

# **South Dakota Department of Transportation**

## **Interstate Corridor Study**

### **Phase II Report**

February 2001

Prepared for:

South Dakota Department of Transportation  
Office of Transportation Planning & Programs  
700 East Broadway Avenue  
Pierre, South Dakota 57501-2586

Prepared by:

Kirkham Michael Consulting Engineers  
9110 West Dodge Road  
Omaha, Nebraska 68124-0129

Felsburg, Holt & Ullevig  
7951 E. Maplewood Ave., Ste 200  
Englewood, Colorado 80111

# SDDOT Interstate Corridor Study - Phase II

## TABLE OF CONTENTS

<b>INTRODUCTION.....</b>	<b>1</b>
INTERCHANGE EVALUATION PROCESS .....	3
<b>I-90: EXIT 10, US 85 NORTH, SPEARFISH .....</b>	<b>4</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	4
PROPOSED IMPROVEMENTS .....	5
<b>I-90: EXIT 44, BETHLEHEM ROAD, PIEDMONT.....</b>	<b>13</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	13
PROPOSED SHORT-TERM IMPROVEMENTS.....	14
LONG-TERM FUTURE IMPROVEMENTS .....	14
<b>I-90: EXIT 46 – ELK CREEK ROAD, PIEDMONT .....</b>	<b>16</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	16
PROPOSED SHORT–TERM IMPROVEMENTS .....	17
LONG-TERM FUTURE IMPROVEMENTS .....	18
<b>I-90: EXIT 48 – STAGEBARN CANYON, PIEDMONT .....</b>	<b>20</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	20
PROPOSED SHORT-TERM IMPROVEMENTS.....	21
PROPOSED LONG-TERM IMPROVEMENTS .....	22
<b>I-90: EXIT 51 – BLACK HAWK ROAD, BLACK HAWK .....</b>	<b>25</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	25
PROPOSED INTERCHANGE ALTERNATIVES .....	26
SUMMARY OF ALTERNATIVES.....	32
<b>I-90: EXIT 55 – DEADWOOD AVENUE, RAPID CITY.....</b>	<b>34</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	34
PROPOSED INTERCHANGE ALTERNATIVES .....	35
SUMMARY OF ALTERNATIVES.....	44
<b>I-90: EXIT 59 - LACROSSE STREET, RAPID CITY .....</b>	<b>45</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	45
PROPOSED IMPROVEMENTS .....	47
<b>I-90: EXIT 60 – EAST NORTH STREET, RAPID CITY .....</b>	<b>50</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	50
PROPOSED INTERCHANGE ALTERNATIVES .....	51
SUMMARY OF ALTERNATIVES.....	61

# *SDDOT Interstate Corridor Study - Phase II*

<b>I-90: EXIT 61 – ELK VALE ROAD, RAPID CITY.....</b>	<b>62</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	62
SHORT-TERM IMPROVEMENTS .....	63
POTENTIAL ULTIMATE IMPROVEMENT.....	63
<b>MOUNT RUSHMORE ROAD CONNECTION .....</b>	<b>67</b>
<b>I-90: EXIT 332 - SD 37, MITCHELL .....</b>	<b>69</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	69
PROPOSED INTERCHANGE ALTERNATIVES .....	70
<b>I-90: EXIT 395 – MARION ROAD, SIOUX FALLS .....</b>	<b>76</b>
PROPOSED INTERCHANGE CONCEPT.....	76
EXISTING INTERCHANGE CHARACTERISTICS.....	81
PROPOSED INTERCHANGE ALTERNATIVES .....	83
<b>I-90: EXIT 399, CLIFF AVENUE, SIOUX FALLS .....</b>	<b>87</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	87
PROPOSED INTERCHANGE CONCEPT.....	88
<b>I-90: EXIT 400, I-229 INTERCHANGE, SIOUX FALLS.....</b>	<b>91</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	91
PROPOSED INTERCHANGE ALTERNATIVES .....	92
<b>I-29: EXIT 2, NORTH SIOUX CITY .....</b>	<b>95</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	95
PROPOSED INTERCHANGE ALTERNATIVES .....	96
<b>I-29: EXIT 4, MCCOOK LAKE, NORTH SIOUX CITY.....</b>	<b>100</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	100
PROPOSED INTERCHANGE CONCEPT.....	101
<b>I-29: EXIT 79 – 12<sup>TH</sup> STREET, SIOUX FALLS .....</b>	<b>107</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	107
PROPOSED INTERCHANGE ALTERNATIVES .....	109
<b>I-29: EXIT 80 - MADISON STREET, SIOUX FALLS.....</b>	<b>113</b>
PROPOSED INTERCHANGE CONCEPT.....	113
<b>I-29: EXIT 81 - RUSSELL/MAPLE, SIOUX FALLS.....</b>	<b>117</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	117
PROPOSED INTERCHANGE CONCEPT.....	118
<b>I-29: EXIT 82 - BENSON ROAD, SIOUX FALLS .....</b>	<b>123</b>

# *SDDOT Interstate Corridor Study - Phase II*

PROPOSED INTERCHANGE CONCEPT.....	123
<b>I-29: EXIT 129 – C.R. 26, BROOKINGS .....</b>	<b>128</b>
PROPOSED INTERCHANGE ALTERNATIVES .....	128
<b>I-29: EXIT 132 – US 14, BROOKINGS.....</b>	<b>132</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	132
PROPOSED INTERCHANGE CONCEPT.....	133
<b>I-29: EXIT 177 – US 212, WATERTOWN.....</b>	<b>136</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	136
PROPOSED INTERCHANGE ALTERNATIVES .....	137
<b>I-229: EXIT 3 – MINNESOTA AVENUE, SIOUX FALLS .....</b>	<b>142</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	142
PROPOSED INTERCHANGE CONCEPT.....	143
<b>I-229: EXIT 5, 26<sup>TH</sup> STREET, SIOUX FALLS .....</b>	<b>147</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	147
PROPOSED INTERCHANGE ALTERNATIVES .....	148
<b>I-229: EXIT 7 – RICE STREET, SIOUX FALLS .....</b>	<b>153</b>
EXISTING INTERCHANGE CHARACTERISTICS.....	153
PROPOSED INTERCHANGE ALTERNATIVES .....	155

# SDDOT Interstate Corridor Study - Phase II

## LIST OF FIGURES

Figure 1. I-90/US 85, Spearfish - Alt. #1.....	6
Figure 2. I-90/US 85, Spearfish - Alt. #2a.....	9
Figure 3. I-90/US 85, Spearfish - Alt. #2b.....	12
Figure 4. I-90/Bethlehem Road, Piedmont.....	15
Figure 5. I-90/Elk Creek Road, Piedmont.....	19
Figure 6. I-90/Stagebarn Canyon – Short Term Imp.....	23
Figure 7. I-90/Stagebarn Canyon – Long Term Imp.....	24
Figure 8. I-90/Black Hawk Road, Single Point Interchange.....	27
Figure 9. I-90/Black Hawk Road, Diamond Interchange.....	30
Figure 10. I-90/Black Hawk Road, I-90 East of Interchange.....	31
Figure 11. I-90/Deadwood Avenue, Standard Diamond.....	36
Figure 12. I-90/Deadwood Avenue, Single Point.....	39
Figure 13. I-90/Deadwood Avenue, Tight Diamond.....	42
Figure 14. I-90/LaCrosse Street.....	48
Figure 15. I-90/East North Street – Alt. #1.....	52
Figure 16. I-90/East North Street – Alt. #2.....	56
Figure 17. I-90/East North Street – Alt. #3.....	59
Figure 18. I-90/Elk Vale Road.....	64
Figure 19. I-190/Mt. Rushmore Road Connection.....	68
Figure 20. I-90/SD 37 Off Ramp and Access Management.....	72
Figure 21. I-90/SD 37 Single Point Interchange.....	74
Figure 22. I-90/Marion Road.....	78
Figure 23. I-90/I-29 System Interchange.....	85
Figure 24. I-90/Cliff Avenue.....	89
Figure 25. I-90/I-229 System Interchange.....	93
Figure 26. I-29 Exit 2 Single Point Interchange.....	97
Figure 27. I-29/McCook Lake Diamond Interchange.....	102
Figure 28. I-29/McCook Lake Single Point Interchange.....	105
Figure 29. I-29/12 <sup>th</sup> Street.....	110
Figure 30. I-29/Madison Street Single Point.....	114
Figure 31. I-29/Russell/Maple Partial Cloverleaf Interchange.....	120
Figure 32. I-29/Benson Road Single Point.....	124
Figure 33. I-29/C.R. 26 Partial Cloverleaf, Brookings.....	129
Figure 34. I-29/US 14 Partial Cloverleaf, Brookings.....	134
Figure 35. I-29/US 212 Traffic Signalization.....	138
Figure 36. I-29/US 212 Single Point Interchange.....	140
Figure 37. I-229/Minnesota Avenue Single Point Interchange.....	144
Figure 38. I-229/26 <sup>th</sup> Street.....	150

# *SDDOT Interstate Corridor Study - Phase II*

## Introduction

The South Dakota Department of Transportation retained the services of Kirkham Michael Consulting Engineers and Felsburg, Holt & Ullevig to conduct an analysis of several segments of the interstate system located throughout the State of South Dakota. The study was conducted in two phases. Phase I included a review of the roadway geometrics, accident history, the forecasting of traffic volumes for the Years 2010 and 2020 and the evaluation of existing and future levels of service at the interchanges within the study corridors.

As a result of the findings from the Phase I report, a total of 26 interchanges were identified for further analysis. The primary objective of Phase II of the study, summarized in this report, is to identify improvements that will accommodate the future traffic volumes and address system deficiencies. Phase II consists of the development of detailed geometric layouts of these interchanges, and a review of the projected traffic operations associated with the interchange design. In some cases, additional traffic counts were obtained to evaluate traffic operations along the crossroad corridor through the interchange. Recommended improvements include such items as the number of lanes required, intersection channelization and traffic control improvements. A capacity analysis to determine the level of service on the mainline, ramps and connecting arterials will also be conducted.

In addition to the geometric figuration of the proposed interchange improvements, an estimate of the right of way requirements to construct the improvements is provided. The anticipated impact to the number of businesses or homes is also addressed. Access management in the vicinity of the interchange is also discussed in greater detail.

A statement of probable construction costs was developed for each proposed improvement. Construction quantities were estimated based on major items, such as pavement, bridges, traffic control devices and retaining walls. Items such as earthwork and drainage structures were based on rough assumptions and estimations based on available information.

It should be noted that the inclusion of an interchange in the Phase II report does not automatically indicate that it is one of the high priority locations for reconstruction. It simply means that there was a need for some additional design and/or analysis in order to fully evaluate the proposed improvements. In many cases, the information developed in Phase I was adequate to determine what improvements are required at that interchange. The interchange designs presented in this report are the recommendations of the consultant team. Local governments and the public will be solicited for input as the interchange improvements are developed and programmed by the South Dakota Department of Transportation.

The interchanges evaluated in Phase II of this study are shown in the following table. In addition to these interchanges, the feasibility of providing a direct connection from I-190 to Mount Rushmore Road (US 16) in Rapid City is also evaluated as a part of this study.

# *SDDOT Interstate Corridor Study - Phase II*

## *Interchanges Evaluated in Phase II*

<b>Interstate</b>	<b>Exit No.</b>	<b>Description</b>
Interstate 90	10	US 85 North, Spearfish
Interstate 90	44	Bethlehem Road, Piedmont
Interstate 90	46	Elk Creek Road, Piedmont
Interstate 90	48	Stagebarn Canyon, Piedmont
Interstate 90	51	Black Hawk Road (SD 79), Black Hawk
Interstate 90	55	Deadwood Avenue (SD 445), Rapid City
Interstate 90	59	LaCrosse Street, Rapid City
Interstate 90	60	East North Street (US 16B), Rapid City
Interstate 90	61	Elk Vale Road (SD 437), Rapid City
Interstate 90	332	SD 37, Mitchell
Interstate 90	395	Marion Road, Sioux Falls
Interstate 90	396	I-29/I-90 Interchange, Sioux Falls
Interstate 90	400	I-229/I-90 Interchange, Sioux Falls
Interstate 29	2	SD 105, North Sioux City
Interstate 29	4	McCook Lake, North Sioux City
Interstate 29	79	12 <sup>th</sup> Street (SD 42), Sioux Falls
Interstate 29	80	Madison Street, Sioux Falls
Interstate 29	81	Russell/Maple, Sioux Falls
Interstate 29	82	Benson Road, Sioux Falls
Interstate 29	129	County Road 26, Brookings
Interstate 29	132	US 14, Brookings
Interstate 29	177	US 212, Watertown
Interstate 229	3	Minnesota Avenue, Sioux Falls
Interstate 229	5	26 <sup>th</sup> Street, Sioux Falls
Interstate 229	7	Rice Street, Sioux Falls

In an effort to provide a consistent methodology for the review and analysis of each interchange, a standard format was developed. Each section of the report contains a brief review of the Phase I analysis of an interchange. The proposed alternative interchange concepts are then identified and evaluated based on geometry, safety, capacity, access control, right of way impacts and construction costs.

In addition to the evaluation of the interchanges listed above, a concept for a direct connection from I-190 to Mount Rushmore Road in Rapid City was also developed.

# SDDOT Interstate Corridor Study - Phase II

## Interchange Evaluation Process

A process was developed to evaluate the proposed interchange improvements for programming purposes. All of the interchanges evaluated in the Phase I report were included in the evaluation process. With over 60 interchanges evaluated across the state, it was necessary to develop an objective methodology for determining the areas of greatest need. It should be noted that the inclusion of a particular interchange or improvement in the Phase II study does not mean that it would have a higher resulting priority than those interchanges not included in Phase I.

The following descriptions of the evaluation criteria were used in the Interchange Evaluation Process. The criteria are not listed in any particular order of significance.

1. **Geometrics** - This criterion is an evaluation of five key geometric elements at the interchange. These elements include access spacing from the ramps, ramp intersection sight distance, ramp stopping sight distance, on-ramp taper rate, and cross-road stopping sight distance.
2. **Safety** - This is a measure of the accident history recorded at the interchange, measured in terms of the 3-year weighted crash rate (weighted accidents/million entering vehicles).
3. **Capacity** - This criterion assesses the level of congestion (measured by Level of Service) which is experienced today and which is projected to occur in the future at both the ramp terminal intersections and the freeway merge/diverge points.
4. **Structure/Pavement Condition** - This is a measure of the remaining life of the bridge structure and of the roadway pavement.
5. **Regional Significance** - This is an assessment of the relative importance of the interchange to the state and regional roadway system, based on the classification and the function of the crossroad.
6. **Cost-Effectiveness** - This criterion assesses the ratio of the relative benefits of the improvements to their relative capital and right-of-way costs.
7. **Constructability** - This is a qualitative assessment of the ease with which the improvements could be constructed with the least amount of impacts to the traveling public.
8. **Acquisition** - This criterion assesses the need to acquire right-of-way and to displace residences or businesses.
9. **Environmental Impact** - This criterion represents a general measure of the environmental impacts likely to be associated with the project and the ability to mitigate those impacts.
10. **Community Support** - This is an assessment of the level of support for or opposition to the project, as expressed by the community.



# SDDOT Interstate Corridor Study - Phase II

## I-90: Exit 332 - SD 37, Mitchell

Traffic volumes at Exit 332 are expected to increase in future years due to additional development along the Highway 37 corridor. The Phase I analysis indicated that with the addition of traffic signals at the ramp intersections, the interchange will provide acceptable levels of service through the Year 2020. However, as traffic volumes on SD 37 grow,



additional traffic signals will likely be required along the corridor. Consideration should be given to reconstructing the interchange with a single point configuration, which would increase the signal spacing from approximately 450' between the northern ramps and the next major intersection, to approximately 800'. If reconstructed, the relatively minor geometric deficiencies could be addressed at that time.

## Existing Interchange Characteristics

### **Geometry**

The existing interchange is a modified diamond configuration, with a spacing of approximately 700' between the interchange ramp intersections. Both intersections are presently signalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto Hwy 37. The cross section of Hwy 37 is a four-lane divided section, with a wide median. Separate left turn lanes are provided at the major intersections. It should be noted that the spacing of access along Hwy 37 north and south of the interchange is less than desirable and affects the safety and operations of traffic using Hwy 37. Geometric deficiencies of note include a superelevation rate of 6.0% is provided on Ramp A and 5.0% on Ramp C. The K values for the sag vertical curves on Ramps A and B are well below the criteria of 90.

### **Traffic Safety**

This interchange ranked 13<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 31 accidents occurred at this interchange between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

# SDDOT Interstate Corridor Study - Phase II

## Capacity

The capacity analysis performed for the existing configuration of the Exit 332 interchange indicates that all of the traffic movements are currently operating at or above level of service B. The Year 2010 and 2020 capacity analyses assumed the current diamond interchange configuration with traffic signalization. With minor improvements, all movements are anticipated to operate at or above LOS B for the years 2010 and 2020.

### Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
EB Diverge	C	A	A	A	Acceptable
EB Merge	C	A	A	A	Acceptable
WB Diverge	C	A	A	A	Acceptable
WB Merge	C	A	A	A	Acceptable
North Intersection	D	A	A	A	Acceptable
South Intersection	D	A	A	A	Acceptable

## Proposed Interchange Alternatives

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels with the construction of separate right turn lanes on the off-ramps and the use of access management techniques along SD 37. As an alternative to these improvements, a single point interchange concept was also developed for this location.

### Alternative #1 – Off Ramp Improvements and Access Management

The first alternative simply consists of the construction of a separate right turn lane for both the eastbound and westbound off-ramps and some access management improvements along SD 37. A functional design of the proposed improvements is shown in Figure 20.

### Geometry

In addition to the separate right turn lanes on the off-ramps, there are a few other geometric modifications recommended along Hwy 37. One recommendation is to provide improved sight distance for left turning vehicles at the major intersections. With the wide median, vehicles in the opposing left turn lane restrict the distance to see on coming through traffic. One effective method to improve the sight distance is to reconstruct the left turn lane closer to the opposing through lanes as shown in the figure. This also helps to reduce the distance the left turning vehicle must travel through the intersection. Storage lengths for the left turn lanes along Hwy 37 should provide 200' of storage, which is more than adequate to accommodate the projected traffic volumes. The northbound and southbound right turn lanes on the off-ramps should provide 150' of storage. A second recommendation is to reduce the numbers of access points

# *SDDOT Interstate Corridor Study - Phase II*

along Hwy 37 especially full movement access points. This will improve traffic flow and safety along the corridor.

## *Traffic Safety*

The construction of the proposed improvements will improve traffic operations along Hwy 37, which should result in a reduction in accidents at the interchange and adjacent intersections.

## *Capacity*

As previously stated, the interchange will operate at acceptable levels for the Year 2020 with the proposed improvements. It should be noted that the proposed off-ramp improvements could be delayed until 2010 and still have anticipated levels of service that are acceptable so that the current improvements would meet their service life.

## *Access Control*

In addition to the modifications recommended for the left turn lanes on Hwy 37, some restrictions to turning movements at the adjacent intersections and into adjacent properties should also be considered. Currently, the traffic volumes at these intersections are low enough to function well. However, as traffic volumes grow, it will become more difficult to turn left onto Hwy 37 from the frontage road intersections. See proposed changes in Figure 20.

To be specifically noted are the access locations nearest to the interchange. The unsignalized intersection north of the interchange should continue to operate acceptably with improvements to the left turn lanes, however it should be monitored and at such time the access could be restricted to right in/right out access by closing the median. Access to the adjacent developments could still be provided by the frontage road connection at the signal to the north.

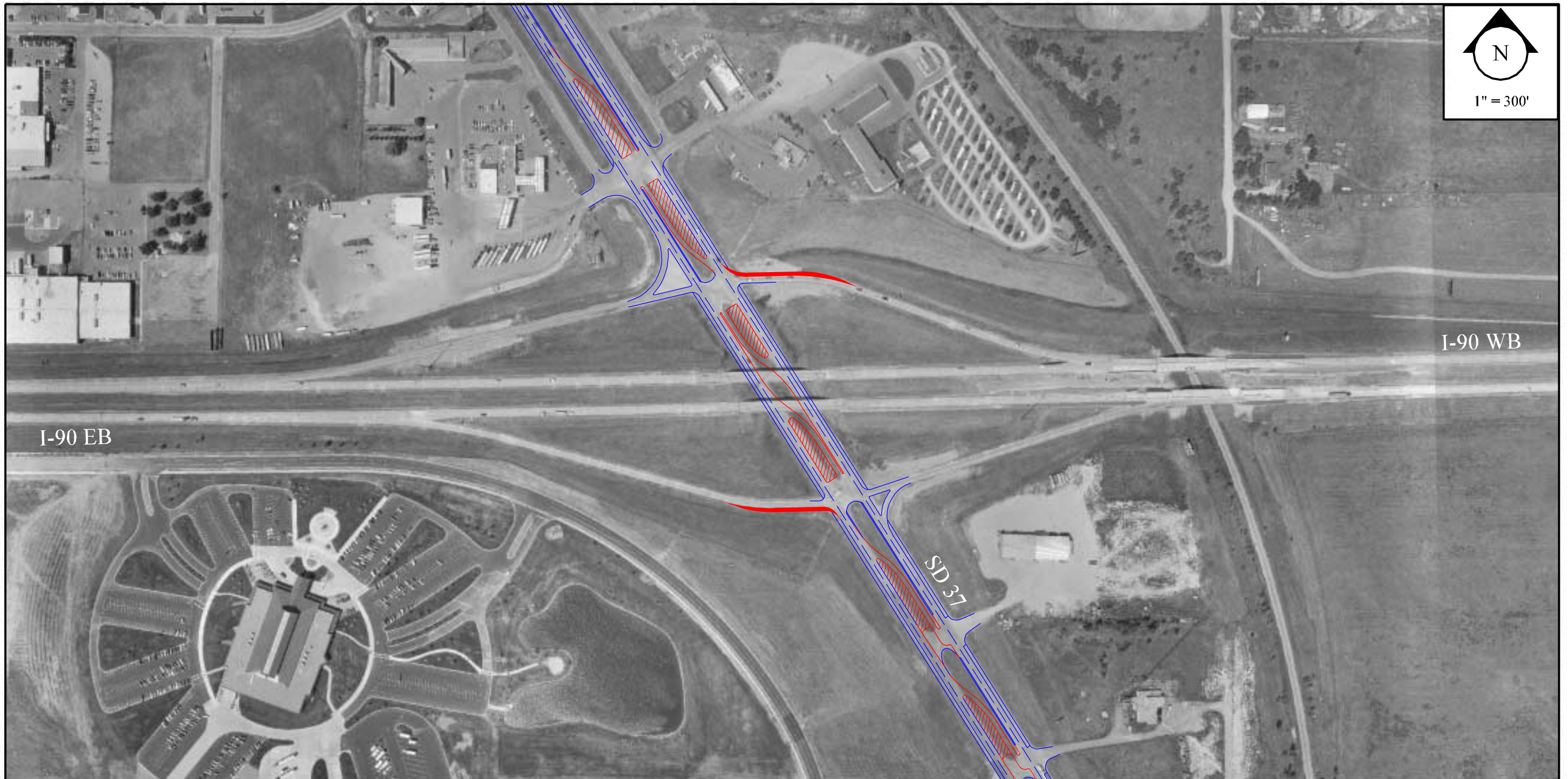
The access points south of the interchange are anticipated to operate acceptably with the current land uses. In the event these areas are redeveloped, consideration should be given to access management improvements along this corridor. Full access could be limited to one point and possibly a right-in/right out could be provided closer to the interchange. The full movement access should be located as far from the interchange as possible without negatively impacting the signal at Hwy 37 and Spruce Street.

## *Right-of-Way*

The proposed improvements for the off-ramps and the median along Hwy 37 will not require any additional right of way.

## *Probable Construction Costs*

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the right turn lanes and median reconstruction on Hwy 37 is estimated at \$250 thousand. A breakdown of the quantities and construction costs is included in the Appendix.



# SDDOT Interstate Corridor Study - Phase II

## **Alternative # 2 – Single Point Interchange**

Although the capacity analysis indicated that the diamond interchange configuration would provide acceptable traffic operations through the Year 2020 with some minor improvements, unforeseen developments in the vicinity of the interchange may result in significant increases in traffic movements through the interchange. At some point in the future, it may be necessary to provide a configuration with increased capacity. Another positive advantage to the construction of a single point interchange is the increased spacing that it would provide between the interchange and the closest intersections to the north and south as part of the access management concepts discussed previously. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 21.

### *Geometry*

Based on the traffic projections, single left turn lanes for the single point interchange will provide acceptable traffic operations. As was the case for the diamond interchange, the left turn storage on the Hwy 37 approaches should be 200'. The configuration of the single point interchange results in approximately 200' of storage for the left and right turn lanes on the off-ramps.

### *Traffic Safety*

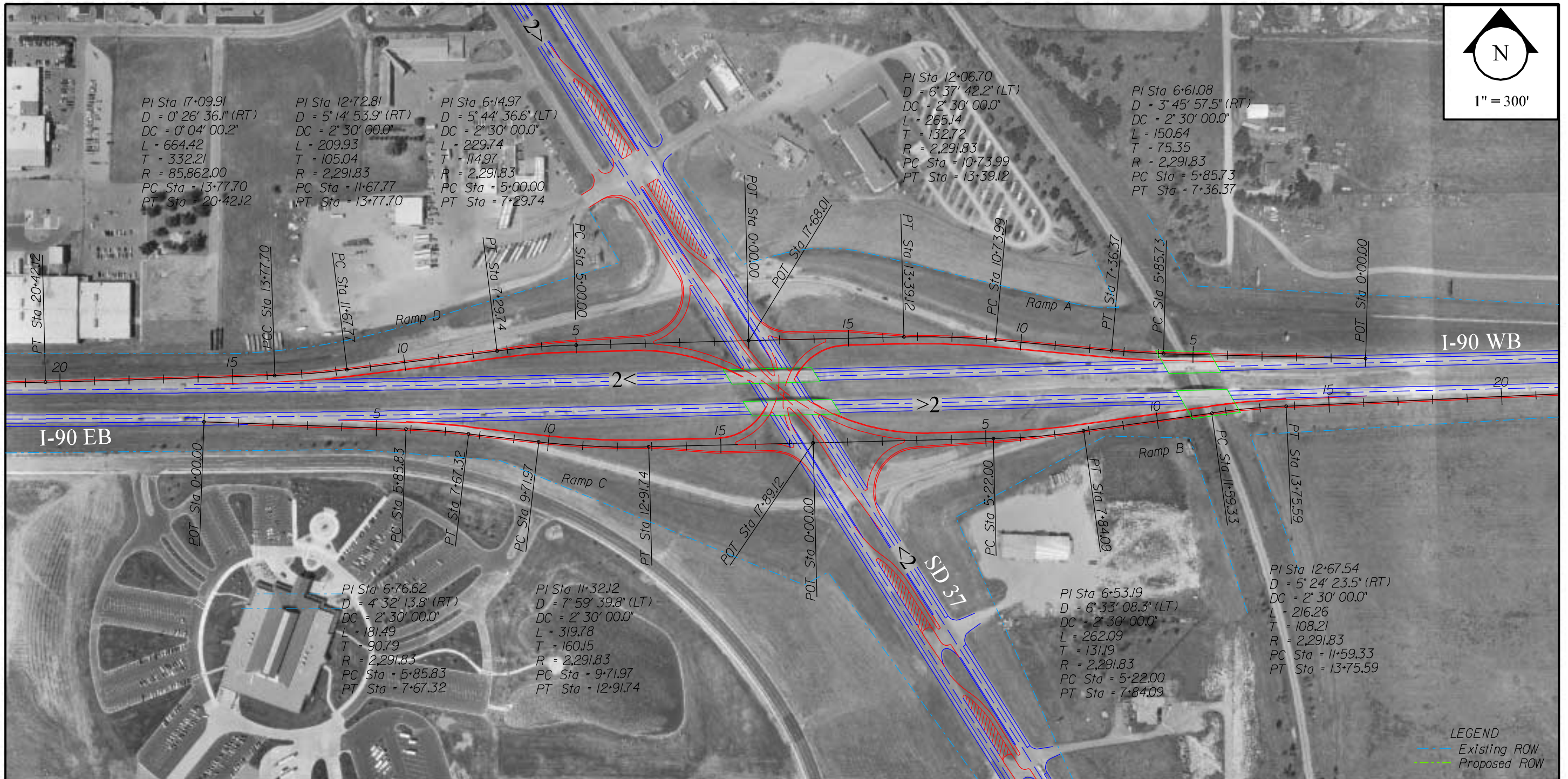
The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10<sup>th</sup> Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

### *Capacity*

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in the following table.

### *I-90/Hwy 37 Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Hwy 37 Single Point Interchange	2010	Sig.	C	B	-	B	B	-	B	-	-	B	-	-	B
Hwy 37 Single Point Interchange	2020	Sig.	C	B	-	C	B	-	B	-	-	B	-	-	B



# *SDDOT Interstate Corridor Study - Phase II*

## *Access Control*

The modifications to the access points along Hwy 37 discussed for the previous alternative are recommended with the single point concept as well. The increased distance between the interchange and the next adjacent access breaks will help improve traffic operations along the corridor.

## *Right-of-Way*

Additional right of way will not be required to construct the proposed single point interchange and other improvements at Exit 332.

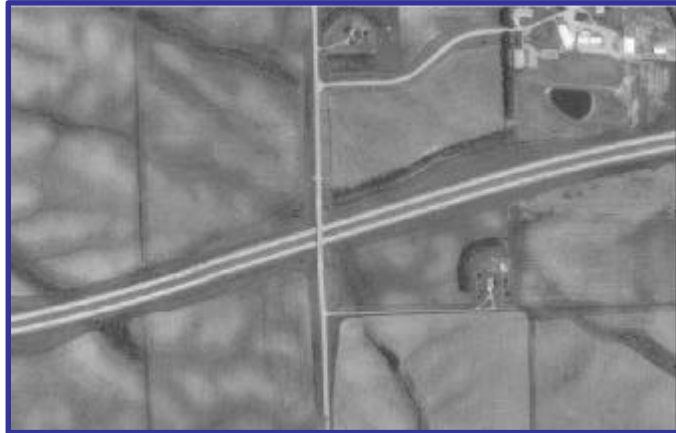
## *Probable Construction Costs*

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the single point interchange and reconstruction of the medians along Hwy 37 is estimated at \$7.2 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-90: Exit 395 – Marion Road, Sioux Falls

A new interchange is proposed for the Marion Road crossing of I-90, located approximately one mile west of I-29. The City of Sioux Falls completed the *Interstate 90 and Marion Road Interchange Justification Study* in December 1999. This study recommended a typical diamond interchange. However, the capacity analysis conducted with this study revealed that with the lane configuration indicated in the



justification study, the projected level of service in the Year 2020 is LOS D at the westbound ramp. Dual left turn lanes for the westbound off-ramps were evaluated in the Phase I study, which resulted in LOS C. This subsequent investigation evaluates providing a loop ramp on the north half of the interchange to accommodate the heavy westbound left turn movements. This partial cloverleaf concept also included laying out the interchange to construct additional loop ramps as needed in the future. The Phase II investigation has been performed to further evaluate geometric and operational characteristics for improving the new proposed interchange. The results of this investigation are summarized below along with selected information from the Exit 395 Phase I analysis.

### Proposed Interchange Concept

The policy developed by the FHWA for access to the interstate system requires that all reasonable design alternatives be considered. This includes determining if the existing interchanges, local road and streets, or frontage roads in the area can provide the necessary access or be improved to satisfactorily accommodate the design year traffic demands without the construction of a new interchange.

The interchange justification study completed by the City of Sioux Falls in December 1999 determined a typical diamond interchange was the preferred concept for this location at Marion Road and I-90. It was revealed during the Phase I investigation that the typical diamond interchange will not operate with an acceptable delay in the Year 2020. The Phase I study indicated that dual left turn lanes are recommended to accommodate the heavy projected left turn movements at the westbound on and off ramps. The investigation in Phase II evaluated a partial cloverleaf concept for this location. The results of this investigation with the partial cloverleaf interchange improved the Year 2020 level of service (LOS) to a "B" from a "D" with the original typical diamond concept at the north ramp intersection.



## *SDDOT Interstate Corridor Study - Phase II*

A functional design of the proposed partial cloverleaf interchange laid out with the necessary clearances to construct additional loops ramps as needed in the future is shown in Figure 22. The dotted westbound ramp shown in the figure provides reference to the amount of right of way that would be needed to build a typical diamond interchange.

### ***Geometry***

In order to accommodate the projected traffic volumes, it will be necessary to widen Marion Road to a four-lane divided section in the vicinity of the proposed interchange, with a raised median and separate left turn lanes to the I-90 on-ramps. A raised median is recommended to provide channelization at the intersections. The analysis indicated that a 500' northbound left turn lane and a 150' southbound left turn lane would accommodate the 95<sup>th</sup> percentile queue length. Each of the ramps has one lane and the off ramps each allow for a separate right movement from this lane. The eastbound to southbound right turn and the westbound to southbound left turn are projected to be heavy movements. The provision of separate right and left turn lanes for the off-ramps will allow for more efficient traffic operations. The capacity analysis indicates that the interchange will operate at acceptable levels with the construction of single left turn lanes and additional through lanes.

Consideration, at the time of design, should be given to the possibility of providing three through lanes in each direction on the interstate mainline at some date in the future. The design of the bridge structure should allow for this future expansion if the need arises.

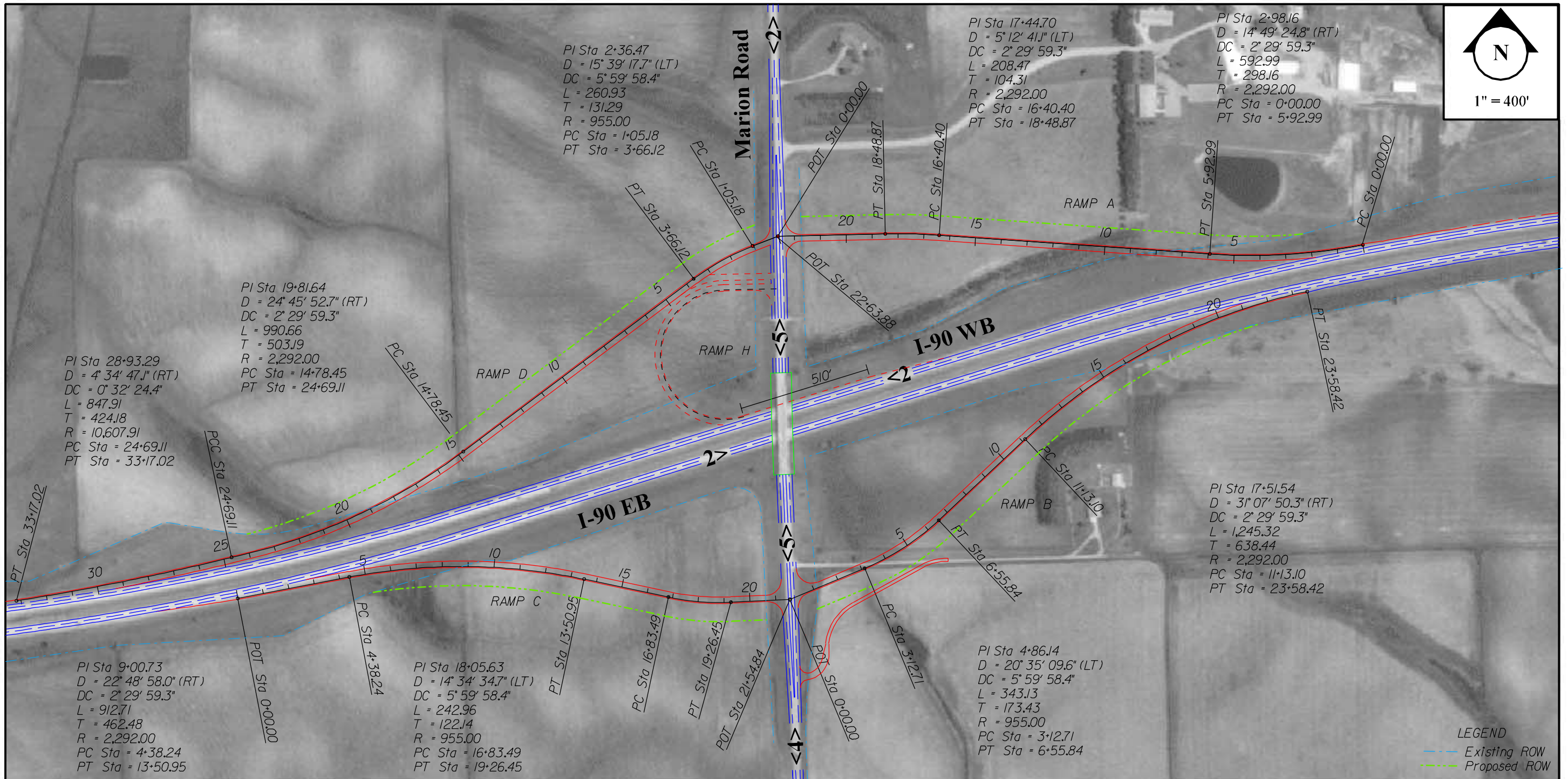
### ***Traffic Safety***

Since this is a new interchange, there is no accident history in the area. However, it is anticipated that the construction of a new interchange at Marion Road will result in some accidents occurring on the ramps and at the intersections with Marion Road. A similar accident pattern may develop initially associated with driver's unfamiliarity with a newly constructed interchange as compared to other newly constructed partial cloverleaf interchanges. It is anticipated that the accident frequency will decrease over time once drivers are familiar with this interchange configuration.

### ***Capacity***

The requirements for analysis of future traffic operations for the interchange concept were based on evaluation of the Year 2020 traffic volume projections. The results of the analysis are summarized below. As shown in the table, the partial cloverleaf interchange with the lane configuration described in the previous section will operate at acceptable levels of service.

Although the Year 2010 and 2020 traffic volume projections at the south ramp intersection do meet the MUTCD peak hour traffic warrant, it will require future engineering study to determine whether a signal is necessary since the predominant movement at the off ramp is right turning traffic. The Phase II results indicate this intersection would operate sufficiently with no signalization in Year 2010 and 2020. A signalized analysis was also performed for this intersection for comparison, which indicated an improved level of service in Year 2010 and 2020.



# SDDOT Interstate Corridor Study - Phase II

Related to traffic operations were concerns of the signing of Exit 395 and 396 due to the close spacing of the two interchanges. It was also noted that the existing signs and sign bridges are over thirty years old. During the design phase of any improvements to this area consideration should be given to the replacement and location of directional signs

## *I-90/Marion Road Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Marion Road/ I-90 WB Ramps	2010	Sig.	B	A	-	-	A	-	A	-	-	-	-	-	B
Marion Road/ I-90 EB Ramps	2010	Unsig.	-	-	-	A	-	-	C	-	B	-	-	-	B
Marion Road/ I-90 EB Ramps	2010	Sig.	-	A	-	A	A	-	A	A	-	-	-	-	A
Marion Road/ I-90 WB Ramps	2020	Sig.	C	A	-	-	A	-	C	-	A	-	-	-	B
Marion Road/ I-90 EB Ramps	2020	Unsig.	-	-	-	B	-	-	C	-	C	-	-	-	C
Marion Road/ I-90 EB Ramps	2020	Sig.	-	A	-	A	A	-	B	B	-	-	-	-	A

Future traffic operations for the ramp movements were also evaluated which includes the recommendation to construct a loop ramp in the northeast quadrant. The following table summarizes the analysis of the merge and diverge movements for the Year 2010 and 2020. The capacity analysis indicates that the level of service for these movements will operate at LOS B or better. The lane configuration assumes one lane on and off ramps and two through lanes in each direction on I-90.

## *I-90/Marion Road Ramp LOS Analysis*

Direction	Year	Movement	LOS
I-90 Westbound	2010	Merge	A
		Diverge	A
I-90 Eastbound	2010	Merge	B
		Diverge	A
I-90 Westbound	2020	Merge	B
		Diverge	B
I-90 Eastbound	2020	Merge	B
		Diverge	A

## **Access Control**

Since the property in the vicinity of the proposed interchange is currently undeveloped, there is an opportunity to limit the access locations along Marion Road. The farmstead driveway in the

## *SDDOT Interstate Corridor Study - Phase II*

southeast quadrant will need to be relocated to provide a minimum of 300' from the south ramp intersection. It appears some land acquisition may be necessary to relocate this driveway access depending on the ownership of the farmland in the southeastern quadrant. Since so much of the property is required for construction of the eastbound on-ramp, the SDDOT will investigate the feasibility and need for acquiring the entire parcel.

### ***Right-of-Way***

Other than farmland acquisition, there appears to be no geometric constraints in constructing the loop ramp and all of the on and off ramps in the three quadrants. It appears that adequate right of way is available to widen Marion Road to a four-lane divided section in the vicinity of the proposed interchange, with a raised median and separate left turn lanes to the I-90 on-ramps. Other than the northeast quadrant, triangular sections of right of way will be required in the remaining three quadrants of the interchange to accommodate construction of the ramps, with the necessary clearances to construct additional future loop ramps in the southern section of the interchange, totaling 42.8 acres. This includes the right of way necessary to relocate the private driveway in the southeast quadrant as discussed earlier. If the entire parcel is acquired, a total of 51.1 acres of right of way will be required to construct the interchange.

### ***Probable Construction Costs***

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the partial cloverleaf interchange at Marion Road is estimated at \$7.1 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate includes construction costs for the portion of Marion Road through the interchange area. It was assumed that it includes the portion of Marion Road through the ramp intersections. It is assumed that the widening of Marion Road will be constructed as a separate project. The City of Sioux Falls has indicated that they will participate in the construction of the local connections in coordination with the construction of the interchange.

# SDDOT Interstate Corridor Study - Phase II

## I-90: Exit 396, I-29/I-90, Sioux Falls

Exit 396 on I-90 is the full cloverleaf system interchange with I-29. The capacity analysis from the Phase I investigation revealed that the existing interchange does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. However, the radii provided on the loop ramps are only 205', which is well below a 30 mph design speed. In addition, the weaving distance



provided between the loop ramps does not meet current design criteria. The other geometric deficiencies are relatively minor, and can be corrected at the time of reconstruction. In an effort to address the geometric issues, a full cloverleaf interchange that meets current design criteria was developed for this system interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 395 Phase I analysis.

### Existing Interchange Characteristics

#### Geometry

Existing geometry features reviewed using the as-built plans for this interchange. Every ramp at this interchange was found to have some deficiencies. The as-built plans indicate that the superelevation rate on Ramps A, B, C and D is only slightly above the 4% criteria. The loop ramps have a radius of only 205', which is below a 30 mph design speed. They were constructed with a 6% superelevation rate, which is necessary with that radius. The on-ramp taper rate for Ramp D should also be lengthened when the interchange is reconstructed.

#### Traffic Safety

The accident analysis ranked this interchange 12<sup>th</sup> of the 62 interchanges evaluated. Since it did not meet the criteria of a high accident location, the individual accident records at this interchange were not reviewed. A total of 38 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

#### Capacity

The movements evaluated at a full cloverleaf interchange fall into three categories. The direct ramp movements (Ramps A, B, C, and D) are analyzed as a diverge movement from one interstate and a merge movement to the other interstate. For example, Ramp A, which provides the westbound to northbound movement, is analyzed as a westbound diverge on I-90, and a northbound merge on I-29. The area between the loop ramps is analyzed as a weave movement.

# SDDOT Interstate Corridor Study - Phase II

The results of the capacity analysis performed for the existing full cloverleaf interchange shown in the following table indicate that the ramp merge, diverge and weave areas are currently operating at level of service (LOS) A, with the exception of the northbound diverge movement, which is operating at LOS B. The Phase I results for Year 2010 and 2020 projected traffic volumes indicate the existing full cloverleaf interchange configuration will operate at a LOS B or better on all ramps.

## I-90/I-29 Ramp LOS Analysis – with Existing Configuration

Direction	Year	Movement	LOS
I-90 Westbound	1998	Merge	A
		Weave	A
		Diverge	A
I-90 Eastbound	1998	Merge	A
		Weave	A
		Diverge	A
I-90 Westbound	2010	Merge	B
		Weave	A
		Diverge	A
I-90 Eastbound	2010	Merge	B
		Weave	A
		Diverge	A
I-90 Westbound	2020	Merge	B
		Weave	B
		Diverge	B
I-90 Eastbound	2020	Merge	B
		Weave	A
		Diverge	B
I-29 Northbound	1998	Merge	A
		Weave	A
		Diverge	B
I-29 Southbound	1998	Merge	A
		Weave	A
		Diverge	A
I-29 Northbound	2010	Merge	A
		Weave	A
		Diverge	B
I-29 Southbound	2010	Merge	B
		Weave	A
		Diverge	A
I-29 Northbound	2020	Merge	B
		Weave	A
		Diverge	B
I-29 Southbound	2020	Merge	B
		Weave	A
		Diverge	A

# *SDDOT Interstate Corridor Study - Phase II*

## **Proposed Interchange Alternatives**

The primary problem at this interchange is the design speed on the loop ramps and the weaving distance provided between the loop ramps. When the interchange is reconstructed, it is recommended that the full cloverleaf concept be maintained, but designed to conform with current design standards. The proposed configuration is shown in Figure 23.

The Phase II investigation evaluated the concern about the proposed modified Exit 396 cloverleaf interchange concept further reducing the short distance provided between the on and off ramps for Exit 83 and the eastbound on ramp at Exit 395. According to the SDDOT Design Manual, the recommended distance between an entrance and an exit ramp is 2,000'. Currently, the Exit 396 ramps are approximately 1,400' apart at Exit 83 and 1,900' apart at Exit 395. With the concept shown in Figure 23, this distance is reduced even further. The LOS results from Phase II indicate the length of the auxiliary lane between the ramps at Exit 83 and Exit 396 and at eastbound Exit 395 and Exit 396 will provide acceptable weaving operations.

The other option would be to provide a collector-distributor (CD) road along both sides of I-29. Again, due to the proximity of the interchange to the south, the CD roads would need to begin south of Exit 83, and continue all the way through the I-90 interchange. This concept was not developed once the Phase II portion of the study concluded the auxiliary lane distance between ramp terminals and Exit 83 provided adequate LOS for the weaving movements projected for Year 2020 traffic volumes.

Another option would be to provide a CD road on both northbound and southbound I-29 just to accommodate the weave movements between the loop ramps. This would allow the weave movements to occur separate from the mainline movements, which may result in a safer weave operation. However, in order to accommodate the CD roads, it would be necessary to lengthen the I-90 bridges over I-29. The analysis indicates that the CD roads are not required to provide acceptable traffic operations for the projected traffic volumes.

A concept for the ultimate configuration of this interchange was also considered. Based on the Year 2015 traffic model, the heavy turning movements in the future appear to be the northbound to eastbound movement (Ramp B) and the westbound to southbound movement (Ramp H). The accommodation of the Ramp B volume is not a problem, since this is basically a right turn movement. However, the replacement of Ramp H to accommodate a higher turning volume beyond the Year 2020 is more difficult to address. A flyover ramp from westbound I-90 to southbound I-29 would have to first swing north of I-90, travel over I-29, over I-90 and tie back into southbound I-29 prior to the off-ramp for Exit 83. A preliminary review of this alignment indicates that there is not enough distance between the eastbound to southbound (Ramp C) on-ramp, and the Exit 83 off-ramp to accommodate this flyover connection. Therefore, the full cloverleaf design alternative was the only concept evaluated for this proposed interchange.

# SDDOT Interstate Corridor Study - Phase II

## **Alternative #1 – Full Cloverleaf**

The Full Cloverleaf Interchange alternative is depicted on Figure 23. The interchange concept was formulated to meet the criteria found in the SDDOT Roadway Design Manual.

### *Geometry*

As discussed previously, the primary problem at this interchange is the design speed on the loop ramps and the weaving distance provided between the loop ramps. When the interchange is reconstructed, it is recommended that the full cloverleaf concept be maintained, but designed to conform with current design standards. Each of the new on and off ramps will be continue to provide one lane, and will be constructed to meet the following design criteria.

### *Geometric Design Criteria*

Geometric Feature	Criteria
Superelevation	4%
Lane Width	19'
Right Shoulder Width	4'
Inslope	6:1
On-Ramp Taper Rate	50:1
Minimum Horizontal Radius	330'

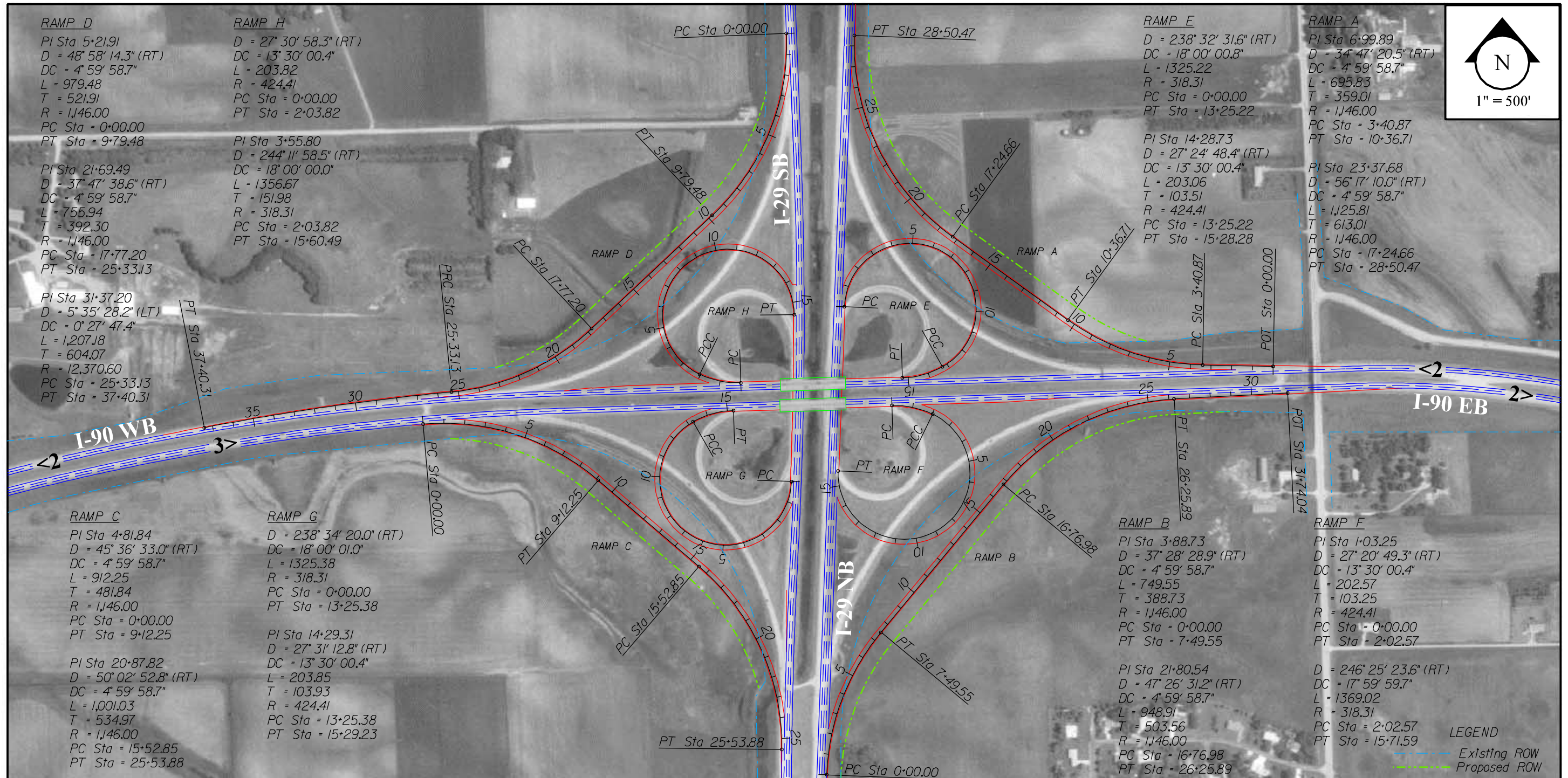
### **Traffic Safety**

Since this interchange is recommended to remain as a full cloverleaf concept but reconstructed to conform with current design standards, it is anticipated that this alternative would improve any existing safety deficiencies related to the design speed on the loop ramps and the weaving distance provided between the loop ramps. The results from the Phase II investigation did not indicate any problems related with weaving operations between the Exit 395 ramps and the ramps at Exit 395 and Exit 83 for the projected Year 2010 and 2020 traffic volumes.

### **Capacity**

As shown in the figure, the proposed concept for this interchange is basically the same configuration, with larger, constant radius loop ramps and more distance for the weaving areas between the loop ramps. Therefore, a capacity analysis was not performed with the reconstructed interchange. In the Year 2010 and 2020, based on the analysis of the existing configuration as shown in the following table, all of the movements evaluated are projected to still operate at a LOS A or B. Since the movements are the same, the only changes would be the distances between the adjacent ramps. The weaving areas between the adjacent ramps of Exit 395 and Exit 83 were also evaluated and determined that the auxiliary lanes with the reconstructed interchange will operate at a LOS A in the Year 2010 and 2020.





# *SDDOT Interstate Corridor Study - Phase II*

Direction	Year	Movement	LOS
I-90 Eastbound	2010	Weave	A
I-90 Eastbound	2020	Weave	A
I-29 Northbound	2010	Weave	A
I-29 Southbound	2010	Weave	A
I-29 Northbound	2020	Weave	A
I-29 Southbound	2020	Weave	A

***Access Control***

Since the property in the vicinity of the existing full cloverleaf interchange is currently undeveloped, there is an opportunity to continue the limit of access locations along I-90 and I-29. There are no recommended changes to access control proposed for Exit 396.

***Right-of-Way***

There is a considerable amount of right-of-way that must be acquired in order to construct a new full cloverleaf interchange conforming with current design standards. Sections of right of way along the alignment of the existing ramps will be required in all four quadrants of the interchange to accommodate construction of the new ramps and loops, totaling 29.1 acres. Fortunately, other than farmland acquisition, there appears to be no geometric constraints in constructing the new full cloverleaf interchange. There should not be any major impacts to homes or businesses associated with the acquisition of the necessary right-of-way around the proposed interchange. Some development pressure is beginning to surface adjacent to the interchange. A more detailed identification of right of way requirements will be required in the near future.

***Probable Construction Costs***

A statement of probable construction costs was prepared for the reconstruction of the full cloverleaf interchange. The improvements as shown in Figure 23 are anticipated to cost approximately \$11.3 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-90: Exit 399, Cliff Avenue, Sioux Falls

The capacity analysis conducted for the interchange located at Exit 399 (Cliff Avenue) on I-90 does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. However, the westbound off-ramp currently backs up onto the mainline during certain periods. As traffic volumes grow, even though the signalized intersections are projected to provide acceptable traffic operations, the queuing problem will continue. It may be desirable to construct a separate right turn lane on the westbound off-ramp to increase the capacity and storage length available on the ramp.



Ultimately, it may be necessary to construct a single point interchange at this location to address these deficiencies, to reduce the number of signals along Cliff Avenue and to provide improved traffic operations and progression. This interchange is programmed for reconstruction in the Year 2005. Access control along Cliff Avenue should also be addressed at the time of improvements, in cooperation with the City of Sioux Falls and the adjacent property owners.

### Existing Interchange Characteristics

#### **Geometry**

The existing interchange is a diamond configuration, with a spacing of approximately 500' between the interchange ramp intersections. Both intersections are presently signalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto Cliff Avenue. The cross section of Cliff Avenue is a five-lane section, with a two-way left turn lane south of the interchange.

#### **Traffic Safety**

This interchange ranked 16<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 37 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

#### **Capacity**

The capacity analysis performed for the existing configuration of the Cliff Avenue interchange indicates that the ramp intersections are currently operating at level of service A. By the Year

# SDDOT Interstate Corridor Study - Phase II

2020, the eastbound ramp intersection is projected to operate at LOS B and the westbound ramp intersection at LOS C.

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
EB Diverge	C	A	B	C	Acceptable
EB Merge	C	B	B	C	Acceptable
WB Diverge	C	A	B	C	Acceptable
WB Merge	C	A	B	C	Acceptable
North Intersection	D	A	B	C	Acceptable
South Intersection	D	A	A	B	Acceptable

## Proposed Interchange Concept

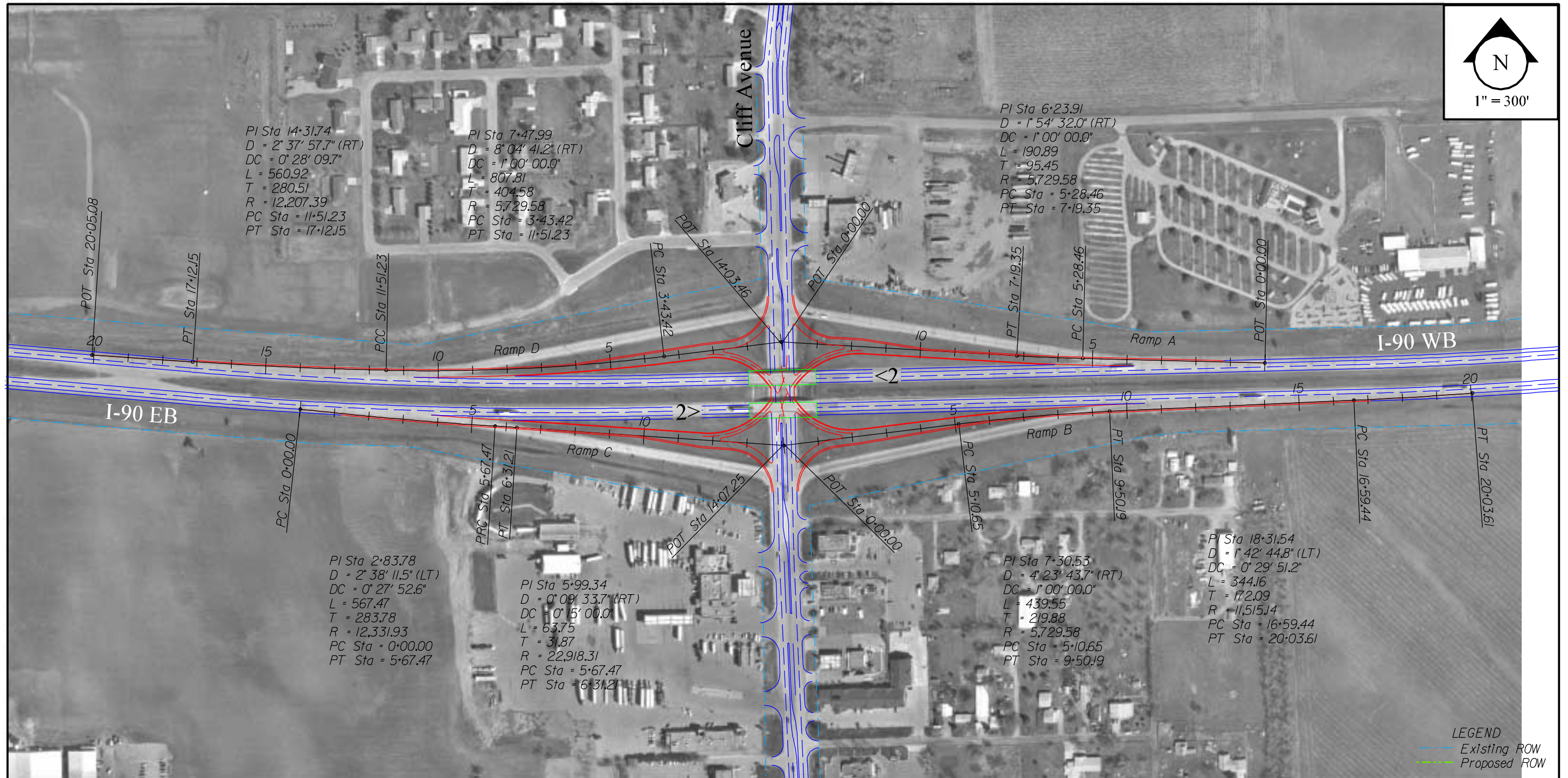
The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels through the Year 2020. As an alternative to the existing diamond interchange, a single point interchange concept was also developed for this location. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 24.

### Geometry

Based on the traffic projections, it appears that single left turn lanes for the single point interchange will provide acceptable traffic operations. However, with the cross section of Cliff Avenue, the left turn lanes on the off-ramps should be constructed to provide dual left turn lanes in the future. The configuration shown in the figure provides approximately 250' of storage for the left turn lanes and 200' of storage for the right turn lanes. If a raised median is constructed along Cliff Avenue, 200' of storage should be provided for the northbound and southbound left turn lanes.

### Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10<sup>th</sup> Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.



# SDDOT Interstate Corridor Study - Phase II

## **Capacity**

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in following table.

### *I-90/Cliff Avenue Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Cliff Ave. Single Point Interchange	2020	Sig.	C	C	-	C	C	-	B	-	-	B	-	-	C

## **Access Control**

On the north side of the interchange, an unsignalized intersection with Cliff Avenue to the west is located only 200' north of the ramp intersection. In addition, driveways to the property located on the east side of Cliff Avenue are only 150' north of the ramp intersection. It would be advantageous to continue the four lane divided section to the north and driveways be consolidated to create a four way intersection. The four lane divided section could then be transitioned back to the existing four lane undivided section, approximately 1500' to the north of the interchange.

South of the interchange Cliff Avenue is a five lane section with a center two way left turn lane. It would be beneficial for both operations and safety to continue a five lane divided section south of the interchange past the intersection of North 60<sup>th</sup> Street with Cliff Avenue. Currently there are many ingress/egress points for the adjacent properties. It is recommended to consolidate as many of these as possible and provide only one full movement access between the interchange and North 60<sup>th</sup> Street. A possible median configuration can be seen in Figure 24.

Concern has been expressed by the City of Sioux Falls regarding the impact a raised median would have on the heavy truck operations along this corridor. The resulting U-turn movements that would occur would be very difficult for the truck traffic that access the adjacent properties. A thorough access management study, working closely with the City of Sioux Falls and adjacent property owners, should be conducted on this section of Cliff Avenue to determine specific improvements to enhance traffic operations and safety.

## **Right-of-Way**

Additional right of way will not be required to construct the proposed single point interchange and other improvements at the Cliff Avenue interchange with I-90.

## **Probable Construction Costs**

A statement of probable construction costs was prepared for the construction of the single point interchange. Design and construction of the interchange is estimated at \$5.74 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-90: Exit 400, I-229 Interchange, Sioux Falls

The capacity analysis performed for this interchange in the Phase I study indicated that the existing trumpet interchange will be able to accommodate the Year 2020 traffic volumes. The key issues at this interchange are providing I-90 access to and from the north and addressing the geometric deficiencies of the ramps.

A full cloverleaf interchange was developed in Phase I that meets current design standards and corrects the existing geometric deficiencies. The proposed full cloverleaf interchange can be constructed in phases, with the ramps for movements to and from the north added at a later date as warranted by growth and development in the area.



### Existing Interchange Characteristics

#### **Geometry**

The existing trumpet interchange contains loop ramps in the northern quadrants of the interchange with substandard radii and 8% superelevation rates. The loop ramp in the northwest quadrant contains a minimum radius of 230', and the loop ramp in the northeast quadrant contains a 180' radius. In addition the direct ramps in the southern quadrants have a superelevation rate of 7%. The on-ramp taper rates for ramps B and C are also below the design criteria of 50:1.

#### **Traffic Safety**

This interchange ranked 10<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. The detailed analysis conducted for this interchange indicated that the predominate accident type is out of control vehicles, mostly during inclement weather. A total of 33 accidents occurred at this intersection between 1997 and 1999. One of the accidents was fatal, which vaulted this interchange into the high accident group. Since most of the out of control accidents occurred when there was snow or ice on the roadway, there could be some correlation with the superelevation rates provided on the ramps.

#### **Capacity**

The capacity analysis performed for the existing trumpet configuration indicates that all of the traffic movements are currently operating at level of service A or B. By the Year 2020, all of the traffic movements are projected to operate at LOS B or C.

# SDDOT Interstate Corridor Study - Phase II

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
I-90 EB Diverge	C	A	B	C	Acceptable
I-90 EB Merge	C	B	B	C	Acceptable
I-229 NB/EB Diverge	C	A	B	B	Acceptable
I-229 NB/WS Diverge	C	A	B	B	Acceptable
I-229 EB/SB Merge	C	A	B	C	Acceptable
I-229 WB/SB Merge	C	A	B	B	Acceptable
I-229 WB Weave	C	A	B	C	Acceptable

## Proposed Interchange Alternatives

Based on the capacity analysis conducted in Phase I, it appears that the current configuration of the interchange will accommodate the traffic projections through the Year 2020. The decision to reconstruct this interchange will be based on the desire to provide improved I-90 access to and from the north, or to address the geometric deficiencies on the ramps. A functional design of the proposed interchange is shown in Figure 25.

### Geometry

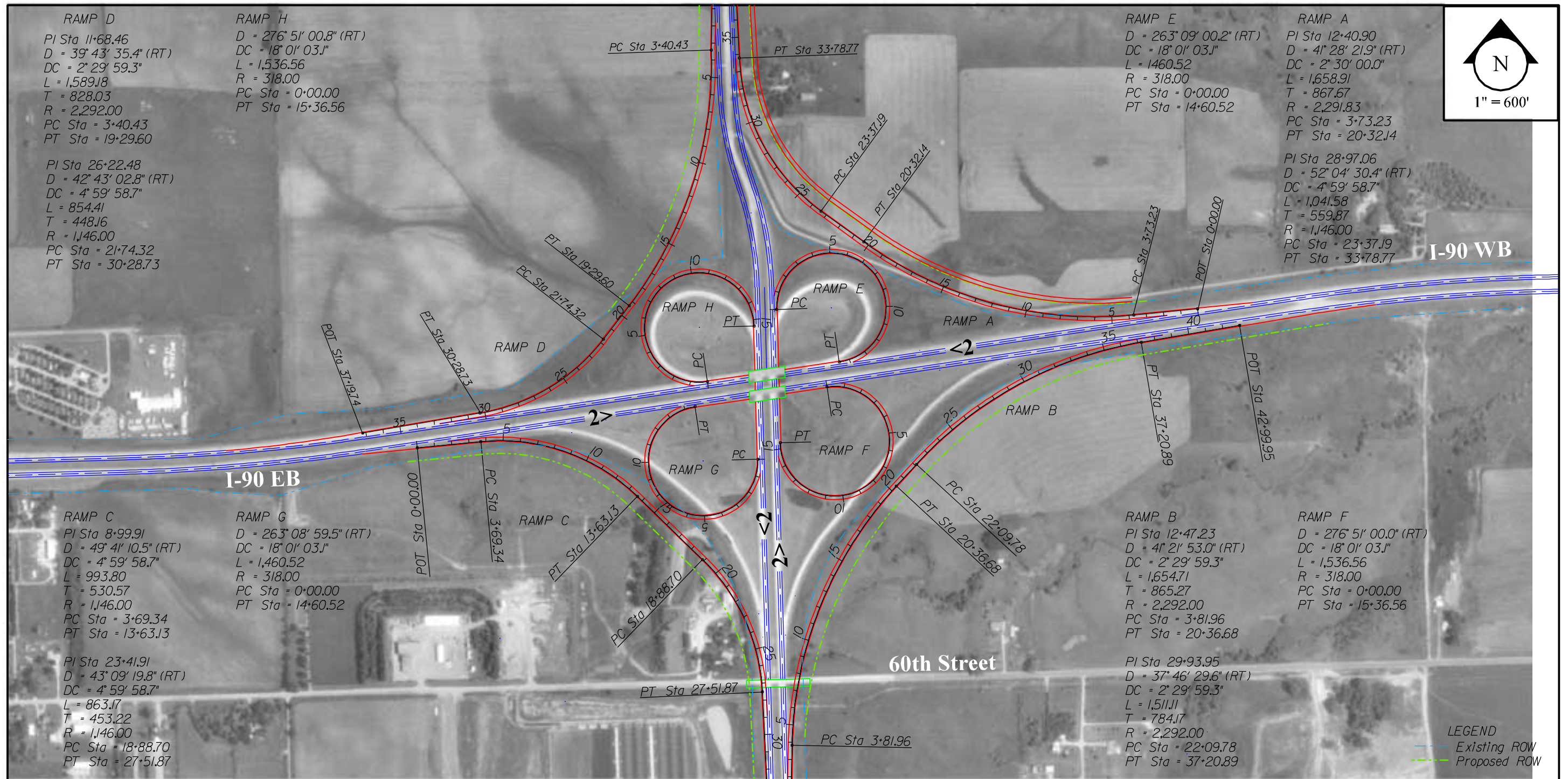
The ultimate configuration for the interchange, as shown in the figure, provides loop ramps in each of the four interchange quadrants. The loop ramps as designed provide a 318' constant radius. The reconstruction of the two existing loop ramps also results in an extended weaving area between the loops on the I-90 westbound mainline.

In order to accommodate the construction of the loop ramps, it is necessary to realign the existing direct ramps in the southeast and southwest quadrants. This also provides an opportunity to correct the geometric deficiencies with regard to superelevation rate, taper lengths and pavement widths.

New direct ramps are proposed for the northeast and northwest quadrants to complete the accessibility of I-90 to and from the north. Although these ramps may not be required initially, the ultimate configuration of the interchange should be provided for through the right of way acquisition process.

It should be noted that the existing bridge structures are new and were designed for future expansion and therefore will not be considered in the cost estimates.





# *SDDOT Interstate Corridor Study - Phase II*

## ***Traffic Safety***

The reconstruction of the existing loop ramps and the direct ramps to the south should help to reduce the frequency of out of control accidents during inclement weather. It should be noted that the total number of accidents at this interchange is relatively low compared to the volume of traffic, however, the one fatal accident resulted in identification as a high accident location.

## ***Capacity***

The major turning movements at the I-90/I-229 interchange will remain constant with the full cloverleaf interchange. The only significant change is with regard to the weaving distance provided on I-90 westbound between the loop ramps. With the increased distance provided, this movement is projected to improve from LOS C to LOS B in the Year 2020. The remaining merge/diverge movements are projected to operate at LOS C or better in the Year 2020.

Based on the traffic projections developed for the existing configuration in the Year 2020, the volume of traffic to and from the north is anticipated to be considerably less than to I-229 to the south. With these lower turning volumes, the new merge and diverge movements on I-90 westbound and the weave movements between the loop ramps for I-90 eastbound are anticipated to also operate at LOS C or better.

## ***Access Control***

The only access control issues pertinent to this interchange are with regard to the roadway to the north. As the area north of I-90 develops, direct access to the county road should be controlled and kept sufficient distance away from the northern ends of the ramp tapers. The first access point to the north should probably be a minimum of ½ mile north of the ramp tapers. A frontage road should be constructed to provide access to the two properties located north of I-90.

## ***Right-of-way***

A total of 29.5 acres of right of way will be required to construct the full cloverleaf interchange as shown in the figure. The most significant impact to adjacent property is in the southeast quadrant of the interchange. In order to construct a loop ramp and realign the direct ramp in that quadrant, it will be necessary to acquire the farmstead. Based on the aerial photo, it appears that the construction limits will result in a total acquisition of this property.

The farmstead located on the northern edge of the new interchange, on the east side of the county road, will also be impacted by the construction. However, it appears that this impact will be relatively minor. In fact, a slight shift in the roadway alignment to the west would minimize the impact even further.

## ***Probable Construction Costs***

A statement of probable construction costs was prepared for the construction of the full cloverleaf interchange. Design and construction of the interchange is estimated at \$6.7 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 2, North Sioux City

The capacity analysis performed for this interchange in the Phase I study indicated that the existing tight diamond configuration will be able to accommodate the Year 2020 traffic volumes with signalization provided at both of the ramp intersections. However, with the amount of undeveloped property in the immediate vicinity of the interchange, and the close proximity of adjacent access points on the cross road, a single point interchange concept was developed. The single point configuration has the ability to accommodate considerably more traffic through the interchange, should any future development result in a significant increase in traffic above the levels forecast. It will also provide an opportunity to improve the geometric deficiencies of the present configuration.



### Existing Interchange Characteristics

#### **Geometry**

The existing interchange is a tight diamond configuration, with a spacing of approximately 400' between the interchange ramp intersections. Both intersections are presently signalized. The northbound off-ramp widens to a three-lane section, providing dual right turn lanes and a shared through/left turn lane. The southbound off-ramp provides a shared left/through/right lane. The crossroad provides a shared through/left turn lane at each of the ramp intersections.

#### **Traffic Safety**

This interchange ranked 15<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 40 accidents occurred at this intersection between 1997 and 1999. The Exit 2 accident history does not imply any specific geometric deficiencies that may be contributing to the accidents.

#### **Capacity**

The capacity analysis performed for the existing configuration of the Exit 2 interchange indicates that all of the traffic movements are currently operating at level of service A or B. By the Year 2020, all of the traffic movements are projected to operate at LOS B, with the exception of the southbound off-ramp intersection, which is projected to operate at LOS C.

# SDDOT Interstate Corridor Study - Phase II

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	B	B	Acceptable
NB Merge	C	A	B	B	Acceptable
SB Diverge	C	A	B	B	Acceptable
SB Merge	C	B	B	B	Acceptable
East Intersection	D	B	B	B	Acceptable
West Intersection	D	A	A	C	Acceptable

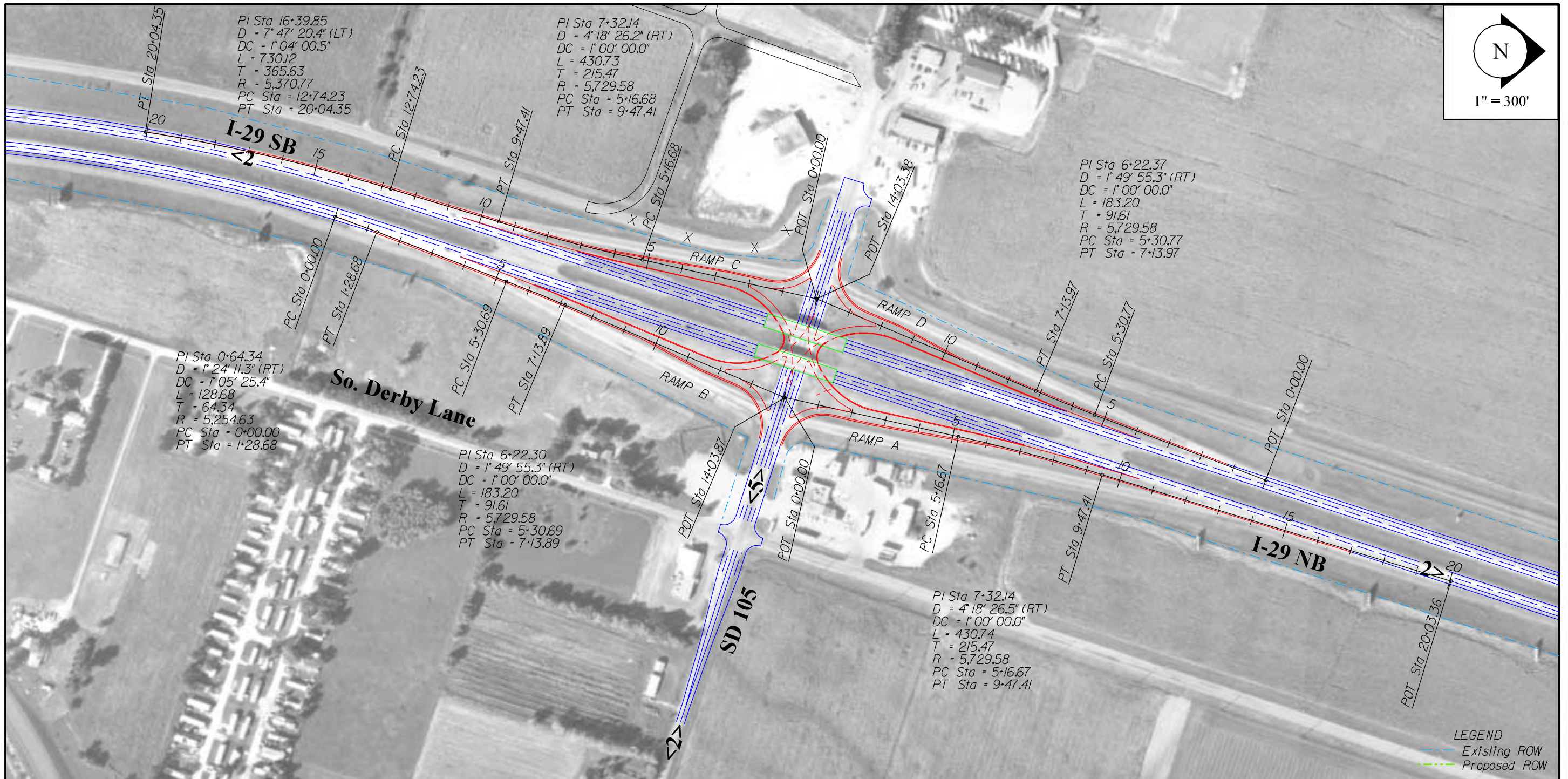
## Proposed Interchange Alternatives

Although the capacity analysis indicated that the present tight diamond configuration would provide acceptable traffic operations through the Year 2020, unforeseen developments in the vicinity of the interchange may result in significant increases in traffic movements through the interchange. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of the single point interchange is likely to be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed interchange is shown in Figure 26.

### Geometry

At the time of reconstruction, it is recommended that a five-lane section be provided on the crossroad, from the intersection with South Derby Lane on the east to the frontage road intersection on the west. It may be desirable to consider the construction of a raised median on the crossroad approaches to the interchange, which would restrict the driveways to the property in the northeast quadrant to right-in/right-out access.

The westbound left turn lane at the interchange will require a storage length of approximately 300' to accommodate the 95<sup>th</sup> percentile queue length. The eastbound left turn lane will only require 100' of storage, however, it is recommended that the minimum of 200' of storage be constructed. The capacity analysis indicates that the 200' of storage for the left and right turn lanes on the off-ramps will be more than adequate to accommodate the projected traffic volumes. It should be noted that the configuration shown in the figure has the ability to accommodate dual left turn lanes from the off-ramps, should conditions require the additional capacity. The table below summarizes the recommended right and left turn storage lengths.



# SDDOT Interstate Corridor Study - Phase II

## Recommended Vehicle Storage Lengths

Intersection	Movement	Recommended Storage Length
Exit 2 Single Point Off-Ramps	Northbound Left-Turn	200 feet
	Northbound Right-turn	200 feet
	Southbound Left-turn	200 feet
	Southbound Right-turn	200 feet
Exit 2	Westbound Left-turn	300 feet
	Eastbound Left-turn	200 feet

## Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10<sup>th</sup> Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

## Capacity

The capacity analysis performed for the existing conditions applies to this concept as well. The turning movements, lane configurations and traffic control were kept constant between the two scenarios. As previously indicated, this configuration will operate at acceptable levels of service through the Year 2020.

The results of the capacity analysis are depicted in the following table. As shown in the table, the single point interchange as shown in the figure will operate at acceptable levels of service in the Year 2025.

## I-29 Exit 2 Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Exit 2 Single Point Interchange	2010	Sig.	B	-	-	B	-	-	B	B	-	B	A	-	B
Exit 2 Single Point Interchange	2020	Sig.	B	-	-	B	-	-	C	B	-	B	A	-	B

Future traffic operations for the ramp movements will be the same as evaluated for the existing conditions, since one-lane on and off ramps will still be provided. The capacity analysis indicated that the level of service for these movements will operate at LOS B for the Year 2020.

## Access Control

The widening of crossroad through the interchange will offer the opportunity to either combine driveways or limit access to right-in/right-out only on the east side of the interchange. On the west side, the frontage road in the southwest quadrant of the interchange has recently been

## *SDDOT Interstate Corridor Study - Phase II*

relocated to the west side of the development. Ultimately, the frontage road in the northwest quadrant should also be relocated to west to provide more separation from the interchange ramps and to align with the frontage road to the south.

### ***Right-of-Way***

It appears that no additional right of way will be required to construct the proposed single point interchange at Exit 2.

### ***Probable Construction Costs***

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the single point interchange and widening of crossroad is estimated at \$5.5 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 4, McCook Lake, North Sioux City

The diamond interchange located at Exit 4 on I-29 is likely to be relocated approximately 1,400' to the north in order to align with a future dike road to the west. The Phase I study developed a two concepts, a diamond interchange and a single point interchange. The capacity analysis indicated that either concept will be able to accommodate the Year 2020 traffic forecasts at this interchange. Under both concepts, a grade separation over the adjacent railroad on the east side of I-29 and Military Road will be required. The interchange is ready to proceed into preliminary design, with the improvements programmed for the Year 2004. The ultimate interchange configuration should be conducive to the heavy truck traffic leaving the Gateway Industrial Park and Flynn Business Park, with good connections to Military Road and the former SD 105 highway. The design and construction should be coordinated with the future Dike Road. The business community and public should be involved during the design process. SIMPCO recommends that the interchange provide a connection to Streeter Drive.



### Existing Interchange Characteristics

#### **Geometry**

The existing diamond interchange provides single lane off-ramps with stop sign control. The crossroad provides a three-lane section, with separate left turn lanes at the ramp intersections. On the west side of the interchange, a frontage road intersection is located approximately 250' west of the southbound ramp intersection. To the east, an at-grade railroad crossing is located approximately 400' east of the northbound ramp intersection. An intersection with Military Road is located another 75' east of the railroad crossing. There are a few minor geometric deficiencies at the existing interchange, however, the reconstruction of the interchange to the north will remove those deficiencies.

#### **Traffic Safety**

This interchange ranked 44<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 7 accidents occurred at this intersection between 1997 and 1999. The Exit 4 accident history does not imply any specific geometric deficiencies that may be contributing to the accidents.



# SDDOT Interstate Corridor Study - Phase II

## Capacity

The capacity analysis performed for the existing diamond interchange configuration of the Exit 4 interchange indicates that all of the traffic movements are currently operating at level of service A. By the Year 2020, all of the traffic movements are projected to operate at LOS B. Based on the traffic projections, traffic signalization should not be required at the ramp intersections with the crossroad.

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	A	B	Acceptable
NB Merge	C	A	B	B	Acceptable
SB Diverge	C	A	A	B	Acceptable
SB Merge	C	A	B	B	Acceptable
East Intersection	D	A	B	B	Acceptable
West Intersection	D	A	A	B	Acceptable

## Proposed Interchange Concept

The capacity analysis indicates that the present tight diamond configuration provides acceptable traffic operations through the Year 2020. With that in mind, a diamond interchange concept was developed for the relocated interchange. A single point interchange was also designed for comparison purposes.

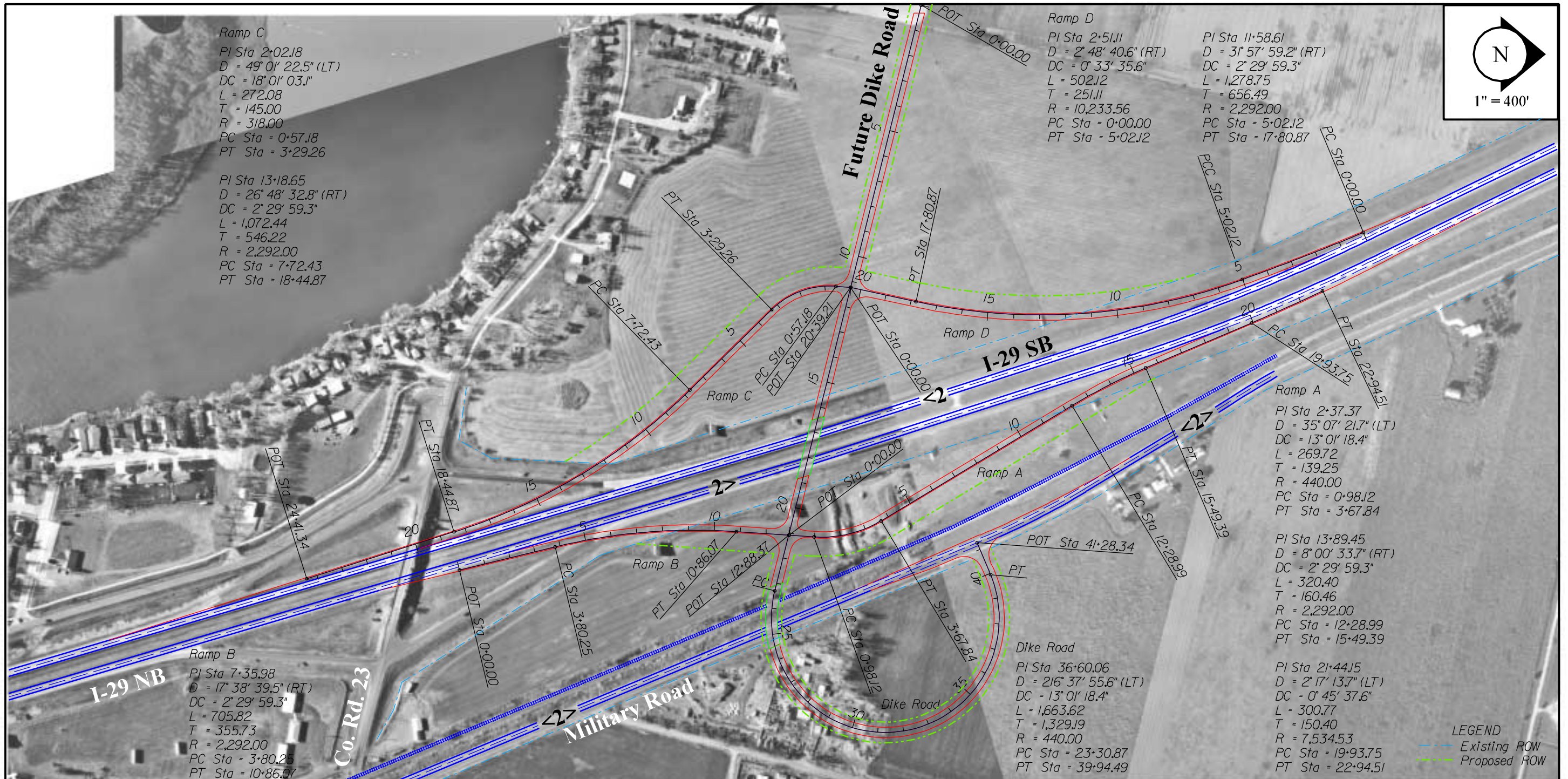
### Alternative #1 – Diamond Interchange

This concept is shown in Figure 27. Due to the proximity of the railroad and Military Road to the east of the interstate, the northbound ramps must be constructed closer to the mainline of the interstate than under normal conditions. In order to provide acceptable spacing between the ramp intersections, the southbound ramps were kicked out further to the west, which results in approximately 950' between the intersections.

### Geometry

Based on the capacity analysis, it appears that single lane off-ramps will accommodate the projected traffic volumes. However, it is recommended that the northbound and southbound off-ramps be constructed to provide separate left and right turn lanes. This will eliminate the need to widen the off-ramps at the intersection if traffic signal warrants are met in the future.

With the diamond interchange concept, it is possible maintain the tangent alignment of the future dike road to the west. Although this results in a skewed crossing of the interstate, requiring a longer bridge, the benefit of a tangent alignment is worth the additional structure costs. The typical section of this dike road is two-lanes with separate left turn lanes at the intersections.



# SDDOT Interstate Corridor Study - Phase II

In order to provide access to Military Road on the east side of I-29, it is necessary to provide a grade separation over the railroad and the roadway, and provide a connection back to Military Road as shown in the figure. Since the crossroad travels over the interstate, it is impossible to get back down to grade before reaching the railroad crossing. Military Road will require widening at the new intersection to provide a southbound left turn lane.

The eastbound and westbound left turn lanes on the dike road at the interchange should be constructed with a storage length of 150' to accommodate the projected turning movements. The separate left turn lanes on the northbound and southbound off-ramps should also provide 150' of storage. The westbound left turn lane from the dike road to the frontage road is recommended to provide 150' of storage, as is the southbound left turn lane on Military Road at the new connection.

### *Recommended Vehicle Storage Lengths*

Intersection	Movement	Recommended Storage Length
Diamond Interchange Off-Ramps	Northbound Left-Turn	150 feet
	Southbound Left-turn	150 feet
Future Dike Road/ Interchange Ramps	Westbound Left-turn	150 feet
	Eastbound Left-turn	150 feet
Dike Rd./Frontage Rd.	Westbound Left-turn	150 feet
Dike Rd./Military Rd.	Southbound Left-turn	150 feet

### *Traffic Safety*

The construction of the diamond interchange shown in the figure will likely not have any significant effect on the frequency of traffic accidents at this location. Any change would likely result in a reduction in accident frequency due to the elimination of some of the existing geometric deficiencies, such as the limited sight distance created by the existing bridge over I-29.

### *Capacity*

The capacity analysis performed for the existing conditions applies to this concept as well. The turning movements, lane configurations and traffic control were kept constant between the two scenarios. As previously indicated, this configuration will operate at acceptable levels of service through the Year 2020.

### *Access Control*

There are no major access control issues as there are no access points in the immediate vicinity of the proposed diamond interchange. If at a future date an access in the vicinity of the interchange is constructed it should be a minimum of 300' away from the proposed interchange ramps.

# *SDDOT Interstate Corridor Study - Phase II*

## *Right-of-Way*

Since the interchange will be relocated to the north, a considerable amount of right of way will be required to construct the proposed improvements. A total of 32.0 acres of right of way will be necessary to construct the diamond interchange and connection to Military Road. A right of way width of 80' is recommended for the future dike road and new frontage road. The proposed improvements will also require the acquisition and relocation of the business located between I-29 and Military Road, and the business located on the east side of Military Road. The right of way associated with the remainder of the future dike road to the west of the frontage road intersection was not calculated.

## *Probable Construction Costs*

A statement of probable construction costs was prepared for the construction of the diamond interchange and other proposed improvements. Design and construction of the diamond interchange, frontage road and connection to Military Road is estimated at \$6.06 million. This includes the grade separation over the railroad and Military Road. A breakdown of the quantities and construction costs is included in the Appendix.

## ***Alternative #2 – Single Point Interchange***

This concept is shown in Figure 28. It is difficult to construct a single point interchange when the crossroad is skewed to the interstate. Therefore, in order to eliminate the skew, the alignment of the future dike road was shifted to provide a more perpendicular crossing of I-29.

## *Geometry*

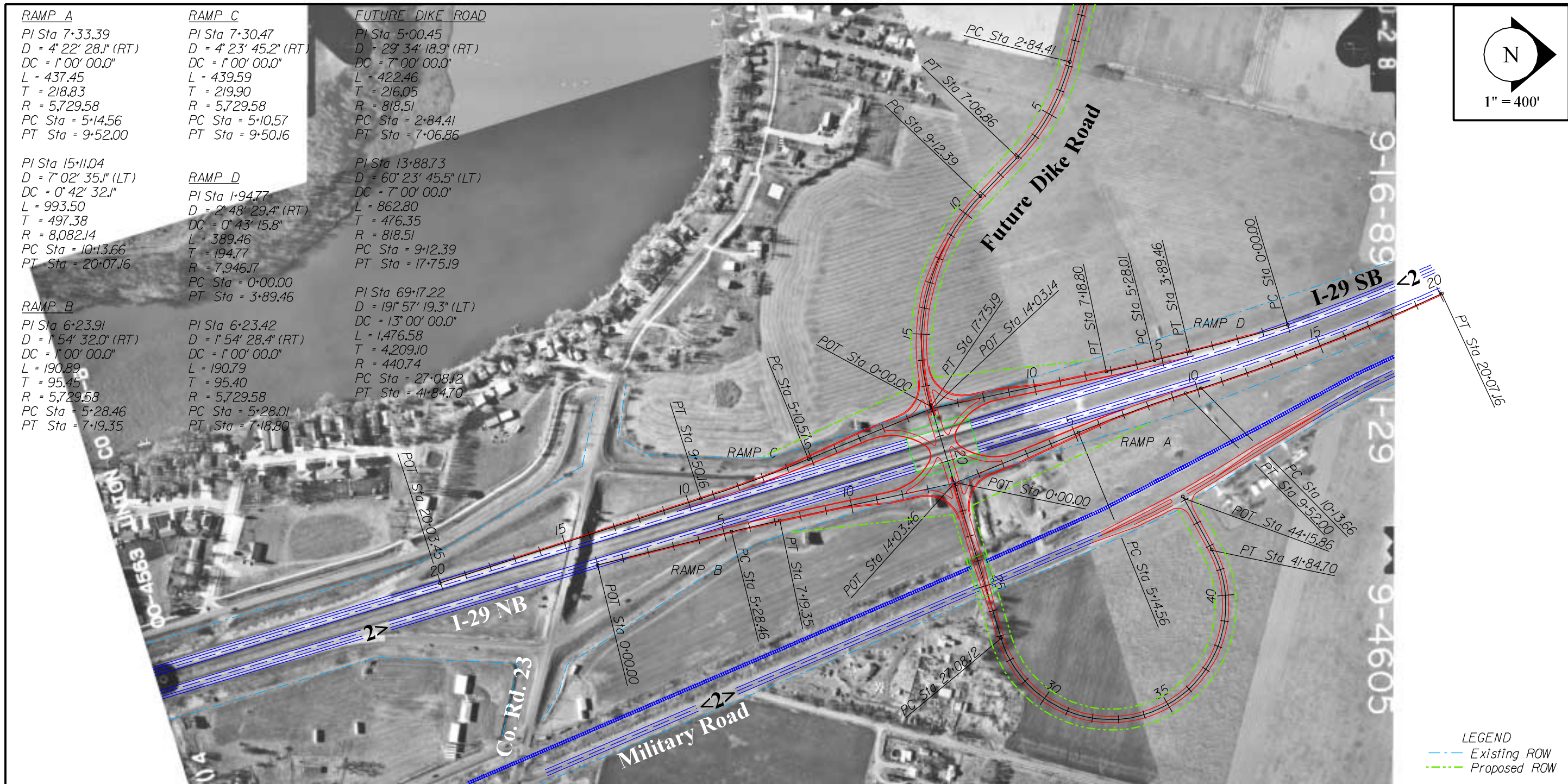
The single point interchange shown in the figure is a very compact design, which works well with the proximity of the railroad and Military Road to the east. As was the case with the diamond interchange concept, a grade separation is provided over both the railroad and Military Road. The number of lanes and the length of left turn storage length required is the same as for the diamond interchange concept. The length of frontage road that needs to be constructed is less due to the shifted alignment of the future dike road.

## *Traffic Safety*

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10<sup>th</sup> Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

## *Capacity*

The capacity analysis performed for the single point interchange indicates that this configuration will operate at acceptable levels of service through the Year 2020.



# SDDOT Interstate Corridor Study - Phase II

## Capacity Analysis with Single Point Interchange

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
Single Point Interchange	D	N/A	A	B	Acceptable

## Access Control

There are no major access control issues as there are no access points in the immediate vicinity of the proposed diamond interchange. If at a future date an access in the vicinity of the interchange is constructed it should be a minimum of 300' away from the proposed interchange.

## Right-of-Way

Since the interchange will be relocated to the north, a considerable amount of right of way will be required to construct the proposed improvements. A total of 12.9 acres of right of way will be necessary to construct the single point interchange and connection to Military Road. A right of way width of 80' is recommended for the future dike road and new frontage road. The proposed improvements will also require the acquisition and relocation of the business located between I-29 and Military Road. With this alignment, the business located on the east side of Military Road can remain. The right of way associated with the remainder of the future dike road to the west of the frontage road intersection was not calculated.

## Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the single point interchange and other proposed improvements. Design and construction of the interchange, frontage road and connection to Military Road is estimated at \$8.74 million. This includes the grade separation over the railroad and Military Road. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 79 – 12<sup>th</sup> Street, Sioux Falls

This interchange is currently programmed for reconstruction in the Year 2004. Along with the proposed interchange improvements, I-29 will be widened to provide three lanes in each direction from 41<sup>st</sup> Street (Exit 77) to SD 38 (Exit 38). The segment of 12<sup>th</sup> Street, from I-29 to Marion Road, is also scheduled for widening during 2004. At that time the 12<sup>th</sup> Street segment will consist of a six-lane section.

The area surrounding the interchange is highly developed close to the interchange, particularly on the west side. As a result, there are some constraints on potential interchange improvements. Due to the projected traffic volumes and heavy turning movements near the on and off ramps, proposed improvements must be able accommodate the traffic flow and minimize the impacts to the adjacent properties. A single point interchange was developed in Phase I of this study to address these issues. As a part of the Phase II study, further investigation has been performed to evaluate geometric and operational characteristics of the proposed concept for reconstruction of the interchange. The results of the Phase II investigation are summarized below along with selected information from Exit 79 Phase I analysis.



### Existing Interchange Characteristics

#### **Geometry**

Existing geometric features were reviewed using the as-built plans for this interchange. Every ramp at this interchange was found to have some geometric deficiencies. The as-built plans indicate that the clear zone provided on Ramps B and D is less than 30'. The grade on Ramp C is 6%, which exceeds the design criteria. The on-ramp taper rates for Ramps A and C are below the design criteria of 50:1. The profiles on several of the ramps are slightly below the 50 mph design criteria.

#### **Traffic Safety**

This interchange ranks 7<sup>th</sup> out of the 62 interchanges evaluated in the study based on a 3-year crash rate, and is considered one of the high accident locations. A detailed accident analysis was conducted at this interchange to determine if any accident trends are present that could be addressed by the development of alternative interchange concepts. The predominate accident type at this interchange is rear-end accidents. A total of 54 rear-end accidents occurred during the three-year evaluation period at the two ramp intersections. The largest number occurred on the northbound off-ramp. Westbound rear-end accidents at the west ramp intersection were also

# SDDOT Interstate Corridor Study - Phase II

relatively high. The other predominate accident type at this interchange is associated with the turning movements at the ramp intersections. A total of 33 left turn and right angle accidents were reported during the three-year period. The accidents related to turning movements were relatively evenly distributed on all of the ramps.

## Capacity

Most of the existing traffic operations at the Exit 79 interchange are within the acceptable range, except for the eastbound left turn at the northbound off-ramp intersection, and the southbound right turn movement at the southbound off-ramp intersection. Future traffic operations are expected to be problematic if no interchange improvements are made. As shown in the table below, analysis of projected future traffic conditions in both the Year 2010 and 2020 indicated that there would be a number of movements operating at or above capacity at each intersection.

### I-29/12<sup>th</sup> Street Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
12 <sup>th</sup> Street/ I-29 NB Ramps	1998	Sig.	C	-	A	-	-	-	E	A	-	-	C	A	B
12 <sup>th</sup> Street/ I-29 SB Ramps	1998	Sig.	-	-	-	D	-	F	-	C	-	D	A	-	C
12 <sup>th</sup> Street/ I-29 NB Ramps	2010	Sig.	E	-	A	-	-	-	E	A	-	-	D	A	C
12 <sup>th</sup> Street/ I-29 SB Ramps	2010	Sig.	-	-	-	D	-	F	-	E	-	D	A	-	D
12 <sup>th</sup> Street/ I-29 NB Ramps	2020	Sig.	E	-	A	-	-	-	F	A	-	-	E	A	D
12 <sup>th</sup> Street/ I-29 SB Ramps	2020	Sig.	-	-	-	D	-	F	-	F	-	F	A	-	D

Along with the analysis performed on the intersection movements, the movements on the interchange ramps were also analyzed. All of the existing ramp movements and future projected ramp movements operate at an acceptable LOS of C or better. The results of the ramp analysis are shown in the following table.

For the year 2010 and 2020 ramp and interchange analyses, the currently scheduled improvements were included. These improvements included the widening of I-29 to three lanes in each direction and adding storage length to the left turn lanes off of 12<sup>th</sup> Street onto the northbound and southbound on ramps.



# SDDOT Interstate Corridor Study - Phase II

## *I-29/12<sup>th</sup> Street Ramp LOS Analysis*

Direction	Year	Movement	LOS
I-29 Northbound	1998	Merge	B
		Diverge	B
I-29 Southbound	1998	Merge	C
		Diverge	B
I-29 Northbound	2010	Merge	B
		Diverge	B
I-29 Southbound	2010	Merge	B
		Diverge	B
I-29 Northbound	2020	Merge	C
		Diverge	C
I-29 Southbound	2020	Merge	C
		Diverge	B

## **Proposed Interchange Alternatives**

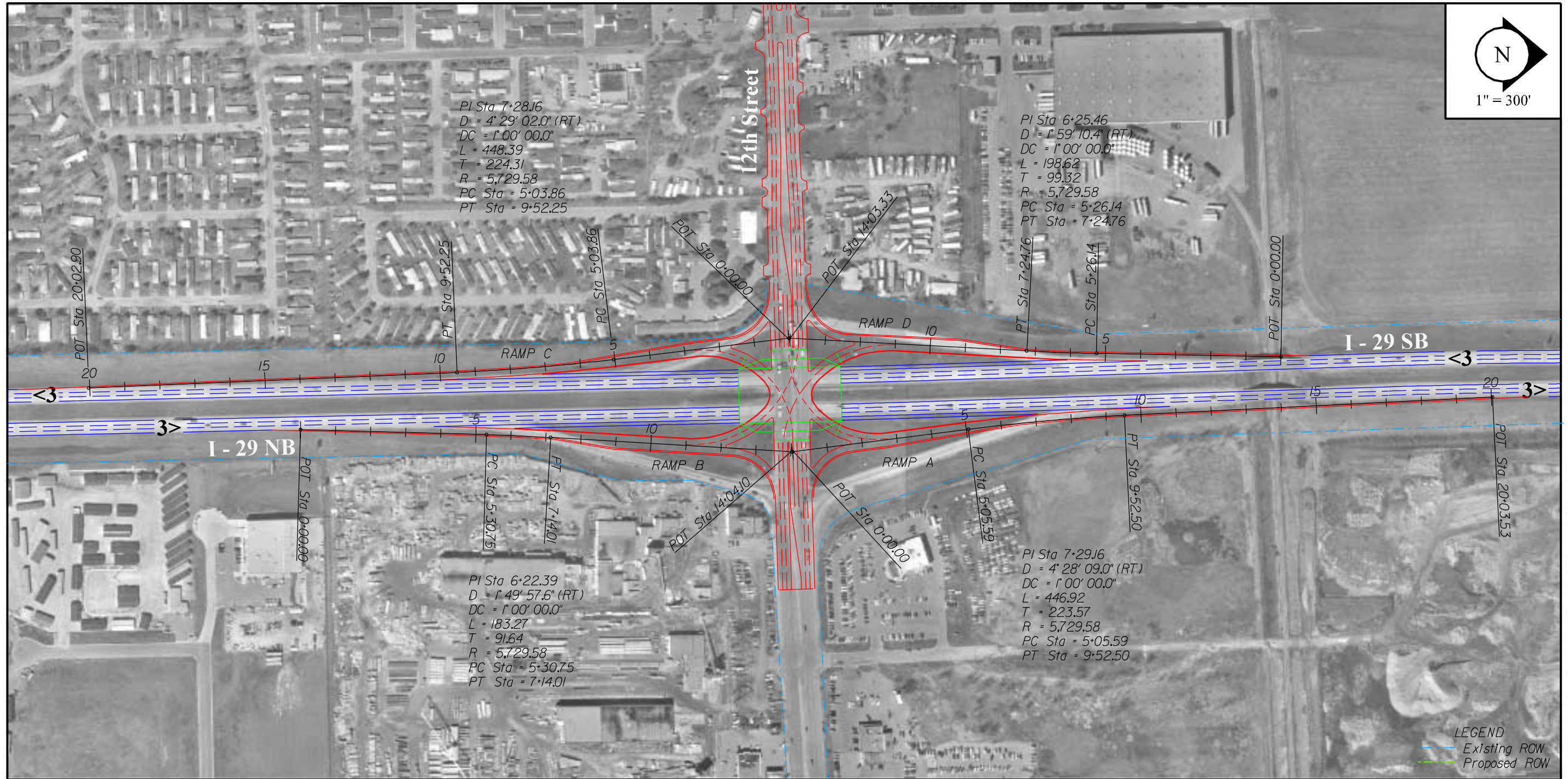
Based on the geometric deficiencies and capacity problems stated previously, a complete reconstruction of the interchange is warranted. When it becomes necessary to reconstruct this interchange, the opportunity of implementing an entirely different interchange type may exist. The new interchange design was limited by existing characteristics and development in the vicinity of the interchange. Due to the amount of development surrounding the interchange and the limited right away available, it was determined that a single point urban interchange would have the least impact on adjacent development and still provide adequate capacity to accommodate the heavy turning movements. A functional design of the proposed interchange is shown in Figure 29.

### **Geometry**

In order to accommodate the projected traffic volumes, it will be necessary to widen 12<sup>th</sup> Street to a six-lane cross section, with a raised median and dual left turn lanes. The dual left turn lanes will be able to accommodate the future traffic movements from 12<sup>th</sup> Street onto the northbound and southbound on ramps. The City of Sioux Falls has expressed concern with regard to the merging movements on the on-ramps created by the dual left turn lanes from 12<sup>th</sup> Street. It is suggested that the raised median begin at the interchange and extend two blocks to the west and one block to the east. The single point interchange configuration provides free right turns for the eastbound and westbound movements from 12<sup>th</sup> Street to the I-29 on-ramps.

### **Traffic Safety**

The current interchange is considered a high accident interchange with the accident history over the last three years. The installation of a SPUI would represent a change from the existing type of interchange and may result in a slight increase at first because of a driver's unfamiliarity with the interchange configuration. However, it is anticipated that the accident frequency will decrease over time as the drivers become more familiar with the SPUI layout.



# SDDOT Interstate Corridor Study - Phase II

## Capacity

With the SPUI concept, the number of signalized intersections on 12<sup>th</sup> Street would be reduced. Analysis of the traffic movements for Year 2010 and 2020 was performed and the results are depicted in the following table. As shown in the table, the single point interchange with the lane configuration described in the previous section will operate at acceptable levels of service through the Year 2020. All of the traffic movements operate at an acceptable level of C or better.

### I-29/12<sup>th</sup> Street Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
12 <sup>th</sup> Street/ I-29 SPUI	2010	Sig.	C	-	-	C	-	-	D	C	-	C	B	-	C
12 <sup>th</sup> Street/ I-29 SPUI	2020	Sig.	C	-	-	C	-	-	D	C	-	C	C	-	C

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for Year 2010 and 2020. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better.

### I-29/12<sup>th</sup> Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2010	Merge	B
		Diverge	B
I-29 Southbound	2010	Merge	B
		Diverge	C
I-29 Northbound	2020	Merge	C
		Diverge	C
I-29 Southbound	2020	Merge	C
		Diverge	B

## Access Control

With the new SPUI design and construction of a raised median on 12<sup>th</sup> Street, there are instances where access would differ from existing conditions. To the west of the interchange, the median would extend two blocks and would affect the turning movements at four driveways on the north side of 12<sup>th</sup> Street. All four of the driveways affected by the median allow for free movements currently, but would be changed to only right-in/right-out (RIRO) access. These driveways serve as access for a truck stop, a residence, and a fast food restaurant. The first break in the median could be provided at the intersection of 12<sup>th</sup> Street and South Petro, as shown in the figure. On the south side, the raised median would change five driveways into RIRO access. These driveways are mainly for a residential subdivision and a hotel.

## *SDDOT Interstate Corridor Study - Phase II*

The heavy truck traffic along this section of 12<sup>th</sup> Street may have difficulty maneuvering with the raised medians. A thorough access management study, with participation from the City of Sioux Falls and the adjacent property owners should be conducted at the time of design of the proposed single point interchange.

### ***Right-of-Way***

It appears that the new SPUI interchange will be able to be constructed within the available right of way. The SPUI interchange is a more compact design and the ramps would be able to fit inside the limits of the existing ramps.

### ***Probable Construction Costs***

A statement of probable construction costs was prepared for the construction of the single point interchange. Construction of this concept is anticipated to be approximately \$8.51 million. A breakdown of the quantities and construction costs is included in the Appendix. This includes the additional costs of widening 12<sup>th</sup> Street to provide dual left turn lanes through the interchange. It is assumed that the reconstruction of 12<sup>th</sup> Street from I-29 to Marion Road will include the remainder of the 12<sup>th</sup> Street construction costs.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 80 - Madison Street, Sioux Falls

A new interchange is proposed at Madison Street and I-29 in the northwest portion of Sioux Falls. The Phase I analysis indicated that due to the proximity of deep rock quarries located on the east side of I-29, a single point interchange would be the preferred concept for this interchange. An interchange justification study was prepared for this interchange to provide a detailed evaluation of the proposed configuration, anticipated traffic operations and the impacts associated with construction. This section of the report summarizes the information developed in that study.



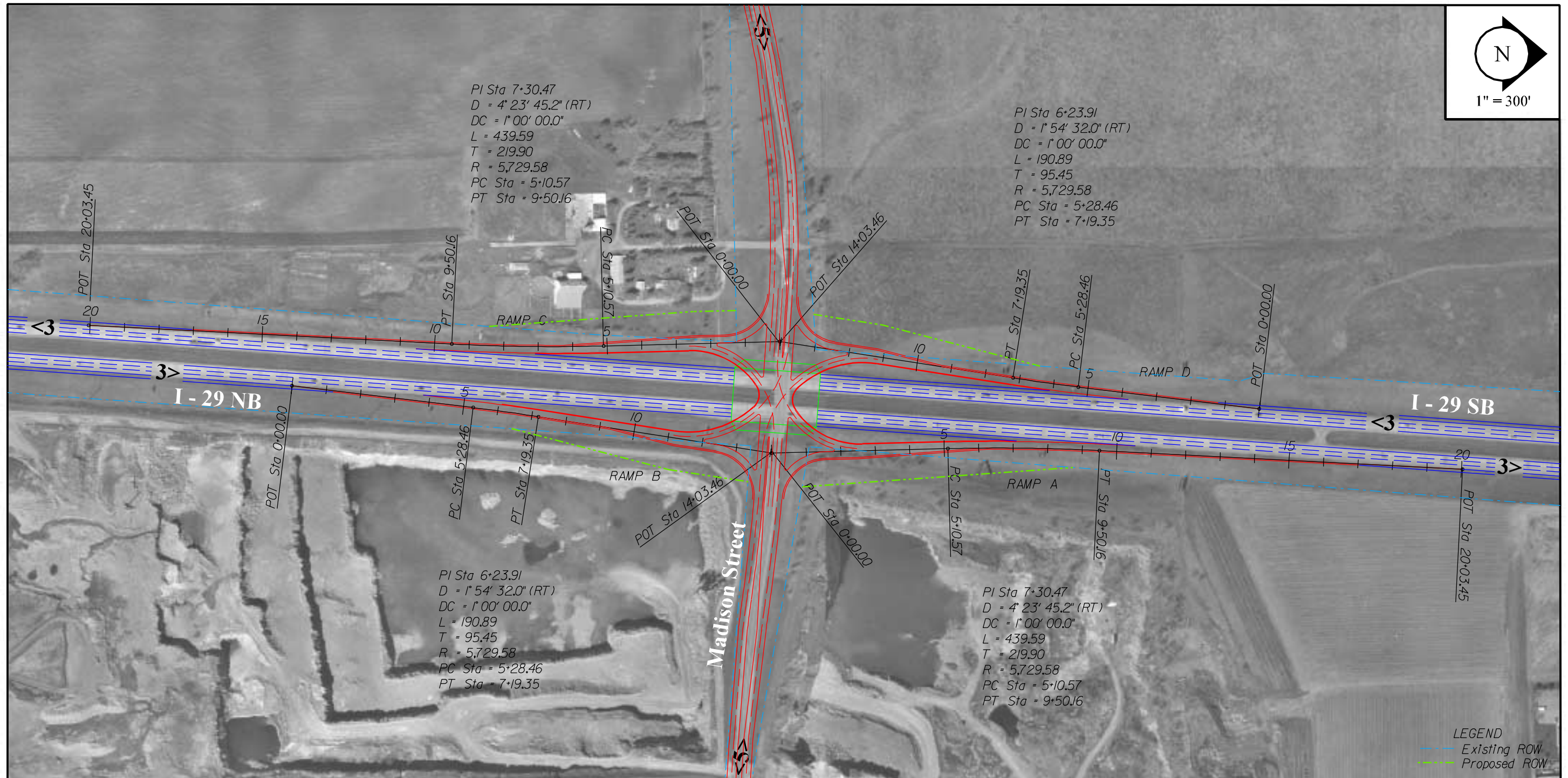
### Proposed Interchange Concept

The policy developed by the FHWA for access to the interstate system requires that all reasonable design alternatives be considered. This includes determining if the existing interchanges, local road and streets, or frontage roads in the area can provide the necessary access or be improved to satisfactorily accommodate the design year traffic demands without the construction of a new interchange.

The interchange justification study evaluated a single point urban interchange, a tight diamond interchange and the construction of frontage roads as alternative concepts. The evaluation in the justification study determined that a single point interchange was the preferred concept for this location. It was determined that the SPUI will operate with acceptable delay and will have significantly less right of way requirements compared to the diamond interchange alternative. A functional design of the proposed interchange is shown in Figure 30.

### Geometry

In order to accommodate the projected traffic volumes, it will be necessary to widen Madison Street to a four-lane divided section, with a raised median and separate left turn lanes. At the interchange, dual left turn lanes from Madison Street to the I-29 on-ramps are provided. The City of Sioux Falls has expressed concern about the merging movements on the on-ramps created by the dual left turn lanes from Madison Street. The analysis indicated that 200' eastbound and westbound left turn lanes would accommodate the 95<sup>th</sup> percentile queue length. The single point interchange configuration provides free right turns for the eastbound and westbound movements from Madison Street to the I-29 on-ramps. A summary of the recommended vehicle storage lengths for the turning movements is shown in the following table.



# SDDOT Interstate Corridor Study - Phase II

## Recommended Vehicle Storage Lengths

Intersection	Movement	Recommended Storage Length
Madison Street Single Point Off-Ramps	Dual Northbound Left-Turn	200 feet
	Northbound Right-turn	200 feet
	Dual Southbound Left-turn	200 feet
	Southbound Right-turn	200 feet
Madison Street	Westbound Dual Left-turn	200 feet
	Eastbound Dual Left-turn	200 feet

The capacity analysis indicates that the interchange will operate at acceptable levels with the construction of single left turn lanes and the free right turn lanes. However, since the cross section of Madison Street can accommodate dual left turn lanes from the off-ramps, it is recommended that the interchange be constructed with the dual left turn lanes. The concept shown in the figure provides approximately 250' of storage in one of the left turn lanes, and approximately 175' of storage in the other, which is considerably more than is required to accommodate the 95<sup>th</sup> percentile queue length.

## Traffic Safety

Since this is a new interchange, there is no accident history in the area. However, it is anticipated that the construction of a new interchange at Madison Street will result in some accidents occurring on the ramps and at the intersections with Madison Street. In fact, the accident history at the single point interchange with 10th Street on I-229 has experienced accidents associated with driver's unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

## Capacity

The requirements for analysis of future traffic operations for the interchange justification study were based on evaluation of the Year 2025 traffic volume projections. Since the process used to develop the Year 2025 traffic projections was based on additional traffic count information in the area, the analysis performed at this interchange utilized those volumes as opposed to the Year 2020 traffic projections developed in the Phase I study. The results of the analysis are depicted in the table below. As shown in the table, the single point interchange with the lane configuration described in the previous section will operate at acceptable levels of service.

## I-29/Madison Street Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Madison Street Single Point	2025	Sig.	C	-	-	C	-	-	C	B	-	C	B	-	B

# SDDOT Interstate Corridor Study - Phase II

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for the Year 2025. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better. The lane configuration assumes one lane on and off ramps and three through lanes on I-29.

## *I-29/Madison Street Ramp LOS Analysis*

Direction	Year	Movement	LOS
I-29 Northbound	2025	Merge	C
		Diverge	B
I-29 Southbound	2025	Merge	C
		Diverge	C

### ***Access Control***

Since the property in the vicinity of the proposed interchange is currently undeveloped, with the exception of the farmstead located in the southwest quadrant, there is an opportunity to limit the access locations along Madison Street. On the east side of I-29, the rock quarries located on the north and south side of Madison Street will effectively prevent any access point being constructed within 800' to 1,000' of the interchange. On the west side of I-29, access to the farmstead in the southwest quadrant should either be restricted to right-in/right-out access or be relocated to provide a minimum of 400' from the beginning of the right turn lanes at the interchange. It appears that adequate right of way is available to relocate this driveway access.

### ***Right-of-Way***

The construction of the single point interchange will require minimal amounts of right of way. Triangular sections of right of way will be required in each quadrant of the interchange to accommodate construction of the ramps, totaling 3.7 acres.

### ***Probable Construction Costs***

A statement of probable construction costs was prepared for the proposed construction of the interchange. Construction of the single point interchange at Madison Street is estimated at \$7.13 million. A breakdown of the quantities and construction costs is included in the Appendix. This estimate includes construction costs for the portion of Madison Street through the interchange area. It is assumed that the widening of Madison Street will be constructed as a separate project.



# *SDDOT Interstate Corridor Study - Phase II*

## **I-29: Exit 81 - Russell/Maple, Sioux Falls**

Several concepts for reconstruction of this interchange were developed and evaluated as a part of Phase I of this study. As a result of that evaluation and further detailed analysis by the South Dakota Department of Transportation, it was determined that the preferred concept for this interchange consists of a realignment of the Russell Street to provide a direct connection to the west to Maple Street. In addition to the realignment of the crossroad, the interchange concept provides loop ramps in the northwest and southeast quadrants to accommodate heavy turning movements onto the interstate. The new bridge on Maple/Russell Street should be designed with a sidewalk wide enough to accommodate a bicycle path.



### **Existing Interchange Characteristics**

#### ***Geometry***

The most notable geometric deficiency at this interchange is the left hand exit provided from southbound I-29 to the intersection with Maple and Russell Streets. The current interchange configuration is unconventional, and does not meet driver expectation. The turning movements at the intersection of Maple Street with Russell Street show that the major movement is the northbound to westbound left turn from Russell Street to Maple Street, and the eastbound to southbound right turn movement. In addition, the traffic control provided at the intersection on Maple Street with the southbound on-ramp requires the eastbound movement on Maple Street to stop and allows the westbound to southbound left turn movement, which is the heaviest, to turn without stopping.

#### ***Traffic Safety***

This interchange ranks 5<sup>th</sup> out of the 62 interchanges evaluated in the study, with a three-year crash rate of 2.45 weighted accidents per million entering vehicles. A detailed accident analysis was conducted to determine if any accident trends are present that could be addressed by the development of alternative interchange concepts. The predominate accident types at this interchange are rear-end and out of control accidents. The number of intersections and various turning movements required at within the interchange area, along with the large volumes, appear to play a role in these types of accidents. The most prominent area for rear-end accidents is at the southbound off-ramp intersection with Maple Street and Russell Street. A total of 9 rear-end accidents occurred during the three-year evaluation period.

The other predominate accident type at this interchange is out of control vehicles. A total of 25 out of control vehicle accidents occurred during the three-year period. Eleven of these were on I-29 northbound, near the area where the northbound on-ramp from Russell Street merges with

## *SDDOT Interstate Corridor Study - Phase II*

the mainline. These accidents may be associated with the 4E curve on the northbound mainline in this area. Eight more out of control vehicles were involved in accidents on or near the I-29 southbound exit to Russell Street. Most of these accidents occurred during inclement weather conditions, with snow or ice on the roadway.

### **Capacity**

The capacity analysis performed for the existing configuration of the Maple Street/Russell Street interchange indicates that the northbound off-ramp at Maple Street and the southbound off-ramp at Maple Street are currently operating at level of service F. With that being the case, the Year 2010 and 2020 analyses were conducted assuming traffic signalization has been installed at these two intersections. The northbound off-ramp is projected to operate at LOS B for the Year 2010, however, the southbound off-ramp remains at LOS F. By the Year 2020, both intersections are projected to operate at LOS F, even with signalization. In addition, the signalized intersection of Maple Street/Russell Street and the southbound off-ramp is projected to operate at LOS F in the Years 2010 and 2020. The merge and diverge analysis of the ramps with the I-29 mainline indicates that they will operate at acceptable levels of service through the Year 2020.

### **Proposed Interchange Concept**

The preferred interchange configuration for this interchange begins with a realignment of the connection from Russell Street to Maple Street. The primary traffic movement at the intersection of Russell Street with Maple Street is the east/west directional movement. The concept consists of introducing a curve on Russell Street to the northwest to provide a direct connection to Maple Street to the west of I-29. This realignment creates significant impact to the property located in the southwest corner of the Maple/Russell Street intersection, which is mostly owned by the South Dakota DOT.

This realignment provides enough room to construct a loop ramp in the northwest quadrant of the interchange to accommodate the heavy westbound to southbound left turn movement onto the interstate. Another loop ramp is provided in the southeast quadrant. Although this left turn movement is not as heavy, configuration of the interchange makes it very difficult to construct a typical left turn movement with a direct on-ramp to northbound I-29. The left hand exit for the southbound off-ramp is replaced with a conventional direct off-ramp, which requires relocation of the frontage road in the northwest quadrant of the interchange. It also creates a conventional intersection with the southbound off-ramp and on-ramp.

The difficult movement to accommodate with this concept is the connection to Maple Street on the east side of I-29. In order to provide a direct connection to Maple Street without interfering with the northbound on-ramp connection from Russell Street, it is necessary to provide a grade separation structure, with the connection to Maple Street passing under the elevated northbound on-ramp. A separate connection from the east leg of Maple Street must also be provided to the northbound on-ramp. A conceptual design of the proposed interchange is shown

# SDDOT Interstate Corridor Study - Phase II

in Figure 31. The SDDOT is in the process of developing the preliminary design for this interchange.

### **Geometry**

The realignment of the Russell Street/Maple Street connection will provide a typical four-lane divided cross section with separate left and right turn lanes to accommodate the projected traffic volumes. The construction of loop ramps at the interchange eliminates left turn movements from Maple Street onto I-29. The only left turn lane on this portion of Maple Street is to provide access to the continuation of Maple Street to the east. Separate right turn lanes are proposed for the eastbound and westbound approaches of Maple Street at the signalized intersections. The table below summarizes the right and left turn storage lengths required to accommodate the 95<sup>th</sup> percentile queue length.

### *Recommended Vehicle Storage Lengths*

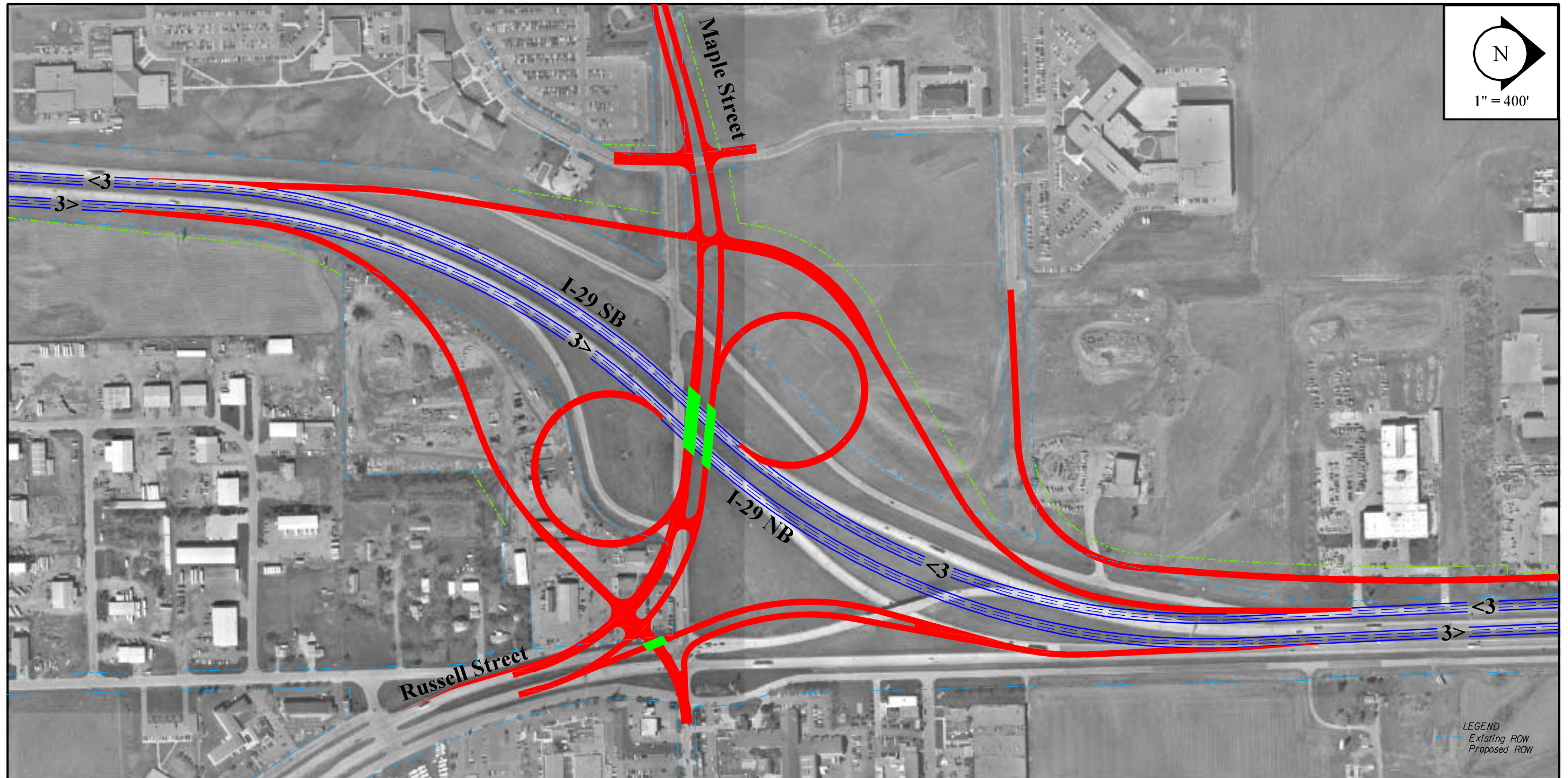
Intersection	Movement	Recommended Storage Length
Russell Street/ Maple Street/ NB Off-Ramp Intersection	Eastbound Left-turn	300 feet
	Northbound Right-turn	400 feet
	Northbound Dual Left-turn	200 feet
	Westbound Right-turn	150 feet
Maple Street/ SB Off-Ramp Intersection	Southbound Dual Left-turn	200 feet
	Southbound Right-turn	150 feet
	Eastbound Right-turn	150 feet

A three-lane section is proposed for the northbound and southbound off-ramps at the intersections with Maple Street. The configuration consists of dual left turn lanes and separate right turn lanes.

In addition to the construction of the interchange, it will be necessary to relocate the frontage roads on the east and west sides of I-29 to the north. As shown in the figure, the frontage road on the west side of I-29 can be relocated to connect with the existing roadway network in the development in the northwest quadrant of the interchange. On the east side, the frontage road connection to Maple Street must be eliminated to accommodate the proposed connection to the northbound on-ramp to I-29.

### **Traffic Safety**

The construction of the proposed interchange to provide a more conventional interchange that meets driver's expectations should help to reduce the accident frequency at this location. In addition, the reconstruction will provide an opportunity to address the other geometric deficiencies present at the existing interchange.



# SDDOT Interstate Corridor Study - Phase II

## Capacity

As a part of the interchange justification studies performed for the Madison Street and Benson Road interchanges, located one mile north and south of this interchange, Year 2025 traffic forecasts were developed for this interchange. Since the process used to develop the Year 2025 traffic projections was based on additional traffic count information in the area, the analysis performed at this interchange utilizes those volumes as opposed to the Year 2020 traffic projections developed in the Phase I study.

Three roadway network scenarios were evaluated as a part of the two justification studies. Traffic projections were developed assuming the construction of a Madison Street interchange, the construction of a Benson Road interchange, and the construction of both new interchanges. For purposes of this analysis, the traffic forecasts used assumed that both new interchanges would be in place by the Year 2025.

The results of the capacity analysis are depicted in the table. As shown in the table, the partial cloverleaf interchange as shown in the figure will operate at acceptable levels of service in the Year 2025.

### I-29/Russell/Maple Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Maple Street East Intersection	2025	Sig.	B	-	C	-	-	-	-	A	-	-	B	A	B
Maple Street West Intersection	2025	Sig.	-	-	-	B	-	C	-	A	A	-	A	-	A

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for the Year 2025. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better. The lane configuration assumes one lane on and off ramps and three through lanes on I-29.

### I-29/Russell/Maple Ramp LOS Analysis

Direction	Year	Movement	LOS
I-29 Northbound	2025	Loop Merge	B
		Ramp Merge	B
		Diverge	B
I-29 Southbound	2025	Loop Merge	B
		Ramp Merge	B
		Diverge	B

# *SDDOT Interstate Corridor Study - Phase II*

## ***Access Control***

The major reconstruction of the Maple Street and Russell Street corridor through the interchange will provide an opportunity to clean up the location of access points in the vicinity of the interchange. On the west side of the interchange, the first full movement access point will be located approximately 300 feet from the intersection with the southbound off-ramp. On the east side, the closest intersection on Russell Street will be approximately 1,050 feet from the intersection with the northbound off-ramp.

## ***Right-of-Way***

The construction of the partial cloverleaf interchange will require a significant amount of right of way to accommodate the proposed interchange and the realignment of the Russell Street/Maple Street connection. The proposed improvements will require the relocation of the SDDOT and State Patrol facilities located in the southeast quadrant of the interchange. The SDDOT maintenance yard and State Patrol represents 19.5 acres of the total 40.3 acres of right of way required for this concept.

## ***Probable Construction Costs***

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the partial cloverleaf interchange and realignment of the Russell Street/Maple Street connection is estimated at \$11.5 million. A breakdown of the quantities and construction costs is included in the Appendix.

# *SDDOT Interstate Corridor Study - Phase II*

## **I-29: Exit 82 - Benson Road, Sioux Falls**

A new interchange is proposed at Benson Road and I-29 in the northwest portion of Sioux Falls. This interchange was not originally analyzed as a part of the Phase I study. However, an interchange justification study was prepared for this interchange in the Fall of 2000 to provide a detailed evaluation of the proposed configuration, anticipated traffic operations and the impacts associated with construction. This section of the report summarizes the information developed in that study.



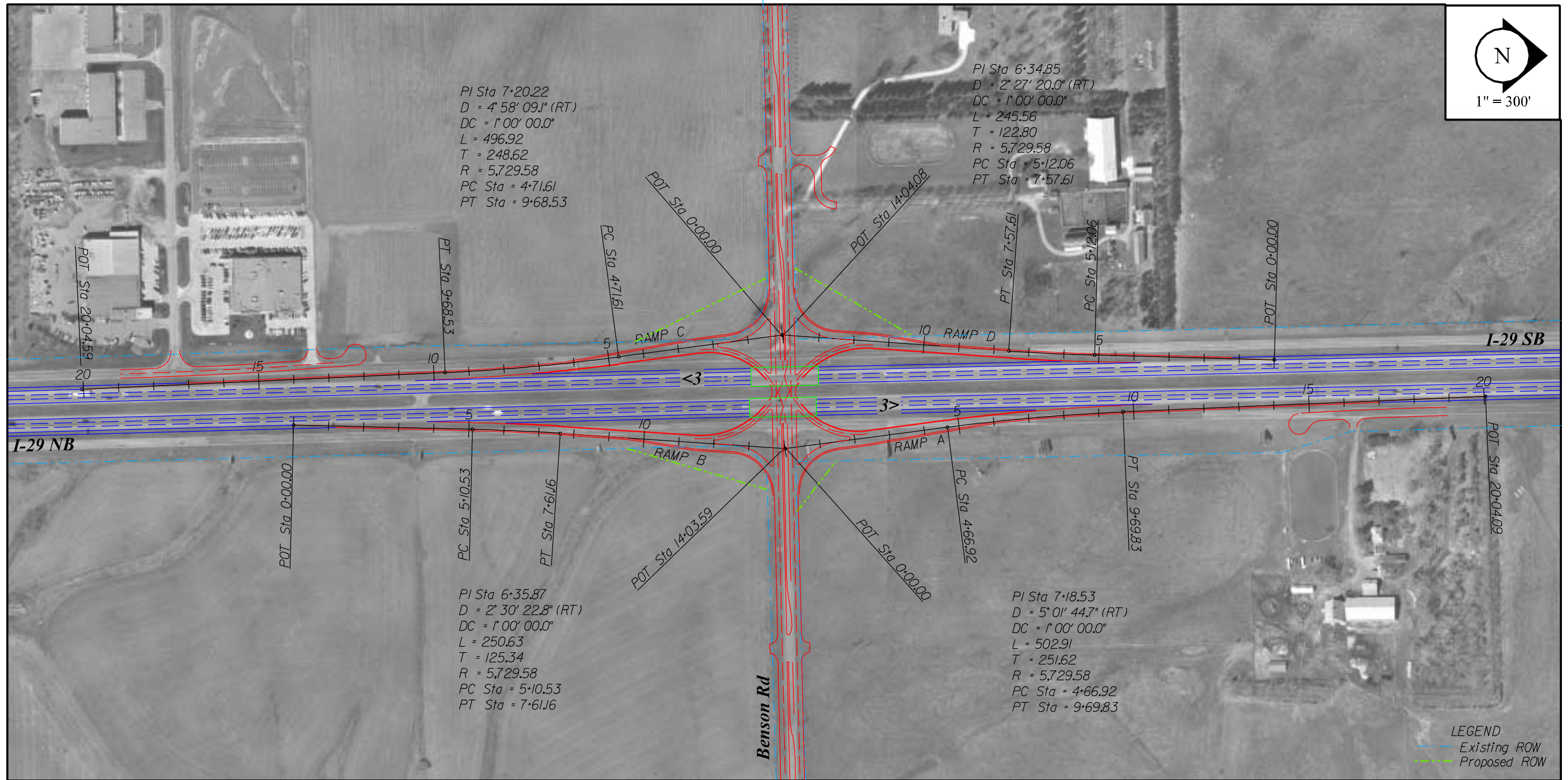
### **Proposed Interchange Concept**

The policy developed by the FHWA for access to the interstate system requires that all reasonable design alternatives be considered. This includes determining if the existing interchanges, local road and streets, or frontage roads in the area can provide the necessary access or be improved to satisfactorily accommodate the design year traffic demands without the construction of a new interchange.

The interchange justification study evaluated a single point urban interchange, a typical diamond interchange and the use of the existing frontage roads as alternative concepts. The evaluation in the justification study determined that a single point interchange was the preferred concept for this location. It was determined that the SPUI will operate with acceptable delay and will have significantly less right of way requirements compared to the diamond interchange alternative. Due to the topography in the area of the interchange, it is recommended that the mainline of I-29 be constructed over the extension of Benson Road. A functional design of the proposed interchange is shown in Figure 32.

### **Geometry**

In order to accommodate the projected traffic volumes, it will be necessary to widen Benson Road to a four-lane divided section, with a raised median and separate left turn lanes. At the interchange, single left turn lanes from Benson Road to the I-29 off-ramps are provided. The analysis indicated that 200' of storage would accommodate the 95th percentile queue length for all of the left turn movements, with the exception of the westbound left turn, which will require 450' of storage. The single point interchange configuration also provides free right turns for the eastbound and westbound movements from Benson Road to the I-29 on-ramps.





# *SDDOT Interstate Corridor Study - Phase II*

## *Recommended Vehicle Storage Lengths*

Intersection	Movement	Recommended Storage Length
Benson Road Single Point Off-Ramps	Dual Northbound Left-Turn	200 feet
	Northbound Right-turn	200 feet
	Dual Southbound Left-turn	200 feet
	Southbound Right-turn	200 feet
Benson Road	Westbound Single Left-turn	450 feet
	Eastbound Single Left-turn	200 feet

The capacity analysis indicates that the interchange will operate at acceptable levels with the construction of single left turn lanes and the free right turn lanes. However, since the cross section of Benson Road can accommodate dual left turn lanes from the off-ramps, it is recommended that the interchange off-ramps be constructed with the dual left turn lanes. The concept shown in the figure provides approximately 250' of storage in one of the left turn lanes, and approximately 175' of storage in the other, which is considerably more than is required to accommodate the 95<sup>th</sup> percentile queue length.

The mainline of I-29 will be widened to provide three-lanes in each direction in the near future. The topography in the vicinity of the proposed interchange is best suited to having the interstate mainline pass over the extension of Benson Road. This will require the construction of twin bridges on I-29 over Benson Road along with fill material required on the approaches to the structures.

In addition to the construction of the interchange, it will be necessary to eliminate the frontage roads on the east and west sides of I-29 in the vicinity of the interchange. As shown in the figure, the frontage road on the east side of I-29, north of Benson Road, will terminate at the driveway to provide access to the property. Similarly, the frontage road on the west side of I-29, south of Benson Road will also terminate at the northern driveway of the property located southwest of the interchange.

### ***Traffic Safety***

Since this is a new interchange, there is no accident history in the area. However, it is anticipated that the construction of a new interchange at Benson Road will result in some accidents occurring on the ramps and at the intersections with Benson Road. In fact, the accident history at the single point interchange with 10th Street on I-229 has experienced accidents associated with driver's unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well. Since two separate structures will be provided on I-29 over Benson Road, icy conditions during inclement weather will not be as significant as created by one large structure when the turning movements are above the interstate mainline. The narrower bridges and the separated by a median will reduce the area of icing created by the shadow of the structure.

# SDDOT Interstate Corridor Study - Phase II

## **Capacity**

The requirements for analysis of future traffic operations for the interchange justification study were based on evaluation of the Year 2025 traffic volume projections. Since the process used to develop the Year 2025 traffic projections was based on additional traffic count information, the analysis performed at this location utilized those volumes as opposed to the Year 2020 traffic projections developed in the Phase I study. As shown in the table, the single point interchange with the lane configuration described in the previous section will operate at acceptable levels of service.

### *I-29/Benson Road Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Benson Road Single Point	2025	Sig.	D	-	-	D	-	-	C	A	-	C	A	-	B

Future traffic operations for the ramp movements were also evaluated. The table below summarizes the analysis of the merge and diverge movements for the Year 2025. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better. The lane configuration assumes one lane on and off ramps and three through lanes on I-29.

### *I-29/Benson Road Ramp LOS Analysis*

Direction	Year	Movement	LOS
I-29 Northbound	2025	Merge	C
		Diverge	B
I-29 Southbound	2025	Merge	C
		Diverge	B

## **Access Control**

Since the property in the vicinity of the proposed interchange is currently undeveloped, with the exception of the farmstead located in the northwest quadrant, there is an opportunity to limit the access locations along Benson Road. On both sides of I-29, the first access point should be the intersection with the relocated frontage roads. These intersections should be located a minimum of 400' from the end of the return for the right turn lanes at the interchange. Beyond that access location, desirable spacing to the next full movement intersection should be limited to 600'.

## **Right-of-Way**

The construction of the single point interchange will require minimal amounts of property beyond the available interstate right of way. A total of 2.2 acres of right of way is required to construct the concept shown.

# *SDDOT Interstate Corridor Study - Phase II*

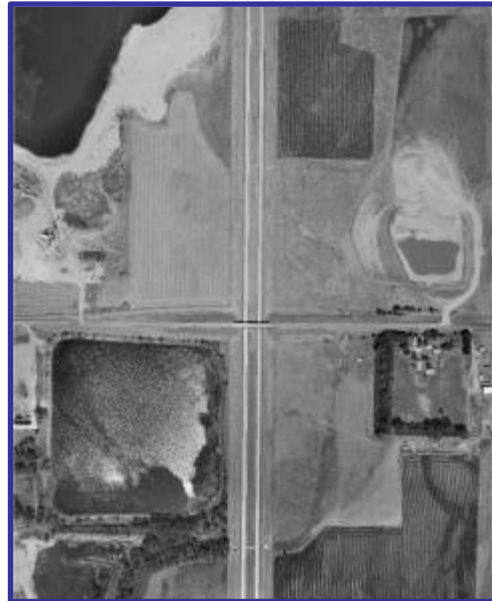
## ***Probable Construction Costs***

A statement of probable construction costs was prepared for the proposed construction of the interchange. Design and construction of the single point interchange at Benson Road is estimated at \$7.94 million. Another element of the project is the cost of elevating the mainline of I-29 over Benson Road. The preliminary cost estimate for design and construction of the mainline reconstruction is \$2.66 million. The bridges and approach slabs are included in the cost of the interchange. A breakdown of the quantities and construction costs is included in the Appendix. This estimate includes construction costs for the portion of Benson Road through the interchange area. It is assumed that the paving and widening of Benson Road will be constructed as a separate project.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 129 – C.R. 26, Brookings

The city of Brookings is proposing that an interchange be constructed at the cross road located 3 miles south of U.S. 14 (Exit 132). The Phase I investigation stated that this interchange will serve the expected new development in the area and divert some traffic from Exit 132. There has been a considerable amount of growth in the southern portion of Brookings, and this growth is expected to continue over the next 20 years. This new interchange would provide direct access to the interstate for much of this development, while allowing traffic from currently using Exit 132 to use a less congested route. This Phase II analysis will further evaluate geometric and operational characteristics of the proposed interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 129 Phase I analysis.

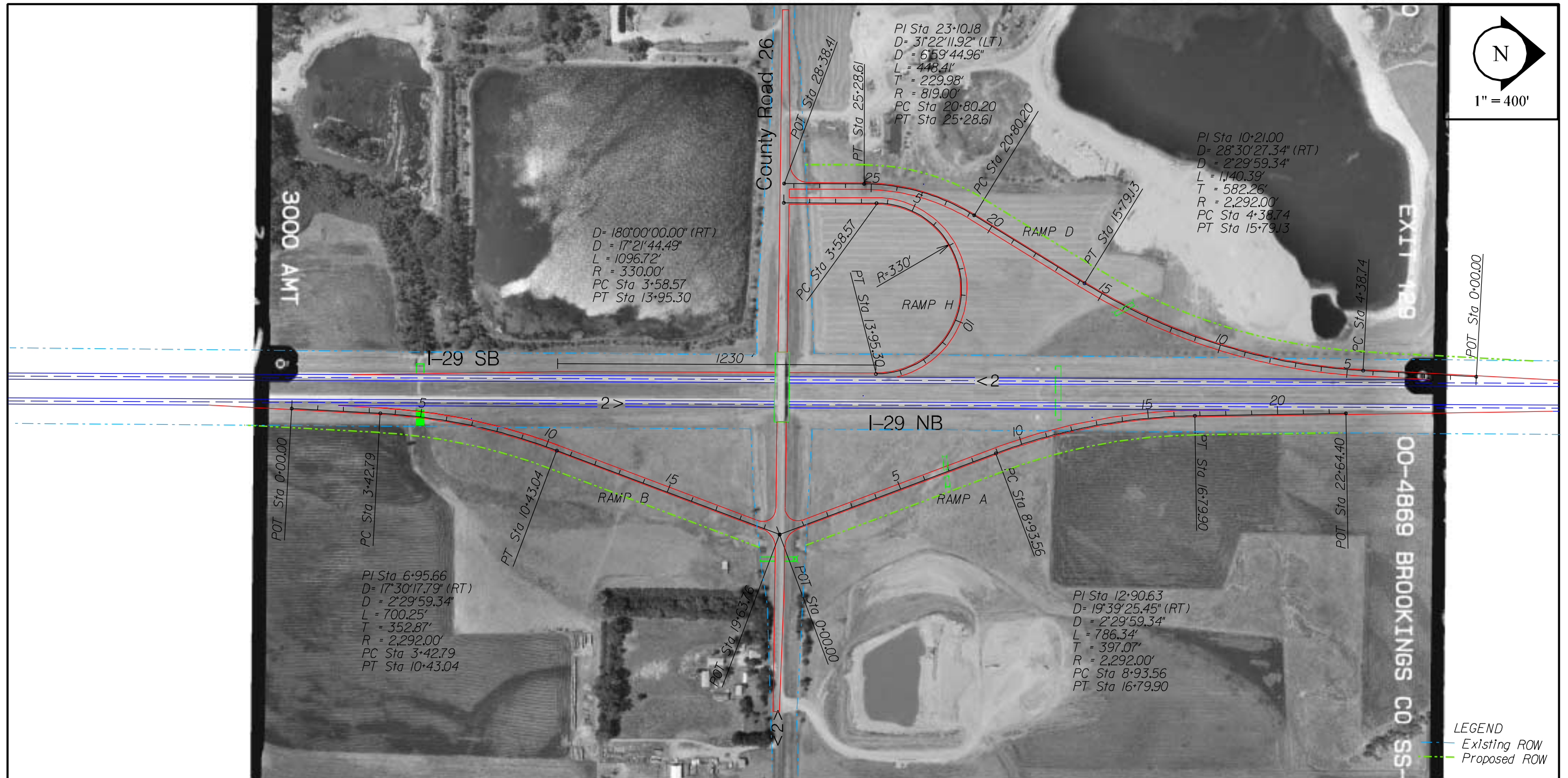


### Proposed Interchange Alternatives

Since this is a new interchange, there are no limitations in place by an existing structure or interchange. However, there are a few constraints that affect the design of an interchange at this site. There are two lakes in the vicinity of the proposed interchange location; one in the southwest quadrant and the other in the northwest quadrant. Due to the location of the lake in the southwest quadrant, it is necessary to provide a partial cloverleaf design, with a loop in the northwest quadrant to provide access to southbound I-29. The lake located in the northwest quadrant is located far enough to the west to provide the necessary room for construction of the loop ramp. Due to these constraints, only the partial cloverleaf design alternative was evaluated for this proposed interchange.

#### Geometry

The Partial Cloverleaf Interchange alternative is depicted on Figure 33. The interchange concept was developed to meet the criteria found in the SDDOT Roadway Design Manual. As shown in the figure, the design is a partial cloverleaf with the loop ramp in the northwest quadrant. There is enough room in the northwest quadrant of the interchange to accommodate both the loop ramp and the southbound off-ramp in the same quadrant. Each of the ramps provides for one lane of travel, with widening to provide separate left and right turn lanes at the intersections with the crossroad. County Road 26 should remain a two lane road, with widening at the ramp intersections to provide separate left turn lanes.



# SDDOT Interstate Corridor Study - Phase II

## **Traffic Safety**

Since this is a new interchange, there is no accident history for existing conditions. Although the construction of a new interchange will result in some accidents at this location, it is anticipated that this alternative would not create unusual safety concerns.

## **Capacity**

The two intersections with the county road will provide stop sign control for the off-ramps. The projected traffic volume at each of the intersections does not meet the MUTCD traffic warrants and would operate sufficiently with no signalization. All of the traffic movements are projected to operate at an acceptable level of C or better. The level of service (LOS) for all of the projected turning movements for both the 2010 and the 2020 are shown below.

### *Intersection Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
C.R. 26/ I-29 NB Ramps	2010	Unsig.	C	-	-	-	-	-	A	-	-	-	-	-	-
C.R. 26/ I-29 SB Ramps	2010	Unsig.	-	-	-	B	-	-	-	-	-	A	-	-	-
C.R. 26/ I-29 NB Ramps	2020	Unsig.	C	-	-	-	-	-	A	-	-	-	-	-	-
C.R. 26/ I-29 SB Ramps	2020	Unsig.	-	-	-	B	-	-	-	-	-	A	-	-	-

The level of service of the ramp movements was also analyzed. All of the ramp movements in both the Year 2010 and the Year 2020 are projected to operate at LOS A. The LOS of the ramp movements for 2010 and 2020 are shown in the table below.

### *I-29/Exit 129 Ramp Movement Level of Service Analysis*

Direction	Year	Movement	LOS
I-29 Northbound	2010	Merge	A
		Diverge	A
I-90 Southbound	2010	Merge	A
		Diverge	A
I-29 Northbound	2020	Merge	A
		Diverge	A
I-90 Southbound	2020	Merge	A
		Diverge	A

## **Access Control**

Access along the county road should be restricted within 300' of the ramp intersections, if possible.

## *SDDOT Interstate Corridor Study - Phase II*

### ***Right-of-way***

There is a considerable amount of right-of-way that must be acquired to construct the new interchange. The estimated area required is approximately 32.2 acres. There should not be any major impacts to homes or businesses associated with the acquisition of the necessary right-of-way around the proposed interchange

### ***Probable Construction Costs***

A statement of probable construction costs was prepared for the construction of the partial cloverleaf interchange. Construction of this concept is anticipated to be approximately \$5.63 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 132 – US 14, Brookings

The interchange located at Exit 132 on I-29 does not require any significant improvements to accommodate the Year 2010 or Year 2020 traffic volume projections. The geometric deficiencies of the ramps are minor, and can be corrected at the time of pavement reconstruction. With the installation of traffic signals, the interchange is projected to operate at acceptable levels of service. In addition to the traffic signalization, it is recommended that the southbound right turn lane on Ramp D be constructed to provide 200' of storage. There is also concern about pedestrian access across I-29, once the new ice rink and the new events facility are constructed on the east side of the interstate.



Ultimately, if traffic volumes warrant, the construction of a loop ramp in the northeast quadrant would be necessary to reduce the impact from northbound left turns and avoid a new hotel that has been constructed in the southeast quadrant. Access control along US 14 to the east and west should also be addressed at the time of improvements.

### Existing Interchange Characteristics

#### Geometry

The existing interchange is a diamond configuration, with a spacing of approximately 1000' between the interchange ramp intersections. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto US 14. The cross section of US 14 is a five-lane divided section, with a wide median.

#### Traffic Safety

This interchange ranked 21<sup>st</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 35 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

#### Capacity

The capacity analysis performed for the existing configuration of the US 14 interchange indicates that the ramp intersections are currently operating at level of service C. By the Year 2020, the northbound ramp intersection is projected to operate at LOS E and the southbound ramp intersection at LOS F, with the existing unsignalized intersections.



# SDDOT Interstate Corridor Study - Phase II

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	A	A	Acceptable
NB Merge	C	A	A	A	Acceptable
SB Diverge	C	A	A	A	Acceptable
SB Merge	C	A	A	A	Acceptable
West Intersection	D	C	F	F	Unacceptable
East Intersection	D	C	C	E	Unacceptable

## Proposed Interchange Concept

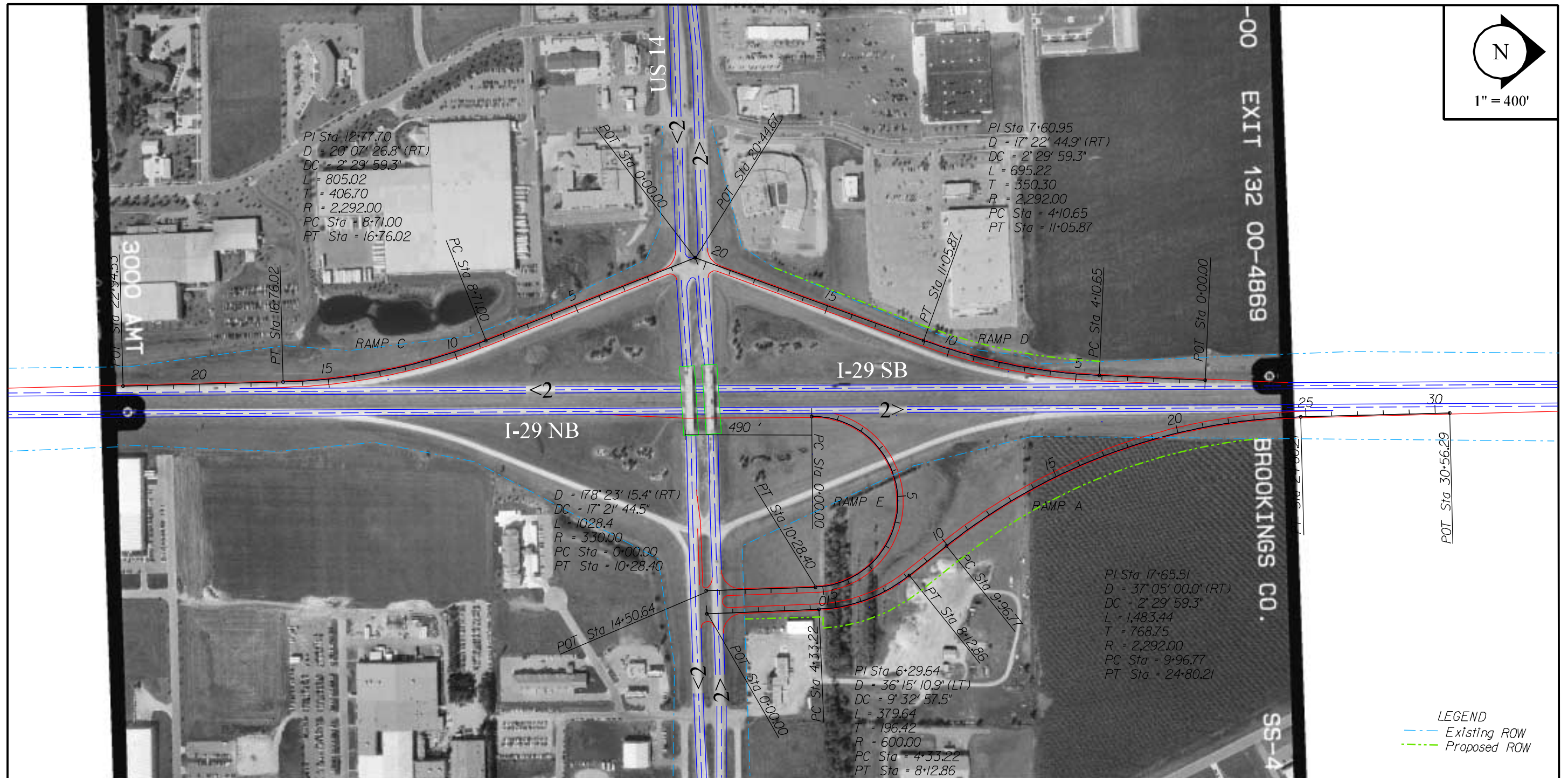
The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at unacceptable levels in the year 2010 and 2020. Signalization of the ramp terminals and the extension of the southbound off ramp right turn storage is anticipated to provide acceptable levels of service at the terminals. However, in the event that it becomes necessary to reconstruct the interchange due to higher traffic volumes, an alternative to the existing diamond interchange, a partial cloverleaf interchange concept was also developed for this location. A functional design of the proposed partial cloverleaf interchange is shown in Figure 34.

### Geometry

For the existing diamond interchange, only a few modifications are necessary to provide acceptable traffic operations in the Year 2020. Based on the traffic projections, it is recommended that a right turn lane with 200' of storage be provided on the southbound off ramp to accommodate that heavy turn movement, along with the installation of traffic signals at both ramp intersections. If a raised median is constructed along US 14, 200' of storage should be provided for the eastbound and westbound left turn lanes.

The construction of partial cloverleaf interchange at Exit 132 has been restricted somewhat due to recent development in the area. A hotel was recently constructed in the southeast quadrant of the interchange, which restricts the ability to reconstruct the interchange with a northbound to westbound free right loop ramp. With that concept, it would be necessary to reconstruct the northbound off-ramp further to the east to align with the northbound on-ramp on the north side of US 14. Therefore, the loop ramp shown in the figure provides for both right and left turns onto US 14. Signalization will be required at this intersection to provide acceptable traffic operations.

If at a later date it is determined that US 14 needs to be reconstructed, consideration should be given to narrowing or eliminating the median. One advantage to this option is that only one structure over I-29 would be needed.



# SDDOT Interstate Corridor Study - Phase II

## **Traffic Safety**

The construction of a partial cloverleaf interchange is not anticipated to adversely affect the safety of the interchange.

## **Capacity**

The capacity analysis performed for the partial cloverleaf interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in following table.

### *I-29/US 14 Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
US 14 Partial Cloverleaf East Ramps Terminal	2020	Sig.	-	-	-	C	-	A	A	A	-	-	A	-	A
US 14 Partial Cloverleaf West Ramps Terminal	2020	Sig.	-	-	-	B	-	A	-	A	A	A	A	-	A

## **Access Control**

In the immediate area of the interchange the existing access management is acceptable. Further to the north and south consideration should be given at the time of reconstruction to the use of a five lane divided section and the reduction of the access points to adjacent properties to as few as possible. This will improve traffic flow through the corridor and increase the safety in the area.

## **Right-of-Way**

The South Dakota Department of Transportation owns the property located in the northeast quadrant of the interchange. This facility will be relocated within the next several years, which presents an opportunity to construct the partial cloverleaf interchange. A total of 13.2 acres of right of way will be required to construct the concept shown in Figure 34. The majority of the right of way is associated with the construction of the ramps in the northeast quadrant. However, some right of way will also be required in the northwest quadrant to reconstruct that southbound off-ramp to meet current design criteria.

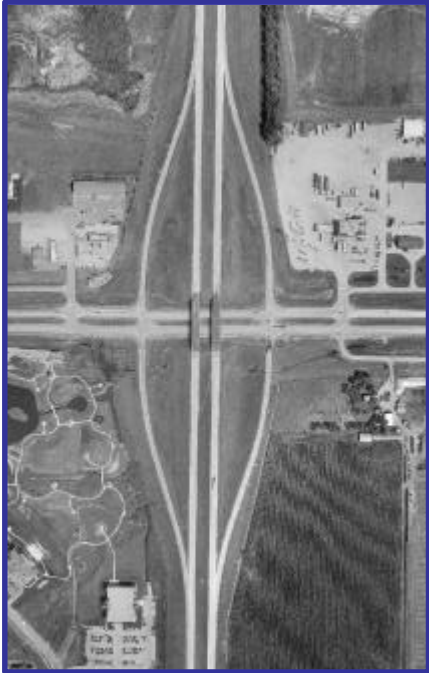
## **Probable Construction Costs**

A statement of probable construction costs was prepared for the installation of traffic signals for the existing diamond interchange and for construction of the partial cloverleaf interchange. The installation of the traffic signals and construction of a southbound right turn lane are estimated at \$365,000. The design and construction of the interchange is estimated at \$6.3 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-29: Exit 177 – US 212, Watertown

The capacity analysis performed for this interchange in the Phase I study indicated that the diamond interchange configuration will require some minor modifications in order to accommodate the Year 2020 traffic volumes. Traffic signalization is recommended at each of the ramp intersections, along with the construction of separate right turn lanes on the off-ramps. Due to the close proximity of adjacent access points on US 212, a single point interchange concept was also developed. The single point configuration has the ability to accommodate considerably more traffic through the interchange, should any future development result in a significant increase in traffic above the levels forecast. It will also provide an opportunity to improve the minor geometric deficiencies of the present interchange.



### Existing Interchange Characteristics

#### Geometry

The existing interchange is a diamond configuration, with a spacing of approximately 700' between the interchange ramp intersections. Both intersections are presently unsignalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto US 212. The cross section of US 212 is a four-lane divided section, with a wide median. Separate left turn lanes are provided at the major intersections.

#### Traffic Safety

This interchange ranked 17<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 19 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

#### Capacity

The capacity analysis performed for the existing configuration of the Exit 177 interchange indicates that all of the traffic movements are currently operating at level of service B. By the Year 2020, the northbound ramp intersection is projected to operate at LOS F and the southbound ramp intersection at LOS D, without the installation of traffic signals.

# SDDOT Interstate Corridor Study - Phase II

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge	C	A	A	A	Acceptable
NB Merge	C	A	A	A	Acceptable
SB Diverge	C	A	A	A	Acceptable
SB Merge	C	A	A	A	Acceptable
East Intersection	D	B	D	<b>F</b>	<b>Unacceptable</b>
West Intersection	D	B	C	D	Acceptable

## Proposed Interchange Alternatives

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels with the construction of separate right turn lanes on the off-ramps and the installation of traffic signals at both ramp intersections. As an alternative to these improvements, a single point interchange concept was also developed for this location.

### **Alternative #1 – Signalization and Access Management**

The first alternative simply consists of the construction of a separate right turn lane for both the northbound and southbound off-ramps and the installation of traffic signals at both intersections. A functional design of the proposed improvements is shown in Figure 35.

### *Geometry*

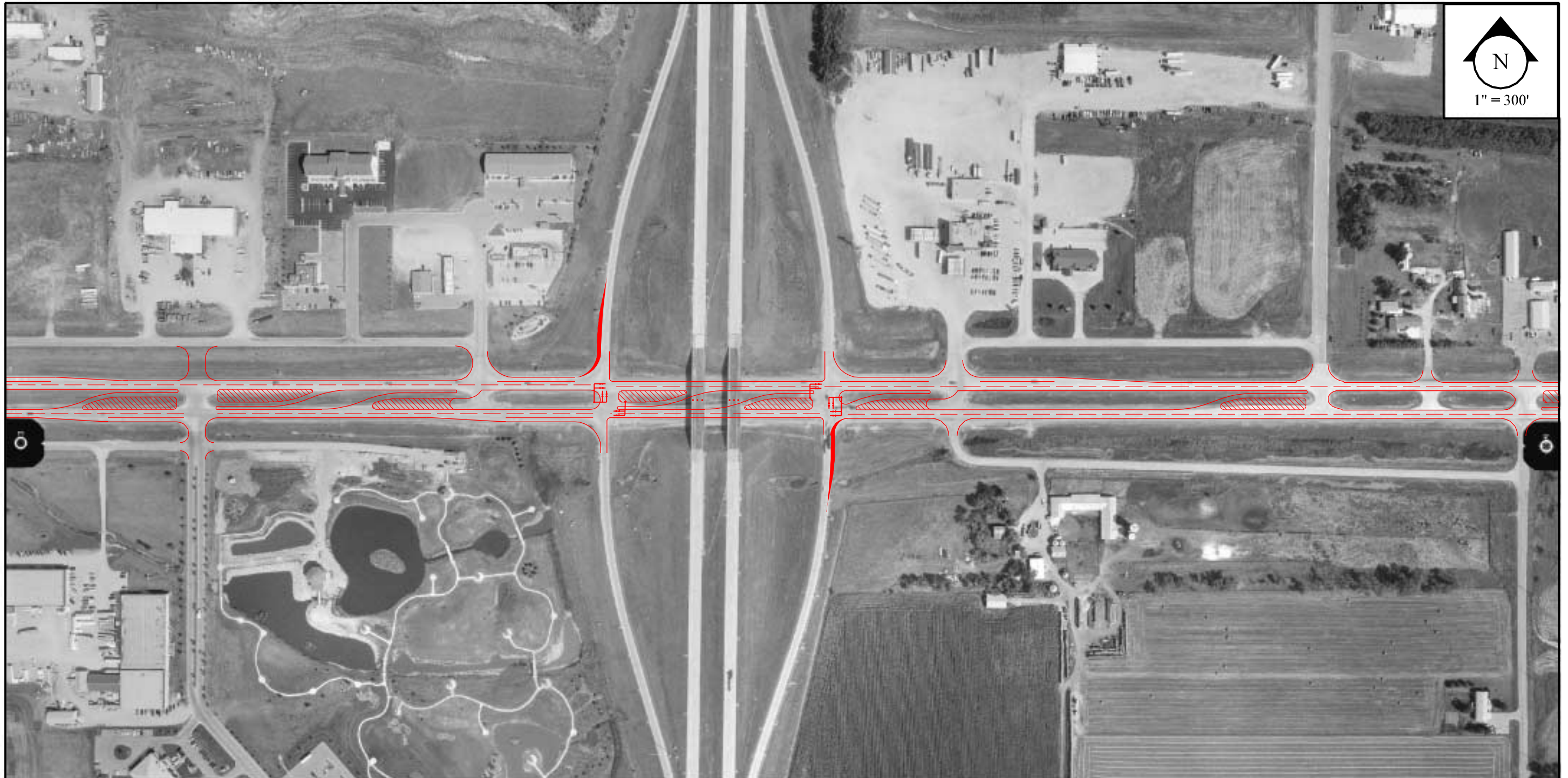
In addition to the separate right turn lanes on the off-ramps, there are a few other geometric modifications recommended along US 212 to provide improved sight distance for left turning vehicles at the major intersections. With the wide median, vehicles in the opposing left turn lane restrict the distance to see on coming through traffic. One effective method to improve the sight distance is to reconstruct the left turn lane closer to the opposing through lanes as shown in the figure. This also helps to reduce the distance the left turning vehicle must travel through the intersection. Storage lengths for the left turn lanes along US 212 should provide 200' of storage, which is more than adequate to accommodate the projected traffic volumes. The northbound and southbound right turn lanes on the off-ramps should provide 150' of storage.

### *Traffic Safety*

The construction of the proposed improvements will improve traffic operations along US 212, and should result in a reduction in accidents at the interchange and adjacent intersections.

### *Capacity*

As previously stated, the interchange will operate at acceptable levels for the Year 2020 with the proposed improvements.



# *SDDOT Interstate Corridor Study - Phase II*

## *Access Control*

In addition to the modifications recommended for the left turn lanes on US 212, some restrictions to turning movements at the adjacent intersections should also be considered. Currently, the traffic volumes at these intersections are low enough to function well. However, as traffic volumes grow, it will become more difficult to turn left onto US 212 from these frontage road intersections. On the west side of the interchange, the concept shown in the figure allows eastbound left turns from US 212 into the frontage road connection closest to the interchange. For left turn movements from the frontage road onto US 212, a new connection is proposed approximately 825' to the west. This location provides acceptable spacing should this intersection require signalization in the future.

On the east side of I-29, a similar concept is proposed. The median is reconstructed to allow eastbound left turns to enter the frontage road, however, southbound left turns onto US 212 are restricted. These left turning vehicles will be required to travel 1,050' feet to the east to make that left turn. Furthermore consideration should be given to access issues regarding the farm in the southeast quadrant of the interchange. The restriction of access to this location might be considered now before it is redeveloped, especially since there is excellent access to the highway at the first road east of the interchange.

## *Right-of-Way*

The proposed improvements for the off-ramps and the median along US 212 will not require any additional right of way.

## *Probable Construction Costs*

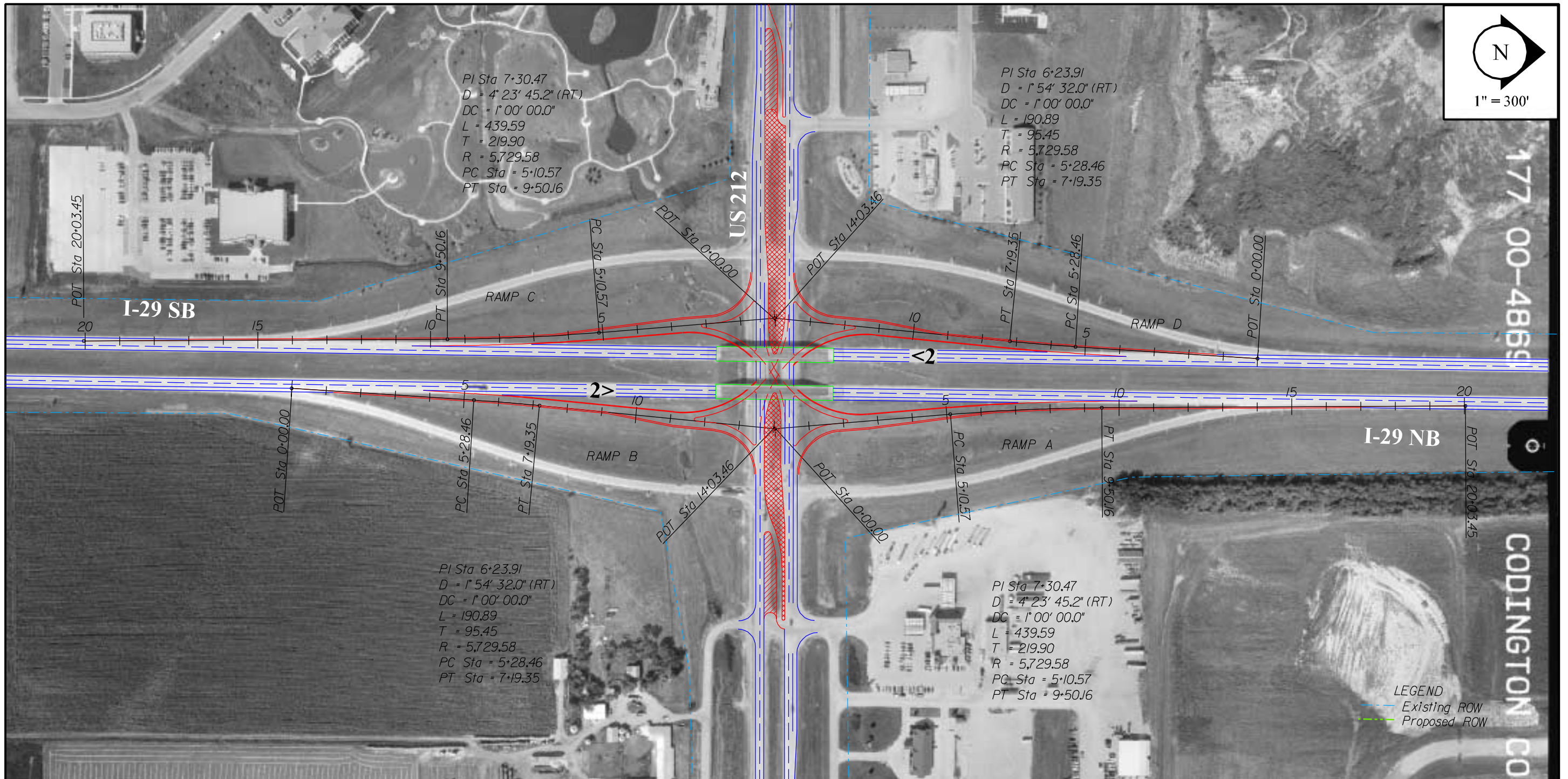
A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the right turn lanes, traffic signals and median reconstruction on US 212 is estimated at \$465,000. A breakdown of the quantities and construction costs is included in the Appendix.

## ***Alternative # 2 – Single Point Interchange***

Although the capacity analysis indicated that the diamond interchange configuration would provide acceptable traffic operations through the Year 2020 with some minor improvements, unforeseen developments in the vicinity of the interchange may result in significant increases in traffic movements through the interchange. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 36.

## *Geometry*

Based on the traffic projections, single left turn lanes for the single point interchange will provide acceptable traffic operations. As was the case for the diamond interchange, the left turn storage on the US 212 approaches should be 200'. The configuration of the single point interchange results in approximately 200' of storage for the left and right turn lanes on the off-ramps.





# SDDOT Interstate Corridor Study - Phase II

## Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10<sup>th</sup> Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

## Capacity

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in the following table.

### I-29/US 212 Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
US 212 Single Point Interchange	2010	Sig.	A	-	-	A	-	-	A	A	-	A	A	-	A
US 212 Single Point Interchange	2020	Sig.	B	-	-	B	-	-	B	B	-	B	B	-	B

Future traffic operations for the ramp movements will be the same as evaluated for the existing conditions, since one-lane on and off ramps will still be provided. The capacity analysis indicated that the level of service for these movements will operate at LOS a for the Year 2020.

## Access Control

The modifications to the access points along US 212 discussed for the previous alternative are recommended with the single point concept as well. The increased distance between the interchange and the next full movement access break will help improve traffic operations along the corridor.

## Right-of-Way

Additional right of way will not be required to construct the proposed single point interchange and other improvements at Exit 177.

## Probable Construction Costs

A statement of probable construction costs was prepared for the construction of the proposed improvements. Design and construction of the single point interchange and reconstruction of the medians along US 212 is estimated at \$6.98 million. A breakdown of the quantities and construction costs is included in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-229: Exit 3 – Minnesota Avenue, Sioux Falls

The capacity analysis performed for the Minnesota Avenue interchange with I-229 in the Phase I study indicated that the existing diamond interchange configuration and traffic control will be able to accommodate the Year 2020 traffic volumes.



A single point interchange concept was also developed for this location to determine if it would be an acceptable replacement for the diamond interchange. The advantages of a single point interchange are the elimination of a traffic signal on Minnesota Avenue and the capacity to accommodate heavier traffic volumes. The adjacent full movement access points located to the north and south of the interchange also impact the traffic operations along Minnesota Avenue.

### Existing Interchange Characteristics

#### **Geometry**

The existing interchange is a diamond configuration, with a spacing of approximately 700' between the interchange ramp intersections. Both intersections are presently signalized. Single lanes are provided on the off-ramps, however, there is enough room for right turning vehicles to squeeze past vehicles waiting to turn left onto Minnesota Avenue. The cross section of Minnesota Avenue is a five-lane section, with a two-way left turn lane.

#### **Traffic Safety**

This interchange ranked 27<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on a three-year crash rate. Since it was not identified as one of the high accident locations, a more detailed accident analysis was not conducted. A total of 51 accidents occurred at this intersection between 1997 and 1999. The accident history at this interchange does not imply any specific geometric deficiencies that may be contributing to the accidents.

#### **Capacity**

The capacity analysis performed for the existing configuration of the Minnesota Avenue interchange indicates that the ramp intersections are currently operating at level of service A. By the Year 2020, the northbound ramp intersection is projected to operate at LOS B and the southbound ramp intersection at LOS A. The construction of the auxiliary lanes on I-229 between the interchanges will eliminate the current merge and diverge movements onto the I-229 mainline.

# SDDOT Interstate Corridor Study - Phase II

## Capacity Analysis with Existing Configuration

Movement	Criteria	Existing	Year 2010	Year 2020	Comments
NB Diverge (NB I-229)	C	B	-	-	Acceptable
NB Merge (NB I-229)	C	B	-	-	Acceptable
SB Diverge (SB I-229)	C	B	-	-	Acceptable
SB Merge (SB I-229)	C	B	-	-	Acceptable
North Intersection	D	A	A	A	Acceptable
South Intersection	D	A	A	B	Acceptable

## Proposed Interchange Concept

The capacity analysis conducted in the Phase I study indicates that the diamond interchange configuration will operate at acceptable levels through the Year 2020. As an alternative to the existing diamond interchange, a single point interchange concept was also developed for this location. At some point in the future, it may be necessary to provide a configuration with increased capacity. The construction of a single point interchange may be tied to the reconstruction of the pavement and bridges at the interchange. A functional design of the proposed single point interchange is shown in Figure 37.

### Geometry

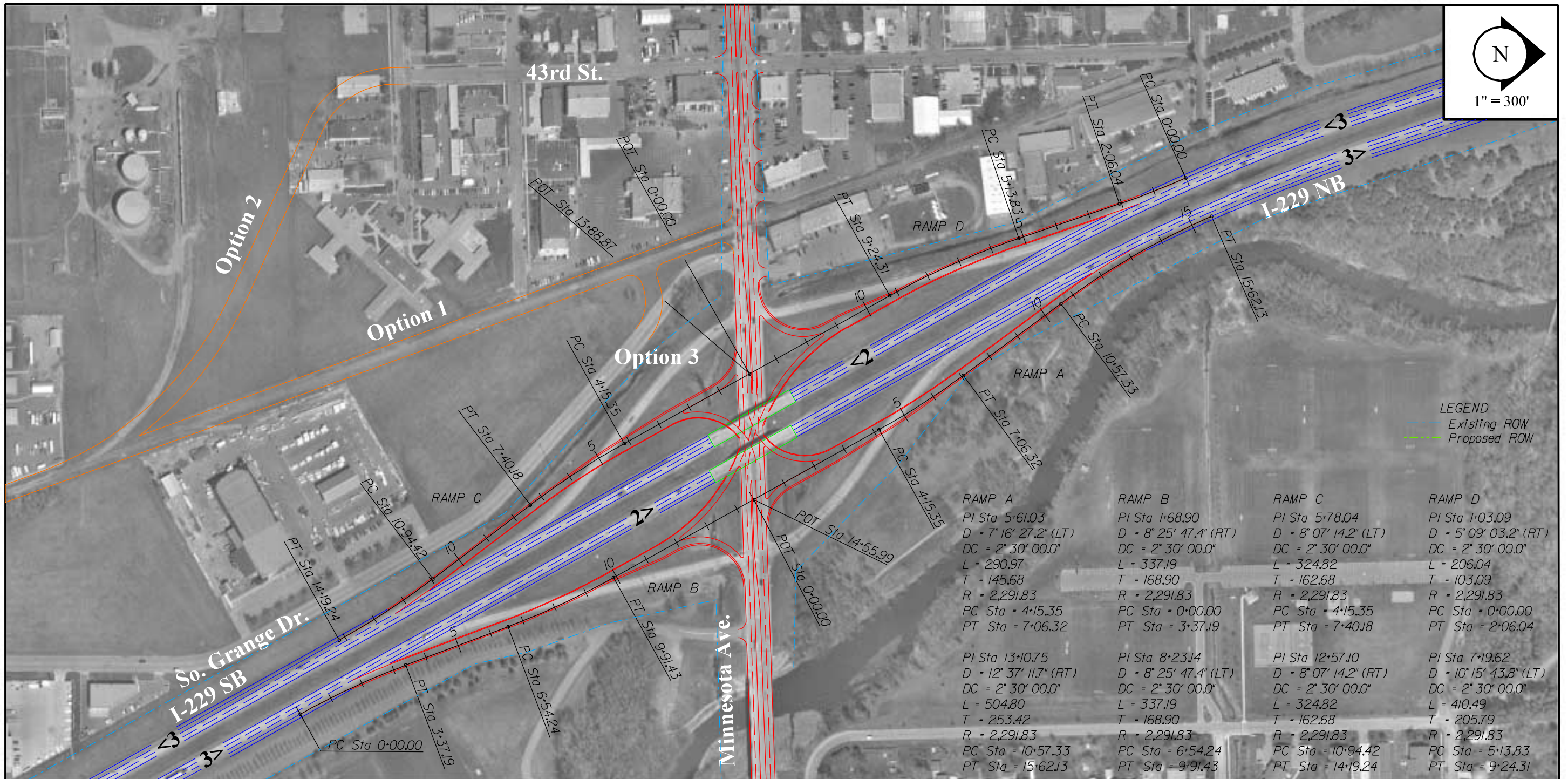
Based on the traffic projections, it appears that single left turn lanes for the single point interchange will provide acceptable traffic operations. However, with the cross section of Minnesota Avenue, the left turn lanes on the off-ramps should be constructed to provide dual left turn lanes in the future. The configuration shown in the figure provides approximately 250' of storage for the left turn lanes and 200' of storage for the right turn lanes. If a raised median is constructed along Minnesota Avenue, 200' of storage should be provided for the northbound and southbound left turn lanes.

### Traffic Safety

The construction of a single point interchange may initially result in an increase in accidents at this location. The accident history at the recently constructed single point interchange with 10<sup>th</sup> Street on I-229 in Sioux Falls has seen some increase associated with driver unfamiliarity with the interchange configuration. It is anticipated that the accident frequency will decrease over time. A similar pattern may develop initially at this interchange as well.

### Capacity

The capacity analysis performed for the single point interchange indicates that it will provide acceptable traffic operations through the Year 2020. The level of service for each movement through the interchange is shown in following table.



# SDDOT Interstate Corridor Study - Phase II

## I-229/Minnesota Avenue Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Minnesota Ave. Single Point Interchange	2020	Sig.	B	A	-	A	A	-	B	-	-	B	-	-	A

### Access Control

On the north side of the interchange, an intersection with South Grange Drive to the west is located only 150' north of the ramp intersection. In addition, driveways to the property located on the east side of Minnesota Avenue are only 100' north of the ramp intersection. The *41<sup>st</sup> Street Corridor Study – Phase II Report*, completed in May 2000, indicates that three options are under consideration for relocation of this intersection. The first option consists of a new roadway connection constructed on the abandoned railroad right of way. This would relocate the intersection approximately 100' further to the north. Option 2 consists of the construction of a new roadway connection that also follows the abandoned railroad alignment, then curves to the north to connect with 43<sup>rd</sup> Street. The 3<sup>rd</sup> option is to connect South Grange Drive to the abandoned railroad alignment immediately west of Minnesota Avenue.

While the construction of Option 2 that connects to 43<sup>rd</sup> Street is the preferred option to improve traffic operations along Minnesota Avenue and provide the maximum distance from the interchange, the City of Sioux Falls has indicated that this option will not be constructed. Option #1 or #3 that connects to Minnesota Avenue at the abandoned railroad line will be coordinated with the SD 115 project identified in the Year 2002 TIP.

The other access control issue is the location of the driveway to the Yankton Trail Park, located in the southwest quadrant of the interchange. This driveway is located approximately 200' south of the interchange ramps. Since the major activities at the park are focused during the evenings and weekends, traffic operations at this intersection should be monitored to determine if access modifications should be constructed. If necessary to improve safety and traffic flow along Minnesota Avenue, the raised median could also be constructed south of the interchange, which would restrict this access to right-in/right-out only. It may be possible to construct the raised median to also allow the northbound left turn from Minnesota Avenue into the park. Full movement access from the park to the arterial street network is provided at 57<sup>th</sup> Street, via a bridge constructed over the Big Sioux River. While this may result in some adverse travel when exiting the park, it would provide safer and more efficient traffic operations along Minnesota Avenue. The City of Sioux Falls has indicated that the full movement access into the park on Minnesota Avenue should be maintained with the ultimate configuration.

### Right-of-Way

Additional right of way will not be required to construct the proposed single point interchange and other improvements at the Minnesota Avenue interchange with I-229.

# *SDDOT Interstate Corridor Study - Phase II*

## ***Probable Construction Costs***

A statement of probable construction costs was prepared for the construction of the single point interchange. Design and construction of the interchange is estimated at \$6.58 million. A breakdown of the quantities and construction costs is included in the Appendix.

# *SDDOT Interstate Corridor Study - Phase II*

## **I-229: Exit 5, 26<sup>th</sup> Street, Sioux Falls**

From the Phase I investigation, it was found that Exit 5 on I-229 contains some significant geometric deficiencies. Along with these deficiencies, there exist some physical limitations on what improvements can be made in the vicinity of the interchange. Analysis of the existing interchange for the projected Year 2010 and 2020 traffic volumes result in poor traffic operations. Three concepts were developed in the Phase I study to help address some of the problems associated with the interchange. This Phase II investigation has been performed to further evaluate operational and geometric characteristics of the interchange. The City of Sioux Falls indicated that there is a Federal Emergency Management Agency (FEMA) buyout programmed for the homes located in the northwest quadrant of the interchange. The removal of those homes located immediately adjacent to the interstate mainline creates an opportunity to construct southbound on and off ramps at this interchange, and significantly improve traffic operations at this interchange.



### **Existing Interchange Characteristics**

#### ***Geometry***

Existing geometric features were reviewed using the as-built plans for this interchange and many deficiencies were found. Primarily, the radius provided on ramps C, G and F are considerably below the 35 mph design criteria. The superelevation rate on Ramps B and C is only slightly above the 5.0% design criteria. The on-ramp taper rates provided on Ramps C and F are below the 50:1 design criteria. The geometry is very unique in the fact that the I-229 southbound off and on ramps are so close to one another and the length of the ramps are extremely short. The two ramps actually tie into a frontage road that runs parallel along I-229. This configuration causes problems in traffic operations on the frontage road, as well as for those vehicles trying to access I-229. 26<sup>th</sup> Street allows for left turn lanes to provide access to the I-229 on ramps. The Northbound off ramp has a separate left turn lane and right turn lane.

#### ***Traffic Safety***

This interchange ranks 14<sup>th</sup> out of the 62 interchanges evaluated in the Phase I study based on three-year crash rate. Over the three year period from 1997-1999 there were a total of 69 accidents. Since this location was not considered one of the high accident locations in the Phase I study, a more detailed analysis of the accident history was not conducted.

# SDDOT Interstate Corridor Study - Phase II

## Capacity

The capacity analysis performed for the existing interchange configuration indicates that the intersections on 26<sup>th</sup> Street are currently operating at acceptable levels of service, however, the intersection with the northbound ramps is operating at LOS D. Traffic counts were not available for the intersection of the southbound ramps and the frontage road. These turning movements were estimated based on the counts provided at the intersection of the frontage road with 26<sup>th</sup> Street.

In the Year 2010, the traffic operations at this interchange are projected to decrease to LOS F at the intersection with the northbound ramps and LOS E at the intersection of the frontage road with the south ramps. For the Year 2020, both intersections on 26<sup>th</sup> Street and the intersection of the frontage road with the south ramps are projected to operate at unacceptable levels of service. The main movements where the traffic operations are at unacceptable levels are the northbound right turn movements and the westbound through movements at the northbound ramp intersection. The northbound left turn movements and westbound left turn movements at the frontage road intersection at 26<sup>th</sup> Street also operate at unacceptable levels of service.

## I-229/26<sup>th</sup> Street Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
26 <sup>th</sup> Street/ I-229 NB Ramps	1999	Sig.	B	-	F	-	-	-	-	B	-	-	E	-	D
26 <sup>th</sup> Street/ Yeager Road	1999	Sig.	D	-	A	-	-	-	-	C	-	C	A	-	C
26 <sup>th</sup> Street/ I-229 NB Ramps	2010	Sig.	C	-	F	-	-	-	-	C	-	-	F	-	F
26 <sup>th</sup> Street/ Yeager Road	2010	Sig.	E	-	B	-	-	-	-	E	-	F	A	-	D
26 <sup>th</sup> Street/ I-229 NB Ramps	2020	Sig.	C	-	F	-	-	-	-	B	-	-	F	-	F
26 <sup>th</sup> Street/ Yeager Road	2020	Sig.	E	-	D	-	-	-	-	F	-	F	A	-	E

The previous analysis indicated that the construction of the auxiliary lanes on I-229 as a part of the current design build project will provide acceptable traffic operations through the Year 2020.

## Proposed Interchange Alternatives

As was mentioned previously, the Exit 5 interchange has many geometric deficiencies. With the projected future traffic, it will also have experience operational deficiencies. The City of Sioux Falls has indicated that a Federal Emergency Management Agency (FEMA) buyout is programmed for the residential neighborhood located in the northwest quadrant of the interchange to address flooding from the Big Sioux River. The removal of the homes located



## *SDDOT Interstate Corridor Study - Phase II*

immediately adjacent to the interstate mainline will provide an opportunity for the construction of a southbound off-ramp with a direct connection to 26<sup>th</sup> Street.

The City of Sioux Falls indicated that Yeager Road, located in the southwest quadrant of the interchange, must remain in service, with a connection to 26<sup>th</sup> Street. They also stated that the rail line immediately west of Yeager Road is abandoned, and the bridge on 26<sup>th</sup> Street over the railroad will be removed. Keeping the intersection of Yeager Road with 26<sup>th</sup> Street in its present location results in the concept for the southbound off-ramp and on-ramp to be reconstructed as shown in Figure 38. This configuration provides a distance of 300' from Yeager Road to the southbound ramps. A distance of 800' is provided between the ramp intersections. If it is possible to relocate Yeager Road to the west once the bridge is removed, additional distance could be provided from the southbound ramp intersection.

### ***Geometry***

With the concept shown, it was assumed that 26<sup>th</sup> Street would be widened to a four-lane roadway with turn lanes at the ramp intersections and at Yeager Road. 26<sup>th</sup> Street, to the west of I-229, is a three-lane roadway. As a result, it will be necessary to taper the two westbound through lanes down to one lane west of Yeager Road. The additional eastbound through lane should also begin to the west of the intersection.

It is also recommended that an additional lane be added to the northbound off-ramp. This will allow for one left turn lane and dual right turn lanes to accommodate the projected heavy right turn movement. Since 26<sup>th</sup> Street tapers to a two-lane section to the east, the additional eastbound through lane must continue far enough to ensure adequate lane utilization of the dual right turn lanes. In addition, the I-229 mainline will be widened to three lanes between the interchanges in the near future as part of the current design build project.

### ***Traffic Safety***

The current interchange is not considered a high accident interchange with the accident history over the last three years, but it does have an above average rate of accident occurrence. With the proposed changes in the ramp configuration and the addition of the left turn lanes and the widening of 26<sup>th</sup> Street, it would be expected that the accident rate at this interchange would decrease in future years.

### ***Capacity***

With the half diamond interchange concept shown in Figure 38, the operational efficiency at the interchange would be improved. Analysis of the traffic movements for Year 2010 and 2020 was performed with the new concept. The results are depicted in the table below. The construction of the southbound on and off ramps provides an acceptable level of service of C or better at all of the intersections with 26<sup>th</sup> Street. Traffic signalization was assumed at all three of the intersections.



# SDDOT Interstate Corridor Study - Phase II

## I-229/26<sup>th</sup> Street Interchange Level of Service Analysis

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
26 <sup>th</sup> Street/ I-229 NB Ramps	2010	Sig.	B	-	C	-	-	-	-	A	-	B	B	-	B
26 <sup>th</sup> Street/ Yeager Road	2010	Sig.	C	-	A	-	-	-	-	A	-	A	A	-	A
26 <sup>th</sup> Street/ I-229 SB Ramps	2010	Sig.	-	-	-	D	-	A	-	B	A	B	A	-	B
26 <sup>th</sup> Street/ I-229 NB Ramps	2020	Sig.	B	-	C	-	-	-	-	C	-	C	C	-	C
26 <sup>th</sup> Street/ Yeager Road	2020	Sig.	C	-	A	-	-	-	-	A	-	A	B	-	A
26 <sup>th</sup> Street/ I-229 SB Ramps	2020	Sig.	-	-	-	D	-	A	-	D	A	C	A	-	C

The I-229 improvement project currently under construction, will provide an auxiliary lane between the Cliff Avenue interchange and the 26<sup>th</sup> Street interchange. As a result, there will be no northbound diverge or southbound merge movements upon completion of that project. However, a 4 lane section of I-229 will still be provided to the north of 26<sup>th</sup> Street. Future traffic operations for the northbound merge and the southbound diverge ramp movements were evaluated, and are summarized below. The capacity analysis indicates that the level of service for these movements will operate at LOS C or better.

## I-229/26<sup>th</sup> Street Ramp LOS Analysis

Direction	Year	Movement	LOS
I-229 Northbound	2010	Merge	B
		Diverge	-
I-229 Southbound	2010	Merge	-
		Diverge	B
I-229 Northbound	2020	Merge	B
		Diverge	-
I-229 Southbound	2020	Merge	-
		Diverge	C

### Access Control

On the east side of the interchange, the nearest driveway location is located further than 300' from the ramp intersection. However, it may be desirable to extend the raised median on 26<sup>th</sup> Street past this driveway to restrict access to right-in/right-out. The next driveway to the east will provide full movement access to the property. Access control is not required to the west of the interchange.

# *SDDOT Interstate Corridor Study - Phase II*

## ***Right-of-Way***

The construction of this concept will require approximately 1.5 acres, located in the northwest quadrant of the interchange. This right of way is necessary to accommodate the southbound off-ramp. Along 26th Street, the widening of the roadway to provide a four-lane section and separate left turn lanes will also require some right of way acquisition.

## ***Probable Construction Costs***

A statement of probable construction costs was prepared for the improvements at the interchange. The total probable cost for this concept is estimated at \$5.67 million. A more detailed breakdown of the cost for this interchange concept can be seen in the Appendix.

# SDDOT Interstate Corridor Study - Phase II

## I-229: Exit 7 – Rice Street, Sioux Falls

For the Phase I investigation of Exit 7, current traffic counts were not available. As a result, the capacity analysis for this interchange was not conducted. Current traffic counts for the ramps were obtained in the summer of 2000 and used to develop Year 2010 and 2020 traffic forecasts. This subsequent investigation has been performed to further evaluate geometric and operational characteristics of the interchange. The results of the Phase II investigation are summarized below along with selected information from the Exit 7 Phase I analysis.



### Existing Interchange Characteristics

#### Geometry

Existing geometric features were reviewed using the as-built plans for this interchange, with deficiencies found on all four of the ramps. The superelevation rate on all of the ramps is 6.0%, which is above the 4.0% criteria. The minimum horizontal radius provided on the loop ramps is only 160', which is well below 30 mph design. The on-ramp tapers for Ramps A and H do not meet the 50:1 design criteria. The K values on the crest vertical curves for Ramps A and D are below the 50 mph design criteria, which correlates to inadequate stopping sight distances.

#### Traffic Safety

This interchange ranks 31<sup>st</sup> out of the 62 interchanges evaluated in the study based on three year crash rate, and is not considered one of the high accident locations. A total of 28 accidents occurred at this intersection between 1997 and 1999. It is unlikely that interchange deficiencies are the primary contributing factor to the occurrence of traffic accidents at this interchange.

#### Capacity

Updated ramp counts were provided by SDDOT for the interchanges along I-229, prior to the beginning of the reconstruction project. Turning movement counts were previously provided for the northbound ramp intersection and Cleveland Avenue with Rice Street. The current traffic counts for the southbound ramps were used to develop the peak hour turning movement counts for this intersection. The through movements on Rice Street were then balanced through the intersection.

Based on these traffic forecasts, it appears that the unsignalized intersection of the southbound off-ramp with Rice Street has movements that are operating at unacceptable levels. All of the movements at the Rice Street and Cleveland Avenue intersection are operating at LOS A. Future

# SDDOT Interstate Corridor Study - Phase II

traffic operations are expected to be problematic if no other traffic improvements are made. As shown in the table below, analysis of projected future traffic conditions at the Exit 7 interchange indicate that the southbound left turn lane will operate at unacceptable levels.

### *I-229/Rice Street Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Rice Street/ I-229 NB Ramps	2000	Sig.	A	A	-	A	A	-	-	A	-	-	A	-	A
Rice Street/ I-229 SB Ramps	2000	Unsig.	-	-	-	F	-	B	A	-	-	-	-	-	-
Rice Street/ I-229 NB Ramps	2010	Sig.	A	A	-	A	A	-	-	A	-	-	A	-	A
Rice Street/ I-229 SB Ramps	2010	Unsig.	-	-	-	F	-	B	A	-	-	-	-	-	-
Rice Street/ I-229 NB Ramps	2020	Sig.	A	A	-	B	A	-	-	A	-	-	B	-	A
Rice Street/ I-229 SB Ramps	2020	Unsig.	-	-	-	F	-	B	B	-	-	-	-	-	-

Along with the analysis performed on the intersection movements, the movements on the interchange ramps were also analyzed. All of the existing ramp movements and future projected ramp movements operate at an acceptable LOS of C or better. The results of the ramp analysis are shown below.

### *I-229/Rice Street Ramp LOS Analysis*

Direction	Year	Movement	LOS
I-229 Northbound	2000	Merge	A
		Diverge	A
I-229 Southbound	2000	Merge	B
		Diverge	A
I-229 Northbound	2010	Merge	A
		Diverge	A
I-229 Southbound	2010	Merge	B
		Diverge	B
I-229 Northbound	2020	Merge	B
		Diverge	A
I-229 Southbound	2020	Merge	C
		Diverge	C

# *SDDOT Interstate Corridor Study - Phase II*

## **Proposed Interchange Alternatives**

Although the present interchange has geometric deficiencies and capacity problems stated previously, a complete reconstruction of the interchange is not warranted. There are several physical constraints in the vicinity of the Rice Street interchange with I-229. The railroad located immediately south of Rice Street limits the ability to construct direct ramps to the south. The geometric deficiencies can be corrected with minor modifications, and the present structure can remain. As a result, the proposed improvements recommended for this interchange consist of minor improvements to the interchange and surrounding area. The installation of traffic signals at the ramp intersections with Rice Street would help alleviate many of the anticipated capacity problems.

### ***Geometry***

The existing interchange does contain some geometric deficiencies that can be addressed when it is time for the ramp pavement to be reconstructed. The driving lane and shoulder widths can be corrected, as well as the superelevation rate. As for the minimum horizontal radius and low K values on the crest vertical curve, the entire interchange would have to be reconstructed. These deficiencies would have to have a severe affect on the safety to warrant total reconstruction of the interchange. It is believed that the present design provides large enough turning radii to accommodate truck movements on and off the interstate. Rice Street will remain a four-lane section with no left or right turn lanes on the roadway in the area of the interchange.

### ***Traffic Safety***

The current interchange is not considered a high accident interchange with the accident history over the last three years. The installation of traffic signals on Rice Street at the southbound ramp intersection would represent a change from the existing conditions and may result in a slight increase in some types of accidents. While the occurrences of accidents may go up on Rice Street with the new signalized intersection, the accidents should not be as severe. It is anticipated that adding the traffic signal should not ultimately have an adverse affect on the safety at and around this interchange.

### ***Capacity***

The installation of a traffic signal at the intersection of the I-229 southbound ramps with Rice Street will improve traffic operations at this intersection. Analysis of the traffic movements for Year 2010 and 2020 was performed with the addition of the signal. The results are depicted in the table below. With the traffic signal installed, the analysis shows that the southbound left turn movement would improve to LOS B in 2010 and LOS C in 2020. The overall levels of service for the ramp intersections are LOS A or better for the projected future volumes.

# SDDOT Interstate Corridor Study - Phase II

## *I-229/Rice Street Interchange Level of Service Analysis*

Intersection	Year	Type	Northbound			Southbound			Eastbound			Westbound			Intersection LOS
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Rice Street/ I-229 NB Ramps	2010	Sig.	A	A	-	A	A	-	-	A	-	-	A	-	A
Rice Street/ I-229 SB Ramps	2010	Sig.	-	-	-	B	-	A	-	A	-	-	A	-	A
Rice Street/ I-229 NB Ramps	2020	Sig.	A	A	-	B	A	-	-	A	-	-	B	-	A
Rice Street/ I-229 SB Ramps	2020	Sig.	-	-	-	C	-	A	-	A	-	-	A	-	A

Since no changes are recommended for the ramps and the interstate mainline through this interchange, the future traffic operations for the ramp movements will remain as previously discussed.

### ***Access Control***

The addition of traffic signals at the intersections with Rice Street will improve traffic operations through the interchange area. Access management along Rice Street is not proposed at this time.

### ***Right-of-Way***

Since only minor modifications will be made to the interchange, it will not be necessary to acquire extra right-of-way. The installation of the two traffic signals should be within the existing right-of-way limits.

### ***Probable Construction Costs***

A construction cost estimate for the installation of a traffic signal at the intersection of the southbound ramps and Rice Street is approximately \$100,000.