OPERATIONAL NEEDS ASSESSMENT

US 41 CTH S (Freedom Road) Addendum

PRELIMINARY REPORT

March 2011

Brown County

WisDOT Project I.D. 1130-31-00

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Wisconsin Department of Transportation
Northeast Region
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US 41 – CTH S (Freedom Road) Appendix
Brown County

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

This report is an addendum to the Operational Needs Assessment Preliminary Report, which was submitted to the Wisconsin Department of Transportation (WisDOT) in March 2009. The original report should be referenced for items not discussed in this addendum. This addendum covers the CTH S (Freedom Road) at the USH 41 interchange. The exhibits, tables, figures, and appendices have been renamed in order for this specific report to be more easily processed.

The purpose of the study is to:

- Analyze how traffic moves through the study area. Traffic movement volumes have been collected and signal timings reviewed.
- Determine where crashes are prevalent. Crash histories at key intersections have been analyzed and evaluated at intersections, interchanges, and roadway geometries.
- Determine when demand will exceed capacity. Future traffic volumes are forecasted and evaluated by HCS, Synchro and Paramics traffic simulation software.
- Determine what can be done to address problems. The improvement options and recommendations for short-term improvements will be tested by Paramics traffic simulation software.
- Provide information for the public. Paramics traffic simulations are suitable for public presentations to demonstrate predictions of traffic conditions in the future with and without improvements.

The main focus of this report is to analyze how traffic is moving throughout the study area. Another focus of this report is to identify and evaluate problem locations with high number of crashes and geometric deficiencies. Future work will be performed including forecasting future traffic volumes and using traffic simulation models to make recommendations for short term improvements in identified problem areas.

Study Location

This report describes the details of the WisDOT operational needs assessment of US Highway 41 (US 41) and Wisconsin State Highway 441 (WIS 441). Project location map has been provided in **Appendix S1:**. The subject highways are in WisDOT's Northeast Region in Northeastern Wisconsin, north of Lake Winnebago in Winnebago, Outagamie, Brown, and Calumet Counties. The CTH S interchange is located in the Town of Lawrence in Brown County.

Crashes and Safety

Crash history was evaluated and analyzed throughout the study corridor (the halfway point of CTH U and CTH S to the halfway point of CTH S and CTH F). Results of the crash analysis are presented in **Appendix S2:**. This included analyzing data for crashes along the freeway mainline, ramp merge and diverge points, and ramp terminal intersections. Crashes were broken into two main categories: freeway mainline crashes and interchange area crashes. This information was then used to calculate crash rates and severity rates to determine any crash trends in the corridor as well as to pinpoint the locations with the highest crash problems.

Crash data along highways is updated and cataloged multiple times annually by WisDOT. The crash data for this study have been supplied by the UW-Madison Traffic Operations and Safety (TOPS) Lab. Strand Associates Inc supplied additional crash data for the US 41 corridor in the project boundary. This data have been collected as part of the ongoing US 41 Interstate Conversion Study.

All crashes, excluding deer related crashes, were entered into a geographical information system (GIS). Crash locations were estimated on the GIS map using the initial crash direction, reference point numbers and distances, crash types, and crash locations. **Figure 2-1** provides a color-coded crash breakdown for the study corridor comparing the segments to the statewide average for this type of facility. The criterion for the breakdown was based on the statewide average for annual crash rates.

This project relied on two methods of crash analyses. Method one is the comparison with the statewide average. This method of crash analysis was used in the locations where the corridor as a whole was evaluated and includes all crashes on the mainline as well as the interchange influence areas. The second method of crash analysis looks at each aspect of the corridor as an individual piece. In this method, crash rates were calculated for all merge, diverge, and ramp terminal intersection locations. The boundaries for these areas were based on the type of ramp that was being analyzed.

Crash data was further divided by year (2002-2009) and severity (property damage only, injury or fatality). Along the mainline, the crashes were also divided into different influence areas. An average crash rate and severity rate were calculated for each area and then broken into an annual crash rate and severity rate.

Annual average daily traffic (AADT) counts were extracted from WisDOT's 2004 statewide volume count. A sensitivity analysis on the volume count data relative to the individual segment crash analysis results was conducted due to uncertainty in the level of accuracy of the volume count data. The sensitivity analysis supported full confidence with all results obtained.

None of the segments or ramps were in the top 5 crash rates or severity for the whole USH 41/ WIS 441 corridor.

EXISTING AND FUTURE TRAFFIC OPERATIONS

Existing and Future Traffic Volumes

The WisDOT Northeast Region Travel Demand Model (NE Region TDM) was used to analyze the US 41 and WIS 441 corridors. The year 2005 and year 2035 socio-economic (SE) data for the NE Region TDM was obtained from the existing metropolitan planning organizations (MPO) models for the urban areas of Green Bay, Appleton-Oshkosh and Fond du Lac. SE data from the Wisconsin Statewide Travel Demand Model was used for the rural zones. Meetings were then held with area municipalities to further refine the location of housing in the zones. Employment information for the rural zones was initially estimated using statewide model information, subdivided into each zone of the NE Region TDM, then verified and adjusted through local meetings. The SE data for year 2020 was interpolated from years 2005 and 2035. The roadway network used to establish vehicle travel was similarly developed by combining networks from the existing urban area models. The network for the remaining model area was developed from the Wisconsin Information System for Local

Roads (WISLR) network. **Appendix S3:** includes 2020 and 2035 balanced link flows and turning movement counts.

Roadway traffic volumes were collected from information provided by WisDOT[1], as well as traffic volumes taken from recent projects completed within the study corridor and turning movement counts were collected. There is no specific base set because the data has come from multiple sources. This information was compared to the NE Region TDM to create balanced traffic volume data for the road segments and intersections in the study area. Peak hour traffic volumes were then developed for use in the Paramics, Synchro, and HCS analysis. **Figure 3-1** includes maps detailing the daily volumes and peak hour volumes derived for the study.

Capacity and Level of Service

A capacity analysis of the existing roadway was completed to determine level of service (LOS) for the WIS 441 and US 41 corridor. Roadway LOS is the measure of a roadway's response to traffic demands, based on factors such as roadway geometry, travel speeds, peak hourly volume, and percent trucks.

The project corridor was broken up into feature categories that highlight specific areas of interest included mainline segments, merge/diverge locations, ramp terminals, and side road intersections. **Figure 3-4** and **Figure 3-5** are detailed maps showing the existing mainline level of service within the US 41 at CTH S area. The feature categories were systematically graded from A to F based on the operating conditions for the specified segment of roadway.

Table 1-1 provides a description of each grade of LOS. *

Table 1-1: Level of Service Grading System

LOS	Description
A	Unrestricted free flow, drivers virtually unaffected by others
B	Slightly restricted stable flow, slight restriction in speed and maneuverability
C	Moderately restricted stable flow, driver operation significantly affected by others
D	Heavily restricted flow, poor level of driver comfort and convenience
E	Unstable flow (approach flow > discharge flow), slow speeds and traffic backups
F	Forced flow, stop-go movements with long backups, max. driver frustration

* Source: Highway Capacity Manual

Highway Capacity Software (HCS) was used to analyze all free flowing movements in the corridor. The software is based on the Highway Capacity Manual (HCM) methodology. Specifically, the software evaluated the mainline segments as well as merge and diverge locations near interchange ramps. The software analyzes the input data and places a LOS letter grade to the evaluated roadway. Along with LOS, the program determines the traffic density to help quantify the traffic flow conditions and support the LOS value.

[1] Traffic count maps by county http://www.dot.wisconsin.gov/travel/counts/maps.htm

Intersections were analyzed with Synchro to determine intersection delay (in seconds) and evaluate the overall performance of the intersection. Using criteria from the Highway Capacity Manual, Synchro translates the delay into an LOS value for each approach and the intersection as a whole. Synchro is specifically designed to evaluate and optimize signalized and un-signalized (non roundabout) intersections.

The existing mainline and ramps of the study location are LOS C or better.

Appendix S3: contains all data extracted from HCS and Synchro and also includes LOS ratings for the interchange intersections and merge and diverge locations. Along with existing conditions, each of the study areas was analyzed for 2020 and 2035 no-build conditions to estimate future traffic operations within the corridor.

The 2020 and 2035 projections at the mainline and ramps of the study location are LOS C or better.

Appendix S3: also presents peak hour factors (PHF) and truck percentages for US 41 at CTH S. The PHF is an indication of the level of traffic concentration within the peak hour. For example, a high PHF would indicate that the traffic is evenly distributed through all four of the 15 minutes segments within the peak hour. A lower PHF indicates that the traffic is primarily concentrated within one of the 15 minute segments. This data was used to calculate the existing LOS values and delay for both mainline and intersections.

All intersections operated without fail in both the existing and 2020 operating conditions. In 2035, all intersections have at least one movement that begins to fail operationally during either the AM or the PM peak hour.

EXISTING HIGHWAY CHARACTERISTICS

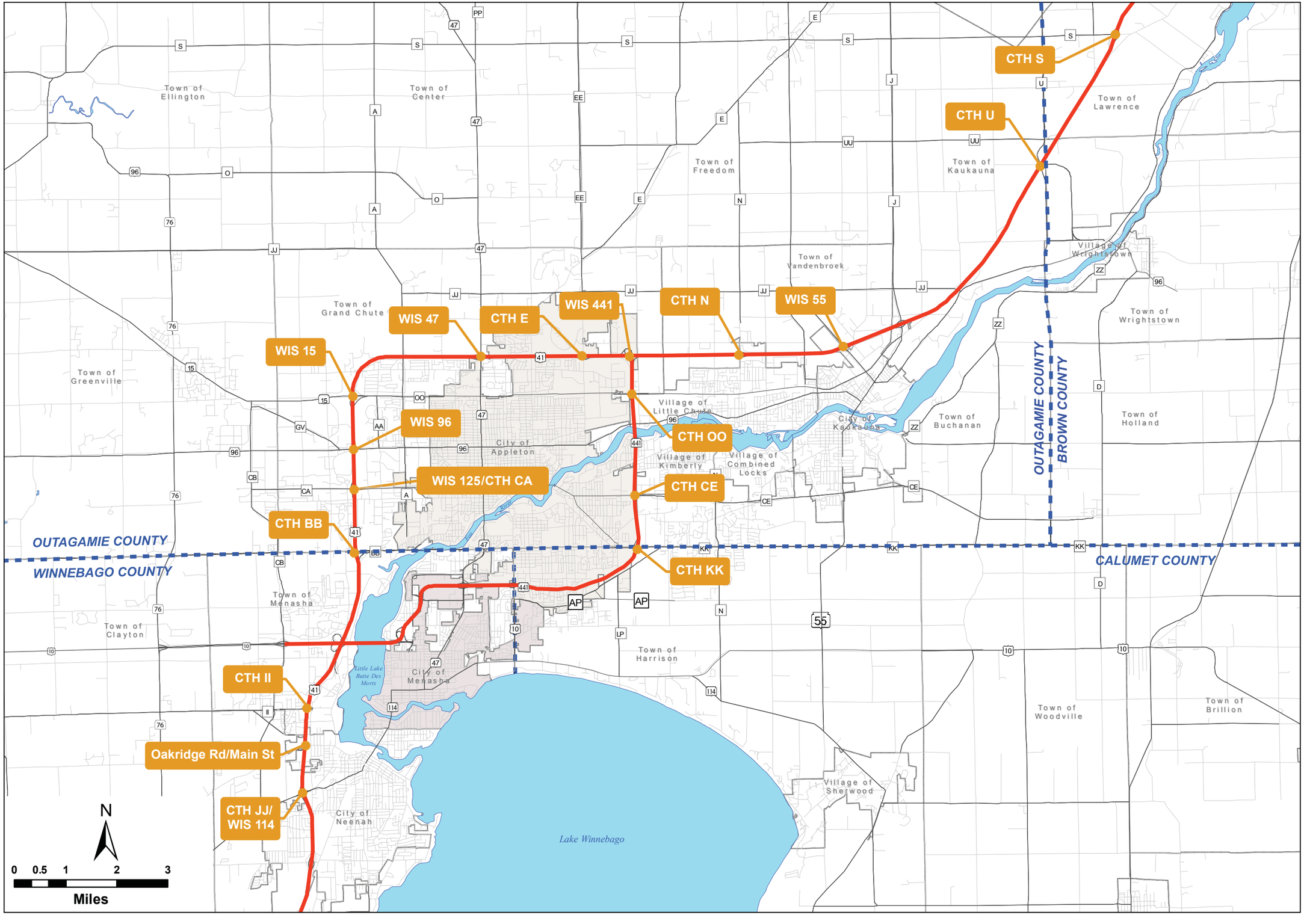
A deficiency analysis was completed for the WIS 441 corridor and results of the analysis are presented in Appendix F of the Operational Needs Assessment Preliminary Report. For US 41, Strand Associates, Inc.'s USH 41 Interstate Conversion – Geometric Deficiencies Report was used to analyze any deficiencies for CTH S.

Vertical Clearance

All bridges throughout the corridor were categorized by GOOD, FAIR, and POOR ratings. CTH S is one of 12 bridges within the US 41 and WIS 441 corridor that have vertical clearances that are less than the desirable vertical clearance criteria(16.75'), yet still meets the minimum vertical clearance(16.33'"). These bridges are being given a FAIR rating with a height of 16.70' for the southbound direction. The bridge height of the northbound direction is 18.50'.

Structural Conditions

Condition of the CTH S Bridge over US 41 is GOOD. These recommendations as well as rehabilitation recommendations for year 2035 are shown in **Appendix S5:.**



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MARCH 2011

US 41 / WIS 441

PROJECT LOCATION MAP

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Appendix S1
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S1-1

Appendix S2: Crash Analysis

Updated crash rates for US 41 have been obtained by the UW-Madison TOPS Lab (Table 2-1). At the time of the report, the TOPS lab did not have 2009 crash data.

Table 2-1: WI Average Annual Crash Rates

RURAL INTERSTATE			
	Total	**Fatal**	**Injury**
2002	46	0.4	14
2003	55	0.6	17
2004	61	0.6	19
2005	67	0.6	20
2006	53	0.4	16
2007	66	0.6	19
2008	79	0.4	21

Rates expressed as HMVMT.

The average statewide rate for a rural interstate highway between 2002 and 2008 is 61 crashes per hundred-million vehicle miles traveled (HMVMT). This figure, again, excludes deer related crashes. This average rate is also used for comparison with the merge and diverge crashes.

Table 2-2 through Table 2-13 present the raw crash data.

Table 2-2: Mainline Crash Summary (2002 to 2009)

	Interchange 'A'	**Interchange 'B'**	**Crashes (8 year total)**	**8-Year Avg. Crash Rate per HMVMT**	**Severity Rate[2]**	**Entering Traffic (AADT)**
US 41 Northbound	CTH U	CTH S	30	52	0.43	41,600
	CTH S	CTH F	25	41	0.36	44,400
US 41 Southbound	CTH F	CTH S	23	37	0.43	44,400
	CTH S	CTH U	38	66	0.42	41,600

Table 2-3: Interchange Crash Summary

CTH S		**Crashes (8 year total)**	**8-Year Avg. Crash Rate per HMVMT**	**Severity Rate[2]**	**Entering Traffic (AADT)**
NB off ramp	Diverge	21	36.51	0.52	41,600
NB on ramp	Merge	20	34.77	0.35	41,600
SB off ramp	Diverge	23	37.47	0.43	44,400
SB on ramp	Merge	25	44.76	0.48	40,400
NB ramp terminals	Intersection	1	0.18	0.00	1,870
SB ramp terminals	Intersection	2	0.35	0.5	1,950

[2] Severity rates: >0.50 = poor; 0.50 – 0.30 = fair; <0.30 = good

Table 2-4: 2002 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		1	2			2	41,600	28	0.00
CTH S	CTH F		2		1		2	4		1	5	44,400	65	0.20
CTH F	CTH S	SB					2		2		2	44,400	26	1.00
CTH S	CTH U		2	1			1	3	1		4	41,600	56	0.25

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-5: 2003 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB					8	4	3	1	8	41,600	111	0.50
CTH S	CTH F						4	4			4	44,400	52	0.00
CTH F	CTH S	SB			1		3	3	1		4	44,400	52	0.25
CTH S	CTH U			1	1		3	4	1		5	41,600	70	0.20

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-6: 2004 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB	3	1	1		1	4	2		6	41,600	83	0.33
CTH S	CTH F						1	1			1	44,400	13	0.00
CTH F	CTH S	SB	2		1		1	3	1		4	44,400	52	0.25
CTH S	CTH U		1		1		4	1	5		6	41,600	83	0.83

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-7: 2005 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		2	2	1		3	41,600	42	0.33
CTH S	CTH F		1	2			2	2	3		5	44,400	65	0.60
CTH F	CTH S	SB	1		1				1		1	44,400	13	1.00
CTH S	CTH U		1		1		4	4	2		6	41,600	83	0.33

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-8: 2006 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		2	2	1		3	41,600	42	0.33
CTH S	CTH F		1	2			2	2	3		5	44,400	65	0.60
CTH F	CTH S	SB	1		1				1		1	44,400	13	1.00
CTH S	CTH U		1		1		4	4	2		6	41,600	83	0.33

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-9: 2007 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		2	2	1		3	41,600	42	0.33
CTH S	CTH F		1	2			2	2	3		5	44,400	65	0.60
CTH F	CTH S	SB	1		1				1		1	44,400	13	1.00
CTH S	CTH U		1		1		4	4	2		6	41,600	83	0.33

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-10: 2008 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		2	2	1		3	41,600	42	0.33
CTH S	CTH F		1	2			2	2	3		5	44,400	65	0.60
CTH F	CTH S	SB	1		1				1		1	44,400	13	1.00
CTH S	CTH U		1		1		4	4	2		6	41,600	83	0.33

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-11: 2009 Mainline Crashes

Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		2	2	1		3	41,600	42	0.33
CTH S	CTH F		1	2			2	2	3		5	44,400	65	0.60
CTH F	CTH S	SB	1		1				1		1	44,400	13	1.00
CTH S	CTH U		1		1		4	4	2		6	41,600	83	0.33

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-12: 2002 through 2009 Mainline Crash Totals

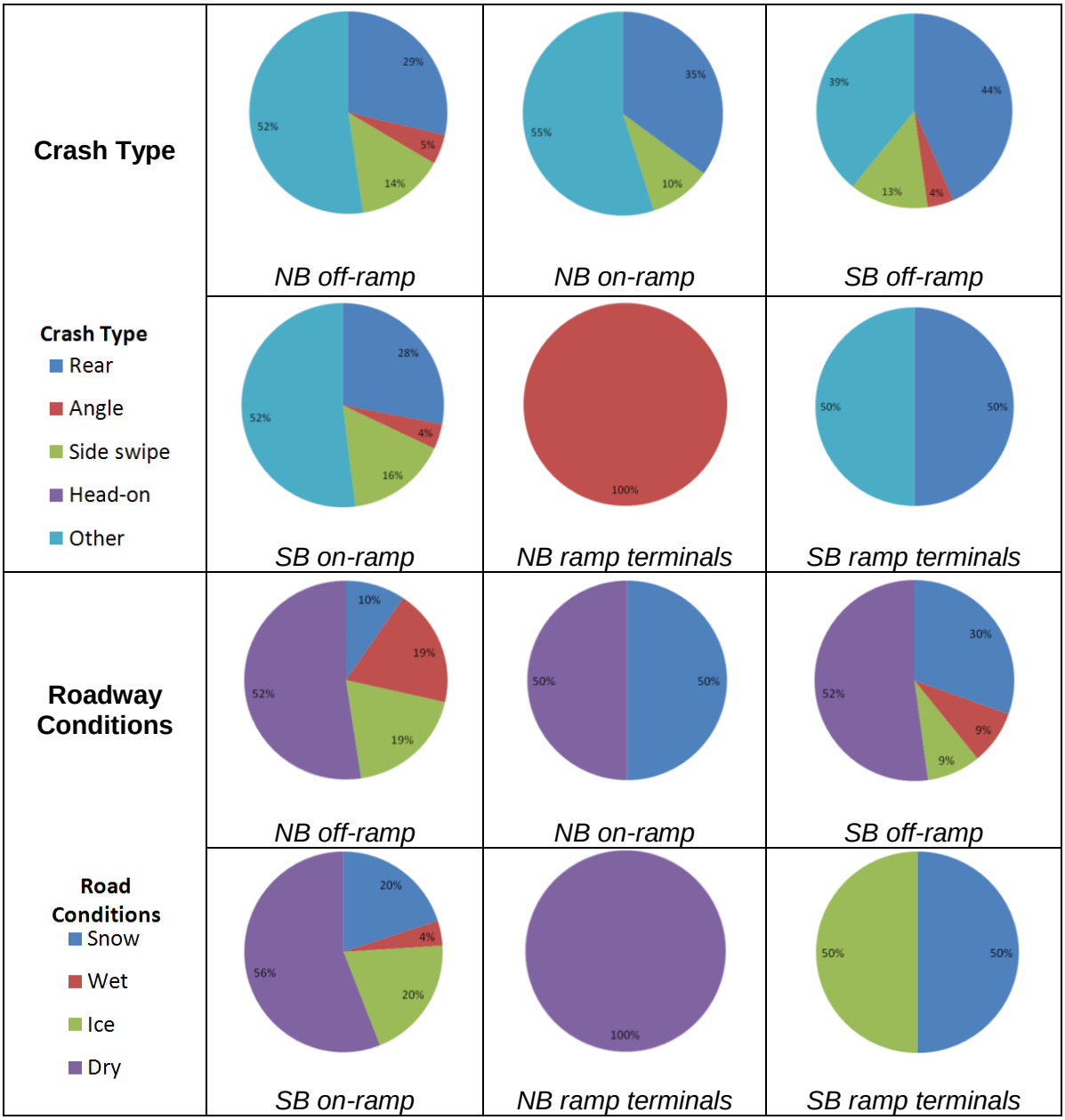
Interchange 'A'	Interchange 'B'	Direction	Crash Type					Crash Severity			Total Crashes	AADT	Avg. Annual Crash Rate	Crash Severity
			Rear	Angle	SS	HO	Other	PDO	Injury	Fatal				
CTH U	CTH S	NB			1		2	2	1		3	41,600	42	0.33
CTH S	CTH F		1	2			2	2	3		5	44,400	65	0.60
CTH F	CTH S	SB	1		1				1		1	44,400	13	1.00
CTH S	CTH U		1		1		4	4	2		6	41,600	83	0.33

SS = sideswipe; HO = head-on; PDO = property damage only

Table 2-13: Detailed Crash Summary

Location		Year	Crash Type					Crash Severity			Entering Traffic AADT	Roadway Condition				Light Condition		Average Annual Crash Rate	Crash Severity	Total Crashes
			Rear	Angle	Side swipe	Head-on	Other	PDO	Injury	Fatal		Snow	Wet	Ice	Dry	Dark	Light			
NB off ramp	Diverge	2002			1		1	2			41600	1	1			1	1	28	0.00	2
		2003					6	2	3	1			1	2	3	5	1	83	0.67	6
		2004	3	1	1			4	1			1		1	3	1	4	70	0.20	5
		2005			1				1						1		1	14	1.00	1
		2006																0	0.00	0
		2007	2				3	2	3				2	1	2	2	3	70	0.60	5
		2008	1				1		2						2		2	28	1.00	2
		2009																0	0.00	0
		Totals	**6**	**1**	**3**	**0**	**11**	**10**	**10**	**1**		**2**	**4**	**4**	**11**	**9**	**12**	**37**	**0.52**	**21**
NB on ramp	Merge	2002	2		1		2	4		1	41600	2			3	1	4	70	0.20	5
		2003					3	3				1			2	3		42	0.00	3
		2004					1	1							1		1	14	0.00	1
		2005	1				1	1	1			2					2	28	0.50	2
		2006																0	0.00	0
		2007	1		1			2							2		2	28	0.00	2
		2008	1				3	1	3			2			2		4	56	0.75	4
		2009	2				1	1	2			3				1	2	42	0.67	3
		Totals	**7**	**0**	**2**	**0**	**11**	**13**	**6**	**1**		**10**	**0**	**0**	**10**	**5**	**15**	**35**	**0.35**	**20**
SB off ramp	Diverge	2002					2		2		44400	2				2		26	1.00	2
		2003		1	1		3	3	2			1	1	1	2	1	4	65	0.40	5
		2004	2		1			2	1						3		3	39	0.33	3
		2005	2					1	1			1			1	1	1	26	0.50	2
		2006	2				1	3							3	1	2	39	0.00	3
		2007	1				1		2						2	1	1	26	1.00	2
		2008	1		1		1	2	1			1	1		1	3		39	0.33	3
		2009	2				1	2	1			2		1		2	1	39	0.33	3
		Totals	**10**	**1**	**3**	**0**	**9**	**13**	**10**	**0**		**7**	**2**	**2**	**12**	**11**	**12**	**37**	**0.43**	**23**
SB on ramp	Merge	2002	2	1			1	3	1		40400	1		1	2		4	57	0.25	4
		2003	1		1		3	4	1					2	3	3	2	72	0.20	5
		2004	1				2		3						3	1	2	43	1.00	3
		2005	1		1		1	2	1					1	2		3	43	0.33	3
		2006	2				2	1	3						4	1	3	57	0.75	4
		2007					4	2	2			3	1			2	2	57	0.50	4
		2008			2			1	1			1		1		1	1	29	0.50	2
		2009																0	0.00	0
		Totals	**7**	**1**	**4**	**0**	**13**	**13**	**12**	**0**		**5**	**1**	**5**	**14**	**8**	**17**	**45**	**0.48**	**25**
NB ramp terminals	Intersection	2002									1870							0	0.00	0
		2003																0	0.00	0
		2004		1				1							1		1	1	0.00	1
		2005																0	0.00	0
		2006																0	0.00	0
		2007																0	0.00	0
		2008																0	0.00	0
		2009																0	0.00	0
		Totals	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**0**		**0**	**0**	**0**	**1**	**0**	**1**	**0.18**	**0.00**	**1**
SB ramp terminals	Intersection	2002					1		1		1950			1			1	1	1.00	1
		2003																0	0.00	0
		2004																0	0.00	0
		2005	1					1				1					1	1	0.00	1
		2006																0	0.00	0
		2007																0	0.00	0
		2008																0	0.00	0
		2009																0	0.00	0
		Totals	**1**	**0**	**0**	**0**	**1**	**1**	**1**	**0**		**1**	**0**	**1**	**0**	**0**	**2**	**0.35**	**0.50**	**2**

Figure 2-1: Intersection Crash Breakdown



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CRASH RATES - 8-YEAR AVERAGE (2002 - 2009)

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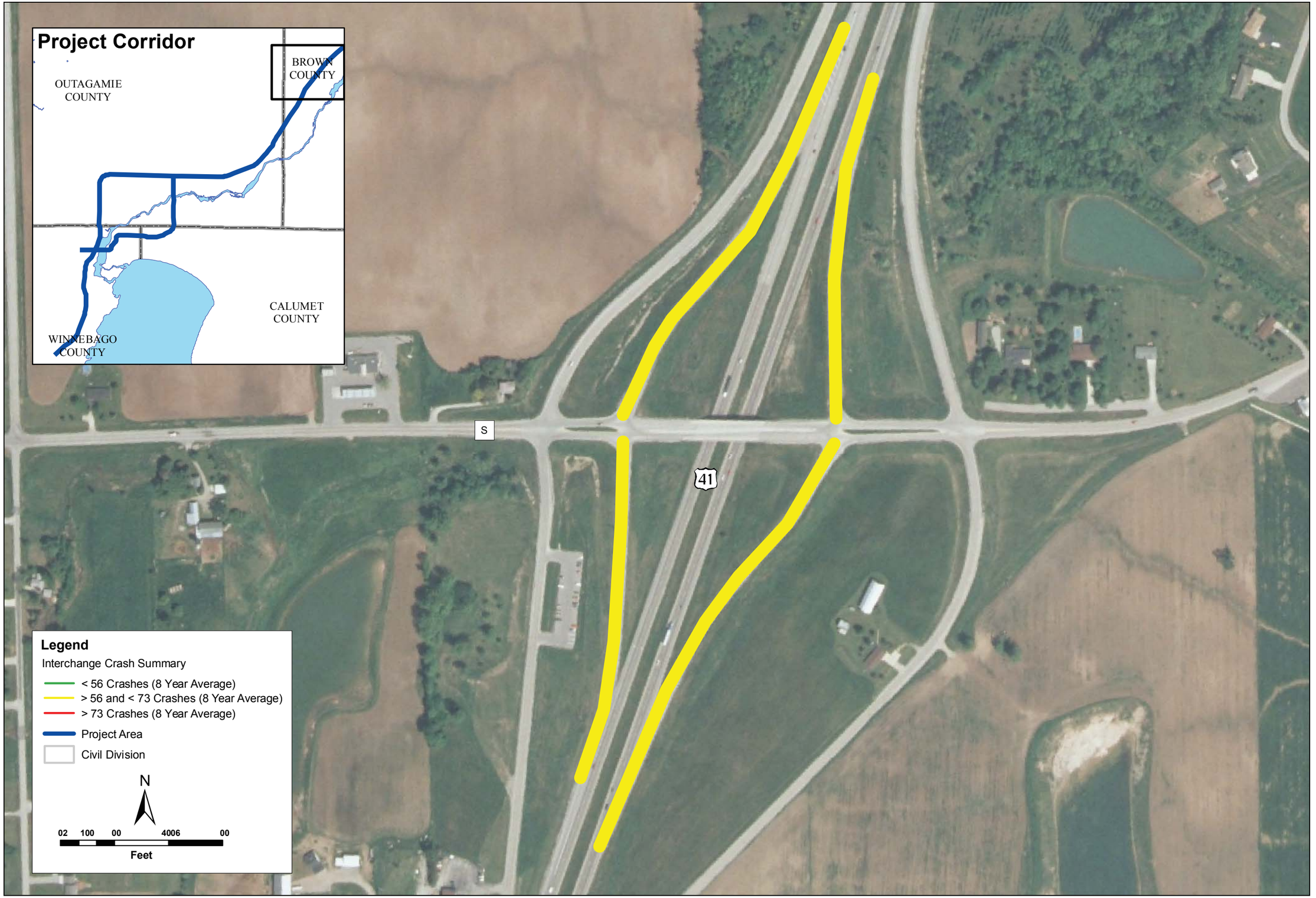
Figure 2-2
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S2-7



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MARCH 2011

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INTERCHANGE CRASH SUMMARY

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Figure 2-3
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

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CRASH RATES (2002)

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Figure 2-4
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S2-9

US 41 / WIS 441

CRASH RATES (2003)

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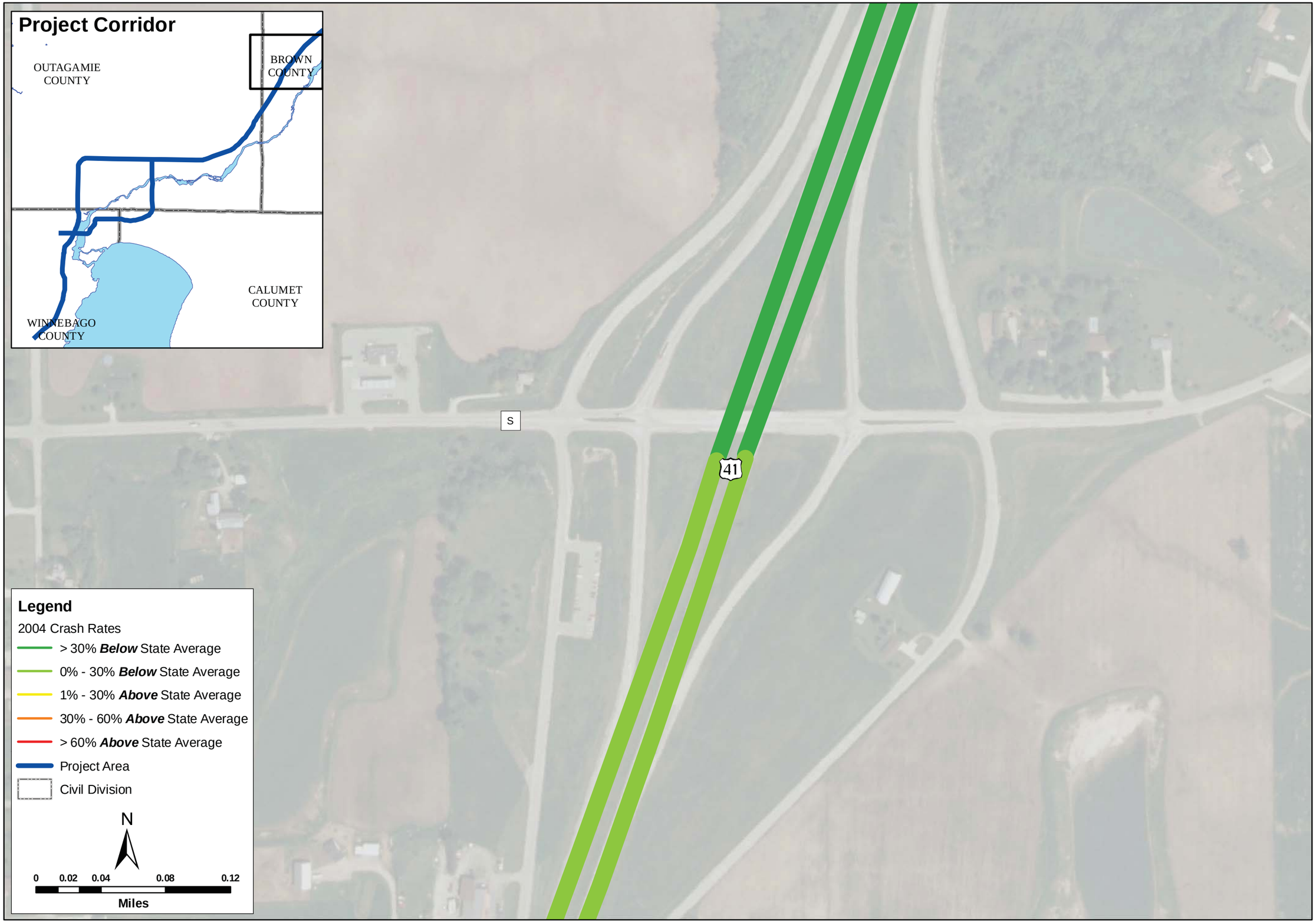
Figure 2-5
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S2-10



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CRASH RATES (2004)

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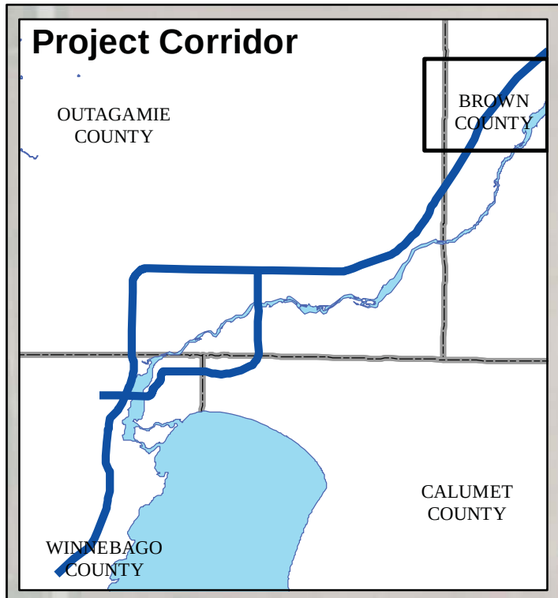
Figure 2-6
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S2-11



S

41

Legend

2005 Crash Rates

- > 30% ***Below*** State Average
- 0% - 30% ***Below*** State Average
- 1% - 30% ***Above*** State Average
- 30% - 60% ***Above*** State Average
- > 60% ***Above*** State Average
- Project Area
- Civil Division

N

0 0.02 0.04 0.08 0.12

Miles

WISCONSIN DEPARTMENT OF TRANSPORTATION

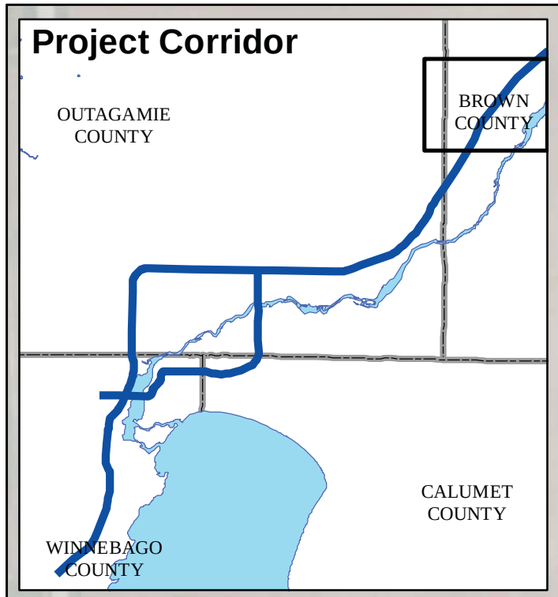
US 41 / WIS 441

CRASH RATES (2005)

HNTB

Figure 2-7
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT



S

41

Legend

2006 Crash Rates

- > 30% ***Below*** State Average
- 0% - 30% ***Below*** State Average
- 1% - 30% ***Above*** State Average
- 30% - 60% ***Above*** State Average
- > 60% ***Above*** State Average
- Project Area
- Civil Division

N

0 0.02 0.04 0.08 0.12

Miles

WISCONSIN DEPARTMENT OF TRANSPORTATION

US 41 / WIS 441

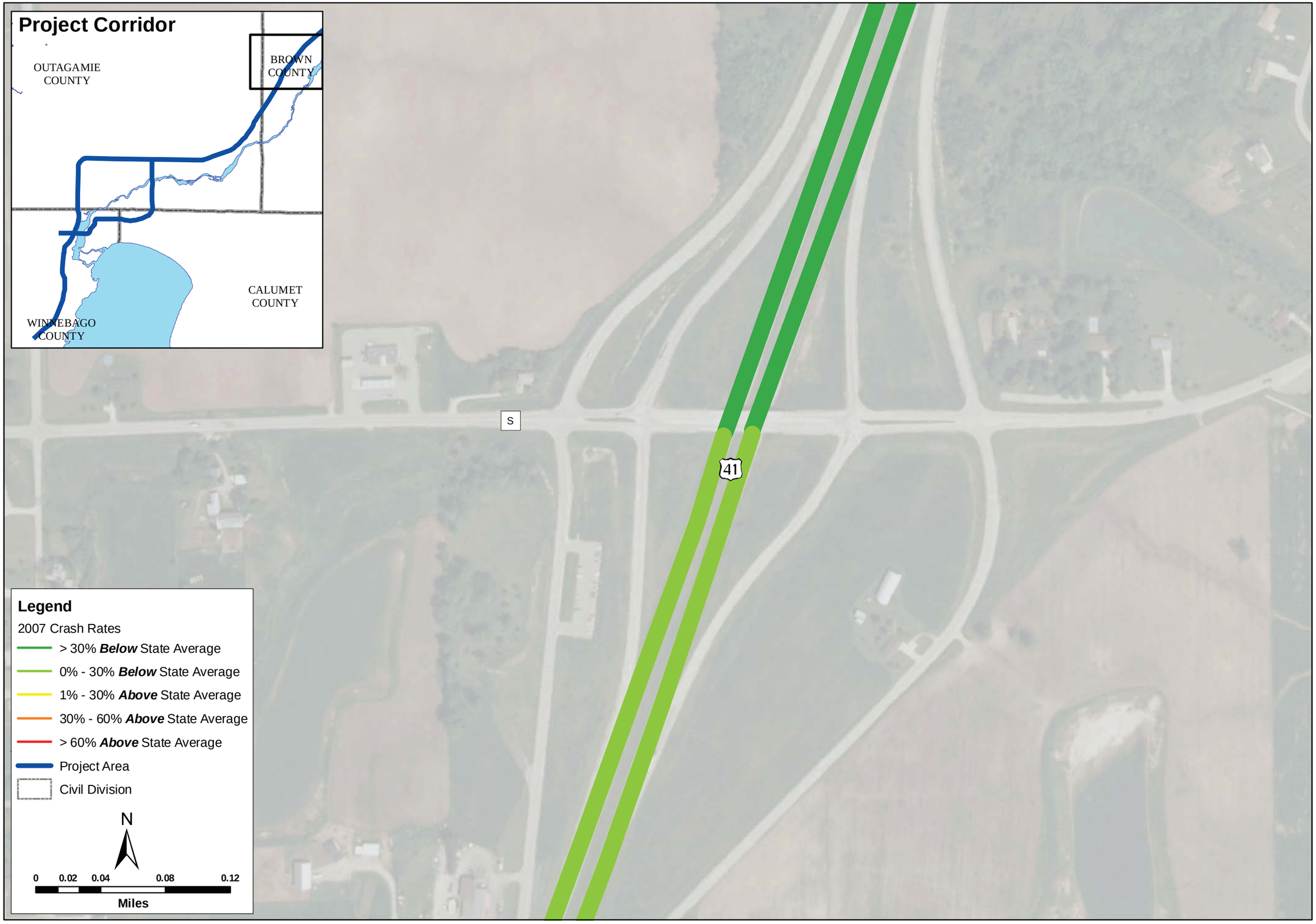
CRASH RATES (2006)

HNTB

Figure 2-8
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S2-13



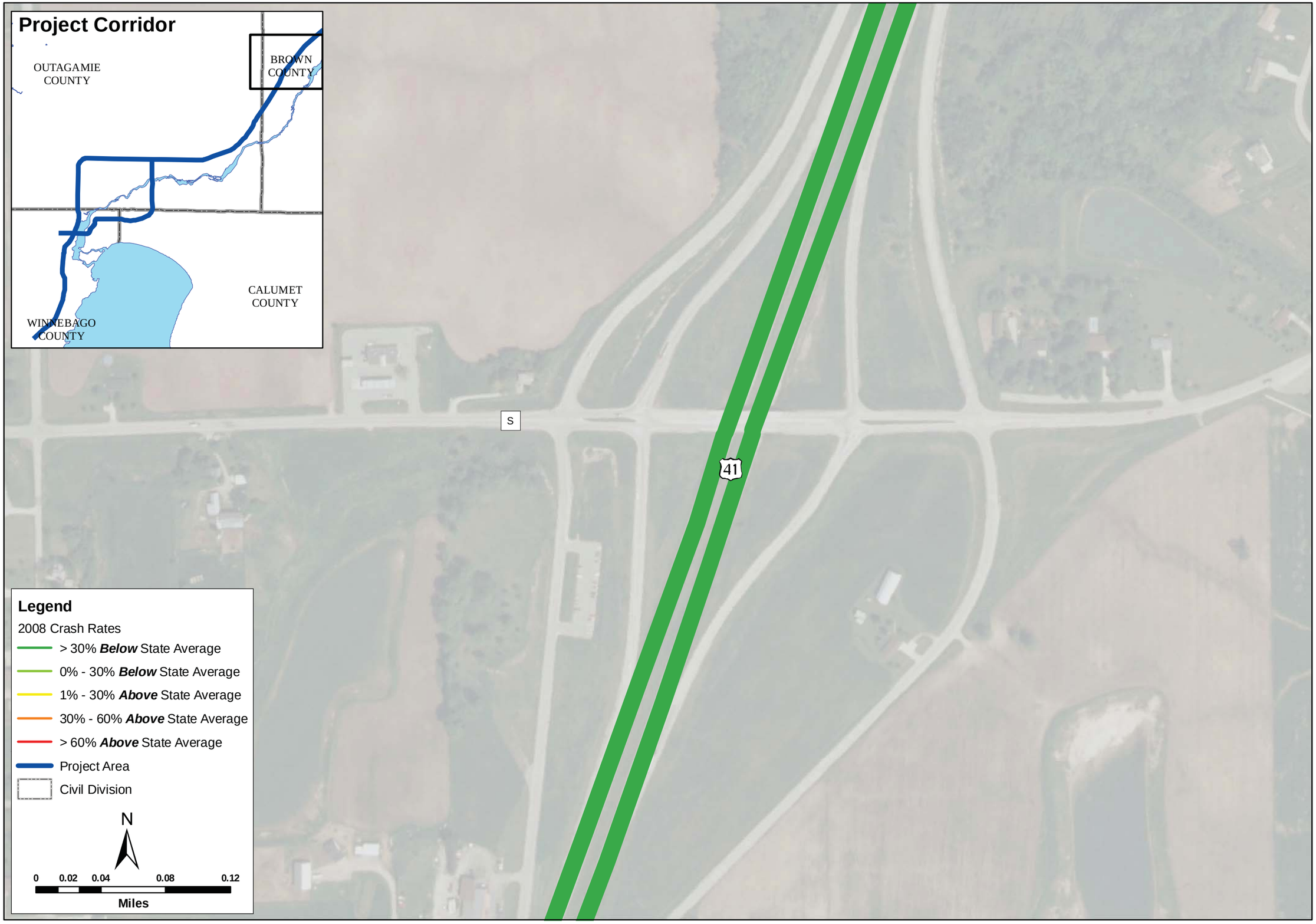
US 41 / WIS 441

CRASH RATES (2007)

HNTB

Figure 2-9
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT



US 41 / WIS 441

CRASH RATES (2008)

HNTB

Figure 2-10
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S2-15

Appendix S3: Level of Service (LOS)

Table 3-1: Freeway LOS

			LOS						**Density** (passenger cars per lane per mile)					
			2010		**2020**		**2035**		**2010**		**2020**		**2035**	
	Segment From	**Segment To**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
NB	CTH U	CTH S	C	B	C	C	C	C	18.2	16.7	21.6	20.5	22.4	23.7
	CTH S	CTH F	C	B	C	C	C	C	19.4	17.1	22.4	20.5	23.3	23.7
SB	CTH F	CTH S	B	C	C	C	C	C	16.4	18.5	21.3	23	18.1	24.8
	CTH S	CTH U	B	B	C	C	C	C	16.7	17.2	20.5	22.2	18.9	24.8

Table 3-2: Ramp LOS

		LOS						**Density** (passenger cars per lane per mile)					
		2010		**2020**		**2035**		**2010**		**2020**		**2035**	
	Type	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**	**AM**	**PM**
NB	Merge	C	B	C	C	D	C	22	18	24.1	23.1	28.3	26.2
	Diverge	C	B	C	C	C	C	21.2	18.8	25.3	23.3	26.3	27.1
SB	Merge	B	B	C	C	C	D	19.4	19.5	25.8	25.6	22.7	30.4
	Diverge	B	C	C	C	C	D	18.5	20.7	24.6	26.1	20.6	28.1

Table 3-3: Cross Street LOS – 2010

Intersection	Traffic Control	Peak Hour	**Level of Service & Delay** (in seconds)												**Intersection LOS & Delay**
			Eastbound			**Westbound**			**Northbound**			**Southbound**			
			LT	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	
Mid Valley	Stop Sign	AM		A 0.1			A 0.3			B 10.7			B 11.3		A 1.1
		PM		A 0.2			A 1.3			B 11.0			B 13.2		A 2.6
SB Ramp	Stop Sign	AM		A 0.0	A 0.0	A 8.3	A 0.0					C 15.7		A 9.0	A 4.0
		PM		A 0.0	A 0.0	A 7.9	A 0.0					C 15.0		B 10.0	A 6.4
NB Ramp	Stop Sign	AM	A 8.3	A 0.0			A 0.0	A 0.0		C 17.3	A 9.3				A 4.3
		PM	A 7.9	A 0.0			A 0.0	A 0.0		B 14.4	A 9.4				A 3.7
French	Stop Sign	AM		A 1.3			A 0.6			B 12.5			A 9.8		A 1.9
		PM		A 0.8			A 0.5			B 13.0			B 10.1		A 2.8

Table 3-4: Cross Street LOS – 2020

Intersection	Traffic Control	Peak Hour	Level of Service & Delay (in seconds)												Intersection LOS & Delay
			Eastbound			Westbound			Northbound			Southbound			
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Mid Valley	Stop Sign	AM		A 0.2			A 0.6			B 13.0			C 20.2		A 2.8
		PM		A 0.4			A 1.6			C 15.0			**D 27.2**		A 4.1
SB Ramp	Stop Sign	AM		A 0.0			A 9.4					**E 44.2**		B 10.4	A 6.8
		PM		A 0.0			A 8.9					**E 49.1**		B 12.4	A 9.6
NB Ramp	Stop Sign	AM	A 9.2	A 0.0			A 0.0	A 0.0		**E 44.8**	A 9.9				A 7.5
		PM	A 8.5	A 0.0			A 0.0	A 0.0		**E 37.2**	B 10.8				A 8.3
French	Stop Sign	AM		A 1.5			A 0.5			C 22.2			B 11.0		A 3.9
		PM		A 0.6			A 0.4			C 23.3			B 11.6		A 4.4

Table 3-5: Cross Street LOS – 2035

Intersection	Traffic Control	Peak Hour	Level of Service & Delay (in seconds)												Intersection LOS & Delay
			Eastbound			Westbound			Northbound			Southbound			
			LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
Mid Valley	Stop Sign	AM		A 0.4			A 0.6			C 22.0			**E 45.7**		A 7.5
		PM		A 0.5			A 1.8			C 23.2			**F 222.5**		**E 35.8**
SB Ramp	Stop Sign	AM		A 0.0			B 10.5					**F 186.6**		B 11.3	C 19.5
		PM		A 0.0			A 9.8					**F 301.3**		B 14.7	**E 37.9**
NB Ramp	Stop Sign	AM	B 10.0	A 0.0			A 0.0	A 0.0		**F 181.7**	B 11.0				C 22.3
		PM	A 9.3	A 0.0			A 0.0	A 0.0		**F 274.4**	B 12.1				**E 43.0**
French	Stop Sign	AM		A 1.3			A 0.6			**F 50.0**			B 11.8		A 7.8
		PM		A 1.0			A 0.4			**F 65.8**			B 13.7		B 11.1

KEY: Yellow = LOS D Orange = LOS E Red = LOS F

Table 3-6: Mainline PHF and Truck Percentages

Mainline	Approach	AM PHF	AM Truck %	PM PHF	PM Truck %
US 41 Mainline	NB	0.90	13.0%	0.96	10.0%
	SB	0.92	11.0%	0.93	10.0%

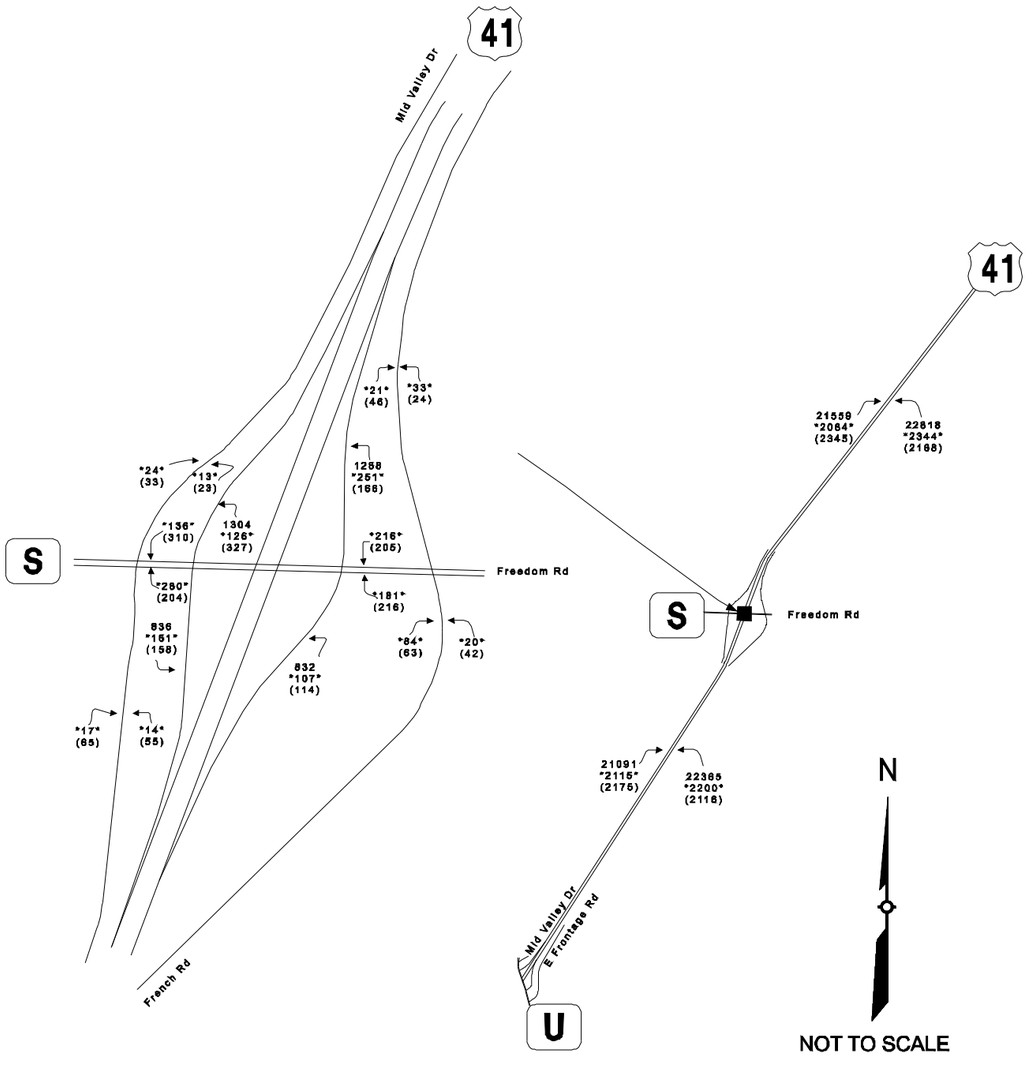
Table 3-7: Ramp PHF and Truck Percentages

Ramp		AM PHF	AM Truck %	PM PHF	PM Truck %
CTH S	NB on	0.88	2.8%	0.99	2.4%
	NB off	0.65	1.9%	0.84	5.3%
	SB on	0.72	3.8%	0.82	3.2%
	SB off	0.88	6.3%	0.91	1.2%

Table 3-8: Intersection and Ramp Terminal PHF and Truck Percentages

Intersection	AM PHF	AM Truck %	PM PHF	PM Truck %
CTH S & Mid Valley Dr	0.88	3.9%	0.99	2.9%
CTH S & SB Ramp	0.85	4.6%	0.91	2.5%
CTH S & NB Ramp	0.87	4.5%	0.93	3.5%
CTH S & French Rd	0.81	4.3%	0.88	2.5%

EXISTING BALANCED LINKFLOWS



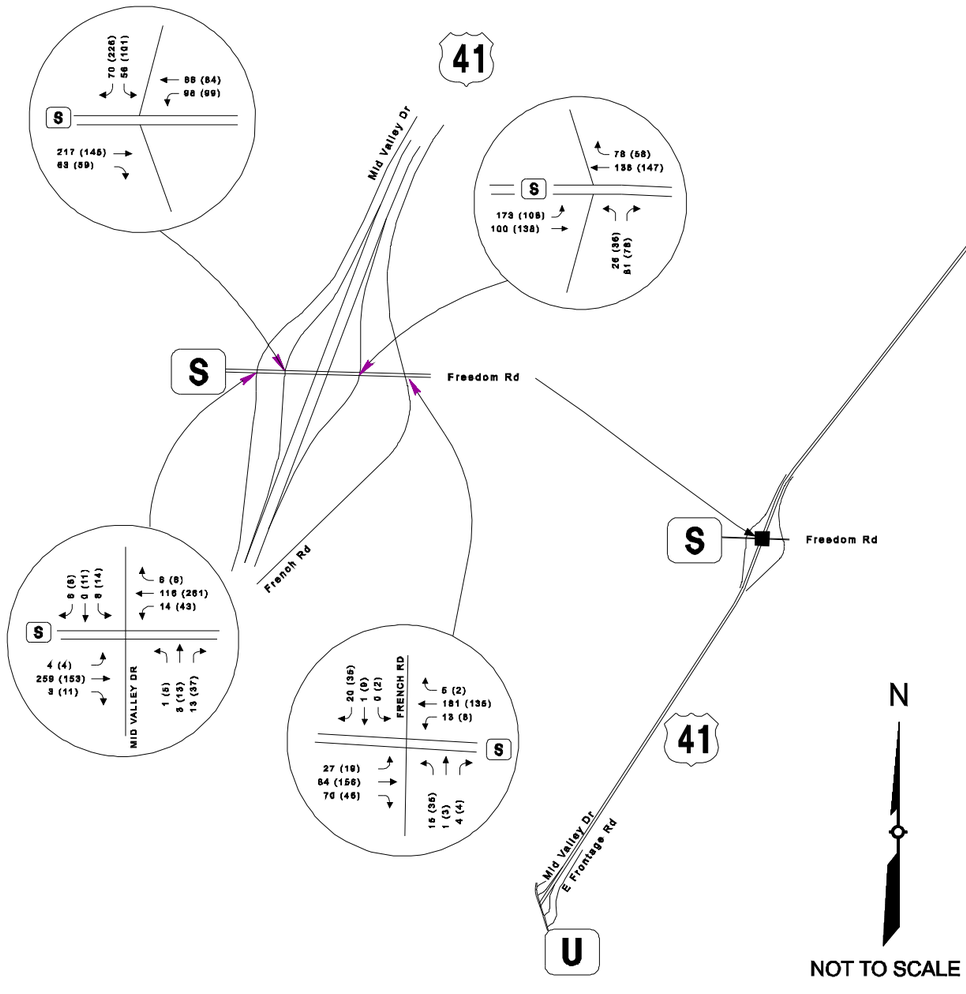
LEGEND

XXXX = AADT

XXXX = AM PEAK HOUR

(XXXX) = PM PEAK HOUR

EXISTING BALANCED TURNING MOVEMENT COUNT



LEGEND

XXXX = AM PEAK HOUR

(XXXX) = PM PEAK HOUR

US 41 / WIS 441

EXISTING BALANCED LINKFLOWS AND TURNING MOVEMENT COUNTS

MARCH 2011

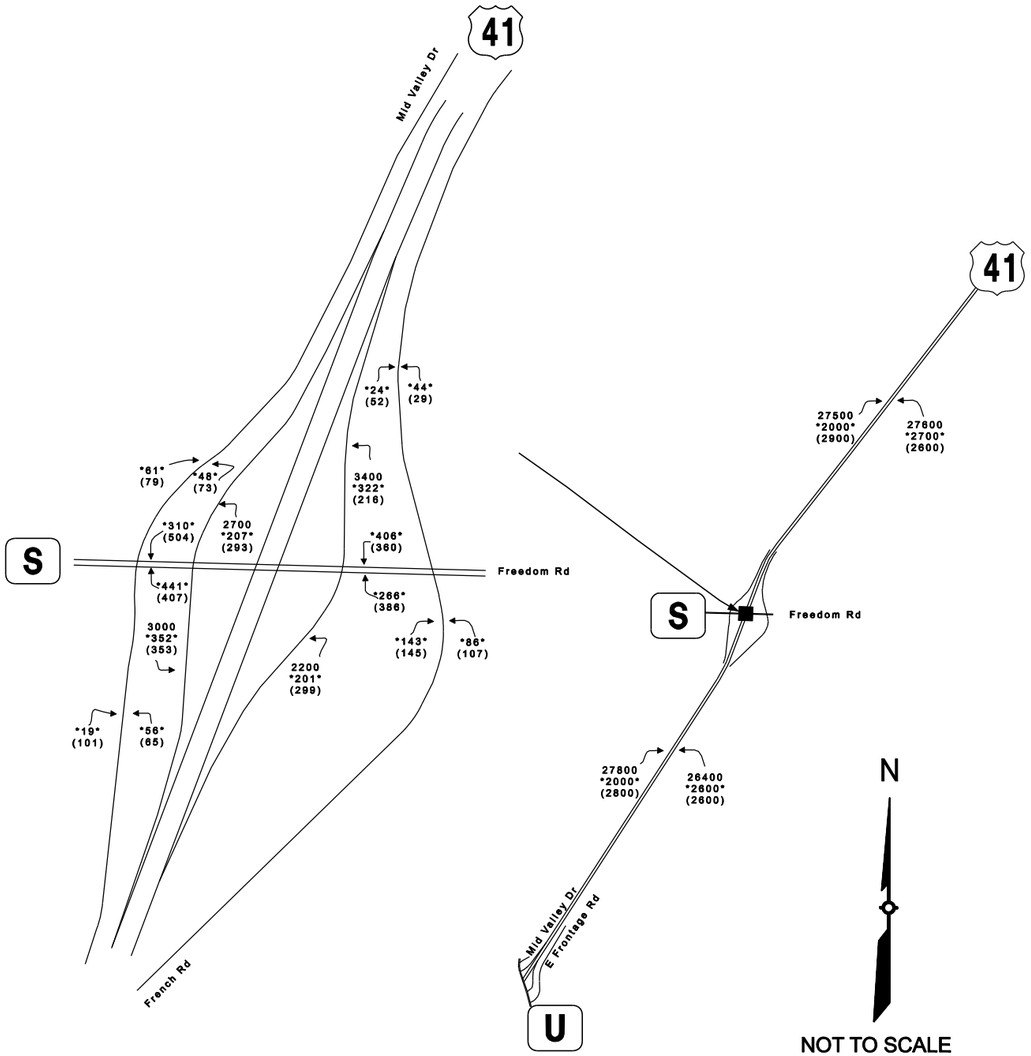
HNTB

Figure 3-1
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S3-4

2020 BALANCED LINKFLOWS



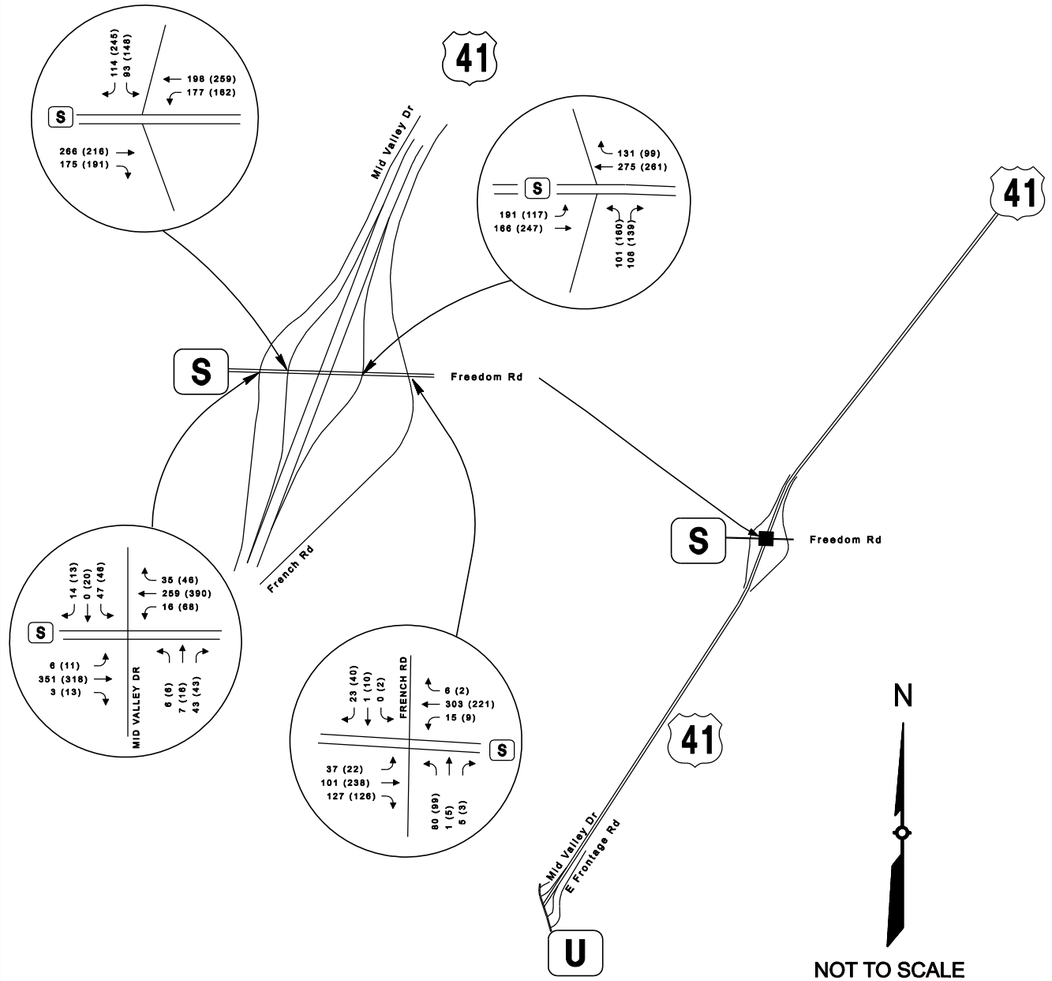
LEGEND

XXXX = AADT

XXXX = AM PEAK HOUR

(XXXX) = PM PEAK HOUR

2020 BALANCED TURNING MOVEMENT COUNT



LEGEND

XXXX = AM PEAK HOUR

(XXXX) = PM PEAK HOUR

US 41 / WIS 441

2020 BALANCED LINKFLOWS AND TURNING MOVEMENT COUNTS

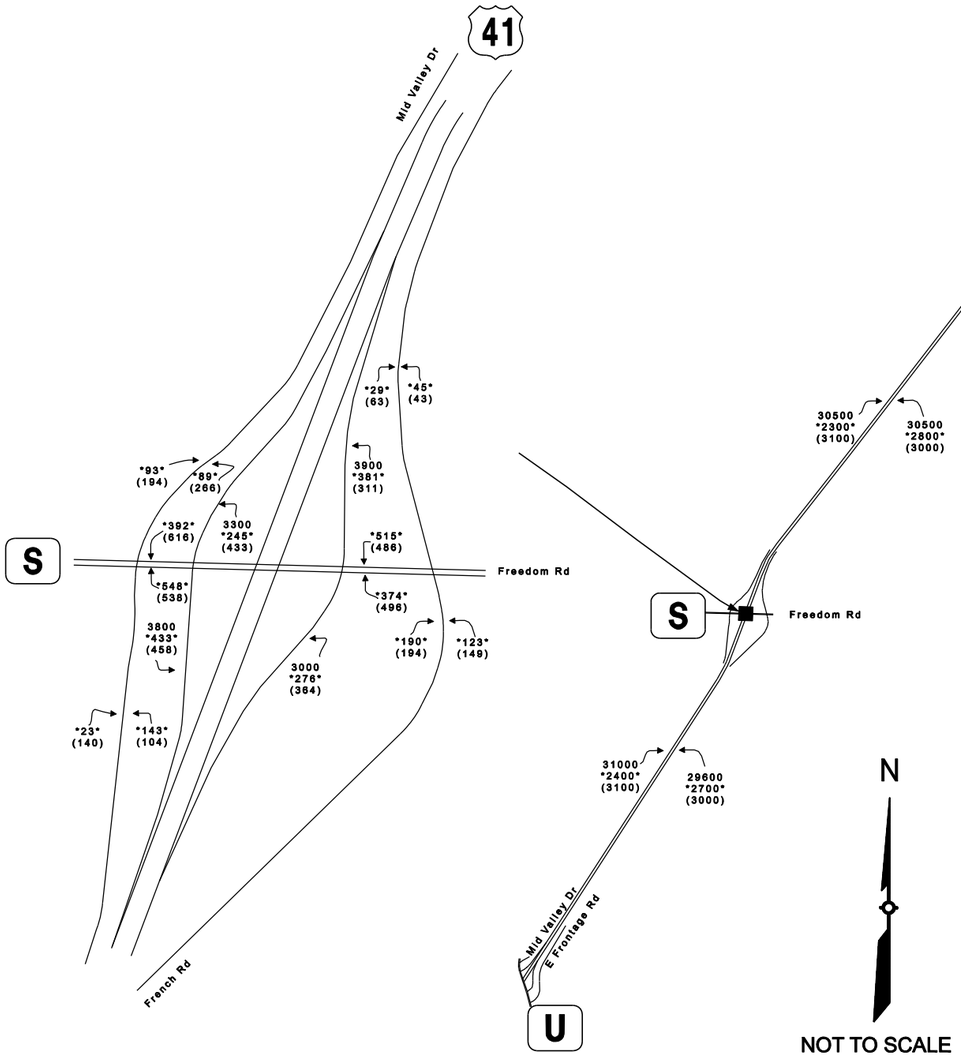
MARCH 2011

HNTB

Figure 3-2
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

2035 BALANCED LINKFLOWS



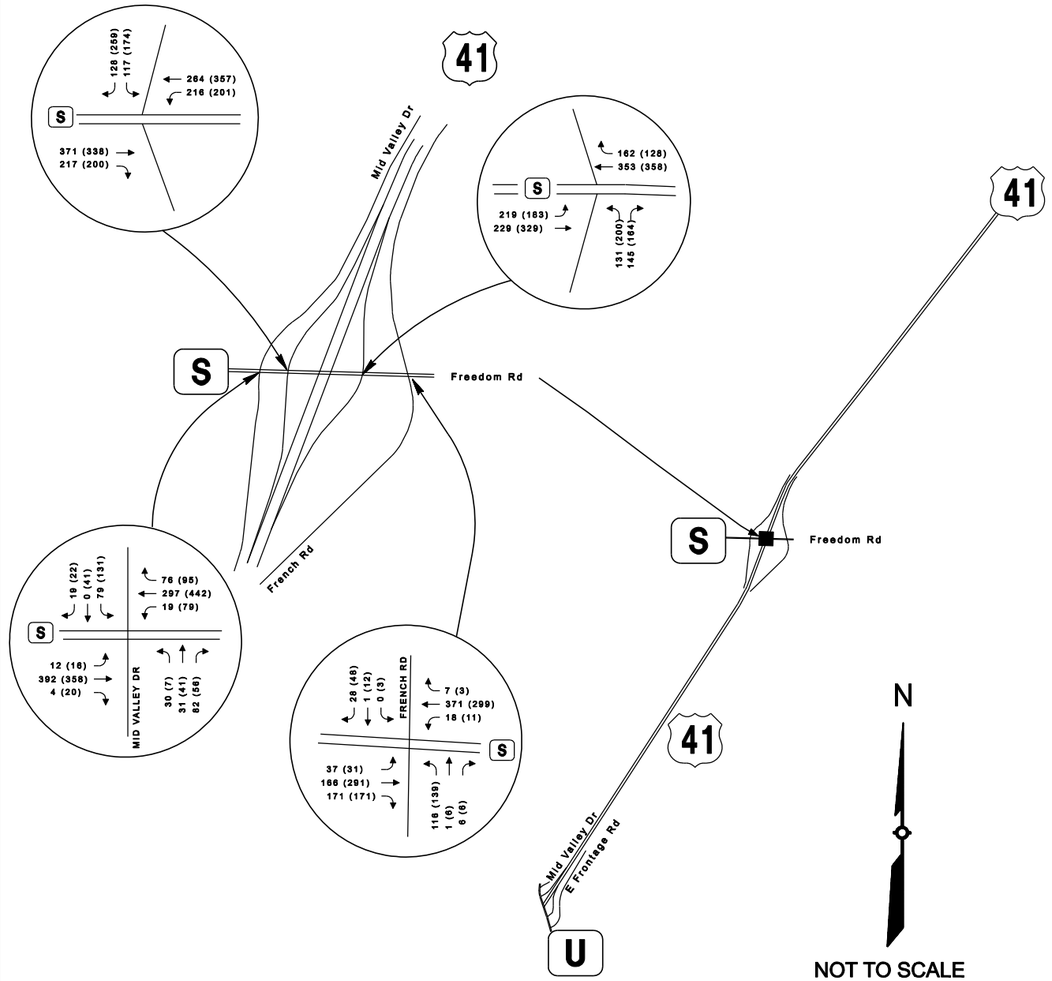
LEGEND

XXXX = AADT

XXXX = AM PEAK HOUR

(XXXX) = PM PEAK HOUR

2035 BALANCED TURNING MOVEMENT COUNT



LEGEND

XXXX = AM PEAK HOUR

(XXXX) = PM PEAK HOUR

WISCONSIN DEPARTMENT OF TRANSPORTATION

US 41 / WIS 441

2035 BALANCED LINKFLOWS AND TURNING MOVEMENT COUNTS

MARCH 2011

HNTB

Figure 3-3
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

WISCONSIN DEPARTMENT OF TRANSPORTATION

MARCH 2011

US 41 / WIS 441

LEVEL OF SERVICE (AM)

HNTB

Figure 3-4
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

WISCONSIN DEPARTMENT OF TRANSPORTATION

MARCH 2011

US 41 / WIS 441

LEVEL OF SERVICE (PM)

HNTB

Figure 3-5
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S3-8

US 41 / WIS 441

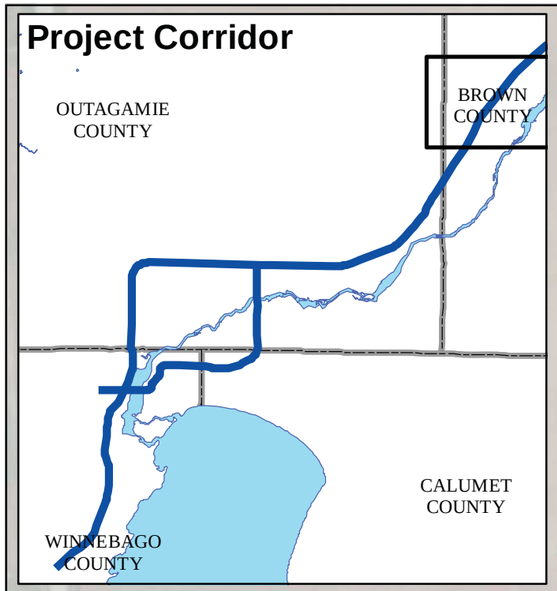
2020 LEVEL OF SERVICE (AM)

HNTB

Figure 3-6
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S3-9



S

41

Legend

2020 PM Level of Service

- A, B, C
- D
- E, F
- Project Area
- Civil Division

N

0 0.02 0.04 0.08 0.12

Miles

US 41 / WIS 441

2020 LEVEL OF SERVICE (PM)

HNTB

Figure 3-7
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S3-10

WISCONSIN DEPARTMENT OF TRANSPORTATION

US 41 / WIS 441

2035 LEVEL OF SERVICE (AM)

HNTB

Figure 3-8
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S3-11

US 41 / WIS 441

2035 LEVEL OF SERVICE (PM)

HNTB

Figure 3-9
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S3-12

Appendix S4: Data Inventory

Table 4-1: US 41 Interchange and Adjacent Intersections Inventory

Interchange		Adjacent Intersections
1	CTH S (Freedom Rd)	Freedom Rd and Mid Valley Dr
		Freedom Rd and US 41 SB Ramp Terminal
		Freedom Rd and US 41 NB Ramp Terminal
		Freedom Rd and French Rd

Table 4-2: US 41 Structure Inventory

Structure Number	Bridge Location (mile maker)	Feature Carried	Feature Under
B-05-0162	157.5	CTH S	US 41

Table 4-3: As-Built Plans Inventory

Project ID	Project Location	Type of Work Completed	Year
1131-08-73	CTH S Interchange	Paving details	1998

Appendix S5: Structural Analysis

Table 5-1: Final Recommendations

No.	Bridge Number	Feature 'On'	Feature 'Under'	Girder Type	FINAL RECOMMENDATION at Year 2020	FINAL RECOMMENDATION at Year 2035	Structural Comment	Vertical Clearance Comment	Bridge Width Comment
1	B-05-0162	CTH S (Freedom Rd)	US 41	Const. Steel	No action needed	No action needed		Does not meet DESIRABLE CLEARANCE standards	

Table 5-2: Current Conditions

BRIDGE CONDITION DETAILS														
No.	Bridge Number	Year Built	Bridge Deck Year	Most Recent Overlay	Current Deck State	HIS‡ Deck Element	Coated/Uncoated Bars	Underside Deck Smart Flag	NBI* Deck	NBI* Super	NBI* Sub	Sufficiency Rating	Inventory Rating (HS-##)	Roadway Under Geometry Flag
1	B-05-0162	1993	1993	---	ORIGINAL	1	C	1	8	8	8	99	21	

FUNCTIONAL CONDITIONS													NOTES †						
Actual Vertical Clearance	Desired Vertical Clearance	Distance Below Desired (ft)	Minimum Vertical Clearance	Distance Below Minimum (ft)	Vertical Clearance Flag	Actual Bridge Width (ft)	Desirable Bridge Width (ft)	Distance Less Than	Minimum Bridge Width	Distance Less Than	Bridge Width "Flag"	Major Bridge Width	Traffic Impact	Vertical Clearance	Bridge Width	Replace Due to Widening	Overlay an Overlay?	Inspections	Structural Notes
16.70	16.75	0.05	16.33		X	67	40		38				---	4	---	---	---	---	---

Table 5-3: 2020 Predicted Condition Ratings

No.	Bridge Number	Age in Year 2020	Coated/Uncoated Bars	HSI‡ Deck Element			Underside Deck Smart Flag			NBI* Deck			NBI* Super			NBI* Sub			Pack Rust Smart Flag			Section Loss Smart Flag			Steel Cracking Smart Flag			Sufficiency Rating	Inventory Rating (HS_##)	Test(s) Failed
				2010	→	2020	2010	→	2020	2010	→	2020	2010	→	2020	2010	→	2020	2010	→	2020	2010	→	2020	2010	→	2020			
1	B-05-0162	27	C	1	–	1	1	–	1	8	–	8	8	**-1**	7	8	**-1**	7	0	**+1**	1	0	**+1**	1	0	**+1**	1	99	21	2-D4

Table 5-4: 2035 Predicted Condition Ratings

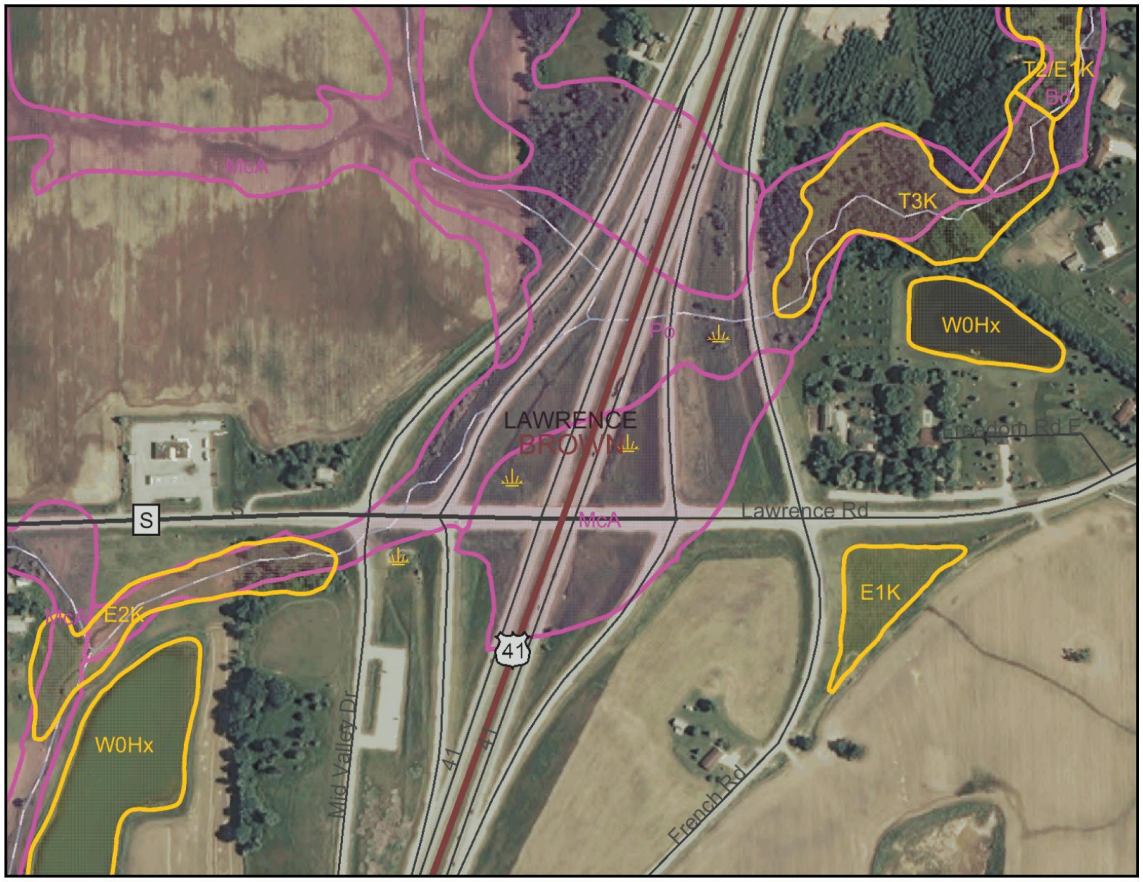
No.	Bridge Number	Age in Year 2035	Coated/ Uncoated Bars	HSI‡ Deck Element				Underside Deck Smart Flag				NBI* Deck				NBI* Super				NBI* Sub				Pack Rust Smart Flag				Section Loss Smart Flag				Steel Cracking Smart Flag				Test(s) Failed	Possibly Structurally Deficient in 2035?
				2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015	2010	UG**	PC§	2035 2015		
1	B-05-0162	42	C	1	-	**+1**	2	1	-	**+1**	2	8	-	**-1**	7	8	-	**-2**	6	8	-	**-2**	6	0	-	**+2**	2	0	-	**+2**	2	0	-	**+2**	2	2-D4	

‡ HSI = Highway Structures Information (system)
* NBI = National Bridge Index
** UG = 2020 Upgrade
§ PC = 2010 to 2035 Predicted Change

† NOTES

1 Traffic impact may be heavily influencing replacement recommendation
2 Bridge has experienced traffic impact incidences; possibly raise girders, lower roadway under or replace structure
3 Vertical clearance does not meet minimum standards; consider raising girders, lowering roadway under or replacing structure
4 Vertical clearance does not meet desirable standards; consider raising girders, lowering roadway under or replacing structure
5 Bridge width does not meet minimum standards; consider re-decking and widening
6 Bridge width does not meet desirable standards; consider re-decking and widening
7 Consider replacing bridge due to inadequate bridge width
8 Consider replacing overpass or lower road under due to inadequate clearance
9 Consider a second overlay
10 Continue to monitor **sufficiency rating**; funding is available for a rating below 50
11 Bridge over water; therefore no vertical clearance requirements
12 Roadway under rating of 2 out of 10 (high replacement priority) due to inadequate minimum median distance and lack of column protection

Wetlands: CTH S and US 41 Interchange



0 550 1100 1650 ft.

Map created on Mar 1, 2011

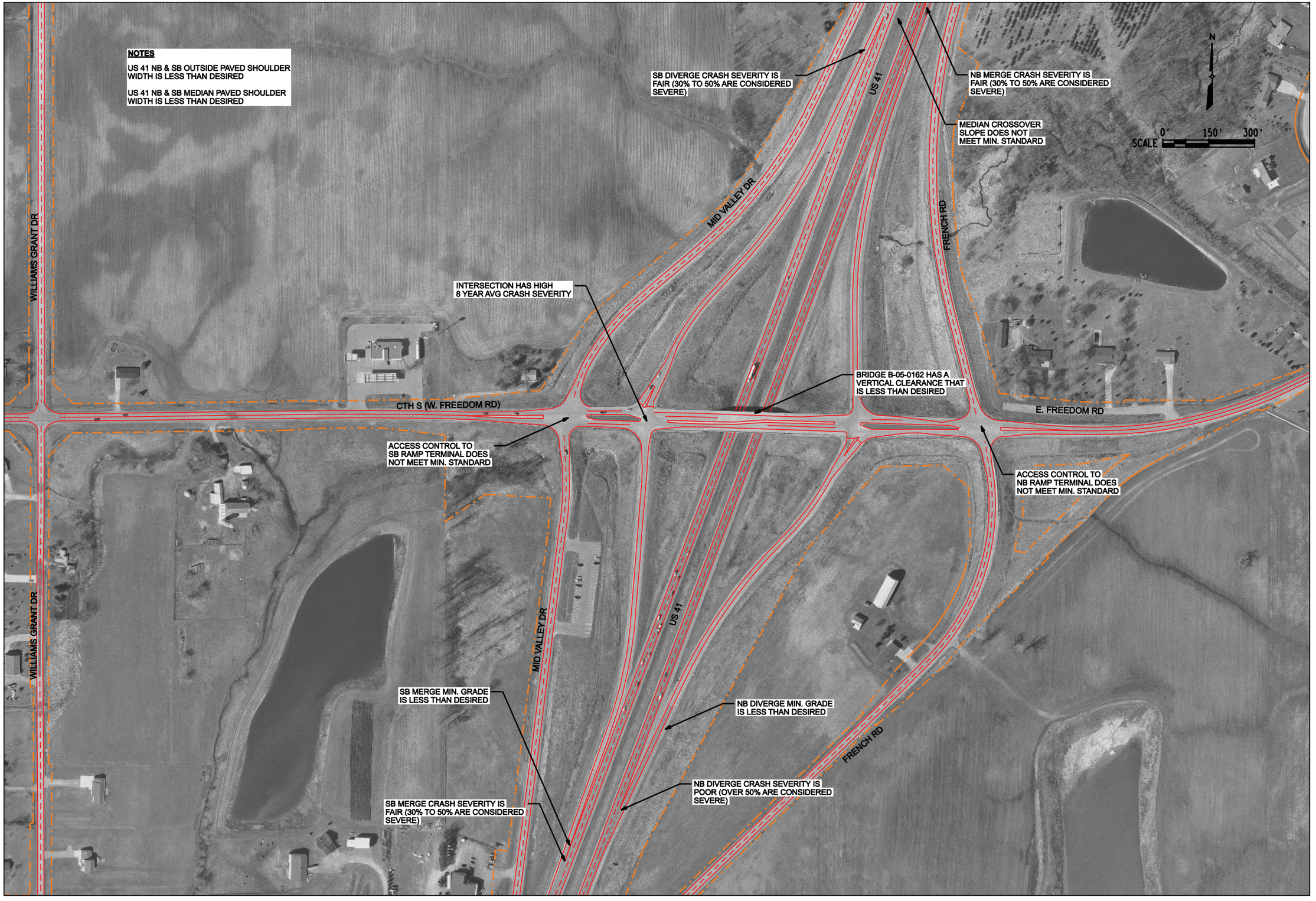
Legend

- **Major Highways**
  - Interstate
  - State Highway
  - U.S. Highways
- **County Roads**
- **Local Roads**
- **24K County Boundaries**
- **Civil Towns**
  - Civil Town
- **USDA Wetspots**
- **DNR Wetland Points**
  - Excavated Pond
  - Dammed Pond
  - Wetland Too Small to Delineate
  - Filled Excavated Pond
  - Filled Dammed Pond
  - Filled Wetland Too Small to Delineate
  - Filled or Drained Wetland
- **DNR Wetland Areas**
  - Upland
  - Wetland
  - Filled or Drained Wetland
- **Wetland Indicator Soils**
- **24K Open Water**
- **24K Rivers and Shorelines**
  - Intermittent
  - Fluctuating
  - Perennial

Scale: 1:5,710

Notes: No deliniated wetalnd within interchange area, likely due to the existinance of an interchange. Map shows that there is "wetland too small to deliniate" within the interchange area. Ashwaubenon Creek flows through the interchange and connects two deliniated wetlands. Standard mitigation procedures would be needed to protect the creek during construction of interchange improvements.

Wisconsin Wetland Inventory (WWI) maps show graphic representations of the type, size and location of wetlands in Wisconsin. These maps have been prepared from the analysis of high altitude imagery in conjunction with soil surveys, topographic maps, previous wetland inventories and field work. State statutes define a wetland as "an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions." The principal focus of the WWI is to produce wetland maps that are graphic representations of the type, size and location of wetlands in Wisconsin. Within this context, the objective of the WWI is to produce reconnaissance level information on the location, type, size of these habitats such that they are accurate at the nominal scale of the 1:24,000 (1 inch = 2000 feet) base map. The DNR recognizes the limitations of using remotely sensed information as the primary data source. They are to be used as a guide for planning purposes. There is no attempt, in either the design or products of this inventory, to define the limits of jurisdiction of any Federal, State, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, State, or local agencies concerning specified agency regulatory programs and jurisdictions that may affect such activities. The most accurate method of determining the legal extent of a wetland for federal or state regulations is a field delineation of the wetland boundary by a professional trained in wetland delineation techniques.



WISCONSIN DEPARTMENT OF TRANSPORTATION

US 41 / WIS 441

GEOMETRIC AND SAFETY DEFICIENCY MAP (MAINLINE AND RAMPS)

MARCH 2011

HNTB

Appendix S7
Sheet 1 of 1

Operational Needs Assessment
CTH S (Freedom Road)
PRELIMINARY REPORT

S7-1