewalk for pedestrians or widened outside lane for bicyclists. Multi-modal facilities were incorporated into each developed concept and further refined throughout the study. Connections to existing facilities north and south of the interchange were also incorporated.

Policy Point #1 Conclusion

It can be concluded that the I-90 Exit 406 interchange needs cannot be adequately satisfied by existing interchanges to I-90 and the local street network can neither provide the desired access, nor can they be reasonably improved to satisfactorily accommodate the Design Year traffic demands. A comprehensive approach to interchange improvement is needed to address the four overarching needs, which establishes the basis for an interchange reconstruction Build condition to address these needs instead of maintaining a No-Build condition. The proposed DDI improvements, represented by DDI Build Alternative 11-5, address these needs and satisfactorily accommodate the Design Year traffic demands.

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

The recommended improvements as part of this IMJR incorporate changes in geometric design of the existing I-90 Exit 406 Standard Diamond interchange to address the established needs.

The development of alternatives for potential improvements began in the 2010 Decennial Interstate Corridor Study. In that study, a Standard Diamond interchange and SPUI configuration was developed and carried forward into the environmental process. However, due to revisions to the Sioux Falls TDM, forecasted traffic volumes were notably different from what was previously analyzed and the SDDOT initiated a study to develop additional interchange and corridor alternatives.

The environmental process for this study incorporates a phased alternatives development and screening process based on the established Purpose and Need. The process was initiated with the development of 11 interchange concepts and four corridor concepts that were screened to identify Build Alternatives. Four Interchange Build Alternatives and three Corridor Build alternatives were carried forward for further refinement and screened to identify a single interchange alternative and corridor alternative type. It was determined that a DDI configuration, represented by Build Alternative 11, best met the project Purpose and Need. Corridor Build Alternative A was selected south of I-90 and Corridor Build Alternative F was selected north of I-90.

The IMJR process further built-out the DDI Build Alternative 11 to meet SDDOT capacity goals that align with the proposed bridge's design life. This process developed DDI Build Alternative 11-1 (represents DDI Build Alternative 11), 11-2, 11-3, 11-4, and 11-5 for further evaluation.

As part of the IMJR build-out of DDI Build Alternatives, TSM opportunities as standalone improvements or part of another Build Alternative were investigated. It was concluded that TSM alternatives were not economically feasible in the near future due to:

- Currently no fixed-route mass transit within the City of Brandon.
- There are no areas within the State of South Dakota that will consistently experience congestion levels extreme enough to make ramp metering or HOV facilities economically feasible in the foreseeable future.

The IMJR evaluation matrix summarizing the evaluation of the No-Build Alternative and DDI Build Alternatives 11-1, 11-2, 11-3, and 11-5 is provided in Table 35.

The recommended Build Alternative in this IMJR is 11-5, based on the following key differentiators:

- Provides the best cross-sectional continuity with SD11/Splitrock Boulevard north and south of interchange. Build Alternative 11-5 is the only Build Alternative that extends two continuous through lanes through both crossover intersections.
 - Because of the cross-sectional continuity through the interchange, Build Alternative 11-5 also provides the best flexibility in meeting traffic growth and changes to traffic patterns within the bridge design life.
 - Provides a signal-controlled pedestrian crossing across the high demand eastbound I-90 off-ramp right-turn lanes.
 - Best minimizes vehicle-bicycle conflicts south of the southern crossover intersection.
 - Best addresses weave movement conflicts between the eastbound I-90 right-turning traffic and southbound through traffic, between southern crossover intersection and Ash Street.
 - While Build Alternative 11-5 does not provide the traffic operational benefits of a free right-turn for the high-volume eastbound off-ramp to southbound SD11/Splitrock Boulevard movement, it manages operations acceptably in terms of both delay and queue length.
 - 11-5 allows for the two business accesses on SD11/Splitrock Boulevard to remain as right-in/right-out accesses.
3. ***An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, shall be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access must include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute and accommodate traffic on the***

Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

The traffic operations analysis of the study area freeway segments demonstrated that the proposed improvements do not have an adverse impact to the safety and operation of I-90 through the study area. The proposed modifications are expected to improve I-90 operations through a design that is consistent with current design standards and meet future traffic projections. Modifications to the two ramp terminals, in particular, are expected to improve intersection operations and safety and reduce the risk of queue spillback onto I-90 mainline that has been observed in current operations. The next major intersections, Hemlock Boulevard and Redwood Boulevard, have ample capacity to accommodate the forecasted demand.

While no changes in access are proposed at SD11/Splitrock Boulevard intersections with public streets, consolidation and removal to private access is proposed at select private access locations to improve SD11/Splitrock Boulevard safety and operations. Properties impacted by proposed access modifications between I-90 and Ash Street are accommodated through new access via Express Avenue.

Adjacent interchanges are four miles on either side of I-90 Exit 406 and evaluated for existing and future-year operations. The Exit 410 interchange is four miles to the east and in the opposite direction of the primary traffic movements to/from I-90 and SD11/Splitrock Boulevard, between Brandon and Sioux Falls. Analysis of this interchange indicated that the current configuration meets future-year operational goals and no operational needs that may be detracting demand from using the interchange. Further, improvements to Exit 410 would not address geometric and safety concerns at Exit 406.

The future-year No-Build and Build Conditions analyses incorporated the planned SPUI improvement at I-90 Exit 402 as part of the Veterans Parkway project. Through the volumes development process and subsequent analyses, it was found that the improvements at Exit 402 did not significantly draw demand from Exit 406. Instead, Build Conditions traffic volumes increased at Exit 406 because potential improvements provided additional capacity to meet demand not served in the No-Build Conditions. Future-year traffic operations were verified at Exit 402 with the SPUI Veterans Parkway connection with I-90 and found that the improvements provide ample capacity for the demand projected in the Sioux Falls MPO TDM. Similar to Exit 410, improvements to Exit 402 do not address the geometric and safety concerns at Exit 406.

It can be concluded that improvements to adjacent interchanges, which are four miles on either side of Exit 406, do not address the establish needs at Exit 406. A conceptual signing plan for the IMJR-recommended DDI Build Alternative 11-5 is provided in Figure 32.

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

The proposed interchange modifications at I-90 Exit 406 will maintain a connection to a public road, SD11/Splitrock Boulevard, and continue to provide for all movements through a DDI configuration. The proposed modifications will meet or exceed current design standards.

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

A need for interchange improvements was originally identified in the 2010 Decennial Interstate Corridor Study, which is a tool used by the SDDOT to assess and plan for improvements throughout the statewide Interstate network. Interchange improvements have been identified and incorporated into the Go Sioux Falls 2040 LRTP, which is prepared as part the Sioux Falls MPO planning process.

Many of the traffic-related considerations that drove design decisions were based on regional traffic demand and surrounding land use. This included high directional commuter traffic from Brandon to Sioux Falls in the morning and back to Brandon in the evening. Large truck demand, particularly those longer than a common semi-truck (WB-67), originates both north and south of I-90 and relies on the I-90 interchange for regional connectivity. Locally, SD11/Splitrock Boulevard offers the only crossing of I-90 within the City of Brandon. The next adjacent crossing is two miles east on 484th Avenue.

The proposed interchange improvements have been identified in the 2022-2025 Developmental STIP as PCN 4433. SD11/Splitrock Boulevard corridor improvements, outside of the control of access limits, associated with this project are identified as PCN 062V within the same 2022-2025 Developmental STIP.

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

The 2010 Decennial Interstate Corridor Study does not indicate a need for any future additional interchanges along I-90 between Exit 402 and Exit 410. Improvements are planned to the I-90 Exit 402 Interchange to improve capacity and connectivity with the new Veterans Parkway.

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

The proposed interchange improvements were developed based on the overarching needs established for this project, which include current geometric deficiencies, transportation demand, access, and safety. Several of these needs were identified in the 2010 Decennial Interstate Corridor Study, which has been the impetus for development of this IMJR document

One of the needs established for this project is future-year traffic demand. Both the Sioux Falls metropolitan area and City of Brandon have experienced notable growth within the last decade. It is expected that this area will continue substantial, sustained growth, driving the need for coordinated long-range planning of transportation improvements between the jurisdictions.

Specific to modifications at I-90 Exit 406, further planning efforts have identified proposed improvement projects within the 2010 Decennial Interstate Corridor Study, the Go Sioux Falls 2040 LRTP, and the 2022-2025 Developmental STIP.

The study that has developed this IMJR and the companion EA document identified additional needs and verified those previously identified within the study area. A Study Advisory Team made up of FHWA, SDDOT, Sioux Falls MPO, and City of Brandon representatives helped guide the development and screening of interchange and corridor alternatives.

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

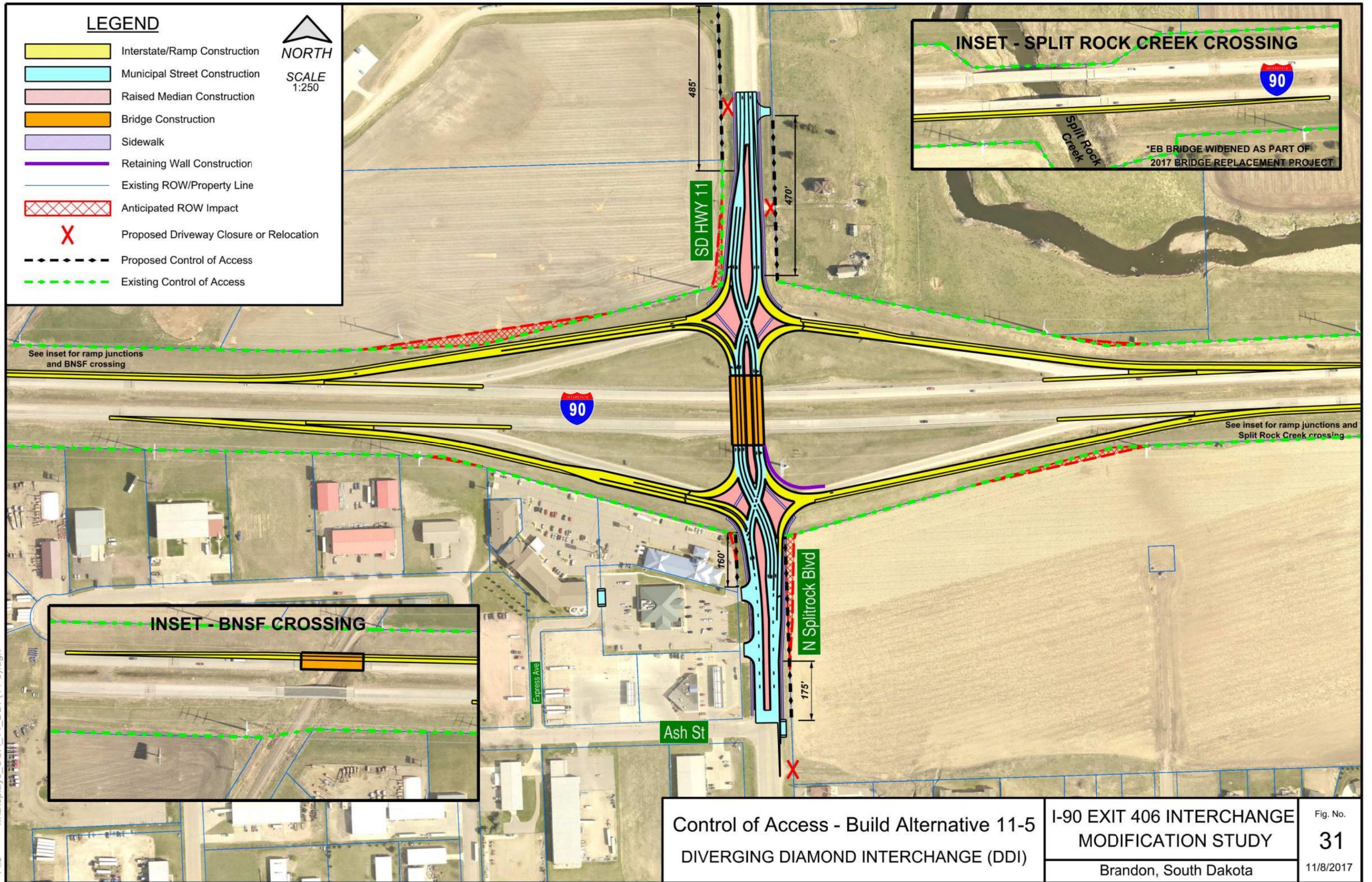
The proposed improvements have been included as an alternative in the associated EA that has been developed concurrently with this IMJR document. The EA document will be the basis for approval of the selected alternative.

LEGEND

- Interstate/Ramp Construction
- Municipal Street Construction
- Raised Median Construction
- Bridge Construction
- Sidewalk
- Retaining Wall Construction
- Existing ROW/Property Line
- Anticipated ROW Impact
- X Proposed Driveway Closure or Relocation
- Proposed Control of Access
- Existing Control of Access



SCALE
1:250



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<p>Control of Access - Build Alternative 11-5 DIVERGING DIAMOND INTERCHANGE (DDI)</p>	<p>I-90 EXIT 406 INTERCHANGE MODIFICATION STUDY</p> <p>Brandon, South Dakota</p>	<p>Fig. No. 31 11/8/2017</p>
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Appendix A: Existing Conditions HCS 2010 Reports

Appendix B: Crash Summary Memorandum

Appendix C: Interchange and Corridor Conceptual Layouts

Appendix D: Concepts Screening Evaluation Memorandum

Appendix E: Interchange and Corridor Build Alternative Layouts

**Appendix F: Environmental Assessment Alternatives Screening Matrix
Memorandum**

Appendix G: Interchange Build Alternative Signing Plans

Appendix H: Traffic Forecasts Memorandum

Appendix I: 2022 No-Build Conditions HCS 2010 Reports

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