

MEMORANDUM

To: Larry Legg, PE
From: Adam Denney, PE
Mark Meisinger, PE, PTOE
Timothy Adams, EIT
Date: 15 July 2019
RE: Lancaster County Supplemental Study – 148th Street Roadway Improvements

Project Background

In December 2018, Felsburg Holt & Ullevig (FHU) completed a safety analysis for 148th Street between the intersections of Amberly Road and Old Cheney Road in Lancaster County, Nebraska. The analysis identified improvements that should be implemented to increase safety and accommodate the future growth and travel within the study area. The completed, *Lancaster County Safety Study – 148th Street*, report is attached with this memo.

At the request of the Lancaster County Engineer, FHU carried out this supplemental study to assess roadway improvements from US 34 (O Street) to 750 feet south of Yankee Hill Road.

The additional work includes an updated safety analysis of the segment and a benefit cost analysis of safety recommendations. This report is based on the comprehensive analysis of over 6 years of crash data from January 1, 2013 to April 4, 2019, provided by Lancaster County.

Roadway Geometrics

148th street is a paved two-lane undivided highway, without shoulders. 148th Street has a posted speed limit of 55 mph along the entire length of the study area. Average annual daily traffic (AADT) was assessed at each subdivided segment during the original study. The individual one-mile segments along 148th Street and their AADT are listed below:

- Old Cheney Road to Pioneers Boulevard: 4,960 AADT
- Pioneers Boulevard to Van Dorn Street: 5,006 AADT
- Van Dorn Street to A Street: 5,002 AADT
- A Street to US 34 (O Street): 4,940 AADT

Crash History

The crash history for the period of January 1, 2013 to April 4, 2019 was examined at each segment to assess crash patterns. The statewide average crash rate for rural Nebraska roadways is 0.721 acc/mvmt (accidents per million vehicle miles traveled) for non-shouldered roadways between the years of 2012-2014. Over the 6-year, 3-month analysis period seven (7) crashes were reported on 148th Street from Old Cheney Road to Pioneers Boulevard, nine (9) crashes from Pioneers Boulevard to Van Dorn Street, seven (7) crashes from Van Dorn Street to A Street, and one (1) crash from A Street to US 34 (O Street). This amounts to a crash rate of 0.532 acc/mvmt for the entire study area along 148th Street. At the highest segment of Pioneers Boulevard to Van Dorn Street the crash rate was 0.795 acc/mvmt, equating to 110% of the state average.

Table 1 summarizes the crash history along the four segments by type over the 6-year, 3-month analysis period. **Table 2** shows the crashes categorized by severity.

Table 1. I48th Street Crash Summary by Type

Segment	Rear End	Side Swipe (Same)	Side Swipe (Opposite)	Right-Angle	Run Off Road	Animal	Totals
Old Cheney Rd to Pioneers Blvd	-	-	1	-	2	4	7
Pioneers Blvd to Van Dorn St	1	1	-	-	6	1	9
Van Dorn St to A St	-	-	1	1	2	3	7
A St to US 34 (O Street)	-	-	-	1	-	-	1

Table 2. I48th Street Crash Summary by Severity

Segment	Fatal	Injury			N-R	PDO	Totals
		INJ-A	INJ-B	INJ-C			
Old Cheney Rd to Pioneers Blvd			1			6	7
Pioneers Blvd to Van Dorn St		1		3		5	9
Van Dorn St to A St		1		2	1	3	7
A St to US 34 (O Street)				1			1

Figure 1 graphically displays the breakdown of crashes by type and severity over the 6-year, 3-month analysis period for the I48th Street analysis corridor. The most frequent pattern involved vehicles running off the roadway followed closely by vehicle/animal collisions.

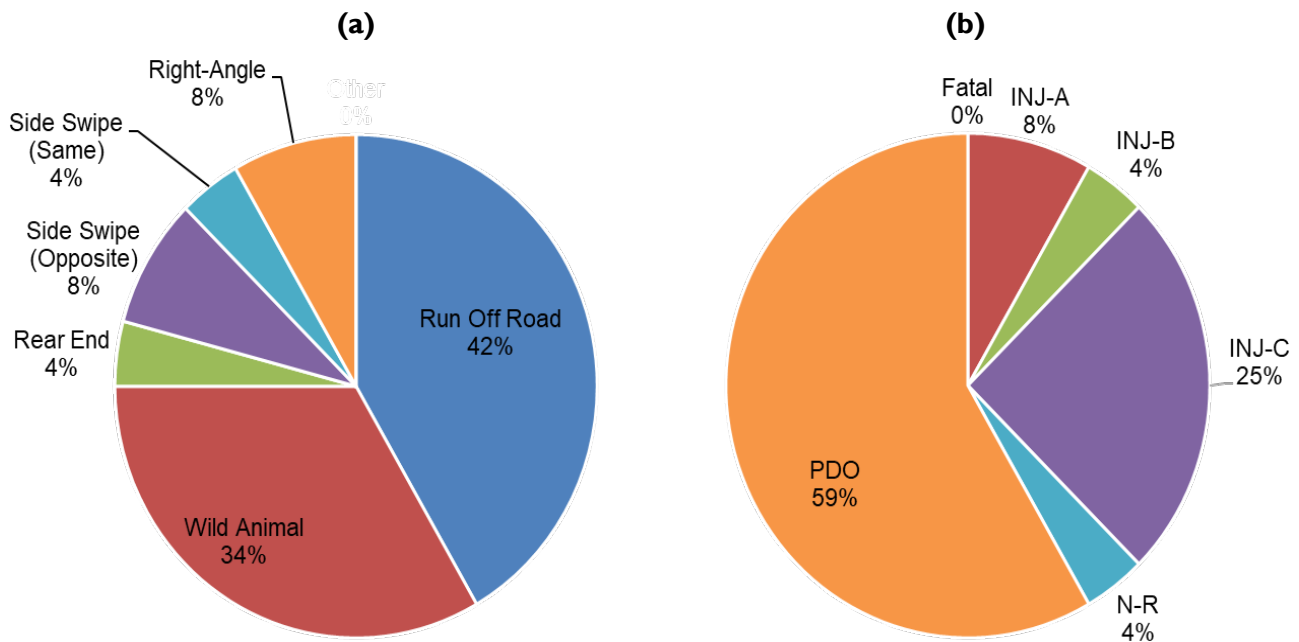


Figure 1. Crashes along I48th Street by Type (a) and Severity (b)

Proposed Improvements

Based on existing traffic operations and crash patterns along the corridor, a countermeasure was developed to improve safety. A detailed description is provided below:

148th Street Countermeasure – Widening and Overlay with Rumble Strips & Safety Edge Improvements

This countermeasure involves two parts;

- Upgrading narrow unpaved shoulders (< 5 feet) to wide paved shoulders (> 5 feet)
- Installing centerline and shoulder rumble strips

Project Cost

Preliminary cost estimates were developed by FHU and Lancaster County for the proposed counter measure. The proposed countermeasure is estimated to have an initial cost of about \$1,580,000 with a total cost of just under \$1,900,000 over a 20-year service life. A detailed breakdown of costs is included at the end of this memo.

Benefits of Project

The observed crash patterns along 148th Street will be directly addressed with the improvements proposed as part of this application. Adding a paved shoulder will allow drivers to better remain in control of their vehicle if they veer and depart from the travel lanes. The rumble strips along the centerline and shoulder will alert drivers of when they do leave their lane. The safety benefits associated with this project can have financial benefit, but the greatest return is its ability to reduce crashes and potential fatalities. **Tables 3a, b, and c** show the Federal Highway Administration’s estimated societal cost of crashes by type and severity, for crashes on rural roadways.

Table 3. FHWA Societal Cost of Traffic Accidents

Crash Type (Multi-Vehicle)	Societal Cost
Right Angle	\$ 103,180
Rear End	\$ 81,801
Sideswipe (Same Dir.)	\$ 55,947
Sideswipe (Opposite Dir.)	\$ 127,084
Head On	\$ 384,577
Left Turn	\$ 140,078
Other	\$ 28,738

(a)

Crash Type (Single-Vehicle)	Societal Cost
Collision w/ Train	\$ 451,095
Collision w/ Pedestrian	\$ 592,281
Collision w/ Bicycle	\$ 263,261
Collision w/ Animal	\$ 25,485
Collision w/ Parked Vehicle	\$ 34,906
Collision w/ Fixed Object	\$ 164,238
Overturn	\$ 357,481

(b)

Crash Severity (All)	Societal Cost
Fatal	\$ 11,608,336
A-Injury	\$ 673,148
B-Injury	\$ 203,999
C-Injury	\$ 129,085
All Injury Combined	\$ 344,252
Property Damage Only	\$ 12,234
Non-Reportable	\$ 1,026

(c)

Benefit Cost Analysis

A Benefit Cost Analysis (BCA) was completed for the proposed improvements. The BCA was completed based on the lifespan of the project, assuming an improvement life period, construction costs, and maintenance costs. The BCA looked at the societal cost of traffic accidents by crash type and crash severity. In general, projects with a B/C ratio of 1.0 or greater have greater benefits than costs over the

analysis time period. Only crashes directly affected by the proposed improvement were used in the benefit/cost calculations. Detailed calculations of the benefit cost analysis are attached to this memo.

For the BCA analysis, Crash Modification Factors (CMF) / Crash Reduction Factors (CRF) were obtained from the Crash Modification Factors Clearinghouse (<http://www.cmfclearinghouse.org>). When more than one CMF/CRF applied to a specific project a composite CMF/CRF factor was developed. All CMF/CRF calculations are attached to this memo.

I48th Street Countermeasure – Widening and Overlay with Rumble Strips & Safety Edge Improvements

The cost of this countermeasure was estimated at \$1,895,817 with a project life of 20 years. This includes an initial construction cost of \$1,579,848 and an operational/maintenance cost of \$15,798 per year.

A CMF of 0.285 / CRF of 0.715 was used for combined rumble strip and shoulder improvements and a CMF of 0.580 / CRF of 0.420 was used for just shoulder improvements when analyzing crash types.

Table 4 summarizes the benefit-cost calculations for the countermeasure by crash type. Based on the factors discussed above, the project would be expected to provide a benefit-cost ratio of **6.11**.

Table 4. I48th Street Countermeasure: Benefit-Cost Calculation by Crash Type

Average Cost/Mitigated Crash (2013 through 2019 average weighting crash type)	\$343,598
Present Value of Avoided Crashes, BENEFIT	\$11,586,841
Present Value Cost, COST	\$1,895,817
Crash Type Benefit/Cost Ratio	6.11

A CMF of 0.460 / CRF of 0.540 was used for all crash severity analysis. **Table 5** summarizes the benefit-cost calculations for the countermeasure by crash severity. Based on the factors discussed above, the project would be expected to provide a benefit-cost ratio of **2.27**.

Table 5. I48th Street Countermeasure: Benefit-Cost Calculation by Crash Severity

Average Cost/Mitigated Crash (2013 through 2019 average weighting crash type)	\$104,064
Present Value of Avoided Crashes, BENEFIT	\$4,308,829
Present Value Cost, COST	\$1,895,817
Crash Type Benefit/Cost Ratio	2.27

LANCASTER COUNTY ENGINEERING DEPARTMENT

ENGINEERS ESTIMATE

DATE: December 27, 2018

PROJECT Part. .

PROJECT NO. .

PROJECT Location:

148th Street

PROJECT Describe:

("O" St. to Hooper)

ITEM NO.	ITEM	ESTIMATED Quantities	UNIT	UNIT PRICE (Enter Engineers Est.)	AMOUNT
148th Street		Asphaltic Concrete Resurfacing and Paving			
1	Cold Milling Class 3	309.20	Sta.	\$385.00	\$119,042.00
2	Asphaltic Concrete, Type "SLX" (1-1/2")	9,700.00	Tons	\$75.00	\$727,500.00
3	Tack Coat	12,368.00	Gal	\$2.00	\$24,736.00
4	Asphaltic Concrete, Type "SPR" for Patching	200.00	Tons	\$85.00	\$17,000.00
5	Asphaltic Concrete, Type "SPR" (Trench Widen)	4,618.00	Tons	\$85.00	\$392,530.00
6	Rental of Skid Loader, Fully Operated	25.00	Hours	\$75.00	\$1,875.00
7	Rental of Dump Truck, Fully Operated	25.00	Hours	\$75.00	\$1,875.00
8	Rental of Cold Mill Head, Fully Operated-(Patching)	25.00	Hours	\$85.00	\$2,125.00
9	Trenched Widening - 3'	618.40	Sta.	\$150.00	\$92,760.00
10	Rumble Strips (Right, Left & Center)	924.60	Sta.	\$10.00	\$9,246.00
11	Traffic Grabber Cones	3,917.00	Cone days	\$0.65	\$2,546.05
12	Furnishing and Operating Pilot Vehicle	24.00	Days	\$500.00	\$12,000.00
13	Flagging	48.00	Days	\$400.00	\$19,200.00
14	Temporary Sign Day	144.00	Sign Days	\$6.50	\$936.00
15	Barricades, Type III	672.00	Barr Days	\$2.00	\$1,344.00
16	Construction Signs	1,120.00	Sign Days	\$1.50	\$1,680.00
17	5" Permanent Pavement Marking Paint	87,840.00	LF	\$0.25	\$21,960.00
18	Shoulder Restoration	618.00	Sta.	\$115.00	\$71,070.00
19	Seeding	0.00	Acres	\$750.00	\$0.00
20	Mulch	0.00	Tons	\$300.00	\$0.00
21	Crushed Rock Surface Course	152.45	Tons	\$50.00	\$7,622.50
22	Remove "W" Beam Guardrail	300.00	LF	\$3.00	\$900.00
23	Build "W" Beam Guardrail	300.00	LF	\$23.00	\$6,900.00
24	End Terminal Type I	4.00	Each	\$2,500.00	\$10,000.00
25	Mobilization	1.00	Lump Sum	\$35,000.00	\$35,000.00
ENGINEERS ESTIMATE				Total	\$1,579,847.55

B/C Analysis by Crash Type
US 34 (O Street) to Yankee Hill Rd
 Supplemental Safety Study



	Unit	
Facility Location		Rural
Service Life	Years	20
Crash History Provided	Years	6.26

Data Entry Required
 Data Calculated

Costs		
Construction	Dollars	\$ 1,579,847.55
Operations & Maint.	Dollars per Year	\$ 15,798.48
Other Capital Costs	Dollars	\$ -
Other Continual Costs	Dollars per Year	\$ -

Improvement:
Shoulders and Rumble Strips

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ADT	Vehicles per Year	4500
Crash Modification Factor (CMF) Average		0.340

Crash Mitigation									
(Enter as many as necessary, However limit to only ONE treatment for any single historical accident)									
Accident Involvement	Accident Type	Facility Type	Number of Crashes	Societal Cost	Treatment	CMF	CMF ID	Number Mitigated	Value Mitigated
Single_VehicleR	Collision with Fixed Object	Segment	10.0	\$ 2,788,977.38	Shoulders & Rumble Strips	0.285	5411, 5312	22.8	\$ 6,370,986.67
Multi_VehicleR	Rear End	Segment	1.0	\$ 171,214.82	Shoulders	0.580	5409	1.3	\$ 229,745.12
Multi_VehicleR	Sideswipe (Same Direction)	Segment	1.0	\$ 15,326.08	Shoulders & Rumble Strips	0.285	5411, 5312	2.3	\$ 35,010.06
Multi_VehicleR	Sideswipe (Opposite Direction)	Segment	2.0	\$ 1,599,948.52	Shoulders & Rumble Strips	0.285	5411, 5312	4.6	\$ 3,654,834.49
Multi_VehicleR	Right Angle	Segment	2.0	\$ 966,025.64	Shoulders	0.580	5409	2.7	\$ 1,296,264.43

Calculations	
Million Vehicles per Year	1.6425
Crashes Mitigated	33.7
Crashes Mitigated/Year	1.686102236
Crashes Mitigated per Million Vehicles	1.02655
Total Historical Societal Cost	\$ 5,541,492
Total Cost Mitigated Over Service Life	\$ 11,586,841
Average Cost per Mitigated Crash	\$ 343,598
Costs total	\$ 1,895,817
Benefits total	\$ 11,586,841
B/C	6.11

B/C Analysis by Crash Severity
US 34 (O Street) to Yankee Hill Rd
 Supplemental Safety Study



Facility Location	Unit	Rural
Service Life	Years	20
Crash History Provided	Years	6.26

Data Entry Required
 Data Calculated

Costs		
Construction	Dollars	\$ 1,579,847.55
Operations & Maint.	Dollars per Year	\$ 15,798.48
Other Capital Costs	Dollars	\$ -
Other Continual Costs	Dollars per Year	\$ -

Improvement:
Shoulders and Rumble Strips

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ADT	Vehicles per Year	4500
Crash Modification Factor (CMF) Average		0.460

Crash Mitigation									
<small>(Enter as many as necessary, However limit to only ONE treatment for any single historical accident)</small>									
	Accident Severity	Facility Type	Number of Crashes	Societal Cost	Treatment	CMF	CMF ID	Number Mitigated	Value Mitigated
	Fatal	Segment	0.0	\$ -	Shoulders, Rumble Strips	0.460	5312, 5409	0.0	\$ -
	A-Injury	Segment	2.0	\$ 1,347,037.56	Shoulders, Rumble Strips	0.460	5312, 5409	3.5	\$ 2,323,962.56
	B-Injury	Segment	1.0	\$ 204,111.54	Shoulders, Rumble Strips	0.460	5312, 5409	1.7	\$ 352,141.31
	C-Injury	Segment	6.0	\$ 774,937.85	Shoulders, Rumble Strips	0.460	5312, 5409	10.4	\$ 1,336,953.48
	Non Reportable	Segment	1.0	\$ 1,026.92	Shoulders, Rumble Strips	0.460	5312, 5409	1.7	\$ 1,771.69
	Property Damage Only	Segment	14.0	\$ 171,373.18	Shoulders, Rumble Strips	0.460	5312, 5409	24.2	\$ 295,659.80

Calculations	
Million Vehicles per Year	1.6425
Crashes Mitigated	41.4
Crashes Mitigated/Year	2.07028754
Crashes Mitigated per Million Vehicles	1.26045
Total Historical Societal Cost	\$ 2,498,487
Total Cost Mitigated Over Service Life	\$ 4,310,489
Average Cost per Mitigated Crash	\$ 104,104
Costs total	\$ 1,895,817
Benefits total	\$ 4,310,489
B/C	2.27



CMF / CRF Details

CMF ID: 5312

Install centerline and shoulder rumble strips

Description: Milled or rolled rumble strips.

Prior Condition: No Rumble Strips

Category: Roadway

Study: [Performance Analysis of Centerline and Shoulder Rumble Strips Installed in Combination in Washington State, D. Olson, M. Sujka, and B. Manchas, 2013](#)

Star Quality Rating:



[\[View score details\]](#)

Crash Modification Factor (CMF)

Value: 0.34

Adjusted Standard Error:

Unadjusted Standard Error: 0.044

Crash Reduction Factor (CRF)

Value:	66 (This value indicates a decrease in crashes)
Adjusted Standard Error:	
Unadjusted Standard Error:	4.4

Applicability

Crash Type:	Head on,Run off road,Sideswipe
Crash Severity:	All
Roadway Types:	Not specified
Number of Lanes:	2
Road Division Type:	
Speed Limit:	
Area Type:	Rural
Traffic Volume:	
Time of Day:	Not specified

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	

Minor Road Traffic Volume:

Development Details

Date Range of Data Used:

2002 to 2010

Municipality:

State:

WA

Country:

Type of Methodology Used:

Simple before/after

Sample Size Used:

Crashes

Before Sample Size Used:

373 Crashes

After Sample Size Used:

72 Crashes

Other Details

Included in Highway Safety Manual?

No

Date Added to Clearinghouse:

Dec-02-2013

Comments:

Exposure presented as VMT Before MVMT = 1,341.7
After MVMT = 765.96 Crash type is lane departures

This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

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CMF / CRF Details

CMF ID: 5409

Upgrade narrow unpaved shoulder (< 5 ft) to wide paved shoulder (> 5 ft)

Description: Upgrade narrow unpaved shoulder (< 5 ft) to wide paved shoulder (> 5 ft)

Prior Condition: Narrow (< 5 ft) unpaved shoulder

Category: Shoulder treatments

Study: [*Evaluation of Safety Effectiveness of Composite Shoulders, Wide Unpaved Shoulders, and Wide Paved Shoulders in Kansas, Zeng et al., 2013*](#)

Star Quality Rating:



[\[View score details\]](#)

Crash Modification Factor (CMF)

Value: 0.58

Adjusted Standard Error:

Unadjusted Standard Error:

0.054

Crash Reduction Factor (CRF)

Value:	42 (<i>This value indicates a decrease in crashes</i>)
Adjusted Standard Error:	
Unadjusted Standard Error:	5.4

Applicability

Crash Type:	All
Crash Severity:	All
Roadway Types:	Major Collector
Number of Lanes:	2
Road Division Type:	Undivided
Speed Limit:	
Area Type:	Rural
Traffic Volume:	65 to 4950 <i>Average Daily Traffic (ADT)</i>
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	

Minor Road Traffic Volume:

Development Details

Date Range of Data Used:

2000 to 2009

Municipality:

State:

KS

Country:

USA

Type of Methodology Used:

Regression cross-section

Sample Size Used:

3135 Crashes

Other Details

Included in Highway Safety Manual?

No

Date Added to Clearinghouse:

Jan-09-2014

Comments:

The cross sectional model compares narrow unpaved shoulders to wide paved shoulders. There are more crashes included in the sample, specifically associated with the category "wide paved shoulders," that wasn't included in the summary statistics.

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CMF / CRF Details

CMF ID: 5411

Upgrade narrow unpaved shoulder (< 5 ft) to wide paved shoulder (> 5 ft)

Description: Upgrade narrow unpaved shoulder (< 5 ft) to wide paved shoulder (> 5 ft)

Prior Condition: Narrow (< 5 ft) unpaved shoulder

Category: Shoulder treatments

Study: [*Evaluation of Safety Effectiveness of Composite Shoulders, Wide Unpaved Shoulders, and Wide Paved Shoulders in Kansas, Zeng et al., 2013*](#)

Star Quality Rating:



[\[View score details\]](#)

Crash Modification Factor (CMF)

Value: 0.23

Adjusted Standard Error:

Unadjusted Standard Error:

0.048

Crash Reduction Factor (CRF)

Value:	77 (This value indicates a decrease in crashes)
Adjusted Standard Error:	
Unadjusted Standard Error:	4.8

Applicability

Crash Type:	Head on,Run off road,Sideswipe
Crash Severity:	All
Roadway Types:	Major Collector
Number of Lanes:	2
Road Division Type:	Undivided
Speed Limit:	
Area Type:	Rural
Traffic Volume:	65 to 4950 <i>Average Daily Traffic (ADT)</i>
Time of Day:	All

If countermeasure is intersection-based

Intersection Type:	
Intersection Geometry:	
Traffic Control:	
Major Road Traffic Volume:	

Minor Road Traffic Volume:

Development Details

Date Range of Data Used:

2000 to 2009

Municipality:

State:

KS

Country:

USA

Type of Methodology Used:

Regression cross-section

Sample Size Used:

430 Crashes

Other Details

Included in Highway Safety Manual?

No

Date Added to Clearinghouse:

Jan-09-2014

Comments:

The cross sectional model compares narrow unpaved shoulders to wide paved shoulders. There are more crashes included in the sample, specifically associated with the category "wide paved shoulders," that wasn't included in the summary statistics.

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