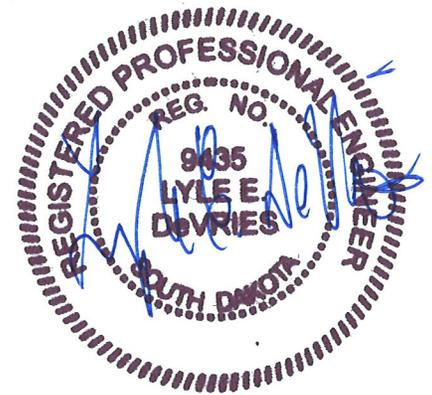


SDDOT INTERSECTION SAFETY STUDY

Prepared for:

South Dakota DOT
700 E. Broadway Ave.
Pierre, South Dakota 57501



Prepared by:

Felsburg Holt & Ullevig
11422 Miracle Hills Drive, Suite 115
Omaha, Nebraska 68154
402-445-4405

Principal-in-Charge: Lyle DeVries, PE, PTOE
Project Manager: Rick Haden
Project Engineers: Mark Meisinger, PE, PTOE & Adam Denney, EI

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I. INTRODUCTION

Felsburg Holt and Ullevig (FHU) has completed a safety study for the South Dakota Department of Transportation (SDDOT) to evaluate and recommend improvements at thirteen 4-lane divided highway intersections along State highways throughout the State. The thirteen intersections were chosen through a screening process of intersections across the state by SDDOT staff. The scope of the study consists of data collection, identification of initial crash patterns, and development of improvements with cost estimates for each intersection. A preferred alternative recommendation is provided for each intersection.

The evaluation and analysis of the proposed improvements are addressed in four separate sections of this report. The intersections were broken out into four different Regions as shown in **Table 0.1** below:

Table 0.1 Study Intersections by Region

No.	Highway	MRM	Intersecting Road
Aberdeen Region			
1.	US 14	403.09	US 81 South Jct.
2.	US 281	173.41	SD 20
3.	US 281	185.03	142 nd Street
4.	US 281	199.22	130 th Street
Mitchell Region			
5.	SD 50	350.91	SD 37W - West Jct.
6.	SD 50	354.95	SD 37E - East Jct.
7.	SD 50	356.10	Birch Street (Tyndall)
8.	SD 50	356.32	Fir Street (Tyndall)
9.	SD 50	356.64	Main Street (Tyndall)
Pierre Region			
10.	US 14	230.69	SD 1804
11W.	US 14	232.38	US 14B/Garfield
11E.	US 14	232.58	Airport Road/ 292 nd Avenue (Kingsway Road)
Rapid City Region			
12.	US 212	36.18	SD 79S - South Jct.

A site visit was conducted in April and May 2014 at each of the study locations. Data collection included field measurements, site observations, sign inventory, and photos. Turning movement counts and Average Daily Traffic (ADT) counts were also performed at each intersection. FHU also collected information available from the SDDOT such as aerial photographs, historical traffic count information and crash history.

The study intersections were evaluated for both substantive and nominal safety conditions. Substantive safety refers to actual crash history which would drive the need for roadway improvements. Nominal safety examines roadway features that may not meet current design standards. While not always exposed as a part of the limited crash history, the improvement of

any identified design features not meeting current standards may reduce the potential number and / or severity of crashes over the life of the roadway.

SUBSTANTIVE SAFETY ANALYSIS

The collision histories for the study intersections were analyzed for the five-year period of January 1, 2008 thru December 31, 2012 utilizing crash data provided by the SDDOT. The number, severity, and rate of collisions by study intersection for the five-year period are shown in **Table 0.2**.

The Crash Rate, in terms of crashes per million entering vehicles at highway junctions, is considered as a more reliable indicator of unusual safety concerns along a highway corridor rather than simply the number of collisions. By adjusting for the traffic volume, it reduces the influence of short high volume segments that can otherwise skew the rate with a large number of relatively minor collisions. A number of locations had crash rates above expected rates using the critical rate method when compared to the other study intersections, and are shown in bold print. It is noted that two locations experienced no reported crashes over the five year study period.

The Severity Rate further adjusts for injuries and fatalities by applying a weighted value based on the *Highway Safety Manual, 1st Edition, 2010 (HSM)* for different degrees of injury in proportion to an equivalent property damage only crash. Several intersections had severity rates above the expected severity rates for other study intersections. These intersections are also shown in bold. One intersection experienced a fatal crash which dramatically increased the severity rate for that location.

The next level of crash review along the project corridor involves an examination of the patterns of crashes. The most frequently observed patterns for the 5-year period are shown in **Table 0.3**. The most frequently observed patterns were Far Side Right Angle collisions, that is a right angle collision between a vehicle entering from a stop sign crossing the median and in collision with a mainline vehicle approaching from the right, representing 36% of the reported crashes at the study intersections. Near Side Right Angle collisions, that is a right angle collision between a vehicle entering from a stop sign in collision with a mainline vehicle approaching from the left was the next largest category with 20%. Leaving the Roadway followed closely with 16%. Left Turns off of the Mainline (4-lane roadway) represented 13% of the crashes and Rear End crashes involving merging vehicles were the next highest.

Table 0.2 Crash Severity-Injury Status

Int. #	Intersection	1 - Fatal	2 - Incap.	3 - Non Incap.	4 - Possible	5 - PDO	Total	EPDO Total	Total Entering Vehicles	5-Year (MEV)*	Crash Rate per MEV	Severity Rate** per MEV
1	US 14/US 81	0	0	2	3	8	13	47.55	4,335	7.91	1.64	6.01
2	US 281/ SD 20	1	0	0	3	5	9	564.95	3,790	6.92	1.30	81.68
3	US 281/142nd St	0	2	1	1	4	8	79.12	3,974	7.25	1.10	10.91
4	US 281/130th St	0	2	0	0	3	5	61.38	5,619	10.25	0.49	5.99
5	SD 50/SD 37W	0	0	0	0	2	2	2.00	2,000	3.65	0.55	0.55
6	SD 50/SD 37E	0	3	3	1	3	10	128.66	2,313	4.22	2.37	30.48
7	SD 50/Birch St	0	0	1	1	2	4	18.74	2,538	4.63	0.86	4.05
8	SD 50/Fir/Ivy St	0	0	0	0	0	0	0.00	2,420	4.42	0.00	0.00
9	SD 50/Main St	0	0	0	2	1	3	13.14	3,384	6.18	0.49	2.13
10	US 14/SD 1804	0	0	0	0	3	3	3.00	6,343	11.58	0.26	0.26
11 W	US 14/US 14B	0	1	2	2	6	11	68.68	7,092	12.94	0.85	5.31
11 E	US 14/Airport Rd	0	2	1	1	4	8	79.12	6,392	11.67	0.69	6.78
12	US 212/SD 79S	0	0	0	0	0	0	0.00	2,516	4.59	0.00	0.00
Totals		1	10	10	14	41	76		52,716			
Avg. EPDO minus 2 highs & 2 lows					4.67	Avg. Rate			7.40	0.82	11.86	
*MEV=Million Entering Vehicles			PDO=Property Damage Only			Incap=Incapacitating			Non Incap= Non Incapacitating			
** Severity Rate is based on EPDO per MEV												

Table 0.3 Crash Patterns

Int. #	Highway	MRM	Int. Road	Rt. Angle Near Side	Rt. Angle Far side	Rear End Mainline	Rear End Merge *	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
1	US 14	403.09	US 81- S	6	0	0	2	0	1	4	13
2	US 281	173.1	SD 20	2	5	1	0	0	0	1	9
3	US 281	185.03	142nd St	0	4	1	0	1	1	1	8
4	US 281	199.22	130th St	1	1	0	0	2	1	0	5
5	SD 50	350.91	SD 37W	0	0	0	0	0	0	2	2
6	SD 50	354.95	SD 37E	1	6	1	0	1	0	1	10
7	SD 50	356.10	Birch St	2	2	0	0	0	0	0	4
8	SD 50	356.32	Fir St	0	0	0	0	0	0	0	0
9	SD 50	356.64	Main St	0	3	0	0	0	0	0	3
10	US 14	230.69	SD 1804	0	0	0	1	0	0	2	3
11 W	US 14	232.38	US 14B	2	0	0	2	0	6	1	11
11 E	US 14	232.58	Airport Rd.	1	6	0	0	0	1	0	8
12	US 212	36.18	SD 79- S	0	0	0	0	0	0	0	0
Totals				15	27	3	5	4	10	12	76
* Rear Ends in channelized right turn lane										Avg. #	5.8

ABERDEEN REGION

Intersections Include:

1. US 14/US 81 Intersection
2. US 281/SD 20 Intersection
3. US 281/142nd Street Intersection
4. US 281/130th Street Intersection



II. ABERDEEN REGION

Four of the study intersections are located in the Aberdeen Region. These intersections include US 14/US 81 (south junction), US 281/SD 20, US 281/142nd Street, and US 281/130th Street.

1. US 14/US 81 Intersection

The south junction of US 14 with US 81 is a three legged intersection approximately 2.4 miles south of the town of Arlington, SD. The posted speed limits along US 14 and US 81 are both 65 miles per hour (MPH). At the intersection, US 14 is a 4-lane divided highway with an 80 foot median separating the travel lanes. An exclusive westbound left-turn lane is provided with approximately 225 feet of storage and also provided is an exclusive eastbound right-turn lane with approximately 325 feet of storage. US 81 is a 2-lane undivided roadway with stop control for left turns, and a northbound channelized right-turn lane provided under yield control.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

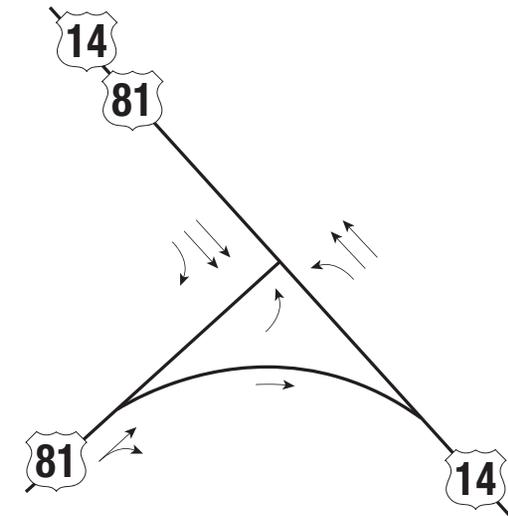
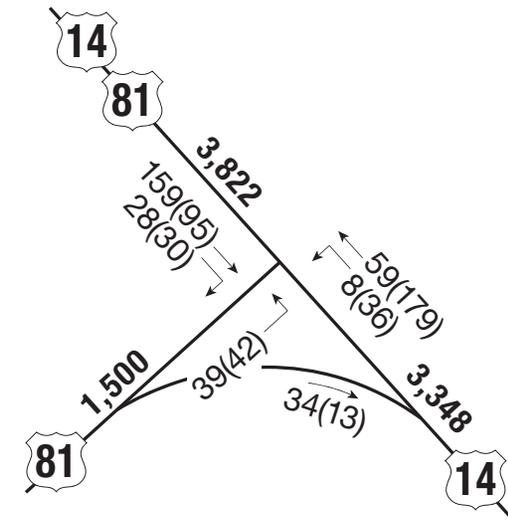
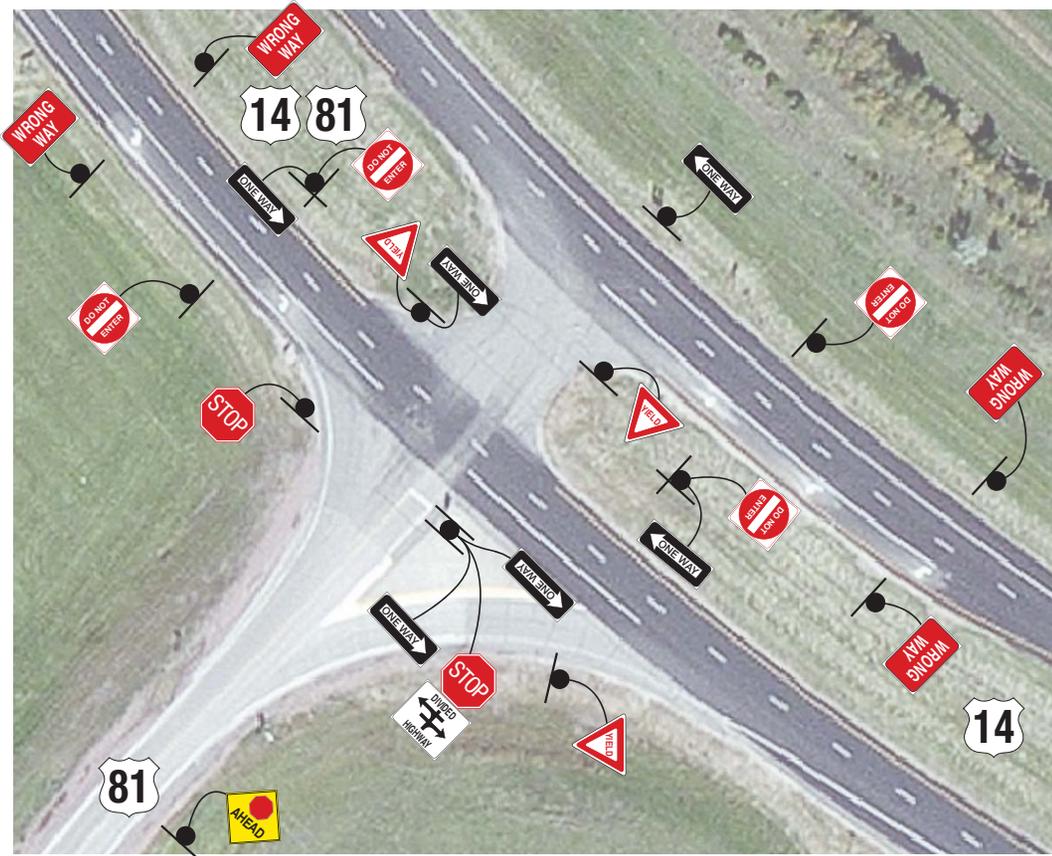
B. Intersection Observation

Below is a list of intersection observations made by FHU staff while conducting site visits:

- The Intersection sits on top of a hill and is on a horizontal curve with radius of approximately 1,900 feet
- Large 48" stop signs on both near right and near left sides of the US 81 approach. A stop ahead sign is also present for northbound traffic
- Scars are visible on pavement just north of the stop bar from vehicles scraping bottom
- 2'-6" x 6' one-way sign
- Yield signs are located in the median for far-side intersections
- A stop bar is present for northbound stop
- Sight distance could be factor looking westbound past right turning vehicles
- There is no advance warning of curve southbound on US 14
- There is no lighting at intersection
- There is a Fatal "Think" Sign on SE corner
- There are chevron delineation signs on curve southbound on US 14

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US14/US81 intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:00 AM to 8:00 AM, and the PM peak hour was 4:30 PM to 5:30 PM. Existing ADT's and turning movement counts are summarized on **Figure 1.1**. The intersection had 4,335 total entering vehicles per day, which ranks it as the 5th highest traffic volume of all studied intersections. The intersection has a truck percentage of 19%. Also shown on **Figure 1.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection. The turning movement count data is included in the **Appendix**.



LEGEND

XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
 XXXX = Daily Traffic Volumes
 X/X = AM/PM Peak Hour Signalized Intersection Level of Service
 x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

- = Stop Sign
- = Yield Sign
- = Do Not Enter Sign
- = Wrong Way Sign
- = Traffic Signal
- = Stop Ahead Sign
- = Intersection Ahead Sign
- = Lane Ends Sign
- = Divided Highway Sign
- = Divided Highway Sign

Figure 1.1
 US 14/US 81 Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US 14/US 81 intersection are summarized in **Tables 1.1** and **1.2** for the most recent five-year period (2008 - 2012).

Table 1.1 US 14/US 81 – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
6	0	0	2	0	1	4	13

A detailed review of the crash history at the intersection indicates a pattern of right angle near side and roadway departure crashes. Right angle near sided crashes represent 46.1% of the total crashes during this five-year period, and leave roadway crashes comprise 30.8% of the total. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; however no other crash pattern was indentified. The crash patterns at the US 14/US 81 intersection are further depicted in **Figure 1.2** by severity and type.

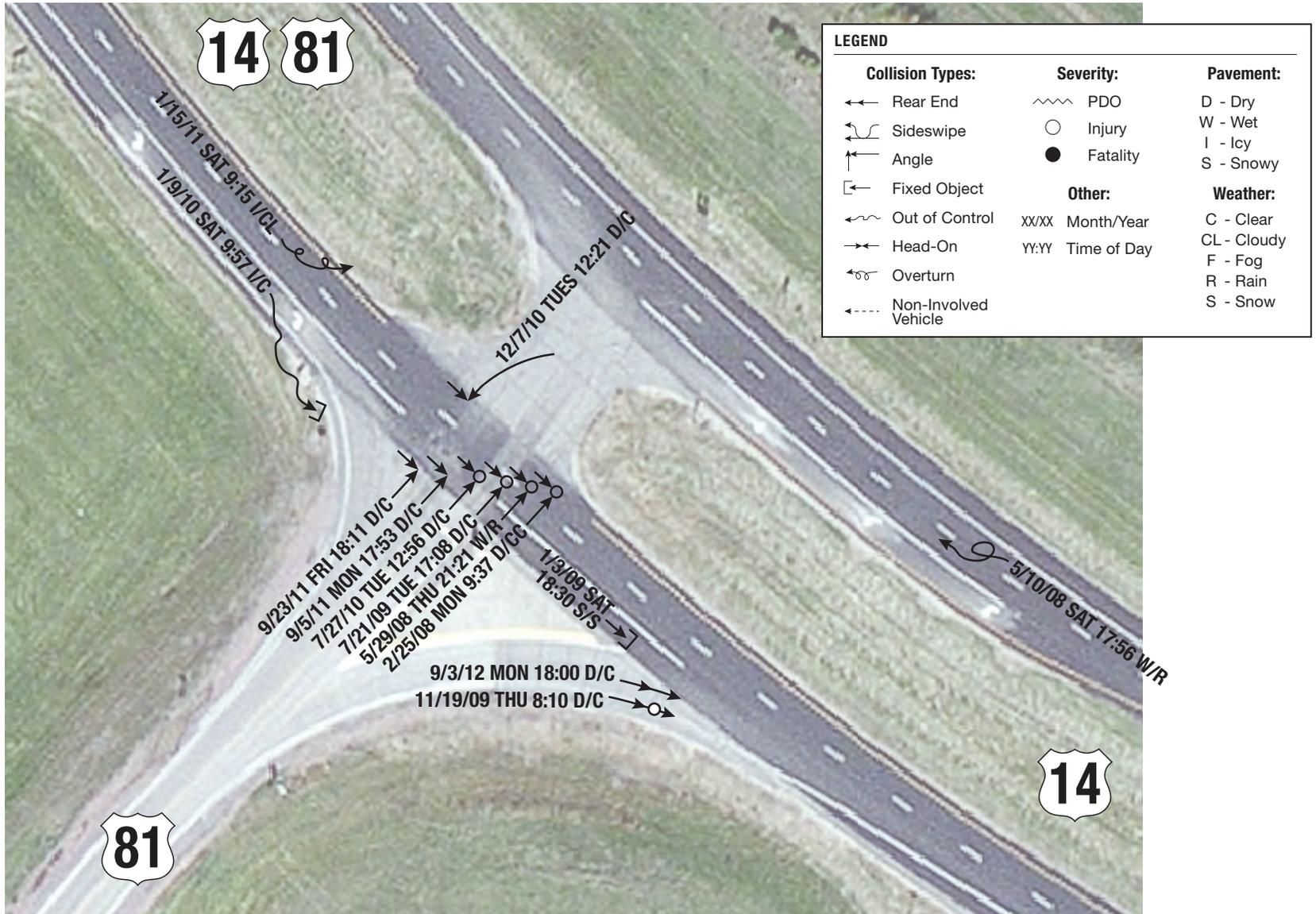
Table 1.2 US 14/US 81 – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
US 14/US 81	0	0	2	3	8	13	4,335	7.91	1.64	6.01
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 1.64. This intersection has the 2nd highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 6.01 which ranks the 5th highest. **Table 1.3** shows the identified crash patterns and possible contributing factors. Also, a set of potential countermeasures was developed based on the type of crash.

Table 1.3 US 14/US 81 – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Rt. Angle - Near Side	<ul style="list-style-type: none"> Non-Involved Right Turning Vehicle Blocking Sight Distance 	<ul style="list-style-type: none"> Offset Right Turn Lane Improve Signing & Markings
Rear End Merge	<ul style="list-style-type: none"> Rear Driver Looking Over Shoulder, Front Driver Hesitates 	<ul style="list-style-type: none"> Add Acceleration Lane Tighten Turn Radius
All	Drivers misjudging approaching traffic	Roundabout



NOTE: Drawing Not to Scale

Figure 1.2
US 14/US 81 Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns, and from on-site observations:

- (1) Improve sight distance with southbound offset right turn lane using signs and markings
- (2) Tighten turn radius and move stop bar
- (3) Construct offset EB right-turn lane with widening providing channelized right-turn lane
- (4) Construct roundabout
- (5) Adjust approach grade of intersection to eliminate cars scraping the pavement
- (6) Remove far side stop sign on northbound approach

F. Economic Appraisal of Countermeasures

Figure 1.3 shows potential countermeasures (1) and (2) for improvements to the intersection. Potential countermeasures (2) and (3) are shown on Figure 1.4. Countermeasure (4) is shown on Figure 1.5.

Table 1.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the Appendix.

Table 1.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Provide Offset Right Turn Lane Using Signs And Markings	\$33,600	\$168,708	5.02
(2) Tighten Turn Radius and Move Stop Bar	\$32,520	\$0	0.00
(3) Construct Offset Right-Turn Lane With Widening	\$99,420	\$168,708	1.70
(4) Construct Roundabout	\$743,040	\$421,771	0.51
(5) Adjust Approach Grade of Intersection to Eliminate Cars Scraping the Pavement	\$50,040	N/A	N/A
(6) Remove Far Side Stop Sign on Northbound Approach	\$1,500	N/A	N/A

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology in the Highway Safety Manual (HSM).

G. Recommendation for Preferred Alternative

1 – It is recommended that an eastbound to southbound offset right-turn lane be provided with signs and markings. By dropping a southbound lane north of the intersection, a single through lane southbound can be carried through the intersection.

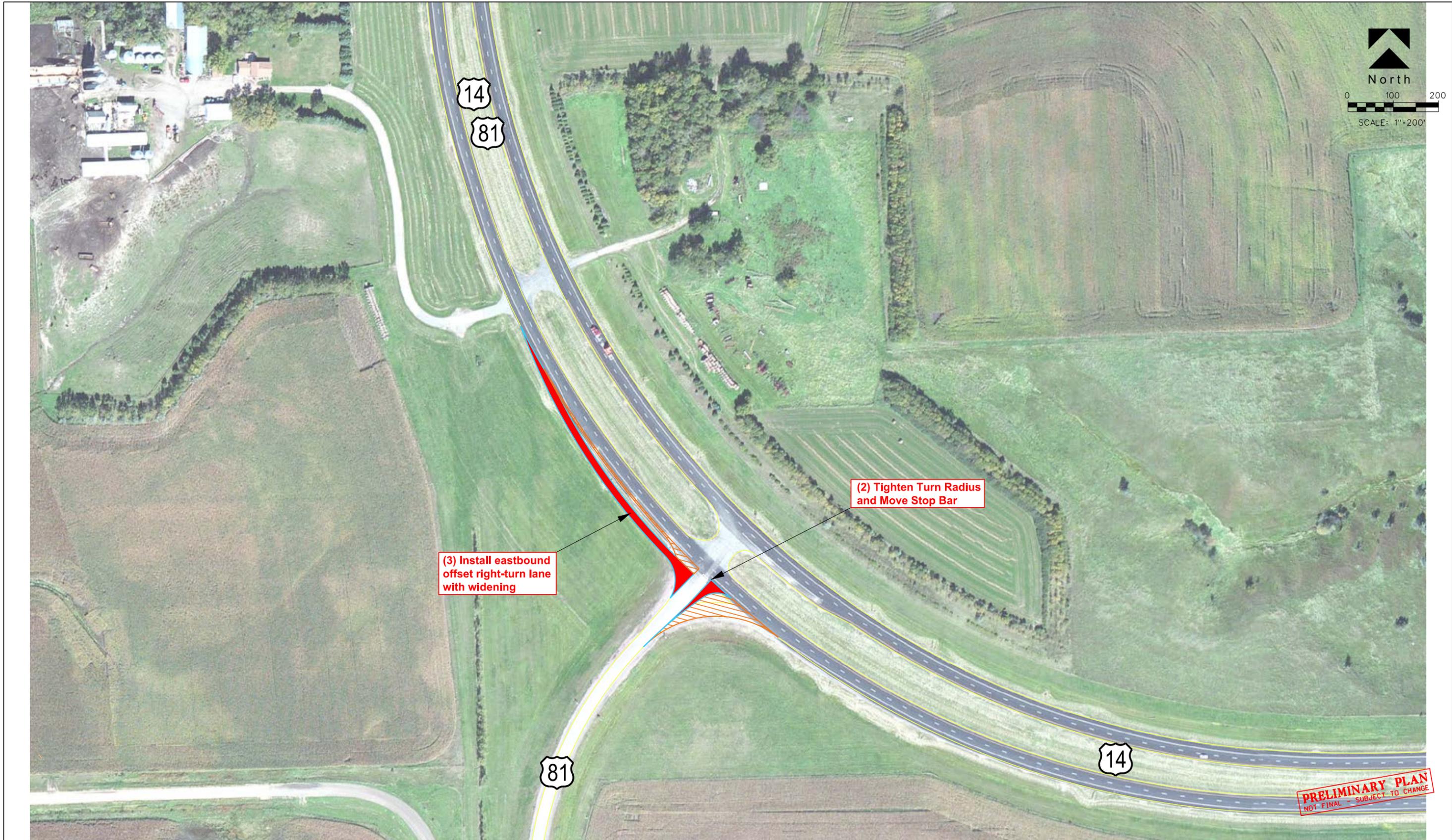


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 1.3
Intersection #1
Intersection Recommendations
US 14 / US 81



(3) Install eastbound offset right-turn lane with widening

(2) Tighten Turn Radius and Move Stop Bar

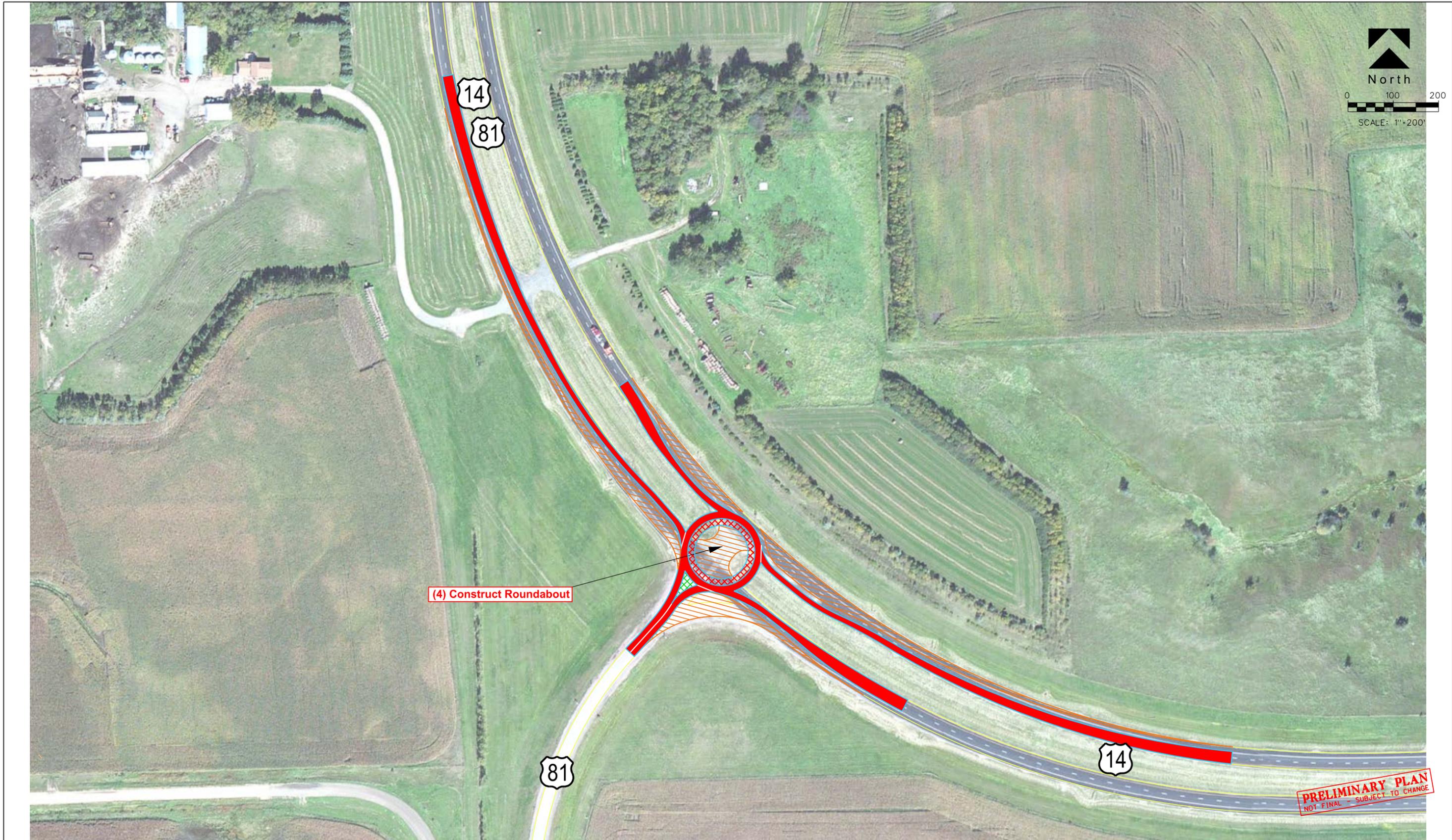
PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND
 Remove Existing Pavement
 New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 1.4
 Intersection #1
 Intersection Recommendations
 US 14 / US 81



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 3

Figure 1.5
Intersection #1
Intersection Recommendations
US 14 / US 81

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2. US 281/SD 20 Intersection

The intersection of US 281 with SD 20 is approximately 0.75 miles west of the town of Mellette, SD. The posted speed limit along US 281 is currently 65 MPH at this intersection. The speed limit drops from 70 MPH to 65 MPH 300 feet north of the SD 20 intersection. SD 20 has a posted speed limit of 65 MPH. At the intersection, US 281 is a 4-lane divided highway with a 55 foot median separating the travel lanes. SD 20 is a 2-lane undivided roadway. This intersection serves as the main access point to the town of Mellette.

A. Data Collection

Traffic data were collected at the intersection in April 2014. The site was visited in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

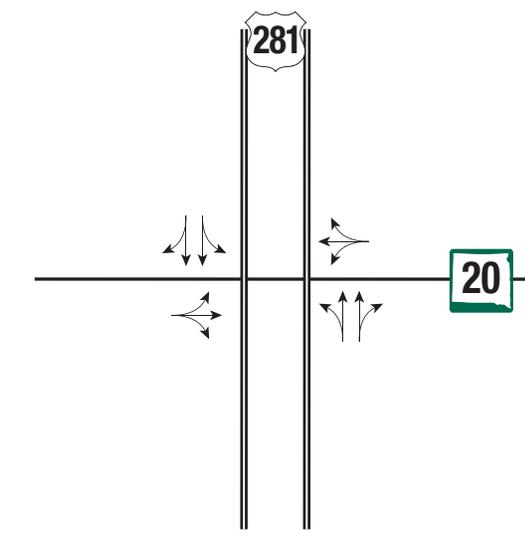
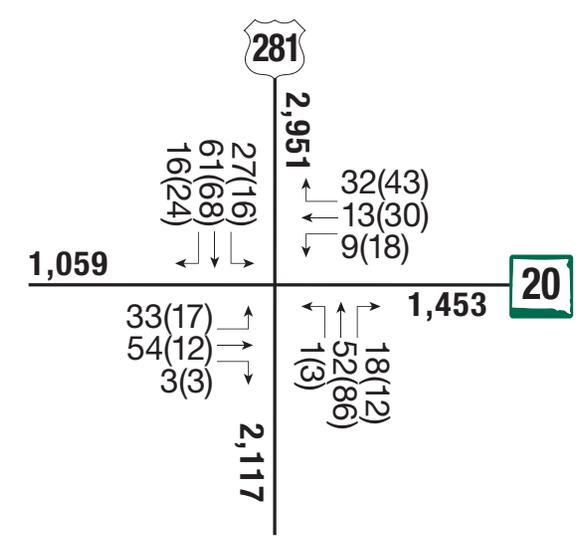
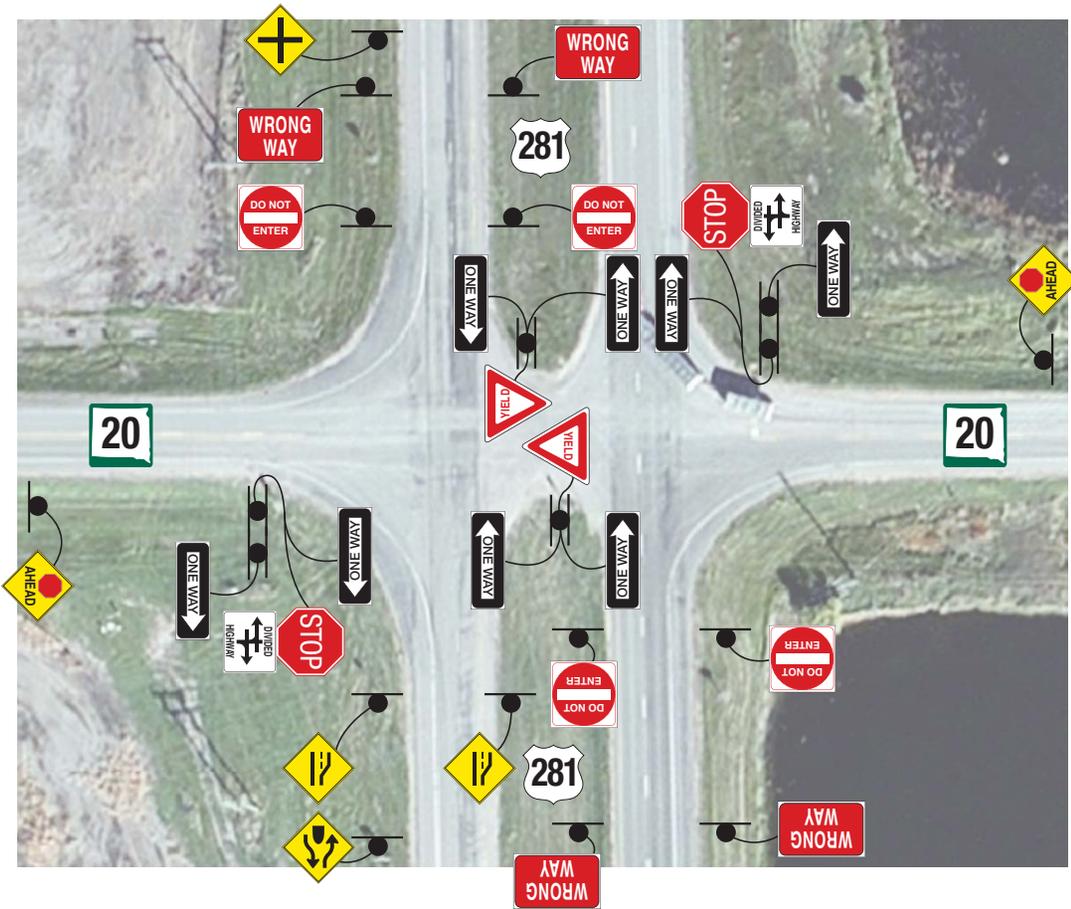
Below is a list of intersection observations made by FHU staff while conducting the site visit:

- The Intersection is the main entrance to the town of Mellette (east of intersection)
- There is a gas station and middle/high school located east of the intersection
- This is a standard intersection, with flat grades and no skews
- Sun glare could be factor for EB and WB travelers on SD 20 at certain times of the year
- Stop bars are present ahead of the stop signs
- Large 48" stop signs are on both SD 20 approaches (Enlarged after 2012)
- LED stop ahead signs and rumble strips were present on SD 20 in advance of intersection
- There are intersection ahead warning signs for SB US 281
- SDDOT has ITS/Monitoring camera at intersection (Installed 6-4-13)
- The intersection has street lighting (Installed after 2012)
- There are no turn lanes on US 281 and the 4 lane section terminates 1,500 feet south of the SD 20 intersection
- Two-stage turning conflicts were observed where left turning vehicle paths crossed in the center median
- There is a fatal "Think" sign on NE corner

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US 281/SD 20 intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 3:30 PM to 4:30 PM. The peak hours could be influenced by the arrival and dismissal of students at Northwestern High School in Mellette, SD. Existing ADT's and turning movement counts are summarized on **Figure 2.1**. The intersection had 3,790 total entering vehicles per day, which ranks it as the 7th highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 24%. Also shown on **Figure 2.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- | | | |
|--|---------------------|---------------------------|
| XXX(XXX) = AM(PM) Peak Hour Traffic Volumes | = Stop Sign | = Stop Ahead Sign |
| XXXX = Daily Traffic Volumes | = Yield Sign | = Intersection Ahead Sign |
| X/X = AM/PM Peak Hour Signalized Intersection Level of Service | = Do Not Enter Sign | = Lane Ends Sign |
| x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service | = Wrong Way Sign | = Divided Highway Sign |
| | = Traffic Signal | = Divided Highway Sign |

Figure 2.1
US 281/US 20 Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US 281/SD 20 intersection are shown in **Tables 2.1** and **2.2** for the most recent five-year period (2008 - 2012).

Table 2.1 US 281/SD 20 – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
2	5	1	0	0	0	1	9

A detailed review of the crash history at the intersection indicates a pattern of right angle far side and right angle near side crashes. Right angle far sided crashes represent 55.6% of the total crashes during this five-year period, and right angle near sided crashes comprise 22.2% of the total. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; however no other crash pattern was indentified. The crash patterns at the US 281/SD 20 intersection are further depicted in **Figure 2.2** by severity and type.

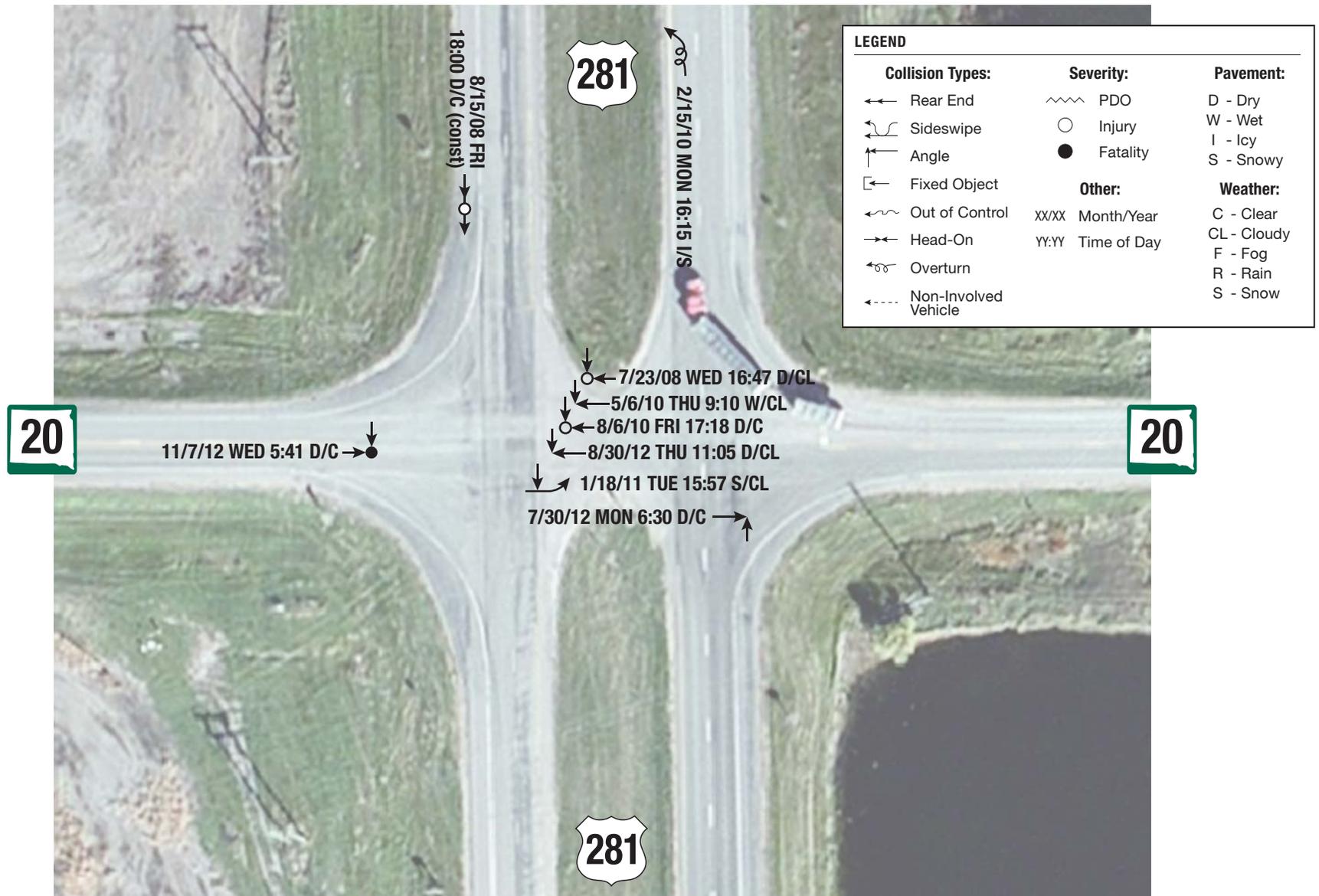
Table 2.2 US 281/SD 20 – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
US 281/SD 20	1	0	0	3	5	9	3,790	6.92	1.30	81.68
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 1.30. This intersection has the 3rd highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 81.68 which ranks it as the highest of the study intersections. This intersection is the only intersection with a recorded fatal crash during the studied five-year period. **Table 2.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 2.3 US 281/SD 20 – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Rt. Angle – Near Side	<ul style="list-style-type: none"> Not Conscious of Stop Sign 	<ul style="list-style-type: none"> Islands and Supplemental Stop Signs
Rt. Angle – Far Side	<ul style="list-style-type: none"> Misjudging Speeds of Major Rd Vehicle 	<ul style="list-style-type: none"> Rural Intersection Conflict Warning System Narrow Roadway to 2 lanes (Eliminate SB North of Intersection)



NOTE: Drawing Not to Scale

Figure 2.2
US 281/SD 20 Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns, and from on-site observations:

- (1) Install center islands on eastbound and westbound approaches with supplemental stop signs
- (2) Install Rural Intersection Conflict Warning System (RICWS)
- (3) Rebuild US 281 as 3-lanes
- (4) Construct roundabout

F. Economic Appraisal of Countermeasures

Figure 2.3 shows potential countermeasures (1) and **Figure 2.4** show potential countermeasure (2) for improvements to the intersection. **Figure 2.5** shows potential countermeasures (3) and **Figure 2.6** show potential countermeasure (4) for improvements to the intersection.

Table 2.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the **Appendix**.

Table 2.4 Economic Appraisal of Countermeasures

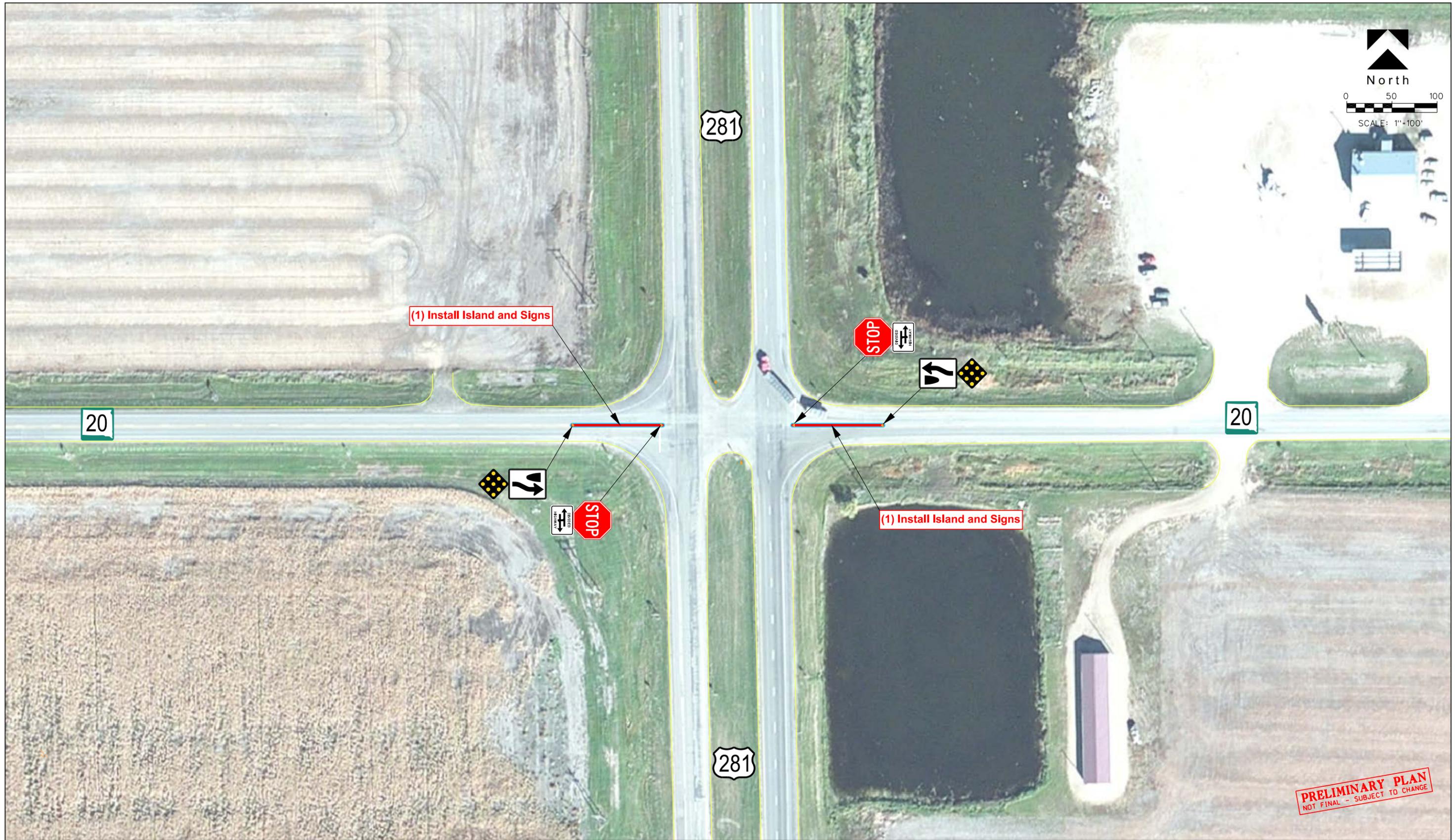
Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Install Splitter Islands and Stop Signs	\$20,340	\$104,534	5.14
(2) Install Rural Intersection Conflict Warning System (RICWS)	\$145,000	\$261,334	1.80
(3) Rebuild US 281 as 3-Lanes	\$634,560	\$674,834	1.06
(4) Construct Roundabout	\$680,640	\$337,417	0.50

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology in the HSM.

G. Recommendation for Preferred Alternative

1 – It is recommended that a Rural Intersection Conflict Warning System be installed at the intersection. This showed a greater benefit than the splitter islands in addressing the same crashes. (2)

2 – Rebuilding US 281 as 3-lanes should be revisited at such a time as a rehabilitation project is warranted. The cost savings for resurfacing only part of the existing 4-lanes together with the reduced maintenance costs should be included in the analysis at that time. (3)

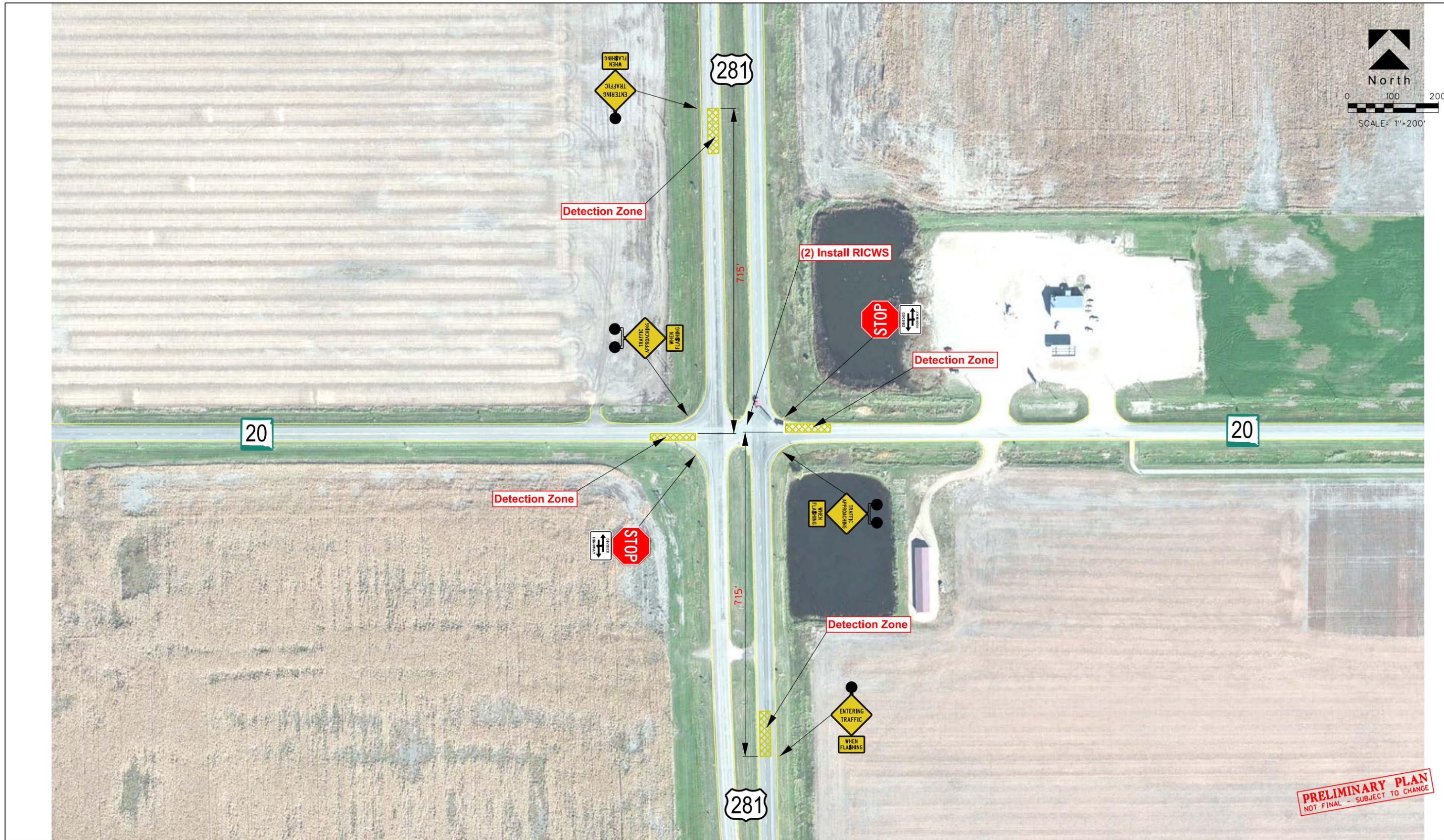


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 2.3
Intersection #2
Intersection Recommendations
US 281 / SD 20

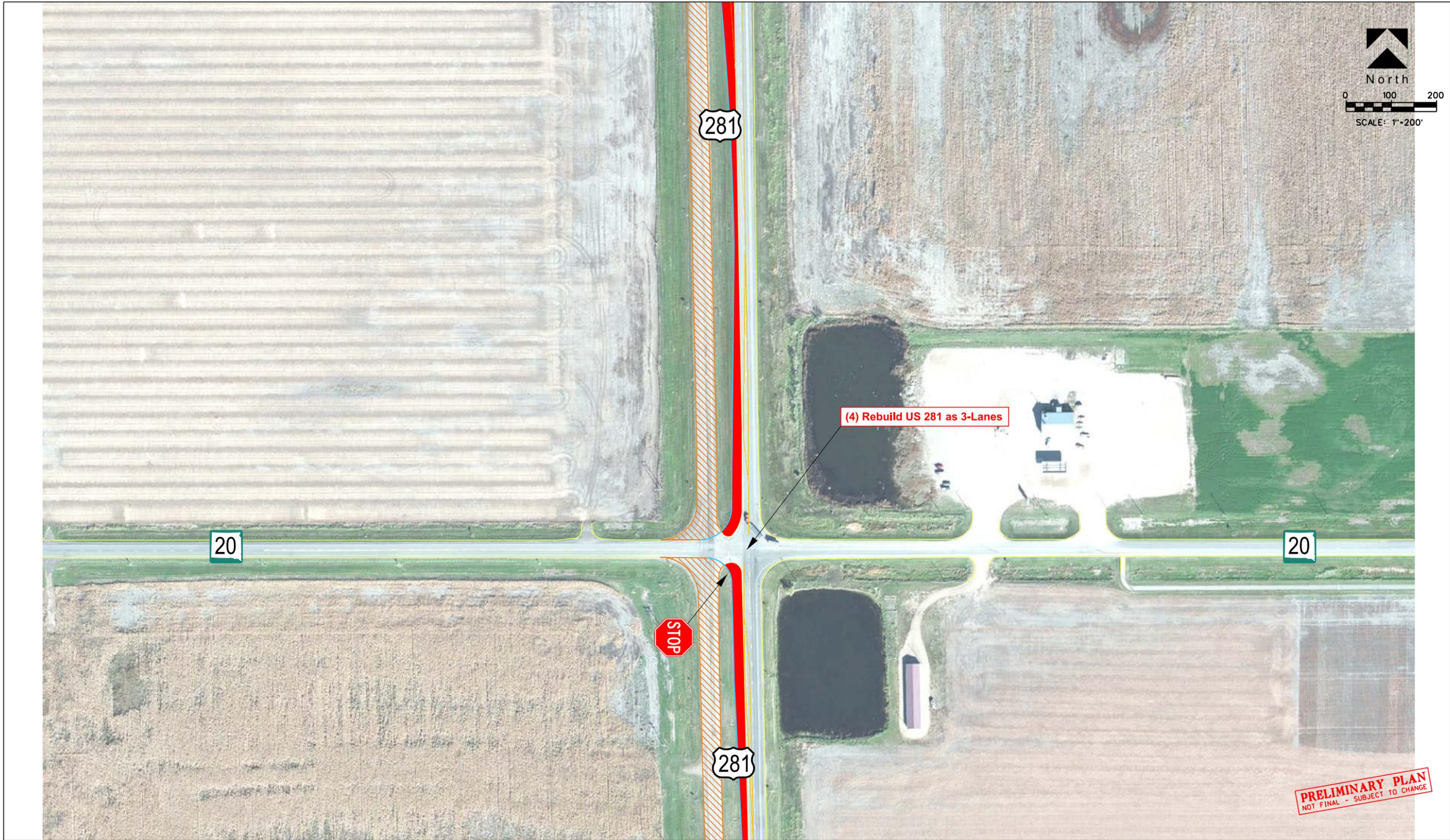


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 2.4
Intersection #2
Intersection Recommendations
US 281 / SD 20



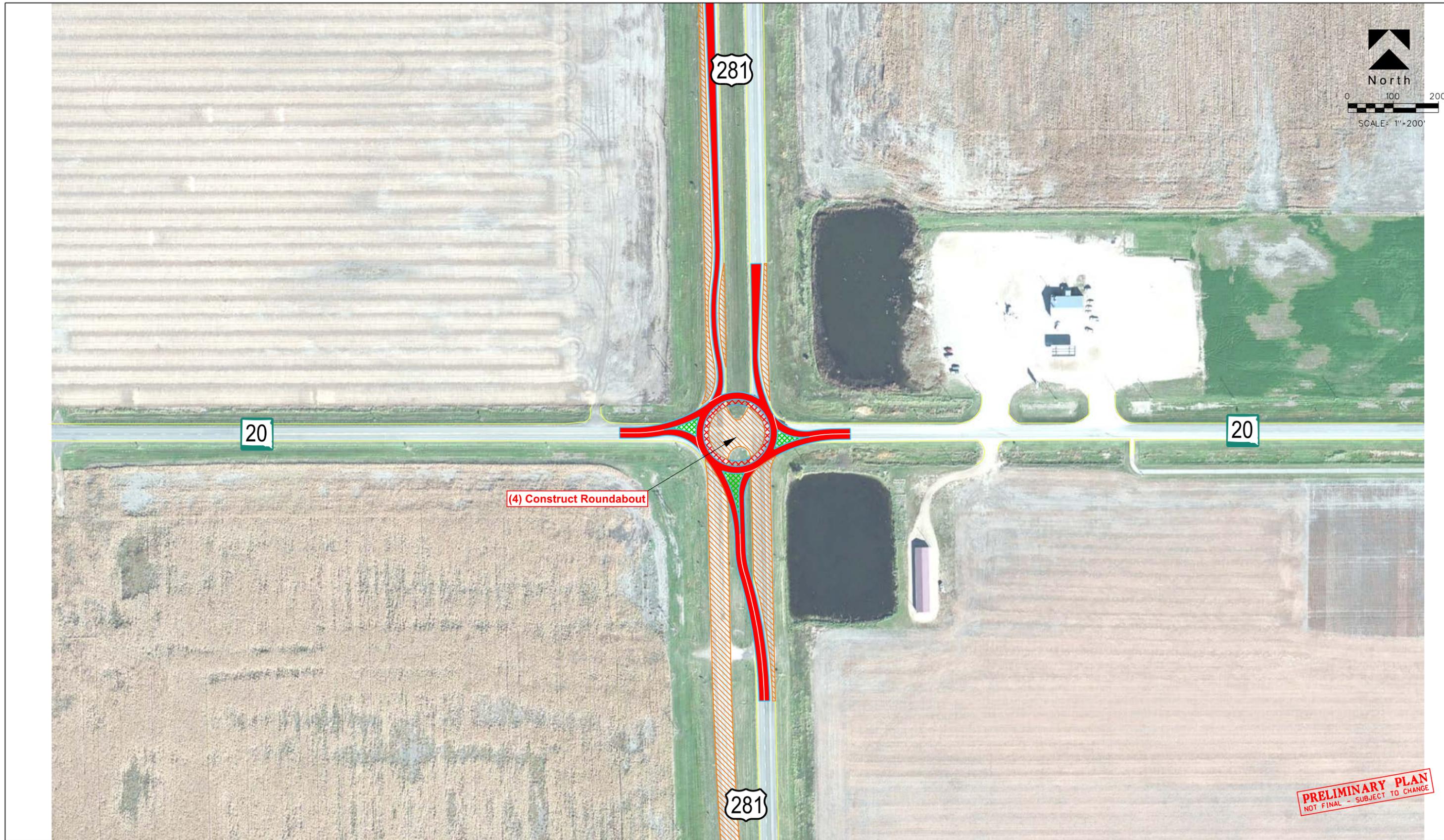
PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND
 Remove Existing Pavement
 New Pavement

CONCEPTUAL DESIGN - OPTION 3

Figure 2.5
Intersection #2
Intersection Recommendations
US 281 / SD 20



PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 4

Figure 2.6
Intersection #2
Intersection Recommendations
US 281 / SD 20

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3. US 281/142nd Street Intersection

The intersection of US 281 with 142nd Street is approximately 9.25 miles south of the city of Aberdeen, SD and 1.0 mile west of the town of Warner, SD. The posted speed limits along US 281 and 142nd Street are both 65 MPH. At the intersection, US 281 is a 4-lane divided highway with a 55 foot median separating the travel lanes. 142nd Street is a 2-lane undivided roadway. This intersection sits on a slight skew (10°) and serves as the main access point to the town of Warner.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

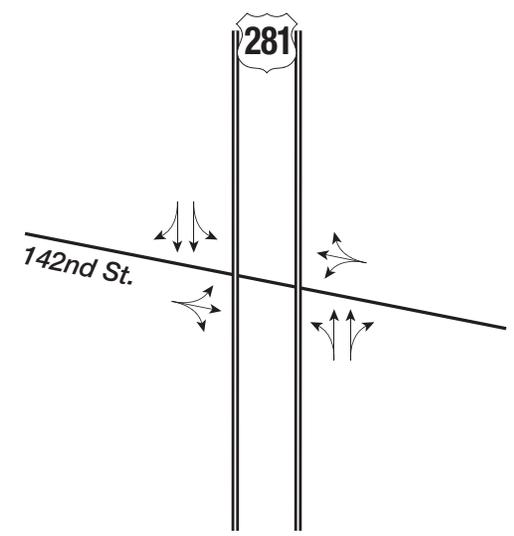
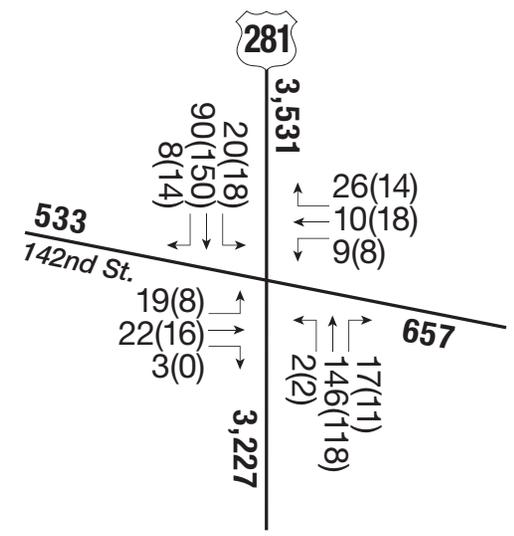
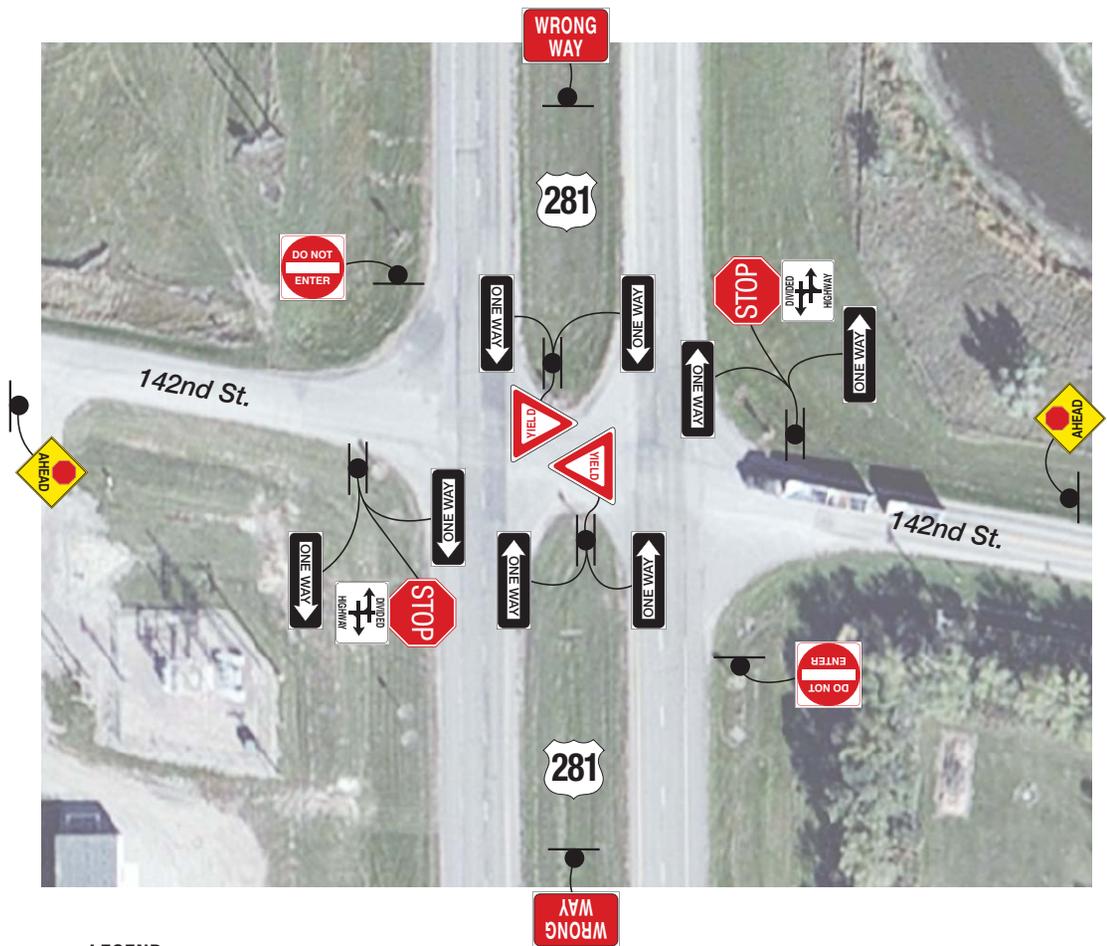
Below is a list of intersection observations made by FHU staff while conducting site visits:

- The intersection is main entrance to the town of Warner, SD (east of intersection)
- An electric substation and grain facility storage are located west of the intersection
- The intersection sits on slight skew. No grade issues.
- Sun glare could be factor for EB and WB travelers on 142nd Street
- No stop bars are present
- Large 36" stop signs are on both 142nd street approaches. Stop ahead signs are in place in advance of intersection
- There are intersection ahead advance warning for NB and SB US 281
- Intersection does not have any street lighting
- There are no turn lanes on US 281
- Two-stage turning conflicts were observed

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US 281/142nd Street intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 5:00 PM to 6:00 PM. Existing ADT's and turning movement counts are summarized on **Figure 3.1**. The intersection had 3,974 total entering vehicles per day, which ranks it as the 6th highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 19%. Also shown on **Figure 3.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- | | | |
|--|---------------------|---------------------------|
| xxx(XXX) = AM(PM) Peak Hour Traffic Volumes | = Stop Sign | = Stop Ahead Sign |
| XXXX = Daily Traffic Volumes | = Yield Sign | = Intersection Ahead Sign |
| X/X = AM/PM Peak Hour Signalized Intersection Level of Service | = Do Not Enter Sign | = Lane Ends Sign |
| x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service | = Wrong Way Sign | = Divided Highway Sign |
| | = Traffic Signal | = Divided Highway Sign |



Figure 3.1
US 281/142nd Street Traffic Conditions



D. Crash Analysis

Crash records from the SDDOT for the US 281/142nd Street intersection are shown in **Tables 3.1** and **3.2** for the most recent five-year period (2008 - 2012).

Table 3.1 US 281/142nd Street – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
0	4	1	0	1	1	1	8

A detailed review of the crash history at the intersection indicates a pattern of right angle far side crashes. Right angle far sided crashes represent 50.0% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; six crashes occurred during the winter months with icy/wet roadway conditions. The crash patterns at the US 281/142nd Street intersection are further depicted in **Figure 3.2** by severity and type.

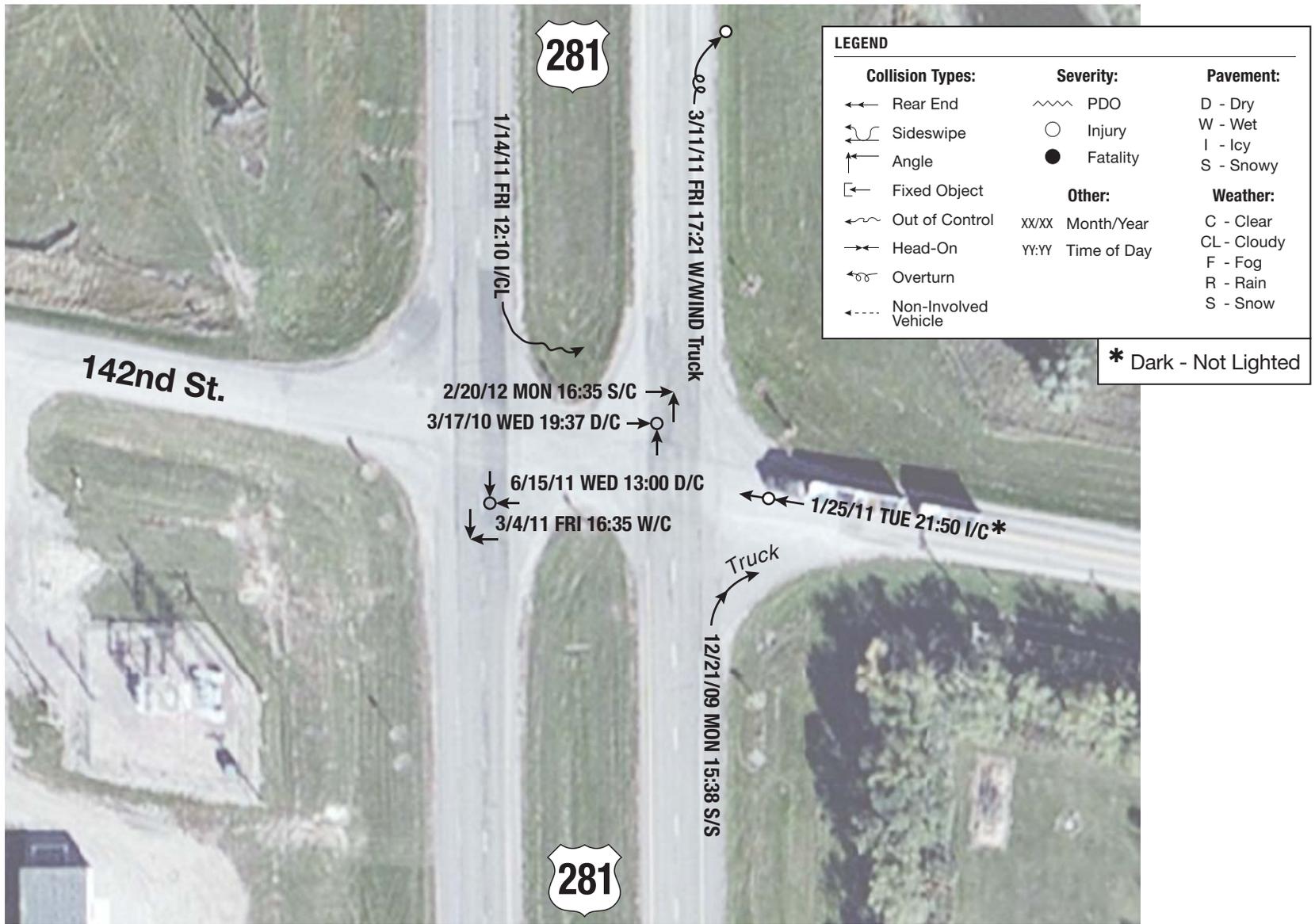
Table 3.2 US 281/142nd Street – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
US 281/142 nd	0	2	1	1	4	8	3,974	7.25	1.10	10.91
Incapacitating (Incap.) Property Damage Only (PDO) * MEV= Million Entering Vehicles										

The crash rate per MEV for the intersection is 1.10. This intersection has the 4th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 10.91 which ranks is at the 3rd highest. **Table 3.3** shows the identified crash patterns and possible contributing factors. Also, a set of countermeasures was developed based on the type of crash.

Table 3.3 US 281/142nd Street – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Rt. Angle - Far Side	<ul style="list-style-type: none"> Misjudging Speeds of Major Road Vehicle 	<ul style="list-style-type: none"> Rural Intersection Conflict Warning System Islands & Supplemental Stop Signs
Adverse Road Conditions	<ul style="list-style-type: none"> Driving too fast for conditions 	<ul style="list-style-type: none"> Monitor pavement conditions, during adverse weather



NOTE: Drawing Not to Scale

Figure 3.2
US 281/142nd Street Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasure based on the identified crash patterns, and from on-site observations:

- (1) Install Center Islands on eastbound and westbound approaches with supplemental stop signs and stop bars
- (2) Install Rural Intersection Conflict Warning System (RICWS)
- (3) Construct median U-turn intersection using J-turns
- (4) Install rumble strips and advanced intersection ahead warning signs for westbound and eastbound
 - Offset right turn deceleration lanes for northbound and southbound

F. Economic Appraisal of Countermeasures

Figure 3.3 shows potential countermeasure (1) and **Figure 3.4** show potential countermeasure (2) for improvements to the intersection. **Figure 3.5** show potential countermeasure (3) for improvements to the intersection. No figure was developed to show potential countermeasure (4).

Table 3.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the **Appendix**.

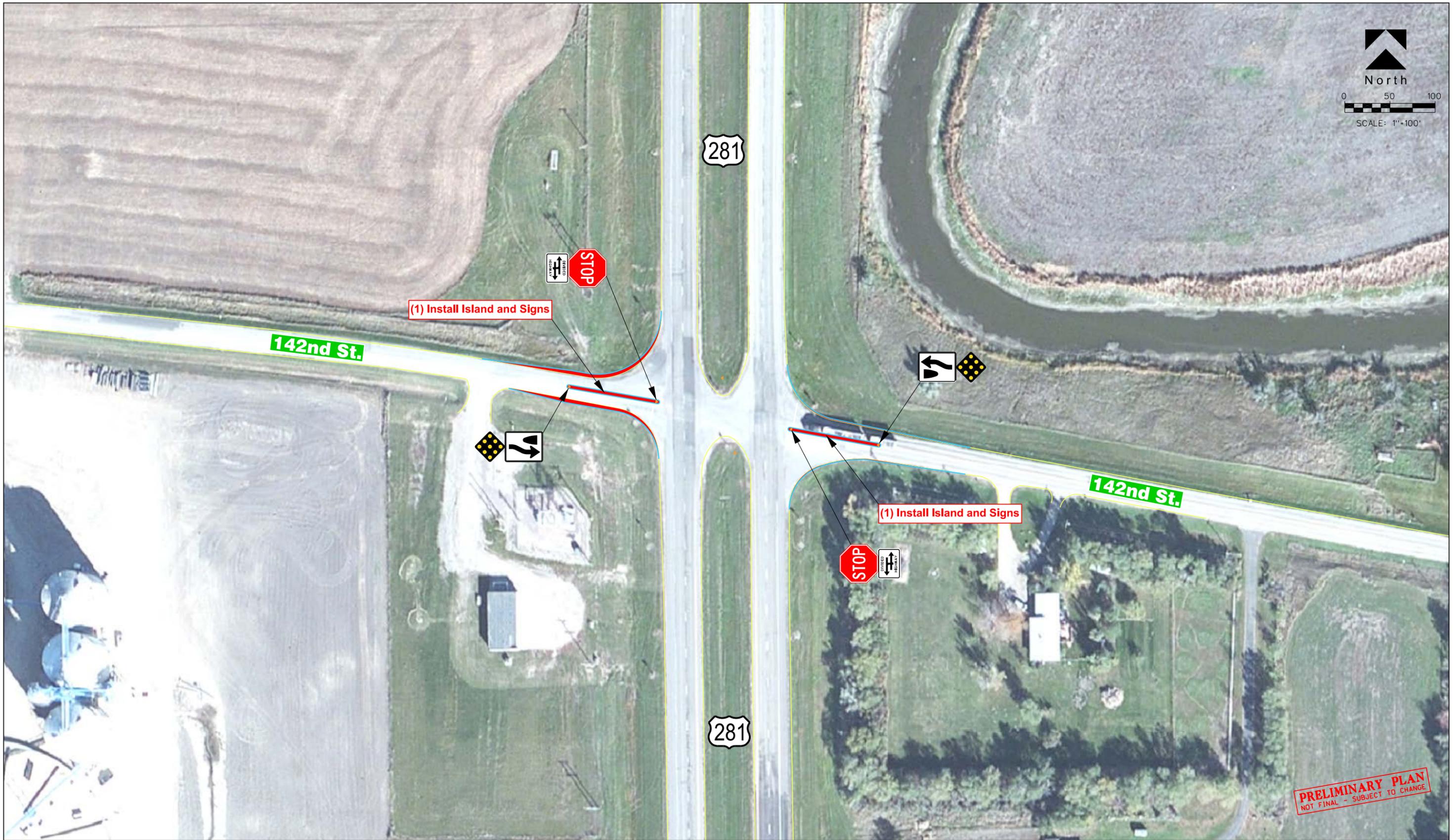
Table 3.4 Economic Appraisal of Countermeasures

Improvement	Cost	User Benefits**		Benefit/Cost Ratio
		Crash	Travel/Delay	
(1) Install Splitter Islands and Stop Signs	\$42,000	\$0	N/A	0.00
(2) Install Rural Intersection Conflict Warning System (RICWS)	\$145,000	\$104,534	N/A	0.72
(3) Construct median U-turn Intersection Using J-turns	\$142,980	\$927,896	(\$809,735)	0.83
(4) Install EB and WB Transverse Rumble Strips	\$6,000	\$261,334	N/A	43.56

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology in the HSM.

G. Recommendation for Preferred Alternative

1 – It is recommended that the median be closed in US 281 at 142nd Street and J-Turn be provided north and south of the current intersection. This has the highest potential for reducing right-angle far side crashes although it would increase travel and delay cost by diverting drivers on 142nd Street. (3)

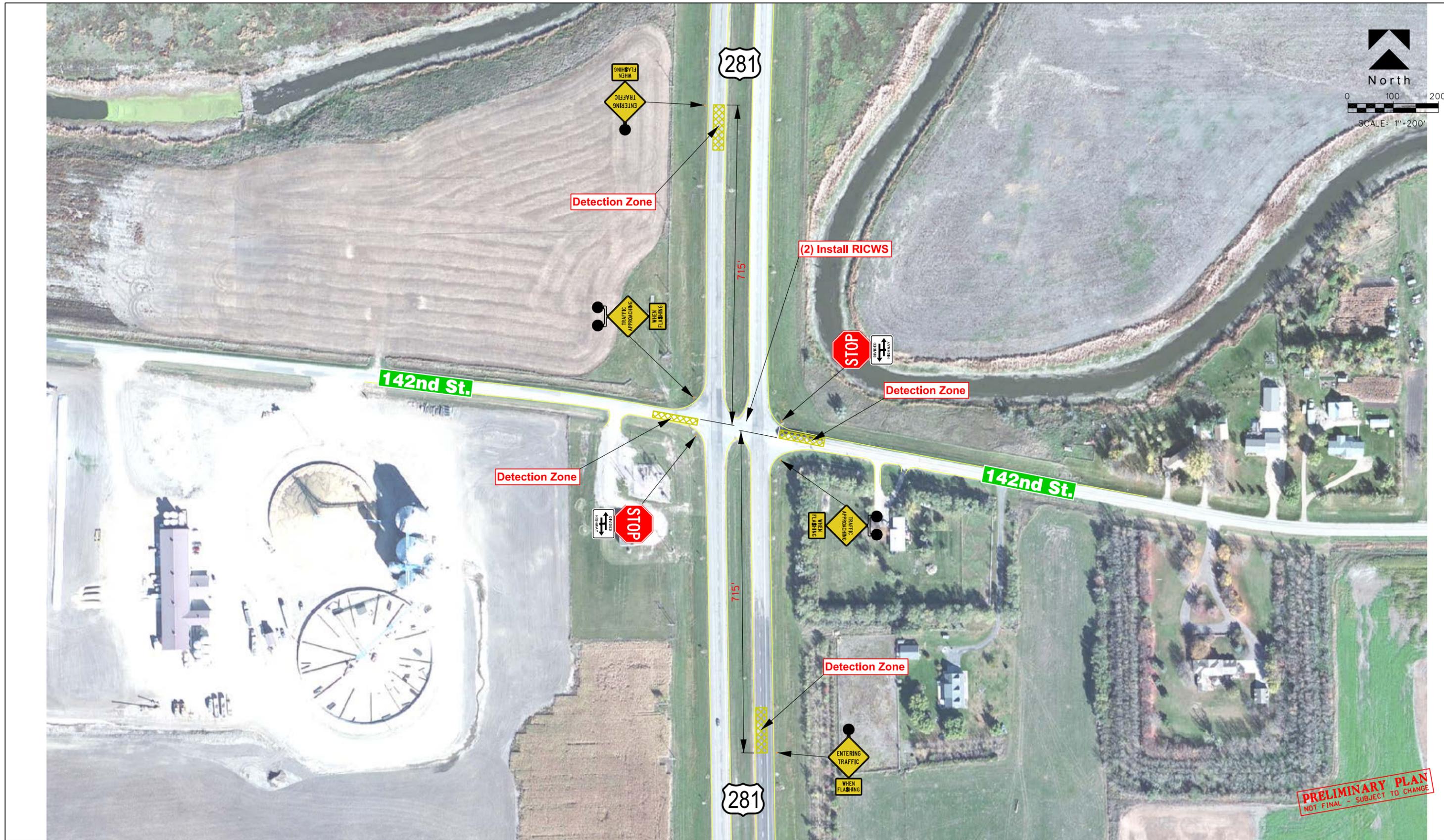


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 3.3
Intersection #3
Intersection Recommendations
US 281 / 142nd Street



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 3.4
Intersection #3
Intersection Recommendations
US 281 / 142nd Street



CONCEPTUAL DESIGN - OPTION 3

Figure 3.5
 Intersection #3
 Intersection Recommendations
 US 281 / 142nd Street

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4. US 281/130th Street Intersection

The intersection of US 281 with 130th Street is approximately 3.0 miles north of the city of Aberdeen, SD. The posted speed limit along US 281 is 65 MPH and along 130th Street the speed limit is 55 MPH. At the intersection, US 281 is a 4-lane divided highway with a 55 foot median separating the travel lanes. An exclusive northbound right-turn lane is provided with approximately 200 feet of storage. 130th Street is a 2-lane undivided roadway.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

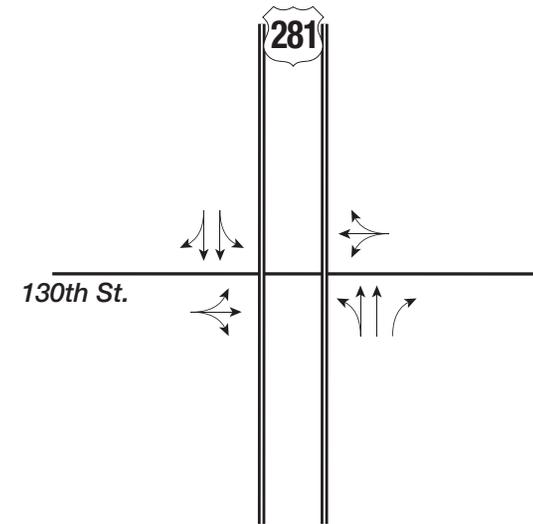
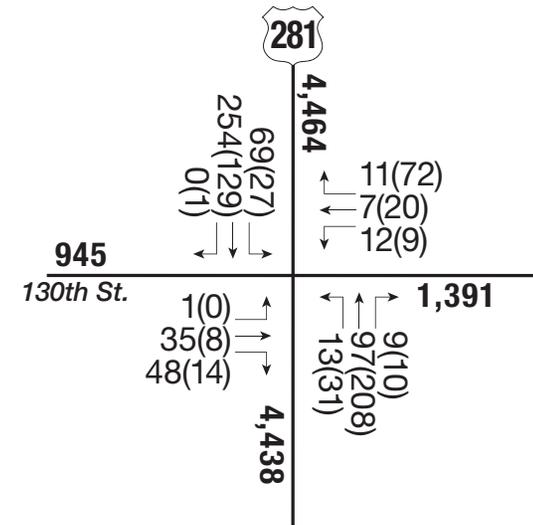
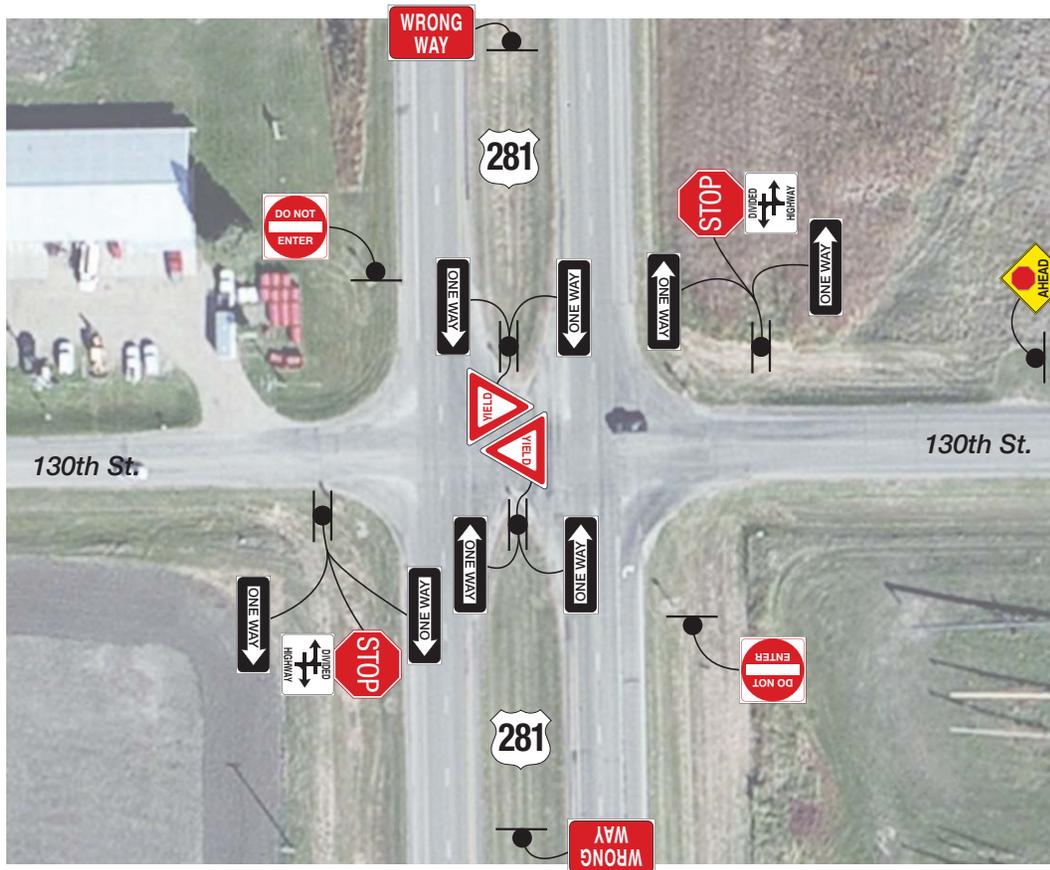
Below is a list of intersection observations made by FHU staff while conducting site visits:

- Intersection sits just northwest of Aberdeen, SD
- Climate Control facility located west of the intersection. Driveway is close to intersection
- There are no skew or grade issues on three approaches
- WB approach is coming down hill
- Sun glare could be factor for EB and WB travelers on 130th Street
- Stop ahead signs are present for westbound and eastbound traffic
- No stop bars are present
- There are large 36" stop signs on both 130th street approaches. Stop ahead signs are also in advance of intersection
- No intersection ahead warning for NB and SB US 281
- Intersection does not have any street lighting
- Northbound right-turn lane present. No other turn lanes on US 281
- Two-stage turning conflicts were observed
- School buses observed making EB to SB movement
- SB to EB is an informal truck route

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US 281/130th Street intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 4:45 PM to 5:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 4.1**. The intersection had 5,619 total entering vehicles per day, which ranks it as the 4th highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 13%. Also shown on **Figure 4.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- xxx(XXX) = AM(PM) Peak Hour Traffic Volumes
- XXXX = Daily Traffic Volumes
- X/X = AM/PM Peak Hour Signalized Intersection Level of Service
- x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

- = Stop Sign
- = Yield Sign
- = Do Not Enter Sign
- = Wrong Way Sign
- = Traffic Signal
- = Stop Ahead Sign
- = Intersection Ahead Sign
- = Lane Ends Sign
- = Divided Highway Sign
- = Divided Highway Sign

Figure 4.1
US 281/130th Street Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US281/130th Street intersection are shown in **Tables 4.1** and **4.2** for the most recent five-year period (2008 - 2012).

Table 4.1 US 281/130th Street – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
1	1	0	0	2	1	0	5

A detailed review of the crash history at the intersection indicates a low pattern of rear end crashes westbound on the minor road. Rear ends on minor road crashes represent 40.0% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; however no other crash pattern was indentified. The severity and type of crashes at the US 281/130th Street intersection are further depicted in **Figure 4.2**.

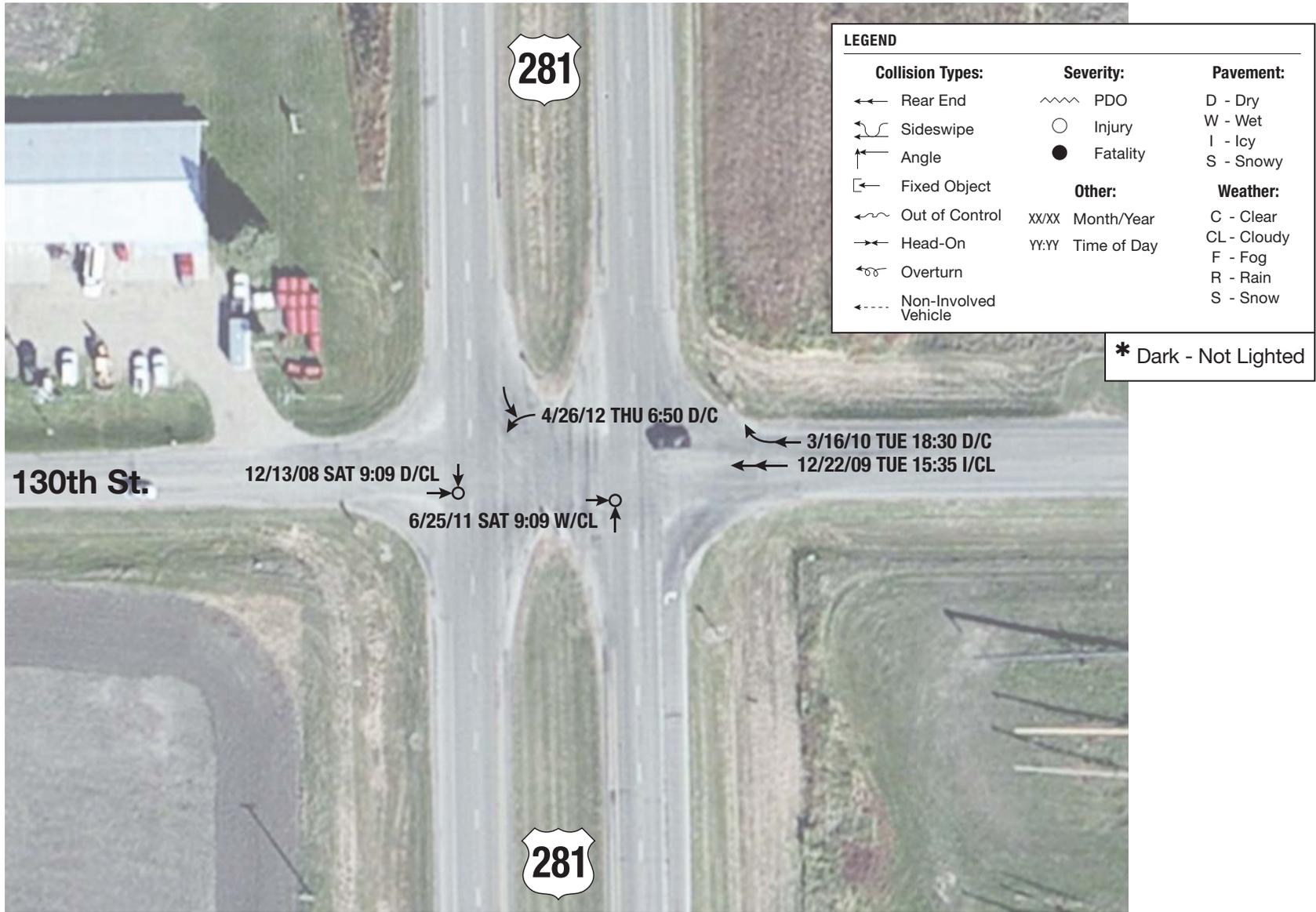
Table 4.2 US 281/130th Street – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
US 281/130 th	0	2	0	0	3	5	5,619	10.25	0.49	5.99
Incapacitating (Incap.)		Property Damage Only (PDO)					* MEV= Million Entering Vehicles			

The crash rate per MEV for the intersection is 0.49. This intersection has the 9th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 5.99 which ranks is at the 6th highest. **Table 4.3** shows the possible countermeasures which are based on typical improvements at other similar intersections since there are no distinct crash patterns.

Table 4.3 US 281/130th Street – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
No distinct patterns	<ul style="list-style-type: none"> Based on SB Left-Turn Volume 	<ul style="list-style-type: none"> Install offset left-turn lanes Close driveway on NW Corner Convert Yields to Stop Signs in Median



NOTE: Drawing Not to Scale

Figure 4.2
US 281/130th Street Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns, at similar intersections and from on-site observations:

- (1) Install stop bars for eastbound and westbound
- (2) Northbound and southbound offset left-turn lanes

F. Economic Appraisal of Countermeasures

Figure 4.3 shows the potential alternative countermeasures to the intersection.

Table 4.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the **Appendix**.

Table 4.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Install Stop Bars	\$6,000	\$12,586	2.10
(2) NB and SB Offset Left-Turns	\$126,030	\$506,125	4.02

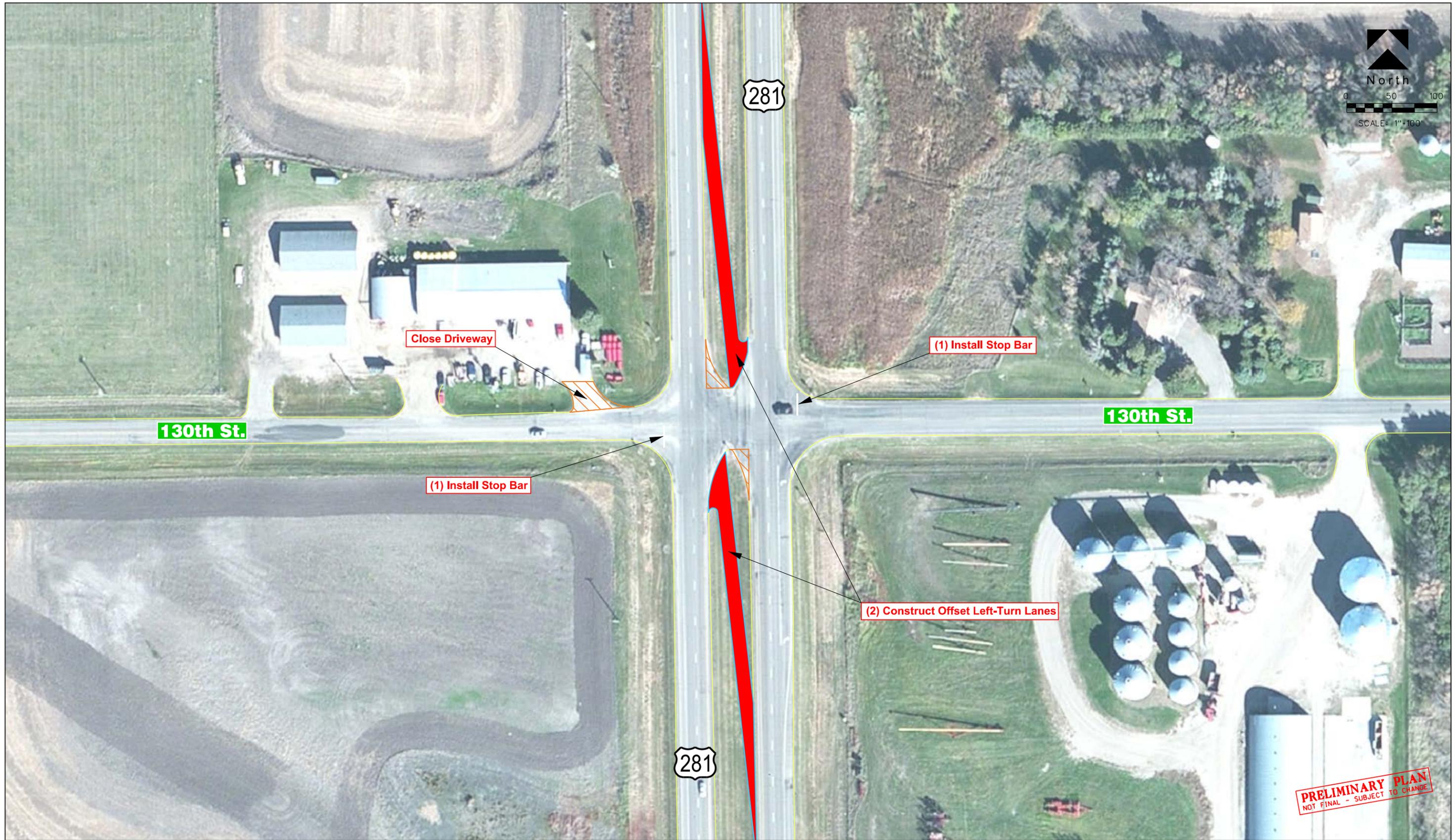
** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology in the HSM.

G. Recommendation for Preferred Alternative

1 – It is recommended that north-south offset left-turn lanes be constructed at this intersection.

2 – It is recommended that Stop Bars be marked on the east-west approaches to the intersection.

3 – It is recommended that the driveway on the northwest corner of the intersection be closed to reduce the potential for conflicts.



LEGEND

-  Remove Existing Pavement
-  New Pavement

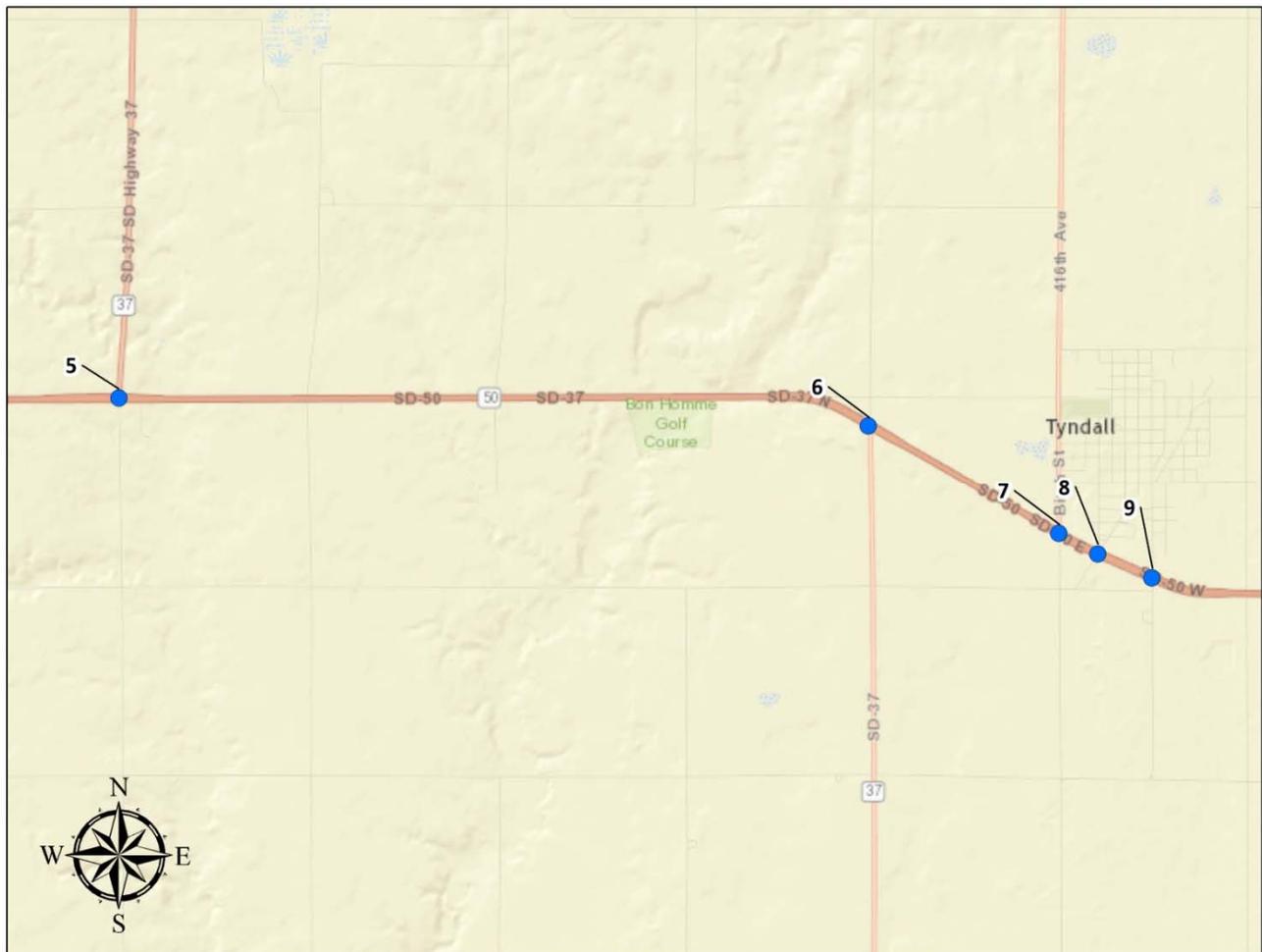
CONCEPTUAL DESIGN - OPTION 1

Figure 4.3
Intersection #4
Intersection Recommendations
US 281 / 130th Street

MITCHELL REGION

Intersections Include:

- 5. SD 50/37W Intersection
- 6. SD 50/37E Intersection
- 7. SD 50/Birch Street Intersection
- 8. SD 50/Fir/Ivy Street Intersection
- 9. SD 50/Main Street Intersection



III. MITCHELL REGION

Five of the study intersections are located in the Mitchell Region. These intersections include SD 50/SD 37W, SD 50/SD 37E, SD 50/Birch Street, SD 50/Fir/Ivy Street, and SD 50/Main Street.

5. SD 50/SD 37W Intersection

The intersection of SD 50 with SD 37 is approximately 5.0 miles east of the town of Avon, SD and 5.5 miles west of Tyndall, SD. The posted speed limits along SD 50 and SD 37W are both 65 MPH. At the intersection, SD 50 is a 4-lane divided highway with a 45 foot median separating the travel lanes. SD 37 is a 2-lane undivided roadway north of the intersection. The south leg of the intersection provides a paved access to an active weigh station 80 feet south of the intersection. A County Road, 114th Avenue, is a very low volume unpaved roadway that extends south of the weigh station.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in April 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

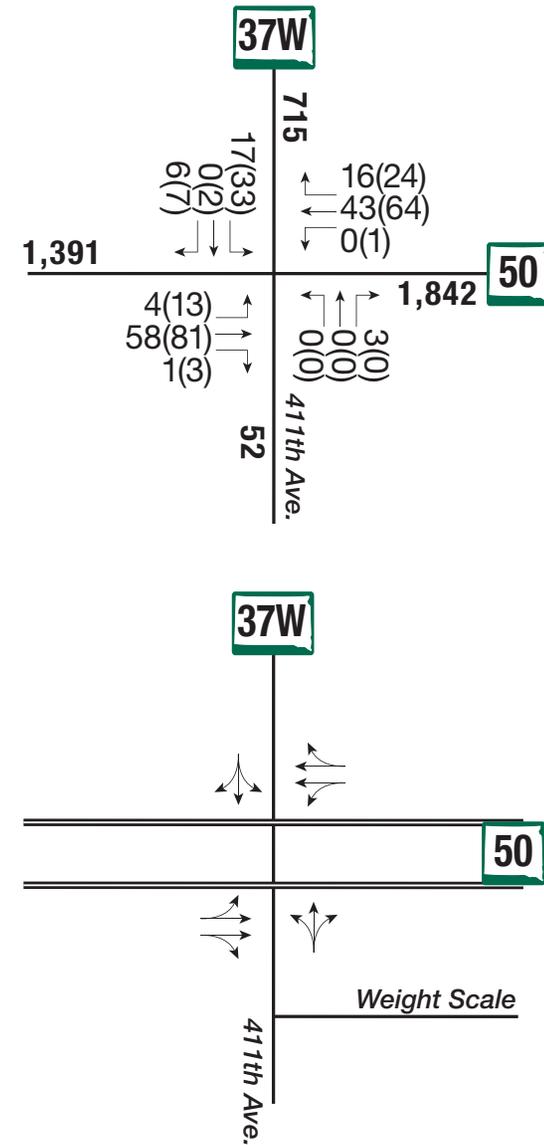
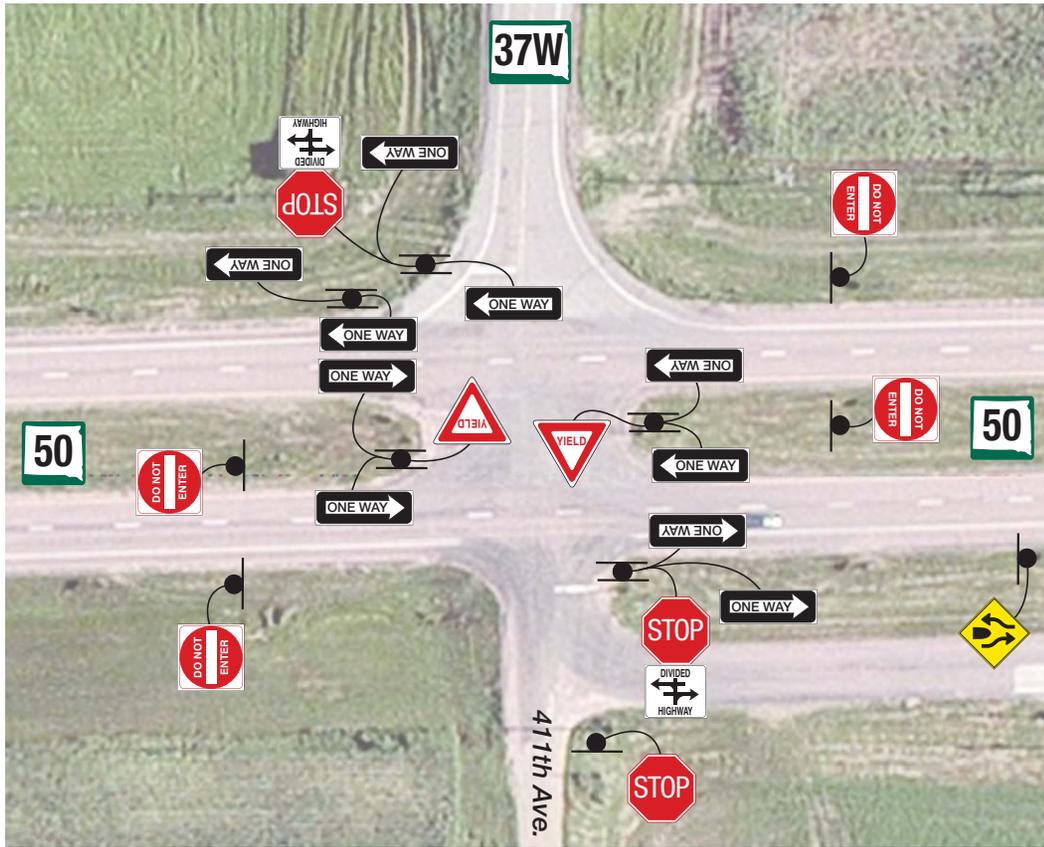
Below is a list of intersection observations made by FHU staff while conducting site visits:

- No EB or WB left turn lanes
- Several repetitive One-Way signs
- Stop bars present. SB stop bar approximately 50' from edge of WB lanes
- Large 48" stop signs on SB approach and 36" stop sign on NB approach
- There are no street lights
- Southbound stop ahead sign is present 1,800 feet in advance of intersection
- A Roadway Safety Audit performed previously at this intersection. As part of this audit, rumble strips were installed, stop ahead signs added, and the stop bar on the north approach was moved up closer to the intersection

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the SD 50/SD 37W intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:45 AM to 8:45 AM, and the PM peak hour was 3:45 PM to 4:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 5.1**. The intersection had 2,000 total entering vehicles per day, which ranks it as the lowest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 10%. Also shown on **Figure 5.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
- XXXX = Daily Traffic Volumes
- X/X = AM/PM Peak Hour Signalized Intersection Level of Service
- x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

- = Stop Sign
- = Yield Sign
- = Do Not Enter Sign
- = Wrong Way Sign
- = Traffic Signal
- = Stop Ahead Sign
- = Intersection Ahead Sign
- = Lane Ends Sign
- = Divided Highway Sign
- = Divided Highway Sign

Figure 5.1

SD 50/SD 37W Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the SD 50/SD 37W intersection are shown in **Tables 5.1** and **5.2** for the most recent five-year period (2008 - 2012).

Table 5.1 SD 50/SD 37W – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
0	0	0	0	0	0	2	2

A detailed review of the crash history at the intersection indicates a pattern of roadway departure crashes. Leave roadway crashes represent 100.0% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; one crash occurred after dark and the other occurred at dawn in foggy conditions. The crash patterns at the SD 50/SD 37W intersection are further depicted in **Figure 5.2** by severity and type.

Table 5.2 SD 50/SD 37W – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
SD 50/SD 37W	0	0	0	0	2	2	2,000	3.65	0.55	0.55
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 0.55. This intersection has the 8th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 0.55 which ranks is at the 3rd lowest. **Table 5.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 5.3 SD 50/SD 37W – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Leave Roadway	<ul style="list-style-type: none"> • Visibility due to weather/ light conditions 	<ul style="list-style-type: none"> • Install Street Lighting

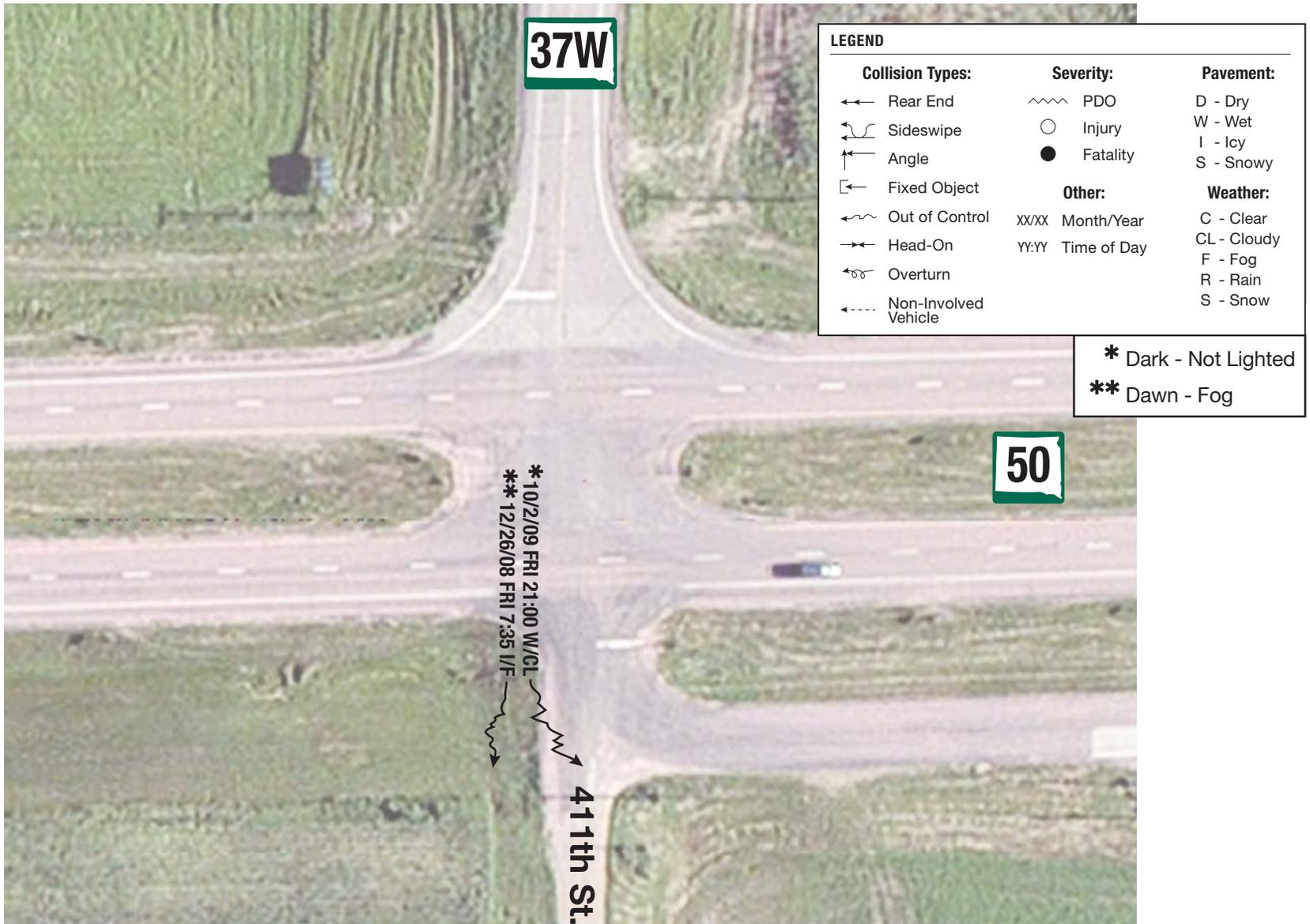


Figure 5.2
SD 50/SD 37W Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns, if present, and from on-site observations:

- (1) Provide Street Lighting. Meets SDDOT Intersection Lighting Warrant 2 (2 nighttime crashes in 12 months) and Warrant 4 (Channelization) and other factors may constitute a confusing condition that may be improved with lighting)
- (2) Remove EB lanes. Convert the westbound lanes to 3-lane with separate eastbound and westbound left-turn lanes.
- (3) Install island and stop sign
 - Install rumble strips
 - Add Flashing LED/Solar Power Stop Sign

F. Economic Appraisal of Countermeasures

Figure 5.3 shows the potential alternative countermeasures (1) and (2) to the intersection. Countermeasure (3) is shown on Figure 5.4.

Table 5.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the Appendix.

Table 5.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Provide Street Lighting	\$27,000	\$70,258	2.60
(2) Rebuild SD 50 as 3-Lanes	\$299,760	\$84,354	0.28
(3) Install Island and Stop Sign	\$24,720	\$0	0.00
Install Transverse Rumble Strips	\$6,000	\$52,267	8.71
Flashing LED/Solar Stop Signs	\$3,000	\$52,267	17.42

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology in the HSM.

G. Recommendation for Preferred Alternative

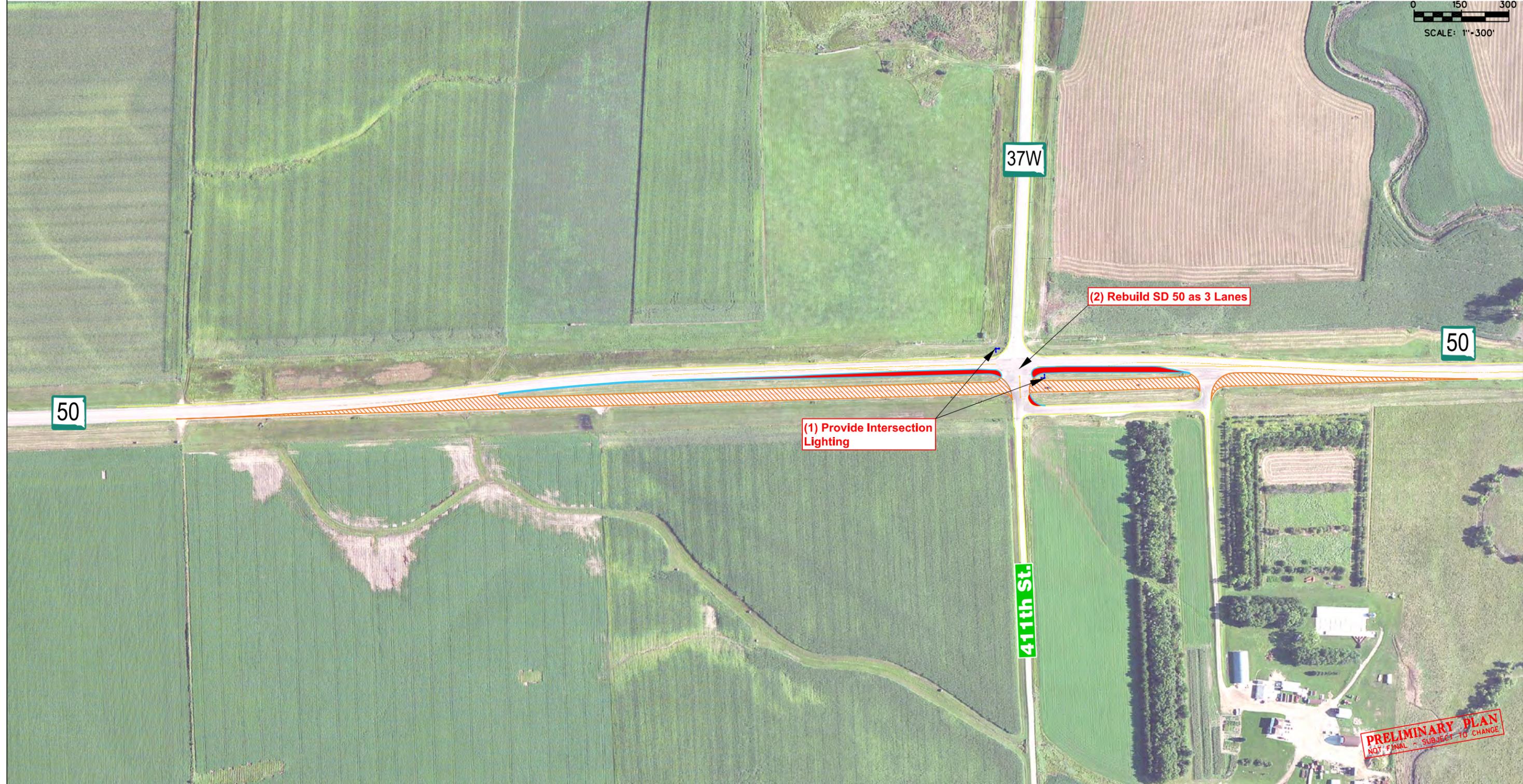
- 1 – It is recommended that Street Lighting and flashing LED/Solar Powered Stop Signs be added for southbound traffic in addition to the Rumble Strips already installed since 2012.
- 2 – It is further recommended that the potential rebuilding of SD 50 from a 4-lane to 3-lane cross section be evaluated at such a time as a rehabilitation project is warranted. The cost savings for resurfacing only part of the existing 4-lane roadway together with the reduced maintenance costs should be included in the analysis at that time.



North



SCALE: 1"=300'



PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE

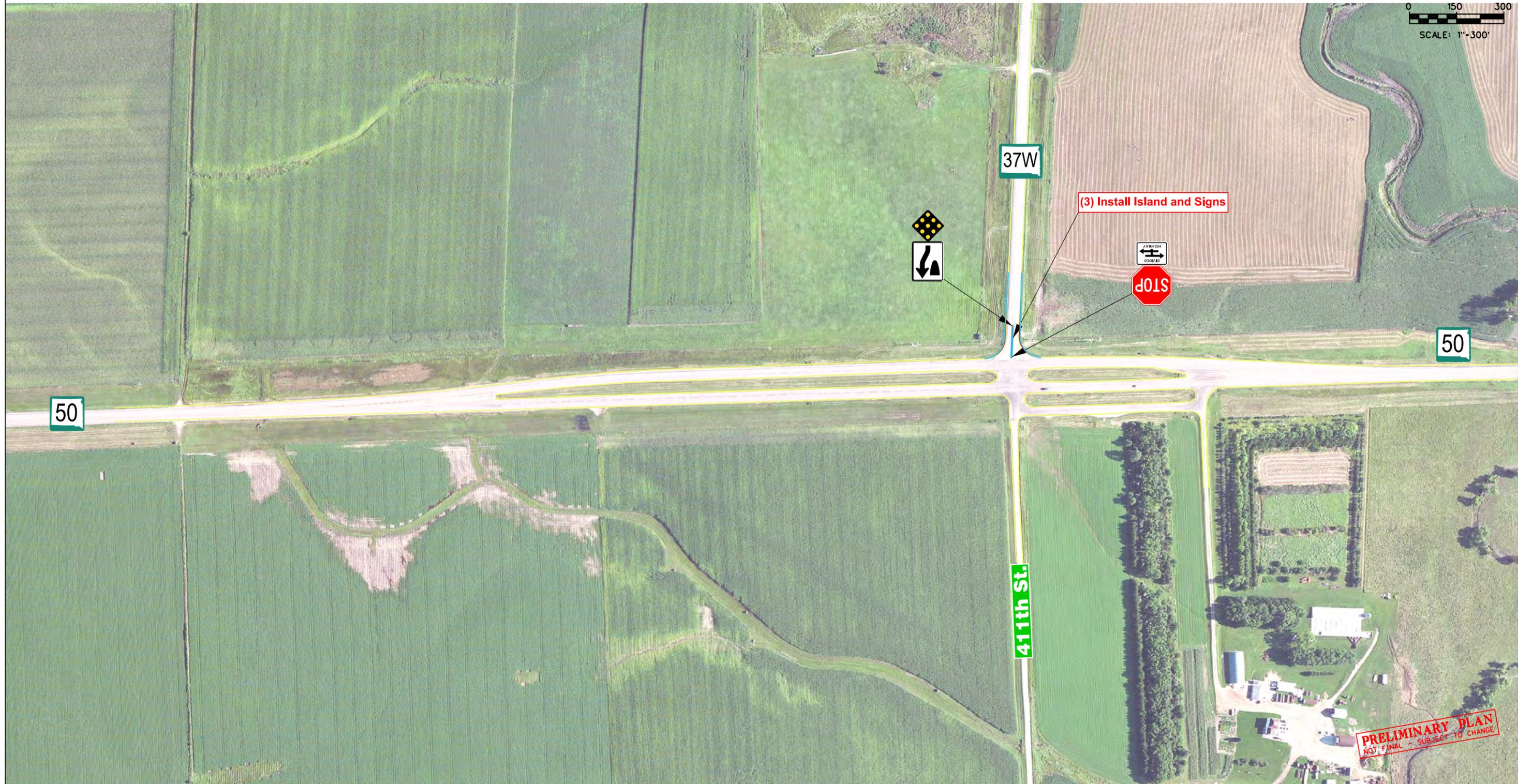
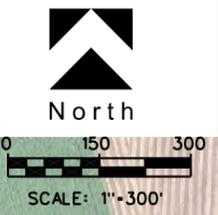


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 5.3
Intersection #5
Intersection Recommendations
SD 50 / SD 37W



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 5.4
Intersection #5
Intersection Recommendations
SD 50 / SD 37W

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6. SD 50/SD 37E Intersection

The intersection of SD 50 with SD 37E is approximately 1.5 miles west of the town of Tyndall, SD. The posted speed limits along SD 50 and SD 37 are both 65 MPH. At the intersection, US 50 is a 4-lane divided highway with a 50 foot median separating the travel lanes. SD 37E is a 2-lane undivided roadway. The intersection is on a skew.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in April 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

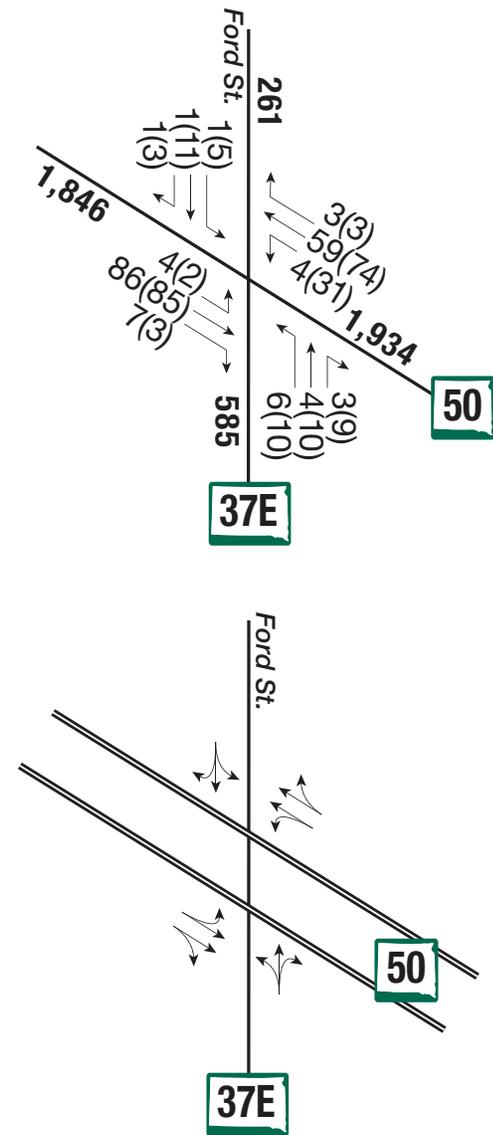
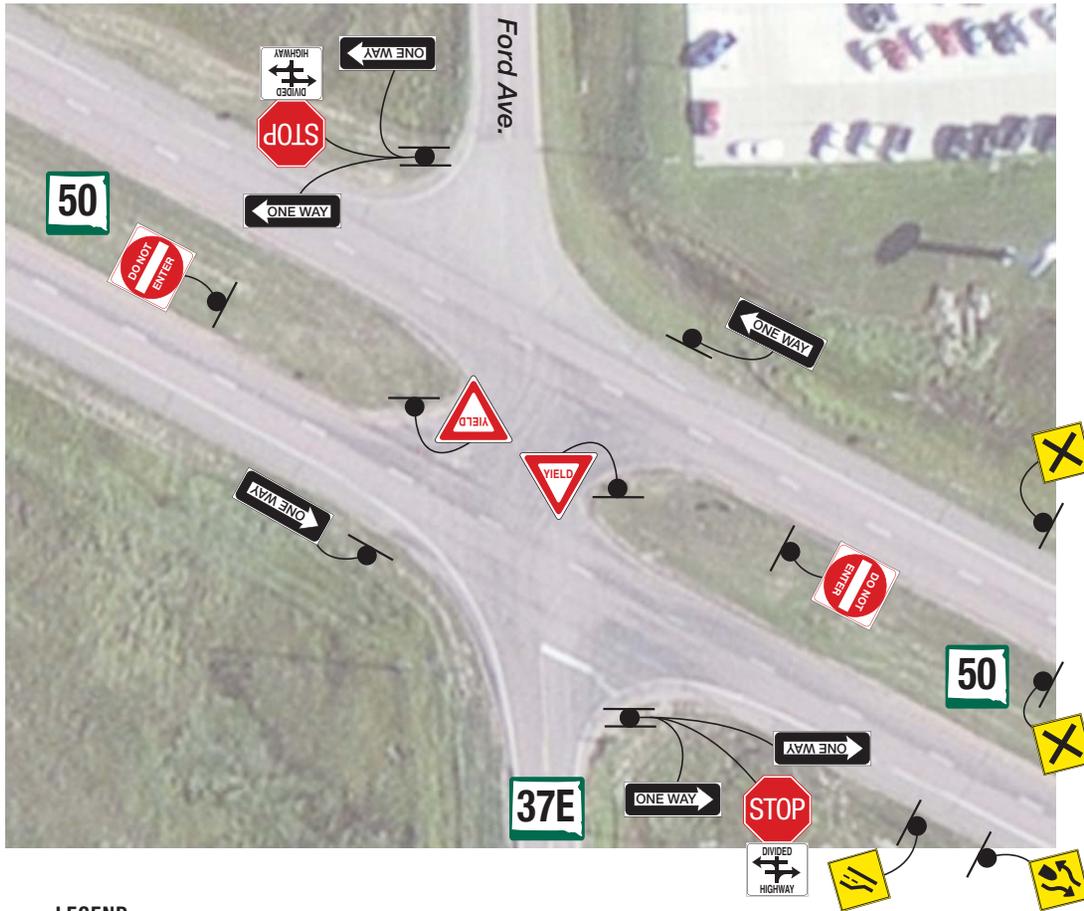
Below is a list of intersection observations made by FHU staff while conducting site visits:

- A car dealership is located on NE corner of intersection
- Stop bar present on NB approach only. No stop bar on SB approach
- 2 Fatal "Think" Signs. One on SE corner and other on NW corner
- Intersection is on a skew (30°)
- Intersection ahead signs present for eastbound and westbound traffic. There is a crest vertical curve located to the east which has been analyzed to meet ASSHTO standards at the posted speed limit
- Median mounted yield signs at skewed orientation
- Intersection does not have any street lighting
- There are no turn lanes in SD 50
- A Roadway Safety Audit conducted previously at this intersection

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the SD 50/SD 37E intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 8:30 AM to 9:30 AM, and the PM peak hour was 3:45 PM to 4:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 6.1**. The intersection had 2,313 total entering vehicles per day, which ranks it as the 2nd lowest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 18%. Also shown on **Figure 6.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
- XXXX = Daily Traffic Volumes
- X/X = AM/PM Peak Hour Signalized Intersection Level of Service
- x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

- = Stop Sign
- = Yield Sign
- = Do Not Enter Sign
- = Wrong Way Sign
- = Traffic Signal
- = Stop Ahead Sign
- = Intersection Ahead Sign
- = Lane Ends Sign
- = Divided Highway Sign
- = Divided Highway Sign

Figure 6.1
SD 50/SD 37E Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the SD 50/SD 37E intersection are shown in **Tables 6.1** and **6.2** for the most recent five-year period (2008 - 2012).

Table 6.1 SD 50/SD 37E – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
1	6	1	0	1	0	1	10

A detailed review of the crash history at the intersection indicates a pattern of right angle far side crashes. Right angle far sided crashes represent 60.0% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; however no other crash pattern was indentified. The crash patterns at the SD 50/SD 37E intersection are further depicted in **Figure 6.2** by severity and type.

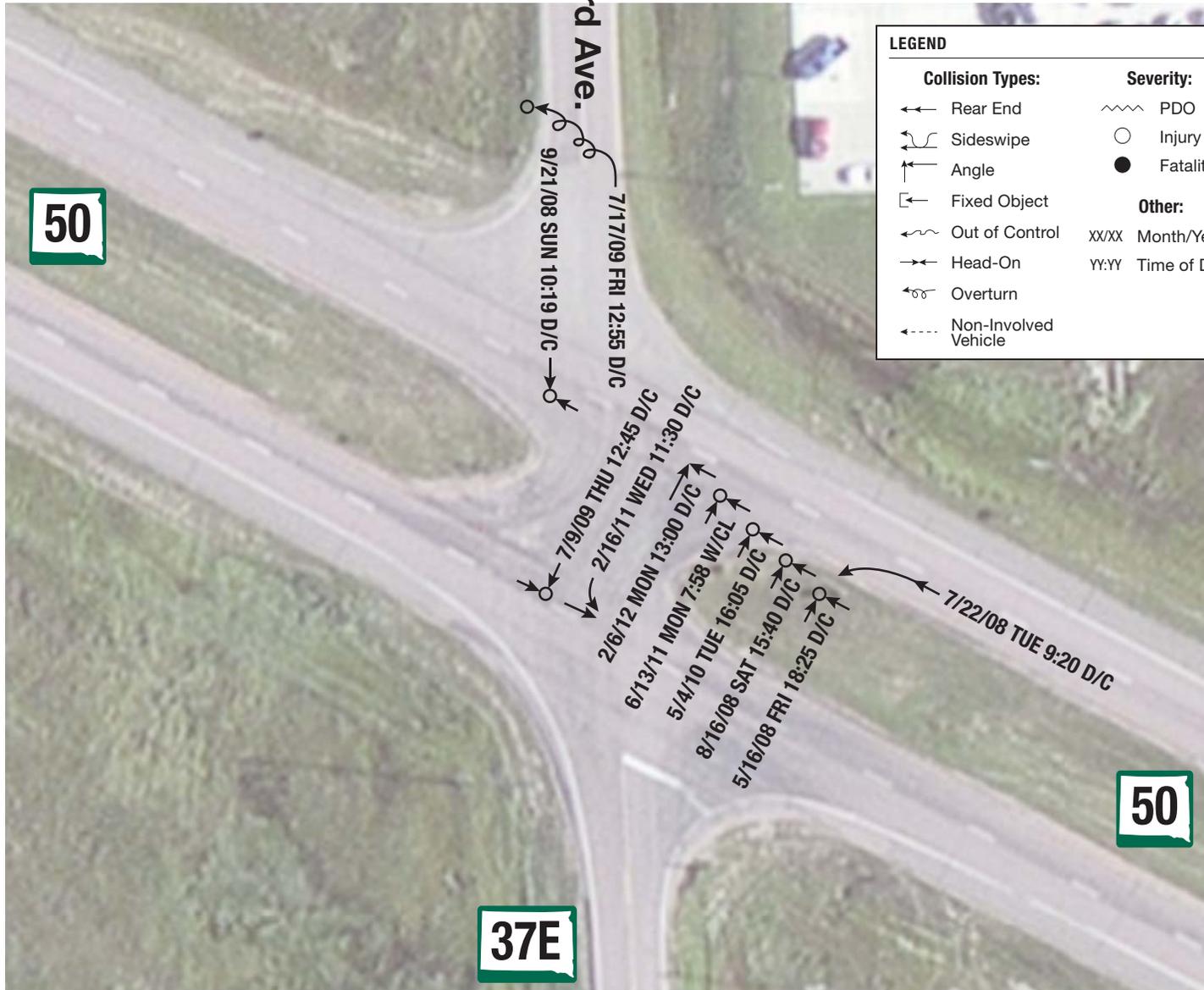
Table 6.2 SD 50/SD 37E – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
SD 50/SD 37E	0	3	3	1	3	10	2,313	4.22	2.37	30.48
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 2.37. This intersection has the highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 30.48 which ranks is at the 2nd highest. **Table 6.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 6.3 SD 50/SD 37E – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Rt Angle-Far Side	<ul style="list-style-type: none"> Restricted Sight Distance (Skew) Misjudging Speeds of Major Road Vehicle 	<ul style="list-style-type: none"> Reduce Skew



NOTE: Drawing Not to Scale

Figure 6.2
SD 50/SD 37E Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns and from on-site observations:

- (1) Rebuild SD 50 as 3-lanes only
- (1A) Realign SD 37E and Ford Street and rebuild SD 50 as 3-lanes
- (2) Realign SD 37E and Ford Street and provide offset left-turn lanes
- (2A) Offset T- Intersections with realignment of 303rd Street
- (3) Construct roundabout

F. Economic Appraisal of Countermeasures

Figure 6.3 shows potential countermeasure (1) for improvements to the intersection. Potential countermeasure (1A) is shown on Figure 6.4. Figure 6.5 shows potential countermeasure (2) and Figure 6.6 show countermeasure (2A). Countermeasure (3) is shown on Figure 6.7.

Table 6.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the Appendix.

Table 6.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Rebuild SD 50 as 3-Lanes Only	\$423,060	\$590,479	1.40
(1A) Realign SD 37E and Ford Street and Rebuild SD 50 as 3-Lanes	\$824,460	\$590,479	0.72
(2) Realign SD 37E and Ford Street and Provide Offset Left-Turn Lanes	\$727,500	\$674,834	0.93
(2A) Offset-T Intersections w/ realignment of 303 rd Street	\$981,270	\$972,896	0.95
(3) Construct Roundabout	\$927,420	\$253,063	0.27

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.

G. Recommendation for Preferred Alternative

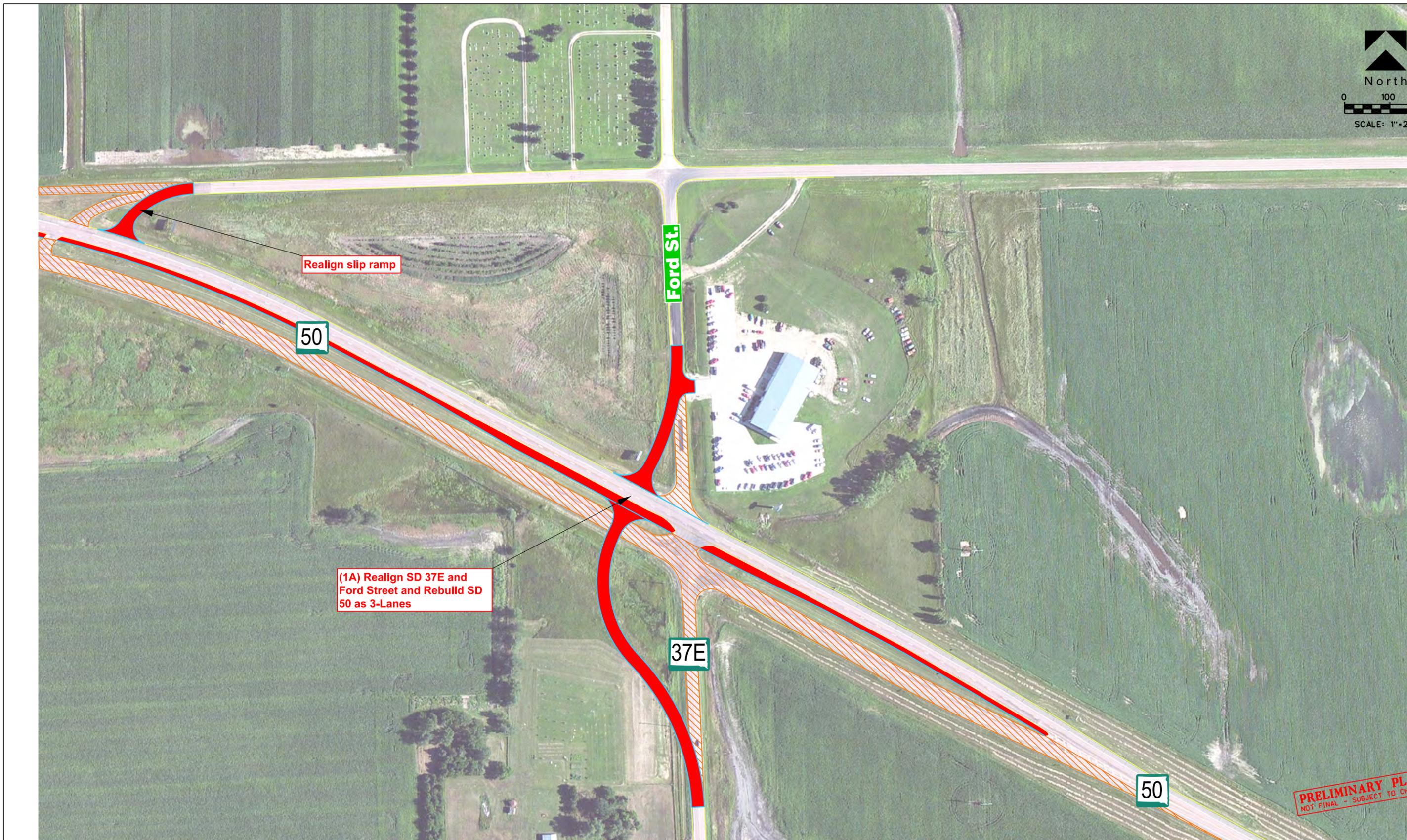
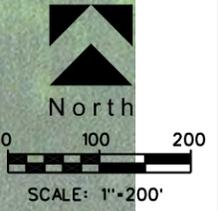
1 – It is recommended that SD 50 be reconstructed from a 4-lane to 3-lane roadway. The cost savings for resurfacing only part of the existing 4-lane roadway together with the reduced maintenance costs should be included in the analysis. This will further increase the Benefit/Cost Ratio. (1)





CONCEPTUAL DESIGN - OPTION 1

Figure 6.3
 Intersection #6
 Intersection Recommendations
 SD 50 / SD 37E



Realign slip ramp

50

(1A) Realign SD 37E and Ford Street and Rebuild SD 50 as 3-Lanes

Ford St.

37E

50

PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE

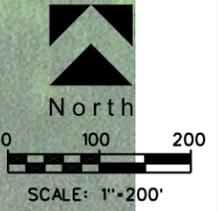
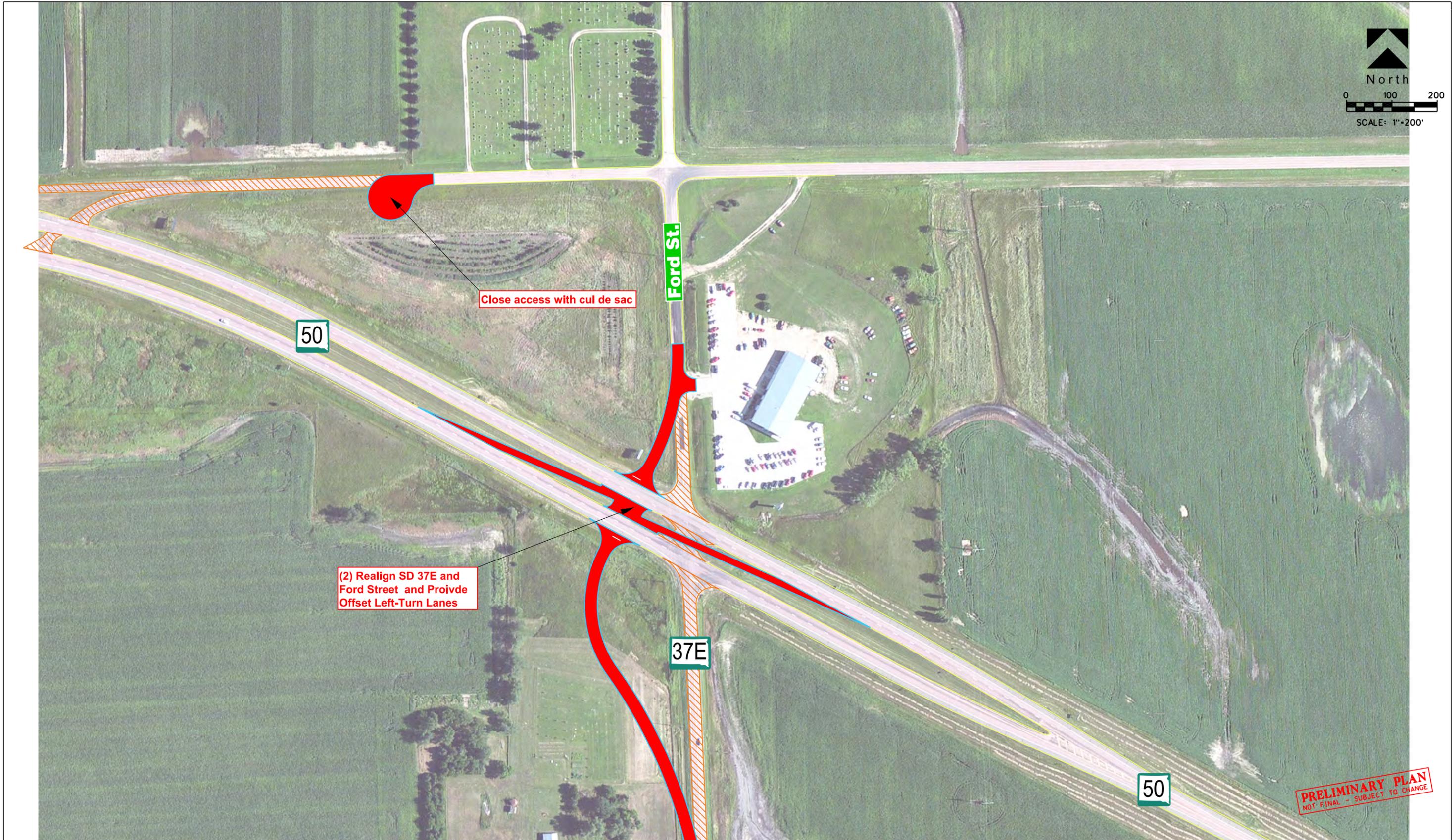


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1A

Figure 6.4
Intersection #6
Intersection Recommendations
SD 50 / SD 37E



50

Ford St.

Close access with cul de sac

(2) Realign SD 37E and Ford Street and Provide Offset Left-Turn Lanes

37E

50

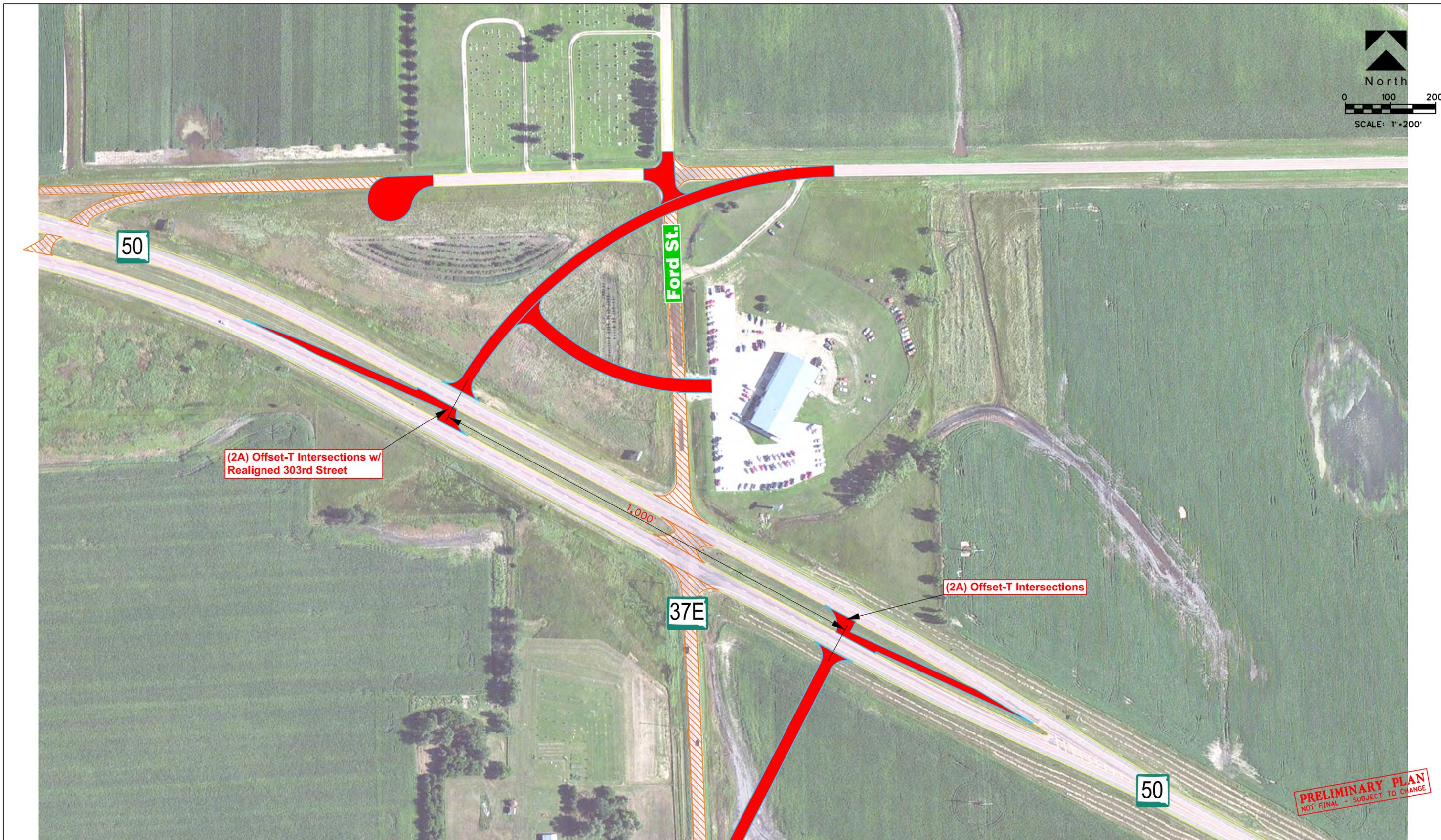
PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND
 Remove Existing Pavement
 New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 6.5
Intersection #6
Intersection Recommendations
SD 50 / SD 37E

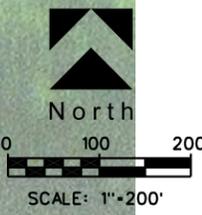
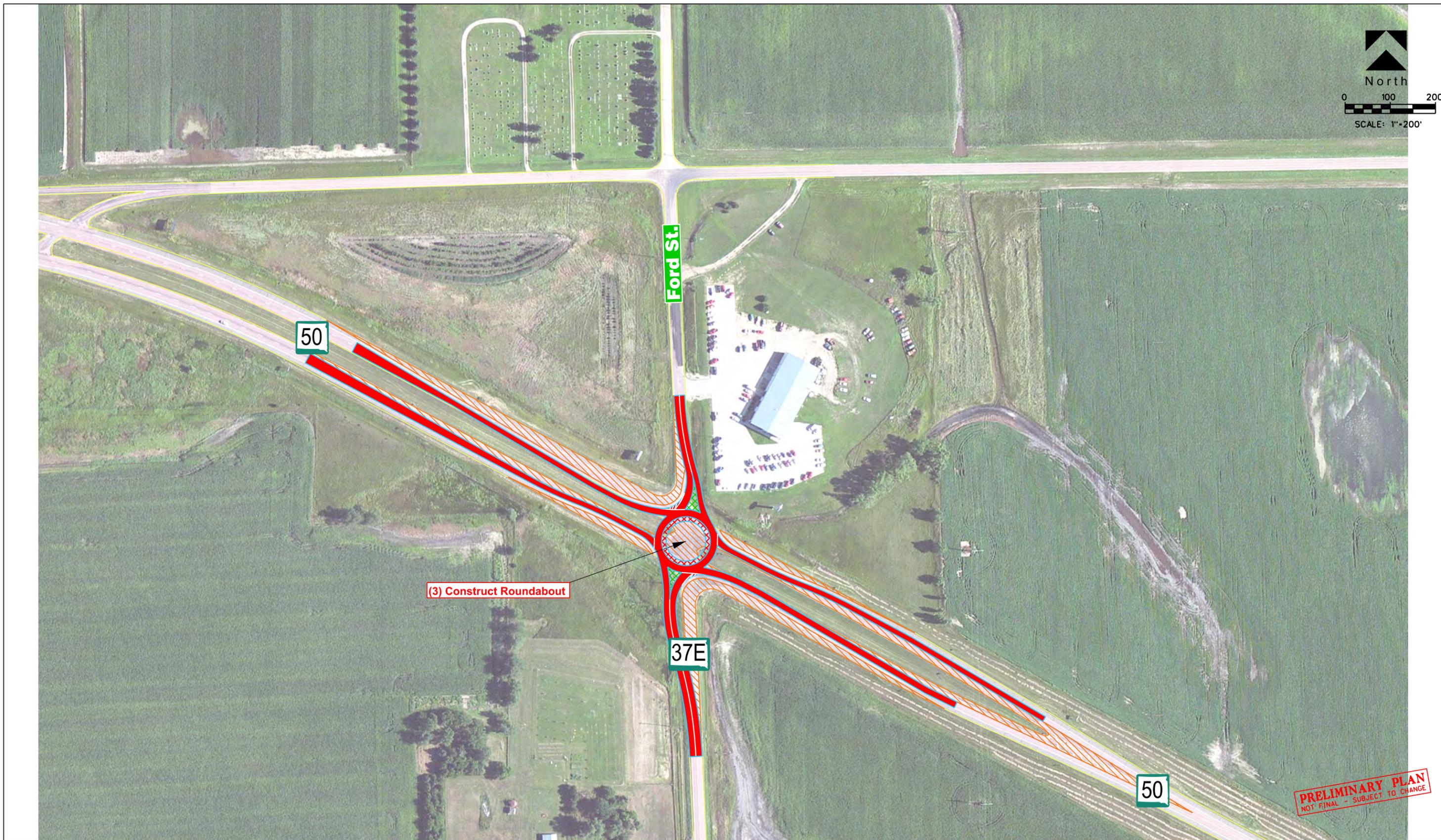


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2A

Figure 6.6
Intersection #6
Intersection Recommendations
SD 50 / SD 37E



(3) Construct Roundabout

PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 3

Figure 6.7
Intersection #6
Intersection Recommendations
SD 50 / SD 37E

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7. SD 50/Birch Street Intersection

The intersection of SD 50 with Birch Street is located on the south side of the town of Tyndall, SD. The posted speed limit along SD 50 is 55 MPH and along Birch Street the posted speed limit is 25 MPH. At the intersection, SD 50 is a 4-lane divided highway with a 40 foot median separating the travel lanes. Birch Street is a 2-lane undivided roadway and provided access to the west side of the town of Tyndall. The intersection is on a 30° skew.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in April 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

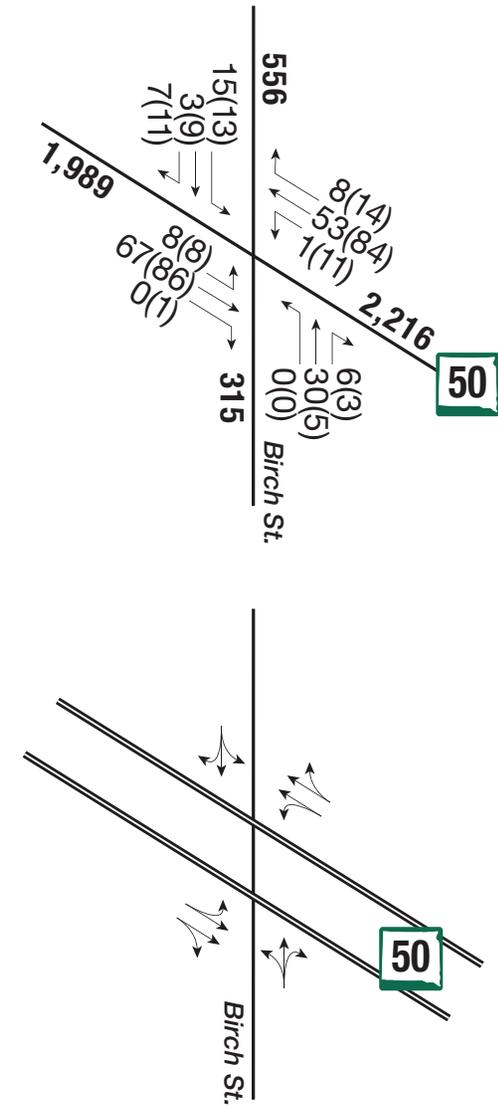
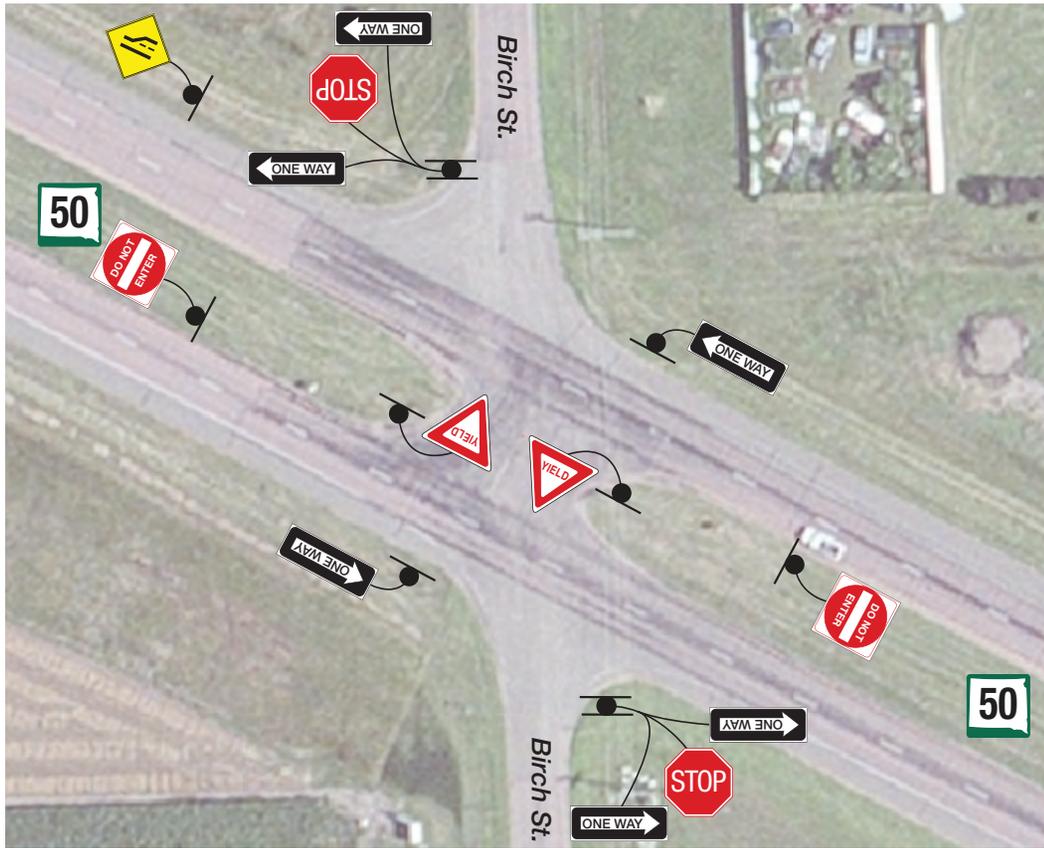
Below is a list of intersection observations made by FHU staff while conducting site visits:

- No stop bars at intersection
- Existing stop signs are 30" diameter
- Intersection is on a skew (30°)
- Median mounted yield signs at skewed orientation
- "Do Not Enter" signs mounted in median only
- Intersection does not have any lighting
- There are no turn lanes on SD 50
- SE corner has power box surround by posts
- Fatal "Think" Sign on SE corner

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the SD 50/Birch Street intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 3:15 PM to 4:15 PM. Existing ADT's and turning movement counts are summarized on **Figure 7.1**. The intersection had 2,538 total entering vehicles per day, which ranks it as the 9th highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 17%. Also shown on **Figure 7.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
 XXXX = Daily Traffic Volumes
 X/X = AM/PM Peak Hour Signalized Intersection Level of Service
 x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

-  = Stop Sign
-  = Yield Sign
-  = Do Not Enter Sign
-  = Wrong Way Sign
-  = Traffic Signal
-  = Stop Ahead Sign
-  = Intersection Ahead Sign
-  = Lane Ends Sign
-  = Divided Highway Sign

Figure 7.1
SD 50/Birch Street Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the SD 50/Birch Street intersection are shown in **Tables 7.1** and **7.2** for the most recent five-year period (2008 - 2012).

Table 7.1 SD 50/Birch Street – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
2	2	0	0	0	0	0	4

A detailed review of the crash history at the intersection indicates a pattern of right angle near side and right angle far side crashes. Right angle near sided crashes represent 50.0% of the total crashes during this five-year period, and right angle far sided crashes comprise the remaining 50.0%. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; three of the crashes occurred under wet or snowy pavement conditions. The crash patterns at the SD 50/Birch Street intersection are further depicted in **Figure 7.2** by severity and type.

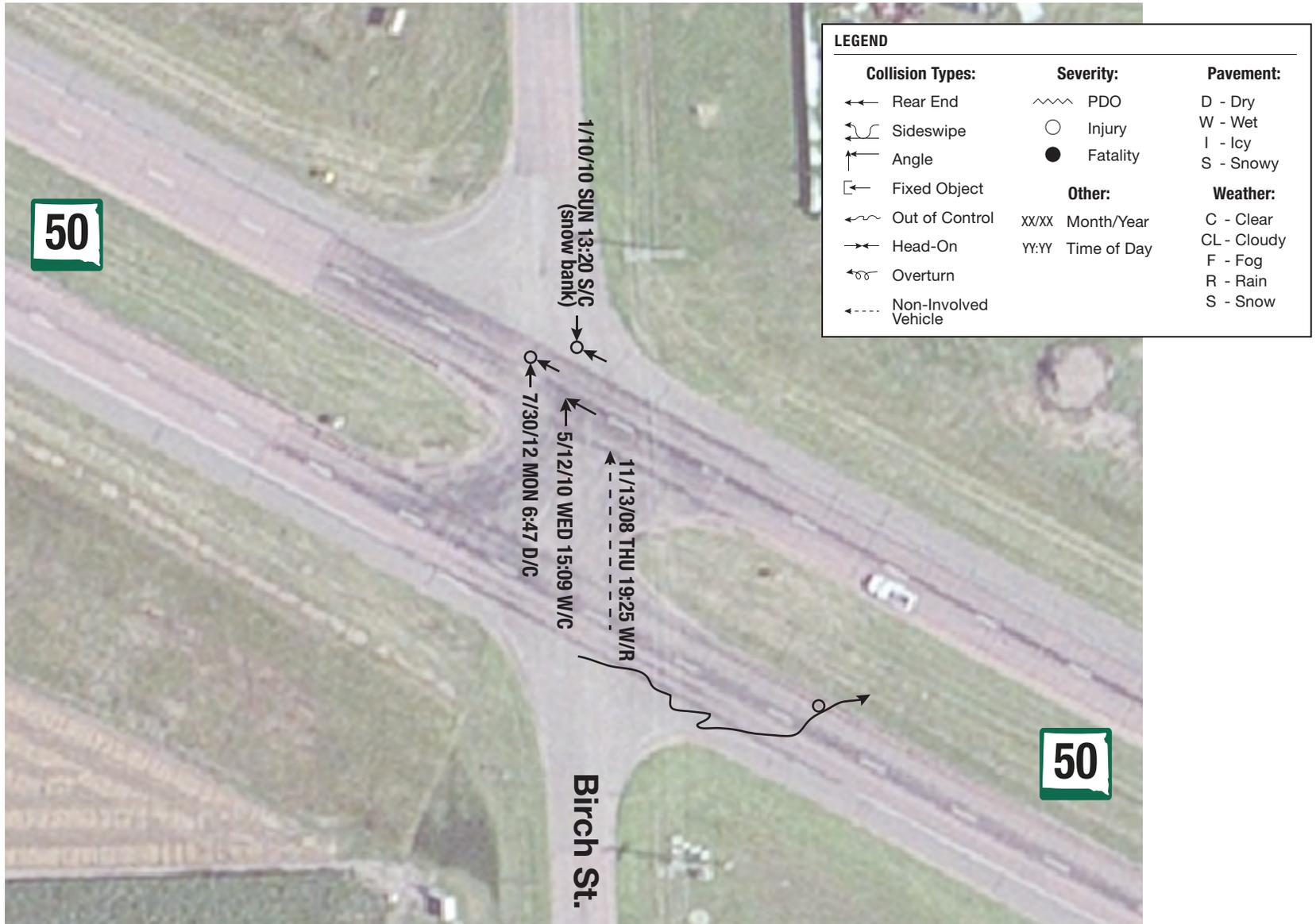
Table 7.2 SD 50/Birch Street – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
SD50/Birch	0	0	1	1	2	4	2,538	4.63	0.86	4.05
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 0.86. This intersection has the 5th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 4.05 which ranks is at the 8th highest. **Table 7.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 7.3 SD 50/Birch Street – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Wet/Snowy Pavement	<ul style="list-style-type: none"> Slick Roadway 	<ul style="list-style-type: none"> Give Attention During Snow Events



NOTE: Drawing Not to Scale

Figure 7.2
SD 50/Birch Street Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns, and from on-site observations:

- (1) Rebuild SD 50 as 3-lanes only
- (1A) Realign Birch Street and rebuild SD 50 as 3-lanes
- (2) Reduce intersection skew with offset T intersections

F. Economic Appraisal of Countermeasures

Figure 7.3 and Figure 7.4 show the potential alternative countermeasures (1) and (1A) to the intersection. Potential countermeasure (2) is shown on Figure 7.5.

Table 7.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the Appendix.

Table 7.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Rebuild SD 50 as 3-Lanes Only	\$392,700	\$337,417	0.86
(1A) Realign Birch Street and Rebuild SD 50 as 3-Lanes	\$822,900	\$421,771	0.51
(2) Reduce Intersection Skew with Offset T Intersections, J-Turn	\$255,360	\$927,896	3.63

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.

G. Recommendation for Preferred Alternative

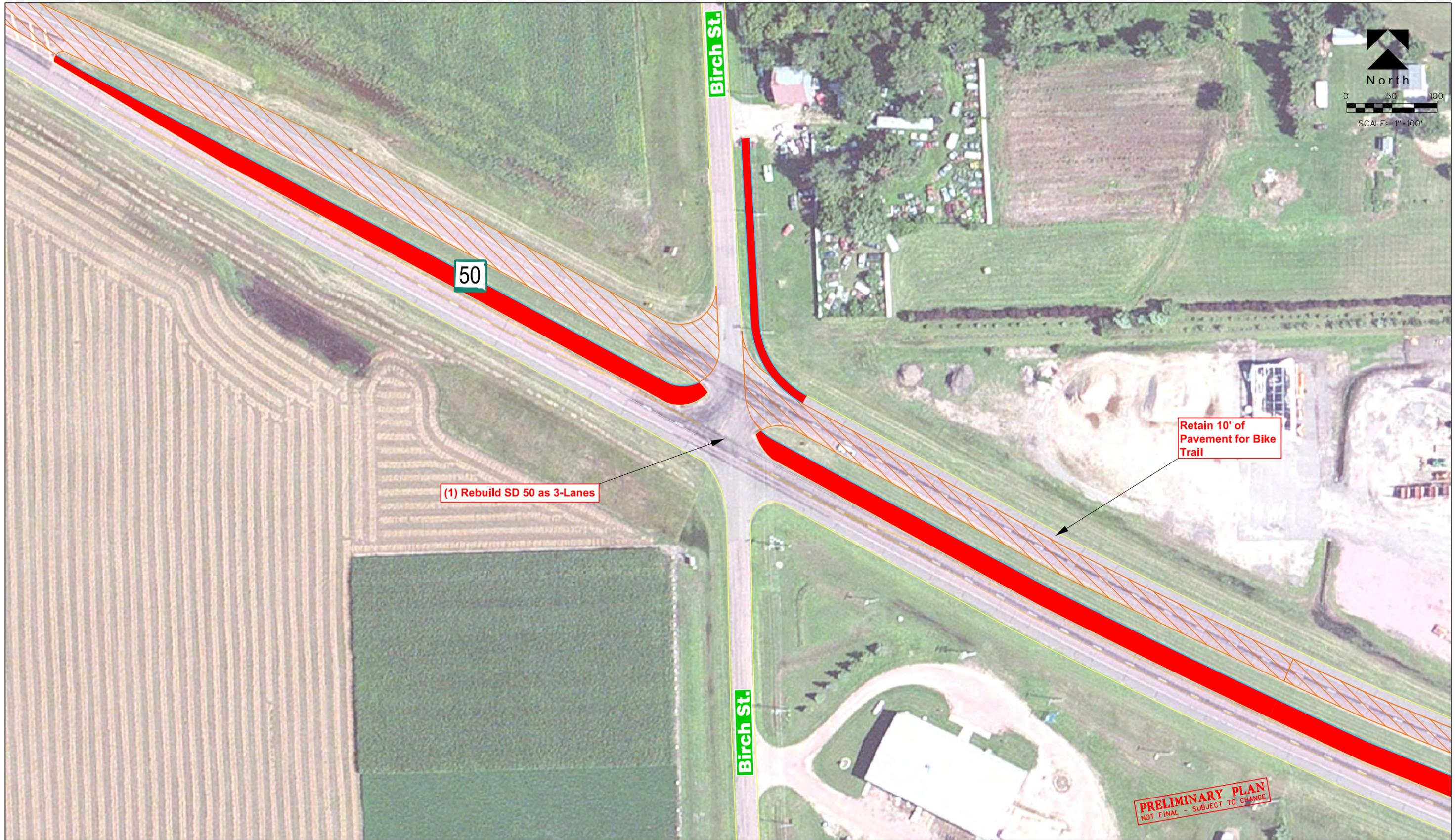
1 – It is further recommended that SD 50 be evaluated as part of a rehabilitation project reconstructing the roadway from 4-lanes to 3-lanes. The cost savings for resurfacing only part of the existing 4-lane roadway together with the reduced maintenance costs should be included in the analysis at that time. This will increase the Benefits/Cost Ratio. (1)

2 –If recommendation #1 is delayed, it is recommended that the median be closed on SD 50 at Birch Street reducing the skew, and providing Offset T Intersections. A left-turn pocket and J-Turn should be provided west of the intersection. (2)

It is noted in further analysis shown in Table 7.5 that Option 2 at Birch Street and Main Street would have an increased travel and delay cost due to the additional travel to make the J-turns, west of Birch and east Main Street, as well as make the U-turn at Fir/Ivy Street due to the median closure. This will offset some of the savings in crashes.

Table 7.5 Benefit Cost Analysis - SD 50 with Birch Street and Main Street

Improvement	Cost	User Benefits		Benefit/Cost Ratio
		Crash	Travel/Delay	
(2) Reduce Intersection Skew with Offset T Intersections, J-Turn	\$702,360	\$1,687,084	(\$638,264)	1.49

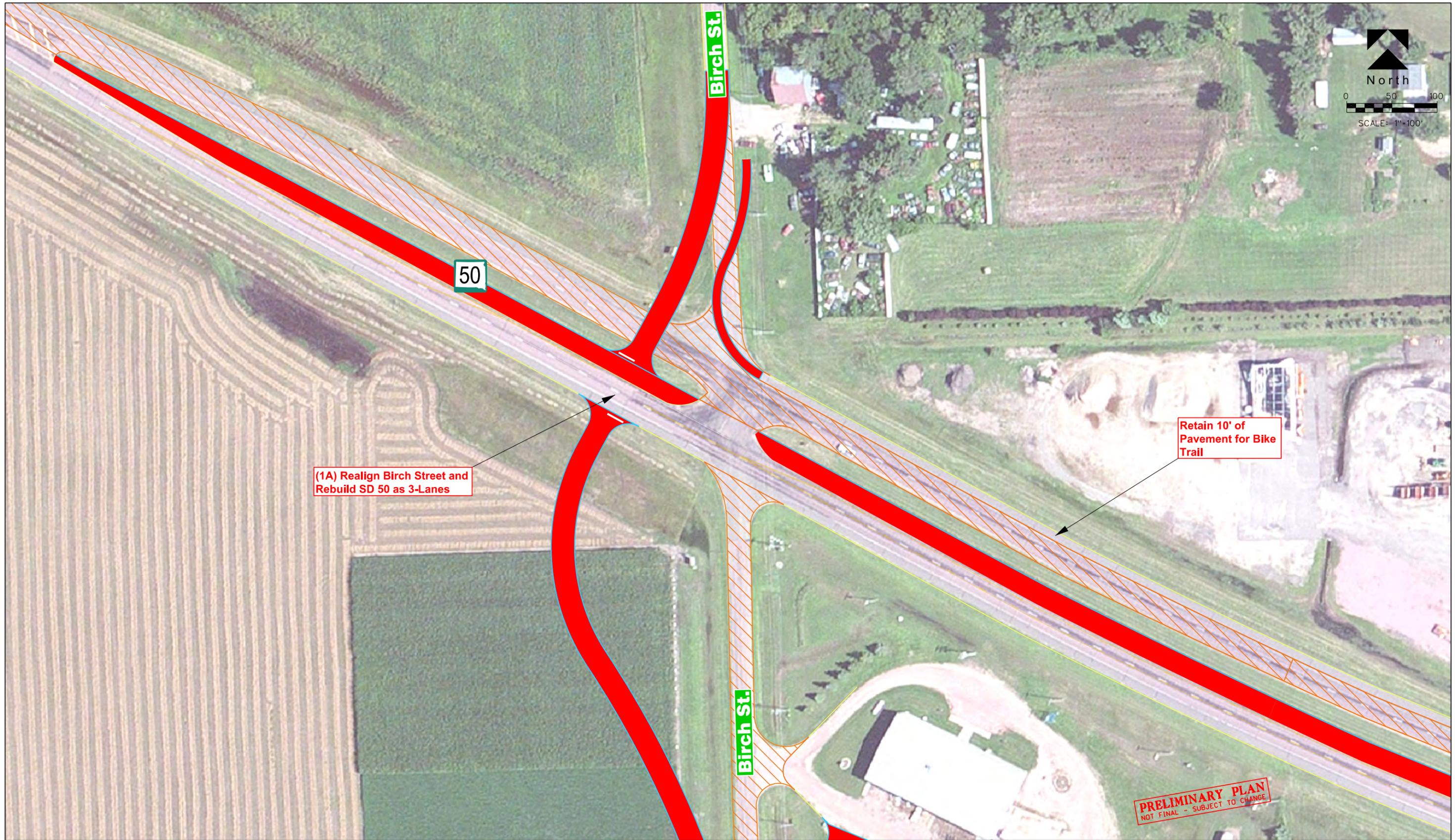


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 7.3
Intersection #7
Intersection Recommendations
SD 50 / Birch Street

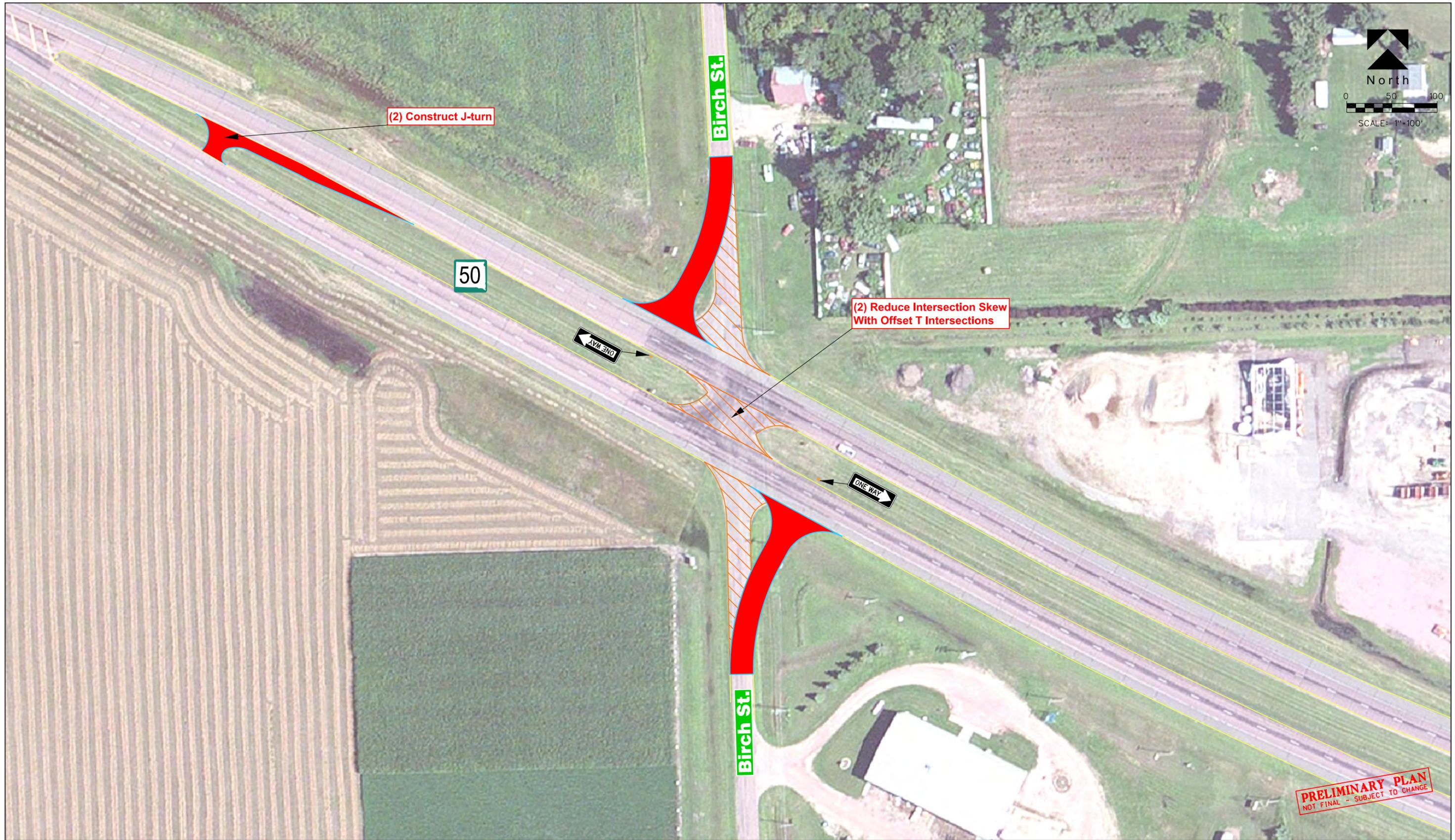


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1A

Figure 7.4
Intersection #7
Intersection Recommendations
SD 50 / Birch Street



(2) Construct J-turn

(2) Reduce Intersection Skew
With Offset T Intersections

50

ONE WAY

ONE WAY

Birch St.

Birch St.

PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 7.5
Intersection #7
Intersection Recommendations
SD 50 / Birch Street

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8. SD 50/Fir/Ivy Street Intersection

The intersection of SD 50 with Fir/Ivy Street is located on the south side of the town of Tyndall, SD. The posted speed limit along SD 50 is 55 MPH and the posted speed limit on Fir Street and Ivy Street are both 25 MPH. At the intersection, SD 50 is a 4-lane divided highway with a 40 foot median separating the travel lanes. Fir Street and Ivy Street are both 2-lane undivided roadways that converge to form the north leg of this intersection. This intersection is on a skew.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in April 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

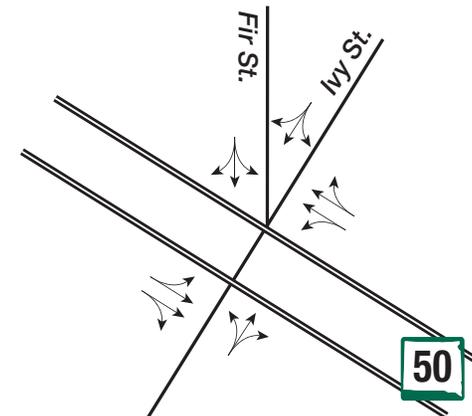
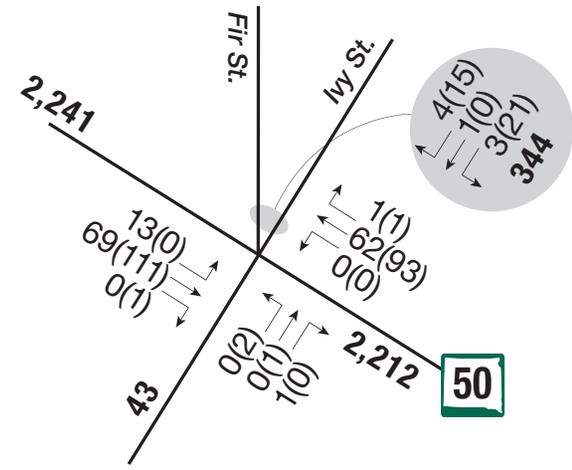
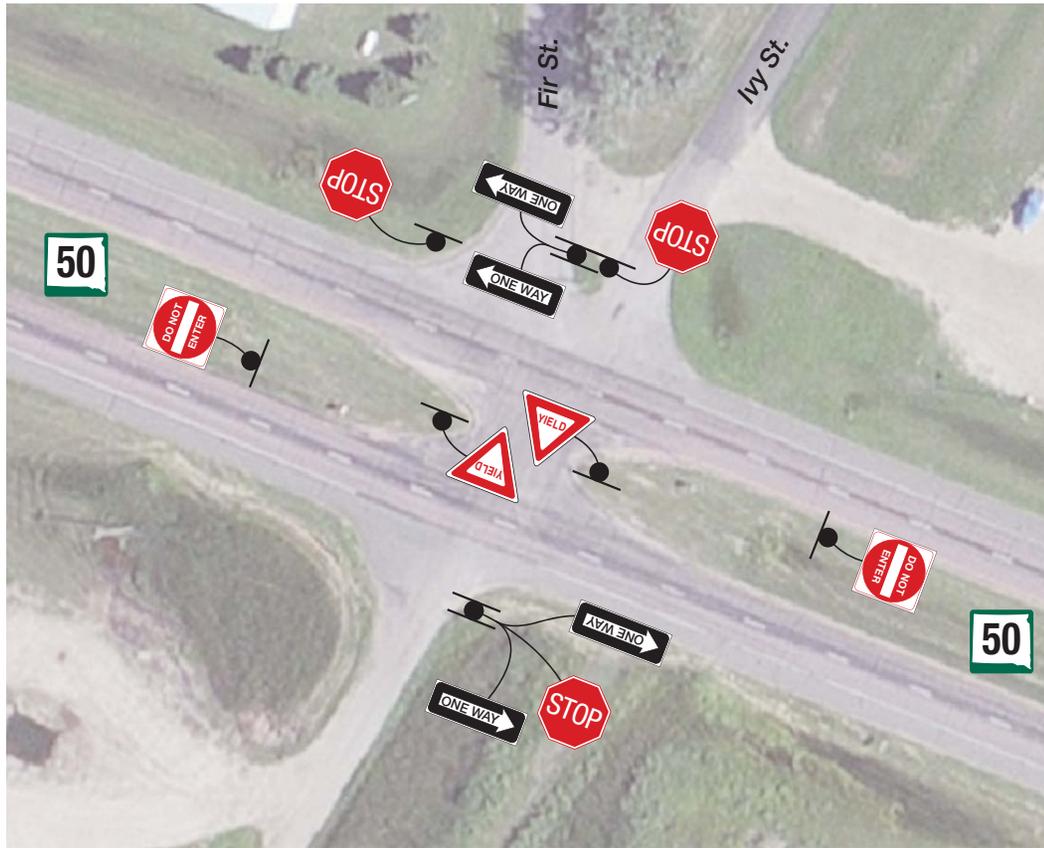
Below is a list of intersection observations made by FHU staff while conducting site visits:

- No stop bars at intersection
- Existing stop signs are 30" diameter
- The intersection of Fir Street is on a skew of 20° from perpendicular with SD 50
- South leg of intersection is gravel road to dump site
- North leg of intersection has complex configuration. Fir Street and Ivy Street both intersect SD 50. City of Tyndall worker stated SDDOT tired to remove one of the north legs years ago but car dealer protested
- SDDOT Maintenance Facility is located on NW corner
- Tyndall Motor Chevy located on NE corner of intersection
- Median mounted yield signs at skewed orientation
- Do Not Enter signs median mount only
- There is one light and pole between Fir Street and Ivy Street on north side of SD 50
- No turn lanes on SD 50

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the SD 50/Fir Street intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 3:45 PM to 4:45 PM. An additional peak period was also observed, the noon peak period was determined to be 11:15 AM to 12:15 PM. This noon peak period could be related to traffic from the car dealership located in the northeast corner of the intersection. Existing ADT's and turning movement counts are summarized on **Figure 8.1**. The intersection had 2,420 total entering vehicles per day, which ranks it as the 3rd lowest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 16%. Also shown on **Figure 8.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- | | | |
|--|---------------------|---------------------------|
| XXX(XXX) = AM(PM) Peak Hour Traffic Volumes | = Stop Sign | = Stop Ahead Sign |
| XXXX = Daily Traffic Volumes | = Yield Sign | = Intersection Ahead Sign |
| X/X = AM/PM Peak Hour Signalized Intersection Level of Service | = Do Not Enter Sign | = Lane Ends Sign |
| x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service | = Wrong Way Sign | = Divided Highway Sign |
| | = Traffic Signal | |

Figure 8.1
SD 50/Fir/Ivy Street Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the SD 50/Fir intersection are shown in **Tables 8.1** and **8.2** for the most recent five-year period (2008 - 2012).

Table 8.1 SD 50/Fir/Ivy Street – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
0	0	0	0	0	0	0	0

A detailed review of the crash history at the intersection indicates there are no crash patterns. The crash patterns at the SD 50/Fir/Ivy Street intersection are further depicted in **Figure 8.2** by severity and type.

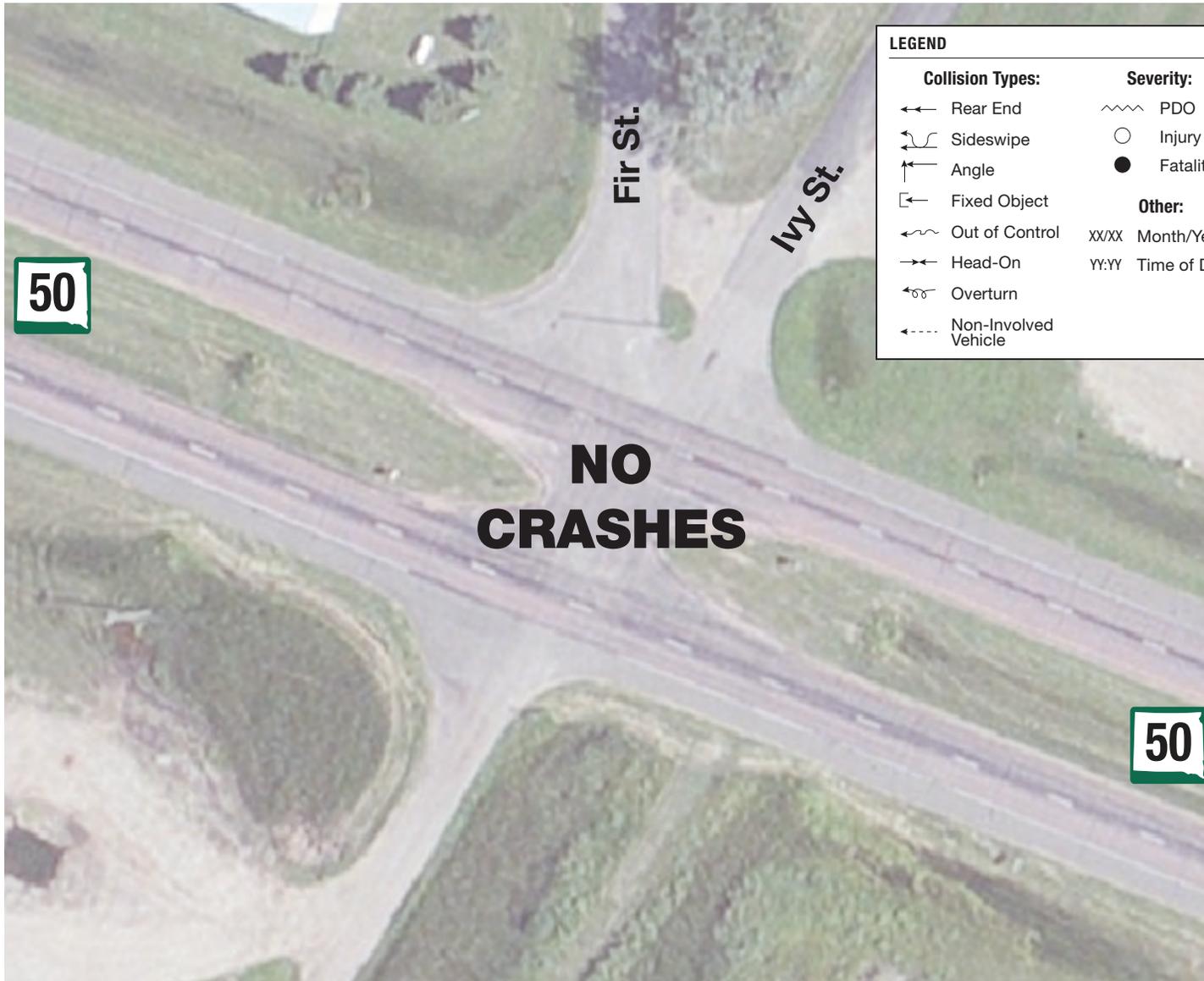
Table 8.2 SD 50/Fir/Ivy Street – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
US50/Fir/Ivy	0	0	0	0	0	0	2,420	4.42	0.00	0.00
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 0.00. This intersection has the lowest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 0.00 which ranks it at the lowest. **Table 8.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 8.3 SD 50/Fir/Ivy Street – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
None	-	-



Collision Types:		Severity:	Pavement:
←←	Rear End	~~~~~	PDO
←↗	Sideswipe	○	Injury
←↖	Angle	●	Fatality
←⊥	Fixed Object		
←~	Out of Control	XX/XX	Month/Year
←→	Head-On	YY:YY	Time of Day
←↻	Overturn		
←---	Non-Involved Vehicle		
		Other:	Weather:
			C - Clear
			CL - Cloudy
			F - Fog
			R - Rain
			S - Snow

NOTE: Drawing Not to Scale

Figure 8.2
SD 50/Fir/Ivy Street Crash Diagram

E. Potential Improvements

Below is a list of possible countermeasures based on the identified crash patterns, and from on-site observations:

- (1) Rebuild SD 50 as 3-lanes only
- (1A) Consolidate Fir and Ivy Streets and rebuild SD 50 as 3-lanes
- (2) Consolidate Fir Street and Ivy Street into a single roadway at the intersection with SD 50
 - Install 36" stop signs
 - Install stop bars

F. Economic Appraisal of Improvements

Figure 8.3 and **Figure 8.4** show the potential alternative countermeasures (1) and (1A) to the intersection. Potential countermeasure (2) is shown on **Figure 8.5**.

Table 8.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the **Appendix**.

Table 8.4 Economic Appraisal of Improvements

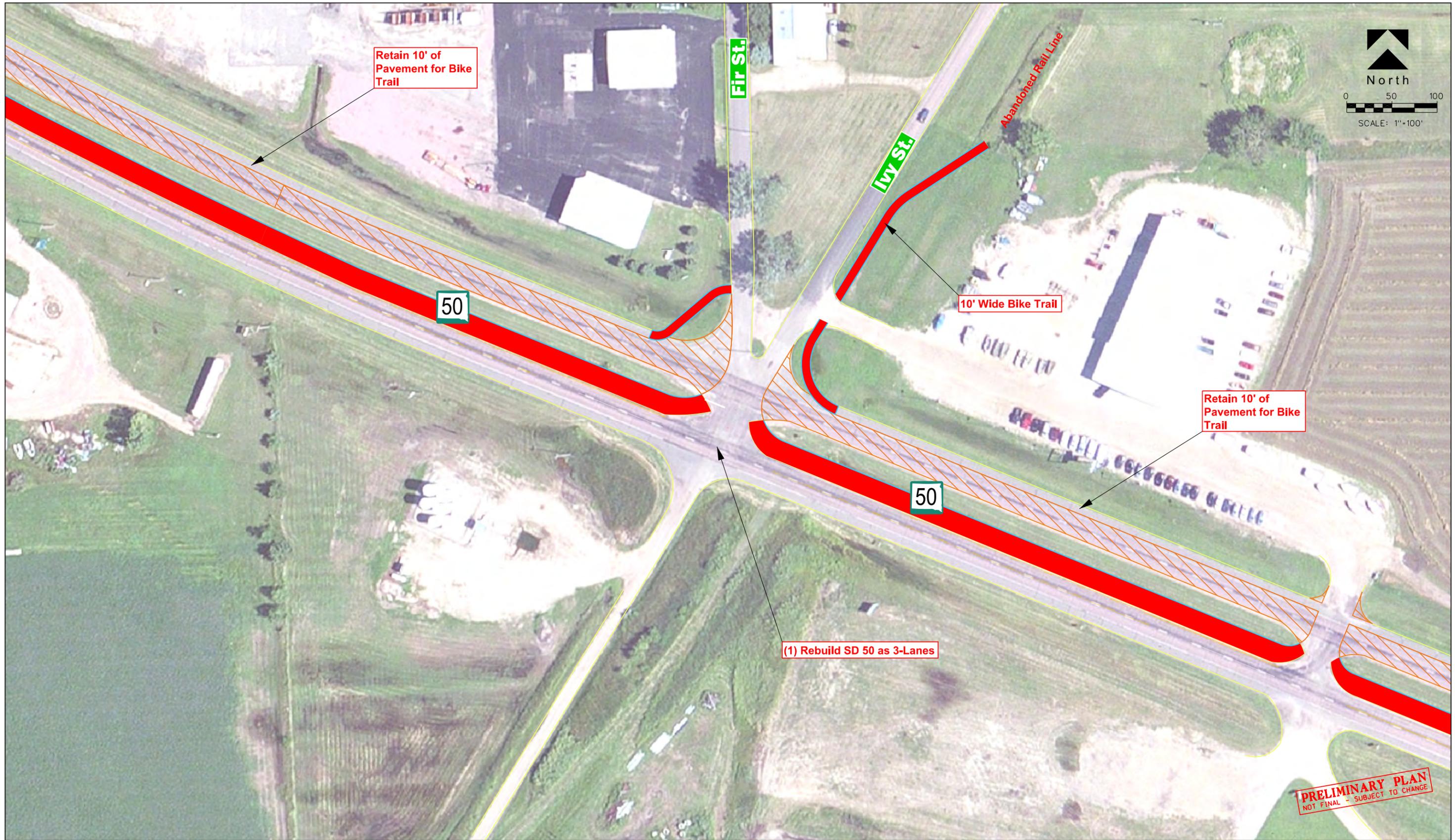
Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Rebuild SD 50 as 3-Lanes Only	\$443,580	\$84,354	0.19
(1A) Consolidate Fir and Ivy Streets and Rebuild SD 50 as 3-Lanes	\$637,680	\$84,354	0.13
(2) Consolidate Fir Street and Ivy Street	\$194,340	\$0	0.00
Install 36" Stop Signs /Stop Bars	\$3,000	\$0	0.00

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.

G. Recommendation for Preferred Alternative

1 – It is recommended that no immediate action be taken at this time since there have been no collisions reported at this intersection in the 5-year study period.

2 – It is recommended that SD 50 be reconstructed from a 4-lane to 3-lane roadway as part of a future rehabilitation project. The cost savings for resurfacing only part of the existing 4-lane roadway together with the reduced maintenance costs should be included in the analysis. This will increase the Benefit/Cost Ratio. (1)



Retain 10' of Pavement for Bike Trail

Fir St.

Ivy St.

Abandoned Rail Line

10' Wide Bike Trail

Retain 10' of Pavement for Bike Trail

50

50

(1) Rebuild SD 50 as 3-Lanes

PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE

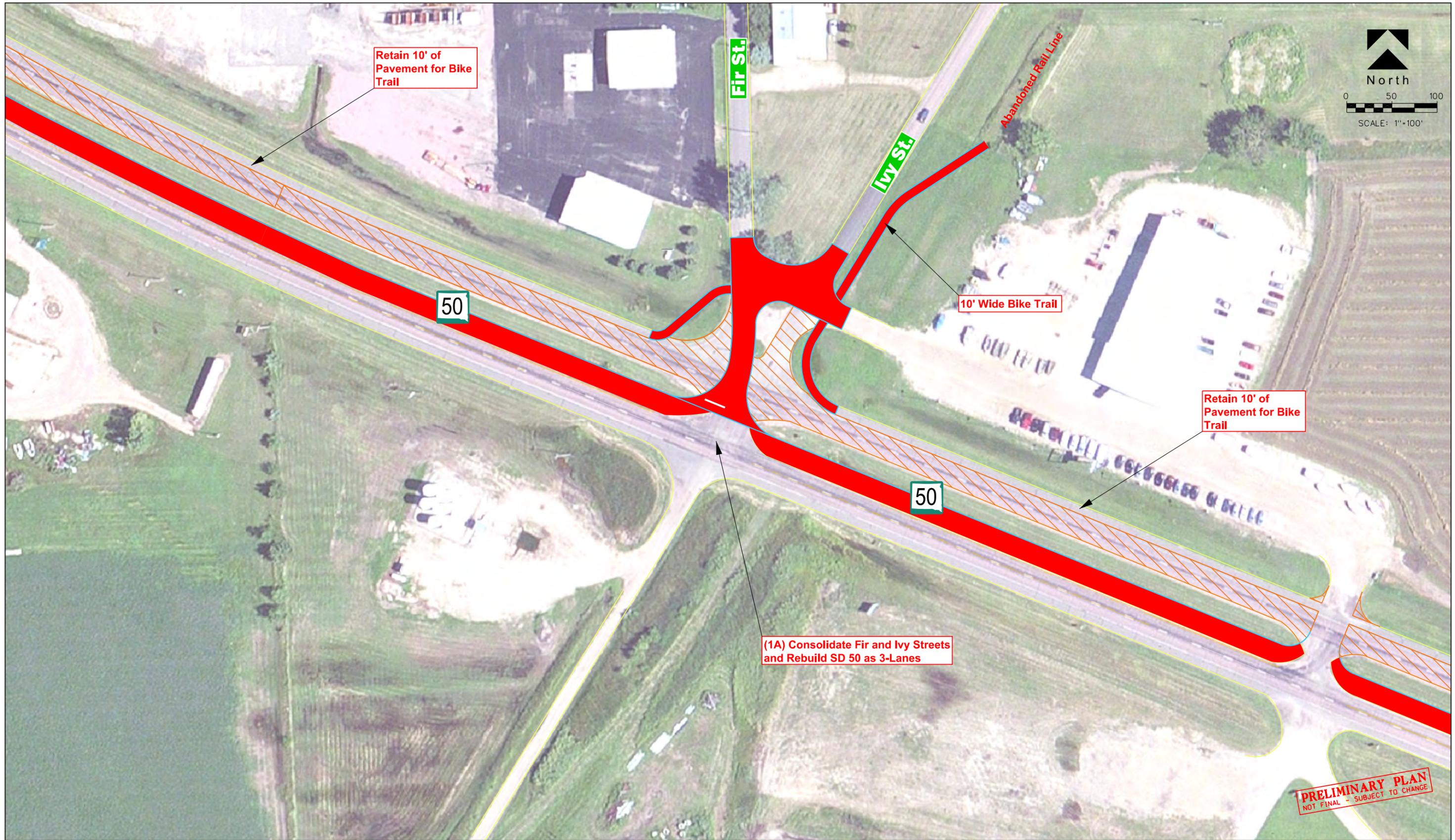


LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 8.3
Intersection #8
Intersection Recommendations
SD 50 / Fir/Ivy Street

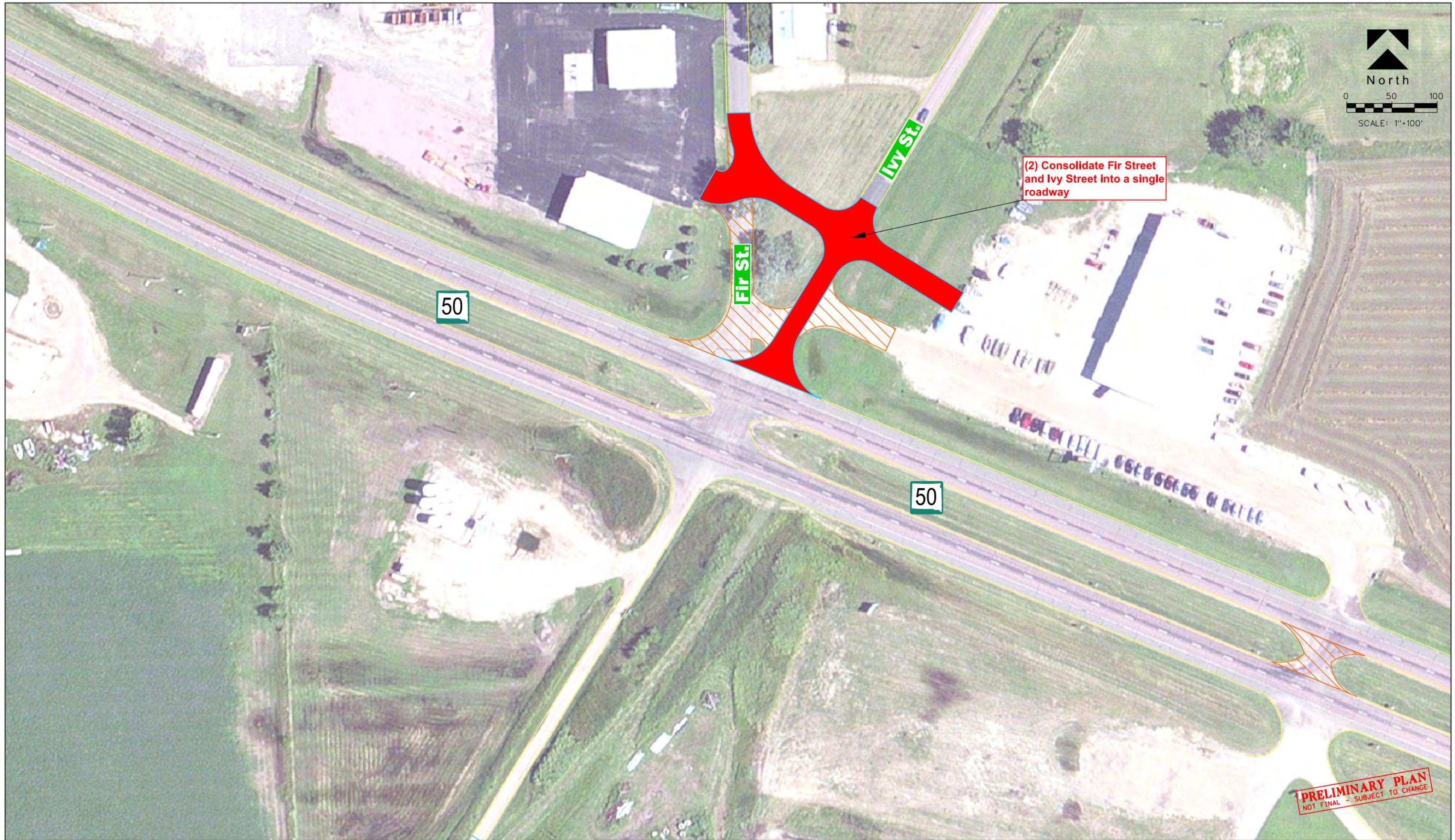


LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 1A

Figure 8.4
Intersection #8
Intersection Recommendations
SD 50 / Fir/Ivy Street



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 8.5
Intersection #8
Intersection Recommendations
SD 50 / Fir/Ivy Street

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9. SD 50/Main Street Intersection

The intersection of SD 50 with Main Street is located on the south side of the town of Tyndall, SD. The posted speed limit along SD 50 is 55 MPH and along Main Street the posted speed limit is 25 MPH. At the intersection, SD 50 is a 4-lane divided highway with a 40 foot median separating the travel lanes. Main Street is a 2-lane undivided roadway. This intersection is on a 25° skew and is the main access point to the town of Tyndall.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in April 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observation

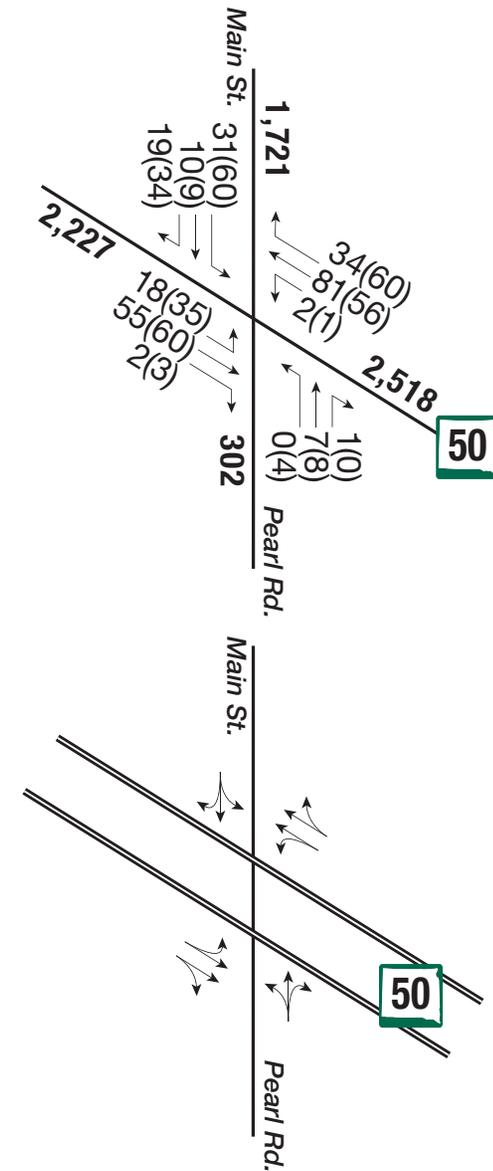
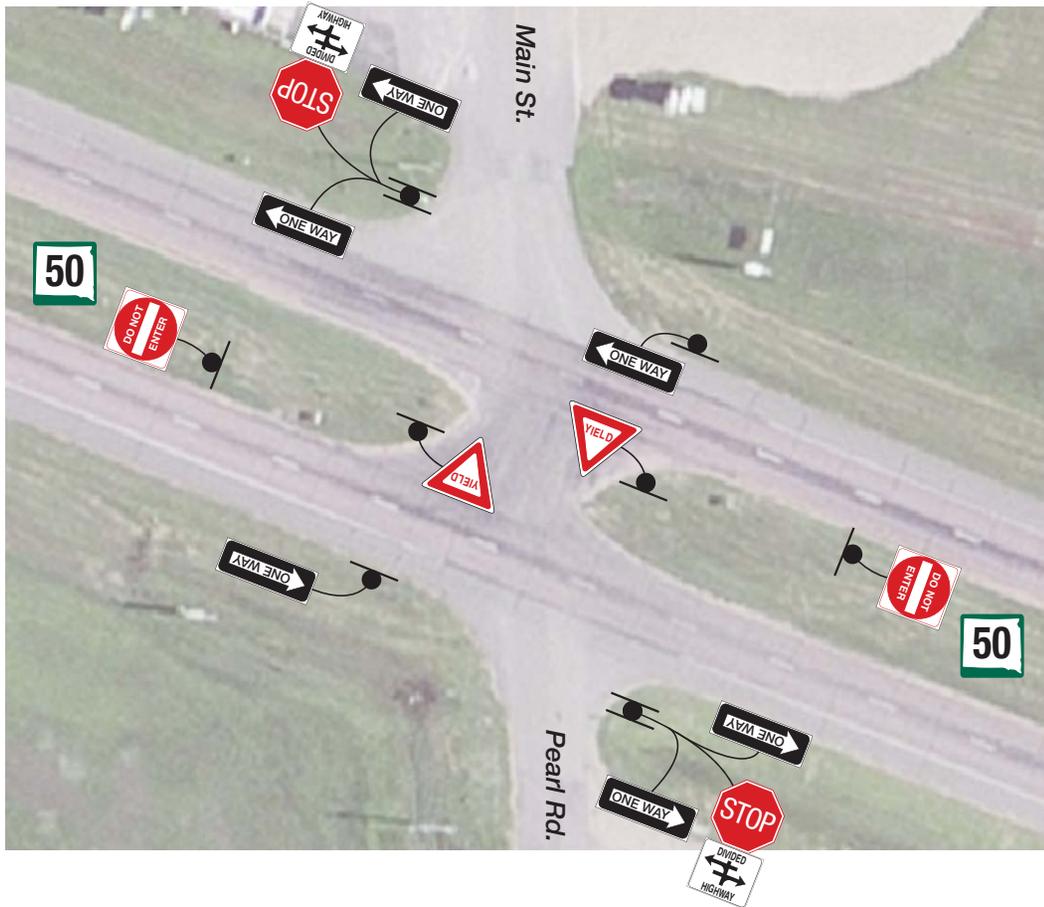
Below is a list of intersection observations made by FHU staff while conducting site visits:

- No stop bars at intersection
- Existing stop signs are 30" diameter
- Intersection is on a skew (25°)
- Dairy Queen located on NE corner of intersection. Gas Station on NW corner of intersection
- Median mounted yield signs at skewed orientation
- "Do Not Enter" signs median mount only
- Intersection ahead warning signs with flashers are present for EB traffic
- Check east leg sight distance (curve)
- Check west leg sight distance (crest)
- Intersection lighting is present. Luminaires located on NW and SW corners of intersection
- There are no turn lanes on SD 50
- Fatal "Think" Sign on SW corner

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the SD 50/Main Street intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 4:45 PM to 5:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 9.1**. The intersection had 3,384 total entering vehicles per day, which ranks it as the 8th highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 13%. Also shown on **Figure 9.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
 XXXX = Daily Traffic Volumes
 X/X = AM/PM Peak Hour Signalized Intersection Level of Service
 x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

- = Stop Sign
- = Yield Sign
- = Do Not Enter Sign
- = Wrong Way Sign
- = Traffic Signal
- = Stop Ahead Sign
- = Intersection Ahead Sign
- = Lane Ends Sign
- = Divided Highway Sign
- = Divided Highway Sign

Figure 9.1

SD 50/Main Street Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the SD 50/Main Street intersection are shown in **Tables 9.1** and **9.2** for the most recent five-year period (2008 - 2012).

Table 9.1 SD 50/Main Street – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
0	3	0	0	0	0	0	3

A detailed review of the crash history at the intersection indicates a pattern of roadway departure crashes. Far Side Right Angle crashes represent 100% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; however no other crash pattern was indentified. The crash patterns at the SD 50/Main Street intersection are further depicted in **Figure 9.2** by severity and type.

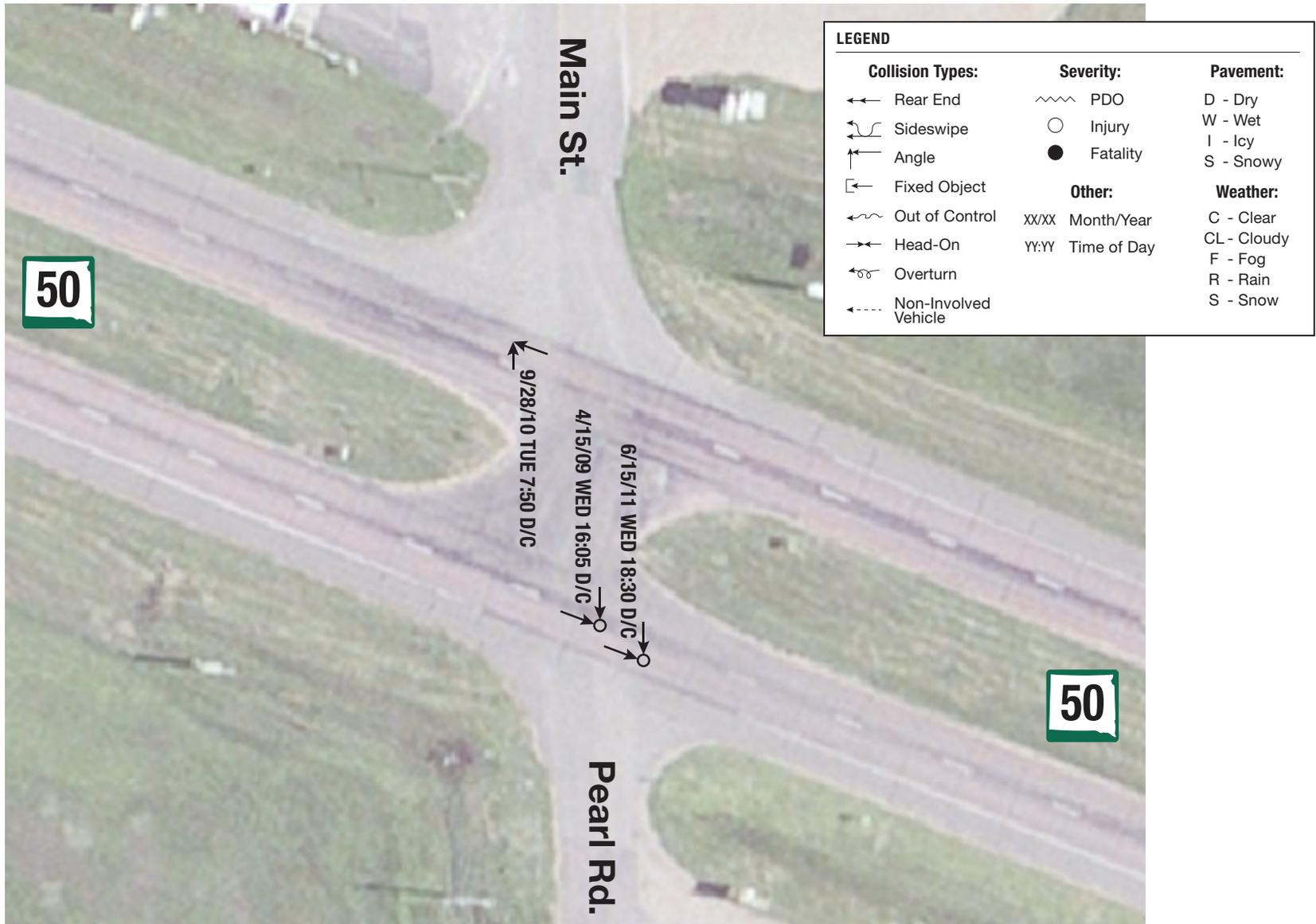
Table 9.2 SD 50/Main Street – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
SD50/Main	0	0	0	2	1	3	3,384	6.18	0.49	2.13
Incapacitating (Incap.)		Property Damage Only (PDO)				* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 0.49. This intersection has the 10th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 2.13 which ranks is at the 9th highest. **Table 9.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 9.3 SD 50/Main Street – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Right Angle Farside	Skew of Intersection	Reduce Skew



NOTE: Drawing Not to Scale

Figure 9.2
SD 50/Main Street Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns, and from on-site observations:

- (1) Rebuild SD 50 as 3-lanes only
- (1A) Realign Main Street and rebuild SD 50 as 3-lanes
- (2) Reduce intersection skew with offset T intersections
 - Install 36" stop signs and install stop bars

F. Economic Appraisal of Countermeasures

Figure 9.3 and **Figure 9.4** show the potential alternative countermeasures (1) and (1A) to the intersection. Potential countermeasure (2) is shown on **Figure 9.5**.

Table 9.4 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the **Appendix**.

Table 9.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Rebuild SD 50 as 3-Lanes Only	\$524,700	\$506,125	0.96
(1A) Realign Main St and Rebuild SD 50 as 3-Lanes	\$685,620	\$590,479	0.86
(2) Reduce Intersection Skew With Offset T Intersections, J-Turn	\$252,660	\$759,188	3.00
Install 36" Stop Signs/Stop Bars	\$1,500	\$0	0.00

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.

G. Recommendation for Preferred Alternative

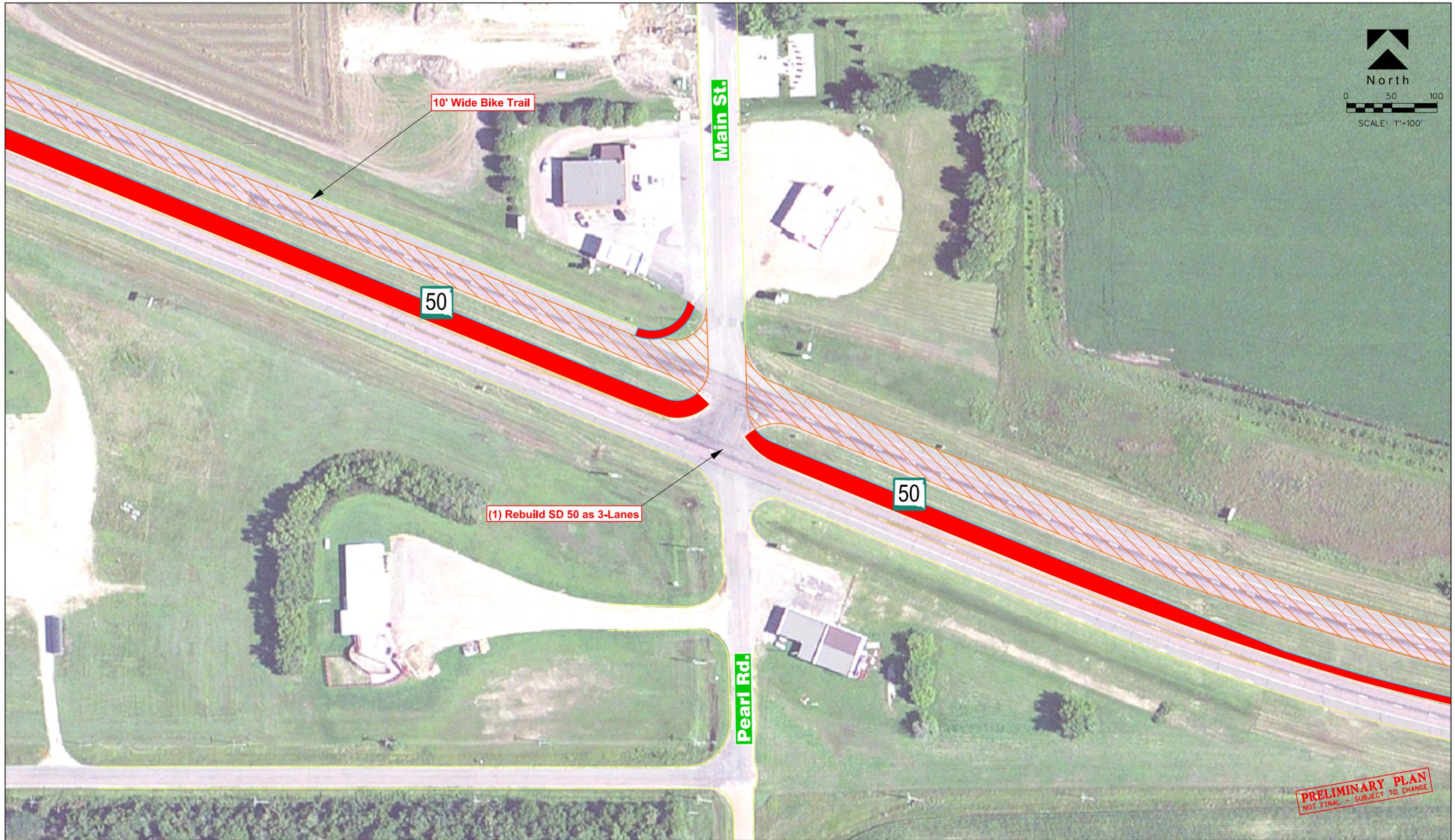
1 – It is recommended that SD 50 be reconstructed from a 4-lane to 3-lane roadway. The cost savings for resurfacing only part of the existing 4-lane roadway together with the reduced maintenance costs should be included in the analysis. This will further increase the Benefit/Cost Ratio. (1)

Although the median closure and offset-T intersections alternative has a higher Benefit/Cost Ratio, the peak hour southbound to eastbound left-turn volume (60) will resist diversion to the next median opening west of the intersection. If the J-Turn is selected consideration should also be given to placing a J-Turn west of Main Street and closing the median break located 950 feet west of Main Street.

It is noted in further analysis shown in **Table 9.5** that Option 2 at Birch Street and Main Street would have an increased travel and delay cost due to the additional travel to make the J-turns, west of Birch and east Main Street, as well as make the U-turn at Fir/Ivy Street due to the median closure. This will offset some of the savings in crashes.

Table 9.5 Benefit Cost Analysis - SD 50 with Birch Street and Main Street

Improvement	Cost	User Benefits		Benefit/Cost Ratio
		Crash	Travel/Delay	
(2) Reduce Intersection Skew with Offset T Intersections, J-Turn	\$702,360	\$1,687,084	(\$638,264)	1.49

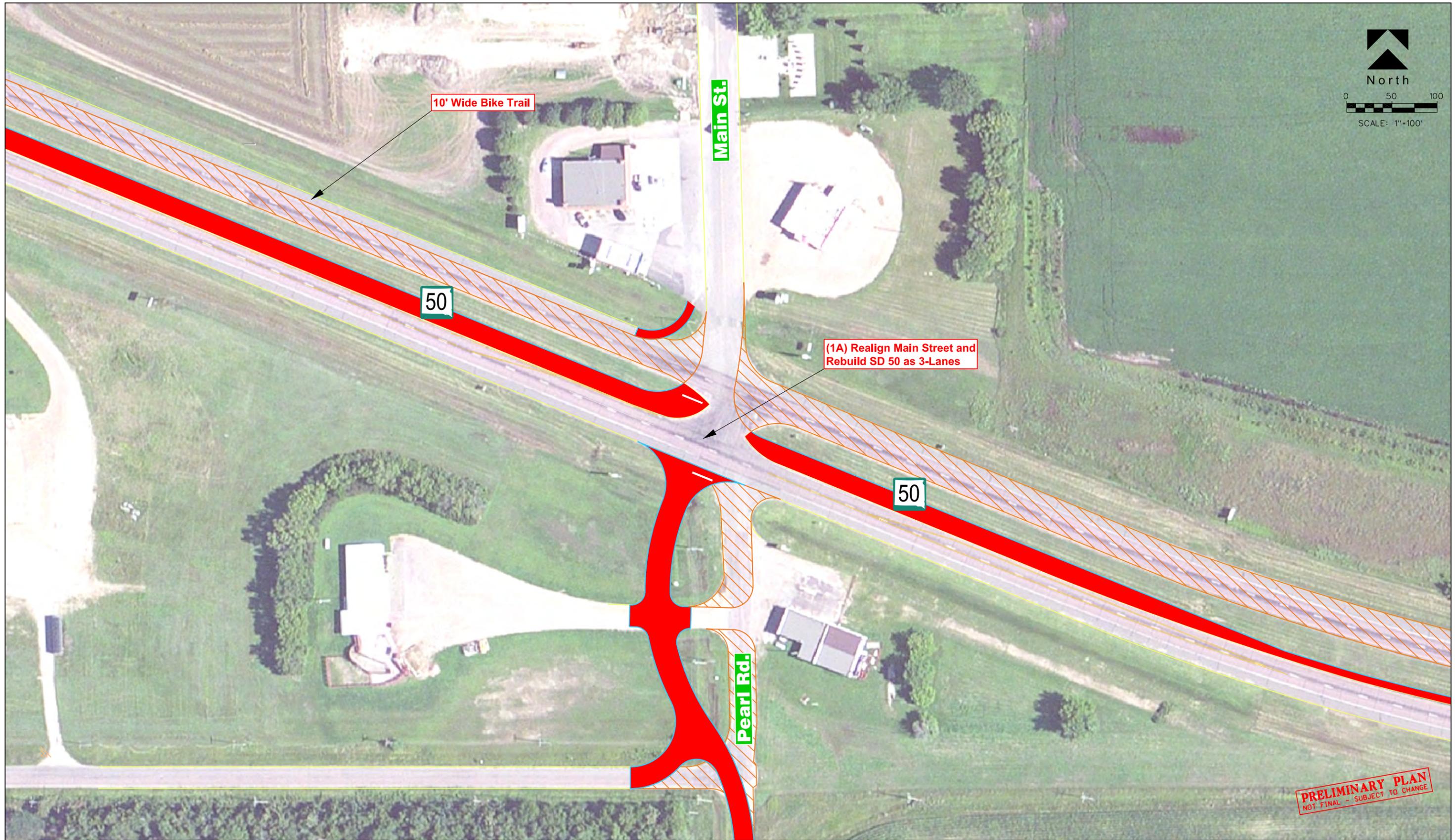


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 9.3
Intersection #9
Intersection Recommendations
SD 50 / Main Street

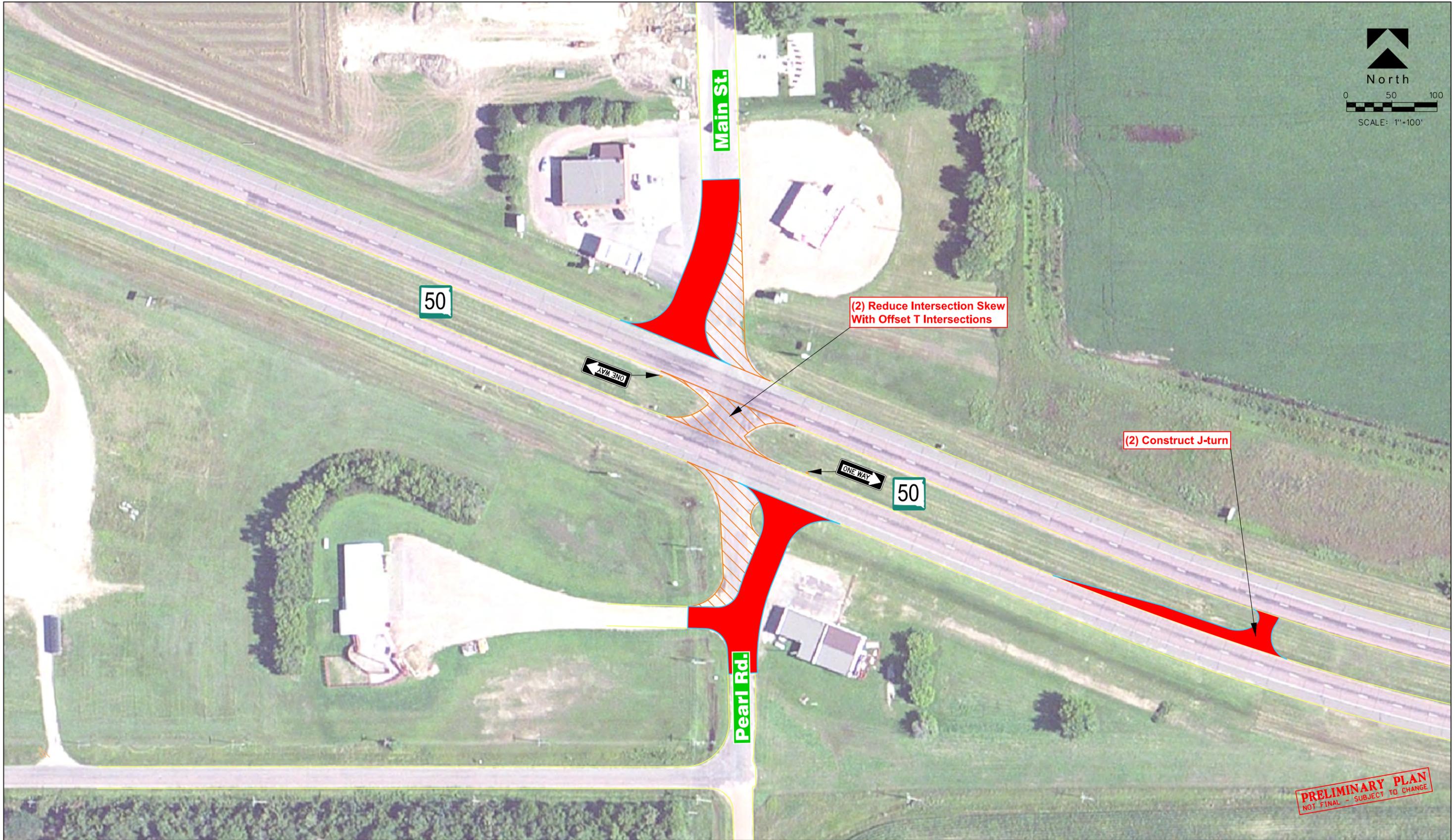


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1A

Figure 9.4
Intersection #9
Intersection Recommendations
SD 50 / Main Street



LEGEND

-  Remove Existing Pavement
-  New Pavement

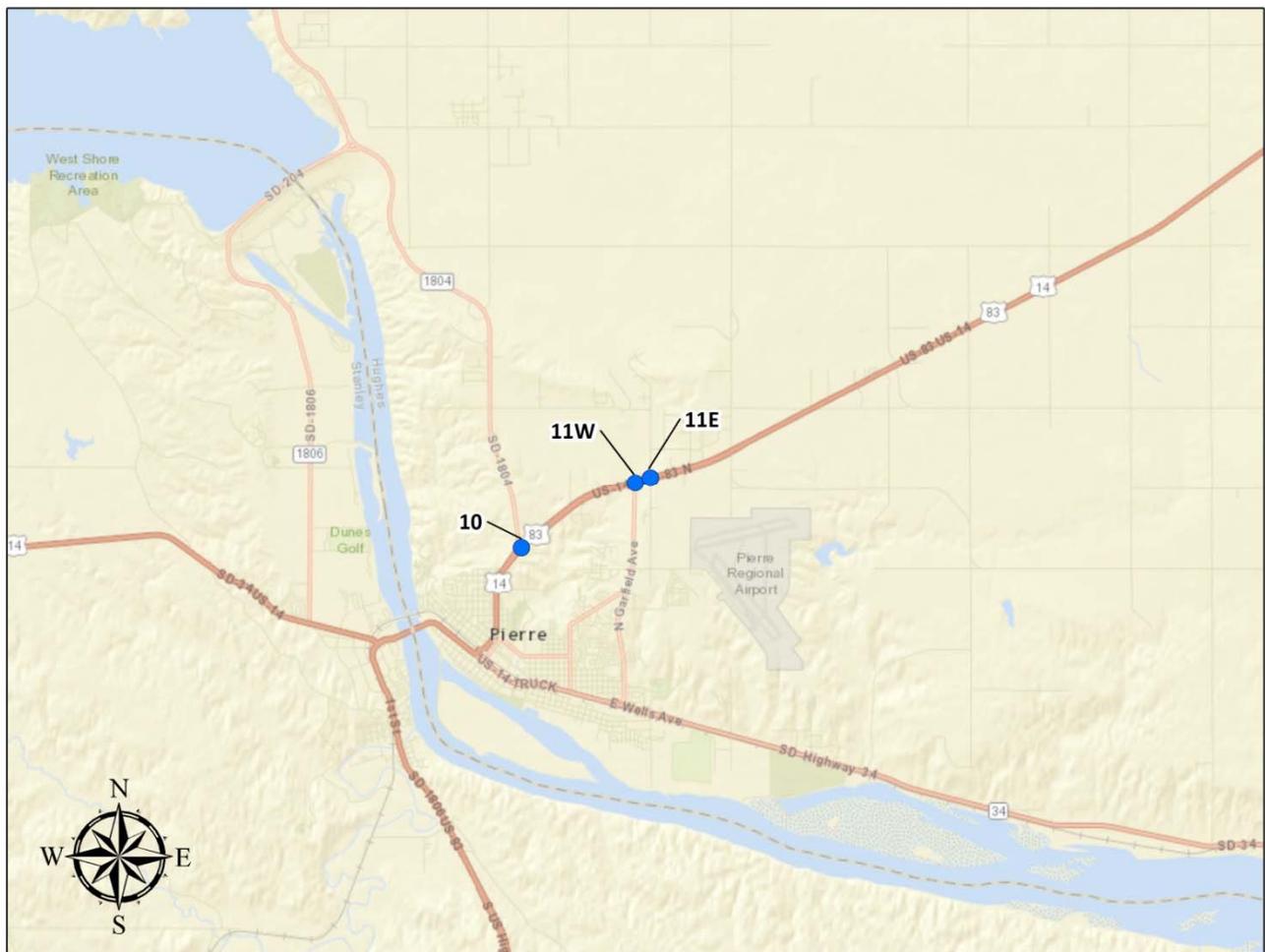
CONCEPTUAL DESIGN - OPTION 2

Figure 9.5
Intersection #9
Intersection Recommendations
SD 50 / Main Street

PIERRE REGION

Intersections Include:

- 10. US 14/SD1804 Intersection
- 11W. US 14/US14B Intersection
- 11E. US 14/Airport Road Intersection



IV. PIERRE REGION

Three of the study intersections are located in the Pierre Region. These intersections include US 14/SD 1804, US 14/Airport Road, and US 14/US 14B.

10. US 14/SD 1804 Intersection

The intersection of US 14 with SD 1804 is in the north central portion of the city of Pierre, SD. The posted speed limits along eastbound US 14 and southbound SD 1804 are 35 MPH. The speed limit on westbound US 14 reduces from 45 MPH to 35 MPH approximately 200 feet east of the junction with SD 1804. At the intersection, US 14 is a 4-lane divided highway with a 40 foot wide median separating the travel lanes. Positively offset left-turn lanes are provided in both the eastbound and westbound directions of US 14 with approximately 325 feet of storage provided for each. Also provided is a westbound channelized right-turn with no deceleration lane provided. SD 1804 is a 2-lane undivided roadway with a southbound channelized right-turn provided; no deceleration lane exists. An acceleration lane is not provided on US 14. SD 1804 serves as a main route to the Oahe Dam and Oahe Downstream Recreation site.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observations

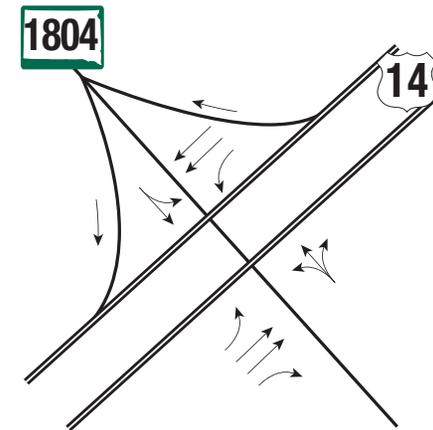
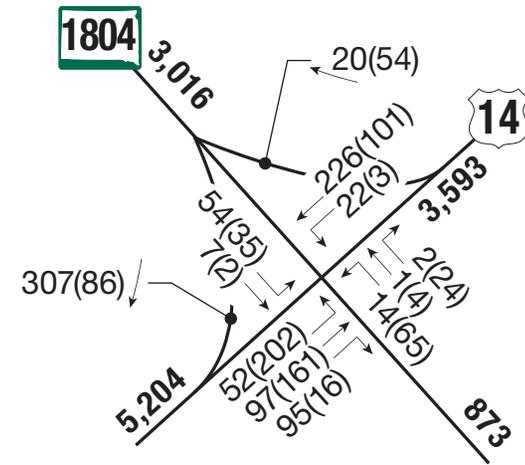
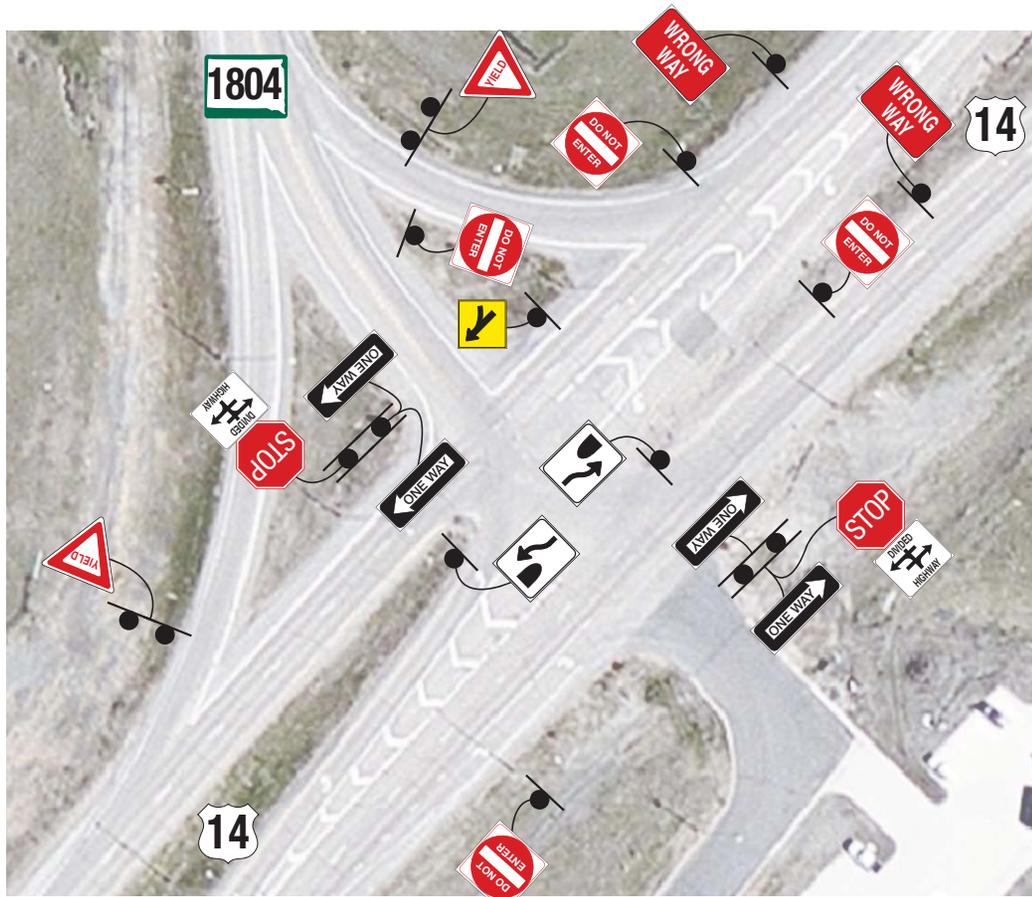
Below is a list of intersection observations made by FHU staff while conducting site visits:

- Government land uses are located to the south. SD 1804 leads to Oahe Dam
- There are no stop bars at intersection
- The intersection has street lighting
- Existing stop signs are 24" (south leg) and 36" (north leg) diameter
- EB and WB offset left-turn lanes are provided
- Safe stopping sight distance on the WB channelized right turn is restricted to approximately 30 MPH by a horizontal curve and uphill incline
- A "Ramp 25 MPH" warning sign and advisory plaque is present for the WB to NB right turn

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US 14/SD 1804 intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 4:45 PM to 5:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 10.1**. The intersection had 6,343 total entering vehicles per day, which ranks as having the 3rd highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The heaviest peak hour turning movements were the southbound to westbound right turn in the AM (307) and the complimentary eastbound to northbound left turn in the PM (202). The intersection has a truck percentage of 3%. Also shown on **Figure 10.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- | | | |
|--|---------------------|---------------------------|
| XXX(XXX) = AM(PM) Peak Hour Traffic Volumes | = Stop Sign | = Stop Ahead Sign |
| XXXX = Daily Traffic Volumes | = Yield Sign | = Intersection Ahead Sign |
| X/X = AM/PM Peak Hour Signalized Intersection Level of Service | = Do Not Enter Sign | = Lane Ends Sign |
| x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service | = Wrong Way Sign | = Divided Highway Sign |
| | = Traffic Signal | = Merge Sign |
| | | = Keep Right Sign |
| | | = Divided Highway Sign |

Figure 10.1
US 14/SD 1804 Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US 14/SD 1804 intersection are shown in **Tables 10.1** and **10.2** for the most recent five-year period (2008 - 2012).

Table 10.1 US 14/SD 1804 – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
0	0	0	1	0	0	2	3

A detailed review of the crash history at the intersection indicates two roadway departure crashes. 66.7% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; no other crash pattern was identified. The crash patterns at the US 14/SD 1804 intersection are further depicted in **Figure 10.2** by severity and type.

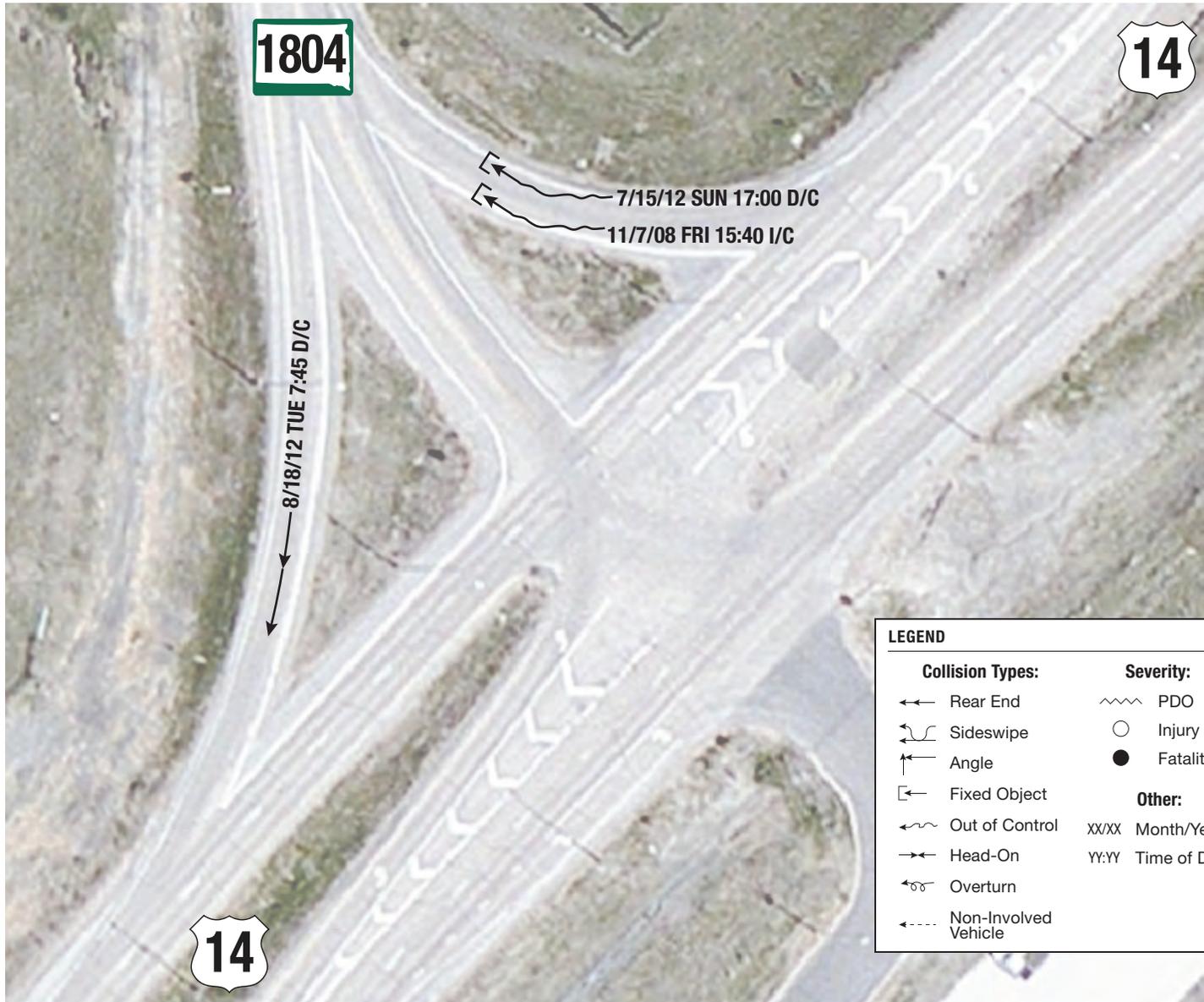
Table 10.2 US 14/SD 1804 – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total				
US14/US1804	0	0	0	0	3	3	6,343	11.58	0.26	0.26
Incapacitating (Incap.)			Property Damage Only (PDO)				* MEV= Million Entering Vehicles			

The crash rate per MEV for the intersection is 0.26. This intersection has the 3rd lowest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor (Appendix D) to the different crash severity type, is 0.26 which ranks is at the 3rd lowest as well. **Table 10.3** shows the identified crash patterns and possible contributing factors. Also, a set of countermeasures was developed based on the type of crashes, traffic volumes, and geometrics.

Table 10.3 US 14/SD 1804 – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Fixed Object	<ul style="list-style-type: none"> Drivers diverging at too high of a speed for geometrics 	<ul style="list-style-type: none"> Provide WB offset Rt. Turn lane Relocate St. Light Pole



NOTE: Drawing Not to Scale

LEGEND	
Collision Types:	Severity:
← Rear End	~ PDO
↔ Sideswipe	○ Injury
↗ Angle	● Fatality
☐ Fixed Object	Other:
←~ Out of Control	XX/XX Month/Year
→→ Head-On	YY:YY Time of Day
↻ Overturn	
←... Non-Involved Vehicle	
	Pavement:
	D - Dry
	W - Wet
	I - Icy
	S - Snowy
	Weather:
	C - Clear
	CL - Cloudy
	F - Fog
	R - Rain
	S - Snow

Figure 10.2
US 14/SD 1804 Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns and from on-site observations:

- (1) Mark and sign westbound offset right-turn lane with deceleration lane by reducing to one through lane 1,500 east of intersection
- (2) Mark and sign an acceleration lane for southbound to westbound right turn
- (3) Relocate light pole on inside of turn lane radius on northeast corner
- (4) Install stop bars
- (5) Lengthen westbound offset turn lane to accommodate deceleration and storage for left turns
- (6) Install curb and gutter section, raised median, and tighten southbound to westbound radius

F. Economic Appraisal of Countermeasures

Figure 10.3 displays countermeasures (1), (2), (3), (4), and (5). Figure 10.4 depicts potential roadway improvements (5) and (6) to the intersection.

Table 10.4 displays the economic analysis of the potential improvements, including the planning level cost estimate in 2014 dollars, the benefits, and the benefit cost ratio. A more detailed cost estimate for each improvement is provided in the Appendix.

Table 10.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefit**	Benefit/Cost Ratio
(1) Mark and Sign WB Offset Right-Turn Lane	\$7,500	\$261,334	34.84
(2) Mark and Sign SB to WB Acceleration Lane	\$9,000	\$261,334	29.04
(3) Relocate Street Light Pole	\$12,000	\$522,668	43.56
(4) Install Stop Bars	\$1,500	\$168,708	112.47
(5) Lengthen WB Offset Lt. Lane	\$115,000	\$104,534	0.91
(6) Install Curb and Gutter Section, Raised Median, and Tighten Southbound to Westbound Radius	\$742,000	\$337,417	0.45

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.

G. Recommendation for Preferred Alternative

1 – It is recommended that an offset right-turn lane be signed and marked for westbound traffic by tapering the two westbound lanes down to one lane beginning approximately 1,500 feet east of the intersection. (1) This assumes average service life of 10 years for signs and markings

2 – It is recommended that a right-turn acceleration lane be signed and marked for the southbound to westbound movement. (2)

3 – It is recommended that Stop Bars be provided for the north-south through and left-turn movements. (4)

4 – It is recommended that westbound left-turn lane be lengthened with any future resurfacing of US 14 based on traffic counts and vehicle tracking in the median. (5)



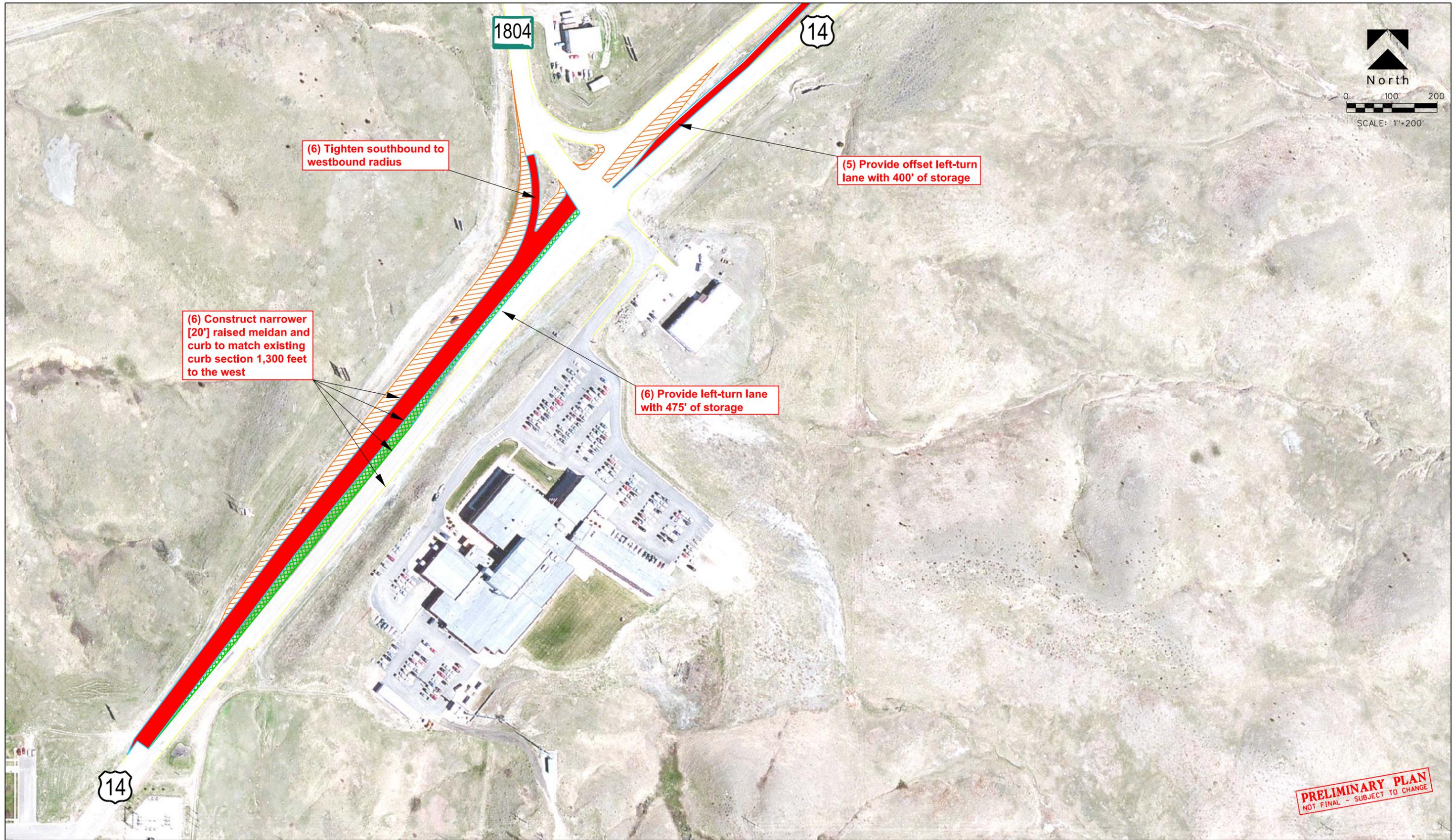


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 10.3
Intersection #10
Intersection Recommendations
US14 / SD1804



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 10.4
Intersection #10
Intersection Recommendations
US14 / SD1804

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11W. US 14/US 14B Intersection

The intersection of US 14 with US 14B is in the northeast part of the City of Pierre, SD. The posted speed limit along US 14 is 65 MPH and along US 14B the posted speed limit is 55 MPH. At the intersection, US 14 is a 4-lane divided highway with a 50 foot median separating the travel lanes. An exclusive westbound left-turn lane is provided with approximately 350 feet of storage. An exclusive eastbound to southbound channelized right-turn is also provided. US 14B is a 2-lane undivided roadway with a northbound to eastbound channelized right-turn provided. Trucks are not allowed on US 14 west of US 14B and must use the designated truck route of US 14B to access the City of Pierre.

A. Data Collection

Traffic data were collected at the intersection in April, 2014. A site visit was conducted in May, 2014 to collect field measurements and conduct on-site observations at the intersection. A photo log was developed and is included in the **Appendix**.

B. Intersection Observations

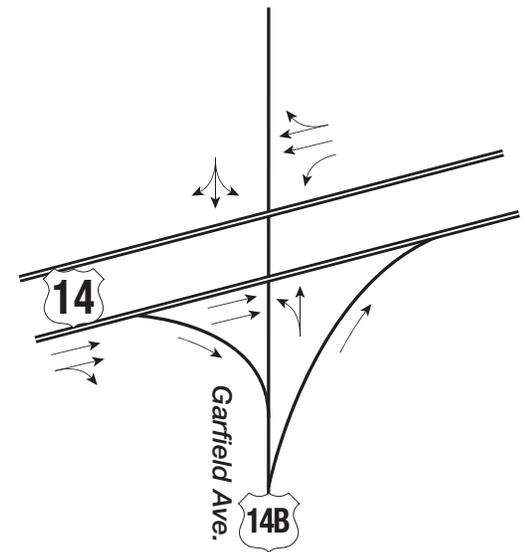
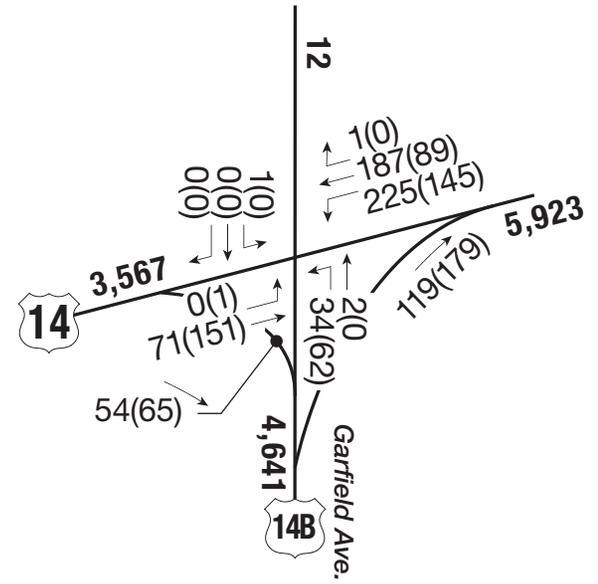
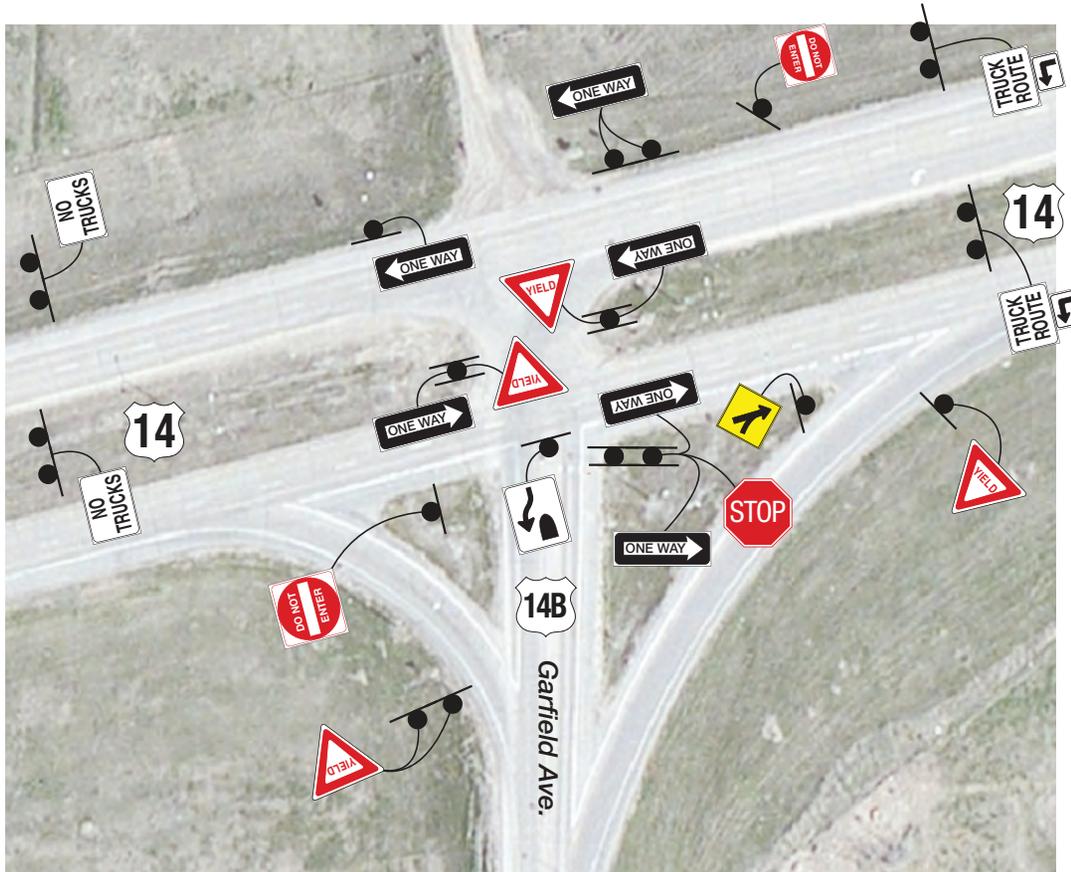
Below is a list of intersection observations made by FHU staff while conducting site visits:

- Street lighting is present at intersection
- Intersection is on slight skew (15°)
- The north leg is a gravel drive to a single home
- A westbound left-turn lane is present on US 14
- There is a heavy WB to SB truck movement (signed truck route)
- Fatal "Think" sign is present on NE corner
- 24" x 72" one-way sign on north side of intersection facing south
- There is a large 48" stop sign on NB US 14B approach
- There is a stop ahead sign for northbound US 14B
- There is a striped median on NB approach without a stop bar
- There are EB and NB channelized right-turn
- Two-stage turning conflicts were observed
- No sight distance issues were noted

C. Traffic Volumes

Peak period turning movement counts were conducted by the SDDOT for both the AM and PM peak periods at the US 14/US 14B intersection on Wednesday, September 4, 2013. The morning peak hour was determined to be 7:00 AM to 8:00 AM, and the PM peak hour was 4:45 PM to 5:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 11W.1**. The intersection had 7,052 total entering vehicles per day, which ranks it as having the highest traffic volume of all studied intersections. The heaviest turning movements were the westbound to southbound left turn in the AM (225) and the complimentary northbound to eastbound right-turn in the PM (179). The turning movement count data is included in the **Appendix**.

The intersection has an overall truck percentage of 15%. The westbound left turn movement and the northbound right turn have 12% and 19% truck turning percentages respectively. Also shown on **Figure 11W.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
 XXXX = Daily Traffic Volumes
 X/X = AM/PM Peak Hour Signalized Intersection Level of Service
 x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

- | | |
|---------------------|---------------------------|
| = Stop Sign | = Stop Ahead Sign |
| = Yield Sign | = Intersection Ahead Sign |
| = Do Not Enter Sign | = Lane Ends Sign |
| = Wrong Way Sign | = Divided Highway Sign |
| = Traffic Signal | = Merge Sign |
| | = Keep Right Sign |

Figure 11W.1
 US 14/US 14B Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US 14/US 14B intersection are shown in **Tables 11W.1** and **11W.2** for the most recent five-year period (2008 - 2012).

Table 11W.1 US 14/US 14B – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
2	0	0	2	0	6	1	11

A detailed review of the crash history at the intersection indicates a pattern of left turn off mainline crashes. Left turn off mainline crashes represent 54.5% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver's Age, Driver's Condition, and Vehicle Type; No other crash pattern was indentified. The crash patterns at the US 14/US 14B intersection are further depicted in **Figure 11W.2** by severity and type.

Table 11W.2 US 14/US 14B – Crash Rates (2008 - 2012)

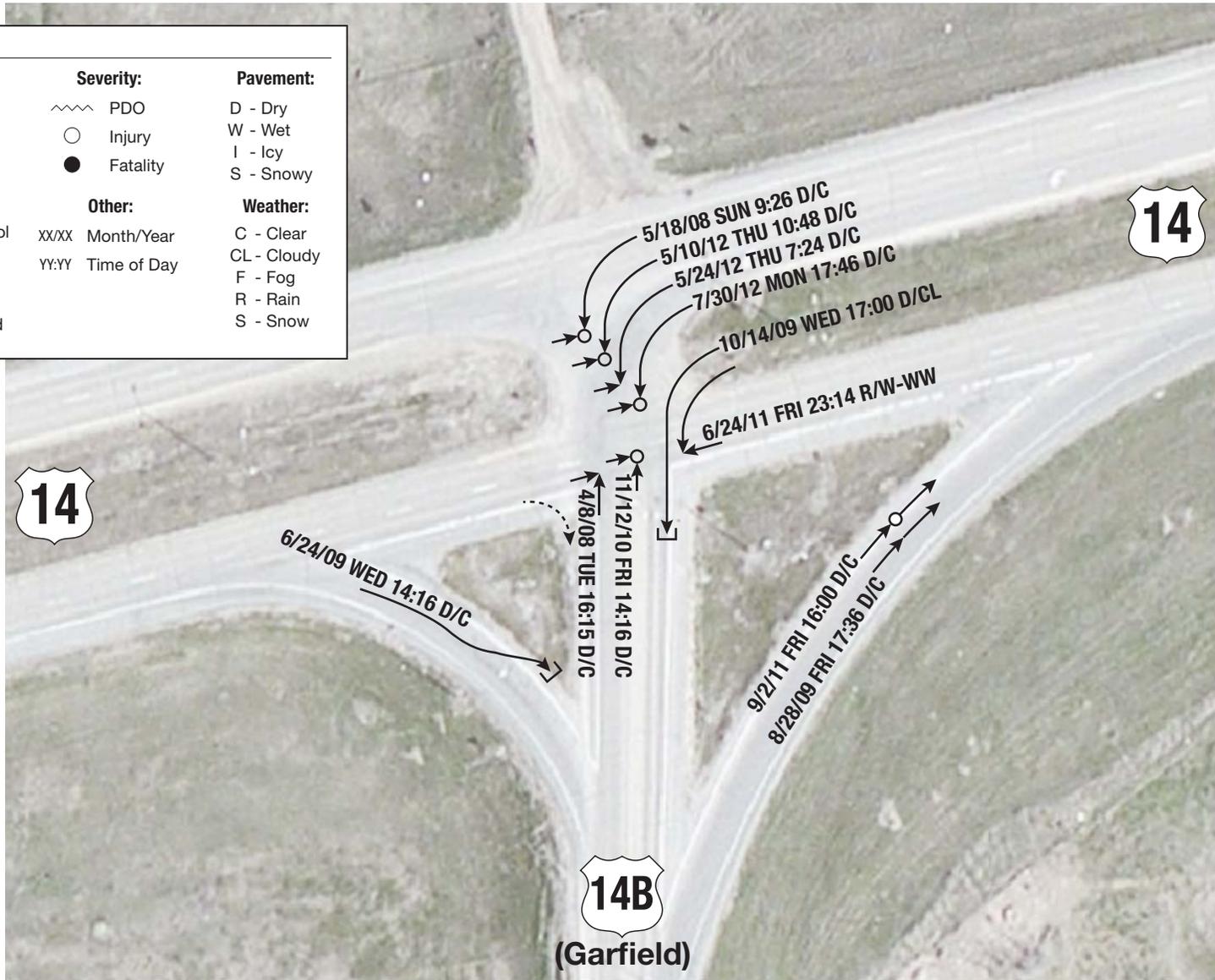
Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*	
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total					
US14/US14B	0	1	2	2	6	11	7,092	12.94	0.85	5.31	
Incapacitating (Incap.)		Property Damage Only (PDO)					* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 0.85. This intersection has the 6th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 5.31 which ranks it as the 7th highest. **Table 11W.3** shows the identified crash patterns and possible contributing factors. Also, a set of countermeasures was developed based on the type of crash.

Table 11W.3 US 14/US 14B – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Lt. Turn off Major Road	<ul style="list-style-type: none"> Left turning Vehicle Assuming EB vehicle is turning right Lt. Driver Misjudging Speed Of EB Vehicle 	<ul style="list-style-type: none"> Offset Left Turn Lane Traffic Signal Realign Roadways
Rt. Angle-Near Side	<ul style="list-style-type: none"> Driver's View Obstructed By Right Turning Vehicle 	<ul style="list-style-type: none"> Offset Right Turn Lanes
Rear-End Merge	<ul style="list-style-type: none"> Driver Looking Over Left Shoulder Running Into back of Slower Vehicle 	<ul style="list-style-type: none"> Install Acceleration Lane Eliminate Right Turn Channelization's
All Patterns	<ul style="list-style-type: none"> Vehicles Driving Too Fast And Misjudging Actions And Speeds Of Other Vehicles 	<ul style="list-style-type: none"> Install Roundabout

LEGEND		
Collision Types:	Severity:	Pavement:
← Rear End	〰 PDO	D - Dry
↔ Sideswipe	○ Injury	W - Wet
↗ Angle	● Fatality	I - Icy
↖ Fixed Object	Other:	S - Snowy
↘ Out of Control	XXXX Month/Year	C - Clear
↔ Head-On	YY:YY Time of Day	CL - Cloudy
↻ Overturn		F - Fog
← Non-Involved Vehicle		R - Rain
		S - Snow



NOTE: Drawing Not to Scale

Figure 11W.2
US 14/US 14B Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns and from on-site observations:

- (1W) Potential roundabout candidate location
- (2W) Install positive offset left-turn lanes on eastbound and westbound US 14 at intersection
- (3W) Construct offset right-turn lane on eastbound US 14 at intersection
- (4W) Construct an acceleration lane for northbound to eastbound channelized right-turn lane
- (5W) Install offset right turn lane on eastbound US 14 with signs and markings
- (6W) Install acceleration lane for northbound to eastbound channelized right turn lane with signs and markings
- (7W) Connect US 14 and US 14B with horizontal curve (MUTCD Signal Warrant are not satisfied at the US14 with US 14B intersection under this configuration). Signal warrants for the intersection can be found in the **Appendix**.
- (8W) Realign US 14B to Airport Road south of US 14

F. Economic Appraisal of Countermeasures

Figure 11.3 shows potential countermeasure (1W). **Figure 11.4** and **Figure 11.6** show countermeasures (2W), (3W), and (4W) for the intersection. **Figure 11.5** display potential countermeasures (2W), (5W), and (6W). **Figure 11.7** shows countermeasure (7W) and **Figure 11.8** shows countermeasure (8W).

Table 11W.4 displays the economic analysis of the potential improvements, including the planning level cost estimate in 2014 dollars, the benefits, and the benefit cost ratio. A more detailed cost estimate for each improvement is provided in the **Appendix**.

Table 11W.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefit**	Benefit/Cost Ratio
(1W) Roundabout	\$1,476,000	\$1,265,313	0.86
(2W) Construct Positive Offset Left-Turn Lane	\$120,000	\$253,063	2.11
(3W) Construct Offset Right-Turn Lane	\$525,000	\$253,063	0.48
(4W) Construct Acceleration Lane	\$950,000	\$253,063	0.27
(5W) Install Offset Right-Turn Lane With Signs and Markings	\$9,000	\$156,801	17.42
(6W) Install Acceleration Lane With Signs and Markings	\$9,000	\$156,801	17.42
(7W) Connect US 14 and US 14B	\$3,230,000	\$253,063	0.08
(8W) Realign US 14B to Airport Road	\$2,260,000	\$927,896	0.41

**** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.**

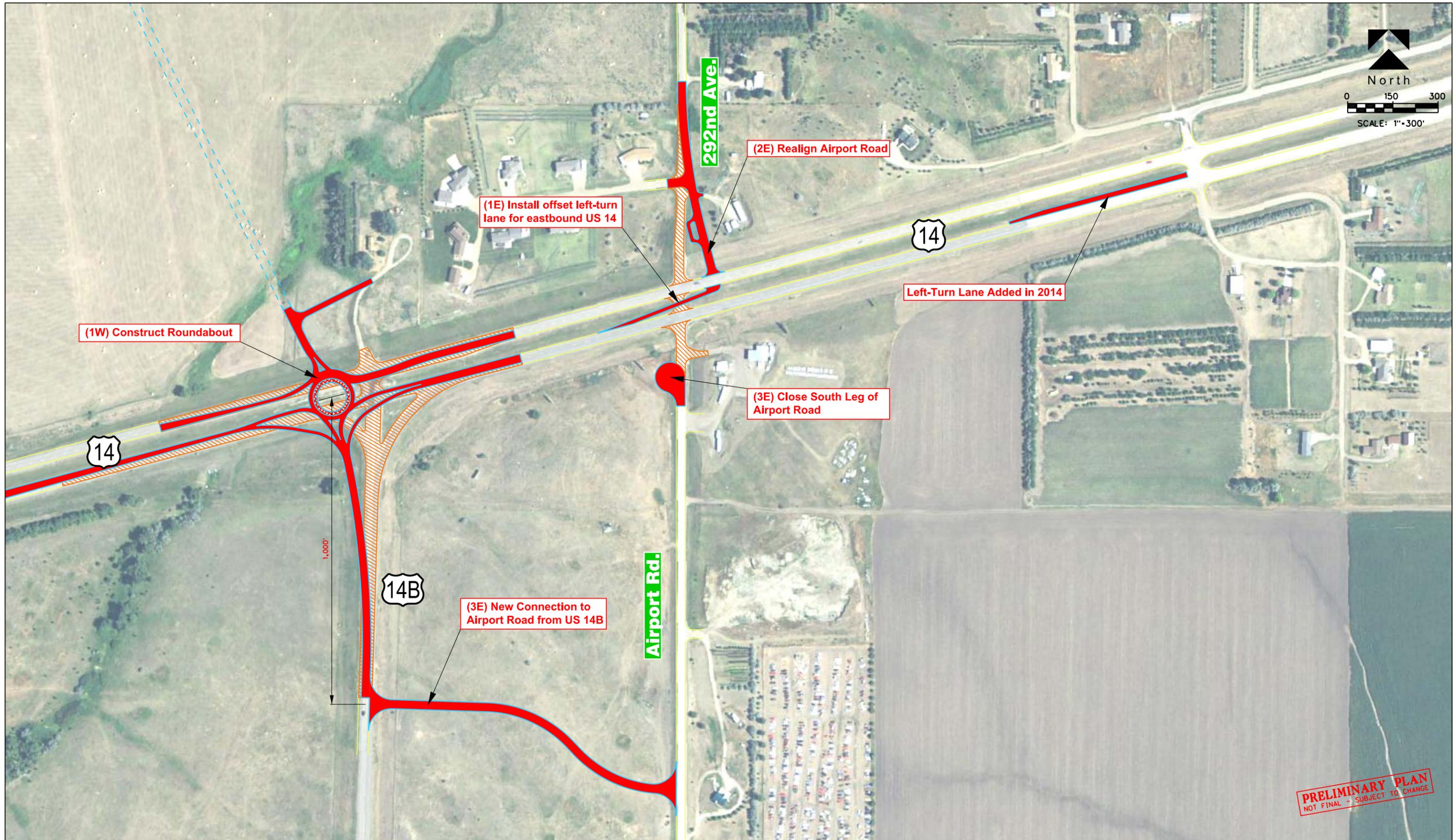
Signal Warrants were also reviewed for existing conditions and improvements 7(W) and 8(W). This analysis (Appendix D) showed a traffic signal would be warranted by the year 2031 for configuration 7(W) and by the year 2018 for configuration 8(W).

G. Preliminary Recommendation for Preferred Alternative

- 1 – It is recommended that offset left-turn lanes be constructed on US 14 at US 14B (2W)
- 2 – It is recommended that an offset right-turn lane be signed and marked for eastbound US 14 by tapering the eastbound lanes down to one lane beginning approximately 1,000 feet west of US 14B. (5W)
- 3 – It is recommended that an acceleration lane be provided for the northbound to eastbound right-turn lane utilizing the south lane of US 14 with signs and markings. (6W)
- 4 – As traffic volumes increase it is recommended that the intersection of US 14 and US 14B be evaluated annually for traffic signal warrants contained in the MUTCD.
- 5 – The intersection should be analyzed for a roundabout at such time as one or more signal warrants are met.

Potential improvements at the intersections of US14 at US 14B and US 14 at Airport Road/ 292nd Avenue (Kingsway Road) must be evaluated in combination with each other since the improvements at one significantly impact each other.

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LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 11.3
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road

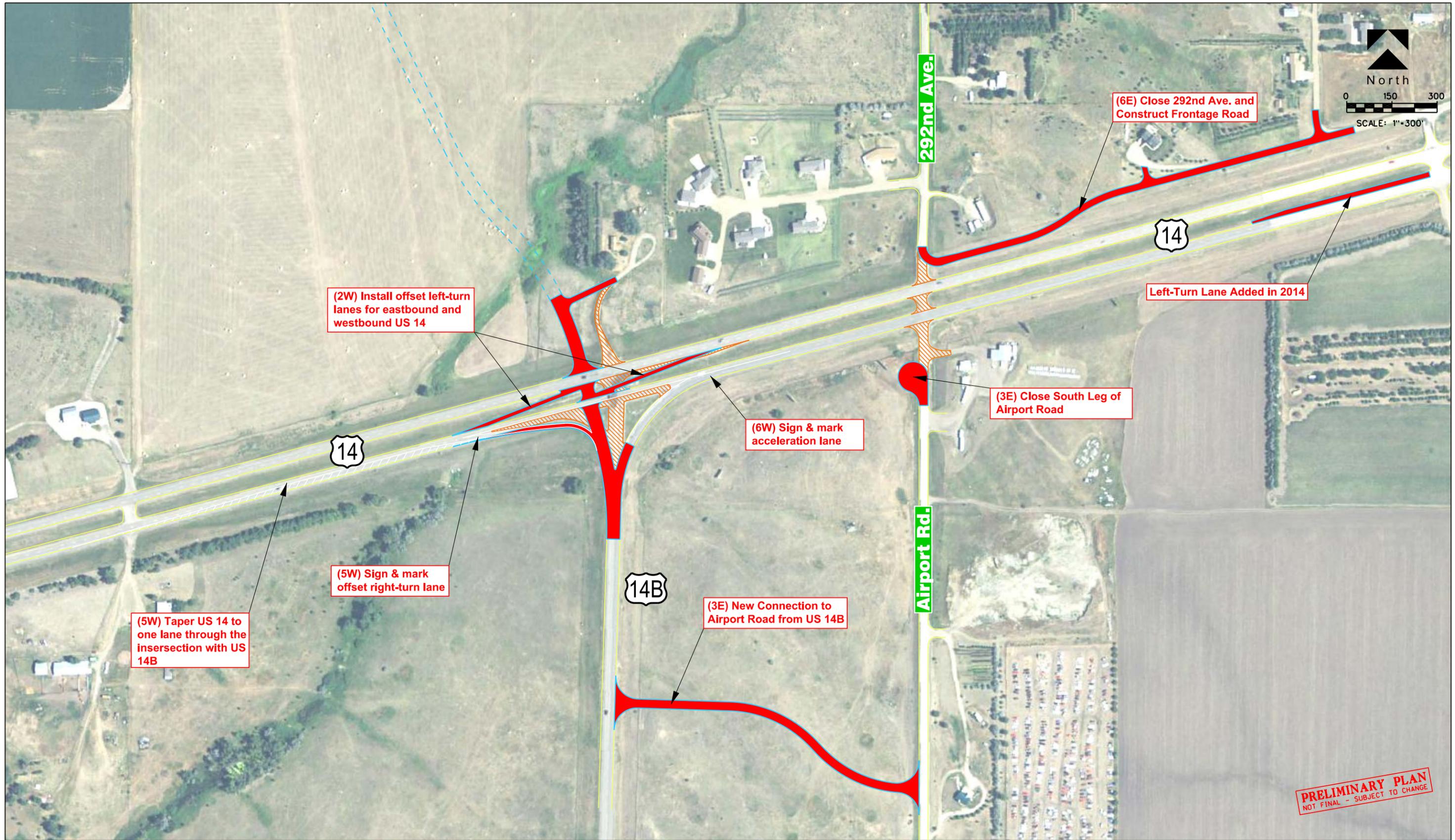


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 11.4
 Intersection #11W & #11E
 Intersection Recommendations
 US14 / US14B / Airport Road



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 3

Figure 11.5
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road



PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 4

Figure 11.6
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road



PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 5

Figure 11.7
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 6

Figure 11.8
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road

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11E. US 14/Airport Road/292nd Avenue (Kingsway Road) Intersection

The intersection of US 14 with Airport Road and 292nd Avenue (Kingsway Road) is in the northeast part of the City of Pierre, SD. The posted speed limit along US 14 is 65 MPH and along Airport Road the posted speed limit is 35 MPH to the south of US 14 and 30 MPH on 292nd Avenue (Kingsway Road) north of US 14. At the intersection, US 14 is a 4-lane divided highway with a 50 foot median separating the travel lanes. Airport Road is a 2-lane unpaved roadway. South of US 14 and 292nd Avenue (Kingsway Road) is a two lane rural cross section north of US 14. Pierre regional airport is located just to the southeast of the intersection.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photolog was developed and is included in the **Appendix**.

B. Intersection Observations

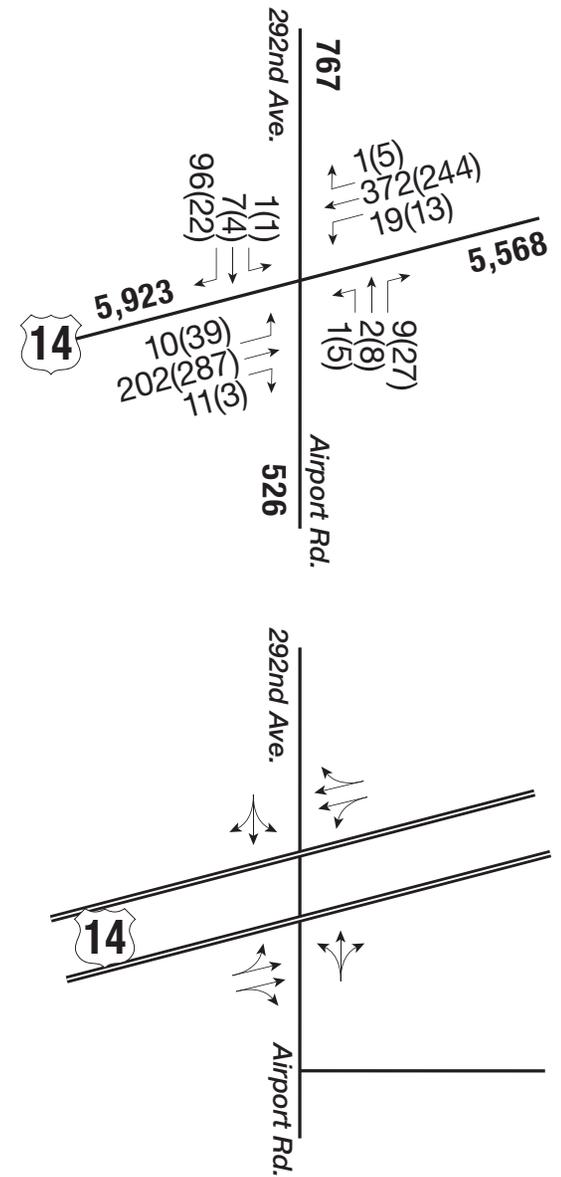
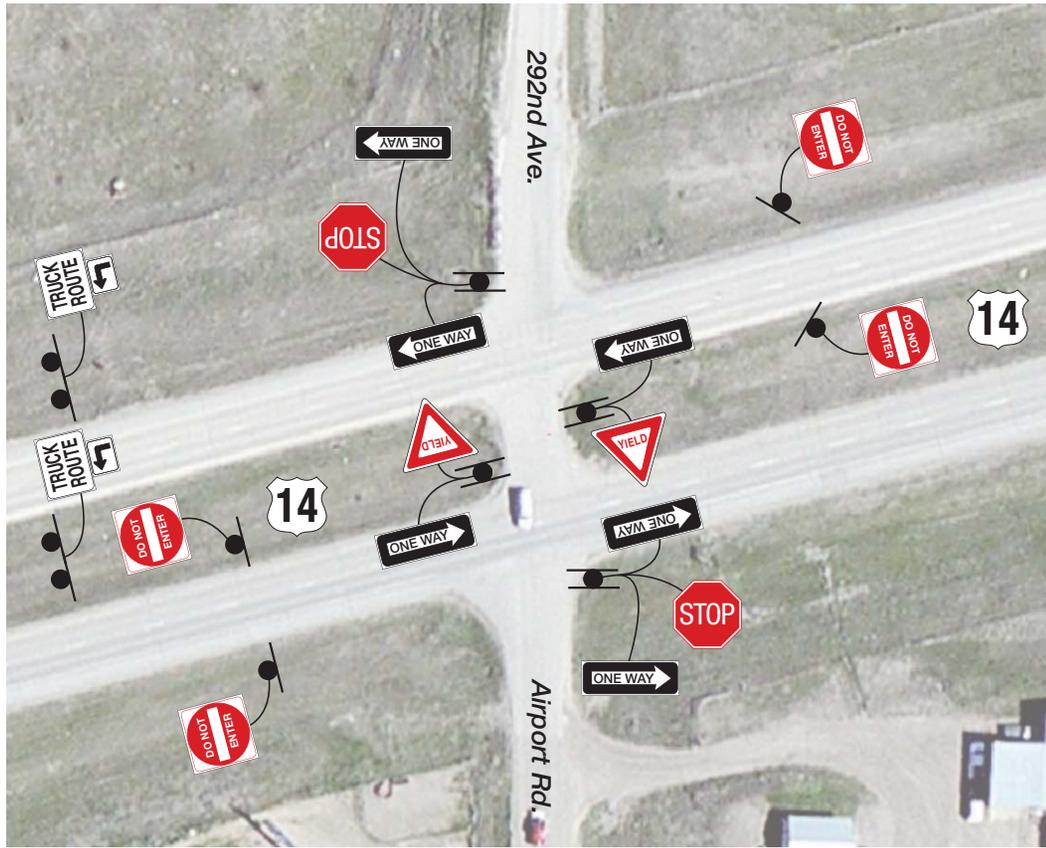
Below is a list of intersection observations made by FHU staff while conducting site visits:

- No street lighting is present at intersection
- Intersection is on a skew (15°)
- North leg is gravel drive to housing development. South leg is a gravel road to airport
- No turn lanes are provided
- Steep grade on Airport Road. Downhill from south to north
- No trucks are allowed on Airport Road. (posted)
- No stop bars are present
- There are 24" stop sign on NB and SB Airport Road approach. No stop ahead signs are present
- Mail boxes along west side of north leg (see in photo) (Appendix) are very close to intersection. Southbound vehicles have to go around mail delivery vehicle and residents stopped to pick up mail
- Two-stage turning conflicts were observed
- Median refuge island is depressed from the EB and WB travel lanes of US 14
- An eastbound left turn lane was added to the Windsor access on US 14. Place 1800 feet east of 292nd Avenue in 2014.

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US 14/Airport Road intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:15 AM to 8:15 AM, and the PM peak hour was 5:00 PM to 6:00 PM. Existing ADT's and turning movement counts are summarized on **Figure 11E.1**. The intersection had 6,392 total entering vehicles per day, which ranks it as having the 2nd highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection has a truck percentage of 10%. The north-south through movements are extremely low, totaling nine vehicles in the AM peak and twelve in the PM peak. Also shown on **Figure 11E.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

- xxx(xxx) = AM(PM) Peak Hour Traffic Volumes
- XXXX = Daily Traffic Volumes
- X/X = AM/PM Peak Hour Signalized Intersection Level of Service
- x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service
-  = Stop Sign
-  = Yield Sign
-  = Do Not Enter Sign
-  = Wrong Way Sign
-  = Stop Ahead Sign
-  = Traffic Signal

Figure 11E.1
US 14/Airport Road Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US 14/Airport Road intersection are shown in **Tables 11E.1 and 11E.2** for the most recent five-year period (2008 - 2012).

Table 11E.1 US 14/Airport Road – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
1	6	0	0	0	1	0	8

A detailed review of the crash history at the intersection indicates a pattern of right angle far side crashes. Although through vehicles on Airport Road were only 1.5% of the entering traffic, right angle far sided crashes involving these movements represent 87.5% of the total crashes during this five-year period. The crashes were also reviewed for patterns by Time of Day, Day of Week, Weather Conditions, Road Surface Conditions, Driver’s Age, Driver’s Condition, and Vehicle Type; however no other crash pattern was identified. The crash patterns at the US 14/Airport Road intersection are further depicted in **Figure 11E.2** by severity and type.

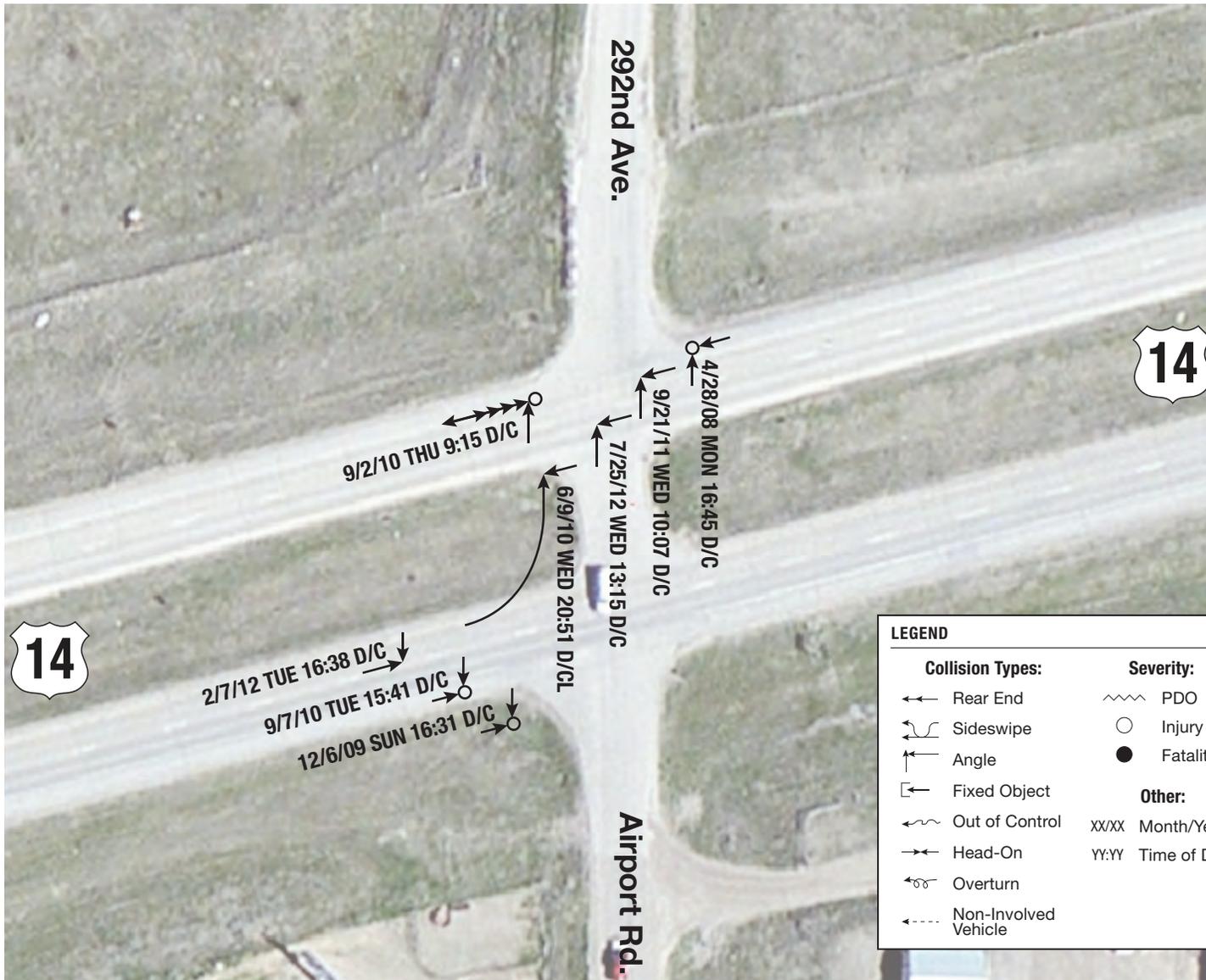
Table 11E.2 US 14/Airport Road – Crash Rates (2008 - 2012)

Intersection	Crashes By Severity						Total Entering Vehicles	5-Year (MEV)*	Crash Rate Per MEV*	Severity Rate Per MEV*	
	1-Fatal	2-Incap.	3-Non-Incap.	4-Possible	5-PDO	Total					
US 14/Airport	0	2	1	1	4	8	6,392	11.67	0.69	6.78	
Incapacitating (Incap.)		Property Damage Only (PDO)					* MEV= Million Entering Vehicles				

The crash rate per MEV for the intersection is 0.69. This intersection has the 7th highest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is 6.78 which ranks it at the 4th highest. **Table 11E.3** shows the identified crash patterns and possible contributing factors. Also, a set of identical countermeasures was developed based on the type of crash.

Table 11E.3 US 14/Airport Road – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
Rt. Angle – Far Side	<ul style="list-style-type: none"> Misjudging Speeds of Major Rd Vehicle Skew of Intersection 	<ul style="list-style-type: none"> Offset Lt. Turn Lanes Realign Intersection to Reduce Skew Close South Leg Close Median Break



NOTE: Drawing Not to Scale

Figure 11E.2
US 14/Airport Road Crash Diagram

E. Potential Countermeasures

Below is a list of possible countermeasures based on the identified crash patterns and on-site observations:

- (1E) Construct offset left-turn lane on eastbound US 14 at intersection
- (2E) Realign Airport Road to reduce the skew and separate from mailboxes
- (3E) Close south leg of Airport Road
- (4E) Close median opening and convert north-south movements to right-in, right-out only
- (5E) Construct connection from US 14B to 292nd Avenue (Kingsway Road) north of US 14
- (6E) Close 292nd Avenue and construct frontage road

F. Economic Appraisal of Countermeasures

Figure 11.3 shows potential improvements (1E), (2E), and (3E) for the intersection. **Figure 11.4** shows improvements (4E) and (5E). **Figure 11.5** and **Figure 11.6** both show potential countermeasure (6E).

Table 11E.4 displays the economic analysis of the potential improvement, including the planning level cost estimate in 2014 dollars, the benefits, and the benefit cost ratio. A more detailed cost estimate for each improvement is provided in the **Appendix**.

Table 11E.4 Economic Appraisal of Countermeasures

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1E) Install Offset Lt. Lanes	\$57,000	\$674,834	11.84
(2E) Realign Intersection To Reduce Skew	\$300,000	\$168,708	0.56
(3E) Close South Leg	\$1,120,000	\$1,180,959	1.05
(4E) Close Median. RIRO Only	\$120,000	\$2,361,918	19.68
(5E) Connect US 14B To 292 nd Avenue	\$1,300,000	\$927,896	0.71
(6E) Close 292 nd Avenue and Construct Frontage Road	\$630,000	\$1,096,605	1.74

** Present worth of future series of safety benefits based on service life and expected change in crash frequency using the predictive methodology of the HSM.

G. Preliminary Recommendation for Preferred Alternative

1 – It is recommended that the median break at Airport Road and 292nd Avenue be closed and north-south movements limited to right-in, right-out. (4E)

2 – It is recommended that SDDOT work with the City of Pierre to identify an appropriate street alignment extending north from US 14 at US 14B. The street should include a connection to 292nd Avenue. (5E)

H. User Benefit/Cost Combined Analysis

The evaluation of all alternatives combining the two intersections would be more comprehensive if other road user costs/benefits accounting for the drivers travel patterns were included in the analysis.

Table 11E.5, shown in this report, is a summary of a more detailed user benefit/cost analysis including the delay savings and fuel savings costs due to added travel and speed change cycles for major movements at the two intersections.

Table 11E.5 Benefit Cost Analysis – US 14 with US 14B/Airport Road

Improvement	Cost Estimate	User Benefits			Benefit/Cost Ratio
		Crash	Fuel Savings	Travel/Delay	
Option 1	\$4.7M	\$5.981M	\$1,723	\$370,000	1.35
Option 2	\$6.4M	\$3,121,107	\$698,651	(\$752,143)	0.48
Option 5	\$6.8M	\$0.460M	\$1,813,863	\$556,000	0.42
Option 6	\$8.1M	\$1.687M	\$1,220,395	(\$502,875)	0.30

I. Recommendations based on more Comprehensive Analysis

It is recommended that Option 2 be pursued which would include:

- A – Closing the median break at Airport Road and 292nd Avenue (Kingsway Road)
- B – Identify and construct the extension of an arterial roadway north of US 14, connecting US 14B to 292nd Avenue (Kingsway Road)
- C – Constructing positive offset left-turn lanes on US 14 at US 14B
- D – Signing and marking offset right-turn deceleration and acceleration lanes provided for eastbound US 14
- E – Traffic signal warrants should be evaluated at the intersection of US 14 and US 14B at such time as traffic volumes increase.
- F – Longer range, the intersection should be further analyzed for a roundabout versus traffic signal at such time as one or more signal warrants are met. It is noted that the roundabout under Option 1 performed better under travel and delay.

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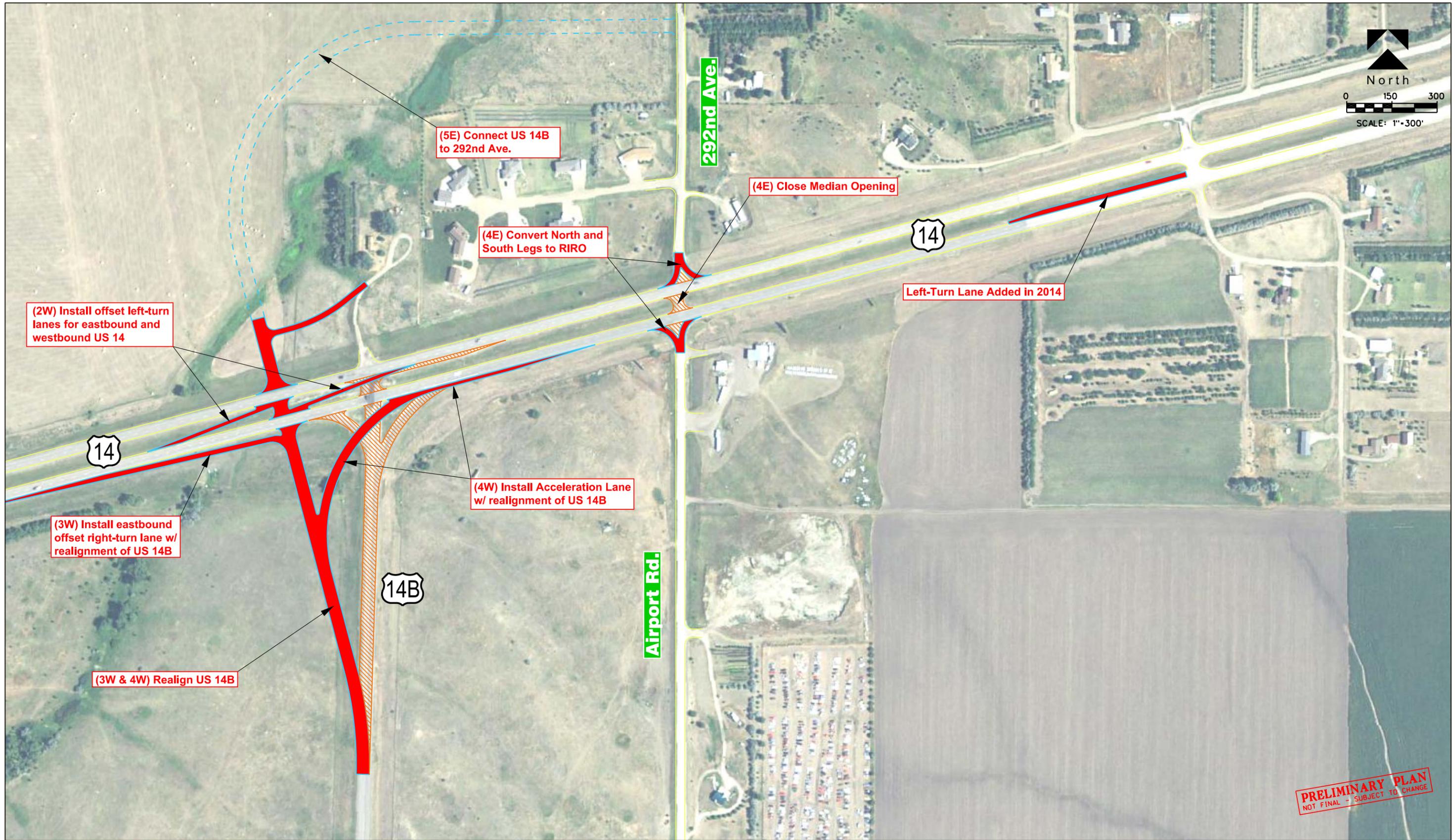


LEGEND

- Remove Existing Pavement
- New Pavement

CONCEPTUAL DESIGN - OPTION 1

Figure 11.3
 Intersection #11W & #11E
 Intersection Recommendations
 US14 / US14B / Airport Road



PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE

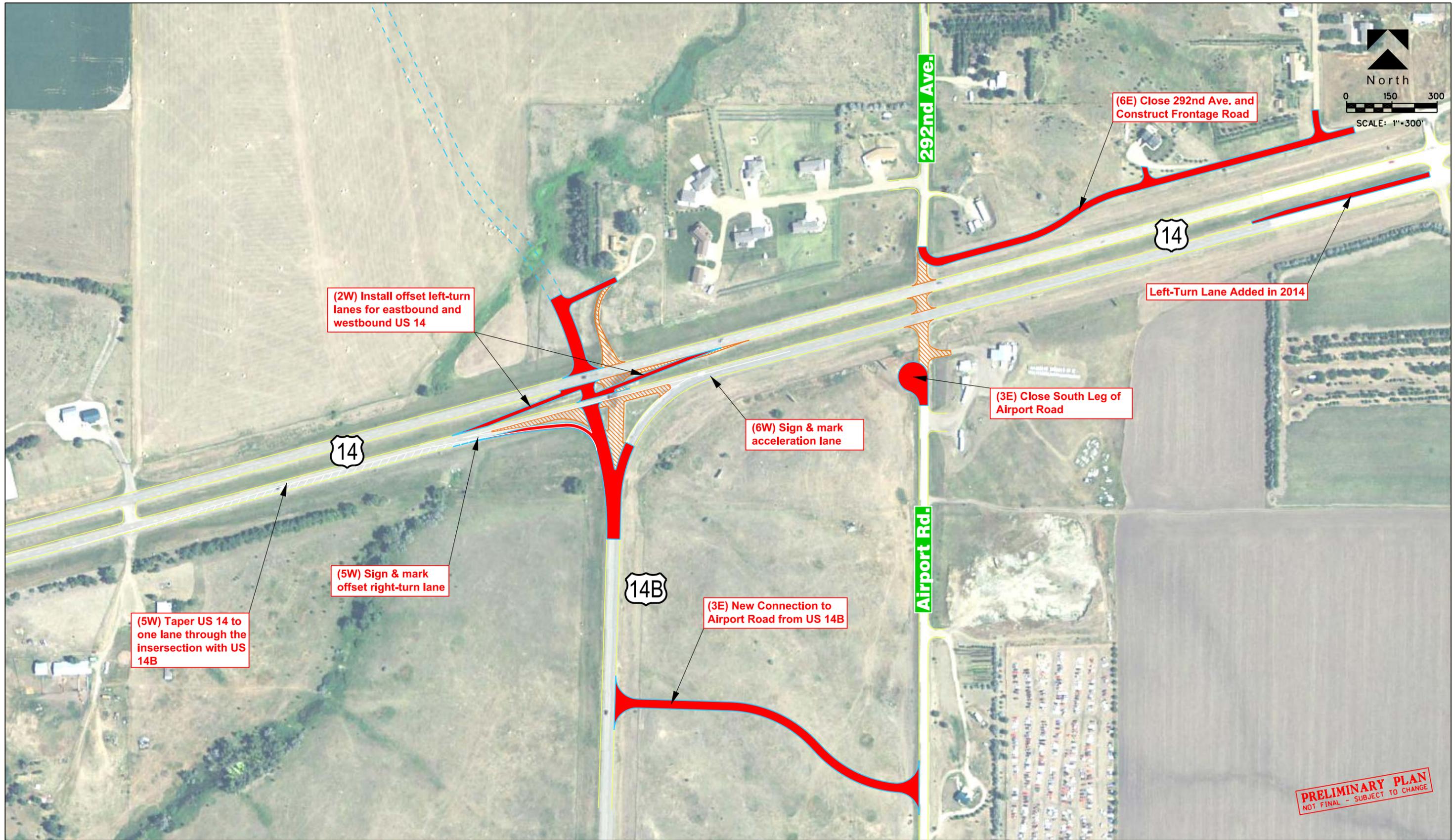


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 2

Figure 11.4
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road

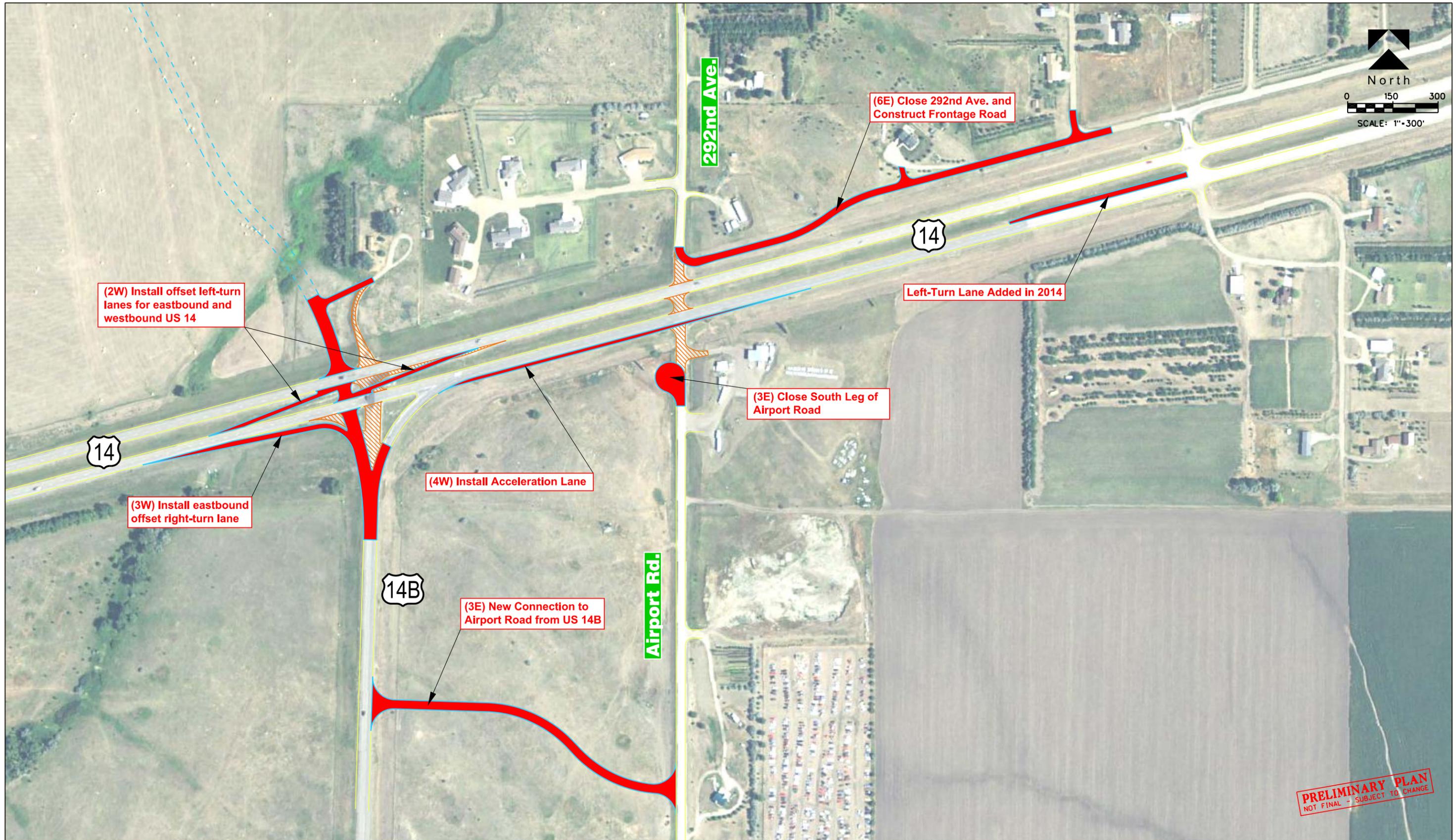


LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 3

Figure 11.5
Intersection #11W & #11E
Intersection Recommendations
US14 / US14B / Airport Road



PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE



LEGEND
 Remove Existing Pavement
 New Pavement

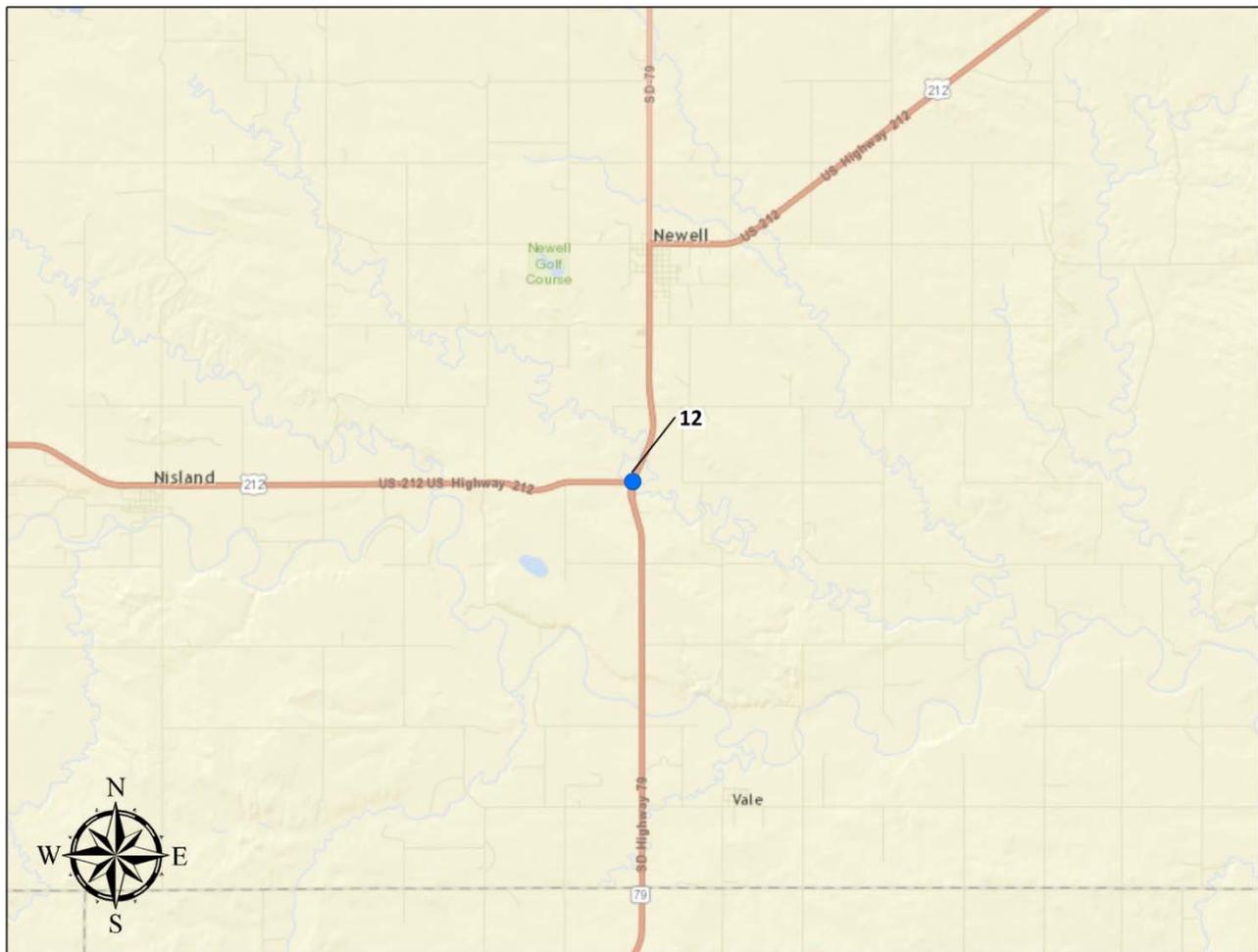
CONCEPTUAL DESIGN - OPTION 4

Figure 11.6
 Intersection #11W & #11E
 Intersection Recommendations
 US14 / US14B / Airport Road

RAPID CITY REGION

Intersections Include:

- 12. US 212/SD 79S Intersection



V. RAPID CITY REGION

One of the study intersections, the US 212/SD 79S, is located in the Rapid City Region.

12. US 212/SD 79S Intersection

The intersection of US 212 with SD 79S is approximately 2.6 mile south of the town of Newell, SD. The posted speed limits along US 212 and SD 79S are both 65 MPH. At the intersection, SD 79S is a 2-lane divided highway with a 75 foot median separating the travel lanes. An exclusive northbound left-turn lane is provided with approximately 175 feet of storage. Large sweeping channelized curves are provided for both the southbound right-turn as well as the eastbound right-turn. US 212 is a 2-lane undivided roadway.

A. Data Collection

Traffic data were collected at the intersection in April 2014. A site visit was conducted in May 2014 to collect field measurements and conduct on-site observations at the intersection. A photolog was developed and is included in the **Appendix**.

B. Intersection Observation

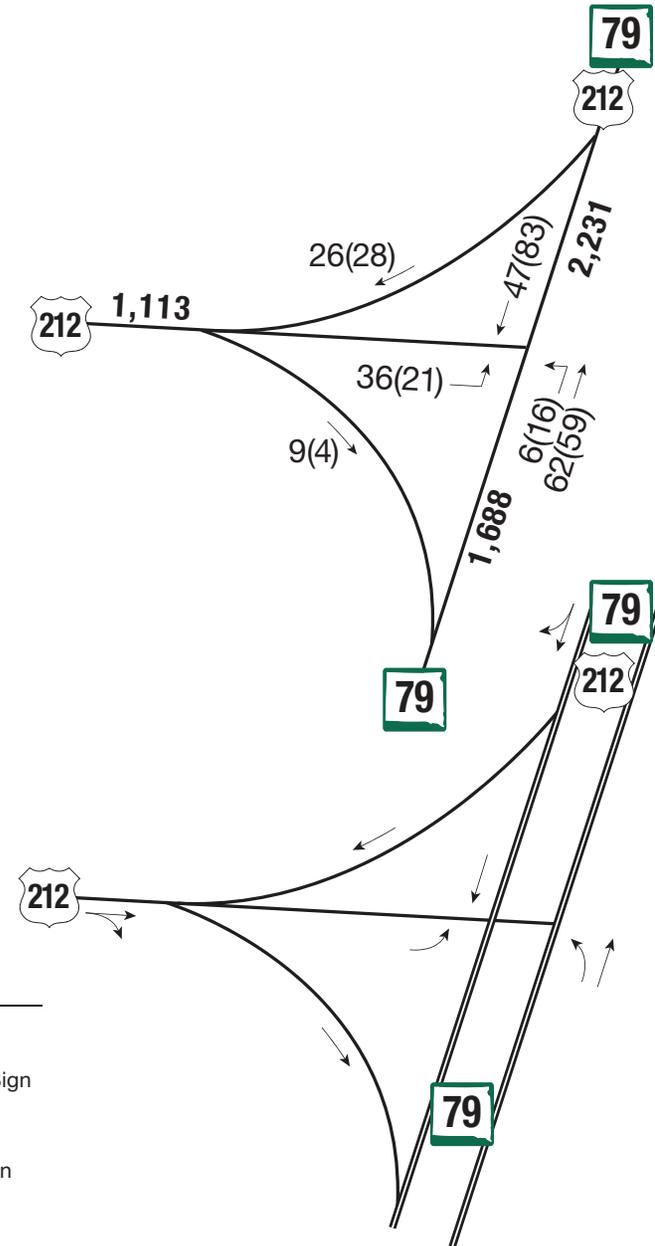
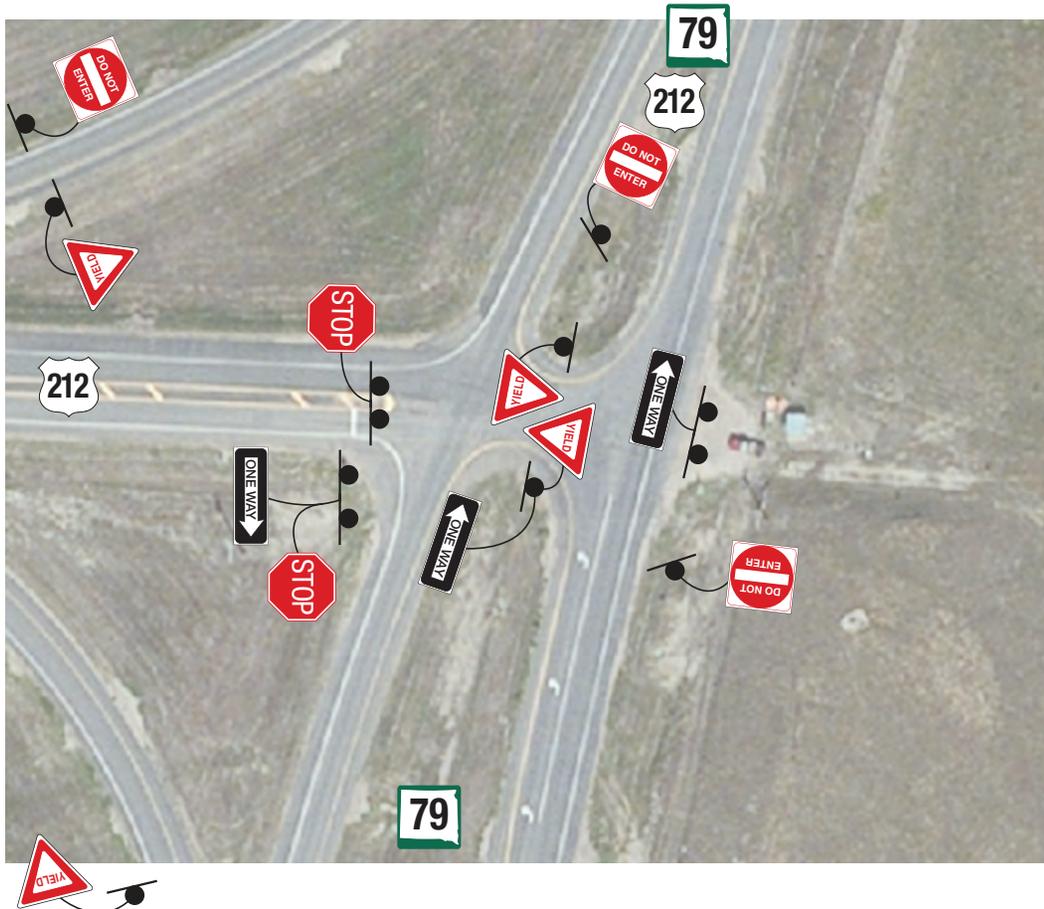
Below is a list of intersection observations made by FHU staff while conducting site visits:

- Divided north-south roadway has only one lane in each direction limits exposure for crossing traffic to one lane in each crossing stage
- There is a separate left turn lane for northbound SD 79
- There are separate right turn lanes for southbound to westbound and eastbound to southbound movements
- Excellent sight distance is available in all directions
- There is a field access on the east side of the intersection that dead-ends
- Three roadside fatality signs are posted on east side of roadway along side slope
- Stop ahead sign is present for eastbound US 212 in advance of intersection
- Shoulder rumble-strips are existing along the east side of SD 79

C. Traffic Volumes

Peak period turning movement counts were conducted for both the AM and PM peak periods at the US 212/SD 79S intersection on Thursday, April 3, 2014. The morning peak hour was determined to be 7:00 AM to 8:00 AM, and the PM peak hour was 3:45 PM to 4:45 PM. Existing ADT's and turning movement counts are summarized on **Figure 12.1**. The intersection had 2,516 total entering vehicles per day, which ranks it as the 10th highest traffic volume of all studied intersections. The turning movement count data is included in the **Appendix**.

The intersection had an overall truck percentage of 10%. Looking at individual movements, the highest truck percentage was the northbound left-turn with 14%. Also shown on **Figure 12.1** are the lane geometry, traffic control, and signage for existing traffic conditions at the intersection.



LEGEND

XXX(XXX) = AM(PM) Peak Hour Traffic Volumes
 XXXX = Daily Traffic Volumes
 X/X = AM/PM Peak Hour Signalized Intersection Level of Service
 x/x = AM/PM Peak Hour Unsignalized Intersection Level of Service

-  = Stop Sign
-  = Yield Sign
-  = Do Not Enter Sign
-  = Wrong Way Sign
-  = Traffic Signal
-  = Stop Ahead Sign
-  = Intersection Ahead Sign
-  = Lane Ends Sign
-  = Divided Highway Sign
-  = Merge Sign

Figure 12.1
 US 212/SD 79S Traffic Conditions

D. Crash Analysis

Crash records from the SDDOT for the US 212/SD 79S intersection are shown in **Tables 12.1** and **12.2** for the most recent five-year period (2008 - 2012).

A review of the crash history at the intersection indicates there were no reported crashes over the five year study period.

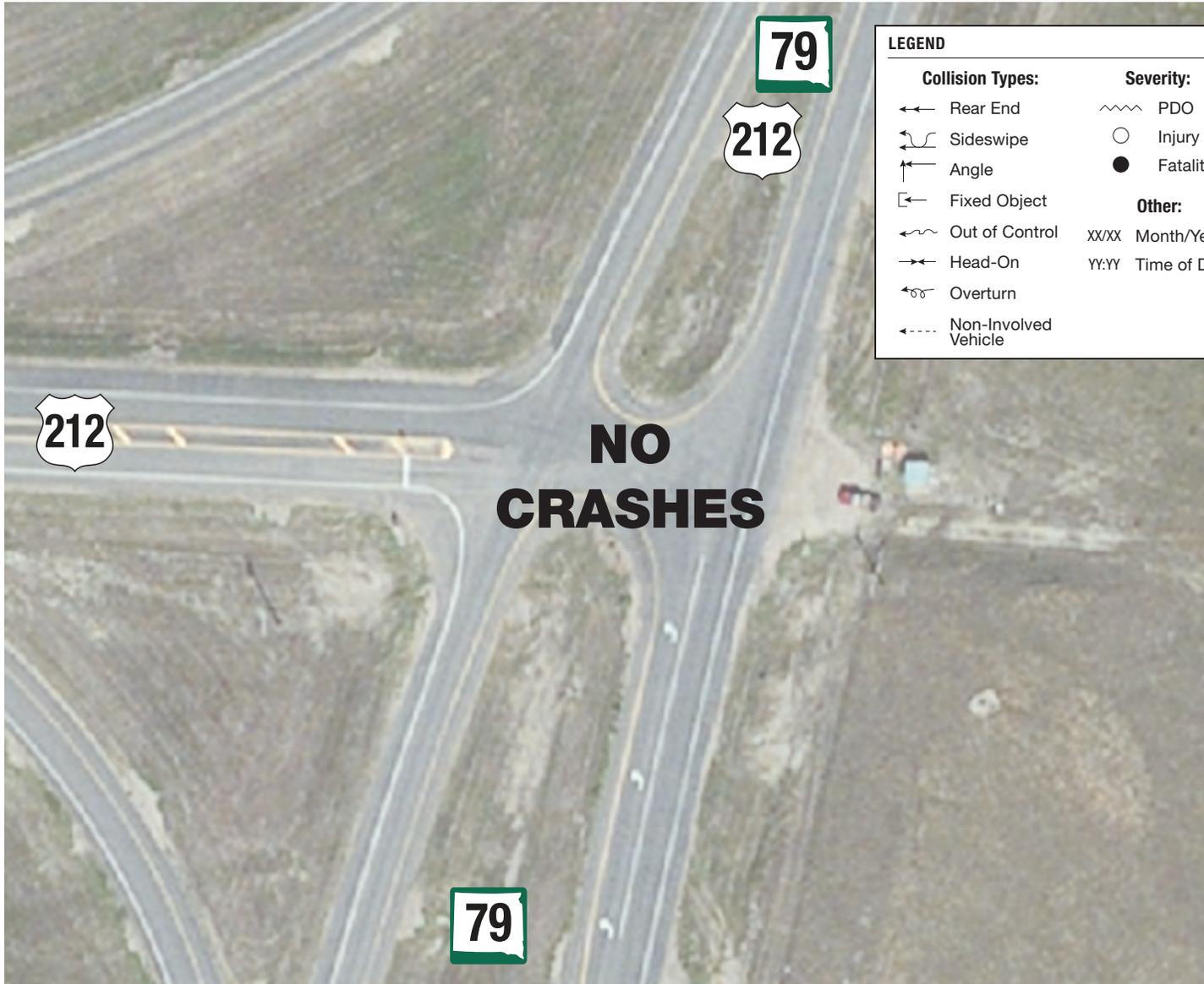
Table 12.1 US 212/SD 79S – Crash Data (2008 - 2012)

Crash Type							
Rt. Angle Near Side	Rt. Angle Far Side	Rear End Mainline	Rear End Merge	Rear End Minor Rd.	Lt. Turn Off Main	Leave Roadway	Total
0	0	0	0	0	0	0	0

The crash rate per MEV for the intersection is 0.00. This intersection has the lowest crash rate among all the studied intersections. The severity rate per MEV, which applies a cost factor to the different crash severity type, is also the lowest.

Table 12.2 US 212/SD 79S – Crash Patterns (2008 - 2012)

Crash Pattern	Contributing Factors	Countermeasures
None	-	-



Collision Types:		Severity:	Pavement:
←	Rear End	〰	PDO
↔	Sideswipe	○	Injury
↖	Angle	●	Fatality
⊠	Fixed Object	Other:	
←〰	Out of Control	XX/XX	Month/Year
↔	Head-On	YY:YY	Time of Day
↖	Overturn	Weather:	
←---	Non-Involved Vehicle	C	Clear
		CL	Cloudy
		F	Fog
		R	Rain
		S	Snow

NOTE: Drawing Not to Scale

Figure 12.2
US 212/SD 79S Crash Diagram

E. Potential Improvements

Below is a list of possible countermeasures from on-site observations:

- (1) Install (R4-7) sign and (OM1-2) object marker on the back of the median mounted stop sign on the eastbound approach of US 212. Install (R6-3a) sign below stop sign on the right side for US 212 eastbound.
- (2) Close access on east side of intersection

F. Economic Appraisal of Improvements

Figure 12.3 shows the potential alternative countermeasures to the intersection.

Table 12.3 displays the potential improvements, the costs, and the benefit cost ratio of each. A more detailed cost estimate for each improvement is provided in the Appendix.

Table 12.3 Economic Appraisal of Improvements

Improvement	Cost	Benefits**	Benefit/Cost Ratio
(1) Install Additional Signage	\$2,500	\$0	0.00
(2) Close Access	\$4,500	\$0	0.00

** Present worth of future series of safety benefits based on service life and expected change in crash frequency.

G. Recommendation for Preferred Alternative

1 – It is recommended that access on the east side of SD 79 and opposite the intersection of US 212 be closed and the additional signing be installed as shown Figure 12.3. (1 & 2)



LEGEND

-  Remove Existing Pavement
-  New Pavement

CONCEPTUAL DESIGN - OPTION 1

PRELIMINARY PLAN
NOT FINAL - SUBJECT TO CHANGE

Figure 12.3
Intersection #12
Intersection Recommendations
US 212 / SD 79S

APPENDIX A	EXISTING TRAFFIC VOLUMES
APPENDIX B	INTERSECTION PHOTOLOGS
APPENDIX C	DETAILED COST ESTIMATES
APPENDIX D	CRASH PREDICTION MODEL
APPENDIX E	OTHER ITEMS