BAKER CORRIDOR
PLANNING STUDY

APPENDIX C: Planning Study Documentation

Baker Corridor Planning Study

November 2015

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Public and Agency Involvement Plan (PAIP)

Baker Corridor Planning Study

January 2015

Prepared for:

Montana Department of Transportation

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1. Introduction

The Montana Department of Transportation (MDT), in partnership with the Federal Highway Administration (FHWA), and in coordination with Fallon County and the City of Baker, is developing a corridor planning study that includes of the City of Baker and surrounding vicinity. The *Baker Corridor Planning Study* will align with MDT's corridor planning process, which provides for early planning-level coordination with the community, resource and other agencies, and develops feasible improvement options to address transportation needs within the study area. The *Baker Corridor Planning Study* is considered a pre-National Environmental Policy Act (NEPA)/Montana Environmental Policy Act (MEPA) process that will develop needs and objectives, identify and analyze improvement options, eliminate non-feasible options, and identify potential environmental impacts and constraints through public, resource agency, and stakeholder input. Information developed will serve to streamline the environmental review process and any future project development.

Information sharing is at the heart of any public process. In accordance with federal and state guidance, this *Public and Agency Involvement Plan (PAIP)* is an important initial document that outlines informational outreach efforts and communication protocols to be followed throughout the planning study process.

1.1 Study Background

The City of Baker (pop. 1,741) is located in Fallon County, in eastern Montana. The city is situated at the junction of U.S. Highway 12 and Montana Highway 7. U.S. Highway 12 (Montana Avenue) and Highway 7 (Main Street) converge at Baker's main intersection, which is used by passenger vehicles both traveling through town and for local access, as well as heavy freight traveling to and from oil and gas development areas in the region. Fallon County has identified the need for a planning study to investigate alternative transportation corridors or alignment options to reduce the volume of truck traffic traveling through town. In addition, the study will examine the railroad crossings, train traffic, and related transportation impacts occurring within the study area.

1.2 Study Goals

The goal of the study is to assess current and projected conditions in the Baker area and to develop a package of improvement options addressing the identified needs. The study will examine freight traffic through the downtown area, as well as the internal transportation network, highway issues, and other identified transportation needs. The study will analyze alternative routes and attempt to minimize the cost of any selected route, while considering and avoiding environmental and social constraints. The study will be conducted over a 12-month period and will utilize Quantm route optimization software to develop and evaluate road alignment scenarios.

1.3 Study Area

Figure 1 provides an overview of the study area. The study area encompasses approximately 48 square miles, and includes the City of Baker and surrounding vicinity.

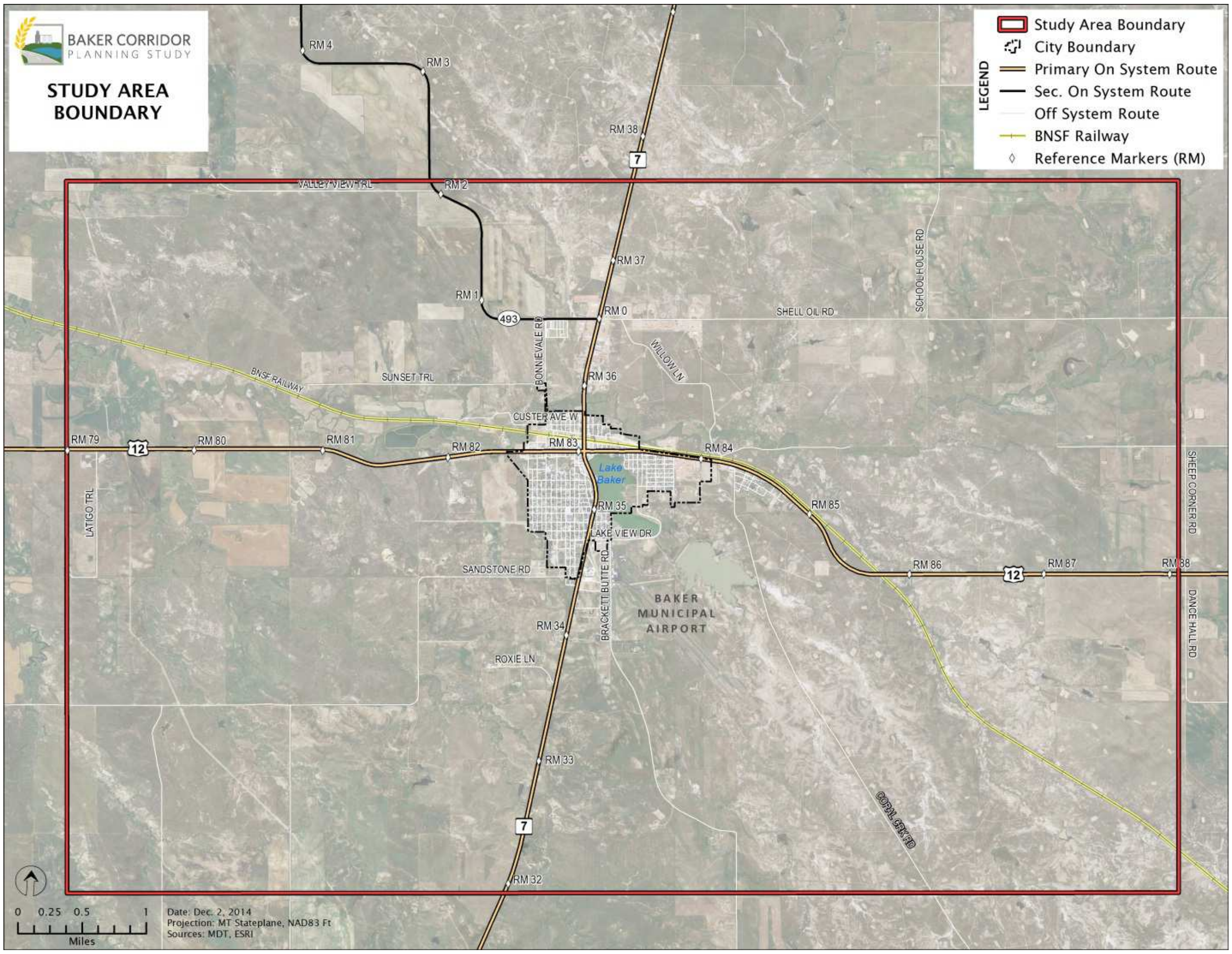

Figure 1: *Baker Corridor Planning Study* Area

2. Public and Agency Involvement

2.1 Public and Agency Involvement Plan Goals

The *PAIP* provides members of the public, stakeholders, and resource agency representatives with opportunities for involvement and input throughout the planning study process. The *PAIP* focuses on a basic premise: MDT commits to working with the public and stakeholders to relay accurate and timely information relating to the study and to ensure concerns relating to planning process are heard and, when possible, are considered.

The goals of the *PAIP* include the following:

- Communicate the purpose and goals of the study.
- Inform the public with balanced and objective information to assist them in understanding the problems, opportunities, and solutions associated with the study.
- Work with the public, resource and other agencies, and stakeholders to ensure their concerns are understood.
- Demonstrate sensitivity and, when possible, responsiveness to issues and ideas.

2.2 Study Contacts

Contact information for MDT and the consultant, as shown below, will be provided in all published materials.

Shane Mintz, MDT District Administrator
Montana Department of Transportation
Glendive District Office
503 North River Avenue
PO Box 890
Glendive, MT 59330-0890
406.345.8212
smintz@mt.gov

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Montana Department of Transportation
2960 Prospect Avenue
PO Box 201001
Helena, MT 59620-1001
406.444.9131
ccollins@mt.gov

Jon Schick, Consultant Project Manager
HDR
1715 South Reserve Street, Suite C
Missoula, MT 59801
406.532.2231
jon.schick@hdrinc.com

2.3 Publications

Publications detailing public involvement opportunities will include newsletters and press releases/advertisements. Informational meeting announcements will be developed by MDT and HDR and placed in the *Fallon County Times* twice prior to each meeting (three weeks and one week before), and will include the meeting date, time, location, purpose, and, if applicable, locations for document review. Informational meeting announcements will also be posted by Fallon County onto their website in advance of the meetings.

Study newsletters will be developed by HDR in coordination with MDT and provided in PDF format at least one month prior to each information meeting and will include updates on study status and findings, recommendations, and other topics as relevant. The newsletters will be posted to the study website by MDT and distributed by HDR to Fallon County for their distribution as well as mailed to study stakeholders. A mailing list will be developed throughout the study process and newsletters will be mailed to list members. The newsletters will also be made available at the informational meetings and MDT, City, and County locations.

2.4 Study Website

MDT will host the project website. The study website is located at the following address: http://www.mdt.mt.gov/pubinvolve/baker/. This website will provide current study information, including study overview, contacts, status updates, upcoming meetings, schedule, and documents. Final version documents will be made available on the website and will include:

- Study Schedule
- *Public and Agency Involvement Plan*
- Environmental Scan
- *Existing and Projected Conditions Technical Memorandum*
- *Needs and Objectives Technical Memorandum*
- *Improvements Options Technical Memorandum*
- Informational Meeting Presentations and Newsletters
- *Public Draft Corridor Planning Study Report*
- *Final Corridor Planning Study Report*
- Frequently Asked Questions (FAQs)

2.5 Document Availability

As stated in Section 2.4 above, electronic versions of study deliverables will be available on the study website. Hard-copy materials will also be distributed to Fallon County and made available at the following City and County locations:

- Fallon County Planning Office – 10 West Fallon Avenue, Baker, MT 59313
- Fallon County Library – 6 West Fallon Avenue, Baker, MT 59313
- MDT Glendive District Office – 503 North River Avenue, Glendive, MT 59330
- MDT Miles City Area Office – 217 North 4th Street, Miles City, MT 59301

2.6 Radio and Television

Meetings may be announced on local radio and/or television stations. Fallon County recommends advertising for the informational meetings on Channel 3 as well as on KFLN radio.

2.7 Stakeholder Contact List

A stakeholder contact list will be developed and updated throughout the planning study process. The stakeholder list will include individuals, businesses, and interest groups identified by the City of Baker, Fallon County, and MDT. Informational meeting sign-in sheets will also serve to expand the list of interested stakeholders. The following stakeholders have been preliminarily identified (see below); additional stakeholders will be included as the study develops.

- City of Baker
- City of Baker Chamber of Commerce and Agriculture
- Baker Municipal Airport
- Fallon County
- Southeast Montana Area Revitalization Team (SMART) – Fallon County Economic Development
- BNSF Railway

- Equity Coop Elevator
- Trucking Operations (Freight and Oil/Gas Services)
  - Continental Pipeline
  - Mitchell's
  - D&M
  - Power Fuel
  - Woody's Trucking
- John Brosz, Brosz Engineering
- Others as requested

2.8 Accommodations for Traditionally Underserved Populations

MDT will attempt to involve and accommodate traditionally underserved segments of the population to ensure disabled, minority, and low-income residents are included in the planning study process. Accommodative measures will include:

- <u>Plan meeting locations carefully</u>: Informational meetings held in Baker will be conducted at a facility that is accessible and compliant with the Americans with Disabilities Act (ADA) in accordance with Title VI regulations.
- <u>Seek help from community leaders and organizations</u>: MDT and HDR will consult with community leaders and representative organizations about how to more effectively involve traditionally underserved populations.
- <u>Be sensitive to diverse audiences</u>: MDT and HDR will make every effort to communicate effectively during informational meetings by avoiding technical jargon and following appropriate rules of conduct.

3. Study Meetings

3.1 Advisory Committee Meetings

Approximately 14 Advisory Committee meetings will be conducted throughout the study, with one occurring every three to four weeks. The Advisory Committee, comprised of MDT and FHWA staff and Fallon County representatives, will track progress, ensure that the corridor planning process is followed, address issues identified through the study process, and review deliverables. These meetings will be held at MDT's Planning offices in Helena, with teleconference/*GoToMeeting* participation made available by MDT.

A one-month comment period will follow the publication of the *Public Draft Corridor Planning Study Report*. All comments received on the report will be compiled into a public comment matrix for review by the Advisory Committee. Written responses to comments will be included in the public comment matrix as appropriate. All comments received, as well as their provided responses, will be compiled into an appendix to the *Final Corridor Planning Study Report*.

3.2 Resource Agency Meetings

One resource agency meeting will be held at MDT's Planning offices in Helena, with conference call arrangements at the MDT's Glendive District Office and Miles City Office. Resource agencies with jurisdictional authority in the study area will be asked to confirm the accuracy and completeness of the Environmental Scan document and to identify areas of concern, avoidance areas, and other constraints.

3.3 Informational Meetings

Two informational meetings will be conducted during the planning study process; these will be held in Baker at an ADA-accessible location and will be facilitated by HDR. The first informational meeting will be held in Baker once the draft *Existing and Projected Conditions Technical Memorandum* and corresponding Environmental Scan have been prepared. The first informational meeting will focus on introducing the study and corridor planning process, presenting the existing conditions, and identifying preliminary issues and constraints within the study area through an interactive process.

The second informational meeting will be held following publication of the *Public Draft Corridor Planning Study Report*. The purpose of this meeting will be to present the findings of the report and discuss recommended improvement options.

3.4 Stakeholder Meetings

HDR and MDT staff will be available as needed to meet with stakeholder groups.

3.5 Study Schedule

It is anticipated that the *Baker Corridor Planning Study* will be completed within a twelve-month period. Per the assumed schedule, all work on this study is expected to be completed by October 31, 2015. Figure 2 illustrates the schedule.

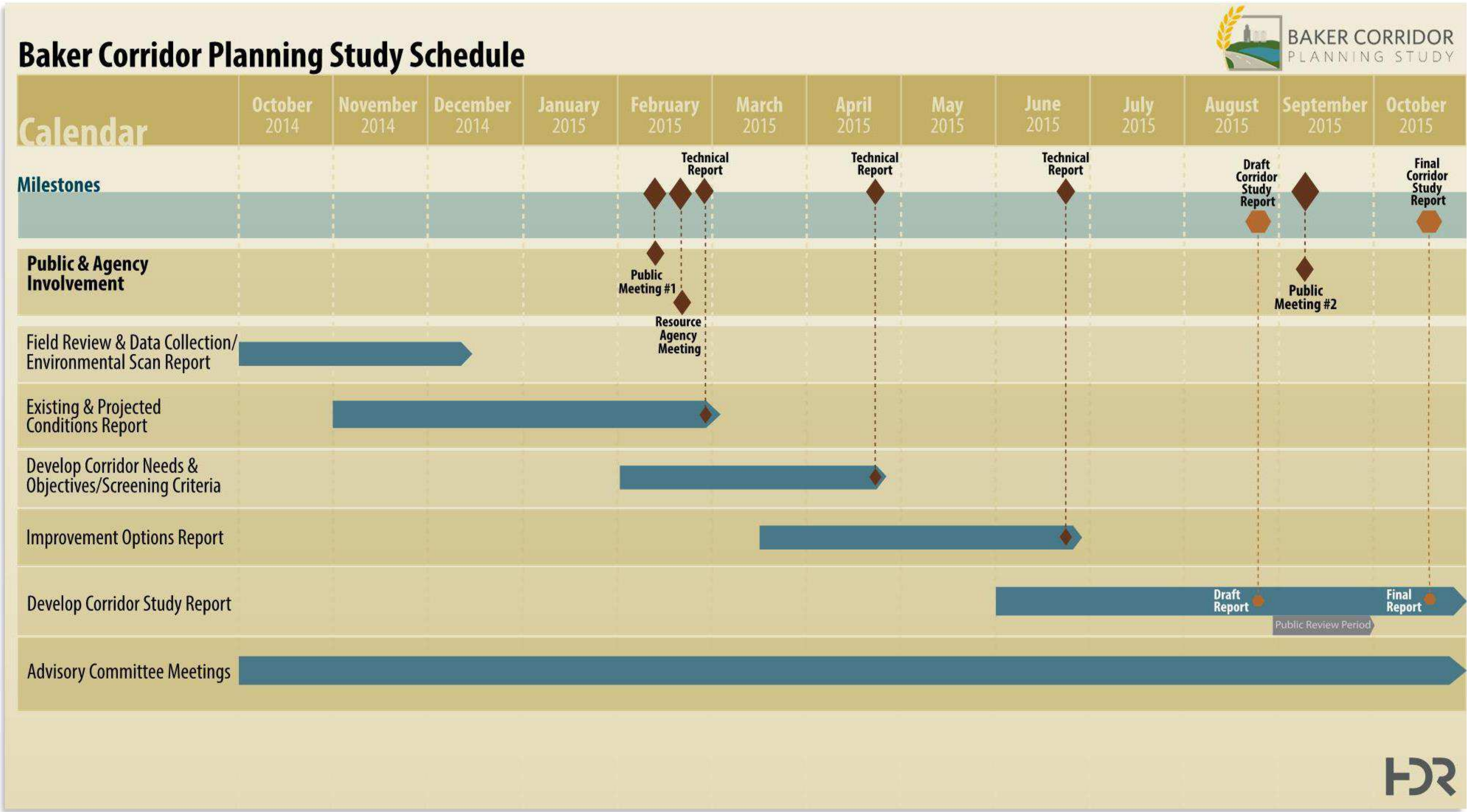

Figure 2: Planning Study Schedule

BAKER CORRIDOR
PLANNING STUDY

Existing and Projected Conditions Report

Baker Corridor Planning Study

March 2015

Prepared for:

Montana Department of Transportation

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Abbreviations and Acronyms

AADT	Annual Average Daily Traffic
ADT	Average Daily Traffic
ACS	American Community Survey
ADT	Average Daily Traffic
BNSF	Burlington Northern Santa Fe
CAPS	Crucial Areas Planning System
CFR	Code of Federal Regulations
DEQ	Montana Department of Environmental Quality
DOC	Montana Department of Commerce
DOLI	Montana Department of Labor and Industry
EO	Executive Order
ESA	Endangered Species Act
FHWA	Federal Highway Administration
FPPA	Farmland Protection Policy Act
FWP	Montana Department of Fish, Wildlife, and Parks
GIS	Geographic Information System
HUC	Hydrologic Unit Code
HV	Heavy Vehicle
LOS	Level of Service
LUST	Leaking Underground Storage Tank
LWCFA	Land and Water Conservation Fund Act
MAP-21	Moving Ahead for Progress in the 21st Century Act
MBTA	Migratory Bird Treaty Act
MDT	Montana Department of Transportation
MEPA	Montana Environmental Policy Act
MFISH	Montana Fisheries Information System
MNHP	Montana Natural Heritage Program
MPDES	Montana Pollutant Discharge Elimination System
MSATs	Mobile Source Air Toxics
NAAQS	National Ambient Air Quality Standards
NBI	National Bridge Inventory
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRIS	Natural Resource Information System
NWI	National Wetlands Inventory
PESC	Permanent Erosion and Sediment Control
PM	Particulate Matter
PvMS	Pavement Management System
RP	Reference Post
SOC	Species of Concern
SSD	Stopping Sight Distance
T&E	Threatened and Endangered
TMDL	Total Maximum Daily Load

USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UST	Underground Storage Tank

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1. Introduction

The Montana Department of Transportation (MDT), in partnership with the Federal Highway Administration (FHWA), and in coordination with Fallon County and the City of Baker, is developing a corridor planning study that includes the City of Baker and surrounding vicinity. The *Baker Corridor Planning Study* is considered a pre-National Environmental Policy Act (NEPA)/Montana Environmental Policy Act (MEPA) process that will develop needs and objectives, identify and analyze improvement options, eliminate non-feasible options, and identify potential environmental impacts and constraints through public, resource agency, and stakeholder input.

The purpose of this report is to examine the existing and projected transportation conditions as well as the social, economic, and environmental setting within the corridor Study Area.

1.1 Study Area and Background

The City of Baker is located in Fallon County, in eastern Montana at the junction of U.S. Highway 12 (US 12) and Montana Highway 7 (MT 7). US 12 and MT 7 is Baker's main intersection, which is used by passenger vehicles both traveling through town and for local access, as well as truck traffic traveling to and from oil and gas development areas in the region.

US 12 and MT 7 within the Study Area are both functionally classified as Rural Minor Arterial routes on the Primary Highway System and Highway 493 (S-493) is classified as a Major Collector route on the Secondary Highway System. The Study Area includes a 9.1-mile segment of US 12 approximately between Reference Marker (RM) 79 and RM 88.1, a 5.7-mile segment of MT 7 approximately between RM 31.9 and RM 37.6, and a 2.1 mile segment of S-493 between RM 0 and RM 2.1. The Study Area includes the City of Baker and the Baker Municipal Airport. The BNSF Railway traverses the Study Area in a northwest-southeast direction. Within the Baker city limits the railroad is located immediately north of US 12. Land use in the Study Area is a diverse mix which includes residential, agricultural, oil and gas development, and recreational areas, among others. Figure 1 provides an overview of the Study Area.

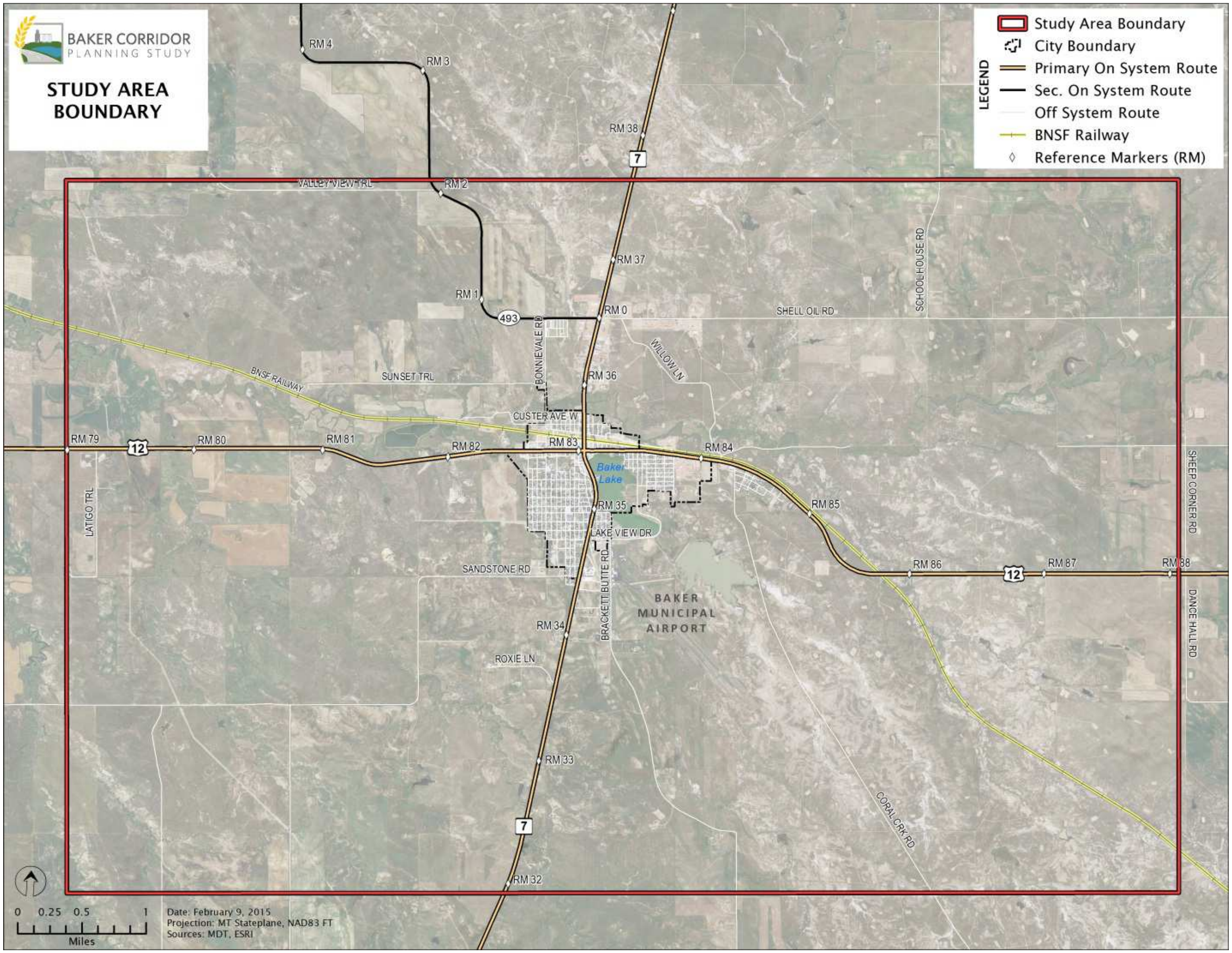

Figure 1: *Baker Corridor Planning Study* Area

2. Existing Socio-Economic Conditions

The following section provides an overview of the existing and projected socio-economic conditions for the Study Area. The information presented includes recent socio-economic data available at the county level, growth trends in population, labor force, occupation, and unemployment trends compared with historical and projected data. This information provides an overview of the short- and long-term economic conditions of the Study Area.

The Study Area is southwest of the Bakken oil field, which is experiencing a boom in oil production and related development. Effects from the Bakken region, as well as an increasing amount of local oil and gas development, have resulted in population increases and associated growth in Fallon County and the City of Baker. The majority of socio-economic data relate to this recent growth spurt within Eastern Montana. Similar to the regional and state-wide effects, population growth in and around Baker is contingent on oil and gas development and other supporting activities that may occur in the future.

2.1 Regional Population and Demographics

After the decline following the 1970s oil boom, Fallon County experienced negative population growth for several decades. Fallon County is now experiencing growth, in part due to recent technological advancements that allow for oil and natural gas that was once inaccessible to be extracted. As a result, the region has experienced economic growth and activity, which has generated a current increasing trend in the county's population. Table 1 below summarizes the population and demographic information for Fallon County.

Table 1: 2013 Census Estimates for Fallon County

Fallon County, Montana		Estimate	Percent
Total Population	Fallon County	3,085	100
	Baker	1,812	58.7
	Plevna	111	3.6
Race	White	3,074	97.8
	African American	4	0.1
	American Indian	66	2.1
	Asian	6	0.2
Ethnicity	Hispanic or Latino	15	0.5
Total Housing Units		1,472	100
	Occupied Housing Units	1,199	81.5
	Owner Occupied	863	
	Renter Occupied	336	
	Vacant	273	18.5

Source: American Community Survey (ACS) 2009-2013 5-Year Estimates

The 2013 population of Fallon County was 3,085, with nearly 60 percent of the county's population residing in the City of Baker. County residents are predominantly self-identified as Caucasian, consisting of almost 98 percent of the population. The American Indian population is slightly greater than 2 percent, compared with about 8 percent for the state as a whole. The Hispanic population is 0.5 percent, which is less than the state proportion.

The Montana Department of Commerce utilizes economic modeling software known as REMI, or Regional Economic Models, Inc., to produce county-level population projections. Figure 2 shows the observed population for Fallon County from 2000 to 2010 and population projections until the year 2030, produced with REMI. The general trend has been confirmed by the Montana Census and Economic Information Center.

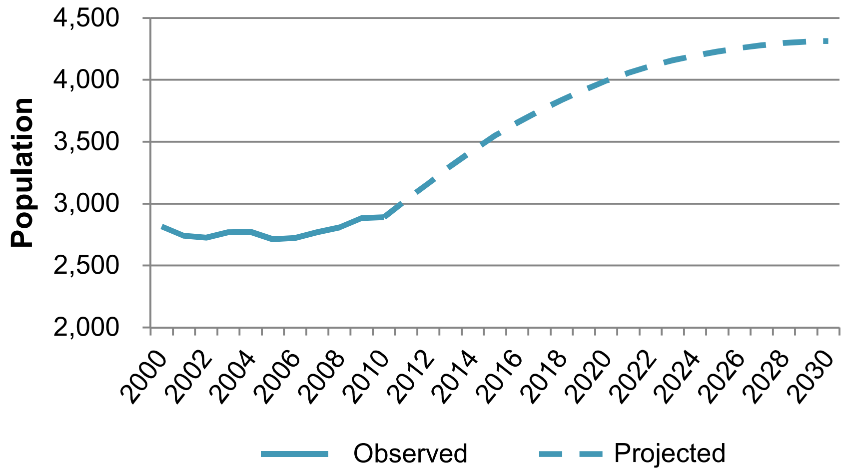

Figure 2: Fallon County Total Observed and Projected Population

For much of the first half of the last decade, the population of Fallon County remained constant; it has seen positive population growth since 2006. Fallon County's population is projected to increase by approximately 1,500 people by the year 2030, population growth rates greater than 3 percent could be expected until 2016. The population would then continue to increase at a slower rate through 2030. This type of growth trend is consistent with many counties in eastern Montana.

Figure 3 compares the actual populations observed through 2010 and projected to the year 2030 for both Fallon County and the State of Montana as a percentage of their respective populations in the year 2000. After 2010, the figure shows that Fallon County will have significant population growth, ultimately reaching around 150 percent of the 2000 population by 2030. Montana will see population growth after 2010 at a more moderate rate than that of Fallon County.

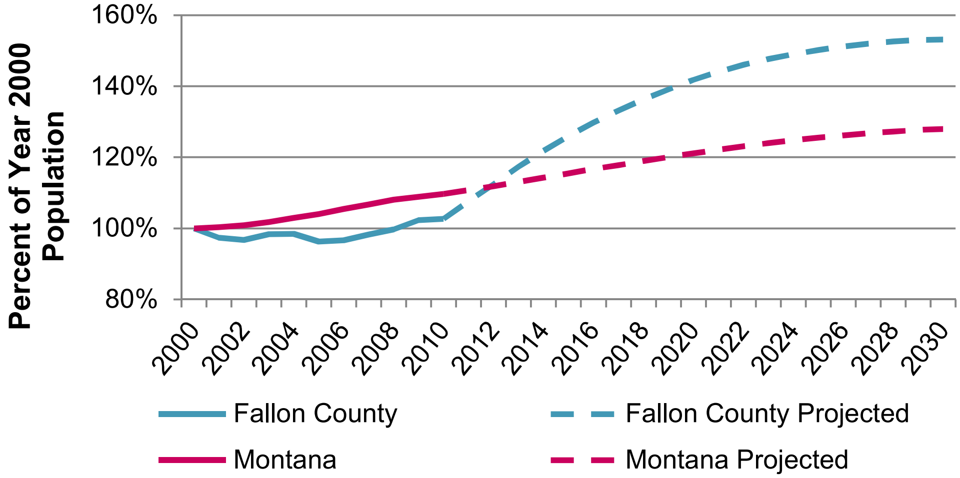

Figure 3: Montana and Fallon County Total Observed and Projected Population (Percent of 2000 population)

Figure 4 depicts the age distribution for Fallon County. The working-age population (ages 20 to 64) is expected to increase by about 500, reaching a high of about 60 percent of the population in 2013 and slowly declining to 50 percent by 2030. The decrease in the proportion of working-age members is because that segment will experience a slower growth rate than the rest of the population.

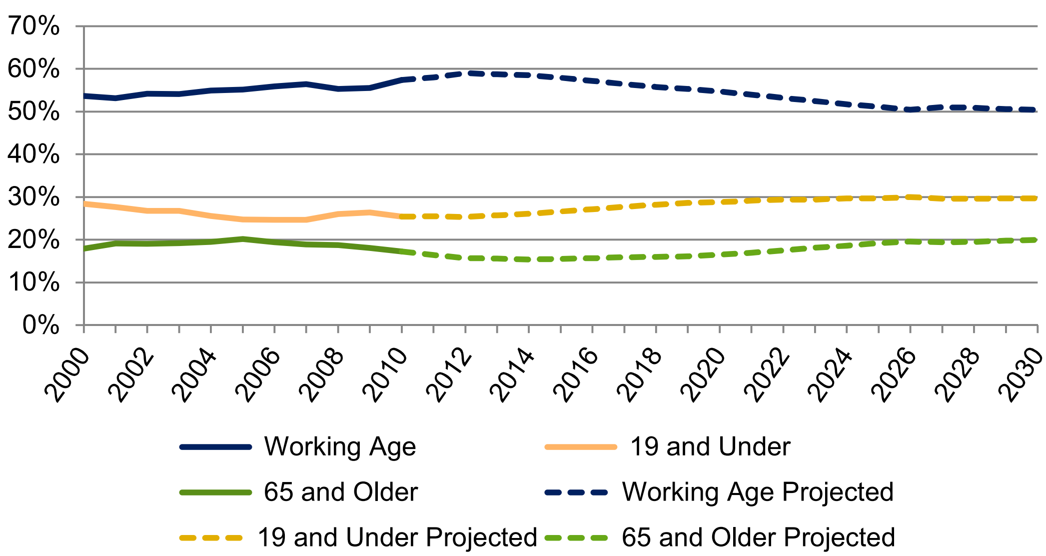

Figure 4: Fallon County Age Distribution (Projected after 2010)

The 19-and-under age group is expected to increase at a moderate rate from current levels to approximately 30 percent of the population by 2030. The population category of 65 and older is also expected to experience a slight increase in proportion of the population, to approximately 20 percent.

2.2 Baker Population and Demographics

Baker is the larger of two communities within Fallon County. According to 2013 American Community Survey (ACS), Baker has a population of 1,812. The 2000 and 2010 US Census found the population of Baker to be 1,695 and 1,741, respectively, implying that the city experienced a population increase of approximately 3 percent over that decade. Fallon County had an approximate 2 percent increase in population over that same time period, with a population of 2,837 in 2000 and 2,890 in 2010. Table 2 summarizes population and age distributions for Baker, Fallon County, and Montana.

Table 2: Age and Gender Data for Baker and Fallon County

Distribution	Baker		Fallon County		Montana	
	Number	%	Number	%	Number	%
Total Population	1,812	-	3,085	-	998,554	-
Male	898	49.6	1,570	50.9	501,549	50.2
Female	914	50.4	1,515	49.1	497,005	49.8
Under 18	401	22.1	791	25.6	222,295	22.3
18-64	1,135	62.6	1,802	58.4	623,298	62.4
65 and Over	276	15.2	492	16.0	152,961	15.3

Source: American Community Survey (ACS) 2009-2013 5-Year Estimates

The population of Baker is roughly 22 percent school-age children (under the age of 18) and approximately 62 percent working age (ages 18 to 64). This is consistent with the proportions seen within the State of Montana. The proportion of Baker's working age population is approximately 4 percent higher than the county-level proportion.

2.3 Regional Economy and Employment

Using data gathered through the ACS from 2008 to 2012, the US Census Bureau produced a 5-year estimate for employment by industry for Fallon County. The industry sector of agriculture, forestry, fishing, and hunting is the top field of employment, followed by educational services, and healthcare and social assistance. Table 3 summarizes Fallon County employment by industry.

Table 3: Fallon County Employment by Industry (2008-2012)

Industry	Estimate
Agriculture, forestry, fishing, and hunting	25.7%
Construction	8.5%
Manufacturing	2.9%
Wholesale Trade	3.1%
Retail Trade	7.4%
Transportation and warehousing, and utilities	6.1%
Information	2.7%
Finance and insurance, and real estate and rental and leasing	4.7%
Professional, scientific, and management, and administrative and water management services	5.5%
Educational services, and health care and social assistance	19.7%
Arts, entertainment, and recreation, and accommodation and food services	6.1%
Other services, except public administration	3.4%
Public Administration	4.1%

Source: American Community Survey (ACS) 2008-2012 5-Year Estimates

Regional Economy and Employment

Unemployment in Fallon County experienced fluctuations similar to those of the statewide rate for the last decade, but has continuously been below the state and national rate. When the recession began in 2007, the region continued to maintain low unemployment levels and did not face the rapid increases in unemployment that were observed at the state and national levels. The sustained levels of low unemployment can likely be attributed to the economic boom in the Bakken region. Figure 5 illustrates and compares the unemployment trends since 2000.

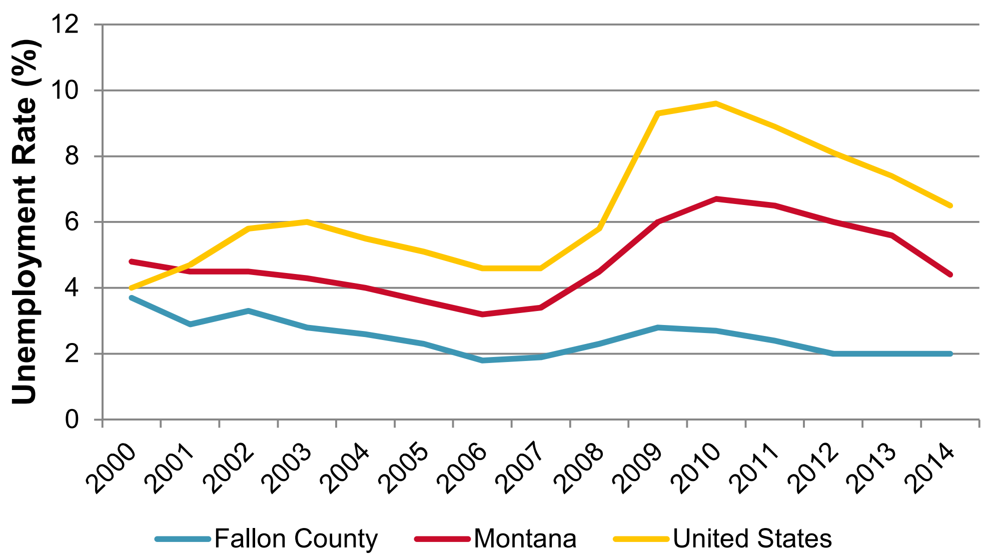

Figure 5: Unemployment Rate Comparison

Table 4 shows the most recent unemployment figures from the state and federal labor departments. With an unemployment rate of 1.4 percent, Fallon County has the lowest level of unemployment in the state. The unemployment rate in Fallon County is a third of the statewide rate and approximately a quarter of the national rate.

Table 4: November 2014 Unemployment Data (not seasonally adjusted)

Geography	Labor Force	Employed	Unemployed	Rate
Fallon County	2,123	2,094	29	1.4%
Montana	516,759	495,171	21,588	4.2%
United States	156,297,0000	147,666,000	8,630,000	5.5%

Source: MT Dept. of Labor and Industry Research and Analysis Bureau, 2015

The income distribution for Fallon County is noticeably different than for the state and nation. Figure 6 shows the percentage of the population in Fallon County, State of Montana, and the United States in income categories from the 2010 Census. Fallon County tends to have a smaller percentage of the population in the lower and higher income categories than the state of Montana and the United States, with the majority of the population falling in the middle of the distribution. Overall, Fallon County and Baker outperform the rest of Montana in terms of household income.

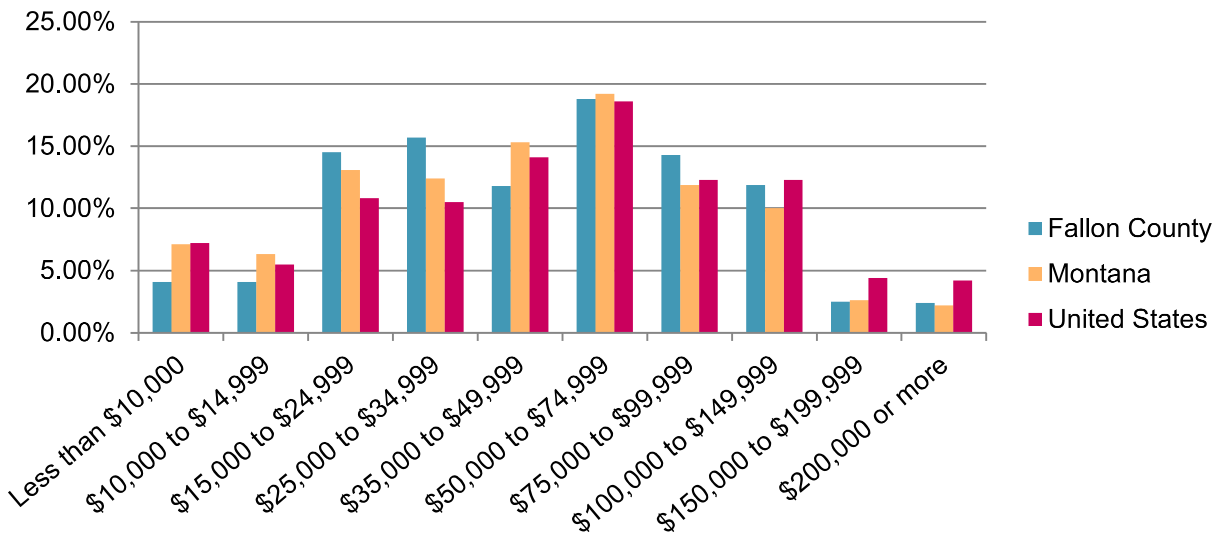

Figure 6: Income Distribution by Household

Figure 7 shows an estimation of the economic base of Fallon County in 2012 from the University of Montana Bureau of Business and Economic Research. The economic base of an economy refers to activities that bring income into an area or the economy that remains in the area. Although the figure considers only Fallon County, it is the best window available into the basic economy of the smaller Study Area.

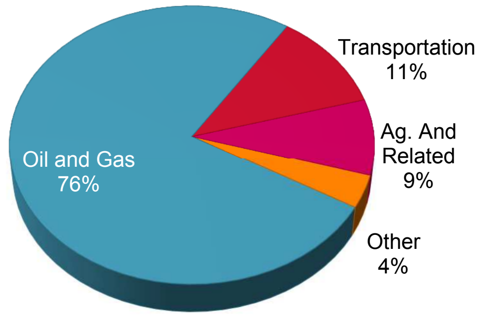

Figure 7: Economic Base of Fallon County, Montana (2012)

By far, the most influential share of the Fallon County economy is the energy industry (76 percent). The next largest portion of the economy is transportation (11 percent), which is likely influenced by the oil and gas industry, as well as agricultural products which are processed and shipped near and through the area. The remaining 13 percent of the economic base is comprised of agriculture and all other industries. Although Fallon County's economic base is composed largely of oil and gas, this industry may derive economic benefit from a share of the current activity of oil extraction in the Bakken region north and east of the Study Area.

3. Existing Roadway Conditions

The functional classification concept groups highways by the character of service they provide. Functional classification recognizes that the public highway network in Montana serves two basic functions: travel mobility and access to property. Arterial highways are characterized by capacity to quickly move relatively large volumes of traffic. They are intended to carry freight and people through an area. Within the Study Area, US 12 and MT 7 are both functionally classified as Rural Minor Arterial routes on the Primary Highway System. Because they contain the highest volumes of traffic and represent the major east-west and north-south transportation system, US 12 and MT 7 are the primary focus for existing roadway conditions.

US 12 provides Baker an east-west linkage to Interstate 94, approximately 80 miles to the west at the City of Miles City, and to North Dakota, approximately 13 miles to the east. MT 7 links Baker to Interstate 94 approximately 45 miles to the north at the Town of Wibaux. Within the Baker city limits, US 12 is Montana Avenue; MT 7 is Lake Street south of US 12 and is Main Street north of the US 12 intersection. Secondary Highway 493 (S-493), also known as Pennel Road, is classified as a Major Collector route on the Secondary Highway System. S-493 intersects MT 7 approximately 1 mile north of downtown Baker. S-493 is a two-lane road that is paved for the first mile, after which it is a gravel-surface roadway. Where available, data for S-493 are included in the existing roadway conditions analysis.

3.1 Traffic Data

The following section summarizes existing traffic conditions and provides a projection of future vehicular volumes and operations based on historical traffic growth rates for the Study Area. Both Average Daily Traffic (ADT) and turning movement count data were obtained within the Study Area to determine existing conditions and project future conditions. In addition, historic Annual Average Daily Traffic (AADT) was obtained within the Study Area.

Existing Traffic Volumes

Existing AADT at locations within and adjacent the Study Area are shown in Table 5. AADT on US 12 and MT 7 are highest at reference markers closest to the City of Baker, but there is additional volume using these corridors to access points outside the Study Area.

Table 5: Annual Average Daily Traffic

Site ID	Route	Reference Marker	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
13-1-4*	US 12	76.13	750	750	980	990	930	1,210	1,220	790	990	1,230
13-1-15	US 12	82.09	1,210	1,210	1,150	1,250	1,180	1,490	1,500	1,100	1470	1,560
13-1-16	US 12	82.60	4,000	4,000	4,330	4,460	3,600	3,730	4,530	4,590	3,750	3,790
13-1-17	US 12	82.65	3,610	3,690	4,310	4,440	3,470	3,590	3,690	3,740	3,520	3,320
13-1-18	US 12	83.07	3,170	3,170	2,780	2,820	2,650	2,600	2,610	2,700	2,280	2,350
13-1-5*	US 12	88.12	880	880	810	1,120	1,050	880	870	880	990	810
13-2-2*	MT 7	29.34	660	660	810	870	820	390	390	710	750	1,030
13-1-19	MT 7	34.32	1,050	1460	1,030	1,130	1,060	1,120	1,120	980	1,350	1,310
13-1-20	MT 7	35.14	2,020	2,680	2,320	2,390	2,000	2,070	2,080	2,320	2,370	2,460
13-1-21	MT 7	35.45	3,930	4,600	3,910	4,020	3,070	3,180	3,190	3,200	3,720	3,730

Site ID	Route	Reference Marker	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
13-1-22	MT 7	35.52	4,080	4,080	3,660	3,770	3,540	3,660	3,730	3,780	3,490	3,580
13-1-23	MT 7	35.76	2,500	2,500	2,760	2,860	2,690	2,910	2,920	2,610	2,690	2,990
13-1-7	MT 7	36.95	1,140	1,140	1,380	1,320	1,240	1,120	1,120	930	1,090	1,320
13-1-12	S-493	1.26	220	330	290	400	380	370	310	310	260	270

Source: MDT 2014
* Site located outside the Study Area Boundary.

Four locations were selected to collect ADT data within the Study Area on October 22, 2014. This data included vehicle classifications to determine a heavy vehicle (HV)[1] percent. Since this was a single day of data, an adjustment factor was applied to the single day count to determine an appropriate AADT. This factor was determined using monthly data at a continuous data recorder within the Study Area, on US 12 at RM 88.5. The continuous data recorder showed that October typically has higher ADT than other months of the year. Table 6 shows the ADT data as well as the adjusted AADT and HV percentage.

Table 6: Average Daily Traffic – October 22, 2014

Corridor	Reference Marker	ADT	AADT	HV
US 12	80	1,467	1,280	14%
US 12	87	1,296	1,130	20%
MT 7	31	834	730	21%
MT 7	37	1,439	1,260	29%

Source: MDT 2014

In addition to the historic AADT within the area, data were collected to supplement this analysis on October 22, 2014 and December 30, 2014. Turning movement counts were collected for a 12-hour period (7 AM through 7 PM) to ensure the peak period was included for the analysis. These counts included a breakdown by vehicle class that was used to determine an HV percentage for each movement. Figure 8 shows the peak period total and HV volumes for each of the six Study Area intersections. The peak period is the 1-hour period throughout the 12-hour study period that has the highest total intersection volume. Note that these can differ from intersection to intersection. Data reported in Figure 8 and used in further analysis and discussions represents the worst-case 1-hour period for each intersection analyzed. In addition to the turning movement volumes, Figure 8 also shows the existing traffic control, such as which legs of an intersection are stopped-controlled.

The Study Area has a high heavy vehicle percentage, as shown in the data from Table 6. As shown in Figure 8, the turning movement data indicates there are higher HV movements between the north and east legs of the intersection of US 12 with MT 7. Larger volumes of HVs

[1] MDT uses standard FHWA vehicle classifications when defining heavy vehicles. Throughout this document, heavy vehicles (HV) are any vehicles within classes 5 through 13 of FHWA's 13 Vehicle Classification system. This includes all vehicles that are two-axle, six-tire, single unit trucks up through seven or more axle, multi-trailer trucks.

make turns from southbound MT 7 to eastbound US 12 and westbound US 12 to northbound MT 7 throughout the day in addition to the peak period.

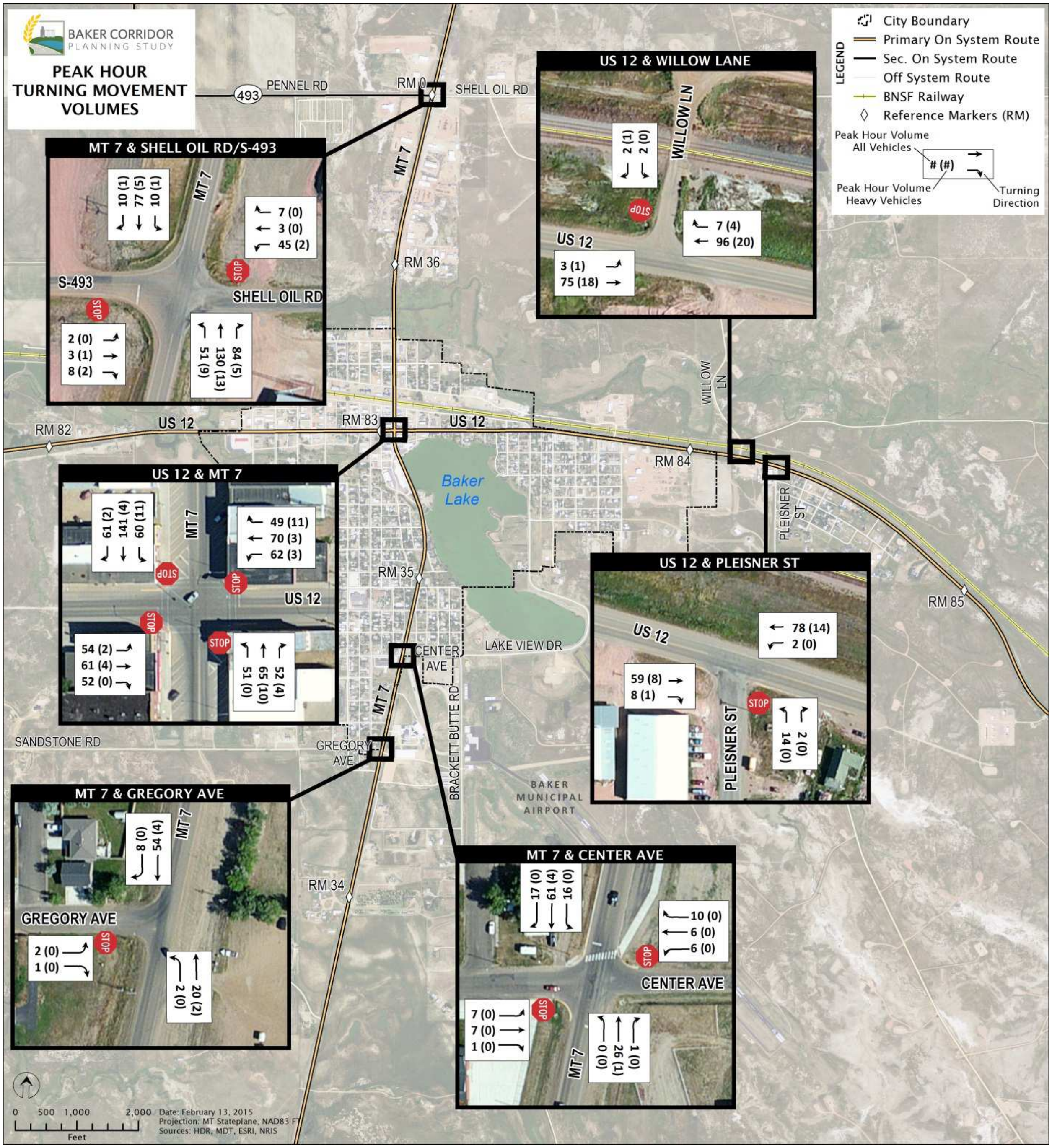

Figure 8: Peak Hour Turning Movement Counts

Peak-period turning movement counts were used to determine the existing Level of Service (LOS) within the Study Area. LOS refers to the degree of congestion on a roadway or at an intersection, measured in average delay, and based on the methodologies provided in the 2010 *Highway Capacity Manual*. LOS A represents free-flow conditions (motorists experience little or no delay and traffic levels are well below roadway capacity), and LOS F represents forced-flow conditions (motorists experience very long delays and traffic volumes exceed roadway capacity). LOS B to E represents decreasing operational conditions. A traffic analysis program, known as Synchro (Version 8.0), was used to determine intersection delay and LOS for existing conditions. Table 7 shows existing conditions LOS at the six Study Area intersections. Per the MDT Traffic Engineering Manual, a non-NHS Primary highway facility has a minimum design criteria level of service C and a desirable level of service B for urban minor arterials. A detailed report of this analysis can be seen in Appendix A.

Table 7: Existing Conditions Level of Service during Peak Hour

Intersection	Peak Hour	Total Peak Hour Vehicles	Peak Hour HV Percentage (%)	LOS (Delay[1])
US 12 & MT 7	5:45 – 6:45 PM	778	7	B (14.4)
US 12 & Willow Lane	5:15 – 6:15 PM	185	24	A (9.6)
US 12 & Pleisner Street	2:45 – 3:45 PM	159	14	A (9.7)
MT 7 & Shell Oil Road/S-493	7:30 – 8:30 AM	428	9	C (15.2)
MT 7 & Center Ave	5:00 – 6:00 PM	158	3	A (9.7)
MT 7 & Gregory Ave	6:00 – 7:00 PM	87	7	A (8.8)

Note: The worst-performing leg LOS is shown for each intersection.
[1]*Delay is shown in seconds.*

Future Traffic Projections

There are a multitude of factors that affect an area's traffic growth over time and may include changes in economic conditions, population, land use, etc. Estimating future traffic growth based on the most recent historic traffic counts provides an indication of the recent economic activity occurring within the Study Area. An average annual growth rate (AAGR) was determined over a 5-year and 10-year period for each site using historic AADT counts from Table 5. Traffic volumes vary throughout the Study Area and each site produced a different growth rate, as well as a different growth rate at a 5-year period compared to a 10-year period. These calculated growth rates are shown in Table 8. In addition to the 5- and 10-year growth rates for all vehicles, Table 8 includes the growth rates for HVs at each site. When examining traffic volumes for all vehicle types, many of the sites had low or even negative growth rates over the two different periods, while some produced higher growth rates. Growth in HV volumes show a wider range, including negative to low growth over the two different periods to upwards of 17 to 23 percent. The 5-year growth rate (2009 to 2013) for HVs on MT 7 show consistently high growth rates throughout the Study Area.

Table 8: Historic AADT Growth Calculations by Site

Site ID	Corridor	Reference Marker	5-Year Growth %	5-Year Growth (HV) %	10-Year Growth %	10-Year Growth (HV) %
13-1-4*	US 12	76.13	5.8	3.9	5.7	1.1
13-1-15	US 12	82.09	5.7	3.9	2.9	1.1
13-1-16	US 12	82.60	1.0	3.9	-0.6	1.1
13-1-17	US 12	82.65	-0.9	0.5	-0.9	-0.1
13-1-18	US 12	83.07	-2.4	0.5	-3.3	-0.1

Site ID	Corridor	Reference Marker	5-Year Growth %	5-Year Growth (HV) %	10-Year Growth %	10-Year Growth (HV) %
13-1-5*	US 12	88.12	-5.1	0.5	-0.9	-0.1
13-2-2*	MT 7	29.34	4.7	19.9	5.1	10.6
13-1-19	MT 7	34.32	4.3	19.9	2.5	10.6
13-1-20	MT 7	35.14	4.2	7.6	2.2	4.2
13-1-21	MT 7	35.45	4.0	7.6	-0.6	4.2
13-1-22	MT 7	35.52	0.2	17.3	-1.4	9.3
13-1-23	MT 7	35.76	2.1	17.3	2.0	9.3
13-1-7	MT 7	36.95	1.3	17.3	1.6	9.3
13-1-12	S-493	1.26	-6.6	23.1	2.3	12.2

* Site located outside the Study Area Boundary.

Projected traffic conditions were analyzed for a 20-year growth period (for year 2034) based on known existing conditions and potential future development likely to occur within the Study Area and region. Future traffic volumes likely will vary based on the level of future economic development. Additionally, future truck volumes (HVs) may increase more dramatically over standard vehicles depending on the level of future development. As such, a range of growth rates were estimated to account for low-, medium-, and high-growth scenarios, and include:

- Low: 2% growth rate for all vehicles (passenger and heavy vehicles)
- Medium: 5% growth rate for all vehicles (passenger and heavy vehicles)
- High: 5% growth rate for standard vehicles, 10% growth rate for heavy vehicles

Future ADT volumes were estimated using the three growth rate scenarios and the results are shown in Table 9.

Table 9: Projected ADT Traffic Volumes (2034)

Site ID	Route	Reference Marker	Existing ADT[1]	2034 Low Growth (2%)	2034 Medium Growth (5%)	2034 High Growth (5% cars/trucks; 10% heavy vehicles
13-1-4*	US 12	76.13	1,230	1,900	3,400	4,000
13-1-15	US 12	82.09	1,560	2,400	4,300	4,900
13-1-16	US 12	82.60	3,790	5,700	10,600	11,100
13-1-17	US 12	82.65	3,320	5,000	9,200	10,000
13-1-18	US 12	83.07	2,350	3,600	6,500	7,300
13-1-5*	US 12	88.12	810	1,200	2,300	3,000
13-2-2*	MT 7	29.34	1,030	1,600	2,900	3,400
13-1-19	MT 7	34.32	1,310	2,000	3,600	4,200
13-1-20	MT 7	35.14	2,460	3,700	6,900	7,400
13-1-21	MT 7	35.45	3,730	5,700	10,400	11,000
13-1-22	MT 7	35.52	3,580	5,400	10,000	10,800
13-1-23	MT 7	35.76	2,990	4,500	8,300	9,100
13-1-7	MT 7	36.95	1,320	2,000	3,700	4,500
13-1-12	S-493	1.26	270	400	800	1,100

[1] *Source: MDT 2014*

Future turning movements were analyzed at the six Study Area intersections and LOS were calculated using the three growth scenarios described above for future year 2034. The future turning movement counts were analyzed for LOS using the existing intersection configurations. Table 10 shows the results of the intersection LOS analysis.

Table 10: Future Conditions (2034) Intersection Level of Service during Peak Hour

Intersection	LOS (Delay[1])			
	Existing Condition (2014)	Low Growth	Medium Growth	High Growth
US 12 & MT 7	B (14.4)	F (71.3)	F (>100)	F (>100)
US 12 & Willow Lane	A (9.6)	B (10.1)	B (11.9)	B (14.1)
US 12 & Pleisner Street	A (9.7)	B (10.4)	B (12.7)	B (14.4)
MT 7 & Shell Oil Road/S-493	C (15.2)	D (28.2)	F (>100)	F (>100)
MT 7 & Center Ave	A (9.7)	B (10.3)	B (12.4)	B (12.7)
MT 7 & Gregory Ave	A (8.8)	A (9.1)	A (9.6)	A (9.9)

Note: The worst-performing leg LOS is shown for each intersection.
[1]Delay is shown in seconds.

As shown in Table 10, the intersection of US 12 and MT 7, assuming existing geometric configurations, will operate at a failing level (LOS F) in the future under all growth scenarios. The MT 7 & Shell Oil Road/S-493 intersection is projected to operate at a failing level under the medium- and high-growth scenarios. More information on the LOS analysis can be found in Appendix A.

Railroad Crossing Queuing

There is an at-grade railroad crossing on MT 7 approximately 415 feet north of the intersection with US 12. The intersection of MT 7 and Railroad Avenue is immediately adjacent to the railroad crossing and decreases the amount of vehicle storage area on northbound MT 7. There is a stop bar located south of the at-grade crossing that allows for approximately 65 feet of storage before encroaching into the Railroad Avenue intersection, which does not accommodate a standard WB-67 vehicle. The grade crossing pavement marking begins at the south approach of the Railroad Avenue intersection, marking the beginning of the larger vehicle queuing area. This queuing area for northbound truck traffic on MT 7 is located approximately 115 feet south of the railroad crossing. In total, the approximate vehicle queue area available on MT 7 from Railroad Avenue to US 12 is 300 feet, which is enough to accommodate 3 semi-trailers (assuming a 100’ long WB-67 vehicle) or approximately 12 regular vehicles (assuming 25’ per vehicle).

3.2 Crash Analysis

Crash records spanning the 10-year period of 2004 to 2013 for the Study Area were examined to identify trends, if any, in the data. Crash records for locations along US 12 and MT 7 immediately adjacent, but outside of the Study Area, were also included in the analysis. The crash data were summarized to determine crash rates by roadway segment. Several indices are typically calculated to report the overall crash statistics for a given Study Area; definitions are as follows.

- Crash rate: The number of crashes per million vehicle miles of travel
- Severity index: The ratio of the sum of the level of crash degree to the total number of crashes
- Severity rate: The crash rate multiplied by the severity index

Figure 9 shows the crash locations within the Study Area as depicted by injury type.

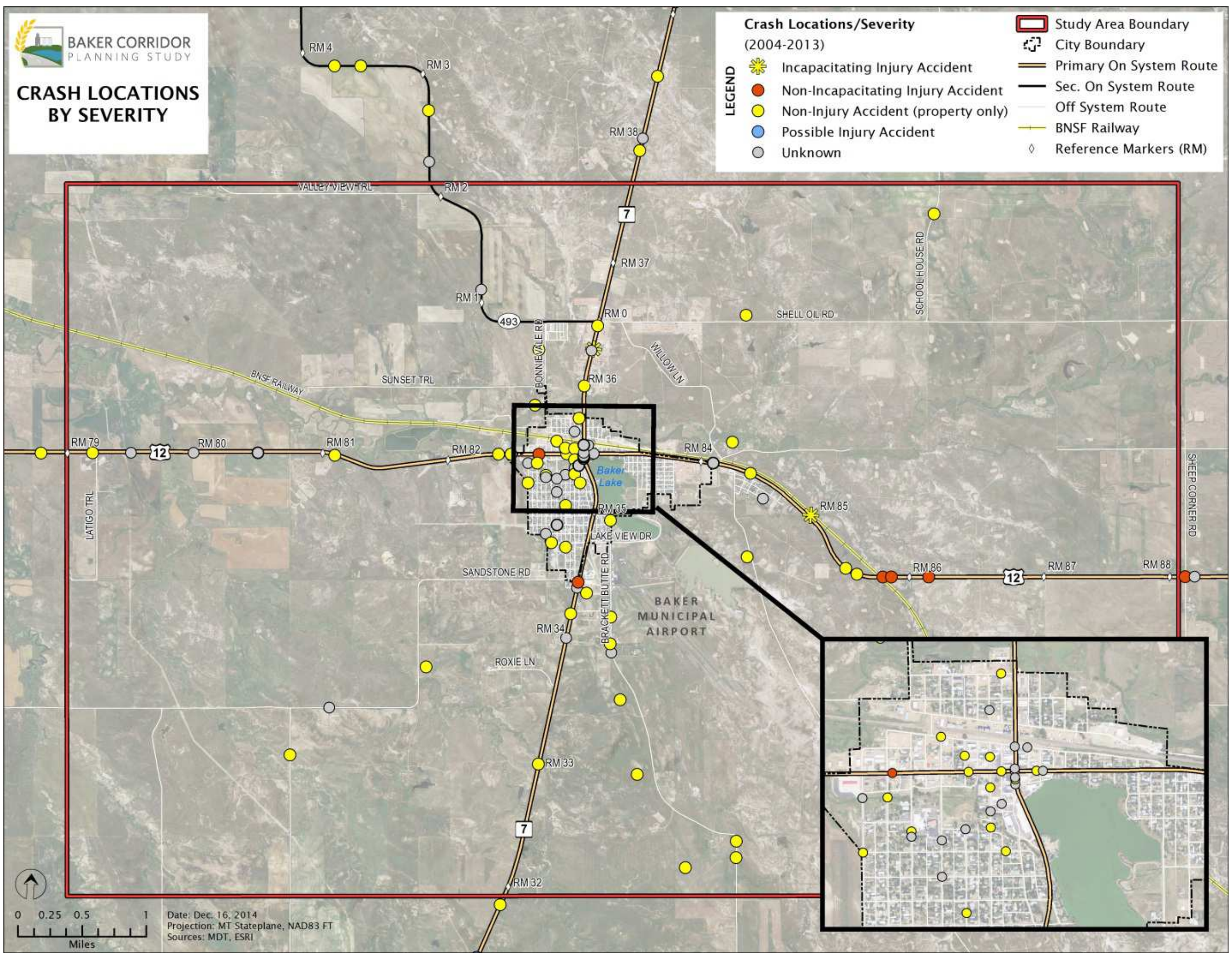

Figure 9: Study Area Crash Locations by Severity

Table 11 summarizes the crash statistics for sections of the two main corridors within the Study Area for all vehicle types (total crashes) and for HVs. Each corridor has a crash rate calculated based on the total crashes for the road segment within the city limits of Baker (urban) and for each of the segments outside the city limits (rural).

Table 11: Crash Statistics

	Total Crashes	Heavy Vehicle Crashes	Crash Rate	Severity Index	Severity Rate
US 12 (RM 77 – RM 82)	17	0	0.94	2.35	2.22
US 12 (RM 82 – RM 83.6)*	14	5	0.64	1.14	0.73
US 12 (RM 83.6 – RM 89)	13	3	0.72	2.15	1.55
MT 7 (RM 31 – RM 34.6)	7	1	0.45	1.57	0.71
MT 7 (RM 34.6 – RM 35.8)*	9	2	0.59	1.00	0.59
MT 7 (RM 35.8 – RM 39)	7	1	0.51	2.00	1.01
Rural Statewide Average[1]	-	-	1.11	2.18	2.41
Urban Statewide Average[1]	-	-	4.51	1.66	7.48

* Road segment located within city limits.
Source: MDT Traffic and Data Collection Analysis, 2014.
[1] *Source: Statewide Primary Route Crash Statistics: 2008 through 2012. MDT, 2015.*

The crash rates within the Study Area for the US 12 and MT 7 corridors, both rural and urban road segments, are below the overall statewide average for State Primary Routes. Table 12 shows the total number of crashes by collision type for US 12 and MT 7.

Table 12: Total Crashes by Collision Type

	Total Crashes	Rear End	Angle	Fixed Object	Roll Over	Other
US 12 (RM 77 – RM 82)	17	0	1	10	2	4
US 12 (RM 82 – RM 83.6)*	14	2	6	3	2	1
US 12 (RM 83.6 – RM 89)	13	3	1	3	4	2
MT 7 (RM 31 – RM 34.6)	7	0	1	3	3	0
MT 7 (RM 34.6 – RM 35.8)*	9	3	5	0	0	1
MT 7 (RM 35.8 – RM 39)	7	1	1	3	1	1

* Road segment located within city limits.
Source: MDT Traffic and Data Collection Analysis, 2014.

There were a variety of crash types within the Study Area as shown in Table 12. Rear end and angle crashes are more common within city limits where drivers perform turning movements entering and exiting the roadway. Fixed object and roll over crashes are more common on the rural portions of the Study Area highway corridors and typically resulted from driver error, weather conditions, or roadway geometric constraints such as curves or grades.

In reviewing the crash data in the Study Area, there were few crash types that occurred in a particular location or road segment that would indicate a higher crash potential. A majority of the contributing factors for crashes in the Study Area were inattentive or careless driving. As shown in Table 12, angle and rear end crashes were common within the Baker city limits, as would be expected. On US 12, five of the 14 crashes that occurred within Baker city limits involved heavy vehicles, although these crashes were of various types with differing contributing circumstances.

A majority of the Study Area crashes were property damage only crashes. One fatal injury crash located near RM 77 on US 12 (outside the Study Area) was recorded within the 10-year period where an improper turn resulted in a head-on collision.

3.3 Right-of-Way and Jurisdictions

Highway right-of-way along the US 12 and MT 7 corridors as well as the paved portion of S-493 is maintained by the State of Montana. Land ownership adjacent to the US 12 and MT 7 corridors within the Study Area is predominantly privately owned. US 12 has two large adjacent State-owned parcels located at approximately RM 80 (south of highway) and between RM 86 and 87 (north of highway). Fallon County owns several large land parcels within the Study Area, one of which (approximately RM 81) has US 12 passing through it. Although not located on the primary system, the Bureau of Land Management owns several parcels within the Study Area. Figure 10 depicts the general land ownership within the Study Area.

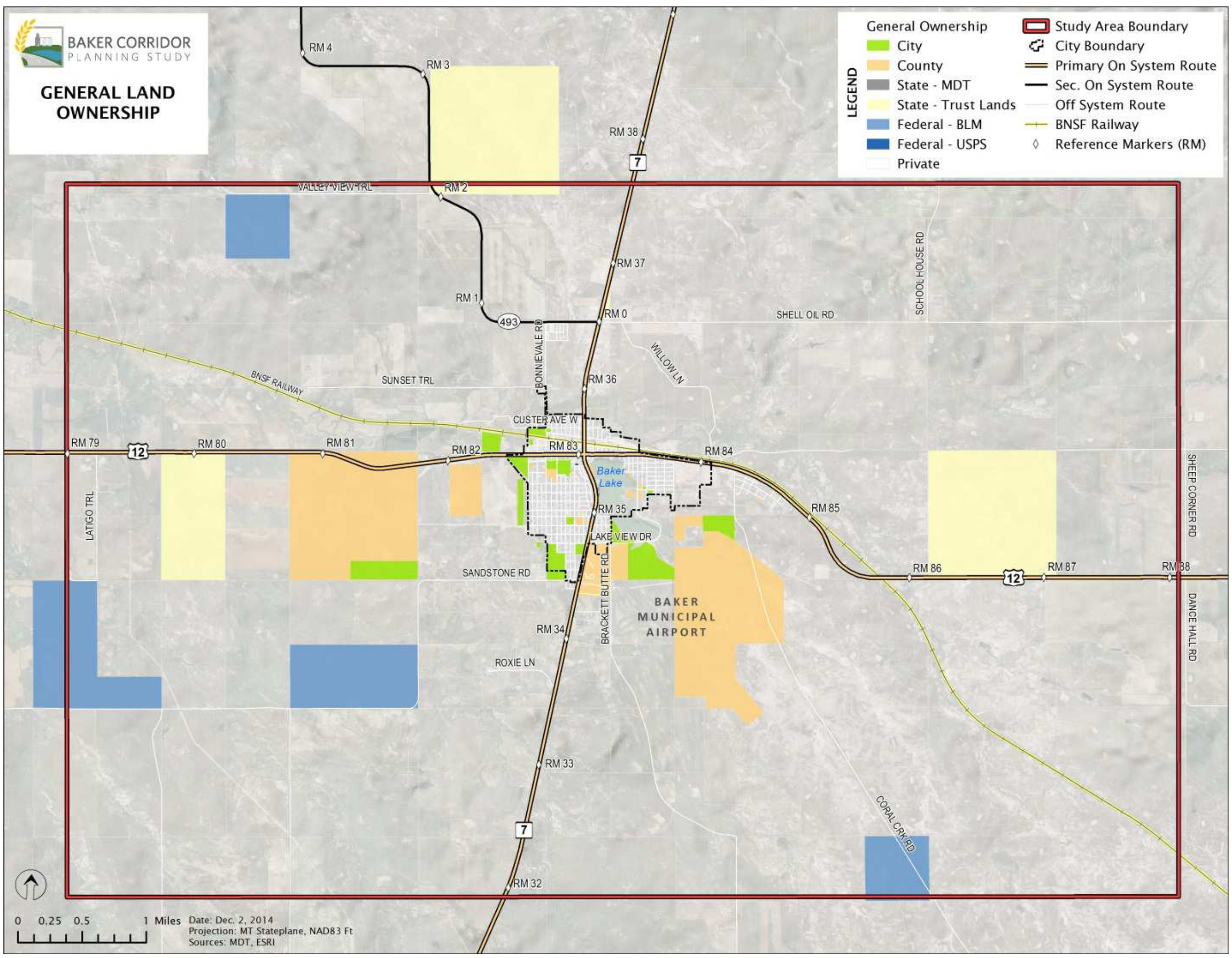

Figure 10: General Land Ownership in the Study Area

As-built construction drawings were reviewed to document existing right-of-way widths on either side of the roadway centerline for the segments of US 12, MT 7, and S-493 located within the Study Area. Right-of-way widths along US 12 vary from 31 feet to 130 feet on each side of centerline, the smaller widths occurring within Baker city limits. MT 7 right-of-way widths range from 20 feet to 177 feet from centerline. Similar to US 12, the smaller widths on MT 7 occur within Baker city limits. The existing right-of-way width along S-493 within the Study Area varies from 50 feet to 100 feet from centerline. Appendix B lists in detail the right-of-way widths by direction from roadway centerline.

3.4 Physical Characteristics

US 12 is an east-west highway spanning almost 2,500 miles from the Washington coast to Detroit that serves as a major linkage across the state. At Miles City on Interstate 94, US 12 splits off from the interstate and heads east for 89 miles, through the City of Baker, into North Dakota. Through the Study Area, US 12 is a two-lane highway with varying shoulder widths, and, where it passes through Baker city limits, has interspersed areas of parallel parking and sidewalks. MT 7 travels a total of 80.5 miles in a south-north direction beginning south of Baker in Ekalaka and heads north to its intersection with Interstate 94 at Wibaux. Through the Study Area, MT 7 is a two-lane highway, and, similar to US 12, has intermittent areas of parallel parking and sidewalks outside the immediate downtown area. Within the downtown area, MT 7 has on-street angled parking one block before and after its intersection with US 12. Speed limits vary throughout the Study Area. Figure 11 shows the posted speed limits for the Study Area.

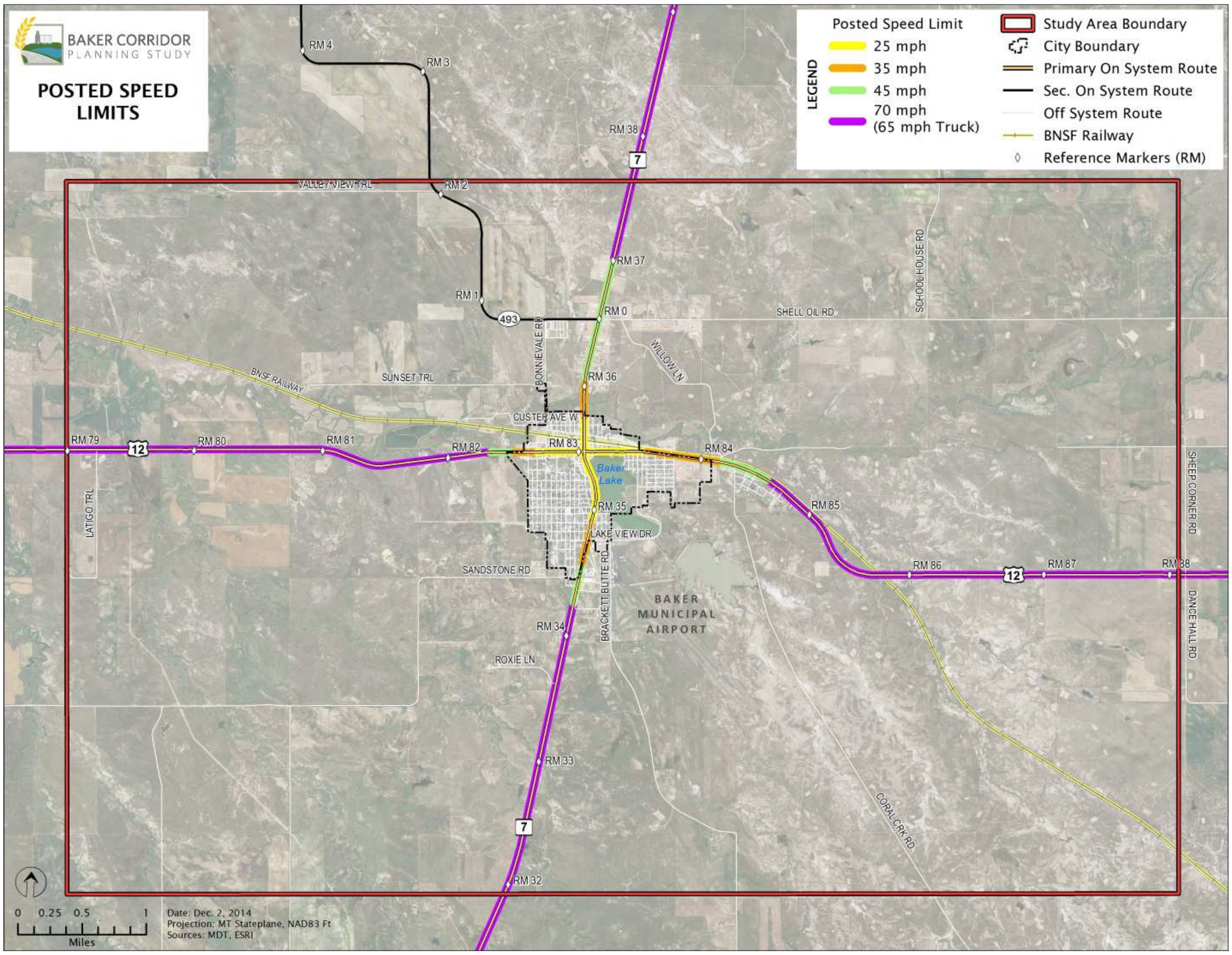

Figure 11: Posted Speed Limits

3.5 Roadway Design Standards

Operational characteristics of a roadway are governed by general design principles and controls as specified in the MDT *Road Design Manual*. While standards typically change over time, it should be noted that the following information is based on the current MDT design standards. Also note that areas not meeting current MDT design standards do not necessarily represent unsafe conditions or warrant improvements. The roadway design standards for US 12 and MT 7 within the Study Area are based on the current MDT design criteria for Rural and Urban Minor Arterials. MDT urban design criteria apply to sections of US 12 and MT 7 located within Baker city limits. Rural minor arterials are described as providing a mix of interstate and interregional travel service, which, in urban areas, can carry local bus routes and provide intra-community connections.

Roadway design speeds are controlled by factors such as topography, anticipated operating speed, adjacent land use, and functional classification of the highway. Per the MDT *Road Design Manual*, rural highways such as US 12 and MT 7 outside of Baker city limits have design speeds controlled primarily by topography and functional classification. Table 13 describes the design standards for Rural and Urban Minor Arterials.

Table 13: Geometric Design Criteria for Rural and Urban Minor Arterials (Non-NHS – Primary) U.S. Customary

Design Element			Design Criteria[2]		
Design Controls	Functional Classification		Rural Minor Arterial	Urban Minor Arterial – Curbed	Urban Minor Arterial – Uncurbed
Design Controls	Design Forecast Year		20 Years		
Design Controls	[1]Design Speed	Level	60 mph	35 mph	35 mph
Design Controls	[1]Design Speed	Rolling	55 mph		
Design Controls	[1]Design Speed	Mountainous	45 mph		
Design Controls	Level of Service		Level/Rolling: B Mountainous: C	Desirable: B Minimum: C	
Roadway Elements	[1]Travel Lane		12”		
Roadway Elements	[1]Shoulder Width	Outside	Varies		
Roadway Elements	Cross Slope	[1]Travel Lane	2% Typical		
Roadway Elements	Cross Slope	Shoulder	2% Typical		
Roadway Elements	Median Width		Varies	N/A	
Roadway Elements	TWLTL Width		N/A	16”	
Earth Cut Section	Ditch	Inslope	6:1 (Width: 10’)	N/A	6:1 (Des/4:1 Min)
Earth Cut Section	Ditch	Width	10’ Minimum	N/A	10’ Min
Earth Cut Section	Ditch	Slope	20:1 towards back slope	N/A	20:1 towards back slope
Earth Cut Section	Back Slope; Cut Depth at Slope Stake	0’ - 5’	5:1		
Earth Cut Section	Back Slope; Cut Depth at Slope Stake	5’ - 10’	Level/Rolling 4:1, Mountainous: 3:1		
Earth Cut Section	Back Slope; Cut Depth at Slope Stake	10’ - 15’	Level/Rolling: 3:1, Mountainous: 2:1		
Earth Cut Section	Back Slope; Cut Depth at Slope Stake	15’ - 20’	Level/Rolling: 2:1, Mountainous: 1:5:1		
Earth Cut Section	Back Slope; Cut Depth at Slope Stake	>20’	1:5:1		
Earth Fill Slopes	Fill Height at Slope Stake	0’ – 10”	6:1		
Earth Fill Slopes	Fill Height at Slope Stake	10’ – 20’	4:1		
Earth Fill Slopes	Fill Height at Slope Stake	20’ – 30’	3:1		
Earth Fill Slopes	Fill Height at Slope Stake	>30’	2:1		

Alignment Elements		Rural			Urban		
Design Speed		45 mph	55 mph	60 mph	30 mph	40 mph	50 mph
[1]Stopping Sight Distance		360’	495’	570’	200’	305’	425’
Passing Sight Distance		1625’	1885’	2135’	N/A	N/A	N/A
[1]Minimum Radius		590’	960’	1200’	250’	533’	760’
[1]Superelevation Rate		e_{max} = 8.0%			e_{max} = 4.0%		e_{max} = 8.0%
[1]Vertical Curvature (K-value)	Crest	61	114	151	19	44	84
[1]Vertical Curvature (K-value)	Sag	79	115	136	37	64	96
[1]Maximum Grade	Level	3%			7%	6%	
[1]Maximum Grade	Rolling	4%			8%	7%	
[1]Maximum Grade	Mountainous	7%			10%	9%	
Minimum Vertical Clearance		17.0’					

Source: Montana Department of Transportation Road Design Manual, Chapter 12.2008
[1] Controlling design criteria (see Section 8.8 in the *Road Design Manual*).
[2] The Study Area only includes Level and Rolling Terrain.

3.6 Roadway Geometrics

Current as-built drawings for the highways within the Study Area were reviewed to identify areas of potential concern that fail to meet current MDT design standards. The current MDT design standards for Urban Minor Arterials were used to evaluate the segment of US 12 and MT 7 located within Baker city limits, and Rural Minor Arterial design standards were used for highway segments located outside city limits. The findings of the existing roadway geometrics within the Study Area are discussed in greater detail in the following sections. Areas not meeting current design standards are shown in Figure 12.

Horizontal Alignment

Horizontal alignment is a measure of the degree of turns and bends in the road. The horizontal alignments of the highways within the Study Area greatly affect the vehicular operations and safety of the overall roadway. The horizontal alignment design elements comply with specific limiting criteria, including minimum radii, superelevation rates, and sight distances.

Table 14 provides a summary of the horizontal alignment curvature for US 12, MT 7, and S-493. The table includes the location of the curve center (approximate RM), length, radius, and horizontal stopping sight distances. The analysis assumed urban design standards throughout Baker city limits. The evaluation noted only one curve located on S-493 that does not meet current minimum MDT design standards for level terrain. The curve represents the 90-degree curve located at RM 0.86 on S-493. Ten curves (five on US 12, four on MT 7, and one on S-493) failed to meet design standards for horizontal stopping sight distances. Stopping Sight Distance (SSD) is defined as the sum of the distance traveled during a drivers' perception/reaction or brake reaction time and the distance traveled while braking to a stop. Stopping sight distance issues were noted on US 12 east of Baker primarily with the horizontal curves west of the railroad overpass. Stopping sight distance issues on MT 7 occur on the hill near RM 33.5 and immediately north of Baker at RM 35.15 and RM 36.03.

Table 14: Horizontal Alignment

Approximate RM of Curve Center	Length Of Curve (FT)/(M)	Radius (FT)/(M)	Stopping Sight Distance (SSD) (FT)/(M)
MT 12 (P-2) FROM RM 79 TO RM 82.63 AS-BUILT PROJECT: STPP-2-2(9)77			
81.04	885.21	2,864.79	578
81.41	781.30	1,909.86	567
82.34	173.31	2,864.79	574
MT 12 (P-2) FROM RM 82.63 TO RM 83.78 AS-BUILT PROJECT: F-(86)19			
83.51	380.8	2,865	246
MT 12 (P-2) FROM RM 83.78 TO RM 88 AS-BUILT PROJECT: F-FG 86(30)			
84.65	3443.2	5,730	246
85.32	842.2	1,910	562
85.72	2256.7	1,910	538
MT 7 (P-27) FROM RM 32 TO RM 35 AS-BUILT PROJECT: STPP-STPE 27-2(14)29			

Approximate RM of Curve Center	Length Of Curve (FT)/(M)	Radius (FT)/(M)	Stopping Sight Distance (SSD) (FT)/(M)
32.13	*721.40*	*3,500*	*162*
33.41	*123.60*	*3,500*	*145*
33.55	*123.60*	*3,500*	*145*
35.15	*381.60*	*620*	*93*
MT 7 (P-27) FROM RM 35 TO RM 38 AS-BUILT PROJECT: F-2(12)			
36.03	1,365	5,730	241
ROUTE 493 (S-493) FROM RM 0 TO RM 2.5 AS-BUILT PROJECT: S-398(1)			
2.07	1,060.0	955.0	434
1.65	1,064.7	955.0	424
0.86	1,125.0	716.3	443

Notes:
a. Red text indicates a failure based on MDT design requirements.
b. *Italicized* text indicates metric.

Vertical Alignment

The vertical alignment relates to the variance in elevation of the roadway. The MDT *Road Design Manual* contains guidelines for the maximum grades on rural and urban minor arterials based on the terrain of the roadway. The maximum grade recommendations for rural level and rural rolling terrain are 3 percent and 4 percent, respectively. The maximum grade recommendations for urban level and urban rolling terrain are 6 percent and 7 percent, respectively. Other vertical alignment design criteria relate to the rate of vertical curvature (K-Value) and stopping sight distance. The K-Value is a measure of the horizontal distance required to produce a 1 percent change in gradient.

The terrain varies slightly throughout the Study Area. Alignment grades through the city limits of Baker are generally flat and meet the maximum grade design standards for urban minor arterials. Appendix B provides a summary of the vertical alignment curvature for US 12, MT 7, and S-493. Review of the as-built plans indicates that there is one curve on MT 7 that does not meet current MDT standards for level terrain. The existing vertical grade exceeds the allowed maximum at approximately RM 37.1, north of Baker. There are also three vertical curves located between RM 37.1 and 37.71 that failed to meet current design standards for vertical stopping sight distance. Design elements listed in Appendix B were determined based on the best available data provided by MDT.

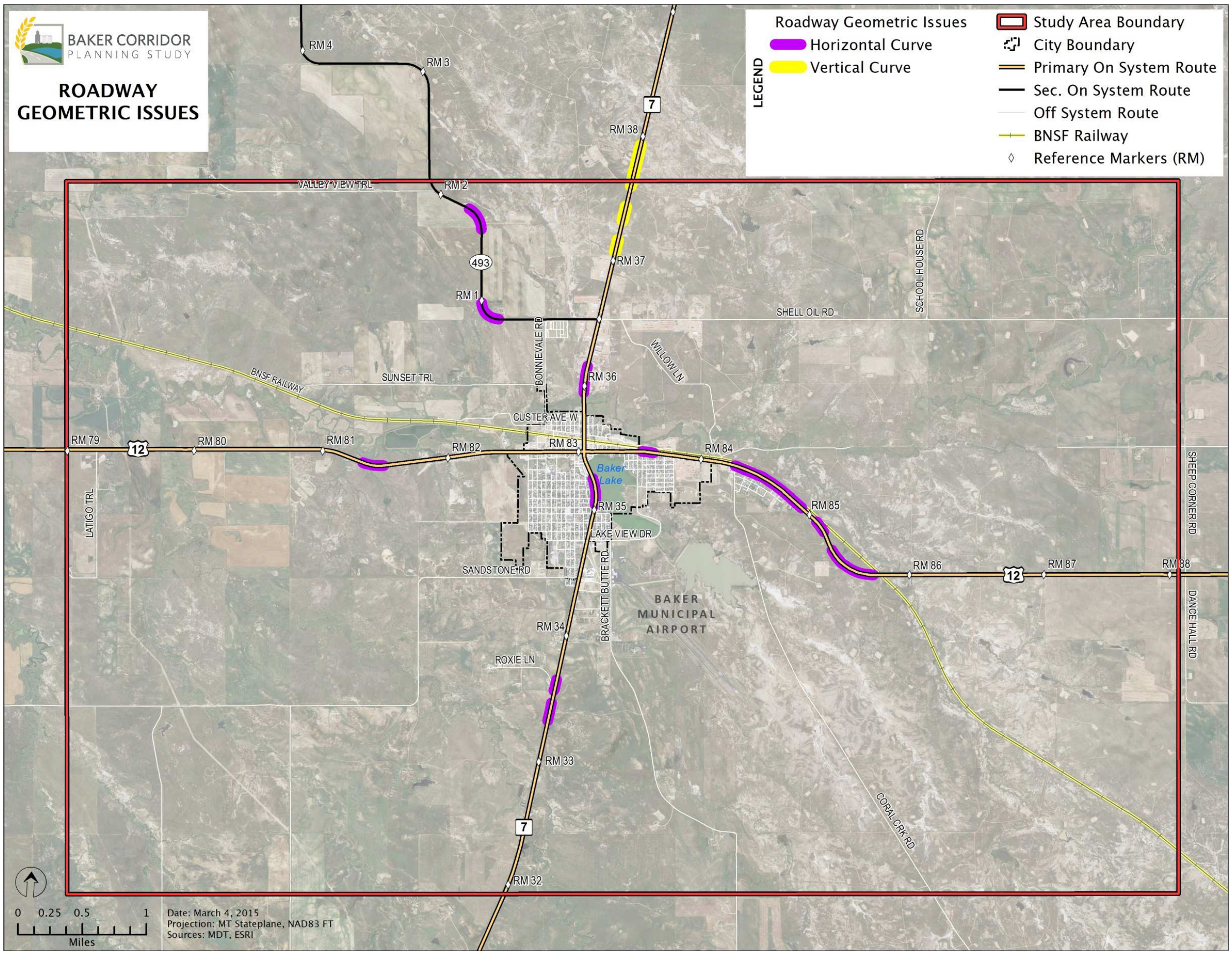

Figure 12: Roadway Geometric Issues

Intersection Turning Movements

The intersection of US 12 and MT 7 was analyzed to determine whether the existing geometric design layout is sufficient to accommodate proper turning movements for larger design vehicles. Anecdotal information suggests that semi-trailers commonly have difficulty making turning movements at this intersection and can conflict with either the opposing lane of traffic or vehicles parked in the angled parking along MT 7. Three design templates were used in analyzing the intersection: a WB-40, WB-50 and WB-67. A WB-40 is the smallest truck available (typically used for local delivery for restaurants and small retail) and has a 40' wheelbase (WB) as measured from the foremost axle to the rearmost axle. A WB-50 vehicle is an intermediate-sized semitrailer with a 50' wheelbase (WB). A WB-67 is a standard-sized semitrailer with a 67' wheelbase and is the typical design vehicle state routes.

The analysis determined that the existing layout of the US 12/MT 7 intersection is insufficient to accommodate left-turn movements of a WB-50 design vehicle. For both left-turn movements from US 12 onto MT 7, the inside wheel path conflicts with a stopped vehicle (shown as red in Figure 13) on MT 7. For turning movements from MT 7 onto US 12, the wheel path for the northbound to westbound left turn conflicts with the stopped vehicle. Figure 13 illustrates the left-turn movement from US 12 onto MT 7. All right-turn movements for the WB-50 can be made without conflict.

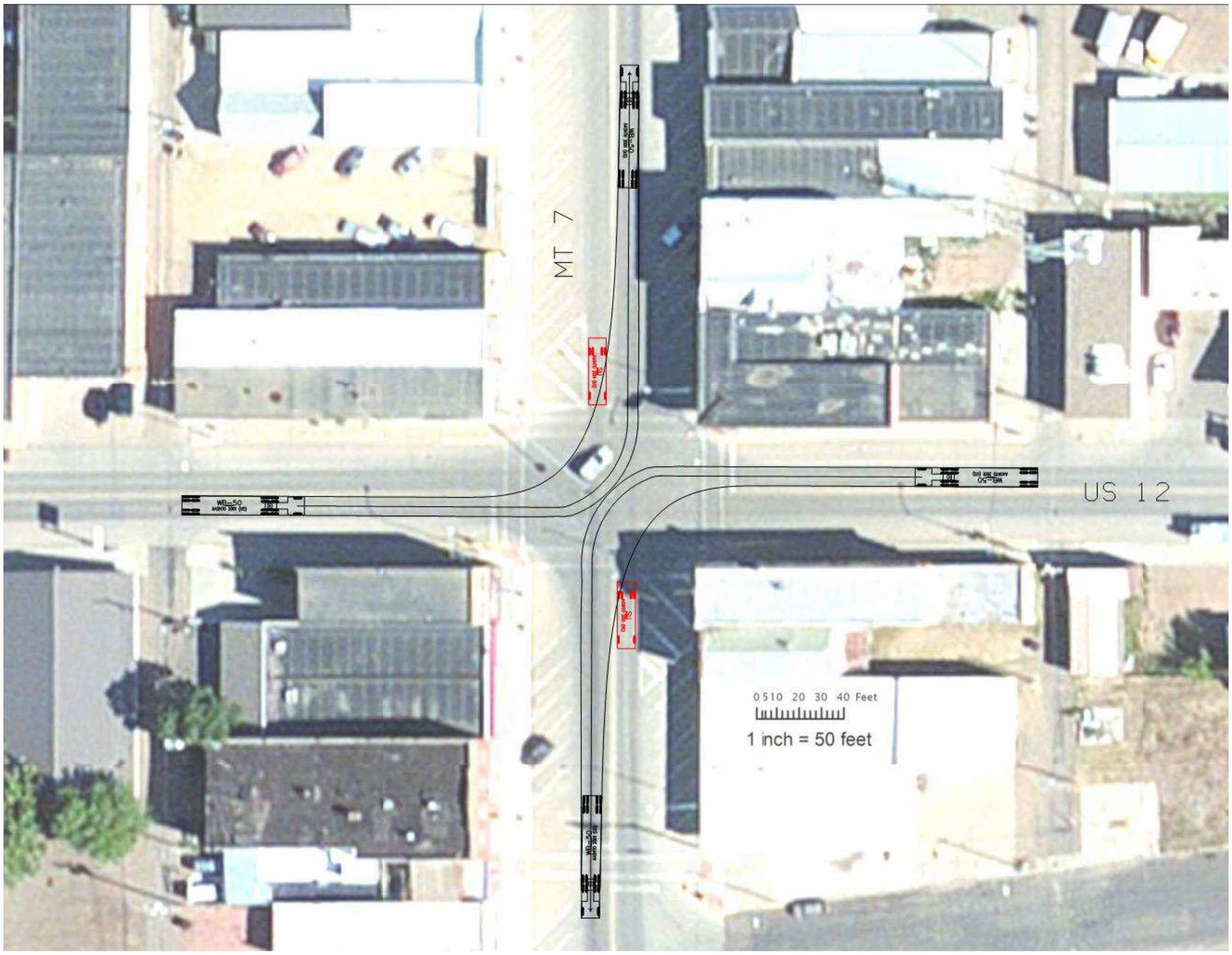

Figure 13: WB-50 Left-turn Movement from US 12 onto MT 7

The WB-67 design vehicle encountered conflicts at all four right-turn movements. Existing corner radii are not sufficient to prevent a truck of this size from rolling over curbing. The inside wheel path for the right-turn movement is extremely close to the existing curb return and crosses into two or three angled parking spaces. Because the shorter WB-50 could not make left-turn movements, it was unnecessary to test for the WB-67. It appears that the angled parking on the northwest and southeast corner of the intersection on MT 7 have been striped out with pavement markings to accommodate right turning vehicles. More detail can be found in Appendix B.

Roadside Clear Zones

The American Association of State Highway and Transportation Officials *Roadside Design Guide* defines a clear zone as the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired minimum width is dependent upon traffic volumes and speeds and on the roadside geometry.

Current MDT standards include recommended guidelines for clear zones in rural and urban roadway sections. The roadside clear zones were examined for US 12, MT 7, and S-493 within the Study Area. Based on this evaluation, one area of concern was identified on US 12 at RM 86.18 on both the north and south sides of the highway. Per the US 12 as-built plans, there is a 16’6” x 11’0” Structural Steel Plate Arch Pipe culvert at this location to accommodate the existing channel crossing. The drainage structure at this location includes concrete cutoff walls located approximately 32 feet from the edge of travel way, within the existing fill slope. Concrete curb is currently in place at this location on US 12 for drainage purposes. The existing side slopes appear to be 4:1 or steeper. Based on current MDT standards, a clear zone distance of at least 40 feet is required for this area of US 12.

Intersection Sight Distances

The intersections of the highways within the Study Area were examined for sight distance deficiencies. The intersection of US 12 and MT 7 is an all-way stop with flashing signal. Per Section 28.9.4 of the MDT *Traffic Engineering Manual*, intersections with all-way stop control need to provide sufficient sight distance so that the first stopped vehicle on each approach is visible to all other approaches. Based on this criterion, there is adequate sight distance at this intersection. The intersection of MT 7 and S-493 was analyzed for both approach and departure sight obstructions. Obstructions were not found within the sight triangles for either case.

3.7 Roadway Surfacing and Pavement Conditions

The MDT *Montana Road Log* was reviewed to obtain current characteristics of US 12, MT 7, and S-493. Information includes the surface type; surface, lane, and shoulder widths; surface and base thickness; and number of travel lanes. Table 15 contains the existing roadway surfacing information for US 12, MT 7, and S-493 within the Study Area. More information is found in Appendix E.

Table 15: Roadway Surface Characteristics for Major Study Area Roadways

SEGMENT REFERENCE MARKER (RM)	WIDTH (feet)			THICKNESS (inches)		SURFACE TYPE[1]	TRAVEL LANES
	Surface	Lane	Shoulder	Surface	Base		
US HIGHWAY 12 (P-2)							
76.954 – 82.187 *(enter Baker City Limits at 82.015)*	24	12	0	2.5	6.5	RMS	2
82.187 – 82.408	44	12	8	4.7	21.9	PMS	2
82.408 – 82.705 *(junction with MT 7 at 82.616)*	43	12	8	9.1	22.9	PCC	2
82.705 – 83.334	44	12	8	4.7	21.9	PMS	2
83.334 – 83.501	42	12	8	8.8	18.0	PMS	2
83.501 – 83.700 *(leave Baker City Limits at 83.616)*	42	12	8	8.8	15.0	PMS	2
83.700 – 84.076	42	12	8	7.6	18.0	PMS	2
84.076 – 85.235	42	12	8	8.8	18.0	PMS	2
85.235 – 88.615	35	12	5	8.8	18.0	PMS	2
MT HIGHWAY 7 (P-27)							
29.152 – 35.368 *(enter Baker City Limits at 34.644)*	28	12	2	3.5	13.0	PMS	2
35.368 – 35.549 *(junction with US12 at 35.473)*	73	12	8	9.1	17.7	PCC	2
35.549 – 35.563	40	12	8	10.8	17.7	PMS	2
35.563 – 35.716	40	12	8	9.9	12.0	PMS	2
35.716 – 44.407 *(leave Baker City Limits at 35.786)*	28	12	2	9.9	12.0	PMS	2
SECONDARY HIGHWAY 493 (S-493)							
0.000 – 1.000	28	12	2	4.2	15.6	PMS	2
1.000 – 4.877	24	-	-	0.0	0.0	GRV	2

Source: 2014 Montana Road Log
[1] RMS = "Road Mix Surfacing" - A compacted roadway, the surface of which is composed of 1 inch or more of gravel, stone, sand, or similar materials mixed on the roadway with bituminous materials.
PMS = "Plant Mix Surfacing - The same as "RMS" except mixed in a plant under precise specifications controlling the consistency of composition.
PCC = "Portland Cement Concrete" - A built up and compacted roadway with concrete surfacing.

Based on the MDT *Montana Road Log*, there is one section on US 12 that does not meet the current MDT standard for minimum pavement width. From RM 76.954 to 82.187, the existing pavement width is listed as 24 feet, made up of two 12-foot lanes and no shoulder. Per the MDT Road Design Manual, a minimum width of 28 feet is desired for rural minor arterials.

Pavement conditions within the Study Area are monitored annually by MDT through their Pavement Management System (PvMS). Information collected during the monitoring is translated into several metrics, which are used as performance measures to track and manage the pavement conditions throughout the state. Several pavement condition indices compiled as part of the PvMS are defined as follows:

- Ride Index (IRI) – Determined by using an internationally applied roughness index in inches per mile, and converting to a 0 to 100 scale.
- Rut Index (RI) – Calculated by converting rut depth to a 0 to 100 scale. Rut measurements are taken approximately every foot and averaged into one-tenth mile reported depths.
- Alligator Crack Index (ACI) – Measured by combining all load-associated cracking, and converting the index into a 0 to 100 scale.
- Miscellaneous Cracking Index (MCI) – Calculated by combining all non-load-associated cracking, and converting the index into a 0 to 100 scale.
- Overall Performance Index (OPI) – Determined by combining and placing various weighting factors on the IRI, RI, ACI, and MCI figures, and converting the index to a 0 to 100 scale. The OPI is calculated to provide a single index describing the current general health of a particular route or system.

Table 16 presents the pavement conditions for the segments of highway within the Study Area. The performance index scale used by the PvMS includes the following ratings: 80 to 100 is considered “good,” 60 to 79.9 is considered “fair,” and 0 to 59.9 is considered “poor.” The target range for IRI on the Primary System is between 60 and 100 percent (below 60 percent in considered undesirable). IRI values for roadway segments falling below approximately 65 percent are considered for tentative construction projects. Based on the IRI performance measure target ranges, US 12 from RM 77.2 to RM 82.6 is approaching an undesirable level, and the segment from RM 82.6 to RM 83.749 has fallen into the “undesirable” range and would qualify for a construction program.

Table 16: Pavement Condition Indices for US 12 and MT 7

SEGMENT REFERENCE MARKER (RM)	RIDE INDEX (IRI)	RUT INDEX (RI)	ALLIGATOR CRACK INDEX (ACI)	MISC. CRACKING INDEX (MCI)	OVERALL PERFORMANCE INDEX (OPI)
US HIGHWAY 12 (P-2)					
77.2 – 82.6[1]	65.09	53.91	95.47	95.17	54.07
82.6 – 83.749	48.00	74.67	100.00	100.00	57.41
83.749 – 95.514	80.33	75.46	99.25	97.68	74.09
MT HIGHWAY 7 (P-27)					
29.0 – 35.4	72.07	75.71	98.35	97.99	69.57
35.4 – 44.5	67.95	70.79	98.19	95.58	64.64

Source: MDT Pavement Management System, 2014
[1] Portions of this segment were resurfaced in 2014 and likely are not reflected in PvMS at the time the report was created.

The OPI includes a combination of all indices listed in Table 16 and provides the most comprehensive index of the pavement condition. The segment of US 12 from RM 77.2 to RM 83.749 is in “poor” condition based on the performance index scale.

A pavement preservation project was recently completed in 2014 on US 12 that begins west of Baker outside the Study Area at approximately RM 77.2 and continues into the western city limits to approximately RM 82.6 near the Baker fire station. According to the MDT 2014 Statewide Transportation Improvement Program, the Baker – West project (UPN 7948) is located on US 12 and is a 5.42 mile overlay project.

3.8 Access Points

Access points located along US 12 and MT 7 within the Study Area were counted using 2013 aerial imagery within GIS and verified using Google Street View. Access points included any defined entrance/exit onto the Primary on-system routes, such as driveways to agricultural lands, businesses, residences, and private roads; alleyways; and intersections with local streets.

Table 17 and Table 18 provide a list of the number and density of access points within the Study Area by half-mile segment. In total, US 12 has 155 access points (66 on the north side and 89 on the south side of the highway) within the Study Area between RM 79 and RM 88.5. MT 7 has a total of 94 access points (49 on the east side and 45 on the west side) between RM 32 and RM 38. The density of access points increases dramatically within the city limits (rows highlighted in bold) due to the amount of residential driveways, alleys, and cross streets.

Table 17: Access Points along US 12

Reference Marker	North of US 12		South of US 12		Total	
	No. of Accesses	Density (access/mi)	No. of Accesses	Density (access/mi)	No. of Accesses	Density (access/mi)
79 to 79.5	1	2	2	4	3	6
79.5 to 80	1	2	0	0	1	2
80 to 80.5	0	0	1	2	1	2
80.5 to 81	1	2	1	2	2	4
81 to 81.5	1	2	2	4	3	6
81.5 to 82	1	2	1	2	2	4
82 to 82.5	5	10	3	6	8	16
82.5 to 83*	28	56	22	44	50	100
83 to 83.5*	20	40	22	44	42	84
83.5 to 84*	1	2	15	30	16	32
84 to 84.5	1	2	12	24	13	26
84.5 to 85	0	0	5	10	5	10
85 to 85.5	1	2	1	2	2	4
85.5 to 86	0	0	0	0	0	0
86 to 86.5	1	2	0	0	1	2
86.5 to 87	1	2	1	2	2	4
87 to 87.5	2	4	0	0	2	4
87.5 to 88	0	0	0	0	0	0
88 to 88.5	1	2	1	2	2	4

* Road segments and access points located within city limits.

Table 18: Access Points along MT 7

Reference Marker	East of MT 7		West of MT 7		Total	
	No. of Accesses	Density (access/mi)	No. of Accesses	Density (access/mi)	No. of Accesses	Density (access/mi)
32 to 32.5	1	2	1	2	2	4
32.5 to 33	3	6	2	4	5	10
33 to 33.5	1	2	1	2	2	4
33.5 to 34	2	4	2	4	4	8
34 to 34.5	4	8	2	4	6	12
34.5 to 35*	6	12	9	18	15	30
35 to 35.5*	7	14	9	18	16	32
35.5 to 36*	11	22	10	20	21	42
36 to 36.5	8	16	5	10	13	26
36.5 to 37	5	10	4	8	9	18
37 to 37.5	1	2	0	0	1	2
37.5 to38	1	2	1	2	2	4

* Road segments and access points located within city limits.

On highway facilities, the primary purposes of access control include maintaining the flow of traffic and the functional integrity of the highway, as well as enhancing public safety. Within city limits, it is typical to have a higher density of access points due to the higher densities of development and facilities. However, in urbanized areas with higher traffic volumes, high densities of access points have the potential to increase traffic-related accidents along a roadway due to the proximity of vehicles entering or exiting of the roadway.

3.9 Hydraulic Structures

As-built drawings were reviewed to develop an inventory of hydraulic structures located along US 12, MT 7, and S-493. Table 19 lists the culverts within the Study Area, including their approximate location, diameter, length, and where applicable, the stream or drainage crossed.

Table 19: Culvert Inventory

Approximate RM of Culvert	Size	Length	Remarks[1, 2]
MT 12 (P-2) FROM MP 79 TO MP 82.63 AS-BUILT PROJECT: STPP-2-2(9)77			
79.01	48"	156'	Drain
79.36	24"	128'	Drain
79.59	36"	130'	Drain
79.61	48"	124'	Drain
79.77	120"	120'	Drain; Red Butte Creek
79.78	120"	120'	Drain; Red Butte Creek
80.11	28.5"x18"	100'	Drain
80.22	73"x45"	128'	Drain; Unnamed tributary of Sandstone Creek
80.48	28"x20"	90'	Drain
80.61	24"	108'	Drain
81.15	54"	272'	Drain; Unnamed tributary of Sandstone Creek

Approximate RM of Culvert	Size	Length	Remarks[1, 2]
81.39	72"	180'	Drain; Unnamed tributary of Sandstone Creek
81.73	24"	166'	Drain
81.88	60"	176'	Drain
81.97	60"	238'	Drain; Unnamed tributary of Sandstone Creek
82.19	28"x20"	100'	Drain
82.24	28.5"x18"	96'	Drain; Unnamed tributary of Sandstone Creek
MT 12 (P-2) FROM MP 82.63 TO MP 83.78 AS-BUILT PROJECT: F-(86)19			
82.67	24"	66'	Drain
82.69	18"	164'	Drain
82.74	18"	310'	Drain
82.80	15"	124'	Drain
82.80	18"x11"	138'	Drain
83.46	29"x18"	58'	Drain
83.62	29"x18"	64'	Drain
MT 12 (P-2) FROM MP 83.78 TO MP 88 AS-BUILT PROJECT: F-FG 86(30)			
84.01	29"X18"	51'	Drain
84.21	24"	72'	Drain
84.48	30"	59'	Drain
84.58	30"	59'	Drain
84.65	24"	59'	Drain
84.77	24"	82'	Drain
84.78	24"	82'	Drain
85.22	24"	95'	Drain
85.60	24"	88'	Drain
85.79	24"	132'	Drain
85.90	48"	188'	Drain
86.18	198"x132"	122'	Drain; Unnamed tributary of Sandstone Creek
86.74	24"	90'	Drain
87.37	24"	97'	Drain
87.54	36"	124'	Drain
88.05	24"	120'	Drain
MT 7 (P-27) FROM MP 32 TO MP 35 AS-BUILT PROJECT: STPP-STPE 27-2(14)29 (METRIC)			
31.02	1350mm	78m	Drain
31.27	600mm	40.4m	Drain
31.36	600mm	53.8m	Drain
31.89	1240mm x 840mm	24.6m	Drain
32.22	750mm	36m	Drain
32.27	600mm	36.8m	Drain
32.66	2700mm	70Jm	Drain; Unnamed tributary of Red Butte Creek
32.77	600mm	47.2m	Drain
33.03	2400mm	42Jm	Drain; Red Butte Creek
33.20	900mm	32.8m	Drain; Unnamed tributary of Red Butte Creek

Approximate RM of Culvert	Size	Length	Remarks[1, 2]
33.40	600mm	26.4m	Drain
33.69	600mm	23.4m	Drain
33.78	600mm	44Jm	Drain
33.85	600mm	33.2m	Drain
34.05	600mm	38m	Drain
34.30	600mm	21.6m	Drain
34.53	725mm x 460mm	17Jm	Drain
34.65	600mm	21.3m	Drain
35.20	4800mm x 1200mm	36.6m	Drain; Unnamed tributary of Sandstone Creek
MT 7 (P-27) FROM MP 35 TO MP 38 AS-BUILT PROJECT: F-2(12)			
35.95	36"	78'	Drain; Unnamed tributary of Sandstone Creek
36.03	24"	70'	Drain
36.85	24"	72'	Drain
37.04	18"	38'	Drain; Unnamed tributary of Sandstone Creek
37.17	24"	67'	Drain
37.30	24"	86'	Drain
37.55	24"	98'	Drain
37.76	24"	96'	Drain
37.86	24"	92'	Drain
38.20	24"	85'	Drain
38.31	36"	62'	Drain
ROUTE 493 (S-493) FROM MP 0 TO MP 2.5 AS-BUILT PROJECT: S-398(1)			
2.48	24"	80'	Drain
2.31	24"	100'	Drain
1.89	24"	80'	Drain
1.52	24"	72'	Drain
0.98	24"	102'	Drain
0.90	24"	102'	Drain
0.76	24"	92'	Drain
0.41	24"	72'	Drain
0.20	96"	104'	Drain; Unnamed tributary of Sandstone Creek

[1] All culverts noted are located underneath the highways as identified in the as-built plans. Culverts located on highway approaches were not inventoried.
[2] The stream or drainage is noted where a mapped stream was identified on either the USGS topographic map or the National Hydrography Dataset GIS data. Mapped streams represent likely jurisdictional water bodies per USACE definition.

Several large historical flooding events have occurred within the Study Area. More information is presented in Section 4.1, Physical Environment, Floodplains and Floodways. Due to the mapped floodplain associated with Sandstone Creek, a hydraulic analysis would be recommended if an improvement option is forwarded from the Study that crosses a known or likely drainage or waterway.

3.10 Bridges

Bridges

There are a total of seven (7) bridges or structures located within the Study Area, according to the MDT *Bridge Management System*. Table 20 provides a brief summary of the bridges, including their general location, features intersected, and year the structure was built. Refer to Figure 14 for the locations of the bridges/structures. More information can be found in Appendix E.

Table 20: Bridges within the Study Area

Bridge ID	On/Off System	Location	Feature Intersect	Year Built
P00002082+06161	On System	US 12, RM 82.46	Drainage	1998
P00002085+07161	On System	US 12, RM 85.75	BNSF Railway	1968
P00027035+01721	On System	MT 7, RM 35.23	Baker Lake Overflow	2009
P00027035+08231	On System	MT 7, RM 35.86	Sandstone Creek	1941
L13673000+01001	Off System	Bonnievale Road	Sandstone Creek	1955
L13764000+07801	Off System	Custer Ave	Sandstone Creek	2012
L13848000+01001*	Off System	Ag Lane, near RM 82.5 on US 12	Sandstone Creek	2003

Source: MDT Bridge Management System, 2014
* Bridge replaced with box culvert in 2014/2015.

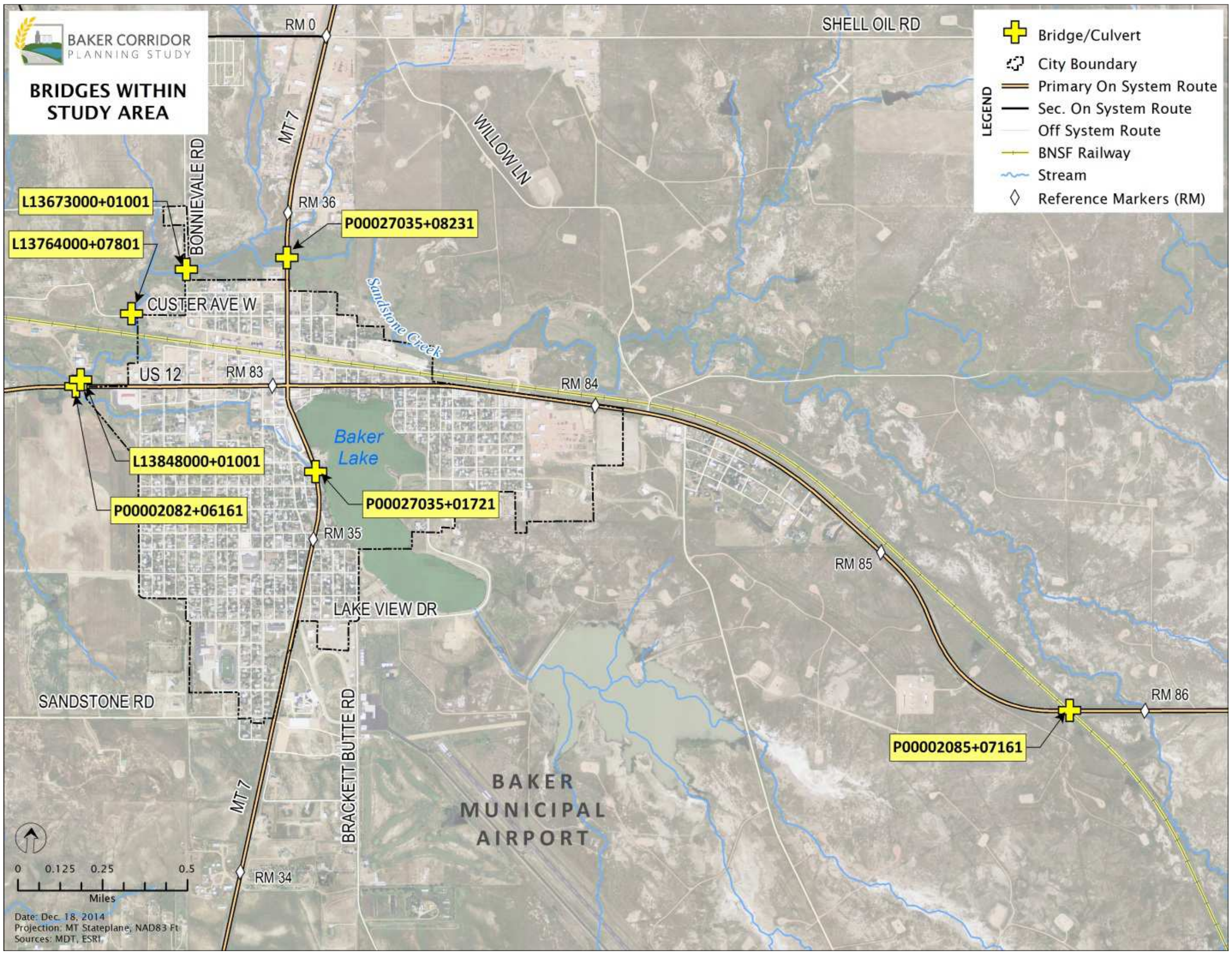

Figure 14: Bridges Located within the Study Area

The MDT Bridge Bureau regularly inspects and rates the bridges and structures located on the state's transportation system. Information available from the MDT Bridge Management System provides metrics on the condition of the structures based on the most current site inspection results. The Sufficiency Rating is a metric describing the overall health and replacement/rehabilitation eligibility of a bridge. The sufficiency rating formula is a method of evaluating highway bridge data by calculating four separate factors to obtain a numeric value, which is indicative of bridge sufficiency to remain in service. The result of this method is a percentage, in which 100 percent would represent an entirely sufficient bridge and 0 (zero) percent would represent an entirely insufficient or deficient bridge. Ratings of 0 to 49.9 percent are eligible for replacement and ratings of 50 to 80 percent are eligible for rehabilitation.

Prior to enactment of the Moving Ahead for Progress in the 21st Century Act (MAP-21), rehabilitation or replacement of eligible bridges was funded under the Highway Bridge Program. Under MAP-21, the Highway Bridge Program has been eliminated and off-system bridges (i.e., not located on the National Highway System) are now funded under the Surface Transportation Program and have to compete for limited funding.

The National Bridge Inventory (NBI) rating system is used within the MDT Bridge Management System to determine the structure status. To receive either structurally deficient or functionally obsolete classification, a highway bridge must meet the following criteria:

- Structurally Deficient:
  - A condition rating of 4 or less for any of the following: Deck, Superstructure, Substructure, or Culvert or Retaining Walls; or
  - An appraisal rating of 2 or less for either: Structural Evaluation or Waterway Adequacy.
- Functionally Obsolete:
  - A condition rating of 3 or less for any of the following: Deck Geometry, Underclearances, Approach Roadway Alignment; or
  - An appraisal rating of 3 for either: Structural Evaluation or Waterway Adequacy.

Table 21 provides the inspection results and structure status based on the NBI rating for the Study Area bridges.

Table 21: Bridge Conditions within the Study Area

Location	Bridge ID	Last Inspection Year	Sufficiency Rating	Structure Status (NBI Rating)
US 12, RM 82.46	P00002082+06161	2014	83	Not Deficient
US 12, RM 85.75	P00002085+07161	2014	77.1	Not Deficient
MT 7, RM 35.23	P00027035+01721	2014	93.3	Not Deficient
MT 7, RM 35.86	P00027035+08231	2014	69.6	Functionally Obsolete
Bonnievale Road	L13673000+01001	2013	73.2	Not Deficient
Custer Ave	L13764000+07801	2013	99.2	Not Deficient
Ag Lane, near RM 82.5 on US 12	L13848000+01001*	2013	47.9	Structurally Deficient

Source: MDT Bridge Management System, 2014
*This structure has been recently replaced and the database has not been updated for this new structure.

According to the MDT Bridge Management System inspection results, the bridge located just north of Baker on MT 7 at RM 35.86 spanning Sandstone Creek (P00027035+08231) has been categorized as Functionally Obsolete. Built in 1941, this bridge is approximately 64.5 feet long and contains three spans, with a wood/timber deck structure and bituminous deck surface type.

The bridge located on Ag Lane near RM 82.5 of US 12 also spanning Sandstone Creek (L13848000+01001) has been categorized as Structurally Deficient. Built in 2003, this structure measures 29.8 feet in length and consists of a wood/timber deck structure and gravel deck surface type. This structure has recently been replaced by a large box culvert structure and the results in Table 21 are not current for this bridge.

3.11 Other Transportation Modes

Rail

The BNSF Railway intersects the Study Area in an east-west direction. There are four BNSF Railway-operated at-grade rail crossings located throughout the Study Area and one grade-separated crossing underneath US 12 east of Baker. Within city limits there is an approximately 2-mile stretch of double track railroad siding. Table 22 provides information on the five railroad crossings located within the Study Area. If improvement options are developed that affect or cross the BNSF Railway, consideration of the current design standards will be necessary to comply with the specific railroad requirements.

Table 22: Railroad Crossings within the Study Area

Location	AADT	Warning Device / Crossing Type	Trains Per Day	# of Tracks	Train Switching	Speed Over Crossing
Baker, E 1.6 mi on US 12	990	RR Underpass, grade separated	5	0	0	40
Baker, E 0.2 mi (Willow Lane)	110	Cross bucks, at-grade	5	2	0	40
Berwald Rd	102	Cross bucks, at-grade	5	2	0	40
Main St (MT 7)	4509	Gates, at-grade	5	3	0	40
N 3rd St W	402	Gates, at-grade	5	3	0	40

Source: MDT, 2014

The crossing described as "Baker, E 0.2 mi" is located on Willow Lane immediately adjacent to US 12. This crossing has been identified by the community as having steeper grades, particularly on the north approach. A steep at-grade crossing can be problematic for some trucks, such as lowboy trailer truckers, which may cause the trucks to become high centered while crossing, rendering this crossing unusable for some trucks. This conflict then requires the trucks to use the crossing on MT 7, just north of downtown, thus adding additional heavy vehicular traffic to downtown streets. While there is a shoulder along the north side of US 12, a crossing closure at Willow Lane may cause vehicles to wait within the shoulder of the highway, which could create a safety issue.

Transit

Fallon County Transportation System provides local service within Baker Monday-Saturday between the hours of 8 AM and 4 PM. It is a demand-response service, primarily providing transport within Baker City limits. It also provides service to Miles City on the first Wednesday of each month and to Dickinson, North Dakota on the third Wednesday of each month. The Fallon County Transportation System provides occasional service to Plevna as requested. No other transit operations are known to operate within the Study Area.

Bicycles and Pedestrians

One separated path exists on Baker Lake that begins at Triangle Park, located on Lakeview Drive, and wraps around the southern end of the lake. Sidewalks exist adjacent to US 12 and

MT 7 in the immediate downtown area, although intermittently throughout the rest of the Study Area.

Air Service
Baker Municipal Airport (BHK) is located 1 mile southeast of Baker. The airport is owned by the City of Baker and Fallon County, and offers regional air service. The airport covers an area of 193 acres and includes one 4,898-foot-long runway. On average, the airport has approximately 19 aircraft operations per day. The Baker Municipal Airport represents a major constraint for potential improvement options in the Study Area southeast of Baker. Improvement options forwarded from the study will need to include appropriate buffer distances to avoid conflict with the airport's protected airspace.

3.12 Utilities

The Study Area includes many utilities, both along the primary highways of US 12 and MT 7 and throughout the urban area of Baker. Utilities include power, telephone, fiber optic, gas, and water/sewer. Outside city limits, utilities include interspersed overhead power and telephone lines that either parallel or cross the highways and appear to supply services to oil and gas development as well as to rural properties.

Information regarding Baker's water and wastewater systems was obtained from the Fallon County Growth Policy. The Growth Policy includes information regarding the potential infrastructure requirements necessary to accommodate planned growth associated with the construction of the Keystone XL Pipeline, and namely water and wastewater requirements for the proposed crew camp area. More information is included in Section 3.13, below.

The City of Baker's potable water system includes five city wells, three underground storage tanks (USTs), and water distribution lines throughout the city. The City's water is supplied by the five wells. Potable water is stored in the three buried concrete tanks on an elevated site on the east side of the city (see Section 4.1, below).

The City of Baker wastewater system includes several wastewater treatment lagoons, an irrigation water holding pond, a lift station located near the lagoons, and wastewater collection lines throughout the city. The collection lines connect Baker residences to a main wastewater pipe running east-west along US 12 out to the wastewater lagoons. Wastewater flow from the North Baker Sewer and Water District north of the city along MT 7 also contributes to the wastewater system. An irrigation pipe extends from the westernmost lagoon in a southeasterly direction to Sandstone Road, then travels east over to the golf course and is used for irrigation.

3.13 Relevant Projects and Planning Documents

Projects Occurring in the Study Area
Several planned projects have been identified within the Study Area, some of which have the potential to increase the demands on Baker's existing transportation system. Figure 15 shows the locations of several planned projects; additional information, where available, is provided below.

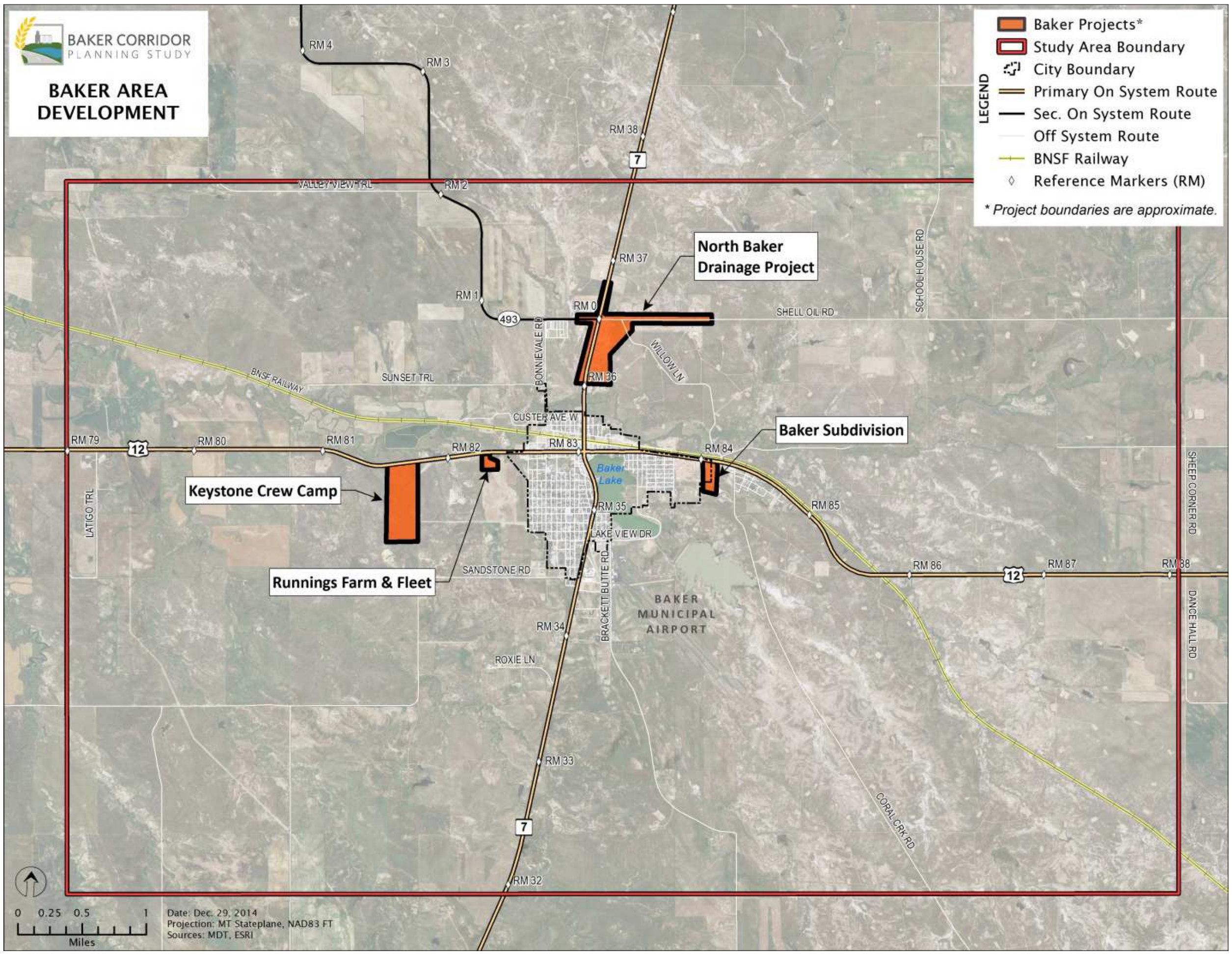

Figure 15: Planned Projects Occurring within the Study Area

NORTH BAKER DRAINAGE PROJECT

The North Baker Drainage Project is a proposed drainage improvement project located north of Baker, centered on the MT 7/S-493/Shell Oil Road intersection. Preliminary plans indicate this project includes roadside ditch improvements and modifications of several approaches to install new culverts and modify existing ones. If improvement options are forwarded from the study in the location of this intersection, consideration and/or coordination of these planned improvements should occur.

BAKER SUBDIVISION

The Baker Subdivision is located west of Baker on US 12. Information is not currently available on the anticipated number of homes to be constructed. This subdivision will create additional traffic on the west side of Baker. If improvement options are forwarded from the study in the location of this planned subdivision, consideration of these planned improvements should occur.

KEYSTONE XL PIPELINE DEVELOPMENT

The proposed Keystone XL Pipeline alignment passes through the western portion of the Study Area in a northwest-southeast direction, crosses US 12 between RM 80 and 81, and continues southeast across MT 7 and outside the Study Area. Figure 16 shows the approximate Keystone

XL pipeline alignment and associated facilities. In addition to the pipeline, the construction of the Bakken Marketlink Project is being proposed, which would consist of piping, booster pumps, meter manifolds, and a tank terminal. It is estimated that the Bakken Marketlink Project could include transport of between approximately 65,000 to 100,000 barrels per day to the Keystone XL Pipeline. The proposal includes a 5-mile pipeline connecting the Baker Tank Farm to the Keystone XL pipeline via the pump station and on ramp facility on S-493/Pennel Road. Based on this proposal, crude oil would be delivered via trucks to collection tank facilities both at the Baker Tank Farm located at approximately RM 74 on US 12 and the proposed tank facility located on S-493/Pennel Road. If built, the planned pipeline improvements could generate substantial traffic due to construction and ongoing use of the facilities.

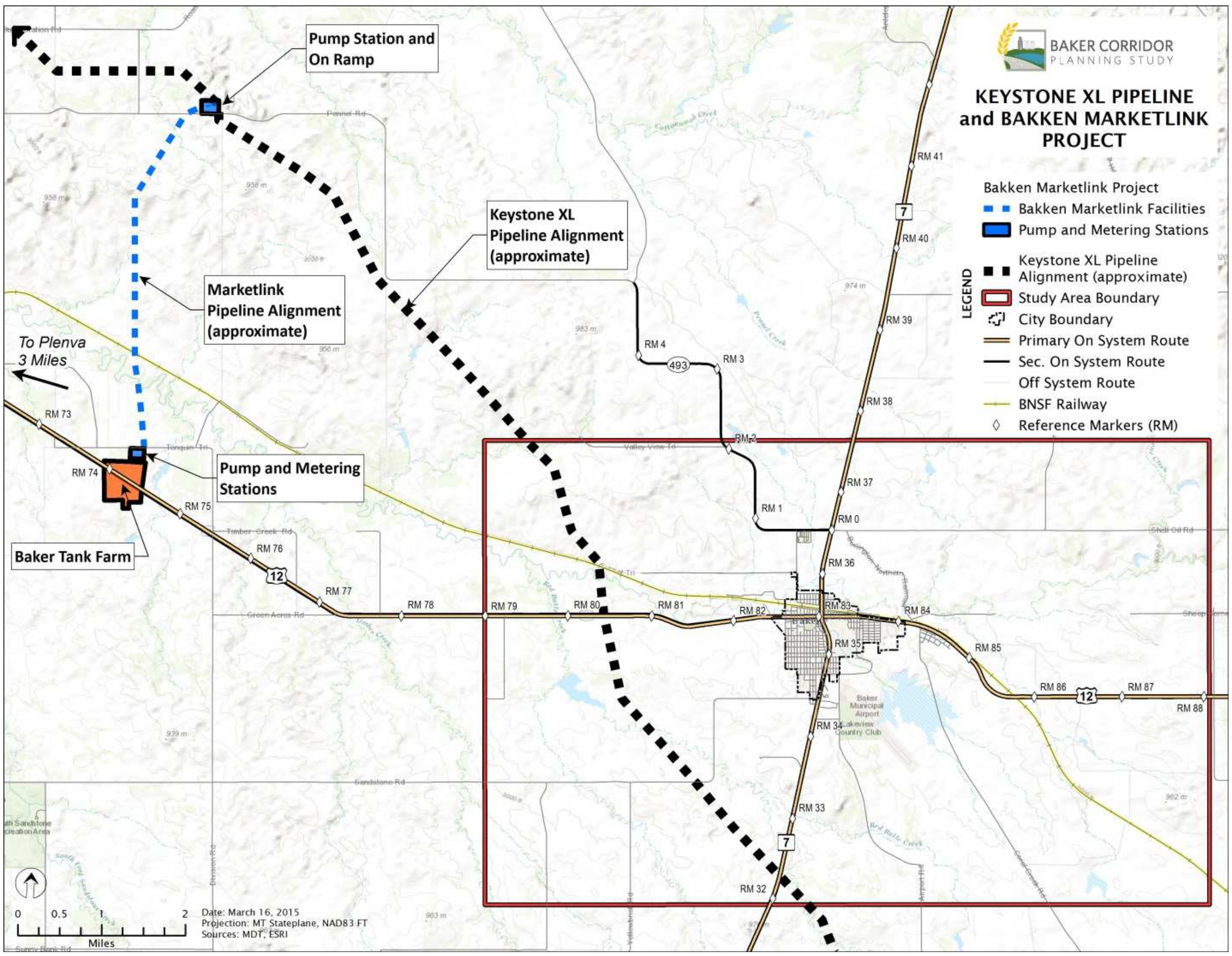

Figure 16: Proposed Keystone XL Pipeline and Bakken Marketlink Project

In anticipation of construction, a workforce camp area (crew camp) and contractor yard is being planned west of Baker immediately south of US 12 from the lagoons to provide a temporary location for housing while workers construct the pipeline. Once construction begins, the crew camp is expected to have a peak camp population of between 995 and 1,165 workers and an average of 500-800 workers over an estimated 6-month construction period spanning several years. Using peak residency numbers, a traffic analysis was conducted that estimated 360 vehicles would be entering/exiting the crew camp onto US 12 on a daily basis during morning/evening shifts. To offset impacts to the transportation system, MDT is requiring warning sign placement near the east/west entrances to the camp on US 12, as well as that the centerline be painted into a double yellow no-passing zone with additional “no passing zone” signage.

Construction of the proposed Keystone XL Pipeline crew camp facility would increase the current demand for water and wastewater service. As specified in the Fallon County Growth Policy, the City of Baker is in negotiations with Keystone XL Pipeline representatives for funds to offset infrastructure impacts generated by the crew camp. The City is seeking $2.5 million to fund the following infrastructure improvements:

- A new water well approximately 2,000 yards west of 6th Street
- A new 250,000-gallon water tank on the east side of the city at the top of a hill
- A fourth cell at the wastewater treatment facility that would function as an evaporation cell
- A 2-mile extension of an 8-inch sewer main to the crew camp site
- A 2-mile extension of a 6-inch water main to the crew camp site

Growth Policy

In 1999, the Montana Legislature revised the growth policy statute (76-1-601 through 76-1-607, MCA), which, among other revisions, set minimum requirements for the content of a local growth policy and to “*provide a framework for implementation activities, including capital improvements planning and subdivision regulation*.” Overall, local adoption of a growth policy creates a tool for community development and for land use planning and decision making within that jurisdiction.

In 2012, Fallon County updated their Growth Policy to include goals, objectives, and policies to facilitate decision-making related to future growth. According to the Growth Plan, the following statement is the community’s vision:

> *“Fallon County’s vision is to retain existing residents, provide amenities that improve quality of life, promote sustainable growth, diversify the local economy to minimize impacts during economic downturns, and mitigate impacts of rapid growth.”*

The Fallon County Growth Policy includes a list of community goals and objectives on a variety of topics that collectively shares their values and concerns over existing conditions and future development within the community. Specific to transportation, the 2012 Growth Policy provides the following specific goals and objectives:

Goals

- Reduce truck traffic levels in the City of Baker.
- Maintain safe streets and roads.
- Minimize disruption of traffic circulation caused by barriers such as the railroad.
- Plan for street and road extensions and preserve adequate right-of-way for such extensions.
- Protect Baker Municipal Airport’s air space.

Objectives

- Improve traffic safety and maintain existing streets and roads.
- Reduce disruptions to traffic circulation resulting from railroad operations.
- Identify and secure sand and gravel resources for future maintenance of county roads.
- Plan for new streets and roads in future growth areas by preserving right-of-way for street and road extensions.
- Maintain existing and future operations at the Baker Municipal Airport.

The Fallon County Growth Policy addresses needed infrastructure improvements to provide services to the west of the city to accommodate the planned Keystone XL Pipeline crew camp facility. The Growth Policy recommends further evaluations to quantify infrastructure requirements and develop design requirements and access management strategies along the US 12 corridor west of Baker.

MDT Highway Projects

According to the MDT 2014 Statewide Transportation Improvement Program, which identifies improvements to the state's transportation system for the period of 2014 to 2018, only one project is located within the Study Area. The Baker - West project (UPN 7948) located on US 12 is a 5.42 mile pavement overlay project beginning at RM 77.2 and was constructed in 2014.

4. Existing Environmental Conditions

This section provides an overview of resources present within the Study Area to determine potential constraints and opportunities for future transportation improvements. Information within this section was obtained from publically available reports, websites, and other available documentation. This information represents a planning-level investigation and is not a detailed environmental analysis.

If improvement options are forwarded from this study into project development, an analysis for compliance with the NEPA and MEPA will be completed as part of the MDT project development process.

4.1 Physical Environment

Soil Resources and Prime Farmland

Soils information was reviewed to determine the presence of prime and unique farmland in the Study Area to demonstrate compliance with the Farmland Protection Policy Act (FPPA). The FPPA is intended "to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses, and to assure that federal programs are administered in a manner that, to the extent practicable, will be compatible with State, unit of local government, and private programs and policies to protect farmland."

The term "farmland" refers to prime farmland; some prime if irrigated farmland; unique farmland; and farmland, other than prime or unique farmland, that is of statewide importance. Prime farmland soils are those that have the best combination of physical and chemical characteristics for producing food, feed, and forage; the area must also be available for these uses. Prime farmland can be either non-irrigated or lands that would be considered prime if irrigated. Farmland of statewide importance is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, forage, and oilseed crops.

Soil surveys of the Study Area are available from the United States Department of Agriculture Natural Resources Conservation Service (NRCS). NRCS soil surveys indicate the presence of farmland of state or local importance, or prime farmland if irrigated within the Study Area. Specifically, areas classified as farmland of state or local importance make up the majority of area within 2 square miles surrounding the City of Baker (refer to Appendix C for more information).

Any forwarded improvement options that require right-of-way within identified farmlands and are supported with federal funds will require a CPA-106 Farmland Conversion Impact Rating Form for Linear Projects completed by MDT and coordinated with NRCS. The NRCS uses information from the impact rating form to keep inventory of the prime and important farmlands within the state.

Geologic Resources

Information on the geology and seismicity in the Study Area came from several published sources. Geologic mapping was reviewed for rock types, the presence of unconsolidated material, and fault lines. The seismicity and potential seismic hazards were also reviewed. This geologic information can help determine potential design and construction issues related to embankments and road design. The following is a brief summary of the geologic and seismic conditions present in the Study Area (refer to Appendix C for more information).

The Study Area covers upland plains dissected by and adjacent to Sandstone Creek. The dominant geologic feature of the area is the Cedar Creek Anticline, which traverses the Study Area from north-northeast to south-southwest, passing just east of the City of Baker. The geologic materials within the Study Area are the Pierre Shale, the Timber Lake, Trail City, and Colgate members of the Fox Hills Formation, the Hell Creek Formation, and the Ludlow member of the Fort Union Formation.

The Pierre Shale, Hell Creek Formation and Fox Hills Formation are Cretaceous-age bedrock consisting of shale, mudstone, siltstone, and sandstone. The Ludlow Member is Paleocene-age bedrock consisting of mudstone, siltstone, and sandstone. The bedrock is generally soft, weathers to bad-land topography, and swelling clays visible at the surface often show a characteristic “popcorn” texture.

These types of soils can create revegetation challenges. The clay heavy soil reacts in extremes to either the lack of or presence of moisture. The design of future projects forwarded from the study should consider including permanent erosion and sediment control (PESC) measures to extent practicable to help the soils stay in place long enough for the plants and grasses to take hold and revegetate the project. Native plant and grass types that can live in soils with high clay content should be chosen.

Improvements brought forward from the study will be subject to more detailed geotechnical analysis. Part of this detailed analysis may involve taking advance borings to evaluate soil characteristics at exact project locations. This is standard procedure for the majority of MDT road projects. The design of any improvements should take into consideration specific requirements that come from the detailed analysis.

Surface Waters

Topographic maps and geographic information system (GIS) data were reviewed to identify the location of surface water bodies such as rivers, streams, lakes, and reservoirs within the Study Area. Listed below and shown on Figure 17 are the primary water bodies within the Study Area.

- Sandstone Creek
- Deep Creek
- Red Butte Creek
- Baker Lake
- Timber Creek

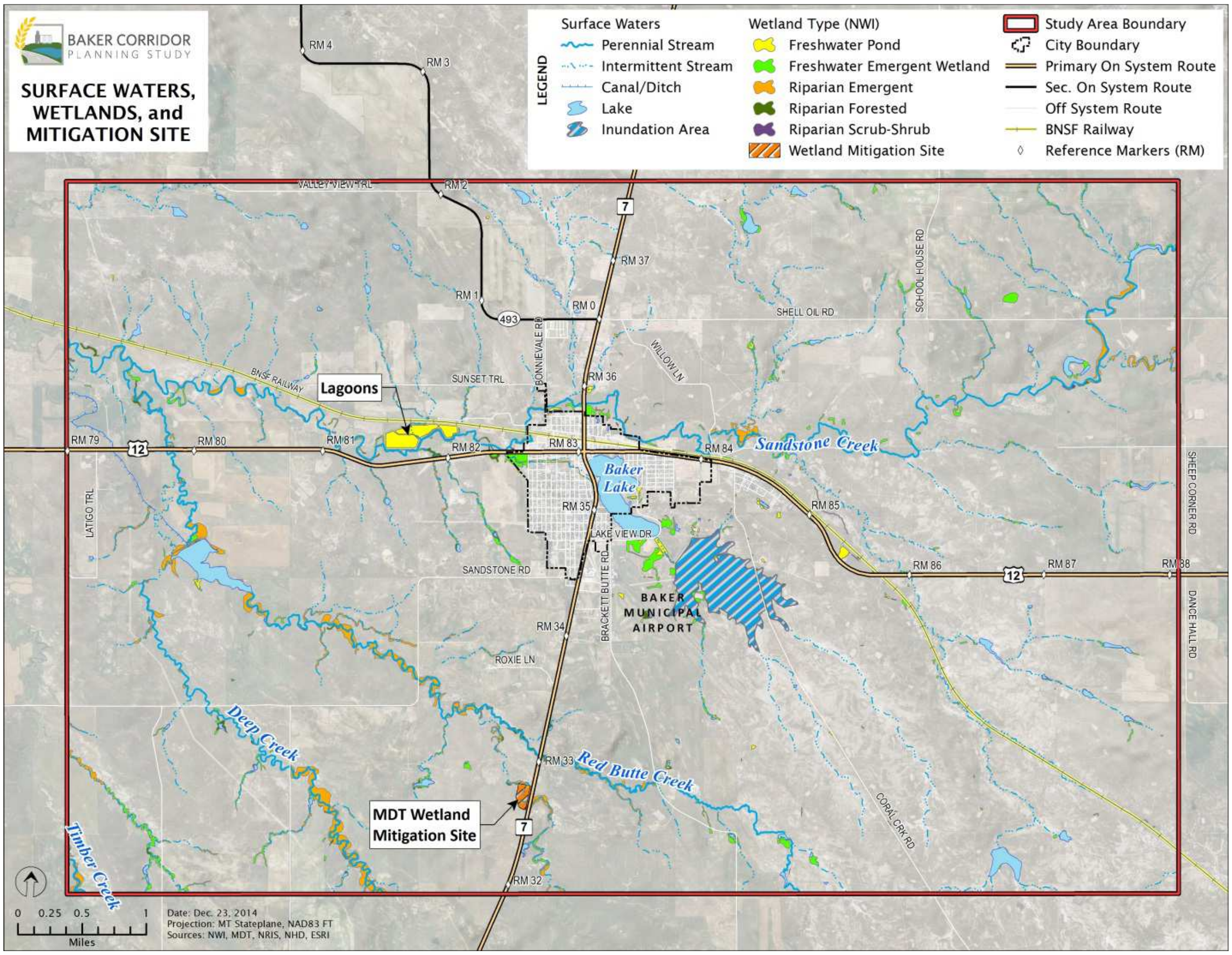

Figure 17: Surface Waters and Wetlands Located within the Study Area

A variety of additional surface waters, including unnamed streams, natural drainages, wetlands, and ponds are present in the Study Area. Impacts to any of these surface waters could occur from improvements such as culverts under the roadway, placement of fill, or rip rap armoring of banks. The United States Army Corps of Engineers (USACE), the Montana Department of Fish, Wildlife and Parks (FWP), and the Montana Department of Environmental Quality (DEQ) all regulate portions of work within surface waters. Coordination with federal, state, and local agencies would be necessary to determine the appropriate permits based on choice of improvement options forwarded from this study. Impacts should be avoided and minimized to the maximum extent practicable. Stream and wetland impacts may trigger compensatory mitigation requirements of the USACE. Construction of forwarded improvement options may trigger the need to obtain coverage under the Montana Pollutant Discharge Elimination System (MPDES) General Permit for Storm Water Discharges Associated with Construction Activity.

TOTAL MAXIMUM DAILY LOADS

The Study Area is located in the Lower Yellowstone Watershed (hydrologic unit code (HUC) 10100005). A search of the DEQ website revealed Sandstone Creek as the only stream on the 303d list within the Study Area (Table 23). Section 303, subsection “d” of the Clean Water Act requires the state of Montana to develop a list, subject to United States Environmental

Protection Agency (USEPA) approval, of water bodies that do not meet water quality standards. When water quality fails to meet state water quality standards, DEQ determines the causes and sources of pollutants in a sub-basin assessment and sets maximum pollutant levels, called total maximum daily loads (TMDL).

TMDLs set by DEQ become the basis for implementation plans to restore water quality to a level that supports State-designated beneficial water uses. The implementation plans identify and describe pollutant controls and management measures to be undertaken (such as best management practices), the mechanisms by which the selected measures would be put into action, and the individuals and entities responsible for implementation projects.

DEQ lists Sandstone Creek as having impairment in the Draft 2014 Integrated 303(d)/305(b) Water Quality Report for Montana. This water body is a Category 5, defined as waters where one or more applicable beneficial uses are impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat. Sandstone Creek is in the O'Fallon TMDL area, but at this time, the TMDL is not completed. One probable source of impairment is agriculture. The other is municipal point source discharges, which could be a result of release of water from wastewater treatment systems. Additionally, the Fallon Growth Policy notes watering of the golf course uses water from the sewage treatment plant. Highway construction and ongoing transportation corridor use are not likely contributors to nitrogen loading in Sandstone Creek, so the nitrogen impairment is unlikely to trigger design modification for future roadway projects. That said, if improvement options are advanced, it will be necessary to reconsider DEQ TMDL standards and potential impacts to water quality within receiving streams and watersheds in the Study Area.

Table 23: 303(d) Listed Streams in Study Area

Named Stream	Quadrant[1]	Category	Possible Impairment	Beneficial Uses
Sandstone Creek	N 1/2	5	Nitrate/Nitrite, Nitrogen(total)	Primary Contact Recreation, Aquatic Life

[1]Quadrants of Study Area used as approximation of location because Study Area is rectangular.

WILD AND SCENIC RIVERS

The Wild and Scenic Rivers Act, created by Congress in 1968, provided for the protection of certain rivers, and their immediate environments, that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, or cultural resources, or other similar values. Based on a review of the United States National Park Service website, none of the waterways within the Study Area carry the wild and scenic designation.

SEWAGE TREATMENT PONDS

Between RM 81 and RM 82 on the north side of US 12 is the City of Baker's three-pond wastewater treatment system. The Fallon Growth Policy noted that the City of Baker is seeking funding to expand this wastewater treatment system by adding an evaporation pond and possible expansion of the other ponds. Construction is currently underway on those improvements. Impacts to the wastewater treatment system should be avoided, as it will involve extra costs and possible land acquisition to offset associated impacts.

Groundwater

According to the Montana Bureau of Mines and Geology Groundwater Information Center, there are 1,682 wells on record in Fallon County. Some of these wells are located within the Study Area. The newest well on record is from July 16, 2014, and the oldest well on record is from October 1900. Approximately one-third (492) of the wells within Fallon County are at a depth of 0 to 99 feet. There are three statewide monitoring network wells in Fallon County. The wells in Fallon County have widely varying uses, with stockwater wells being the most common, followed by domestic wells.

The City of Baker has five public water supply wells ranging in depth 613 to 680 feet and three potable water USTs ranging in size from 100,000 gallons to 200,000 gallons (see Figure 18). Four of the wells are located on the northwest edge of Baker; the fifth well is on the southwest edge of town where the three USTs are similarly located. Public water supply wells have setbacks to ensure the wells are not contaminated. The typical setback is a 100-foot isolation zone inside which there should be no source of pollutant. The public water supply wells and underground potable water storage tanks are areas to be avoided during future project development.

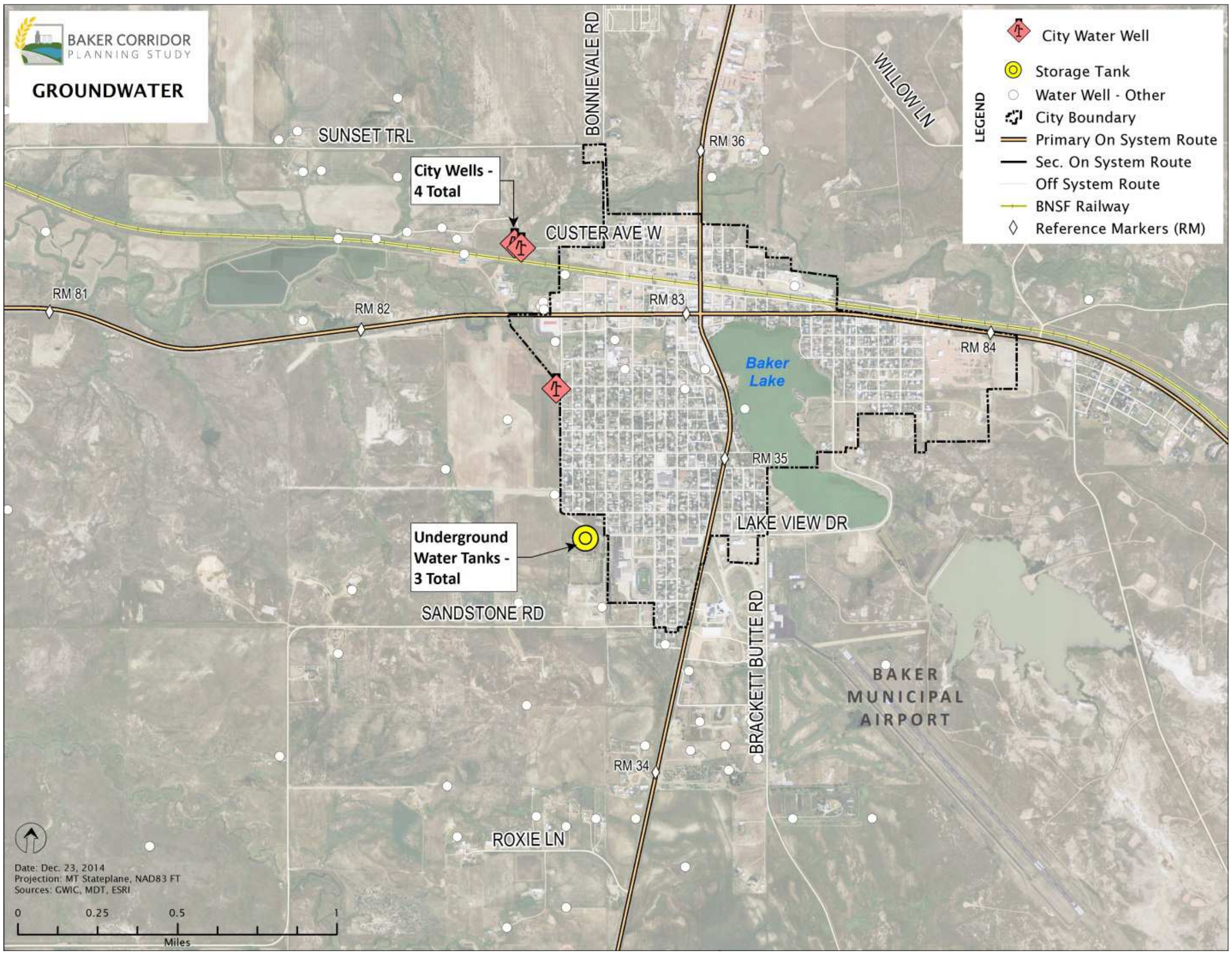

Figure 18: Groundwater Resources within the Study Area

Impacts to the municipal drinking water system should be avoided, as they will involve extra costs and possible land acquisition to offset associated impacts. Impacts to existing domestic wells will also need to be considered if improvement options are forwarded from the study.

Wetlands

The USACE defines wetlands as “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” Wetlands generally include swamps, marshes, bogs, and similar areas.

United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping data are available for this area from the NWI website or the Montana Natural Resource Information System (NRIS) (see Figure 17). The potential wetland areas identified within the Study Area are primarily along Sandstone Creek and in the areas surrounding Baker Lake. An MDT wetland mitigation site was created in 2010 as mitigation for unavoidable wetland impacts resulting from two MDT projects: Baker – South, and Junction S-322 – South. This site is located along MT 7 south of Baker (at Township 7 North, Range 59 East, Section 26; Latitude

46.3291, Longitude -140.2854). The MDT wetland mitigation site is currently not an USACE-approved mitigation bank.

The NWI database provides a planning-level assessment on probable wetlands within the Study Area. These maps are based on the USFWS definition of wetlands, which does not follow the USACE definition that MDT uses in wetland determination and delineation. NWI maps are typically generated based on aerial and satellite imagery, and are not suitable for MDT project wetland determination and/or delineation.

Future wetland delineations would be required if improvement options are forwarded from the study that could potentially impact wetlands. Future projects in the Study Area would need to incorporate project design features to avoid and minimize adverse impacts to wetlands to the maximum extent practicable. Unavoidable impacts to wetlands must be compensated through mitigation in accordance with the USACE regulatory requirements and/or requirements of Executive Order 11990. Work within jurisdictional wetlands would require a Clean Water Act 404 permit from the USACE. If required, mitigation for improvement options forwarded from the study would not be able to use mitigation credits from the MDT wetland mitigation site until approved by the USACE and would rather need to address mitigation separately for each project constructed.

Floodplains and Floodways

Executive Order 11988, Floodplain Management, requires federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities" for the following actions:

- Acquiring, managing, and disposing of federal lands and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements; and
- Conducting federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulation, and licensing activities.

Federal-aid Policy Guide, 23 Code of Federal Regulations (CFR) 650, Bridges, Structures, and Hydraulics, provides “policies and procedures for the location and hydraulic design of highway encroachments on floodplains, including direct Federal highway projects administered by the [Federal Highway Administration (FHWA)].” This document defines “base flood” as the “flood or tide having a 1-percent chance of being exceeded in any given year” and “base flood plain” as the “area subject to flooding by the base flood.”

Federal Emergency Management Agency-issued flood maps for Fallon County indicate that four floodplain zones exist within the Study Area. Refer to Figure 19 for a depiction of mapped floodplains within the Study Area.

In 1985, the U.S. Department of Agriculture Soil Conservation Service prepared the *Sandstone Creek and Tributaries Flood Plain Management Study*. This report is a detailed study with defined flood elevations of Sandstone Creek through the City of Baker and created the regulated floodplain boundaries currently used by the Fallon County Floodplain Administrator.

Any improvement option(s) forwarded from this study would need to ensure impacts to the floodplain and Sandstone Creek are minimized. Modifications to the floodplain would involve additional project time and cost to the extent that map revisions are required.

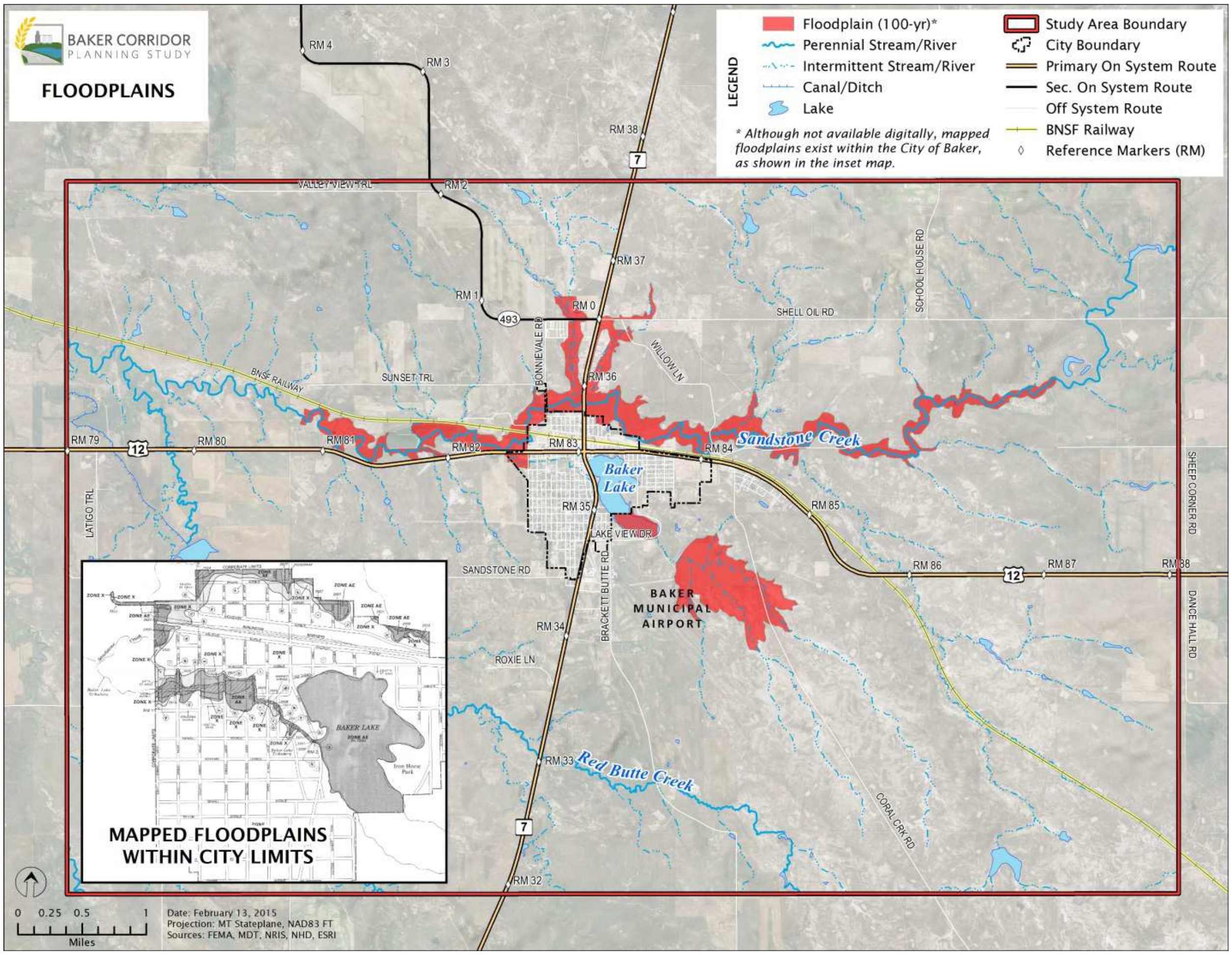

Figure 19: Mapped Floodplains within Study Area

Potential roadway improvements or new alignments occurring to the north of Baker have potential to affect the mapped floodplain for Sandstone Creek. Roadway development involving placement of fill within the regulatory floodplain would require a floodplain permit, necessitating coordination with the Fallon County Floodplain Administrator to minimize floodplain impacts and obtain necessary floodplain permits for project construction.

Irrigation

Irrigated agriculture land exists in Fallon County within the Study Area. Improvement options forwarded from this study have the potential to impact irrigation facilities. Impacts to irrigation facilities should be avoided when feasible, due to the additional costs (above typical project costs) associated with the redesign or relocation of the irrigation structure(s). Future modifications to existing irrigation canals, ditches, or pressurized systems could require consultation with the owners to minimize impacts to agricultural operations.

The Water Resources Survey map indicates the presence of one historical private irrigation system and ditch in the Study Area (refer to Appendix C for more information). More information is presented in Section 4.3, Recreational, Cultural and Historic Resources, below.

Air Quality

The USEPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, including carbon monoxide, nitrogen dioxide, ozone, particulate matter (PM10 and PM2.5), sulfur dioxide, and lead. The USEPA designates communities that do not meet NAAQS as “non-attainment areas.” States are then required to develop a plan to control source emissions and ensure future attainment of NAAQS. The Study Area is not located in a non-attainment area for any of the criteria pollutants. Additionally, there are no non-attainment areas nearby. As a result, special design considerations will not be required in future project design to accommodate NAAQS non-attainment issues.

Depending on the scope of improvements considered in the Study Area, an evaluation of mobile source air toxics (MSATs) may be required. MSATs are compounds emitted from highway vehicles and off-road equipment, which are known or suspected to cause cancer or other serious health and environmental effects.

Hazardous Substances

The NRIS database provides information on UST sites, leaking underground storage tank (LUST) sites, abandoned mine sites, remediation response sites, landfills, National Priority List sites, hazardous waste, crude oil pipelines, and toxic release inventory sites. The following is a brief summary of the primary sites within the Study Area that could impact potential future improvements and may require additional investigation or remediation (refer to Appendix C for more information).

UNDERGROUND STORAGE TANKS

Twenty-six individual USTs were identified within the Study Area. These USTs are registered to various businesses and entities in Baker, including the BNSF Railway, Fueling Facilities, and the Baker Municipal Airport. The majority of the active USTs are located within the city limits of Baker. There are two closed USTs outside the city limits of Baker. Additional investigation regarding the precise locations of the USTs may be necessary depending on the improvement options forwarded from this study.

LEAKING UNDERGROUND STORAGE TANKS

Six active and 10 inactive LUST sites were identified within the Study Area, most of which are within city limits. One inactive LUST site is noted to exist outside of the City of Baker. This location is immediately southwest of RM 37 on MT 7, north of Baker. If a project were to occur in close proximity to this site, or to the City of Baker itself, then further review or potential soil investigation may be necessary. Many of these LUST sites are Petroleum Tank Release

Cleanup Fund (PetroFund) sites. If LUSTs or contaminated soils are encountered, further investigation and possible remediation may be necessary. This could create additional costs associated with a forwarded improvement.

MINE SITES

The NRIS database identifies one abandoned mine site southwest of the intersection of US 12 and MT 7. There is the potential for other abandoned mine sites not currently listed in the NRIS database to exist southwest of Baker. If improvements are forwarded from the study, an on-the-ground field survey will be required to determine if the listed mine still exists and if other abandoned mines are present in the area of possible projects. If an abandoned mine site is located, additional investigation of the soils in this area may be necessary to determine if contamination exists.

The DEQ database identifies one opencut mining site southwest of Baker. The Fallon County Road Department is the permit holder of this opencut mining site.

If there are proposed improvements in the areas near a mine, there is the potential for impacts to project design and construction, and additional investigation may be necessary.

CRUDE OIL PIPELINE

The NRIS database identified one crude oil pipeline in the northwest corner of the Study Area (see Figure 20), but does not currently include detailed information on the pipeline. Considering the amount of oil and gas well development throughout the Study Area, it is probable that other sections of unmapped pipeline exist connecting the oil and gas wells to storage tanks and other facilities. If improvements are proposed in this area, additional research and coordination will be needed to identify any potential conflicts with the pipeline, and on-the-ground site visits and coordination with oil and gas well owners may be necessary.

OIL AND GAS PRODUCTION WELLS

Oil and gas development exists in the Study Area. Three oil and gas formations (Cedar Creek, Pennel, and Lookout Butte) are oriented slightly northwest-southeast and encompass the entire eastern Study Area. These formations contain hundreds of oil and gas wells and associated oil and gas infrastructure (see Figure 20). If future improvements occur in the eastern half of the Study Area, consideration should be given to avoid oil and gas infrastructure where practicable. If projects brought forward from the study occur in close proximity to the oil and gas wells, this would likely warrant additional soil investigations and coordination with oil and gas well owners to determine if contaminated soils are present.

HAZARDOUS WASTE HANDLERS

The DEQ data mapper depicts three hazardous waste handling facilities within the Study Area. They are as follows:

- One facility located in the town of Baker is listed as inactive and a conditionally exempt small-quantity generator;
- One facility located north of Baker on Shell Oil Road is listed as active and a conditionally exempt small-quantity generator;

- One facility located north of Baker on MT 7, immediately south of RM 37 (Nalco Company Baker Warehouse) is listed as active and a large-quantity generator.

It is unlikely that these facilities will impact projects forwarded from the study; however, if construction activities were to occur in close proximity to the Nalco Company Baker Warehouse, a soil investigation could be necessary to determine if contaminated soils are present. A soil investigation would incur additional costs above normal project expenditures. If contaminated soils are present, a special provision regarding handling contaminated soils would be recommended to be included in project documentation.

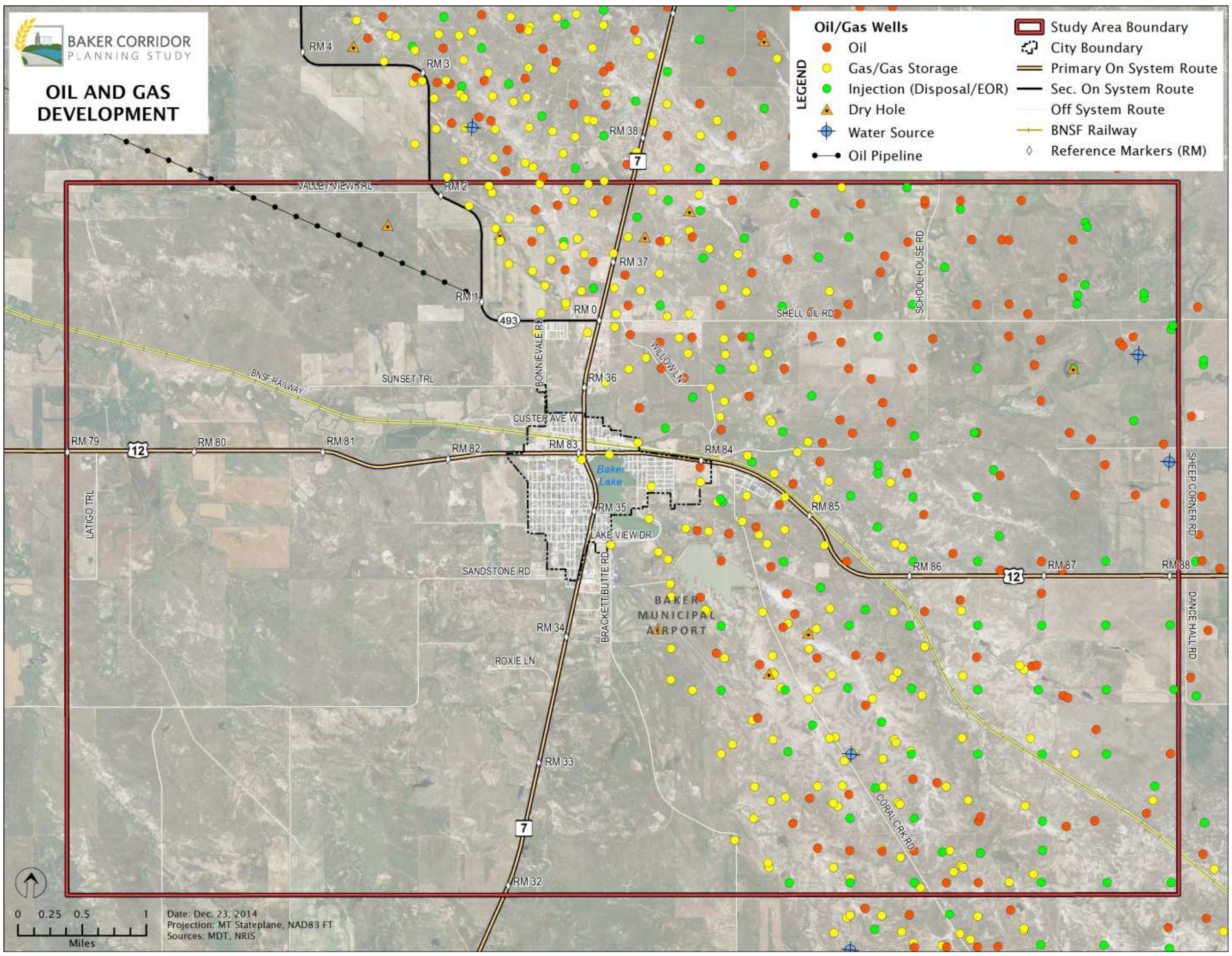

Figure 20: Oil and Gas Development within the Study Area

4.2 Biological Resources

Vegetation

A combination of Great Plains Mixedgrass Prairie, Cultivated Crops, and Big Sagebrush Steppe habitat dominate the land cover near the Study Area (refer to Appendix C). The majority of land coverage within the Study Area is Great Plains habitat, with a few other land cover types interspersed. Table 24 presents land cover listed by the Montana National Heritage Program (MNHP) for Fallon County.

Table 24: Fallon County Land Cover

Land Cover Type	% of Cover
Great Plains Mixedgrass Prairie	46
Big Sagebrush Steppe	16
Cultivated Crops	16
Great Plains Sand Prairie	7
Pasture/Hay	5
Great Plains Badlands	4
Great Plains Riparian	4

Source: MNHP, 2014

If improvement options are forwarded from the study, practices outlined in MDT standard specifications should be followed to minimize adverse impacts to vegetation and facilitate establishment of final stabilization of disturbed areas. Removal of mature trees and shrubs should be limited to the extent practicable.

NOXIOUS WEEDS

Noxious weeds can degrade native vegetative communities, damage riparian areas, compete with native plants, create fire hazards, degrade agricultural and recreational lands, and pose threats to the viability of livestock, humans, and wildlife. Areas with a history of disturbance, such as highway rights-of-way, are at particular risk of weed encroachment. The Invaders Database System lists 49 exotic plant species and 17 noxious weed species in Fallon County, some of which may be present in the Study Area. Fallon County has created a weed control plan that lists 26 noxious weed species as present in Fallon County.

Reseeding of disturbed areas with desirable native plant species will help to reduce the spread and establishment of noxious weeds and to re-establish permanent vegetation. If improvements are forwarded from the study, field surveys for noxious weeds should take place prior to any ground disturbance. In addition, coordination with the Fallon County Weed Board should occur.

General Wildlife Species

MAMMALS

The Study Area is home to a variety of mammal species, including white-tail deer, mule deer, pronghorn antelope, and coyote. Other common mammals potentially occurring in the Study Area include mountain lion, raccoon, striped skunk, badger, bobcat, red fox, beaver, muskrat, long-tailed weasel, white-tailed jackrabbit, western harvest mouse, deer mouse, and prairie vole. If improvement options are forwarded from the study, the need for and viability of wildlife crossing mitigation measures should be explored during the project development process.

AMPHIBIANS AND REPTILES

The MNHP Natural Heritage Tracker database records and maps documented observations of species in a known location. A review of the database was conducted for amphibian species known to occur within the Study Area. Species include, but are not limited to, the following:

- boreal chorus frog
- northern leopard frog

- barred tiger salamander
- greater short-horned lizard
- snapping turtle
- painted turtle
- gopher snake
- prairie rattlesnake
- terrestrial garter snake
- western hog-nosed snake

Any improvements forwarded from the study should take into consideration and minimize impacts to amphibian and reptile habitat where practicable.

BIRDS

The MNHP Natural Heritage Tracker database indicates there are more than 140 species of birds documented with the potential to occur and nest in the Study Area. These species include representative songbirds, birds of prey, waterfowl, owls, and shorebirds.

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA). Under this strict liability law, it is unlawful to pursue, hunt, take, capture, or kill; attempt to take, capture, or kill; possess, offer to or sell, barter, purchase, deliver, or cause to be shipped, exported, imported, transported, carried, or received any migratory bird, part, nest, egg, or product, manufactured or not. Direct disturbance of a nest occupied with birds or eggs is prohibited under the law. The destruction of unoccupied nests of eagles; colonial nesters such as cormorants, herons, and pelicans; and some ground/cavity nesters such as burrowing owls or bank or cliff swallows may also be prohibited under the MBTA.

Data searches revealed that currently there are no known bald eagle or golden eagle nests within the Study Area. The Great Plains riparian habitat is a known ecological system associated with the golden eagle. Bald and golden eagles are protected under the MBTA and managed under the Bald and Golden Eagle Protection Act, which prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle or golden eagle, alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

Any improvements forwarded from this study should consider potential constraints that may result from nesting/breeding periods of migratory birds and presence of unknown or future bald and golden eagles nests. One of the constraints on projects is that any work involving the disturbance or removal of trees or structures associated with nesting birds will need to schedule this work to take place outside the typical nesting season of April 15 to August 15.

FISHERIES

There are only two aquatic resources listed as possessing warm water fishery resources in the Study Area (see Figure 17, above). Table 25 lists fisheries information for named streams within the Study Area.

Table 25: Fisheries Data

Named Stream within Study Area	Quadrant[1]	Fish Species Present
Sandstone Creek	N ½	Black Bullhead, Fathead Minnow, Yellow Perch, Common Carp, White Sucker, River Carpsucker, Green Sunfish, Sand Shiner, Emerald Shiner, Brassy Minnow, Western Silvery/Plains Minnow, Channel Catfish, Creek Chub, Flathead Chub, Goldeye, Lake Chub, Longnose Dace, Northern Pike, Shorthead Redhorse, Stonecat, Brassy Minnow, Brook Stickleback
Baker Lake	Center	Black Bullhead, Black Crappie, Fathead Minnow, Largemouth Bass, Northern Pike, Yellow Perch

Source: FWP Montana Fisheries Information System (MFISH), 2014.
[1]Quadrants of Study Area used as approximation of location because Study Area is rectangular.

Fish passage and/or barrier opportunities should be considered at affected drainages if improvements are forwarded from this study. Per FWP recommendation, culverts should be sized to span the bankfull channel width on fish-bearing streams. Culverts should also be embedded a minimum of 20% of the culvert rise. Studies have shown that culverts embedded at least 20% reduce the potential for the culvert to become a barrier to fish movements. Permitting from regulatory agencies for any future improvements may also require incorporation of additional design measures to facilitate aquatic species passage.

CRUCIAL AREAS PLANNING SYSTEM

The FWP Crucial Areas Planning System (CAPS) is a resource intended to provide non-regulatory information during early planning stages of projects, conservation opportunities, and environmental review. The finest data resolution within CAPS is at the square-mile section scale or water body. Use of these data layers at a more localized scale is not appropriate and may lead to inaccurate interpretations since the classification may or may not apply to the entire square-mile section. The CAPS system was consulted to provide a general overview of the Study Area. CAPS results are presented in Appendix C.

The online CAPS mapping tool provides FWP general recommendations and recommendations specific to transportation projects for both terrestrial and aquatic species and habitat. These recommendations can be applied generically to possible future improvements carried forward from the study.

Threatened and Endangered Species

The USFWS maintains the federal list of threatened and endangered (T&E) species. Species on this list receive protection under the Endangered Species Act (ESA). An “endangered” species is in danger of extinction throughout all or a significant portion of its range. A “threatened” species is likely to become endangered in the foreseeable future. The USFWS also maintains a list of species that are candidates or proposed for possible addition to the federal list. According to the USFWS, five threatened, endangered, proposed, or candidate species are listed as occurring in Fallon County (see Table 26).

Table 26: Threatened and Endangered Species in Fallon County

Species	Status
Greater Sage-Grouse[2]	Candidate
Sprague's Pipit	Candidate
Red Knot	Threatened
Whooping Crane	Endangered
Northern Long-eared Bat	Proposed

Source: USFWS, 2015.

According to the MNHP Natural Heritage Map Viewer database (report generated August 20, 2014), which records and maps documented observations of species in a known location, only the greater sage-grouse and the Sprague's pipit have been recorded within the boundaries of the Study Area.[2] Therefore, it is reasonable to presume that suitable habitats for these species may be present within the Study Area. If improvements are forwarded from the study, an evaluation of potential effects to T&E species will need to be completed during the project development process. As the federal status of protected species changes over time, reevaluation of the listed status and afforded protection to each species should be completed prior to issuing a determination of effect relative to potential impacts.

Species of Concern

Montana species of concern (SOC) are native plants or native animals breeding in the state that are considered to be "at risk" due to declining population trends, threats to their habitats, and/or restricted distribution. Designation of a species as a Montana SOC is not a statutory or regulatory classification. Instead, these designations provide a basis for resource managers and decision-makers to direct limited resources to priority data collection needs and address conservation needs proactively. Each species is assigned a state rank that ranges from S1 (greatest concern) to S5 (least concern). Other state ranks include SU (unrankable due to insufficient information), SH (historically occurred), and SX (believed to be extinct). Modifiers, such as B (breeding) or N (non-breeding), may follow state ranks.

A search of the MNHP species of special concern database (report generated August 19, 2014) revealed four SOC and four potential SOC in Fallon County (Table 27). These eight species have the potential to occur in the Study Area based on presence of suitable habitat (refer to Appendix C for more information).

[2] On September 22, 2015 the U.S. Fish and Wildlife Service determined that the protection for the greater sage grouse under the Endangered Species Act is no longer warranted and is withdrawing the species from the candidate species list. MDT will continue to follow the stipulations for the conservation of the greater sage grouse contained in the State of Montana – Office of the Governor – Executive Order No. 12-2015 "Executive Order Amending and Providing for the Implementation of the Montana Sage Grouse Conservation Strategy."

Table 27: Species of Concern Overlapping the Study Area

Animal Subgroup	Common Name	State[1] Rank	Habitat Description
Birds	Greater Sage-grouse	S2	Sagebrush
	Baird's Sparrow	S3B	Grasslands
	Brewer's sparrow	S3B	Sagebrush
	Chestnut-collard Longspur	S2B	Grasslands
Fish	Brook Stickleback	S4	Small prairie rivers
	Brassy Minnow	S4	Small prairie rivers
	Plains Minnow	S4	Small prairie rivers
	Creek Chub	S4	Small prairie rivers

Source: MNHP, 2014.
[1] State rank definitions are located in Appendix C.

In addition to being a state species of concern, the greater sage-grouse is currently a candidate species for inclusion on the list of threatened and endangered species by the USFWS. The USFWS has a website dedicated solely to the greater sage-grouse (sage grouse). The status of this species will be amended once USFWS biologists have made a final determination.

Montana's governor, Steve Bullock, established by Executive Order the Greater Sage-Grouse Habitat Conservation Advisory Council on February 2, 2013. The purpose of the Council was "to gather information, furnish advice, and provide to the governor recommendations on policies and actions for a state-wide strategy to preclude the need to list the greater sage-grouse under the ESA" by no later than January 31, 2014. The Council was co-chaired by FWP Director, Jeff Hagener, and the governor's Natural Resources Policy Advisor, Tim Baker. Council members included representatives from agriculture and ranching, conservation and sportsmen, energy, mining and power transmission, tribal government, local government, and the legislature. The Council has concluded its work and provided recommendations to the governor's office in the form of a "Montana Strategy to address threats to the sage-grouse in Montana" (refer to Appendix C for more information). This plan should be taken into consideration if habitat for the greater sage-grouse could be impacted.

According to the MNHP, a portion of the sage grouse Cedar Creek Core Area extends into the Study Area, as well as there being several sage grouse leks outside of core habitat that surround the Study Area. A 2014 USGS report evaluating lek buffer distances indicates an effective buffer range of 3.1 to 5 miles for both surface disturbance and linear features. Impacts to sage grouse, including core and non-core habitats, should be minimized and avoided to the extent practicable.

Other sensitive species, including golden eagles, are not listed here, but have the potential to occur within the Study Area. Available literature identifies no nests currently existing within the Study Area. A thorough field investigation for the presence and extent of these species should be conducted if improvement options are forwarded from this study. If present, special conditions to the project design or during construction should be considered to avoid or minimize impacts to these species.

4.3 Recreational, Historical, and Cultural Resources

Recreational Resources

The Baker area offers a variety of year-round activities, including fishing, boating, and swimming at Baker Lake in the summer. In the winter, snowmobiling, ice-skating, and cross-country skiing take over Baker Lake and the surrounding area. Recreation areas within the Study Area include a collection of city parks within the City of Baker, Fallon County Rifle Range & Trapshoot facility to the southwest of town, and a public golf course.

Recreational resource information was gathered through review of both United States Forest Service and FWP resource lists for Fallon County, and the Fallon County Growth Policy. Table 28 lists publically owned recreational resources identified in the Study Area.

Table 28: Recreational Resources

Resource
Mangold Sports Complex
Triangle Park
Iron Horse Park
Senior Citizens Centennial Park
Eastside Park
Fallon County Fairgrounds
County Golf Course
Steve McClain Memorial Park
Baker Lake Recreation Area

Source: Fallon Growth Policy, 2012.

These recreational areas may be protected under Section 4(f) of the U.S. Department of Transportation Act of 1966, which was enacted to protect publically owned parks, recreation areas, wildlife and waterfowl refuges, and public and private historic sites of local, state, and national significance. Federally funded transportation projects cannot impact Section 4(f)-protected properties unless there are no feasible or prudent avoidance alternatives, and all possible planning to minimize harm has occurred. Prior to approving a project that "uses" a Section 4(f) resource, FHWA must find that there is no prudent or feasible alternative that completely avoids the 4(f) resource. "Use" can occur when land is permanently incorporated into a transportation facility or when there is a temporary occupancy of the land that is adverse to a Section 4(f) resource. Constructive "use" can also occur when a project's proximity impacts are so severe that the protected activities, features, or attributes that qualify a resource for protection under Section 4(f) are "substantially impacted." Potential effects on recreational use would need to be considered in accordance with Section 4(f) if improvements are forwarded from this study. Recreational resources potentially protected under Section 4(f) are shown in Figure 21.

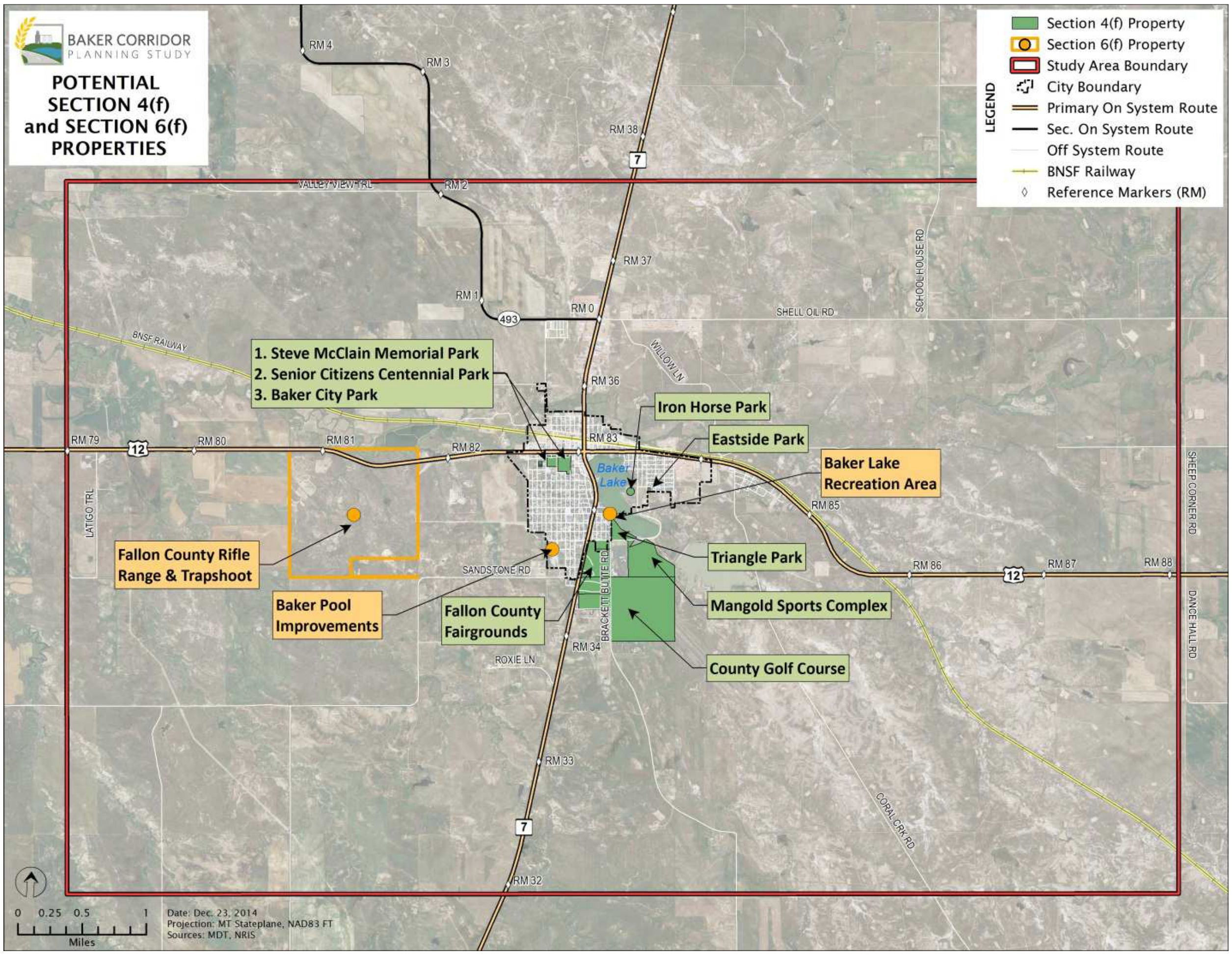

Figure 21: Potential Section 4(f) and 6(f) Properties Located within the Study Area

From a high-level evaluation, some of the resources listed in Table 28 may not being considered Section 4(f) resources, yet it is apparent from the Fallon Growth Policy and the high amount of recreational programs that the City of Baker places a high value on its recreational resources. Efforts should be made with projects advanced from the study to avoid adverse impacts to or right-of-way acquisitions from community recreational resources.

The National Land and Water Conservation Fund Act (LWCFA), or Section 6(f), was enacted to preserve, develop, and assure the quality and quantity of outdoor recreation resources. Section 6(f) protection applies to all projects that impact recreational lands purchased or improved with LWCFA funds. The Secretary of the Interior must approve any conversion of LWCFA property to a use other than public, outdoor recreation. According to FWP LWCFA Sites by County, there are three distinct Section 6(f) resources located within the Study Area: Baker Lake Recreation Area, Baker Pool Improvement, and the Fallon County Rifle Range & Trapshoot facility (see Figure 21 above). The Baker Lake Recreation Area includes the Baker Pool improvement and two other LWCFA improvements within the boundaries of Baker Lake Recreation Area. All the 6(f) and the possible 4(f) resources except the Fallon County Rifle Range & Trapshoot facility are inside the city limits of Baker, most likely not making them a concern to forwarded improvements. It could be difficult and time-consuming to convert these resources to non-recreational purpose properties, and should be avoided if practicable.

Cultural Resources

For federally funded transportation projects, a cultural resource survey must be conducted for the area of potential effect as specified in Section 106 of the National Historic Preservation Act (36 CFR 800). Section 106 requires federal agencies to “take into account the effects of their undertakings on historic properties.” The purpose of the Section 106 process is to identify historic and archaeological properties that could be affected by the undertaking; assess the effects of the project; and investigate methods to avoid, minimize, or mitigate adverse effects on historic properties. These historic resources properties are also generally afforded protection under Section 4(f) of the Transportation Act.

A file search through the Montana State Historic Preservation Office revealed approximately 25 historic or archaeological properties located within the Study Area (refer to Appendix C for more information). Historic buildings, bridges, a railroad line, pre-contact buried campsites, and lithic scatters are all located in the area. These sites represent a small percentage of the archaeological sites and historic properties that can be expected within the Study Area boundaries. Because the Baker area has had minimal ground surveys to date, the current data of known archaeological and historical resources within the Study Area are likely incomplete. On-the-ground archaeological field inventories would be necessary to locate cultural resources within the Study Area or a project-specific location. Direct and indirect impacts (such as visual, noise, and access impacts) to eligible or listed properties would need to be considered if improvements options are carried forward.

The Water Resources Survey map (refer to Appendix C for more information) indicates the presence of one historical private irrigation system and ditch in the Study Area. The private irrigation system and the Munsell ditch shown on the Water Resources Survey map may be historic. At this time, not enough information is known about either the private irrigation system or the Munsell ditch, and a field investigation would be necessary to determine National Register of Historic Places (NRHP) eligibility. If eligible for the NRHP, then efforts must be made to avoid or minimize impacts to the private irrigation system and the Munsell ditch.

4.4 Noise

Evaluation of traffic noise may need to occur for any future improvements in the Study Area. Noise analysis is necessary for “Type I”-classified projects. A Type I project includes a substantial shift in the horizontal or vertical alignments, increasing the number of through lanes, providing passing lanes, or increasing traffic speed and volume.

Type I projects require a detailed noise analysis, consistent with FHWA requirements and MDT policy, which includes measuring ambient noise levels at selected receivers and modeling design year noise levels using projected traffic volumes. If noise levels approach or substantially exceed noise abatement criteria for the project, noise abatement measures may be necessary. A number of possible abatement measures available for consideration include, but are not limited to, the following:

- Alternating the horizontal or vertical alignment;
- Constructing noise barriers such as sound walls or earthen berms; and/or
- Decreasing traffic speed limits.

Noise abatement measures must be considered reasonable and feasible prior to implementation.

Construction activities in the Study Area may cause localized, short-duration noise impacts. These impacts can be minimized by using standard MDT specifications for the control of noise sources during construction.

4.5 Visual Resources

The visual resources of an area include landforms, vegetation, water features, and physical modifications caused by human activities that give the landscape its visual character and aesthetic qualities. Visual resources are typically assessed based on the landscape character (what is seen), visual sensitivity (human preferences and values regarding what is seen), scenic integrity (degree of intactness and wholeness in landscape character), and landscape visibility (relative distance of seen areas) of a geographically defined view shed.

Baker is on the eastern edge of Montana, and the surrounding area is fields and rolling hills with sandstone outcroppings. There are minimal view-obstructing man-made items other than the City of Baker itself. To the north and east of Baker, oil rigs dot the horizon. As a whole, the landscape in the Study Area presents itself as a natural prairie/sagebrush environment with scattered agricultural fields and minimal urbanization. Evaluation of the potential effects on visual resources would need to be conducted if improvement options are forwarded from this study.

5. Areas of Concern

The following section provides a summary of the areas of concern identified within the Study Area. The areas of concern were identified through review of as-built drawings, MDT databases, public databases, field review, and other available resources, and are described more thoroughly in the sections above.

5.1 Transportation System Areas of Concern

Level of Service

Based on a low-growth traffic scenario and existing geometric configurations, the intersection of US 12 and MT 7 will operate at a failing level of service (LOS F) in the future. Also under the low-growth scenario, the intersection of MT 7/S-493/Shell Oil Road will be operating at a LOS D in the future. Medium- and high-growth traffic scenarios show that both intersections are predicted to fail under existing geometric configurations.

Horizontal Alignment

One curve located on S-493 does not meet the current minimum radius per MDT design standards for level terrain. Ten curves failed to meet current design standards for horizontal stopping sight distances.

Vertical Alignment

One curve located north of Baker at RM 37.10 does not meet current MDT design standards for level terrain. Three curves located between RM 37.10 and 37.83 failed to meet current design standards for vertical stopping sight distances.

Clear Zones

One area of concern was identified on US 12 at RM 86.18 on both the north and south sides of the highway. The drainage structure at this location includes concrete cutoff walls located approximately 32 feet from the edge of travel way, within the existing fill slope. The existing side slopes appear to be 4:1 or steeper. Based on current MDT standards, a clear zone distance of at least 40 feet is required for this area of US 12.

Intersections

The main intersection of US 12 and MT 7 has an insufficient geometric layout to accommodate WB-50 and larger design vehicles. Trucks with a 50' and larger wheelbase encounter conflicts making turning movements as this intersection.

Surfacing

One section on US 12 does not meet the current MDT standard for minimum pavement width. From RM 76.954 to 82.187, the existing pavement width is listed as 24 feet, made up of two 12-foot lanes and no shoulder. Per the MDT Road Design Manual, a minimum width of 28 feet is desired for rural minor arterials.

Access Points
A high density of access points exist within Baker city limits, primarily along US 12 through the city.

Bridges
One bridge located just north of Baker on MT 7 at RM 35.86 spanning Sandstone Creek (P00027035+08231) has been categorized as Functionally Obsolete and eligible for rehabilitation.

5.2 Environmental Areas of Concern

Prime Farmland
NRCS soil surveys indicate the presence of farmland of state or local importance, or prime farmland if irrigated within the Study Area.

Geologic Resources
Soil types within the Study Area can involve revegetation challenges and additional erosion and sedimentation considerations during construction.

Surface Waters
Sandstone Creek is a major drainage that crosses the Study Area. A variety of other surface waters, including Baker Lake, as well as many unnamed streams, natural drainages, wetlands, and ponds are present in the Study Area.

Sandstone Creek is identified on DEQ's 303(d) list for impaired water bodies with agriculture as a probable cause for impairment.

Groundwater
The City of Baker has five public water supply wells and three potable water underground storage tanks located within the Study Area.

Wetlands and Wetland Mitigation Site
The Study Area contains many potential wetland areas, primarily along Sandstone Creek and areas surrounding Baker Lake. An MDT wetland mitigation site exists south of Baker along MT 7.

Floodplains and Floodways
Regulated floodplains exist on and along Sandstone Creek within the Study Area.

Hazardous Substances
Twenty-six individual USTs were identified within the Study Area. Six active and 10 inactive LUST sites were identified within the Study Area, most of which are within city limits.

One abandoned mine site was identified southwest of the intersection of US 12 and MT 7.

Oil and Gas Wells and Pipelines

Hundreds of oil and gas wells exist in the entire eastern half of the Study Area. One crude oil pipeline was identified in the northwest corner of the Study Area. Considering the amount of oil and gas well development throughout the Study Area, it is probable that other sections of unmapped pipeline exist connecting the oil and gas wells to storage tanks and other facilities.

Wildlife

Five threatened, endangered, proposed, or candidate species are listed as occurring in Fallon County.

Two threatened, endangered, proposed, or candidate species have documented occurrences within the Study Area.

Four species of concern and four potential species of concern have the potential to occur in the Study Area. Core habitat for the Greater Sage-Grouse exists within the Study Area.

Recreational, Historical, and Cultural Resources

There are multiple possible Section 4(f) and three Section 6(f) properties located within the Study Area at the time the environmental scan was completed.

Approximately 25 historic or archaeological properties are located within the Study Area, including historic buildings, bridges, a railroad, pre-contact buried campsites, and lithic scatters. The Water Resources Survey map indicates the presence of one historical private irrigation system and ditch within the Study Area.

BAKER CORRIDOR
PLANNING STUDY

APPENDIX A: Traffic Analysis

Baker Corridor Planning Study

Memorandum

Project:	Baker Corridor Planning Study
Subject:	Existing & Projected Conditions Report // Traffic Analysis
Date:	Monday, February 02, 2015
To:	Corrina Collins, MDT Project Manager
From:	Jon Schick, HDR Project Manager

Purpose:

This memo summarizes the additional traffic analyses conducted in response to Advisory Committee comments received on the Draft Existing & Projected Conditions Report. The draft report review was dated January 2015 and the comments relate to the Advisory Committee review and discussion on January 14, 2015. Additional analysis was conducted in the following areas, and results are provided below:

1. Traffic Projections
    a. Three separate growth scenarios were used to project future traffic volumes:
        i. Low: 2% growth rate for all vehicles (passenger vehicles and heavy trucks)
        ii. Medium: 5% growth rate for all vehicles
        iii. High: 5% growth rate for regular vehicles, 10% growth rate for heavy vehicles
    b. Average Daily Traffic projections were developed for 2034 based on these 3 scenarios.
2. Level of Service (LOS) Analysis
    a. Two additional intersections at MT 7 & Center Avenue and MT 7 & Gregory Road were added to the LOS analysis.
    b. LOS analyses were conducted for the 6 intersections based on the 3 growth scenarios
    c. Consideration of the at-grade railroad crossing immediately north of the US12/MT7 intersection
3. Turning Movement/Design Vehicle Analysis at US12/MT7 Intersection

Traffic Projections

Three separate traffic growth rate scenarios were used to project future traffic volumes. The three scenarios are described in 1.a. above. Table 1 presents the projected ADT values by scenario for the various traffic recorder locations.

Table 1: Projected ADT Traffic Volumes

Site ID	Corridor	Route Post	2013	2034 LOW (2% & 2%)	2034 MED (5% & 5%)	2034 HIGH (5% & 10%)
13-1-4	US 12	76.13	1230	1900	3400	4000
13-1-15	US 12	82.09	1560	2400	4300	4900
13-1-16	US 12	82.60	3790	5700	10600	11100
13-1-17	US 12	82.65	3320	5000	9200	10000
13-1-18	US 12	83.07	2350	3600	6500	7300
13-1-5	US 12	88.12	810	1200	2300	3000
13-2-2	MT 7	29.34	1030	1600	2900	3400
13-1-19	MT 7	34.32	1310	2000	3600	4200
13-1-20	MT 7	35.14	2460	3700	6900	7400
13-1-21	MT 7	35.45	3730	5700	10400	11000
13-1-22	MT 7	35.52	3580	5400	10000	10800
13-1-23	MT 7	35.76	2990	4500	8300	9100
13-1-7	MT 7	36.95	1320	2000	3700	4500
13-1-12	MT 493	1.26	270	400	800	1100

Level of Service Analysis

Two additional intersections at MT 7 & Center Avenue and MT 7 & Gregory Road were added to the LOS analysis (bold text in Table 2) based on recently obtained turning movement counts. This information (without MT 7 & Center Avenue and MT 7 & Gregory Road intersections) was previously presented in Table 7 in the draft Existing and Projected Conditions Report. Table 2 below includes the existing LOS and delay. The MT 7 & Center Avenue and MT 7 & Gregory Road intersections both operate at a LOS A.

Table 2: Existing Conditions Level of Service during Peak Hour

Intersection	Peak Hour	LOS (Delay[1])
US 12 & MT 7	5:45 – 6:45 PM	B (14.4)
US 12 & Willow Lane	5:15 – 6:15 PM	A (9.6)
US 12 & Pleisner Street	2:45 – 3:45 PM	A (9.7)
MT 7 & Shell Oil Road/S-493	7:30 – 8:30 AM	C (15.2)
MT 7 & Center Ave	**5:00 – 6:00 PM**	**A (9.7)**
MT 7 & Gregory Ave	**6:00 – 7:00 PM**	**A (8.8)**
Note: The worst-performing leg LOS is shown for each intersection. Delay is shown in seconds.		

The Peak Hour Turning Movement Counts exhibit (Figure 8 in the E&P Report) has been revised to show the existing peak turning movements at the newly added intersections, as seen below.

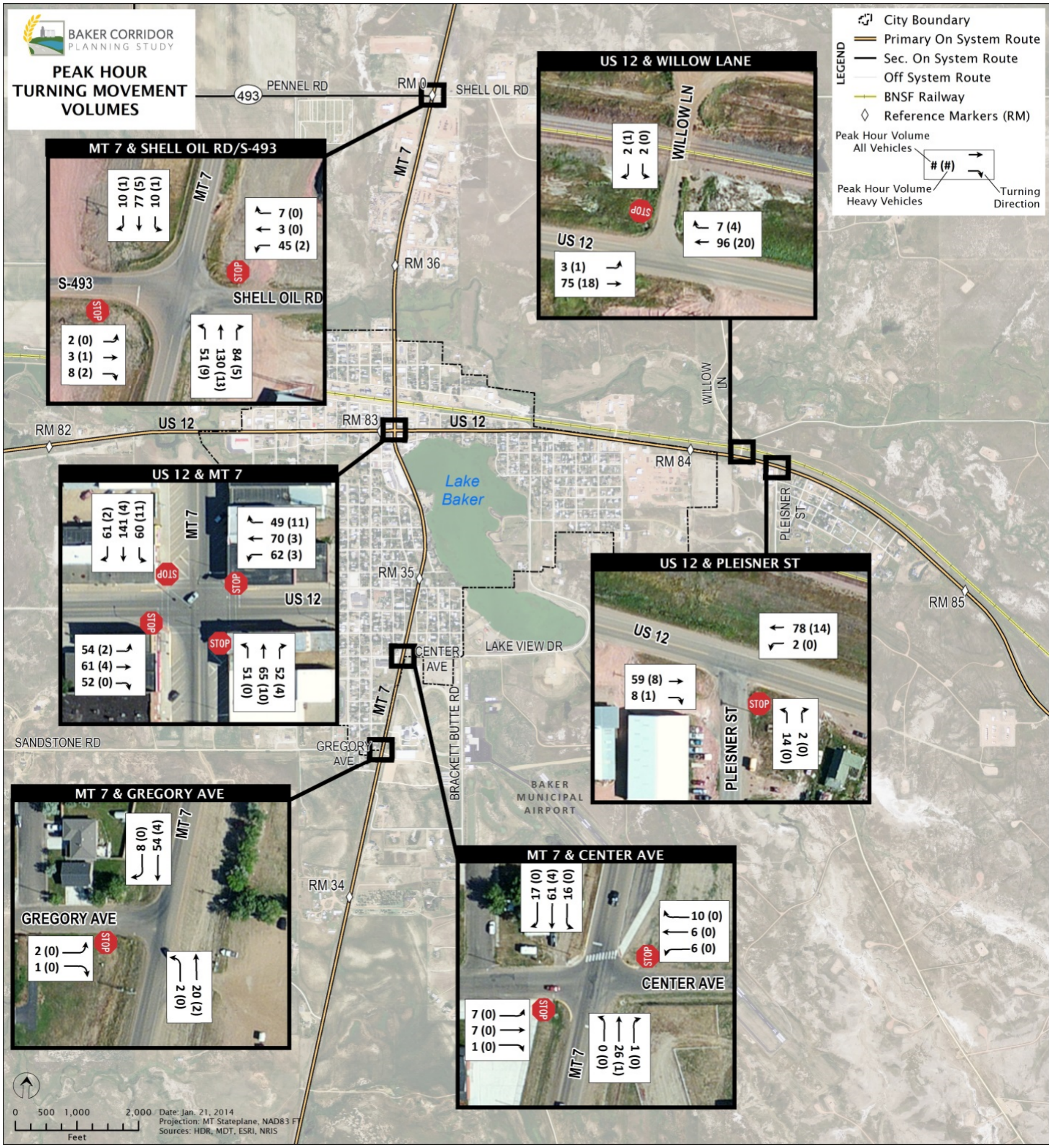

Figure 1: Peak Hour Turning Movement Counts

The Level of Service was modeled for the 6 study area intersections based on the 3 separate growth scenarios for future year 2034. Failing intersections are predicted for the US12/MT7 intersection under all three scenarios. The MT 7/Shell Oil Road intersection is predicted to fail under the medium and high growth scenarios. Preliminary results are provided in the following table.

Table 3: Level of Service Analysis for the Low, Medium, and High Growth Scenarios

Scenario Year	Yearly Growth %	Yearly HV Growth %	US 12 & MT 7		US 12 & Willow Lane		US 12 & Pleisner		Shell Oil Road & MT 7		Center Ave & MT 7		Gregory Ave & MT 7	
			LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay
2014	-	-	B	14.4	A	9.6	A	9.7	C	15.2	A	9.7	A	8.8
2034	2%	2%	F	71.3	B	10.1	B	10.4	D	28.2	B	10.3	A	9.1
2034	5%	5%	F	>100	B	11.9	B	12.7	F	>100	B	12.4	A	9.6
2034	5%	10%	F	>100	B	14.1	B	14.4	F	>100	B	12.7	A	9.9

Turning Movement/Design Vehicle Analysis

The intersection of US 12 and MT 7 was analyzed to determine whether the existing geometric design layout is sufficient to accommodate proper turning movements for larger design vehicles. Three design templates were used in analyzing the intersection: a WB-40, WB-50 and WB-67. A WB-40 is the smallest truck available (typically used for local delivery for restaurants and small retail) and has a 40' wheelbase (WB) as measured from the foremost axle to the rearmost axle. A WB-50 vehicle is an intermediate-sized semitrailer with a 50' wheelbase (WB). A WB-67 is a standard-sized semitrailer with a 67' wheelbase.

The analysis determined that a WB-40 can maneuver both right and left turns without conflict. For the left-turn movement of a WB-40 from US12 onto MT 7 (see Figure 3), the inside wheel path approaches the stopped vehicle, but can clear the turn without conflict. Because the intersection is a 4-way stop, the turning vehicles should have some "wiggle room" in order to maintain clearance from the stopped vehicle.

The existing layout of the US 12/MT 7 intersection is insufficient to accommodate left-turn movements of a WB-50 design vehicle. For turning movements from MT 7 onto US 12, the wheel path for the NB to WB left turn conflicts with the stopped vehicle (Figure 4). For both left-turn movements from US 12 onto MT 7, the inside wheel path conflicts with a stopped vehicle on MT 7 and requires tracking into the adjacent angled parking (Figure 5). All right-turn movements for the WB-50 can be made without conflict (Figures 6 and 7).

The WB-67 design vehicle encountered conflicts at all four right-turn movements. The inside wheel path for the right-turn movement is extremely close to the existing curb return and crosses into two or three angled parking spaces. Because the shorter WB-50 could not make left-turn movements, it was unnecessary to test for the WB-67. It appears that the angled parking on the northwest and southeast corner of the intersection on MT 7 have been striped out with pavement markings to accommodate right turning vehicles.

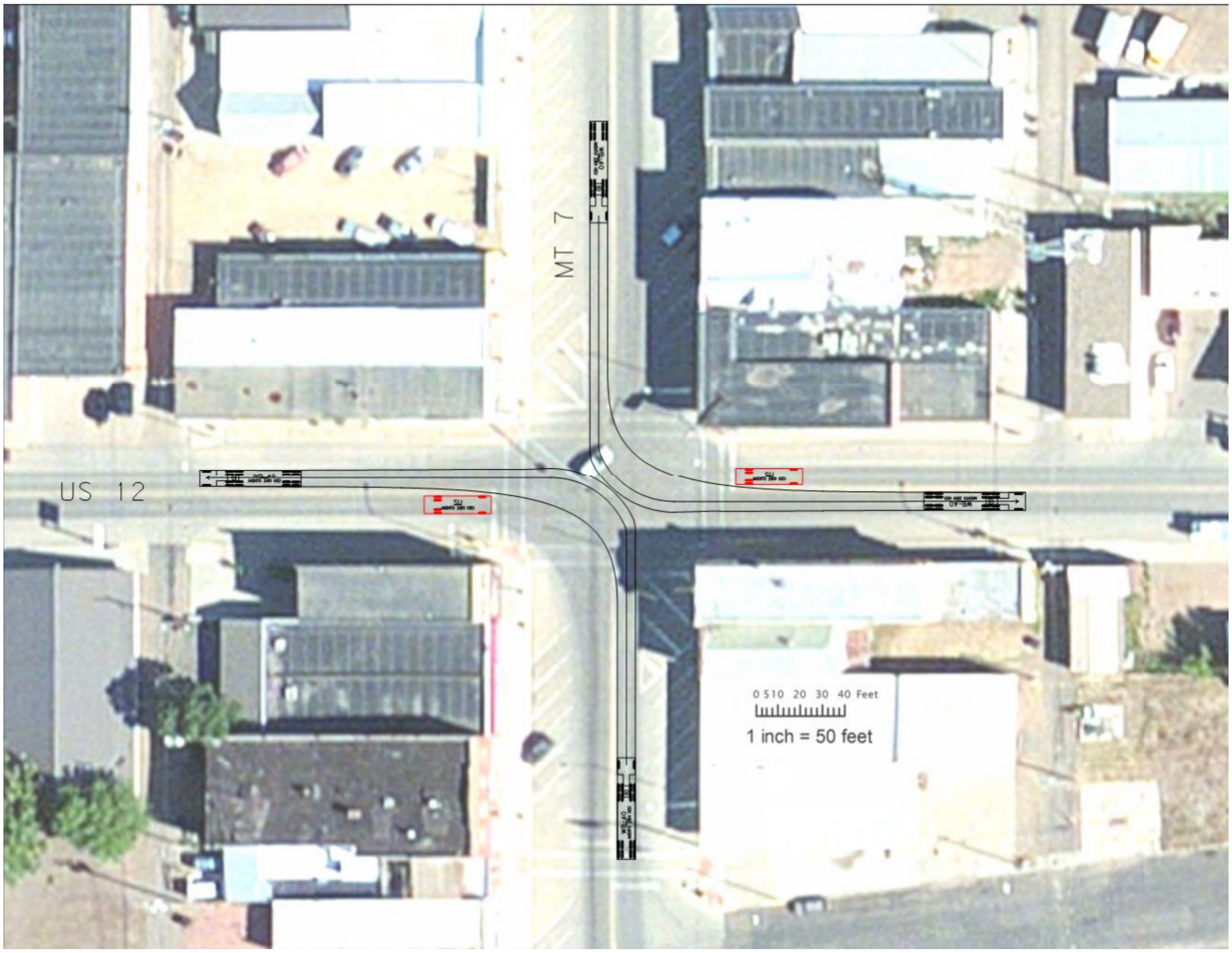

Figure 2: WB-40 left-turn movement from MT 7 onto US 12. No conflict encountered.

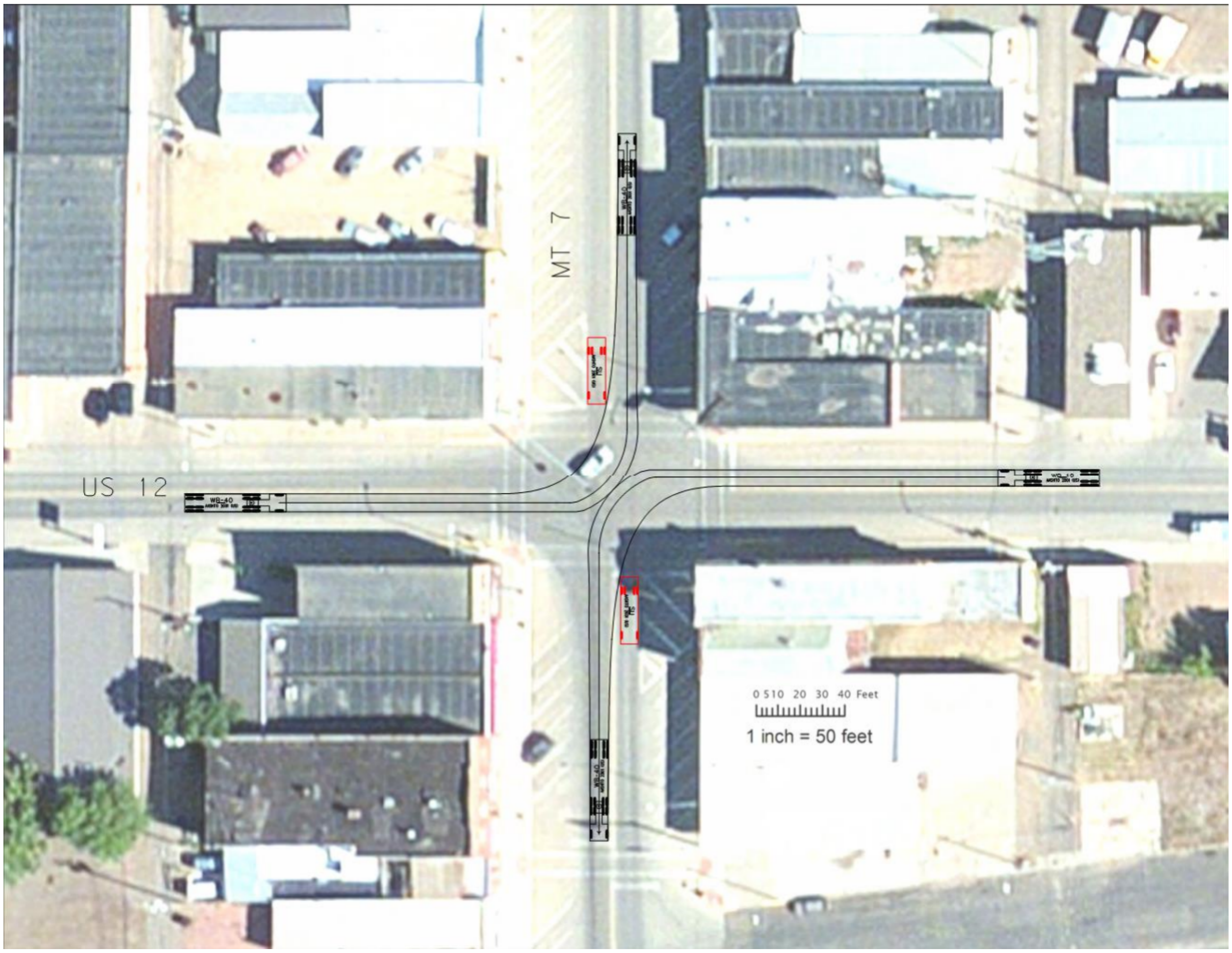

Figure 3: WB-40 left-turn movement from US12 onto MT 7. No conflict encountered. This inside wheel path approaches the stopped vehicle, but can clear the turn without conflict.

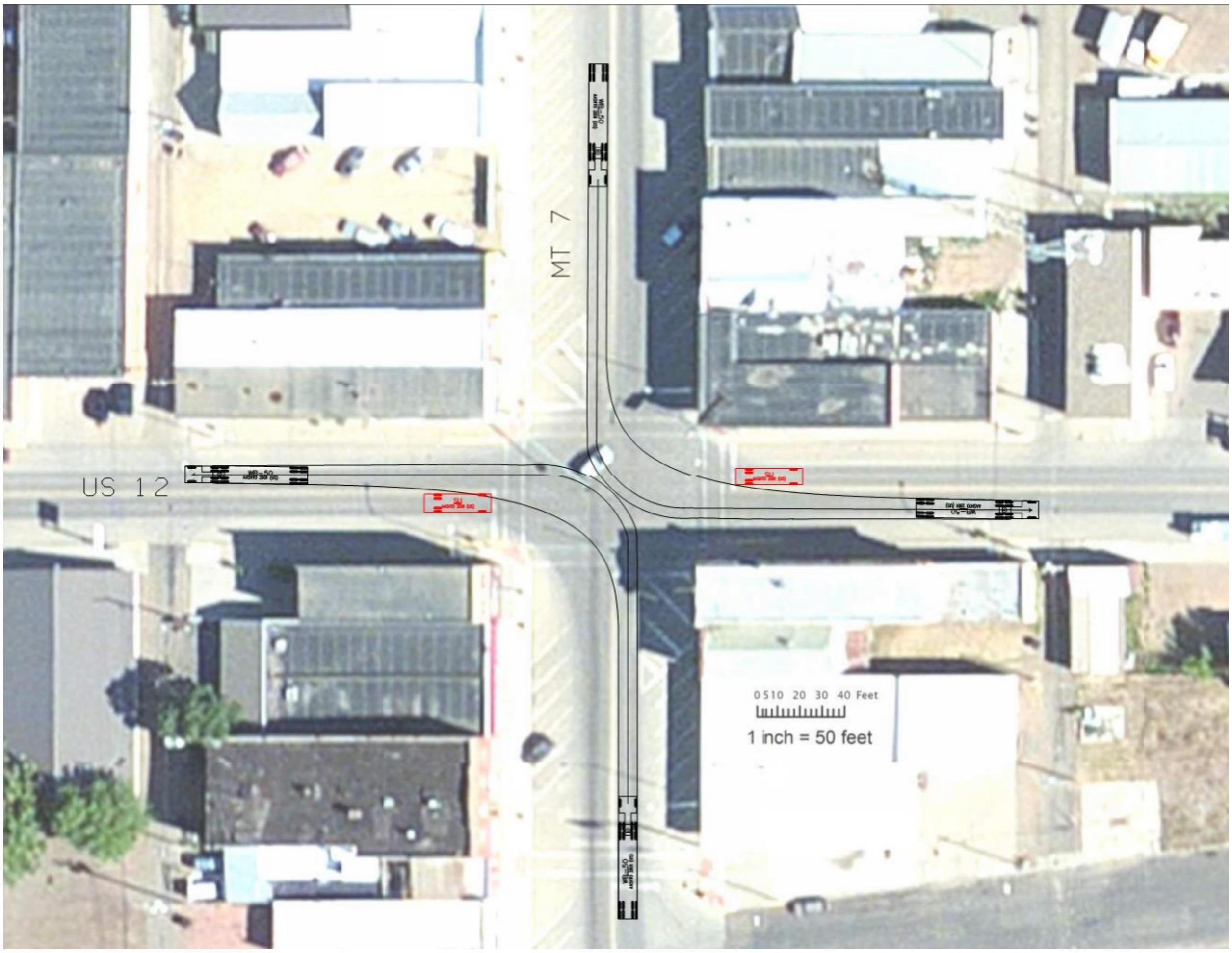

Figure 4: WB-50 left-turn movement from MT 7 onto US12. Conflict encountered: the wheel path for the NB to WB left turn conflicts with the stopped vehicle.

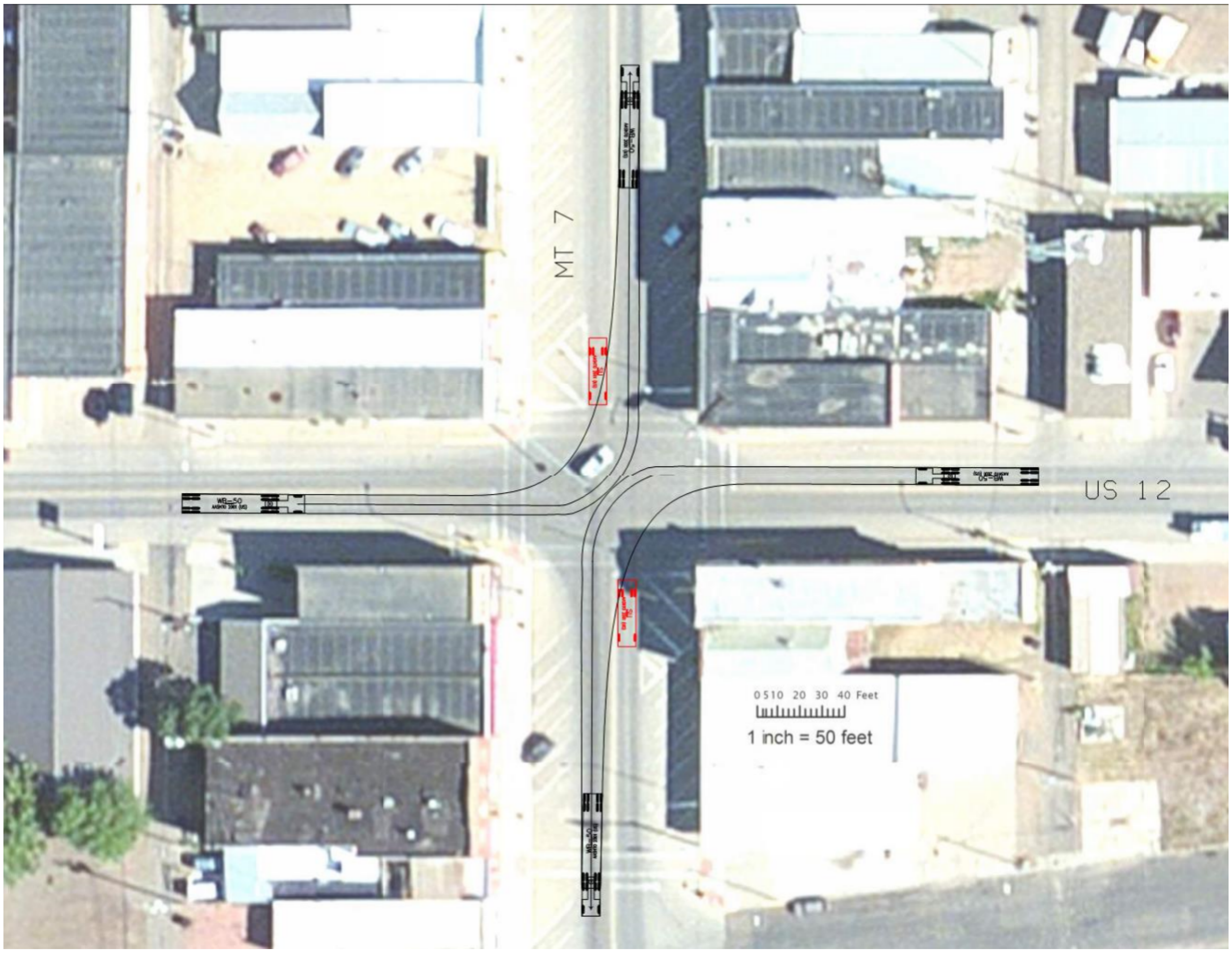

Figure 5: WB-50 left-turn movement from US 12 onto MT 7. Conflict encountered: The inside wheel path conflicts with a stopped vehicle on MT 7 and requires tracking into the adjacent angled parking.

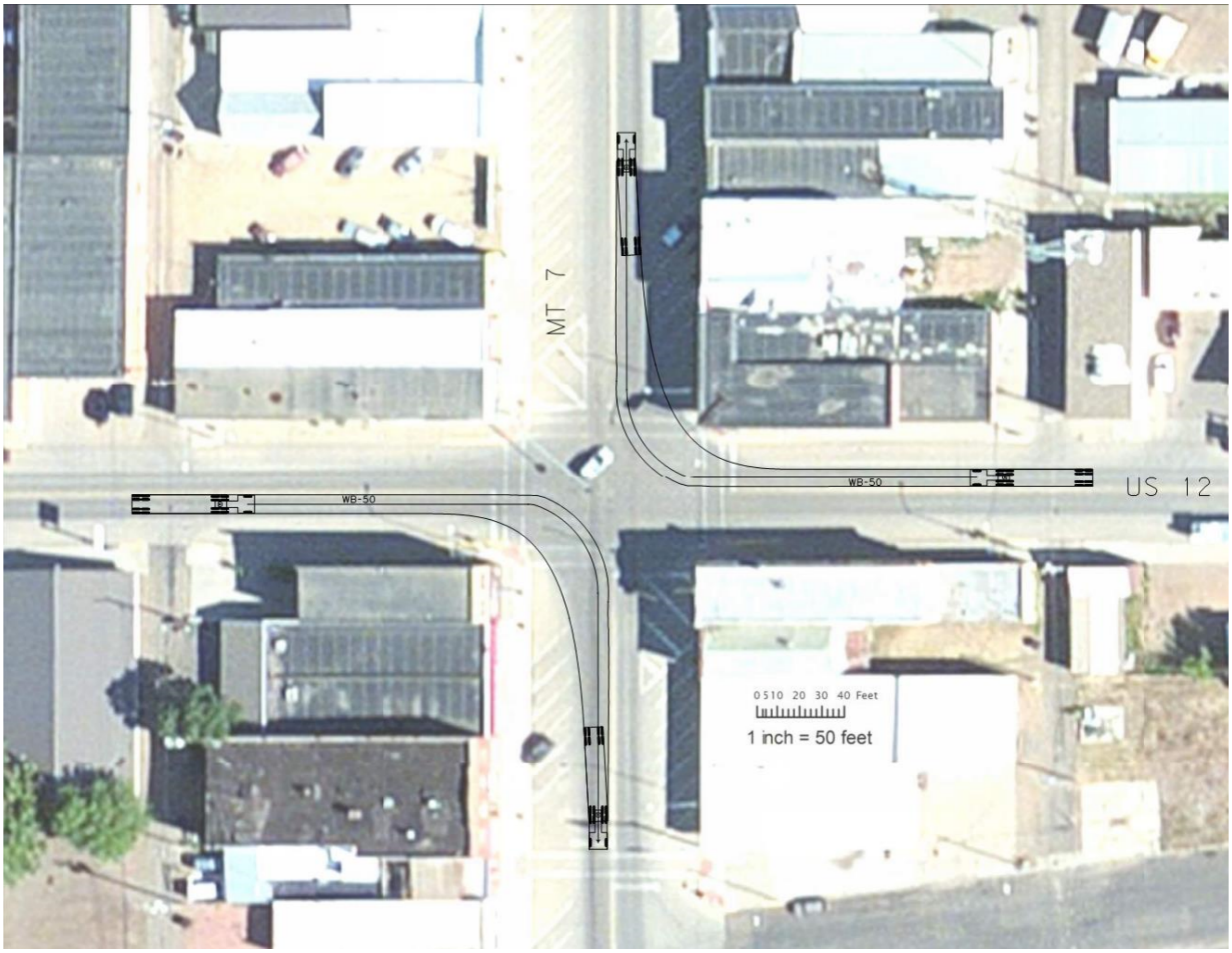

Figure 6: WB-50 right-turn movement from US 12 onto MT 7. No conflicts encountered.

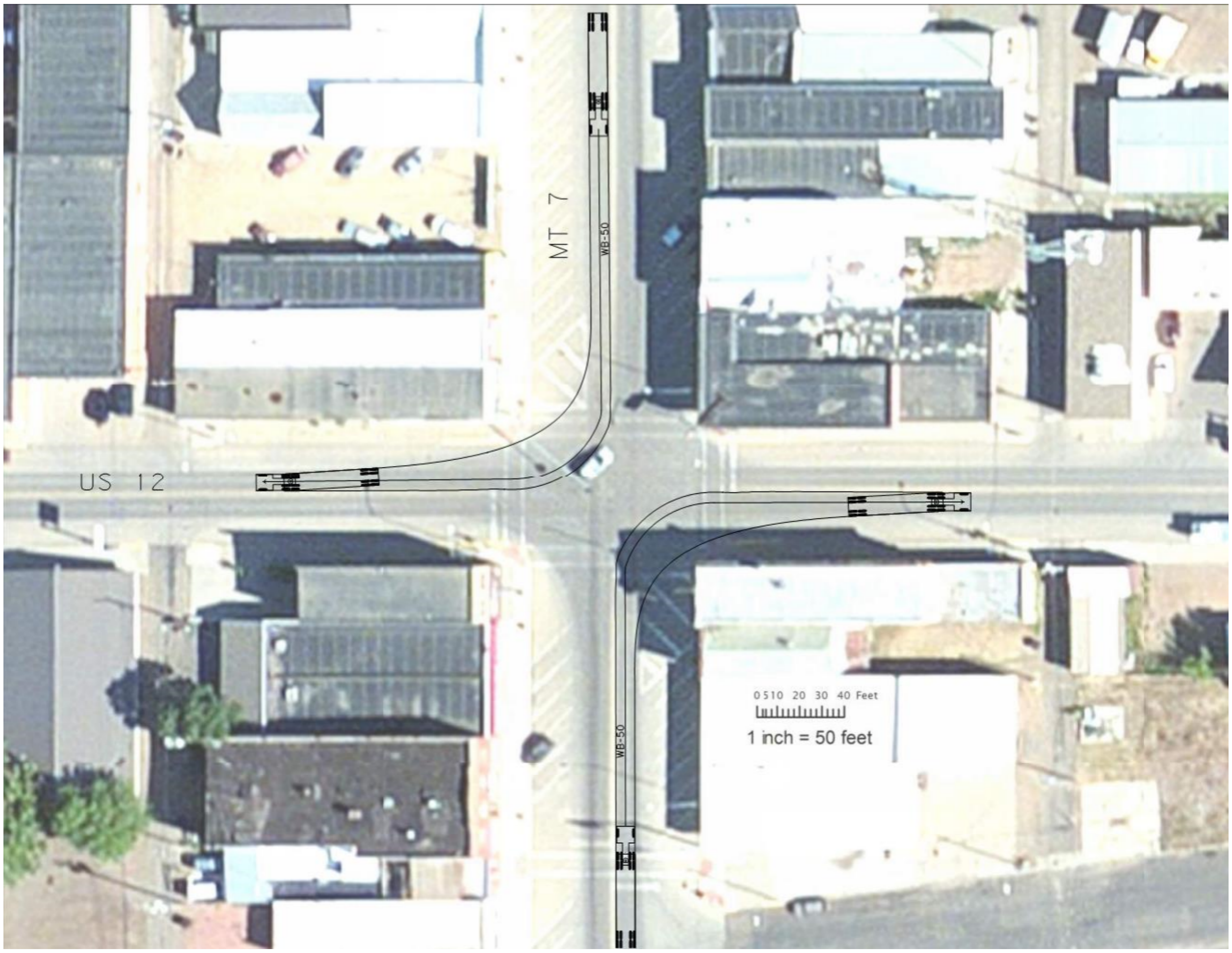

Figure 7: WB-50 right-turn movement from MT 7 onto US 12. No conflicts encountered.

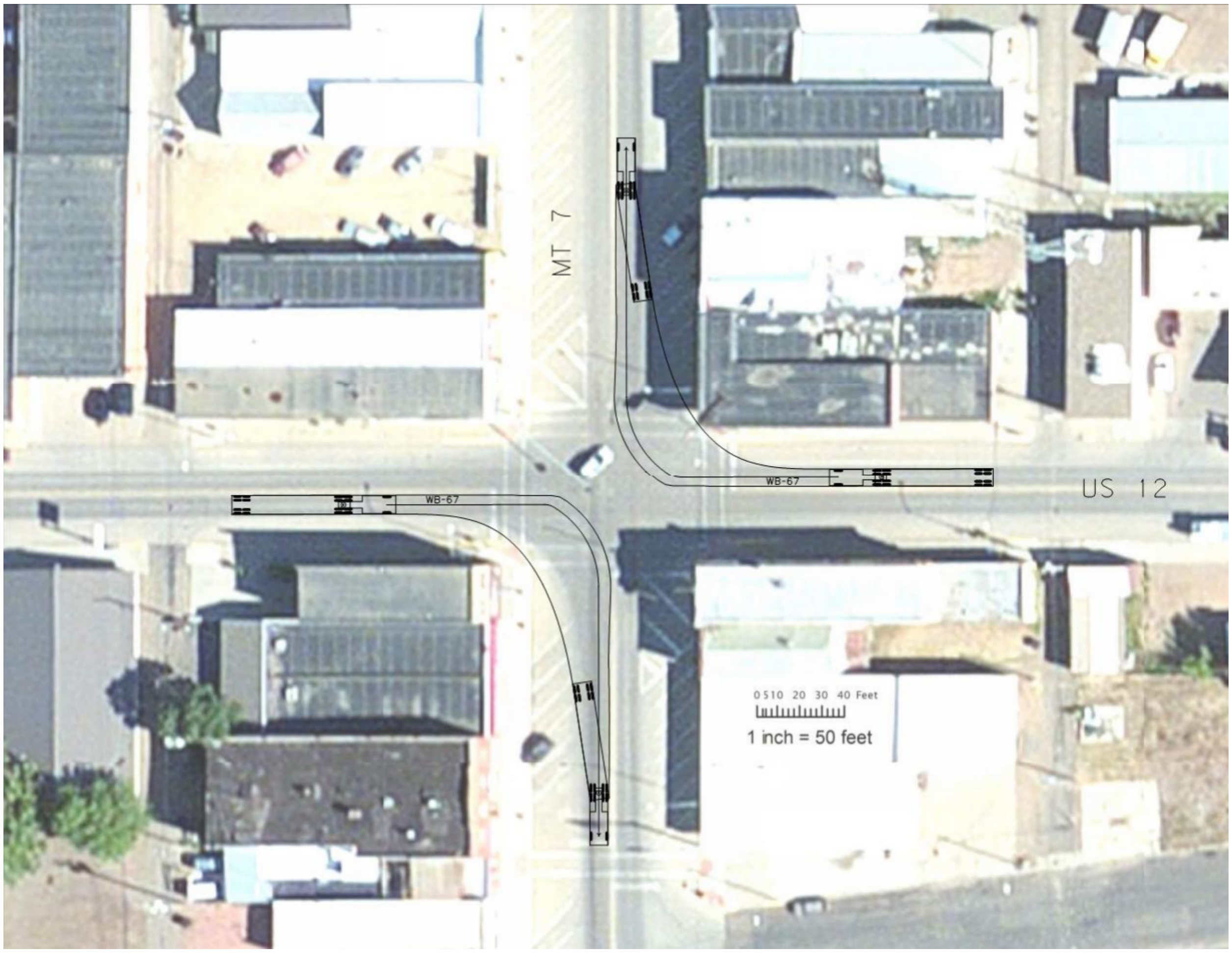

Figure 8: WB-67 right-turn movement from US 12 onto MT 7. Conflict encountered: the inside wheel path of for the right-turn movement is extremely close to the existing curb return and crosses into two or three angled parking spaces on MT 7.

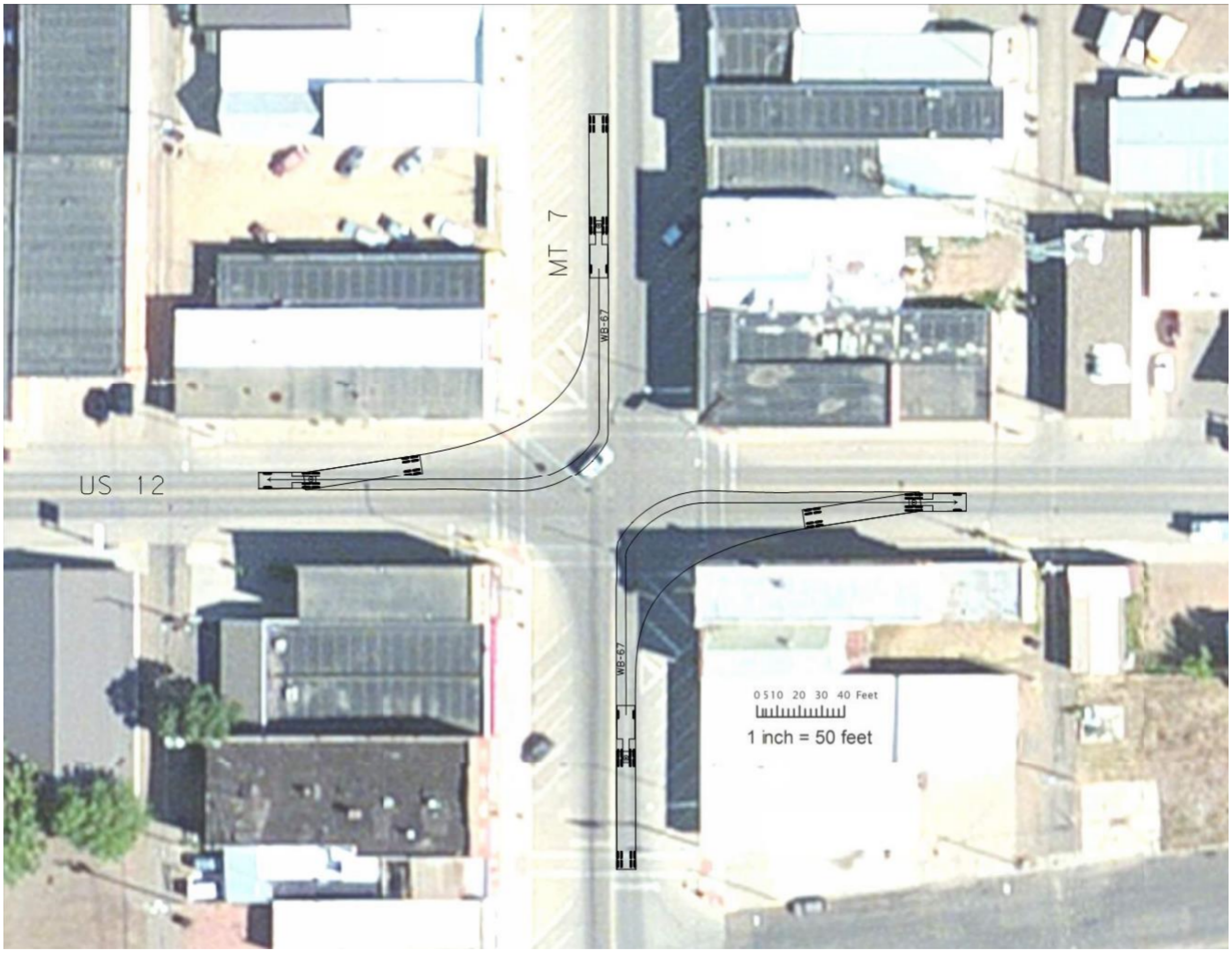

Figure 9: WB-67 right-turn movement from MT 7 onto US 12. Conflict encountered: the inside wheel path of for the right-turn movement is extremely close to the existing curb return and crosses into adjacent parallel parking spaces on US 12.

Intersection	
Intersection Delay, s/veh	12.6
Intersection LOS	B

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	54	61	52	0	62	70	49	0	51	65	52
Peak Hour Factor	0.92	0.64	0.76	0.87	0.92	0.86	0.88	0.88	0.92	0.75	0.86	0.72
Heavy Vehicles, %	2	4	7	0	2	5	4	22	2	0	15	8
Mvmt Flow	0	84	80	60	0	72	80	56	0	68	76	72
Number of Lanes	0	0	1	0	0	0	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	1	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	1	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	1	1
HCM Control Delay	12	11.8	11.5
HCM LOS	B	B	B

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	30%	32%	34%	23%
Vol Thru, %	39%	37%	39%	54%
Vol Right, %	31%	31%	27%	23%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	168	167	181	262
LT Vol	51	54	62	60
Through Vol	65	61	70	141
RT Vol	52	52	49	61
Lane Flow Rate	216	224	207	311
Geometry Grp	1	1	1	1
Degree of Util (X)	0.336	0.358	0.335	0.497
Departure Headway (Hd)	5.597	5.744	5.819	5.745
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	639	622	614	623
Service Time	3.67	3.817	3.894	3.811
HCM Lane V/C Ratio	0.338	0.36	0.337	0.499
HCM Control Delay	11.5	12	11.8	14.4
HCM Lane LOS	B	B	B	B
HCM 95th-tile Q	1.5	1.6	1.5	2.8

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	60	141	61
Peak Hour Factor	0.92	0.94	0.86	0.73
Heavy Vehicles, %	2	18	3	3
Mvmt Flow	0	64	164	84
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	1
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	14.4
HCM LOS	B

Lane

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	3	75	96	7	2	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	33	24	21	57	0	50
Mvmt Flow	8	88	112	20	4	8

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	132	0	-	0	226	122
Stage 1	-	-	-	-	122	-
Stage 2	-	-	-	-	104	-
Critical Hdwy	4.43	-	-	-	6.4	6.7
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.497	-	-	-	3.5	3.75
Pot Cap-1 Maneuver	1283	-	-	-	767	815
Stage 1	-	-	-	-	908	-
Stage 2	-	-	-	-	925	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1283	-	-	-	762	815
Mov Cap-2 Maneuver	-	-	-	-	762	-
Stage 1	-	-	-	-	908	-
Stage 2	-	-	-	-	919	-

Approach	EB	WB	SB
HCM Control Delay, s	0.6	0	9.6
HCM LOS			A

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1283	-	-	-	797
HCM Lane V/C Ratio	0.006	-	-	-	0.015
HCM Control Delay (s)	7.8	0	-	-	9.6
HCM Lane LOS	A	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	-	0

Intersection	
Int Delay, s/veh	1.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	59	8	2	78	14	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	14	13	10	18	10	10
Mvmt Flow	76	12	4	96	28	4

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	88	0	186	82
Stage 1	-	-	-	-	82	-
Stage 2	-	-	-	-	104	-
Critical Hdwy	-	-	4.2	-	6.5	6.3
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	-	-	2.29	-	3.59	3.39
Pot Cap-1 Maneuver	-	-	1459	-	785	956
Stage 1	-	-	-	-	921	-
Stage 2	-	-	-	-	901	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1459	-	783	956
Mov Cap-2 Maneuver	-	-	-	-	783	-
Stage 1	-	-	-	-	921	-
Stage 2	-	-	-	-	898	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	9.7
HCM LOS			A

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	801	-	-	1459	-
HCM Lane V/C Ratio	0.04	-	-	0.003	-
HCM Control Delay (s)	9.7	-	-	7.5	0
HCM Lane LOS	A	-	-	A	A
HCM 95th %tile Q(veh)	0.1	-	-	0	-

Intersection	
Int Delay, s/veh	3.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	2	3	8	45	3	7	51	130	84	10	77	10
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	50	25	50	75	38	44	80	74	55	50	77	50
Heavy Vehicles, %	10	33	25	10	10	10	18	10	6	10	6	10
Mvmt Flow	4	12	16	60	8	16	64	176	153	20	100	20

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	541	606	110	544	540	252	120	0	0	328	0	0
Stage 1	150	150	-	380	380	-	-	-	-	-	-	-
Stage 2	391	456	-	164	160	-	-	-	-	-	-	-
Critical Hdwy	7.2	6.83	6.45	7.2	6.6	6.3	4.28	-	-	4.2	-	-
Critical Hdwy Stg 1	6.2	5.83	-	6.2	5.6	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.2	5.83	-	6.2	5.6	-	-	-	-	-	-	-
Follow-up Hdwy	3.59	4.297	3.525	3.59	4.09	3.39	2.362	-	-	2.29	-	-
Pot Cap-1 Maneuver	440	373	885	438	438	768	1374	-	-	1188	-	-
Stage 1	834	718	-	626	600	-	-	-	-	-	-	-
Stage 2	618	519	-	820	751	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	400	345	885	395	405	768	1374	-	-	1188	-	-
Mov Cap-2 Maneuver	400	345	-	395	405	-	-	-	-	-	-	-
Stage 1	786	705	-	590	565	-	-	-	-	-	-	-
Stage 2	562	489	-	777	737	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.5	15.2	1.3	1.2
HCM LOS	B	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1374	-	-	509	436	1188	-	-
HCM Lane V/C Ratio	0.046	-	-	0.063	0.192	0.017	-	-
HCM Control Delay (s)	7.7	0	-	12.5	15.2	8.1	0	-
HCM Lane LOS	A	A	-	B	C	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.2	0.7	0.1	-	-

Intersection	
Int Delay, s/veh	3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	7	7	1	6	6	10	1	26	1	16	61	17
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	1	1	1	1	1	1	1	4	1	1	7	1
Mvmt Flow	8	8	1	7	7	11	1	28	1	17	66	18

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	150	142	76	146	151	29	85	0	0	29	0	0
Stage 1	110	110	-	31	31	-	-	-	-	-	-	-
Stage 2	40	32	-	115	120	-	-	-	-	-	-	-
Critical Hdwy	7.11	6.51	6.21	7.11	6.51	6.21	4.11	-	-	4.11	-	-
Critical Hdwy Stg 1	6.11	5.51	-	6.11	5.51	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.11	5.51	-	6.11	5.51	-	-	-	-	-	-	-
Follow-up Hdwy	3.509	4.009	3.309	3.509	4.009	3.309	2.209	-	-	2.209	-	-
Pot Cap-1 Maneuver	820	751	988	825	742	1049	1518	-	-	1591	-	-
Stage 1	898	806	-	988	871	-	-	-	-	-	-	-
Stage 2	977	870	-	892	798	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	799	742	988	810	733	1049	1518	-	-	1591	-	-
Mov Cap-2 Maneuver	799	742	-	810	733	-	-	-	-	-	-	-
Stage 1	897	797	-	987	870	-	-	-	-	-	-	-
Stage 2	959	869	-	873	789	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.7	9.2	0.3	1.2
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1518	-	-	781	876	1591	-	-
HCM Lane V/C Ratio	0.001	-	-	0.021	0.027	0.011	-	-
HCM Control Delay (s)	7.4	0	-	9.7	9.2	7.3	0	-
HCM Lane LOS	A	A	-	A	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0.1	0	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	2	1	2	20	54	8
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	1	1	1	10	7	1
Mvmt Flow	2	1	2	22	59	9

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	89	63	67	0	-	0
Stage 1	63	-	-	-	-	-
Stage 2	26	-	-	-	-	-
Critical Hdwy	6.41	6.21	4.11	-	-	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	2.209	-	-	-
Pot Cap-1 Maneuver	914	1004	1541	-	-	-
Stage 1	962	-	-	-	-	-
Stage 2	999	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	913	1004	1541	-	-	-
Mov Cap-2 Maneuver	913	-	-	-	-	-
Stage 1	962	-	-	-	-	-
Stage 2	998	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	8.8	0.7	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1541	-	941	-	-
HCM Lane V/C Ratio	0.001	-	0.003	-	-
HCM Control Delay (s)	7.3	0	8.8	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Intersection Delay, s/veh	43.8
Intersection LOS	E

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	80	91	77	0	92	104	73	0	76	97	77
Peak Hour Factor	0.92	0.64	0.76	0.87	0.92	0.86	0.88	0.88	0.92	0.75	0.86	0.72
Heavy Vehicles, %	2	4	7	0	2	5	4	22	2	0	15	8
Mvmt Flow	0	125	120	89	0	107	118	83	0	101	113	107
Number of Lanes	0	0	1	0	0	0	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	1	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	1	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	1	1
HCM Control Delay	32.6	29.5	29.6
HCM LOS	D	D	D

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	30%	32%	34%	23%
Vol Thru, %	39%	37%	39%	54%
Vol Right, %	31%	31%	27%	23%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	250	248	269	390
LT Vol	76	80	92	89
Through Vol	97	91	104	210
RT Vol	77	77	73	91
Lane Flow Rate	321	333	308	464
Geometry Grp	1	1	1	1
Degree of Util (X)	0.723	0.758	0.713	1
Departure Headway (Hd)	8.103	8.188	8.332	8.069
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	446	443	438	454
Service Time	6.134	6.193	6.337	6.069
HCM Lane V/C Ratio	0.72	0.752	0.703	1.022
HCM Control Delay	29.6	32.6	29.5	71.3
HCM Lane LOS	D	D	D	F
HCM 95th-tile Q	5.7	6.4	5.5	12.9

Intersection				
Intersection Delay, s/veh				
Intersection LOS				

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	89	210	91
Peak Hour Factor	0.92	0.94	0.86	0.73
Heavy Vehicles, %	2	18	3	3
Mvmt Flow	0	95	244	125
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	1
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	71.3
HCM LOS	F

Lane

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	4	111	143	10	3	3
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	33	24	21	57	0	50
Mvmt Flow	11	131	166	29	6	12

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	195	0	-	0	333	181
Stage 1	-	-	-	-	181	-
Stage 2	-	-	-	-	152	-
Critical Hdwy	4.43	-	-	-	6.4	6.7
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.497	-	-	-	3.5	3.75
Pot Cap-1 Maneuver	1213	-	-	-	666	752
Stage 1	-	-	-	-	855	-
Stage 2	-	-	-	-	881	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1213	-	-	-	659	752
Mov Cap-2 Maneuver	-	-	-	-	659	-
Stage 1	-	-	-	-	855	-
Stage 2	-	-	-	-	872	-

Approach	EB	WB	SB
HCM Control Delay, s	0.6	0	10.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1213	-	-	-	718
HCM Lane V/C Ratio	0.009	-	-	-	0.025
HCM Control Delay (s)	8	0	-	-	10.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	1.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	88	12	3	116	21	3
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	14	13	10	18	10	10
Mvmt Flow	113	18	6	143	42	6

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	131	0	277	122
Stage 1	-	-	-	-	122	-
Stage 2	-	-	-	-	155	-
Critical Hdwy	-	-	4.2	-	6.5	6.3
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	-	-	2.29	-	3.59	3.39
Pot Cap-1 Maneuver	-	-	1406	-	696	908
Stage 1	-	-	-	-	884	-
Stage 2	-	-	-	-	854	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1406	-	693	908
Mov Cap-2 Maneuver	-	-	-	-	693	-
Stage 1	-	-	-	-	884	-
Stage 2	-	-	-	-	850	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	10.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	714	-	-	1406	-
HCM Lane V/C Ratio	0.067	-	-	0.004	-
HCM Control Delay (s)	10.4	-	-	7.6	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0	-

Intersection	
Int Delay, s/veh	5.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	3	4	12	67	4	10	76	193	125	15	114	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	50	25	50	75	38	44	80	74	55	50	77	50
Heavy Vehicles, %	10	33	25	10	10	10	18	10	6	10	6	10
Mvmt Flow	6	16	24	89	11	23	95	261	227	30	148	30

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	804	901	163	807	802	374	178	0	0	488	0	0
Stage 1	223	223	-	564	564	-	-	-	-	-	-	-
Stage 2	581	678	-	243	238	-	-	-	-	-	-	-
Critical Hdwy	7.2	6.83	6.45	7.2	6.6	6.3	4.28	-	-	4.2	-	-
Critical Hdwy Stg 1	6.2	5.83	-	6.2	5.6	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.2	5.83	-	6.2	5.6	-	-	-	-	-	-	-
Follow-up Hdwy	3.59	4.297	3.525	3.59	4.09	3.39	2.362	-	-	2.29	-	-
Pot Cap-1 Maneuver	292	247	825	291	308	655	1307	-	-	1035	-	-
Stage 1	762	665	-	496	496	-	-	-	-	-	-	-
Stage 2	486	408	-	743	694	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	246	214	825	240	267	655	1307	-	-	1035	-	-
Mov Cap-2 Maneuver	246	214	-	240	267	-	-	-	-	-	-	-
Stage 1	684	644	-	445	445	-	-	-	-	-	-	-
Stage 2	411	366	-	681	672	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	16.5	28.2	1.3	1.2
HCM LOS	C	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1307	-	-	359	275	1035	-	-
HCM Lane V/C Ratio	0.073	-	-	0.128	0.446	0.029	-	-
HCM Control Delay (s)	8	0	-	16.5	28.2	8.6	0	-
HCM Lane LOS	A	A	-	C	D	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.4	2.2	0.1	-	-

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	10	1	9	9	15	1	39	1	24	91	25
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	1	1	1	1	1	1	1	3	1	1	7	1
Mvmt Flow	11	11	1	10	10	16	1	42	1	26	99	27

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	223	211	113	216	223	43	126	0	0	43	0	0
Stage 1	165	165	-	45	45	-	-	-	-	-	-	-
Stage 2	58	46	-	171	178	-	-	-	-	-	-	-
Critical Hdwy	7.11	6.51	6.21	7.11	6.51	6.21	4.11	-	-	4.11	-	-
Critical Hdwy Stg 1	6.11	5.51	-	6.11	5.51	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.11	5.51	-	6.11	5.51	-	-	-	-	-	-	-
Follow-up Hdwy	3.509	4.009	3.309	3.509	4.009	3.309	2.209	-	-	2.209	-	-
Pot Cap-1 Maneuver	735	688	943	743	678	1030	1467	-	-	1572	-	-
Stage 1	839	764	-	971	859	-	-	-	-	-	-	-
Stage 2	956	859	-	833	754	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	705	675	943	722	665	1030	1467	-	-	1572	-	-
Mov Cap-2 Maneuver	705	675	-	722	665	-	-	-	-	-	-	-
Stage 1	838	750	-	970	858	-	-	-	-	-	-	-
Stage 2	929	858	-	805	740	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.3	9.6	0.2	1.3
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1467	-	-	699	814	1572	-	-
HCM Lane V/C Ratio	0.001	-	-	0.033	0.044	0.017	-	-
HCM Control Delay (s)	7.5	0	-	10.3	9.6	7.3	0	-
HCM Lane LOS	A	A	-	B	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0.1	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	3	1	3	30	80	12
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	1	1	1	10	8	1
Mvmt Flow	3	1	3	33	87	13

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	132	93	100	0	-	0
Stage 1	93	-	-	-	-	-
Stage 2	39	-	-	-	-	-
Critical Hdwy	6.41	6.21	4.11	-	-	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	2.209	-	-	-
Pot Cap-1 Maneuver	864	967	1499	-	-	-
Stage 1	933	-	-	-	-	-
Stage 2	986	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	862	967	1499	-	-	-
Mov Cap-2 Maneuver	862	-	-	-	-	-
Stage 1	933	-	-	-	-	-
Stage 2	984	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.1	0.7	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1499	-	886	-	-
HCM Lane V/C Ratio	0.002	-	0.005	-	-
HCM Control Delay (s)	7.4	0	9.1	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	80	91	77	92	104	73	76	97	77	89	210	91
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.98	0.99		0.98	0.99		0.99	0.99		0.99
Parking Bus, Adj	1.00	1.00	0.88	1.00	1.00	0.88	1.00	1.00	0.88	1.00	1.00	0.88
Adj Sat Flow, veh/h/ln	1827	1827	1900	1810	1705	1900	1900	1703	1900	1610	1845	1900
Adj Flow Rate, veh/h	125	120	89	107	118	83	101	113	107	95	244	125
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Percent Heavy Veh, %	4	7	7	5	4	4	0	15	15	18	3	3
Cap, veh/h	519	338	251	517	324	228	392	280	265	462	401	205
Arrive On Green	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Sat Flow, veh/h	1139	845	627	1120	809	569	1024	701	663	992	1003	514
Grp Volume(v), veh/h	125	0	209	107	0	201	101	0	220	95	0	369
Grp Sat Flow(s),veh/h/ln	1139	0	1473	1120	0	1378	1024	0	1364	992	0	1517
Q Serve(g_s), s	3.5	0.0	4.0	3.0	0.0	4.1	3.5	0.0	4.6	3.0	0.0	7.7
Cycle Q Clear(g_c), s	7.6	0.0	4.0	6.9	0.0	4.1	11.2	0.0	4.6	7.6	0.0	7.7
Prop In Lane	1.00		0.43	1.00		0.41	1.00		0.49	1.00		0.34
Lane Grp Cap(c), veh/h	519	0	589	517	0	551	392	0	546	462	0	607
V/C Ratio(X)	0.24	0.00	0.35	0.21	0.00	0.36	0.26	0.00	0.40	0.21	0.00	0.61
Avail Cap(c_a), veh/h	519	0	589	517	0	551	392	0	546	462	0	607
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.1	0.0	8.4	10.8	0.0	8.4	14.0	0.0	8.6	11.3	0.0	9.5
Incr Delay (d2), s/veh	1.1	0.0	1.7	0.9	0.0	1.9	1.6	0.0	2.2	1.0	0.0	4.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	1.2	0.0	1.8	1.0	0.0	1.8	1.2	0.0	2.0	0.9	0.0	3.9
LnGrp Delay(d),s/veh	12.2	0.0	10.1	11.7	0.0	10.3	15.5	0.0	10.8	12.3	0.0	14.0
LnGrp LOS	B		B	B		B	B		B	B		B
Approach Vol, veh/h		334			308			321			464	
Approach Delay, s/veh		10.9			10.8			12.3			13.7	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		20.0		20.0		20.0		20.0
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		16.0		16.0		16.0		16.0
Max Q Clear Time (g_c+I1), s		13.2		9.6		9.7		8.9
Green Ext Time (p_c), s		1.3		2.0		2.6		2.1

Intersection Summary			
HCM 2010 Ctrl Delay			12.1
HCM 2010 LOS			B

Intersection	
Int Delay, s/veh	0.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	4	111	143	10	3	3
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	33	24	21	57	0	50
Mvmt Flow	11	131	166	29	6	12

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	195	0	-	0	333	181
Stage 1	-	-	-	-	181	-
Stage 2	-	-	-	-	152	-
Critical Hdwy	4.43	-	-	-	6.4	6.7
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.497	-	-	-	3.5	3.75
Pot Cap-1 Maneuver	1213	-	-	-	666	752
Stage 1	-	-	-	-	855	-
Stage 2	-	-	-	-	881	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1213	-	-	-	659	752
Mov Cap-2 Maneuver	-	-	-	-	659	-
Stage 1	-	-	-	-	855	-
Stage 2	-	-	-	-	872	-

Approach	EB	WB	SB
HCM Control Delay, s	0.6	0	10.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1213	-	-	-	718
HCM Lane V/C Ratio	0.009	-	-	-	0.025
HCM Control Delay (s)	8	0	-	-	10.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Intersection	
Int Delay, s/veh	1.7

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	88	12	3	116	21	3
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	14	13	10	18	10	10
Mvmt Flow	113	18	6	143	42	6

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	131	0	277	122
Stage 1	-	-	-	-	122	-
Stage 2	-	-	-	-	155	-
Critical Hdwy	-	-	4.2	-	6.5	6.3
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	-	-	2.29	-	3.59	3.39
Pot Cap-1 Maneuver	-	-	1406	-	696	908
Stage 1	-	-	-	-	884	-
Stage 2	-	-	-	-	854	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1406	-	693	908
Mov Cap-2 Maneuver	-	-	-	-	693	-
Stage 1	-	-	-	-	884	-
Stage 2	-	-	-	-	850	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	10.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	714	-	-	1406	-
HCM Lane V/C Ratio	0.067	-	-	0.004	-
HCM Control Delay (s)	10.4	-	-	7.6	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.2	-	-	0	-

Intersection	
Int Delay, s/veh	5.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	3	4	12	67	4	10	76	193	125	15	114	15
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	50	25	50	75	38	44	80	74	55	50	77	50
Heavy Vehicles, %	10	33	25	10	10	10	18	10	6	10	6	10
Mvmt Flow	6	16	24	89	11	23	95	261	227	30	148	30

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	804	901	163	807	802	374	178	0	0	488	0	0
Stage 1	223	223	-	564	564	-	-	-	-	-	-	-
Stage 2	581	678	-	243	238	-	-	-	-	-	-	-
Critical Hdwy	7.2	6.83	6.45	7.2	6.6	6.3	4.28	-	-	4.2	-	-
Critical Hdwy Stg 1	6.2	5.83	-	6.2	5.6	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.2	5.83	-	6.2	5.6	-	-	-	-	-	-	-
Follow-up Hdwy	3.59	4.297	3.525	3.59	4.09	3.39	2.362	-	-	2.29	-	-
Pot Cap-1 Maneuver	292	247	825	291	308	655	1307	-	-	1035	-	-
Stage 1	762	665	-	496	496	-	-	-	-	-	-	-
Stage 2	486	408	-	743	694	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	246	214	825	240	267	655	1307	-	-	1035	-	-
Mov Cap-2 Maneuver	246	214	-	240	267	-	-	-	-	-	-	-
Stage 1	684	644	-	445	445	-	-	-	-	-	-	-
Stage 2	411	366	-	681	672	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	16.5	28.2	1.3	1.2
HCM LOS	C	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1307	-	-	359	275	1035	-	-
HCM Lane V/C Ratio	0.073	-	-	0.128	0.446	0.029	-	-
HCM Control Delay (s)	8	0	-	16.5	28.2	8.6	0	-
HCM Lane LOS	A	A	-	C	D	A	A	-
HCM 95th %tile Q(veh)	0.2	-	-	0.4	2.2	0.1	-	-

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	10	10	1	9	9	15	1	39	1	24	91	25
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	1	1	1	1	1	1	1	3	1	1	7	1
Mvmt Flow	11	11	1	10	10	16	1	42	1	26	99	27

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	223	211	113	216	223	43	126	0	0	43	0	0
Stage 1	165	165	-	45	45	-	-	-	-	-	-	-
Stage 2	58	46	-	171	178	-	-	-	-	-	-	-
Critical Hdwy	7.11	6.51	6.21	7.11	6.51	6.21	4.11	-	-	4.11	-	-
Critical Hdwy Stg 1	6.11	5.51	-	6.11	5.51	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.11	5.51	-	6.11	5.51	-	-	-	-	-	-	-
Follow-up Hdwy	3.509	4.009	3.309	3.509	4.009	3.309	2.209	-	-	2.209	-	-
Pot Cap-1 Maneuver	735	688	943	743	678	1030	1467	-	-	1572	-	-
Stage 1	839	764	-	971	859	-	-	-	-	-	-	-
Stage 2	956	859	-	833	754	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	705	675	943	722	665	1030	1467	-	-	1572	-	-
Mov Cap-2 Maneuver	705	675	-	722	665	-	-	-	-	-	-	-
Stage 1	838	750	-	970	858	-	-	-	-	-	-	-
Stage 2	929	858	-	805	740	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.3	9.6	0.2	1.3
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1467	-	-	699	814	1572	-	-
HCM Lane V/C Ratio	0.001	-	-	0.033	0.044	0.017	-	-
HCM Control Delay (s)	7.5	0	-	10.3	9.6	7.3	0	-
HCM Lane LOS	A	A	-	B	A	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0.1	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	3	1	3	30	80	12
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	1	1	1	10	8	1
Mvmt Flow	3	1	3	33	87	13

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	132	93	100	0	-	0
Stage 1	93	-	-	-	-	-
Stage 2	39	-	-	-	-	-
Critical Hdwy	6.41	6.21	4.11	-	-	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	2.209	-	-	-
Pot Cap-1 Maneuver	864	967	1499	-	-	-
Stage 1	933	-	-	-	-	-
Stage 2	986	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	862	967	1499	-	-	-
Mov Cap-2 Maneuver	862	-	-	-	-	-
Stage 1	933	-	-	-	-	-
Stage 2	984	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.1	0.7	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1499	-	886	-	-
HCM Lane V/C Ratio	0.002	-	0.005	-	-
HCM Control Delay (s)	7.4	0	9.1	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Intersection Delay, s/veh	78.5
Intersection LOS	F

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	143	162	138	0	165	186	130	0	135	173	138
Peak Hour Factor	0.92	0.64	0.76	0.87	0.92	0.86	0.88	0.88	0.92	0.75	0.86	0.72
Heavy Vehicles, %	2	3	7	3	2	5	4	22	2	3	16	8
Mvmt Flow	0	223	213	159	0	192	211	148	0	180	201	192
Number of Lanes	0	0	1	0	0	0	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	1	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	1	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	1	1
HCM Control Delay	78	78.3	78
HCM LOS	F	F	F

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	30%	32%	34%	23%
Vol Thru, %	39%	37%	39%	54%
Vol Right, %	31%	31%	27%	23%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	446	443	481	696
LT Vol	135	143	165	159
Through Vol	173	162	186	375
RT Vol	138	138	130	162
Lane Flow Rate	573	595	551	827
Geometry Grp	1	1	1	1
Degree of Util (X)	1	1	1	1
Departure Headway (Hd)	9.523	9.526	9.589	9.809
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	384	387	386	380
Service Time	7.523	7.526	7.589	7.809
HCM Lane V/C Ratio	1.492	1.537	1.427	2.176
HCM Control Delay	78	78	78.3	79.2
HCM Lane LOS	F	F	F	F
HCM 95th-tile Q	11.9	11.9	11.9	11.7

Intersection				
Intersection Delay, s/veh				
Intersection LOS				

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	159	375	162
Peak Hour Factor	0.92	0.94	0.86	0.73
Heavy Vehicles, %	2	18	3	3
Mvmt Flow	0	169	436	222
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	1
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	79.2
HCM LOS	F

Lane

Intersection	
Int Delay, s/veh	0.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	8	199	255	19	5	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	38	24	21	58	5	50
Mvmt Flow	21	234	297	54	10	24

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	351	0	-	0	600	324
Stage 1	-	-	-	-	324	-
Stage 2	-	-	-	-	276	-
Critical Hdwy	4.48	-	-	-	6.45	6.7
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	2.542	-	-	-	3.545	3.75
Pot Cap-1 Maneuver	1033	-	-	-	459	619
Stage 1	-	-	-	-	726	-
Stage 2	-	-	-	-	764	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1033	-	-	-	448	619
Mov Cap-2 Maneuver	-	-	-	-	448	-
Stage 1	-	-	-	-	726	-
Stage 2	-	-	-	-	746	-

Approach	EB	WB	SB
HCM Control Delay, s	0.7	0	11.9
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1033	-	-	-	557
HCM Lane V/C Ratio	0.02	-	-	-	0.061
HCM Control Delay (s)	8.6	0	-	-	11.9
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.2

Intersection	
Int Delay, s/veh	2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	156	22	5	207	37	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	13	14	5	18	5	5
Mvmt Flow	200	33	10	256	74	10

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	233	0	492	216
Stage 1	-	-	-	-	216	-
Stage 2	-	-	-	-	276	-
Critical Hdwy	-	-	4.15	-	6.45	6.25
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	-	-	2.245	-	3.545	3.345
Pot Cap-1 Maneuver	-	-	1317	-	531	816
Stage 1	-	-	-	-	813	-
Stage 2	-	-	-	-	764	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1317	-	526	816
Mov Cap-2 Maneuver	-	-	-	-	526	-
Stage 1	-	-	-	-	813	-
Stage 2	-	-	-	-	757	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	12.7
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	549	-	-	1317	-
HCM Lane V/C Ratio	0.153	-	-	0.008	-
HCM Control Delay (s)	12.7	-	-	7.8	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.5	-	-	0	-

Intersection	
Int Delay, s/veh	219.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	8	21	119	8	19	135	344	223	27	204	27
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	50	25	50	75	38	44	80	74	55	50	77	50
Heavy Vehicles, %	5	38	24	5	5	5	18	10	6	11	6	11
Mvmt Flow	10	32	42	159	21	43	169	465	405	54	265	54

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1437	1608	292	1442	1432	668	319	0	0	870	0	0
Stage 1	400	400	-	1005	1005	-	-	-	-	-	-	-
Stage 2	1037	1208	-	437	427	-	-	-	-	-	-	-
Critical Hdwy	7.15	6.88	6.44	7.15	6.55	6.25	4.28	-	-	4.21	-	-
Critical Hdwy Stg 1	6.15	5.88	-	6.15	5.55	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.15	5.88	-	6.15	5.55	-	-	-	-	-	-	-
Follow-up Hdwy	3.545	4.342	3.516	3.545	4.045	3.345	2.362	-	-	2.299	-	-
Pot Cap-1 Maneuver	109	87	698	~ 108	132	453	1156	-	-	738	-	-
Stage 1	620	544	-	287	315	-	-	-	-	-	-	-
Stage 2	276	219	-	592	580	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	57	55	698	~ 40	83	453	1156	-	-	738	-	-
Mov Cap-2 Maneuver	57	55	-	~ 40	83	-	-	-	-	-	-	-
Stage 1	428	495	-	198	217	-	-	-	-	-	-	-
Stage 2	156	151	-	474	528	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	119.1	$ 1638.6	1.4	1.5
HCM LOS	F	F		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1156	-	-	103	52	738	-	-
HCM Lane V/C Ratio	0.146	-	-	0.816	4.287	0.073	-	-
HCM Control Delay (s)	8.6	0	-	119.1	$ 1638.6	10.3	0	-
HCM Lane LOS	A	A	-	F	F	B	A	-
HCM 95th %tile Q(veh)	0.5	-	-	4.5	24.7	0.2	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	19	19	3	16	16	27	3	69	3	42	162	45
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5	5	5	5	5	11	5
Mvmt Flow	21	21	3	17	17	29	3	75	3	46	176	49

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	399	377	201	387	399	77	225	0	0	78	0	0
Stage 1	292	292	-	83	83	-	-	-	-	-	-	-
Stage 2	107	85	-	304	316	-	-	-	-	-	-	-
Critical Hdwy	7.15	6.55	6.25	7.15	6.55	6.25	4.15	-	-	4.15	-	-
Critical Hdwy Stg 1	6.15	5.55	-	6.15	5.55	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.15	5.55	-	6.15	5.55	-	-	-	-	-	-	-
Follow-up Hdwy	3.545	4.045	3.345	3.545	4.045	3.345	2.245	-	-	2.245	-	-
Pot Cap-1 Maneuver	556	550	832	566	534	976	1326	-	-	1502	-	-
Stage 1	710	666	-	918	820	-	-	-	-	-	-	-
Stage 2	891	819	-	699	650	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	511	530	832	532	514	976	1326	-	-	1502	-	-
Mov Cap-2 Maneuver	511	530	-	532	514	-	-	-	-	-	-	-
Stage 1	709	643	-	916	818	-	-	-	-	-	-	-
Stage 2	844	817	-	650	627	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.3	11	0.3	1.3
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1326	-	-	535	664	1502	-	-
HCM Lane V/C Ratio	0.002	-	-	0.083	0.097	0.03	-	-
HCM Control Delay (s)	7.7	0	-	12.3	11	7.5	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.3	0.3	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	5	3	5	53	144	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	11	5
Mvmt Flow	5	3	5	58	157	23

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	236	168	179	0	-	0
Stage 1	168	-	-	-	-	-
Stage 2	68	-	-	-	-	-
Critical Hdwy	6.45	6.25	4.15	-	-	-
Critical Hdwy Stg 1	5.45	-	-	-	-	-
Critical Hdwy Stg 2	5.45	-	-	-	-	-
Follow-up Hdwy	3.545	3.345	2.245	-	-	-
Pot Cap-1 Maneuver	746	868	1379	-	-	-
Stage 1	854	-	-	-	-	-
Stage 2	947	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	743	868	1379	-	-	-
Mov Cap-2 Maneuver	743	-	-	-	-	-
Stage 1	854	-	-	-	-	-
Stage 2	943	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.6	0.7	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1379	-	785	-	-
HCM Lane V/C Ratio	0.004	-	0.011	-	-
HCM Control Delay (s)	7.6	0	9.6	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	143	162	138	165	186	130	135	173	138	159	375	162
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	0.99		0.96	0.99		0.96	1.00		0.98	1.00		0.98
Parking Bus, Adj	1.00	1.00	0.88	1.00	1.00	0.88	1.00	1.00	0.88	1.00	1.00	0.88
Adj Sat Flow, veh/h/ln	1845	1805	1900	1810	1705	1900	1845	1695	1900	1610	1845	1900
Adj Flow Rate, veh/h	223	213	159	192	211	148	180	201	192	169	436	222
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Percent Heavy Veh, %	3	7	7	5	4	4	3	16	16	18	3	3
Cap, veh/h	248	280	209	250	272	191	233	346	331	395	502	255
Arrive On Green	0.34	0.34	0.34	0.34	0.34	0.34	0.50	0.50	0.50	0.50	0.50	0.50
Sat Flow, veh/h	994	824	615	964	801	562	765	692	661	850	1003	511
Grp Volume(v), veh/h	223	0	372	192	0	359	180	0	393	169	0	658
Grp Sat Flow(s),veh/h/ln	994	0	1438	964	0	1363	765	0	1354	850	0	1514
Q Serve(g_s), s	5.2	0.0	11.5	5.5	0.0	11.8	5.8	0.0	10.2	8.7	0.0	19.2
Cycle Q Clear(g_c), s	17.0	0.0	11.5	17.0	0.0	11.8	25.0	0.0	10.2	19.0	0.0	19.2
Prop In Lane	1.00		0.43	1.00		0.41	1.00		0.49	1.00		0.34
Lane Grp Cap(c), veh/h	248	0	489	250	0	464	233	0	677	395	0	757
V/C Ratio(X)	0.90	0.00	0.76	0.77	0.00	0.77	0.77	0.00	0.58	0.43	0.00	0.87
Avail Cap(c_a), veh/h	248	0	489	250	0	464	233	0	677	395	0	757
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	23.8	0.0	14.7	23.5	0.0	14.8	23.6	0.0	8.8	15.5	0.0	11.1
Incr Delay (d2), s/veh	36.4	0.0	10.6	20.1	0.0	11.9	21.8	0.0	3.6	3.4	0.0	12.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	5.5	0.0	6.0	4.0	0.0	5.9	3.9	0.0	4.4	2.4	0.0	10.6
LnGrp Delay(d),s/veh	60.2	0.0	25.3	43.6	0.0	26.7	45.4	0.0	12.4	18.8	0.0	24.0
LnGrp LOS	E		C	D		C	D		B	B		C
Approach Vol, veh/h		595			551			573			827	
Approach Delay, s/veh		38.4			32.6			22.8			22.9	
Approach LOS		D			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		29.0		21.0		29.0		21.0
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		25.0		17.0		25.0		17.0
Max Q Clear Time (g_c+I1), s		27.0		19.0		21.2		19.0
Green Ext Time (p_c), s		0.0		0.0		2.8		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	28.6
HCM 2010 LOS	C

Intersection	
Int Delay, s/veh	0.9

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	8	199	255	19	5	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	38	24	21	58	5	50
Mvmt Flow	21	234	297	54	10	24

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	351	0	-	0	600	324
Stage 1	-	-	-	-	324	-
Stage 2	-	-	-	-	276	-
Critical Hdwy	4.48	-	-	-	6.45	6.7
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	2.542	-	-	-	3.545	3.75
Pot Cap-1 Maneuver	1033	-	-	-	459	619
Stage 1	-	-	-	-	726	-
Stage 2	-	-	-	-	764	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1033	-	-	-	448	619
Mov Cap-2 Maneuver	-	-	-	-	448	-
Stage 1	-	-	-	-	726	-
Stage 2	-	-	-	-	746	-

Approach	EB	WB	SB
HCM Control Delay, s	0.7	0	11.9
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1033	-	-	-	557
HCM Lane V/C Ratio	0.02	-	-	-	0.061
HCM Control Delay (s)	8.6	0	-	-	11.9
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.2

Intersection	
Int Delay, s/veh	2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	156	22	5	207	37	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	13	14	5	18	5	5
Mvmt Flow	200	33	10	256	74	10

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	233	0	492	216
Stage 1	-	-	-	-	216	-
Stage 2	-	-	-	-	276	-
Critical Hdwy	-	-	4.15	-	6.45	6.25
Critical Hdwy Stg 1	-	-	-	-	5.45	-
Critical Hdwy Stg 2	-	-	-	-	5.45	-
Follow-up Hdwy	-	-	2.245	-	3.545	3.345
Pot Cap-1 Maneuver	-	-	1317	-	531	816
Stage 1	-	-	-	-	813	-
Stage 2	-	-	-	-	764	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1317	-	526	816
Mov Cap-2 Maneuver	-	-	-	-	526	-
Stage 1	-	-	-	-	813	-
Stage 2	-	-	-	-	757	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.3	12.7
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	549	-	-	1317	-
HCM Lane V/C Ratio	0.153	-	-	0.008	-
HCM Control Delay (s)	12.7	-	-	7.8	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.5	-	-	0	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	8	21	119	8	19	135	344	223	27	204	27
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1495	1900	1900	1810	1900	1610	1757	1900	1900	1768	1900
Adj Flow Rate, veh/h	10	32	42	159	21	43	169	465	405	54	265	54
Adj No. of Lanes	0	1	0	0	1	0	1	1	0	0	1	0
Peak Hour Factor	0.50	0.25	0.50	0.75	0.38	0.44	0.80	0.74	0.55	0.50	0.77	0.50
Percent Heavy Veh, %	38	38	38	5	5	5	18	10	10	6	6	6
Cap, veh/h	94	120	134	318	36	55	465	560	488	128	547	100
Arrive On Green	0.19	0.19	0.19	0.19	0.19	0.19	0.65	0.65	0.65	0.65	0.65	0.65
Sat Flow, veh/h	69	617	687	999	185	283	913	868	756	72	847	156
Grp Volume(v), veh/h	84	0	0	223	0	0	169	0	870	373	0	0
Grp Sat Flow(s),veh/h/ln	1374	0	0	1467	0	0	913	0	1624	1075	0	0
Q Serve(g_s), s	0.0	0.0	0.0	4.4	0.0	0.0	0.0	0.0	20.5	3.7	0.0	0.0
Cycle Q Clear(g_c), s	2.6	0.0	0.0	7.0	0.0	0.0	15.9	0.0	20.5	24.2	0.0	0.0
Prop In Lane	0.12		0.50	0.71		0.19	1.00		0.47	0.14		0.14
Lane Grp Cap(c), veh/h	348	0	0	409	0	0	465	0	1048	776	0	0
V/C Ratio(X)	0.24	0.00	0.00	0.55	0.00	0.00	0.36	0.00	0.83	0.48	0.00	0.00
Avail Cap(c_a), veh/h	511	0	0	578	0	0	531	0	1165	873	0	0
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	17.3	0.0	0.0	18.9	0.0	0.0	6.0	0.0	6.8	5.3	0.0	0.0
Incr Delay (d2), s/veh	0.4	0.0	0.0	1.1	0.0	0.0	0.5	0.0	4.8	0.5	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	1.0	0.0	0.0	3.0	0.0	0.0	1.6	0.0	10.3	2.4	0.0	0.0
LnGrp Delay(d),s/veh	17.7	0.0	0.0	20.0	0.0	0.0	6.4	0.0	11.5	5.8	0.0	0.0
LnGrp LOS	B			C			A		B	A		
Approach Vol, veh/h		84			223			1039			373	
Approach Delay, s/veh		17.7			20.0			10.7			5.8	
Approach LOS		B			C			B			A	
Timer	1	2	3	4	5	6	7	8				
Assigned Phs		2		4		6		8				
Phs Duration (G+Y+Rc), s		36.4		13.8		36.4		13.8				
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0				
Max Green Setting (Gmax), s		36.0		16.0		36.0		16.0				
Max Q Clear Time (g_c+I1), s		22.5		4.6		26.2		9.0				
Green Ext Time (p_c), s		7.8		1.2		6.2		0.9				
Intersection Summary												
HCM 2010 Ctrl Delay			11.2									
HCM 2010 LOS			B									

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	19	19	3	16	16	27	3	69	3	42	162	45
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	5	5	5	5	5	5	11	5
Mvmt Flow	21	21	3	17	17	29	3	75	3	46	176	49

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	399	377	201	387	399	77	225	0	0	78	0	0
Stage 1	292	292	-	83	83	-	-	-	-	-	-	-
Stage 2	107	85	-	304	316	-	-	-	-	-	-	-
Critical Hdwy	7.15	6.55	6.25	7.15	6.55	6.25	4.15	-	-	4.15	-	-
Critical Hdwy Stg 1	6.15	5.55	-	6.15	5.55	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.15	5.55	-	6.15	5.55	-	-	-	-	-	-	-
Follow-up Hdwy	3.545	4.045	3.345	3.545	4.045	3.345	2.245	-	-	2.245	-	-
Pot Cap-1 Maneuver	556	550	832	566	534	976	1326	-	-	1502	-	-
Stage 1	710	666	-	918	820	-	-	-	-	-	-	-
Stage 2	891	819	-	699	650	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	511	530	832	532	514	976	1326	-	-	1502	-	-
Mov Cap-2 Maneuver	511	530	-	532	514	-	-	-	-	-	-	-
Stage 1	709	643	-	916	818	-	-	-	-	-	-	-
Stage 2	844	817	-	650	627	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.3	11	0.3	1.3
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1326	-	-	535	664	1502	-	-
HCM Lane V/C Ratio	0.002	-	-	0.083	0.097	0.03	-	-
HCM Control Delay (s)	7.7	0	-	12.3	11	7.5	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.3	0.3	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	5	3	5	53	144	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	5	5	5	5	11	5
Mvmt Flow	5	3	5	58	157	23

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	236	168	179	0	-	0
Stage 1	168	-	-	-	-	-
Stage 2	68	-	-	-	-	-
Critical Hdwy	6.45	6.25	4.15	-	-	-
Critical Hdwy Stg 1	5.45	-	-	-	-	-
Critical Hdwy Stg 2	5.45	-	-	-	-	-
Follow-up Hdwy	3.545	3.345	2.245	-	-	-
Pot Cap-1 Maneuver	746	868	1379	-	-	-
Stage 1	854	-	-	-	-	-
Stage 2	947	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	743	868	1379	-	-	-
Mov Cap-2 Maneuver	743	-	-	-	-	-
Stage 1	854	-	-	-	-	-
Stage 2	943	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.6	0.7	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1379	-	785	-	-
HCM Lane V/C Ratio	0.004	-	0.011	-	-
HCM Control Delay (s)	7.6	0	9.6	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Intersection Delay, s/veh	79.1
Intersection LOS	F

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	151	178	138	0	177	198	175	0	135	213	154
Peak Hour Factor	0.92	0.64	0.76	0.87	0.92	0.86	0.88	0.88	0.92	0.75	0.86	0.72
Heavy Vehicles, %	2	9	15	3	2	11	10	42	2	5	31	18
Mvmt Flow	0	236	234	159	0	206	225	199	0	180	248	214
Number of Lanes	0	0	1	0	0	0	1	0	0	0	1	0

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	1	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	1	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	1	1	1
HCM Control Delay	78.5	78.6	78.1
HCM LOS	F	F	F

Lane	NBLn1	EBLn1	WBLn1	SBLn1
Vol Left, %	27%	32%	32%	27%
Vol Thru, %	42%	38%	36%	51%
Vol Right, %	31%	30%	32%	22%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	502	467	550	765
LT Vol	135	151	177	204
Through Vol	213	178	198	391
RT Vol	154	138	175	170
Lane Flow Rate	642	629	630	905
Geometry Grp	1	1	1	1
Degree of Util (X)	1	1	1	1
Departure Headway (Hd)	9.552	9.638	9.658	10.129
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	385	384	384	371
Service Time	7.552	7.638	7.658	8.129
HCM Lane V/C Ratio	1.668	1.638	1.641	2.439
HCM Control Delay	78.1	78.5	78.6	80.6
HCM Lane LOS	F	F	F	F
HCM 95th-tile Q	11.9	11.8	11.8	11.5

Intersection				
Intersection Delay, s/veh				
Intersection LOS				

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	204	391	170
Peak Hour Factor	0.92	0.94	0.86	0.73
Heavy Vehicles, %	2	36	7	8
Mvmt Flow	0	217	455	233
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	1
Conflicting Approach Left	WB
Conflicting Lanes Left	1
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	80.6
HCM LOS	F

Lane

Intersection	
Int Delay, s/veh	1.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	12	272	337	35	5	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	58	44	40	70	10	70
Mvmt Flow	32	320	392	100	10	40

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	492	0	-	0	825	442
Stage 1	-	-	-	-	442	-
Stage 2	-	-	-	-	383	-
Critical Hdwy	4.68	-	-	-	6.5	6.9
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	2.722	-	-	-	3.59	3.93
Pot Cap-1 Maneuver	835	-	-	-	332	495
Stage 1	-	-	-	-	631	-
Stage 2	-	-	-	-	672	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	835	-	-	-	316	495
Mov Cap-2 Maneuver	-	-	-	-	316	-
Stage 1	-	-	-	-	631	-
Stage 2	-	-	-	-	640	-

Approach	EB	WB	SB
HCM Control Delay, s	0.9	0	14.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	835	-	-	-	445
HCM Lane V/C Ratio	0.038	-	-	-	0.112
HCM Control Delay (s)	9.5	0	-	-	14.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.4

Intersection	
Int Delay, s/veh	1.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	189	26	5	264	37	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	29	27	10	36	10	10
Mvmt Flow	242	39	10	326	74	10

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	281	0	608	262
Stage 1	-	-	-	-	262	-
Stage 2	-	-	-	-	346	-
Critical Hdwy	-	-	4.2	-	6.5	6.3
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	-	-	2.29	-	3.59	3.39
Pot Cap-1 Maneuver	-	-	1237	-	446	758
Stage 1	-	-	-	-	764	-
Stage 2	-	-	-	-	699	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1237	-	442	758
Mov Cap-2 Maneuver	-	-	-	-	442	-
Stage 1	-	-	-	-	764	-
Stage 2	-	-	-	-	692	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	14.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	465	-	-	1237	-
HCM Lane V/C Ratio	0.181	-	-	0.008	-
HCM Control Delay (s)	14.4	-	-	7.9	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.7	-	-	0	-

Intersection	
Int Delay, s/veh	56.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	5	12	29	127	8	19	172	397	244	31	225	31
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	50	25	50	75	38	44	80	74	55	50	77	50
Heavy Vehicles, %	10	58	45	10	10	10	35	22	14	23	15	23
Mvmt Flow	10	48	58	169	21	43	215	536	444	62	292	62

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1667	1857	323	1688	1666	758	354	0	0	980	0	0
Stage 1	447	447	-	1188	1188	-	-	-	-	-	-	-
Stage 2	1220	1410	-	500	478	-	-	-	-	-	-	-
Critical Hdwy	7.2	7.08	6.65	7.2	6.6	6.3	4.45	-	-	4.33	-	-
Critical Hdwy Stg 1	6.2	6.08	-	6.2	5.6	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.2	6.08	-	6.2	5.6	-	-	-	-	-	-	-
Follow-up Hdwy	3.59	4.522	3.705	3.59	4.09	3.39	2.515	-	-	2.407	-	-
Pot Cap-1 Maneuver	73	53	629	~ 71	92	394	1043	-	-	627	-	-
Stage 1	576	489	-	221	253	-	-	-	-	-	-	-
Stage 2	212	157	-	538	542	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	22	~ 23	629	-	40	394	1043	-	-	627	-	-
Mov Cap-2 Maneuver	22	~ 23	-	-	40	-	-	-	-	-	-	-
Stage 1	284	428	-	~ 109	125	-	-	-	-	-	-	-
Stage 2	77	77	-	380	475	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	$ 937.3		1.7	1.7
HCM LOS	F	-		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1043	-	-	44	-	627	-	-
HCM Lane V/C Ratio	0.206	-	-	2.636	-	0.099	-	-
HCM Control Delay (s)	9.3	0	-	$ 937.3	-	11.4	0	-
HCM Lane LOS	A	A	-	F	-	B	A	-
HCM 95th %tile Q(veh)	0.8	-	-	12.5	-	0.3	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	3.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	19	19	3	16	16	27	3	73	3	42	178	45
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	10	10	10	10	10	10	10	10	10	10	15	10
Mvmt Flow	21	21	3	17	17	29	3	79	3	46	193	49

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	420	398	218	409	422	81	242	0	0	83	0	0
Stage 1	309	309	-	88	88	-	-	-	-	-	-	-
Stage 2	111	89	-	321	334	-	-	-	-	-	-	-
Critical Hdwy	7.2	6.6	6.3	7.2	6.6	6.3	4.2	-	-	4.2	-	-
Critical Hdwy Stg 1	6.2	5.6	-	6.2	5.6	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.2	5.6	-	6.2	5.6	-	-	-	-	-	-	-
Follow-up Hdwy	3.59	4.09	3.39	3.59	4.09	3.39	2.29	-	-	2.29	-	-
Pot Cap-1 Maneuver	530	527	802	539	511	957	1279	-	-	1465	-	-
Stage 1	684	645	-	900	807	-	-	-	-	-	-	-
Stage 2	875	806	-	674	629	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	485	506	802	505	491	957	1279	-	-	1465	-	-
Mov Cap-2 Maneuver	485	506	-	505	491	-	-	-	-	-	-	-
Stage 1	683	621	-	898	805	-	-	-	-	-	-	-
Stage 2	828	804	-	625	606	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.7	11.3	0.3	1.2
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1279	-	-	510	638	1465	-	-
HCM Lane V/C Ratio	0.003	-	-	0.087	0.101	0.031	-	-
HCM Control Delay (s)	7.8	0	-	12.7	11.3	7.5	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.3	0.3	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	5	3	5	61	160	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	10	10	10	13	27	10
Mvmt Flow	5	3	5	66	174	23

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	262	185	197	0	-	0
Stage 1	185	-	-	-	-	-
Stage 2	77	-	-	-	-	-
Critical Hdwy	6.5	6.3	4.2	-	-	-
Critical Hdwy Stg 1	5.5	-	-	-	-	-
Critical Hdwy Stg 2	5.5	-	-	-	-	-
Follow-up Hdwy	3.59	3.39	2.29	-	-	-
Pot Cap-1 Maneuver	710	837	1329	-	-	-
Stage 1	828	-	-	-	-	-
Stage 2	926	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	707	837	1329	-	-	-
Mov Cap-2 Maneuver	707	-	-	-	-	-
Stage 1	828	-	-	-	-	-
Stage 2	922	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.9	0.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1329	-	751	-	-
HCM Lane V/C Ratio	0.004	-	0.012	-	-
HCM Control Delay (s)	7.7	0	9.9	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	151	178	138	177	198	175	135	213	154	204	391	170
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.96	1.00		0.96	1.00		0.98	1.00		0.98
Parking Bus, Adj	1.00	1.00	0.88	1.00	1.00	0.88	1.00	1.00	0.88	1.00	1.00	0.88
Adj Sat Flow, veh/h/ln	1743	1725	1900	1712	1520	1900	1810	1520	1900	1397	1770	1900
Adj Flow Rate, veh/h	236	234	159	206	225	199	180	248	214	217	455	233
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Percent Heavy Veh, %	9	15	15	11	10	10	5	31	31	36	7	7
Cap, veh/h	149	318	216	232	246	218	139	327	282	238	480	246
Arrive On Green	0.39	0.39	0.39	0.39	0.39	0.39	0.50	0.50	0.50	0.50	0.50	0.50
Sat Flow, veh/h	898	825	560	907	639	565	730	655	565	695	961	492
Grp Volume(v), veh/h	236	0	393	206	0	424	180	0	462	217	0	688
Grp Sat Flow(s),veh/h/ln	898	0	1385	907	0	1204	730	0	1220	695	0	1453
Q Serve(g_s), s	3.6	0.0	17.0	10.0	0.0	23.4	3.5	0.0	21.3	13.7	0.0	31.5
Cycle Q Clear(g_c), s	27.0	0.0	17.0	27.0	0.0	23.4	35.0	0.0	21.3	35.0	0.0	31.5
Prop In Lane	1.00		0.40	1.00		0.47	1.00		0.46	1.00		0.34
Lane Grp Cap(c), veh/h	149	0	534	232	0	464	139	0	610	238	0	726
V/C Ratio(X)	1.58	0.00	0.74	0.89	0.00	0.91	1.29	0.00	0.76	0.91	0.00	0.95
Avail Cap(c_a), veh/h	149	0	534	232	0	464	139	0	610	238	0	726
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	34.4	0.0	18.4	31.9	0.0	20.4	34.5	0.0	14.1	30.7	0.0	16.6
Incr Delay (d2), s/veh	290.4	0.0	5.3	31.3	0.0	22.3	174.0	0.0	8.6	38.9	0.0	22.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	14.9	0.0	7.2	6.0	0.0	10.5	9.4	0.0	8.5	6.7	0.0	17.0
LnGrp Delay(d),s/veh	324.8	0.0	23.7	63.2	0.0	42.7	208.6	0.0	22.6	69.7	0.0	39.4
LnGrp LOS	F		C	E		D	F		C	E		D
Approach Vol, veh/h		629			630			642			905	
Approach Delay, s/veh		136.7			49.4			74.8			46.6	
Approach LOS		F			D			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		39.0		31.0		39.0		31.0
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		35.0		27.0		35.0		27.0
Max Q Clear Time (g_c+I1), s		37.0		29.0		37.0		29.0
Green Ext Time (p_c), s		0.0		0.0		0.0		0.0

Intersection Summary			
HCM 2010 Ctrl Delay			73.9
HCM 2010 LOS			E

Intersection						
Int Delay, s/veh	1.1					

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	12	272	337	35	5	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	38	85	86	35	50	25
Heavy Vehicles, %	58	44	40	70	10	70
Mvmt Flow	32	320	392	100	10	40

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	492	0	-	0	825	442
Stage 1	-	-	-	-	442	-
Stage 2	-	-	-	-	383	-
Critical Hdwy	4.68	-	-	-	6.5	6.9
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	2.722	-	-	-	3.59	3.93
Pot Cap-1 Maneuver	835	-	-	-	332	495
Stage 1	-	-	-	-	631	-
Stage 2	-	-	-	-	672	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	835	-	-	-	316	495
Mov Cap-2 Maneuver	-	-	-	-	316	-
Stage 1	-	-	-	-	631	-
Stage 2	-	-	-	-	640	-

Approach	EB	WB	SB
HCM Control Delay, s	0.9	0	14.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	835	-	-	-	445
HCM Lane V/C Ratio	0.038	-	-	-	0.112
HCM Control Delay (s)	9.5	0	-	-	14.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0.1	-	-	-	0.4

Intersection	
Int Delay, s/veh	1.8

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	189	26	5	264	37	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	78	67	50	81	50	50
Heavy Vehicles, %	29	27	10	36	10	10
Mvmt Flow	242	39	10	326	74	10

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	281	0	608	262
Stage 1	-	-	-	-	262	-
Stage 2	-	-	-	-	346	-
Critical Hdwy	-	-	4.2	-	6.5	6.3
Critical Hdwy Stg 1	-	-	-	-	5.5	-
Critical Hdwy Stg 2	-	-	-	-	5.5	-
Follow-up Hdwy	-	-	2.29	-	3.59	3.39
Pot Cap-1 Maneuver	-	-	1237	-	446	758
Stage 1	-	-	-	-	764	-
Stage 2	-	-	-	-	699	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1237	-	442	758
Mov Cap-2 Maneuver	-	-	-	-	442	-
Stage 1	-	-	-	-	764	-
Stage 2	-	-	-	-	692	-

Approach	EB	WB	NB
HCM Control Delay, s	0	0.2	14.4
HCM LOS			B

Minor Lane/Major Mvmt	NBLn1	EBT	EBR	WBL	WBT
Capacity (veh/h)	465	-	-	1237	-
HCM Lane V/C Ratio	0.181	-	-	0.008	-
HCM Control Delay (s)	14.4	-	-	7.9	0
HCM Lane LOS	B	-	-	A	A
HCM 95th %tile Q(veh)	0.7	-	-	0	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	12	29	127	8	19	172	397	244	31	225	31
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1289	1900	1900	1727	1900	1407	1605	1900	1900	1619	1900
Adj Flow Rate, veh/h	10	48	58	169	21	43	215	536	444	62	292	62
Adj No. of Lanes	0	1	0	0	1	0	1	1	0	0	1	0
Peak Hour Factor	0.50	0.25	0.50	0.75	0.38	0.44	0.80	0.74	0.55	0.50	0.77	0.50
Percent Heavy Veh, %	58	58	58	10	10	10	35	22	22	15	15	15
Cap, veh/h	61	118	127	267	29	48	256	555	460	68	259	48
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.68	0.68	0.68	0.68	0.68	0.68
Sat Flow, veh/h	43	560	603	876	140	230	773	813	673	18	380	70
Grp Volume(v), veh/h	116	0	0	233	0	0	215	0	980	416	0	0
Grp Sat Flow(s),veh/h/ln	1206	0	0	1247	0	0	773	0	1486	468	0	0
Q Serve(g_s), s	0.0	0.0	0.0	7.2	0.0	0.0	0.0	0.0	45.8	5.2	0.0	0.0
Cycle Q Clear(g_c), s	6.4	0.0	0.0	13.6	0.0	0.0	51.0	0.0	45.8	51.0	0.0	0.0
Prop In Lane	0.09		0.50	0.73		0.18	1.00		0.45	0.15		0.15
Lane Grp Cap(c), veh/h	306	0	0	345	0	0	256	0	1015	375	0	0
V/C Ratio(X)	0.38	0.00	0.00	0.68	0.00	0.00	0.84	0.00	0.97	1.11	0.00	0.00
Avail Cap(c_a), veh/h	310	0	0	350	0	0	256	0	1015	375	0	0
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	0.00
Uniform Delay (d), s/veh	25.8	0.0	0.0	28.7	0.0	0.0	18.4	0.0	11.0	20.0	0.0	0.0
Incr Delay (d2), s/veh	0.8	0.0	0.0	5.0	0.0	0.0	21.4	0.0	20.3	79.7	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(-26165%),veh/ln	2.2	0.0	0.0	5.1	0.0	0.0	5.9	0.0	24.0	13.1	0.0	0.0
LnGrp Delay(d),s/veh	26.6	0.0	0.0	33.7	0.0	0.0	39.8	0.0	31.4	99.7	0.0	0.0
LnGrp LOS	C			C			D		C	F		
Approach Vol, veh/h		116			233			1195			416	
Approach Delay, s/veh		26.6			33.7			32.9			99.7	
Approach LOS		C			C			C			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		55.0		19.7		55.0		19.7
Change Period (Y+Rc), s		4.0		4.0		4.0		4.0
Max Green Setting (Gmax), s		51.0		16.0		51.0		16.0
Max Q Clear Time (g_c+I1), s		53.0		8.4		53.0		15.6
Green Ext Time (p_c), s		0.0		1.2		0.0		0.1

Intersection Summary			
HCM 2010 Ctrl Delay			46.8
HCM 2010 LOS			D

Intersection	
Int Delay, s/veh	3.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Vol, veh/h	19	19	3	16	16	27	3	73	3	42	178	45
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	92	92	92	92	92	92	92	92	92	92	92
Heavy Vehicles, %	10	10	10	10	10	10	10	10	10	10	15	10
Mvmt Flow	21	21	3	17	17	29	3	79	3	46	193	49

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	420	398	218	409	422	81	242	0	0	83	0	0
Stage 1	309	309	-	88	88	-	-	-	-	-	-	-
Stage 2	111	89	-	321	334	-	-	-	-	-	-	-
Critical Hdwy	7.2	6.6	6.3	7.2	6.6	6.3	4.2	-	-	4.2	-	-
Critical Hdwy Stg 1	6.2	5.6	-	6.2	5.6	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.2	5.6	-	6.2	5.6	-	-	-	-	-	-	-
Follow-up Hdwy	3.59	4.09	3.39	3.59	4.09	3.39	2.29	-	-	2.29	-	-
Pot Cap-1 Maneuver	530	527	802	539	511	957	1279	-	-	1465	-	-
Stage 1	684	645	-	900	807	-	-	-	-	-	-	-
Stage 2	875	806	-	674	629	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	485	506	802	505	491	957	1279	-	-	1465	-	-
Mov Cap-2 Maneuver	485	506	-	505	491	-	-	-	-	-	-	-
Stage 1	683	621	-	898	805	-	-	-	-	-	-	-
Stage 2	828	804	-	625	606	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.7	11.3	0.3	1.2
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1279	-	-	510	638	1465	-	-
HCM Lane V/C Ratio	0.003	-	-	0.087	0.101	0.031	-	-
HCM Control Delay (s)	7.8	0	-	12.7	11.3	7.5	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.3	0.3	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	5	3	5	61	160	21
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	92	92	92	92
Heavy Vehicles, %	10	10	10	13	27	10
Mvmt Flow	5	3	5	66	174	23

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	262	185	197	0	-	0
Stage 1	185	-	-	-	-	-
Stage 2	77	-	-	-	-	-
Critical Hdwy	6.5	6.3	4.2	-	-	-
Critical Hdwy Stg 1	5.5	-	-	-	-	-
Critical Hdwy Stg 2	5.5	-	-	-	-	-
Follow-up Hdwy	3.59	3.39	2.29	-	-	-
Pot Cap-1 Maneuver	710	837	1329	-	-	-
Stage 1	828	-	-	-	-	-
Stage 2	926	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	707	837	1329	-	-	-
Mov Cap-2 Maneuver	707	-	-	-	-	-
Stage 1	828	-	-	-	-	-
Stage 2	922	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.9	0.6	0
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1329	-	751	-	-
HCM Lane V/C Ratio	0.004	-	0.012	-	-
HCM Control Delay (s)	7.7	0	9.9	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

BAKER CORRIDOR
PLANNING STUDY

APPENDIX B: Roadway Geometric Analysis

Baker Corridor Planning Study

SUMMARY OF MDT CONTROLLING DESIGN CRITERIA
MAIN LINE SUMMARY (UNDIVIDED)

PROJECT:	BAKER CORRIDOR PLANNING STUDY	**ROUTE:**	US 12
PROJECT LOCATION:	CITY OF BAKER, FALLON COUNTY, MT	**BEGINNING RM:**	79.00
HIGHWAY SECTION:	BAKER	**ENDING RM:**	88.00
FUNCTIONAL CLASSIFICATION:	MINOR ARTERIAL		

TRAFFIC VOLUMES AND FACTORS:

CONSTRUCTION YEAR	DESIGN YEAR	TRAFFIC FACTORS
TBD	TBD	K=
AADT (VPD)	**AADT (VPD)**	D=
SEE TRAFFIC DATA	SEE TRAFFIC DATA	T=

THE POSTED SPEED LIMIT IS: 70 MPH **TERRAIN IS:** LEVEL **AVERAGE ELEVATION IS:**

LANE AND SHOULDER WIDTH:

	EXISTING (FT)	MDT RECOMMENDED MINIMUM (FT)
WIDTH OF TRAVELED WAY:	24	24
SHOULDER WIDTH:	2	2

VERTICAL ALIGNMENT AND STOPPING SIGHT DISTANCE:

VPI STATION	REFERENCE MARKER BEGIN	REFERENCE MARKER END	APPROACH GRADE (%)	DEPARTURE GRADE (%)	LENGTH OF CURVE (FT)	TYPE OF CURVE	MAX GRADE FIG. 12-4 (RURAL) FIG. 12-8 (URBAN) LEVEL=3% (RURAL) 7%(URBAN) (%)	K-VALUE: K=L/A (EQ. 10.5-2) EXISTING (FT)	K-VALUE: FIG. 12-4 (RURAL) FIG. 12-8 (URBAN) REQUIRED (FT)	STOPPING SIGHT DISTANCE: K=S^2/2158 (US) K=S^2/658 (METRIC) FIG. 10.5A EXISTING (FT)	STOPPING SIGHT DISTANCE: FIG. 12-4 (RURAL) FIG. 12-8 (URBAN) REQUIRED (FT)	DESIGN SPEED (MPH)	AS-BUILT PROJECT NUMBER	NOTES
1592+00.	78.93	79.12	-0.732	-0.200	1000	SAG	3	1879.70	136	2014.05	570	60	STPP 2-2(9)77	
1600+90.	79.00					Reference Point							STPP 2-2(9)77	
1612+00.	79.21	79.59	-0.200	-1.531	2000	CREST	3	1502.63	151	1800.74	570	60	STPP 2-2(9)77	
1628+00.	79.51	79.70	-1.531	0.250	1000	SAG	3	561.48	136	1100.76	570	60	STPP 2-2(9)77	
1640+00.	79.74	79.89	0.250	0.688	800	SAG	3	1826.48	136	1985.33	570	60	STPP 2-2(9)77	
1696+00.	80.80	81.18	0.688	-1.188	2000	CREST	3	1066.10	151	1516.79	570	60	STPP 2-2(9)77	
1712+00.	81.10	81.29	-1.188	0.200	1000	SAG	3	720.46	136	1246.90	570	60	STPP 2-2(9)77	
1739+50.	81.63	81.81	0.200	0.373	1000	SAG	3	5780.35	136	3531.85	570	60	STPP 2-2(9)77	
1765+00.	82.11	82.41	0.373	-0.824	1600	CREST	3	1336.68	151	1698.39	570	60	STPP 2-2(9)77	
1777+50.	82.34	82.50	-0.824	0.099	800	SAG	7	866.74	136	1367.63	570	60	STPP 2-2(9)77	Timber bridge beginning at 1782+11.5 63'-3 span struct.
1421+64.4	84.00					Reference Point							F-FG86	
1425+00.	84.06	84.14	0.648	1.705	400	SAG	7	378.43	51	903.69	253	35	F-FG86	Assumed 35MPH Design Speed through town starting at approx.
1429+00.	84.14	84.22	1.705	0.167	400	CREST	7	260.08	32	749.17	253	35	F-FG86	RM 82.5 and ending at RM 84.5
1435+00.	84.25	84.37	0.167	1.000	600	SAG	7	720.29	51	1246.75	253	35	F-FG86	
1443+00.	84.40	84.48	1.000	0.810	400	CREST	7	2105.26	32	2131.47	253	35	F-FG86	
1453+40.	84.60	84.68	0.810	0.112	400	CREST	7	573.07	151	1112.06	570	60	F-FG86	
1491+00.	85.31	85.39	0.112	0.386	400	SAG	3	1459.85	136	1774.93	570	60	F-FG86	
1514+00.	85.75	85.90	0.386	3.000	800	SAG	3	306.04	136	812.68	570	60	F-FG86	
1525+50.	85.97	86.16	3.000	-3.000	1000	CREST	3	166.67	151	599.72	570	60	F-FG86	213' Prestressed Concrete Structure
1537+00.	86.18	86.34	-3.000	1.047	800	SAG	3	197.68	136	653.14	570	60	F-FG86	
1576+00.	86.92	87.07	1.047	1.202	800	SAG	3	5161.29	136	3337.37	570	60	F-FG86	
1621+50.	87.79	87.97	1.202	-0.791	1000	CREST	3	501.76	151	1040.57	570	60	F-FG86	
1676+50.	88.83	88.94	-0.791	0.282	600	SAG	3	559.18	136	1098.50	570	60	F-FG86	

HORIZONTAL ALIGNMENT AND STOPPING SIGHT DISTANCE:

HPI STATION	REFERENCE MARKER BEGIN	REFERENCE MARKER END	SUPERELEVATION MDT MAX (FT/FT)	SUPERELEVATION EXISTING (FT/FT)	TYPE OF CURVE	DESIGN SPEED (MPH)	LENGTH EXISTING (FT)	SPIRAL LENGTH EXISTING (FT)	RADIUS EXISTING (FT)	RADIUS REQUIRED (FT)	EXISTING GRADE (%)	FIG. 8.6A HORIZONTAL SSD EXISTING (FT)	FIG. 8.6A HORIZONTAL SSD REQUIRED (FT)	AS-BUILT PROJECT NUMBER	
1600+90.	79.00				Reference Point									STPP 2-2(9)77	
1639+65.65	79.73				No Curve	60	Section Corner							STPP 2-2(9)77	
1692+58.28	80.74				No Curve	60	Section Corner							STPP 2-2(9)77	
1708+83.62	80.92	81.17	0.080	0.050	SPIRAL	60	885.21	200	2864.79	1200	-1.188%	578	570	STPP 2-2(9)77	
1728+40.79	81.30	81.53	0.080	0.070	SPIRAL	60	781.30	200	1909.86	1200	-0.200%	567	570	STPP 2-2(9)77	
1777+08.2	82.28	82.39	0.080	0.050	SPIRAL	60	173.31	200	2864.79	1200	-0.824%	574	570	STPP 2-2(9)77	
1357+00.	82.60				Reference Point									F-(86)19	
1380+22.3	83.04				No Curve	35								F-(86)19	Assumed 35MPH Design Speed through town
1404+82.5	83.47	83.54	0.040	N.C.	SIMPLE	35	380.8		2865	392	0.030%	246	253	F-(86)19	starting at approx. RM 82.5 and ending at
1421+64.4	84.00				No Curve		Reference Point							F-FG86(30)	RM 84.5
1455+89.9	84.32	84.97	0.080	N.C.	SIMPLE	35	3443.2		5730	392	0.112%	246	253	F-FG86(30)	
1491+18.4	85.24	85.40	0.080	0.080	SIMPLE	60	842.2		1910	1200	0.386%	562	570	F-FG86(30)	
1512+71.4	85.51	85.94	0.080	0.080	SIMPLE	60	2256.7		1910	1200	3.000%	538	570	F-FG86(30)	

SUMMARY OF MDT CONTROLLING DESIGN CRITERIA
MAIN LINE SUMMARY (UNDIVIDED)

PROJECT:	BAKER CORRIDOR PLANNING STUDY	**ROUTE:**	MT 7
PROJECT LOCATION:	CITY OF BAKER, FALLON COUNTY, MT	**BEGINNING RM:**	31.500
HIGHWAY SECTION:	BAKER	**ENDING RM:**	38.00
FUNCTIONAL CLASSIFICATIOI	MINOR ARTERIAL		

TRAFFIC VOLUMES AND FACTORS:

CONSTRUCTION YEAR	**DESIGN YEAR**	**TRAFFIC FACTORS**
TBD	TBD	**K=**
AADT (VPD)	**AADT (VPD)**	**D=**
SEE TRAFFIC DATA	SEE TRAFFIC DATA	**T=**

THE POSTED SPEED LIMIT IS: 70 MPH **TERRAIN IS:** LEVEL **AVERAGE ELEVATION IS:**

LANE AND SHOULDER WIDTH:

	EXISTING	**RM**		**MDT RECOMMENDED MINIMUM**	
	(M)	**FROM**	**TO**	**(FT)**	***(M)***
WIDTH OF TRAVELED WAY:	*3.6*	32	35.4	24	*3.6*
SHOULDER WIDTH:	*0.6*	32	34.8	2	*0.6*
SHOULDER WIDTH:	*2.75*	34.8	35.3		
SHOULDER WIDTH:	*0.45*	35.3	35.4		

VPI STATION	REFERENCE MARKER BEGIN	REFERENCE MARKER END	APPROACH GRADE (%)	DEPARTURE GRADE (%)	LENGTH OF CURVE (FT)/*(M)*	TYPE OF CURVE	MAX GRADE FIG. 12-4 (RURAL) FIG. 12-8 (URBAN) LEVEL=3% (RURAL) 7%(URBAN) %	K-VALUE EXISTING (FT)/*(M)* K=L/A (MDT ROAD DESIGN MANUAL EQ. 10.5-2)	K-VALUE REQUIRED (FT)/*(M)* FIG. 12-4 (RURAL) FIG. 12-8 (URBAN)	STOPPING SIGHT DISTANCE EXISTING (FT)/*(M)* K=S^2 / 2158 (US) K=S^2/658 (METRIC) FIG. 10.5A	STOPPING SIGHT DISTANCE REQUIRED (FT)/*(M)* FIG. 12-4 (RURAL) FIG. 12-8 (URBAN)	EXISTING SPEED (MPH)/*(kph)*	AS-BUILT PROJECT NUMBER	NOTES
127+90.	31.00					Reference Point								
131+00.	31.19	31.25	-0.991	0.800	*300*	SAG	3	*167.50*	*45*	331.99	*185*	*90*	STPP-STPE 27-2(14)29	*Metric Job, Existing Speed*
136+50.	31.53	31.63	0.800	-2.070	*500*	CREST	3	*174.22*	*52*	338.58	*185*	*90*	STPP-STPE 27-2(14)29	*Limit based on Signing Plans in As-Builts*
142+20.	31.89	31.95	-2.070	-2.491	*300*	CREST	3	*712.59*	*52*	684.75	*185*	*90*	STPP-STPE 27-2(14)29	
147+40.	32.21	32.25	-2.491	0.732	*200*	SAG	3	*62.05*	*45*	202.07	*185*	*90*	STPP-STPE 27-2(14)29	
151+50.	32.47	32.54	0.732	-1.247	*400*	CREST	3	*202.12*	*52*	364.69	*185*	*90*	STPP-STPE 27-2(14)29	
160+80.	33.04	33.10	-1.247	1.077	*300*	SAG	3	*129.09*	*45*	291.44	*185*	*90*	STPP-STPE 27-2(14)29	
166+00.	33.37	33.41	1.077	3.975	*200*	SAG	4	*69.01*	*45*	213.10	*185*	*90*	STPP-STPE 27-2(14)29	
170+00.	33.62	33.68	3.975	-0.241	*320*	CREST	4	*75.90*	*52*	223.48	*185*	*90*	STPP-STPE 27-2(14)29	
178+30.	34.13	34.18	-0.241	-3.930	*270*	CREST	4	*73.19*	*52*	219.45	*185*	*90*	STPP-STPE 27-2(14)29	
182+60.	34.40	34.44	-3.930	-1.750	*240*	SAG	4	*110.09*	*23*	269.15	*105*	*65*	STPP-STPE 27-2(14)29	Assumed 35MPH/65KPH Design Speed
188+60.	34.77	34.81	-1.750	-1.294	*200*	SAG	7	*438.60*	*18*	537.21	*85*	*65*	STPP-STPE 27-2(14)29	through town starting at approx. RM 34.3 and ending at RM 37.0
192+00.	34.98	35.02	-1.294	0.312	*200*	SAG	7	*124.53*	*18*	286.26	*85*	*65*	STPP-STPE 27-2(14)29	
196+17.	35.24	35.26	0.312	-0.326	*100*	CREST	7	*156.74*	*11*	321.15	*85*	*65*	STPP-STPE 27-2(14)29	
7+50.	35.65	35.69	-0.60	-2.50	200	CREST	7	105.26	14	476.61	253	35	F-2(12)	US Units
11+70.	35.75	35.83	-2.50	0.09	400	SAG	7	154.44	21	577.31	253	35	F-2(12)	
18+00.	35.83		0.09	0.00		NO V.C.							F-2(12)	
26+94.	36.00					Reference Point							F-2(12)	
27+00.	36.00	36.11	0.00	1.56	600	SAG	7	384.62	51	911.04	253	35	F-2(12)	
35+00.	36.15	36.27	1.56	0.07	600	CREST	3	401.61	32	930.95	253	35	F-2(12)	
45+00.	36.34	36.38	0.07	0.50	200	SAG	3	456.62	51	992.67	253	35	F-2(12)	
59+00.	36.61	36.80	0.50	3.00	1000	SAG	4	400.64	51	929.83	253	35	F-2(12)	
73+50.	36.88	37.13	3.00	-2.55	1300	CREST	4	234.23	32	710.97	253	35	F-2(12)	
82+50.	37.05	37.15	-2.55	3.10	500	SAG	4	88.50	136	437.01	570	60	F-2(12)	
88+50.	37.17	37.26	3.10	0.60	500	CREST	4	200.00	151	656.96	570	60	F-2(12)	
97+50.	37.34	37.45	0.60	4.66	600	SAG	4	147.78	136	564.73	570	60	F-2(12)	
109+20.	37.56	37.86	4.66	-2.82	1600	CREST	4	213.90	136	679.41	570	60	F-2(12)	
120+60.	37.77	37.89	-2.82	1.50	600	SAG	4	138.89	136	547.47	570	60	F-2(12)	

HORIZONTAL ALIGNMENT AND STOPPING SIGHT DISTANCE:

HPI STATION	REFERENCE MARKER BEGIN	REFERENCE MARKER END	SUPERELEVATION MDT MAX (FT/FT)	SUPERELEVATION EXISTING (FT/FT)	TYPE OF CURVE	DESIGN SPEED (MPH)/*(kph)*	LENGTH EXISTING (FT)/*(M)*	SPIRAL LENGTH EXISTING (FT)/*(M)*	RADIUS EXISTING (FT)/*(M)*	RADIUS REQUIRED (FT)/*(M)*	EXISTING GRADE (%)	FIG. 8.6A HORIZONTAL SSD EXISTING (FT)/*(M)*	FIG. 8.6A HORIZONTAL SSD REQUIRED (FT)/*(M)*	AS-BUILT PROJECT NUMBER	NOTES
127+90.	31.00				Reference Point									STPP-STPE 27-2(14)29	
146+07.53	31.91	32.35		N.C.	SIMPLE	*90*	*721.40*		*3500*	*305*	-2.491%	*162*	*160*	STPP-STPE 27-2(14)29	*Metric Job, Existing Speed*
166+61.8	33.37	33.44		N.C.	SIMPLE	*90*	*123.60*		*3500*	*305*	3.975%	*145*	*160*	STPP-STPE 27-2(14)29	*Limit based on Signing Plans in As-Builts*
168+89.26	33.51	33.59		N.C.	SIMPLE	*90*	*123.60*		*3500*	*305*	3.975%	*145*	*160*	STPP-STPE 27-2(14)29	
194+67.57	35.03	35.27		N.C.	SIMPLE	*65*	*381.60*		*620*	*158*	0.312%	*93*	*95*	STPP-STPE 27-2(14)29	Assumed 35MPH/65KPH Design Speed
26+94.	36.00				Reference Point									F-2(12)	through town starting at approx. RM 34.3 and
28+43.	35.90	36.16		N.C.	SIMPLE	35	1365.0		5730	253	1.560%	241	253	F-2(12)	ending at RM 37.0

SUMMARY OF MDT CONTROLLING DESIGN CRITERIA
MAIN LINE SUMMARY (UNDIVIDED)

PROJECT:	BAKER CORRIDOR PLANNING STUDY	**ROUTE:**	ROUTE 493
PROJECT LOCATION:	CITY OF BAKER, FALLON COUNTY, MT	**BEGINNING RM:**	0.00
HIGHWAY SECTION:	BAKER	**ENDING RM:**	2.50
FUNCTIONAL CLASSIFICATION:	MAJOR COLLECTOR		

TRAFFIC VOLUMES AND FACTORS:

CONSTRUCTION YEAR	DESIGN YEAR	TRAFFIC FACTORS
TBD	TBD	K=
AADT (VPD)	**AADT (VPD)**	D=
SEE TRAFFIC DATA	SEE TRAFFIC DATA	T=

THE POSTED SPEED LIMIT IS: 60 MPH **TERRAIN IS:** LEVEL **AVERAGE ELEVATION IS:**

LANE AND SHOULDER WIDTH:

	EXISTING (FT)	MDT RECOMMENDED MINIMUM (FT)
WIDTH OF TRAVELED WAY:	24	24
SHOULDER WIDTH:	2	2

VERTICAL ALIGNMENT AND STOPPING SIGHT DISTANCE:

VPI STATION	REFERENCE MARKER BEGIN	REFERENCE MARKER END	APPROACH GRADE (%)	DEPARTURE GRADE (%)	LENGTH OF CURVE (FT)	TYPE OF CURVE	MAX GRADE FIGURE 12-5 LEVEL: 5% %	K VALUE EXISTING K=L/A (EQ. 10.5-2) (FT)	K VALUE REQUIRED FIGURE 12-5 (FT)	STOPPING SIGHT DISTANCE EXISTING K=S^2 / 2158 (US) K=S^2/658 (METRIC) FIG. 10.5A (FT)	STOPPING SIGHT DISTANCE REQUIRED FIGURE 12-5 (FT)	DESIGN SPEED (MPH)	AS-BUILT PROJECT NUMBER	NOTES
697+99.5	2.50					Reference Point								
720+00.	2.08	2.01	-0.300	-1.481	400	CREST	5	338.70	84	854.93	425	50	S-398(1)	Assumed 50 MPH Design Speed
730+00.	1.89	1.86	-1.481	-0.517	200	SAG	5	207.47	96	669.12	425	50	S-398(1)	
740+00.	1.70	1.67	-0.517	-0.104	200	SAG	5	484.26	96	1022.27	425	50	S-398(1)	
750+00.	1.52	1.48	-0.104	0.288	200	SAG	5	510.20	96	1049.30	425	50	S-398(1)	
759+00.	1.34	1.31	0.288	1.485	200	SAG	5	167.08	96	600.47	425	50	S-398(1)	
768+00.	1.17	1.02	1.485	-2.643	800	CREST	5	193.80	84	646.70	425	50	S-398(1)	
779+50.	0.96	0.88	-2.643	1.0886	400	SAG	5	107.19	96	480.96	425	50	S-398(1)	
790+00.	0.76	0.61	1.089	-2.453	800	CREST	5	225.89	84	698.19	425	50	S-398(1)	
802+00.	0.53	0.45	-2.453	-0.148	400	SAG	5	173.54	96	611.96	425	50	S-398(1)	
810+00.	0.38	0.34	-0.148	1.402	200	SAG	5	129.03	96	527.69	425	50	S-398(1)	
814+00.	0.30	0.19	1.402	-2.833	600	CREST	5	141.68	84	552.94	425	50	S-398(1)	
820+00.	0.19	0.08	-2.833	0.646	600	SAG	5	172.46	96	610.06	425	50	S-398(1)	

HORIZONTAL ALIGNMENT AND STOPPING SIGHT DISTANCE:

HPI STATION	REFERENCE MARKER BEGIN	REFERENCE MARKER END	SUPERELEVATION MDT MAX (FT/FT)	SUPERELEVATION EXISTING (FT/FT)	TYPE OF CURVE	DESIGN SPEED (MPH)	LENGTH EXISTING (FT)	SPIRAL LENGTH EXISTING (FT)	RADIUS EXISTING (FT)	RADIUS REQUIRED (FT)	EXISTING GRADE (%)	FIG. 8.6A HORIZONTAL SSD EXISTING (FT)	FIG. 8.6A HORIZONTAL SSD REQUIRED (FT)	AS-BUILT PROJECT NUMBER	
697+99.5	2.50				Reference Point										
720+43.6	2.18	1.97	0.080	N.C.	SIMPLE	50	1060.0		955.0	760	-1.481%	434	425	S-398(1)	Assumed 50 MPH Design Speed
743+00.	1.75	1.55	0.080	N.C.	SIMPLE	50	1064.7		955.0	760	-0.104%	424	425	S-398(1)	
784+67.1	0.96	0.75	0.080	N.C.	SIMPLE	50	1125.0		716.3	760	-2.643%	443	425	S-398(1)	

HORIZONTAL ALIGNMENT SUMMARY			
APPROXIMATE RM OF CURVE CENTER	**LENGTH OF CURVE (FT)/*(M)***	**RADIUS (FT)/*(M)***	**HORIZ. SSD (FT)/*(M)***
MT 12 (P-2) FROM RM 79 TO RM 82.63 AS-BUILT PROJECT: STPP-2-2(9)77			
81.04	885.21	2864.79	578
81.41	781.30	1909.86	567
82.34	173.31	2864.79	574
MT 12 (P-2) FROM RM 82.63 TO RM 83.78 AS-BUILT PROJECT: F-(86)19			
83.51	380.8	2865	246
MT 12 (P-2) FROM RM 83.78 TO RM 88 AS-BUILT PROJECT: F-FG86(30)			
84.65	3443.2	5730	246
85.32	842.2	1910	562
85.72	2256.7	1910	538
MT 7 (P-27) FROM RM 32 TO RM 35 AS-BUILT PROJECT: STPP-STPE 27-2(14)29			
32.13	*721.40*	***3500***	162
33.41	*123.60*	***3500***	145
33.55	*123.60*	***3500***	145
35.15	*381.60*	***620***	93
MT 7 (P-27) FROM RM 35 TO RM 38 AS-BUILT PROJECT: F-2(12)			
36.03	1365	5730	241
ROUTE 493 (S-793) FROM RM 0 TO RM 2.5 AS-BUILT PROJECT: F-2(12)			
2.07	1060.0	955.0	434
1.65	1064.7	955.0	424
0.86	1125.0	716.3	443

METRIC
US

Design Requirements referenced from MDT
Road Design Manual: Figure 12-4 "Rural Minor Arterials",
Figure 12-5 "Rural Collector Roads", and Figure 12-8
Urban Minor Arterials

VERTICAL ALIGNMENT SUMMARY						
APPROXIMATE RM OF CURVE CENTER	**TYPE OF CURVE**	**LENGTH (FT)/*(M)***	**GRADE IN (G1)%**	**GRADE OUT (G2)%**	**K-VALUE**	**STOPPING SIGHT DISTANCE (SSD) (FT)/*(M)***
MT 12 (P-2) FROM RM 79 TO RM 83 AS-BUILT PROJECT: STPP 2-2(9)77						
79.02	SAG	1000	-0.7320	-0.2000	1879.70	2014.05
79.40	CREST	2000	-0.2000	-1.5310	1502.63	1800.74
79.61	SAG	1000	-1.5310	0.2500	561.48	1100.76
79.82	SAG	800	0.2500	0.6880	1826.48	1985.33
80.99	CREST	2000	0.6880	-1.1880	1066.10	1516.79
81.20	SAG	1000	-1.1880	0.2000	720.46	1246.90
81.72	SAG	1000	0.2000	0.3730	5780.35	3531.85
82.26	CREST	1600	0.3730	-0.8240	1336.68	1698.39
82.42	SAG	800	-0.8240	0.0990	866.74	1367.63
MT 12 (P-2) FROM RM 84 TO RM 89 AS-BUILT PROJECT: F-FG86						
84.10	SAG	400	0.6480	1.7050	378.43	903.69
84.18	CREST	400	1.7050	0.1670	260.08	749.17
84.31	SAG	600	0.1670	1.0000	720.29	1246.75
84.44	CREST	400	1.0000	0.8100	2105.26	2131.47
84.64	CREST	400	0.8100	0.1120	573.07	1112.06
85.35	SAG	400	0.1120	0.3860	1459.85	1774.93
85.82	SAG	800	0.3860	3.0000	306.04	812.68
86.06	CREST	1000	3.0000	-3.0000	166.67	599.72
86.26	SAG	800	-3.0000	1.0470	197.68	653.14
87.00	SAG	800	1.0470	1.2020	5161.29	3337.37
87.88	CREST	1000	1.2020	-0.7910	501.76	1040.57
88.88	SAG	600	-0.7910	0.2820	559.18	1098.50
MT 7 (P-27) FROM RM 31 TO RM 35 AS-BUILT PROJECT: STPP-STPE 27-2(14)29						
31.22	SAG	*300*	-0.9910	0.8000	***167.50***	***331.99***
31.58	CREST	*500*	0.8000	-2.0700	***174.22***	***338.58***
31.92	CREST	*300*	-2.0700	-2.4910	***712.59***	***684.75***
32.23	SAG	*200*	-2.4910	0.7320	***62.05***	***202.07***
32.50	CREST	*400*	0.7320	-1.2470	***202.12***	***364.69***
33.07	SAG	*300*	-1.2470	1.0770	***129.09***	***291.44***
33.39	SAG	*200*	1.0770	3.9750	***69.01***	***213.10***
33.65	CREST	*320*	3.9750	-0.2410	***75.90***	***223.48***
34.16	CREST	*270*	-0.2410	-3.9300	***73.19***	***219.45***
34.42	SAG	*240*	-3.9300	-1.7500	***110.09***	***269.15***
34.79	SAG	*200*	-1.7500	-1.2940	***438.60***	***537.21***
35.00	SAG	*200*	-1.2940	0.3120	***124.53***	***286.26***
35.25	CREST	*100*	0.3120	-0.3260	***156.74***	***321.15***
MT 7 (P-27) FROM RM 35 TO RM 38 AS-BUILT PROJECT: F-2(12)						
35.67	CREST	200	-0.6000	-2.5000	105.26	476.61
35.79	SAG	400	-2.5000	0.0900	154.44	577.31
35.83	NO V.C.		0.0900	0.0000		

APPROXIMATE RM OF CURVE CENTER	TYPE OF CURVE	LENGTH (FT)/*(M)*	GRADE IN (G1)%	GRADE OUT (G2)%	K-VALUE	STOPPING SIGHT DISTANCE (SSD) (FT)/*(M)*
36.06	SAG	600	0.0000	1.5600	384.62	911.04
36.21	CREST	600	1.5600	0.0660	401.61	930.95
36.36	SAG	200	0.0660	0.5040	456.62	992.67
36.70	SAG	1000	0.5040	3.0000	400.64	929.83
37.00	CREST	1300	3.0000	-2.5500	234.23	710.97
37.10	SAG	500	-2.5500	3.1000	88.50	437.01
37.21	CREST	500	3.1000	0.6000	200.00	656.96
37.39	SAG	600	0.6000	4.6600	147.78	564.73
37.71	CREST	1600	4.6600	-2.8200	213.90	679.41
37.83	SAG	600	-2.8200	1.5000	138.89	547.47
ROUTE 493 (S-793) FROM RM 0 TO RM 2.5 AS-BUILT PROJECT: S-398(1)						
2.05	CREST	400	-0.3	-1.481	338.70	854.93
1.87	SAG	200	-1.481	-0.517	207.47	669.12
1.69	SAG	200	-0.517	-0.104	484.26	1022.27
1.50	SAG	200	-0.104	0.288	510.20	1049.30
1.33	SAG	200	0.288	1.485	167.08	600.47
1.10	CREST	800	1.485	-2.643	193.80	646.70
0.92	SAG	400	-2.643	1.0886	107.19	480.96
0.68	CREST	800	1.0886	-2.453	225.89	698.19
0.49	SAG	400	-2.453	-0.148	173.54	611.96
0.36	SAG	200	-0.148	1.402	129.03	527.69
0.25	CREST	600	1.402	-2.833	141.68	552.94
0.13	SAG	600	-2.833	0.646	172.46	610.06

METRIC

US

FAILED BASED ON MDT DESIGN REQUIREMENTS

Design Requirements referenced from MDT Road Design Manual: Figure 12-4 "Rural Minor Arterials", Figure 12-5 "Rural Collector Roads", and Figure 12-8 Urban Minor Arterials

RIGHT-OF WAY WIDTHS

MT 12 (P-2) FROM RM 79 TO RM 82.63
AS-BUILT PROJECT: STPP 2-2(9)77

RP	NORTH	SOUTH
78.88	110	100
79.29	110	100
79.30	110	80
79.48	110	80
79.50	110	110
79.76	110	110
79.77	110	100
80.08	110	100
80.10	110	80
80.39	110	80
80.41	110	110
80.47	110	110
80.48	110	100
80.66	110	100
80.67	110	110
80.92	110	110
80.96	110	100
81.11	110	100
81.13	110	120
81.16	110	120
81.20	110	80
81.26	110	80
81.27	110	110
81.37	110	110
81.39	110	130
81.45	110	130
81.46	110	110
81.79	110	110
81.80	110	100
81.87	110	100
81.88	110	110
82.01	110	110
82.03	90	110
82.05	90	110
82.07	90	90
82.15	90	90
82.16	90	70
82.26	90	70
82.26	80	70
82.27	80	70
82.28	80	80
82.44	80	80
82.46	60	80
82.62	60	80

MT 12 (P-2) FROM RM 82.63 TO RM 83.78 AS-BUILT PROJECT: F-(86)19		
RP	NORTH	SOUTH
82.6	31	35
82.7	27	39
82.7	27	31

MT 12 (P-2) FROM RM 83.78 TO RM 88 AS-BUILT PROJECT: F-FG86(30)		
RP	NORTH	SOUTH
84.00	30	70
84.31	40	60.5
84.97	40	50
84.97	40	80
85.08	40	80
85.09	40	50
85.23	40	50
85.24	40	70
85.35	80	70
85.37	80	100
85.47	80	100
85.48	80	80
85.73	80	80
85.92	90	90
86.08	90	90
86.09	80	80
86.16	80	80
86.16	80	100
86.22	80	100
86.22	80	80
86.34	80	80
86.34	80	90
87.35	80	90
87.35	80	65
87.60	80	65
87.60	80	80
87.68	80	80
87.70	100	80
87.72	100	80
87.74	80	80
88.00	80	80

MT 7 (P-27) FROM RM 32 TO RM 35 AS-BUILT PROJECT: STPP-STPE 27-2(14)29 (METRIC)		
RP	WEST	EAST
31.90	27	26.6
31.94	33	26.6
32.03	33	26.6
32.05	26	26.6
32.37	26	26.6
32.39	30	26.6
32.55	30	35.82

32.60	30	35.82
32.62	47	35.82
32.62	47	35.82
32.63	47	41
32.67	47	41
32.70	34	41
32.72	34	31.37
32.77	34	31.37
32.78	31	31.37
33.04	31	
33.05	28	
33.21	28	31.26
33.21	28	31.26
33.27	54	31.26
33.29	54	31.26
33.34	25	31.26
33.37	25	31.26
33.44	22.7	31.15
33.75	22.7	22.99
33.78	29	25
33.84	29	25
33.85	22.73	25
34.01	22.78	25
34.03	29	25
34.13	29	25
34.14	33	25
34.18	33	25
34.20	22.84	25
34.20	22.84	25
34.21	22.91	22.81
34.46	20.52	22.76
34.46-35.11	EX. R/W	EX. R/W
35.11	EX. R/W	10.02
35.11	EX. R/W	12
35.13	EX. R/W	12
35.14	EX. R/W	14
35.16	EX. R/W	15
35.18	12	15
35.19	12	15
35.19	13.2	15
35.19	13.2	22
35.20	22.2	14
35.20	26.55	12.3
35.21	28.1	10.97
35.21	33.82	10.97
35.22	5.95	10.97
35.39	5.95	10.97

MT 7 (P-27) FROM RM 35 TO RM 38
AS-BUILT PROJECT: F-2(12)

RP	EAST	WEST
35.76	70	60
37.37	70	60
37.37	70	80
37.52	70	80

37.52	80	80
37.59	80	80
37.59	70	60
38.00	70	60

ROUTE 493 (S-793) FROM RM 0 TO RM 2.5
AS-BUILT PROJECT: F-2(12)

RP	NORTH/EAST	SOUTH/WEST
2.50	70	60
2.16	70	60
2.15	70	70
1.95	70	70
1.93	50	70
1.33	50	70
1.31	70	90
1.30	90	90
1.08	90	90
1.06	70	70
0.84	70	70
0.83	70	80
0.75	70	80
0.74	80	80
0.61	80	80
0.59	80	60
0.28	80	60
0.28	70	60
0.06	70	60
0.02	100	90
0.00	100	90

CLEAR ZONE SUMMARY

RM FROM-TO	SIDE OF ROAD	DESCRIPTION
MT 12 (P-2) FROM RM 79 TO RM 83 AS-BUILT PROJECT: STPP 2-2(9)77		
79.88	North and South	Dual 120" CSP 30' N/S from ETW. 6:1 Slopes
80.22	North and South	73" Drain 50' North 34' South From ETW 6:1 Slopes
81.15	North and South	54" Drain 80' North 60' South from ETW 4:1 Slopes
81.39	North and South	72" Drain and Stockpass 58' North 65' South from ETW 4:1 Slopes
81.88	North and South	60" Drain 60' North 50' South from ETW 4:1 Slopes
81.97	North and South	60" Drain 60' North 60' South from ETW 4:1 Slopes
82.39 - 82.44	North	Guardrail for Structure
82.42 - 82.47	South	Guardrail for Structure
MT 12 (P-2) FROM RM 83.78 TO RM 88 AS-BUILT PROJECT: F-FG86(30)		
85.78 - 86.00	South	Guardrail For Structure
85.92 - 86.02	North	Guardrail For Structure
86.18	North and South	16'5" SSPPA 34' N/S from ETW 3:1 Slopes
MT 7 (P-27) FROM RM 32 TO RM 35 AS-BUILT PROJECT: STPP-STPE 27-2(14)29		
31.02	East and West	1350 mm DR. 100' E/W Steep 3:1 Slopes
32.66	East and West	2700 mm DR. 85' E/W 3:1 Slopes
33.03	East and West	2400 mm Dr. 40' 3:1 Slopes
35.2	East and West	4800mm x 1200mm Box Culverts 13' East 20' West from ETW 3:1 Slopes
MT 7 (P-27) FROM RM 35 TO RM 38 AS-BUILT PROJECT: F-2(12)		
35.79 TO 35.84	East and West	Guardrail for Structure
ROUTE 493 (S-793) FROM RM 0 TO RM 2.5 AS-BUILT PROJECT: F-2(12)		
0.2	North and South	66" CSP 20' North 28' South 4:1 Slopes

AADT TAKEN FROM 5 YEAR CRASH SUMMARY ANALYSIS

ROUTE	AVE AADT	RM FROM	RM TO
US 12	1088	77	82
US 12	3025	82	83
US 12	2508	83	88
US 12	886	88	90
MT 7	654	31	34

*Clear Zone analyzed using the AADT from the 5 Year Crash Summary Analysis and Figure 14.2A (English and Metric) from the MDT Road Design Manual. Slopes are approximate and derived from the As-Built plan and profile.

CULVERY SUMMARY

MT 12 (P-2) FROM RM 79 TO RM 82.63 AS-BUILT PROJECT: STPP 2-2(9)77			
Station	Size	Length	Remarks
79.01	48"	156'	Drain
79.36	24"	128'	Drain
79.59	36"	130'	Drain
79.61	48"	124'	Drain
79.77	120"	120'	Drain
79.78	120"	120'	Drain
80.11	28.5"x18"	100'	Drain
80.22	73"x45"	128'	Drain
80.48	28"x20"	90'	Drain
80.61	24"	108'	Drain
81.15	54"	272'	Drain
81.39	72"	180'	Drain
81.73	24"	166'	Drain
81.88	60"	176'	Drain
81.97	60"	238'	Drain
82.19	28"x20"	100'	Drain
82.24	28.5"x18"	96'	Drain
MT 12 (P-2) FROM RM 82.63 TO RM 83.78 AS-BUILT PROJECT: F-(86)19			
82.67	24"	66'	Drain
82.69	18"	164'	Drain
82.74	18"	310'	Drain
82.80	15"	124'	Drain
82.80	18"x11"	138'	Drain
83.46	29"x18"	58'	Drain
83.62	29"x18"	64'	Drain
MT 12 (P-2) FROM RM 83.78 TO RM 88 AS-BUILT PROJECT: F-FG86(30)			
84.01	29"X18"	51'	Drain
84.21	24"	72'	Drain
84.48	30"	59'	Drain
84.58	30"	59'	Drain
84.65	24"	59'	Drain
84.77	24"	82'	Drain
84.78	24"	82'	Drain
85.22	24"	95'	Drain
85.60	24"	88'	Drain
85.79	24"	132'	Drain
85.90	48"	188'	Drain
86.18	198"x132"	122'	Drain
86.74	24"	90'	Drain
87.37	24"	97'	Drain
87.54	36"	124'	Drain
88.05	24"	120'	Drain

MT 7 (P-27) FROM RM 32 TO RM 35
AS-BUILT PROJECT: STPP-STPE 27-2(14)29
(METRIC)

31.02	1350mm	78m	Drain
31.27	600mm	40.4m	Drain
31.36	600mm	53.8m	Drain
31.89	1240mm x 840mm	24.6m	Drain
32.22	750mm	36m	Drain
32.27	600mm	36.8m	Drain
32.66	2700mm	70Jm	Drain
32.77	600mm	47.2m	Drain
33.03	2400mm	42Jm	Drain
33.20	900mm	32.8m	Drain
33.40	600mm	26.4m	Drain
33.69	600mm	23.4m	Drain
33.78	600mm	44Jm	Drain
33.85	600mm	33.2m	Drain
34.05	600mm	38m	Drain
34.30	600mm	21.6m	Drain
34.53	725mm x 460mm	17Jm	Drain
34.65	600mm	21.3m	Drain
35.20	4800mm x 1200mm	36.6m	Drain

MT 7 (P-27) FROM RM 35 TO RM 38
AS-BUILT PROJECT: F-2(12)

35.95	36"	78'	Drain
36.03	24"	70'	Drain
36.85	24"	72'	Drain
37.04	18"	38'	Drain
37.17	24"	67'	Drain
37.30	24"	86'	Drain
37.55	24"	98'	Drain
37.76	24"	96'	Drain
37.86	24"	92'	Drain
38.20	24"	85'	Drain
38.31	36"	62'	Drain

ROUTE 493 (S-793) FROM RM 0 TO RM 2.5
AS-BUILT PROJECT: F-2(12)

2.48	24"	80'	Drain
2.31	24"	100'	Drain
1.89	24"	80'	Drain
1.52	24"	72'	Drain
0.98	24"	102'	Drain
0.90	24"	102'	Drain
0.76	24"	92'	Drain
0.41	24"	72'	Drain
0.20	96"	104'	Drain

BAKER CORRIDOR
PLANNING STUDY

APPENDIX C: Environmental Scan Report

Baker Corridor Planning Study

BAKER CORRIDOR
PLANNING STUDY

Environmental Scan Report

Baker Corridor Planning Study

February 2015

Prepared by:

Montana Department of Transportation

MONTANA MDT DEPARTMENT OF TRANSPORTATION

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Attachments

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Abbreviations and Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACS	American Community Survey
CAPS	Crucial Areas Planning System
CEIC	Census and Economic Information Center
CFR	Code of Federal Regulations
CRABS	Cultural Resource Annotated Bibliography System
CRIS	Cultural Resource Information Systems
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
DOC	Montana Department of Commerce
DOLI	Montana Department of Labor and Industry
EO	Executive Order
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Maps
FPPA	Farmland Protection Policy Act
FWP	Montana Department of Fish, Wildlife, and Parks
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LUST	Leaking Underground Storage Tank
LWCFA	Land and Water Conservation Fund Act
MBMG	Montana Bureau of Mines and Geology
MBTA	Migratory Bird Treaty Act
MDT	Montana Department of Transportation
MEPA	Montana Environmental Policy Act
MFISH	Montana Fisheries Information System
MNHP	Montana Natural Heritage Program
MPDES	Montana Pollutant Discharge Elimination System
MSATs	Mobile Source Air Toxics
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NPL	National Priority List

NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRIS	Natural Resource Information System
NWI	National Wetlands Inventory
PESC	Permanent Erosion and Sediment Control
PM	Particulate Matter
RP	Reference Post
SFHA	Special Flood Hazard Area
SHPO	State Historic Preservation Office
SOC	Species of Concern
T&E	Threatened and Endangered
TMDL	Total Maximum Daily Load
UM	University of Montana
USACE	United States Army Corps of Engineers
USC	United States Code
USCB	United States Census Bureau
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USNPS	United States National Park Services
UST	Underground Storage Tank

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1. Introduction

The primary objective of this environmental scan report is to provide a planning-level overview of resources and determine potential constraints and opportunities for the Baker Corridor Planning Study. Information in this report was obtained from publically available reports, websites, and documentation. This scan is not a detailed environmental investigation.

If improvement options are forwarded from this study into project development, an analysis for compliance with the National and Montana Environmental Policy Acts (NEPA and MEPA) will be completed as part of the Montana Department of Transportation (MDT) project development process. Information provided in this report may be forwarded into the NEPA/MEPA process at that time.

1.1 Study Area

The Baker Study Area is located in southeast Montana in Fallon County. Land use within the Study Area varies considerably, and includes developed lands consisting of industrial sites (oil and gas), roads, residential, and other commercial enterprises (40%); Great Plains Mixed Grass Prairie (20%); agricultural (20%); and Big Sagebrush Steppe (15%); all interspersed with Great Plains Riparian (5%).

Baker is located at the intersection of US Highway 12 (US 12) and Montana Highway 7 (MT 7). US 12 is known as the Lewis and Clark Highway, despite not being the route followed by Lewis and Clark across the state of Montana. US 12 was first created in 1926. It enters Montana at Lolo Pass and travels east to Baker, at which point it continues east to southwestern North Dakota. MT 7 is a south to north state highway established in 1930 that extends from Ekalaka to Wibaux. MT 7 passes along the east side of Medicine Rocks State Park approximately 25 miles south of Baker. Most of downtown Baker was built during the early to mid-1900s. The discovery of natural gas in 1915 began the oil and gas exploration boom, which lasted into the 1970s. This boom drove the building of downtown Baker during the early to mid-1900s. Technological advances in recent years have allowed for extraction of oil and natural gas that was once inaccessible, providing renewed population and economic growth in the area known as the Bakken region due to the oil formation that the City of Baker sits in.

The Study Area for this environmental scan report includes an approximate 53 square mile area centered on the City of Baker. The Study Area is rectangular and begins at Reference Marker (RM) 79 of US 12 to RM 88 of US 12, and RM 31.9 to RM 37.6 of MT 7. Multiple maps have been prepared to illustrate resources present in the Study Area. For ease of reference, all exhibits are included in Attachment 1. Exhibit 1 is an illustration of the Study Area location, and Exhibit 2 is a topographic map of the Study Area.

1.2 Goals of Study

The main intersection in Baker is the junction of US 12 / MT 7, and is used by passenger vehicles both traveling through town and for local access, as well as heavy vehicular freight in large numbers traveling to and from the nearby Bakken region. The growth of the oil industry in the region is increasing the volume of traffic in the area. Because of this growth, the City of

Baker has identified a need for a planning study to investigate alternative corridor/alignment options and determine a preferred route for US 12 / MT 7 in the Baker area.

The goal of the study is to identify a preferred alternative route for the area, reduce planning time while managing community and social issues, and minimize construction costs through the demonstration of feasible alternatives. The study will seek to minimize the cost of any selected route while considering environmental and social concerns.

2. Physical Environment

2.1 Soil Resources and Prime Farmland

Soils information was reviewed to determine the presence of prime and unique farmland in the Study Area to demonstrate compliance with the Farmland Protection Policy Act (FPPA). The FPPA is intended “to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses, and to assure that federal programs are administered in a manner that, to the extent practicable, will be compatible with State, unit of local government, and private programs and policies to protect farmland.”

The term “farmland” refers to prime farmland; some prime if irrigated farmland; unique farmland; and farmland, other than prime or unique farmland, that is of statewide importance. Prime farmland soils are those that have the best combination of physical and chemical characteristics for producing food, feed, and forage; the area must also be available for these uses. Prime farmland can be either non-irrigated or lands that would be considered prime if irrigated. Farmland of statewide importance is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, forage, and oilseed crops.

Soil surveys of the Study Area are available from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) (see Attachment 2). NRCS soil surveys indicate the presence of farmland of state or local importance, or prime farmland if irrigated within the Study Area. Specifically, areas classified as farmland of state or local importance make up the majority of area within two square miles surrounding the City of Baker (refer to Exhibit 3 in Attachment 1).

Any forwarded improvement options that require right-of-way within identified farmlands and are supported with federal funds will require a CPA-106 Farmland Conversion Impact Rating Form for Linear Projects completed by MDT and coordinated with NRCS. The NRCS uses information from the impact rating form to keep inventory of the prime and important farmlands within the state.

2.2 Geologic Resources

Information on the geology and seismicity in the Study Area came from several published sources. Geologic mapping was reviewed for rock types, the presence of unconsolidated material, and fault lines. The seismicity and potential seismic hazards were also reviewed. This geologic information can help determine potential design and construction issues related to embankments and road design. The following is a brief summary of the geologic and seismic conditions present in the Study Area. Exhibit 4 (in Attachment 1) presents the geologic formations and structures within the Study Area.

The Baker Study Area covers upland plains dissected by and adjacent to Sandstone Creek. The dominant geologic feature of the area is the Cedar Creek Anticline, which traverses the Study Area from North-northeast to South-southwest, passing just east of the City of Baker. The geologic materials within the Study Area are the Pierre Shale, the Timber Lake, Trail City, and Colgate members of the Fox Hills Formation, the Hell Creek Formation, and the Ludlow member of the Fort Union formation.

The Pierre Shale, Hell Creek Formation and Fox Hills Formation are Cretaceous-age bedrock consisting of shale, mudstone, siltstone, and sandstone. The Ludlow Member is Paleocene-age bedrock consisting of mudstone, siltstone, and sandstone. The bedrock is generally soft, weathers to bad-land topography, and swelling clays visible at the surface often show a characteristic “popcorn” texture.

These types of soils can create revegetation challenges. The clay heavy soil reacts in extremes to either the lack of or presence of moisture. The design of future projects forwarded from the study should consider including permanent erosion and sediment control (PESC) measures to extent practicable to help the soils stay in place long enough for the plants and grasses to take hold and revegetate the project. Native plant and grass types that can live in soils with high clay content should be chosen.

Outside of the corridor, several slope failures have been noted near Sandstone Creek, specifically near the town of Plevna. Many small slumps can be observed in cuts and on embankments near Baker, as well as on naturally occurring steep slopes in the area. These slope failures are likely related to over-steepening of the slopes combined with clay soils and groundwater or high volume runoff events.

Improvements brought forward from the study will be subject to more detailed geotechnical analysis. Part of this detailed analysis may involve taking advance borings to evaluate soil characteristics at exact project locations. This is standard procedure for the majority of MDT road projects. The design of any improvements should take into consideration specific requirements that come from the detailed analysis.

2.3 Surface Waters

Topographic maps and geographic information system (GIS) data were reviewed to identify the location of surface water bodies such as rivers, streams, lakes, and reservoirs within the Study Area. Listed below are the named streams within the Study Area.

- Sandstone Creek
- Deep Creek
- Red Butte Creek
- Lake Baker
- Timber Creek

A variety of additional surface waters, including unnamed streams, natural drainages, wetlands, and ponds are present in the Study Area. Impacts to any of these surface waters could occur from improvements such as culverts under the roadway, placement of fill, or rip rap armoring of banks. The United States Army Corps of Engineers (USACE), the Montana Department of Fish, Wildlife and Parks (FWP), and the Montana Department of Environmental Quality (DEQ) all regulate portions of work within surface waters. Coordination with federal, state, and local agencies would be necessary to determine the appropriate permits based on choice of improvement options forwarded from this study. Impacts should be avoided and minimized to the maximum extent practicable. Stream and wetland impacts may trigger compensatory mitigation requirements of the USACE. Construction of forwarded improvement options may trigger the need to obtain coverage under the Montana Pollutant Discharge Elimination System (MPDES) General Permit for Storm Water Discharges Associated with Construction Activity. Exhibit 5 (in Attachment 1) contains maps depicting surface waters found in the Study Area.

Total Maximum Daily Loads

The Study Area is located in the Lower Yellowstone Watershed (hydrologic unit code (HUC) 10100005). A search of the DEQ website revealed the only stream on the 303d list within the Study Area is Sandstone Creek. Information on Sandstone Creek was then obtained from the DEQ website. Section 303 subsection “d” of the Clean Water Act requires the state of Montana to develop a list, subject to United States Environmental Protection Agency (USEPA) approval, of water bodies that do not meet water quality standards. When water quality fails to meet state water quality standards, DEQ determines the causes and sources of pollutants in a sub-basin assessment and sets maximum pollutant levels, called total maximum daily loads (TMDL).

TMDLs set by DEQ become the basis for implementation plans to restore water quality to a level that supports state designated beneficial water uses. The implementation plans identify and describe pollutant controls and management measures to be undertaken (such as best management practices), the mechanisms by which the selected measures would be put into action, and the individuals and entities responsible for implementation projects.

DEQ lists Sandstone Creek as having impairment in the Draft 2014 Integrated 303(d)/305(b) Water Quality Report for Montana (see Table 1 and Attachment 13). This water body is a Category 5, defined as waters where one or more applicable beneficial uses are impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat. Sandstone Creek is the in O’Fallon TMDL area, but at this time, the TMDL is not completed. One probable sources of impairment is agriculture. The other is municipal point source discharges, which could be a result of release of water from wastewater treatment systems. Additionally, the Fallon Growth policy notes watering of the Golf Course uses water from the sewage treatment plant. Highway construction and ongoing transportation corridor use are not likely contributors to Nitrogen loading in Sandstone Creek, so the Nitrogen impairment is unlikely to trigger design modification for future roadway projects. That said, if improvement options are advanced, it will be necessary to reconsider DEQ TMDL standards and potential impacts to water quality within receiving streams and watersheds in the Study Area.

Table 1: 303(d) Listed Streams in Study Area

Named Stream	Quadrant[1]	Category	Possible Impairment	Beneficial Uses
Sandstone Creek	N 1/2	5	Nitrate/Nitrite, Nitrogen(total)	Primary Contact Recreation, Aquatic Life
Deep Creek	SW	Not listed in DEQ's Water Quality Database		
Red Butte Creek	NW, SW, SE	Not listed in DEQ's Water Quality Database		
Timber Creek	SW	Not listed in DEQ's Water Quality Database		

Source: DEQ, 2014
[1]Quadrants of Study Area used as approximation of location because Study Area is rectangular.

Wild and Scenic Rivers
The Wild and Scenic Rivers Act, created by Congress in 1968, provided for the protection of certain rivers, and their immediate environments, that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, or cultural resources, or other similar values. Based on a review of the United States National Park Service (USNPS) website, none of the waterways within the Study Area carry the wild and scenic designation.

Sewage Treatment Ponds
Between RM 81 and RM 82 on the north side of US 12 is the City of Baker's three-pond wastewater treatment system. The Fallon Growth policy noted that the City of Baker is seeking funding to expand this wastewater treatment system by adding an evaporation pond and possible expansion of the other ponds. By the time improvements are brought forward this study, expansion may have taken place. Coordination with the City of Baker should take place to determine if expansion was completed or if it is still anticipated. Impacts to the wastewater treatment system should be avoided, as it will involve extra costs and possible land acquisition to offset associated impacts.

2.4 Groundwater

According to the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC), there are 1,682 wells on record in Fallon County. Some of these wells are located within the Study Area. The newest well on record is from July 16, 2014, and the oldest well on record is from October 1900. Approximately one-third (492) of wells within Fallon County are at a depth of 0 to 99 feet. There are three statewide monitoring network wells in Fallon County. The wells in Fallon County have widely varying uses, with stockwater wells being the most common followed by domestic wells.

The City of Baker has five public water supply wells ranging in depth 613 to 680 feet and three potable water underground storage tanks ranging in size from 100,000 gallons to 200,000 gallons. Four of the wells are located on the northwest edge of Baker; the fifth well is on the southwest edge of town where the three underground storage tanks are similarly located. Public water supply wells have setbacks to ensure the wells are not contaminated. The typical setback is a 100-foot isolation zone in which no source of pollutant should be inside. The public water supply wells and underground potable water storage tanks are items of avoidance. Wells are drilled on a per foot price, the public water supply wells will be expensive as they are deep. Exhibit 6 (in Attachment 1) and Attachment 3 present groundwater data, such as well and geologic source information for Fallon County.

Impacts to the municipal drinking water system should be avoided, as it will involve extra costs and possible land acquisition to offset associated impacts. Impacts to existing domestic wells will also need to be considered if improvement options are forwarded from the study.

2.5 Wetlands

The USACE defines wetlands as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) mapping data is available for this area from the NWI website or the Montana Natural Resource Information System (NRIS) (see Exhibit 5 in Attachment 1). The potential wetland areas identified within the Study Area are primarily along Sandstone Creek and in the areas surrounding Lake Baker. An MDT wetland mitigation site was created in 2010 to mitigate for unavoidable wetland impacts resulting from two MDT projects; Baker – South, and Junction S-322 – South. This site is located along MT 7 south of Baker at Township 7 North, Range 59 East, Section 26 (Latitude 46.3291, Longitude -140.2854). The MDT wetland mitigation site is currently not an USACE-approved mitigation bank. While some useful information can be ascertained from the NWI maps, these maps are based on the USFWS definition of wetlands, which does not follow the USACE definition that MDT uses in wetland determination and delineation. NWI maps are typically generated based on aerial and satellite imagery, and are not accurate enough or detailed enough for MDT project wetland determination and/or delineation.

Future wetland delineations would be required if improvement options are forwarded from the study that could potentially impact wetlands. Future projects in the Study Area would need to incorporate project design features to avoid and minimize adverse impacts to wetlands to the maximum extent practicable. Unavoidable impacts to wetlands must be compensated through mitigation in accordance with the USACE regulatory requirements and/or requirements of Executive Order 11990. Work within jurisdictional wetlands would require a Clean Water Act 404 permit from the USACE. If required, mitigation for improvement options forwarded from the study would not be able to use mitigation credits from the MDT wetland mitigation site until approved by the USACE and would rather need to address mitigation separately for each project constructed.

2.6 Floodplains and Floodways

Executive Order 11988, Floodplain Management, requires federal agencies to avoid to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities" for the following actions:

- acquiring, managing, and disposing of federal lands and facilities;
- providing federally-undertaken, financed, or assisted construction and improvements; and
- conducting federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulation, and licensing activities.

Federal-aid Policy Guide, 23 CFR 650, Bridges, Structures, and Hydraulics, provides “policies and procedures for the location and hydraulic design of highway encroachments on flood plains, including direct Federal highway projects administered by the [Federal Highway Administration (FHWA)].” This document defines “base flood” as the “flood or tide having a 1-percent chance of being exceeded in any given year” and “base flood plain” as the “area subject to flooding by the base flood.”

In 1985, the U.S. Department of Agriculture Soil Conservation Service prepared the *Sandstone Creek and Tributaries Flood Plain Management Study*. This report is a detailed study with defined flood elevations of Sandstone Creek through the City of Baker and created the regulated floodplain boundaries currently used by the Fallon County Floodplain Administrator.

Federal Emergency Management Agency (FEMA)-issued flood maps for Fallon County indicate that four floodplain zones exist within the Study Area, they are as follows (see Exhibit 7 in Attachment 1 and Attachment 14):

Zone AE: Special Flood Hazard Area (SFHA) - 100-Year Flood, Base Flood Elevations Determined;

Zone AE: SFHA – 100-Year Flood, Base Flood Elevations Determined, Floodway Areas;

Zone X: 500-Year Flood;

Zone X: Areas determined to be outside 500-Year flood plain.

Portions of a new bypass to the north of Baker or other improvements within the same area could traverse the Zone AE floodplain for Sandstone Creek. Roadway development would involve placement of fill within the regulatory floodplain and would require a floodplain permit. Project development would then require coordination with Fallon County to minimize floodplain impacts and obtain necessary floodplain permits for project construction. Modifications to the floodplain would involve additional project time and cost to the extent that map revisions are required.

2.7 Irrigation

Irrigated agriculture land exists in Fallon County within the Study Area. Depending on the improvement option(s) proposed during the study, there is potential to impact irrigation facilities. Impacts to irrigation facilities should be avoided when feasible. Future modifications to existing irrigation canals, ditches, or pressurized systems could require redesigning and constructing in consultation with the owners to minimize impacts to agricultural operations. If there is impact to irrigation structures, there could be additional costs above typical project costs associated with the redesign, or moving of the irrigation structure(s). The Water Resources Survey map indicates the presence of one historical private irrigation system and ditch in the Study Area.

The private irrigation system and the Munsell ditch shown on the Water Resources Survey map may be historic (see Attachment 4). At this time not enough information is known about either the private irrigation system or the Munsell ditch, and a field investigation would be necessary to determine National Register of Historic Places eligibility. If eligible for the National Register, then efforts must be made to avoid or minimize impacts to private irrigation system and the Munsell ditch.

2.8 Air Quality

The USEPA has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, including carbon monoxide, nitrogen dioxide, ozone, particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide, and lead. The USEPA designates communities that do not meet NAAQS as “non-attainment areas.” States are then required to develop a plan to control source emissions and ensure future attainment of NAAQS. The Study Area is not located in a non-attainment area for any of the criteria pollutants. Additionally, there are no non-attainment areas nearby. As a result, special design considerations will not be required in future project design to accommodate NAAQS non-attainment issues.

Depending on the scope of improvements considered in the Study Area, an evaluation of mobile source air toxics (MSATs) may be required. MSATs are compounds emitted from highway vehicles and off-road equipment, which are known or suspected to cause cancer or other serious health and environmental effects.

2.9 Hazardous Substances

The NRIS database provides information on underground storage tank (UST) sites, leaking underground storage tank (LUST) sites, abandoned mine sites, remediation response sites, landfills, National Priority List (NPL) sites, hazardous waste, crude oil pipelines, and toxic release inventory sites. The following is a brief summary of the primary sites within the Study Area that could impact improvements and may require additional investigation or remediation if within a forwarded project boundaries.

Underground Storage Tanks

Twenty-six individual USTs are shown to exist within the Study Area. These USTs are registered to various businesses and entities in Baker including the Burlington Northern Santa Fe Railroad, Fueling Facilities, and the Baker Municipal Airport. The majority of the active USTs are located within the city limits of Baker and are unlikely to impact project development of a bypass route around the City of Baker. There are two closed USTs outside of the city limits of Baker. Additional investigation regarding the precise locations of the USTs may need to take place depending on what improvement options are forwarded from this study (see Exhibit 8 in Attachment 1).

Leaking Underground Storage Tanks

Six active and ten inactive LUST sites were identified within the Study Area, most of the sites are within the limits of the town of Baker. One inactive LUST site is noted to exist outside of the City of Baker. This location is immediately southwest of RM 37 on MT 7, north of Baker (see Exhibit 8 in Attachment 1). If a project were to occur in close proximity to this site, or the City of Baker itself, then further review or potential soil investigation may be necessary. Many of these LUST sites are Petroleum Tank Release Cleanup Fund (PetroFund) sites. Exhibit 9 in Attachment 1 shows the PetroFund sites. If LUSTs or contaminated soils are encountered further investigation and possible remediation may be necessary. This could create additional costs associated with a forwarded improvement.

Mine Sites

The NRIS database identifies one abandoned mine site southwest of the intersection of US 12 and MT 7. There is the potential for other abandoned mine sites that are not currently listed in the NRIS database to exist to the southwest of Baker. If improvements are forwarded from the study, an on the ground field survey will be required to determine if the listed mine still exists and if other abandoned mines are present in the area of possible projects. If an abandoned mine site is located, additional investigation of the soils in this area may be necessary to determine if contamination exists.

The DEQ database identifies one opencut mining site to the southwest outside of the City of Baker. Fallon County Road Department is the permit holder of this opencut mining site.

If there are proposed improvements in the areas near a mine (see Exhibit 9 in Attachment 1), there is the potential for impacts to project design and construction, and additional investigation may be necessary.

Crude Oil Pipeline

The NRIS database identified one crude oil pipeline in the northwest corner of the Study Area (see Exhibit 9 in Attachment 1). The NRIS database does not currently have detailed information on the pipeline. With the high amount of oil and gas wells throughout the Study Area, most likely other sections of pipeline exist that connect the oil and gas wells to storage tanks and other facilities that are not currently listed in the NRIS database. If improvements are proposed in this area, additional research and coordination will need to occur to identify any potential conflicts with the pipeline. On the ground site visits and coordination with oil and gas well owners may be necessary to identify other possible hazardous liquid pipelines that could exist in the Study Area.

Oil and Gas Production Wells

Oil and gas development exists in the entire eastern half of the Study Area. Three oil and gas formations (Cedar Creek, Pennel, and Lookout Butte) are oriented slightly northwest-southeast and encompass the entire eastern Study Area. These formations contain hundreds of oil and gas wells and associated oil and gas infrastructure (see Exhibit 10 in Attachment 1). If future improvements occur in the eastern half of the Study Area, consideration should be given to avoid oil and gas infrastructure where practicable. If projects brought forward from the study occur in close proximity to the oil and gas wells this would likely warrant additional soil investigations and coordination with oil and gas well owners to determine if contaminated soils are present.

Hazardous Waste Handlers
The DEQ data mapper depicts three hazardous waste handling facilities within the Study Area. They are as follows:

- one facility located in the town of Baker is listed as inactive and a conditionally exempt small quantity generator;
- one facility located north of Baker on Shell Oil Road is listed as active and a conditionally exempt small quantity generator;
- one facility located north of Baker on MT 7, immediately south of RM 37 (Nalco Company Baker Warehouse) is listed as active and a large quantity generator.

It is unlikely that these facilities will impact projects forwarded from the study, however if activities are to occur in close proximity to the Nalco Company Baker Warehouse (see Exhibit 9 in Attachment 1), then a soil investigation to determine if contaminated soils are present could be necessary. A soil investigation would have additional costs above normal project expenditures. If contaminated soils are present, a special provision regarding handling contaminated soils is recommended to be included in project documentation.

3. Biological Resources

3.1 Vegetation

A combination of Great Plains Mixedgrass Prairie, Cultivated Crops, Big Sagebrush Steppe habitat dominate the land cover near the Study Area (see in Exhibit 11 in Attachment 1 and Attachment 5). The majority of land coverage within the Study Area is Great Plains habitat, with a few other land cover types interspersed. Table 2 (following page) presents land cover listed by Montana National Heritage Program (MNHP) for Fallon County. Attachment 5 contains the land cover report for the entire of Fallon County, which may contain some variations from the Study Area due to the size of Fallon County.

Table 2: Fallon County Land Cover

Land Cover Type	% of Cover
Great Plains Mixedgrass Prairie	46
Big Sagebrush Steppe	16
Cultivated Crops	16
Great Plains Sand Prairie	7
Pasture/Hay	5
Great Plains Badlands	4
Great Plains Riparian	4

Source: MNHP, 2014

If improvement options are forwarded from the study, practices outlined in MDT standard specifications should be followed to minimize adverse impacts to vegetation and facilitate establishment of final stabilization of disturbed areas. Removal of mature trees and shrubs should be limited to the extent practicable.

Noxious Weeds

Noxious weeds can degrade native vegetative communities, damage riparian areas, compete with native plants, create fire hazards, degrade agricultural and recreational lands, and pose threats to the viability of livestock, humans, and wildlife. Areas with a history of disturbance, like highway rights-of-way, are at particular risk of weed encroachment. The Invaders Database System lists 49 exotic plant species and 17 noxious weed species in Fallon County, some of which may be present in the Study Area (Attachment 6). Fallon County has created a weed control plan that lists 26 noxious weed species as present in Fallon County, which is included in Attachment 6.

Reseeding of disturbed areas with desirable native plant species will help to reduce the spread and establishment of noxious weeds and to re-establish permanent vegetation. If improvements are forwarded from the study, field surveys for noxious weeds should take place prior to any ground disturbance. In addition coordination with Fallon County Weed Board should occur.

3.2 General Wildlife Species

Mammals

The Study Area is home to a variety of mammal species including white-tail deer, mule deer, pronghorn antelope, and coyote. Other common mammals potentially occurring in the Study Area include mountain lion, raccoon, striped skunk, badger, bobcat, red fox, beaver, muskrat, long-tailed weasel, white-tailed jackrabbit, western harvest mouse, deer mouse, and prairie vole. The Study Area shape creates a unique scenario where many of the mammal distributions cover the area completely, with only a few species distributions being visible on the map. Exhibit 12 (Attachment 1) shows the visible distributions: white-tail deer, wild turkey, and ring-necked Pheasant. If improvement options are forwarded from the study, the need for and viability of wildlife crossing mitigation measures should be explored during the project development process.

Amphibians and Reptiles

The MNHP Natural Heritage Tracker database records and maps documented observations of species in a known location. A review of the MHNP Tracker database for amphibian species known to occur within the Study Area included, but are not limited to, the boreal chorus frog, northern leopard frog, barred tiger salamander, greater short-horned lizard, snapping turtle, painted turtle, gophersnake, prairie rattlesnake, terrestrial gartersnake, and western hog-nosed snake. Any improvements forwarded from the study should take into consideration and minimize impacts to amphibian and reptile habitat where practicable.

Birds

The MNHP Natural Heritage Tracker database indicates there are more than one hundred forty species of birds documented with the potential to occur and nest in the Study Area. These species include representative songbirds, birds of prey, waterfowl, owls, and shorebirds. Exhibit 12 and Exhibit 13 (Attachment 1) show the bird distributions that are visible in the Study Area.

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA). Under this strict liability law, it is unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product, manufactured or not. Direct disturbance of a nest occupied with birds or eggs is prohibited under the law. The destruction of unoccupied nests of eagles; colonial nesters such as cormorants, herons, and pelicans; and some ground/cavity nesters such as burrowing owls or bank or cliff swallows may also be prohibited under the MBTA.

Data searches revealed that currently there are no known bald eagle or golden eagle nests within the Study Area. The Great Plains riparian habitat is a known ecological system associated with the golden eagle. Bald and golden eagles are protected under the MBTA and managed under the Bald and Golden Eagle Protection Act, which prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. The Act provides criminal penalties for persons who "take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle or golden eagle, alive or dead, or any part, nest, or egg thereof." The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

Any improvements forwarded from this study should consider potential constraints that may result from nesting/breeding periods of migratory birds and presence of unknown or future bald and golden eagles nests. One of the constraints on projects is for any work that involves the disturbance or removal of trees or structures associated with nesting birds will need to schedule this work to take place outside of the typical nesting season of April 15 to August 15.

Fisheries

There are only two aquatic resources listed as possessing warm water fishery resources in the Study Area (see Exhibit 5 in Attachment 1). Table 3 (following page) depicts fisheries information for named streams within the Study Area (see Attachment 7).

Table 3: Fisheries Data

Named Stream within Study Area	Quadrant[1]	Fish Species Present
Sandstone Creek	N ½	Black Bullhead, Fathead Minnow, Yellow Perch, Common Carp, White Sucker, River Carpsucker, Green Sunfish, Sand Shiner, Emerald Shiner, Brassy Minnow, Western Silvery/Plains Minnow, Channel Catfish, Creek Chub, Flathead Chub, Goldeye, Lake Chub, Longnose Dace, Northern Pike, Shorthead Redhorse, Stonecat, Brassy Minnow, Brook Stickleback
Baker Lake	Center	Black Bullhead, Black Crappie, Fathead Minnow, Largemouth Bass, Northern Pike, Yellow Perch

Source: FWP Montana Fisheries Information System (MFISH), 2014.
[1]Quadrants of Study Area used as approximation of location because Study Area is rectangular.

Fish passage and/or barrier opportunities should be considered at affected drainages if improvements are forwarded from this study. Per FWP recommendation, culverts should be sized to span the bankfull channel width on fish-bearing streams. Culverts should also be embedded a minimum of 20% of the culvert rise. Studies have shown that culverts embedded at least 20% reduce the potential for the culvert to become a barrier to fish movements. Permitting from regulatory agencies for any future Study Area improvements may also require incorporation of additional design measures to facilitate aquatic species passage.

Crucial Areas Planning System

The FWP Crucial Areas Planning System (CAPS) is a resource intended to provide non-regulatory information during early planning stages of projects, conservation opportunities, and environmental review. The finest data resolution within CAPS is at the square-mile section scale or water body. Use of these data layers at a more localized scale is not appropriate and may lead to inaccurate interpretations since the classification may or may not apply to the entire square-mile section. The CAPS system was consulted to provide a general overview of the Study Area. CAPS results are presented in Attachment 8.

The online CAPS mapping tool provides FWP general recommendations and recommendations specific to transportation projects for both terrestrial and aquatic species and habitat. These recommendations can be applied generically to possible future improvements carried forward from the study.

3.3 Threatened and Endangered Species

The USFWS maintains the federal list of threatened and endangered (T&E) species. Species on this list receive protection under the Endangered Species Act (ESA). An “endangered” species is in danger of extinction throughout all or a significant portion of its range. A “threatened” species is likely to become endangered in the foreseeable future. The USFWS also maintains a list of species that are candidates or proposed for possible addition to the federal list. According to the USFWS, five threatened, endangered, proposed, or candidate species are listed as occurring in Fallon County (see Table 4 on the following page and Attachment 9).

Table 4: Threatened and Endangered Species in Fallon County

Species	Status
Greater Sage-Grouse	Candidate
Sprague's Pipit	Candidate
Red Knot	Threatened
Whooping Crane	Endangered
Northern Long-eared Bat	Proposed

Source: USFWS, 2015.

According to the MNHP - Natural Heritage Map Viewer (report generated August 20, 2014) database, which records and maps documented observations of species in a known location, only the greater sage-grouse, and the Sprague's pipit have been recorded within the boundaries of the Study Area.[1] Therefore, it is reasonable to presume that suitable habitats for these species may be present within the Study Area (see Exhibit 13 in Attachment 1). If improvements are forwarded from the study, an evaluation of potential effects to T&E species will need to be completed during the project development process. As federal status of protected species changes over time, reevaluation of the listed status and afforded protection to each species should be completed prior to issuing a determination of effect relative to potential impacts.

3.4 Species of Concern

Montana species of concern (SOC) are native plants or native animals breeding in the state that are considered to be "at risk" due to declining population trends, threats to their habitats, and/or restricted distribution. Designation of a species as a Montana SOC is not a statutory or regulatory classification. Instead, these designations provide a basis for resource managers and decision-makers to direct limited resources to priority data collection needs and address conservation needs proactively. Each species is assigned a state rank that ranges from S1 (greatest concern) to S5 (least concern). Other state ranks include SU (unrankable due to insufficient information), SH (historically occurred), and SX (believed to be extinct). Modifiers, such as B (breeding) or N (non-breeding), may follow state ranks.

A search of the MNHP species of special concern database on August 19, 2014, revealed four SOC and four potential SOC in Fallon County. These eight species have the potential to occur in the Study Area based on presence of suitable habitat. For more information and a map depicting distribution, please see Table 5 on the following page, Attachment 10, and Exhibit 13 in Attachment 1.

[1] On September 22, 2015 the U.S. Fish and Wildlife Service determined that the protection for the greater sage grouse under the Endangered Species Act is no longer warranted and is withdrawing the species from the candidate species list. MDT will continue to follow the stipulations for the conservation of the greater sage grouse contained in the State of Montana – Office of the Governor – Executive Order No. 12-2015 "Executive Order Amending and Providing for the implementation of the Montana Sage Grouse Conservation Strategy."

Table 5: Species of Concern Overlapping the Study Area

Animal Subgroup	Common Name	State[1] Rank	Habitat Description
Birds	Greater Sage-grouse	S2	Sagebrush
	Baird's Sparrow	S3B	Grasslands
	Brewer's sparrow	S3B	Sagebrush
	Chestnut-collard Longspur	S2B	Grasslands
Fish	Brook Stickleback	S4	Small prairie rivers
	Brassy Minnow	S4	Small prairie rivers
	Plains Minnow	S4	Small prairie rivers
	Creek Chub	S4	Small prairie rivers

Source: MNHP, 2014.
[1] State rank definitions are located in Appendix C.

In addition to being a state species of concern, the greater sage-grouse is currently listed as a candidate species for listing on the list of threatened and endangered species by the USFWS. The USFWS has a website dedicated solely to the greater sage-grouse. The status of this species will be amended once USFWS biologists have made a final determination.

Montana's governor Steve Bullock established by Executive Order the Greater Sage-Grouse Habitat Conservation Advisory Council on February 2, 2013. The purpose of the Council was to "to gather information, furnish advice, and provide to the governor recommendations on policies and actions for a state-wide strategy to preclude the need to list the greater sage-grouse under the ESA", by no later than January 31, 2014. The Council was co-chaired by FWP Director, Jeff Hagener, and the governor's Natural Resources Policy Advisor, Tim Baker. Council members included representatives from agriculture and ranching, conservation and sportsmen, energy, mining and power transmission, tribal government, local government, and the legislature. The council has concluded its work and provided recommendations to the governor's office in the form of a "Montana Strategy to address threats to the sage-grouse in Montana" (Attachment 11). This plan should be taken into consideration if habitat for the greater sage-grouse could be impacted.

Other sensitive species, including golden eagles, are not listed here, but have the potential to occur within the Study Area. Available literature identifies no nests currently existing within the Study Area. A thorough field investigation for the presence and extent of these species should be conducted if improvement options are forwarded from this study. If present, special conditions to the project design or during construction should be considered to avoid or minimize impacts to these species.

4. Social and Cultural Resources

4.1 Population Demographics and Economic Conditions

Under NEPA/MEPA and associated implementing regulations, state and federal agencies are required to assess potential social and economic impacts resulting from proposed actions. FHWA guidelines recommend consideration of impacts to neighborhoods and community cohesion, social groups including minority populations, and local and/or regional economies, as well as growth and development that may be induced by transportation improvements. Demographic and economic information presented in this section is intended to assist in identifying human populations that might be affected by improvements within the Study Area.

Title VI of the United States Civil Rights Act of 1964, as amended (USC 2000(d)) and EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, require that no minority, or, by extension, low-income person shall be disproportionately adversely impacted by any project receiving federal funds. For transportation projects, this means that no particular minority or low-income person may be disproportionately isolated, displaced, or otherwise subjected to adverse effects. If a project is forwarded from the improvement option(s), environmental justice will need to be further evaluated during the project development process.

As of the 2010 Census, Fallon County ranks 41 out 56 for total county population in Montana. A large share of the population in Fallon County (60 percent) resides within the City of Baker. Fallon counties population ethnicity in 2010 is primarily white/Caucasian (97.4 percent). No reservations exist within the county most likely attributing to the American Indian population at less than one percent. Hispanic or Latino individuals comprise just over one percent of the population. There is a slight decrease in the white population expected as Baker grows due to the vast array of people migrating to the Bakken region taking jobs in the oil and gas field. Table 6 (following page) summarizes 2010 population and demographic data for Fallon County and includes Montana for comparison.

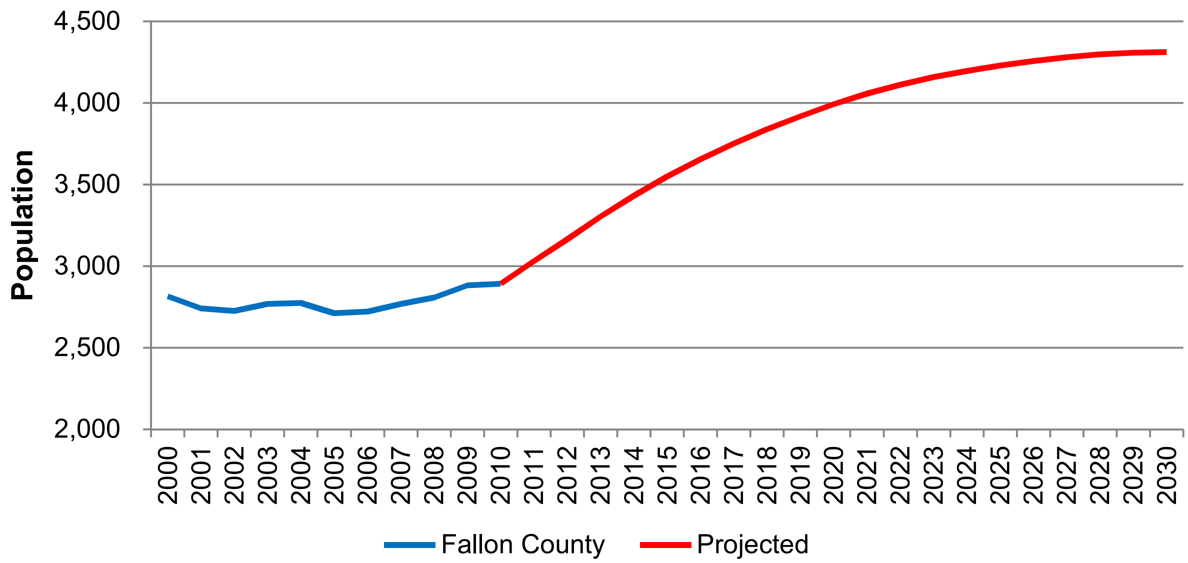
Table 6: 2010 Census Data for Fallon County

	Location	Fallon County	Montana
Population	County	2,890	989,415
	Baker City	1,741	
Ethnic Characteristics	White	97.4%	89.4%
	Black or African American	0.1%	0.4%
	American Indian & Alaska Native	0.4%	6.3%
	Asian	0.6%	0.6%
	Hispanic or Latino	1.2%	2.9%

Source: U.S. Census Bureau, 2010.

According to the 2000 United States Census Bureau (USCB), the population of Fallon County was 2,837. By the 2010 Census, the population of Fallon County was 2,890. This indicates that

Fallon County's population has increased by approximately 3 percent over the last decade. The City of Baker follows the same 3 percent increase from 1,695 in 2000 to 1,741 in 2010, indicating the majority of growth in Fallon County is occurring in the City of Baker. However, regionally, the population for Fallon County shows an increase by a mean of 1.3 percent each year from 2000 to 2013. From 2010 to 2030, the region's population is projected to increase by approximately 1,500 people. This is an increase of approximately 153 percent of the region's 2000 population. On the other hand, Montana will see population growth after 2010, but it will be at a more moderate rate than the Study Area. Figure 1 shows the population of Fallon County from 2000 to 2010 (in blue) and the projections to year 2030 (in red) based on data services through the Montana Department of Commerce (DOC).

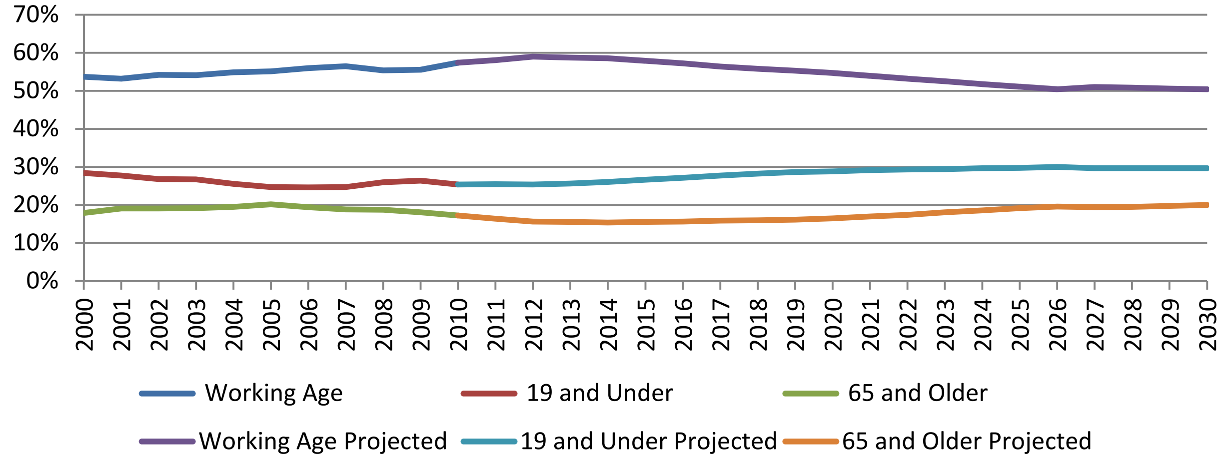


Source: US Census Bureau, 2010.

Figure 1: Total Observed and Projected Population in the Study County

In Fallon County, the working aged population (ages 20 to 64) is expected to increase by about 500 total members, reaching a high of about 60 percent of the population in 2013 and slowly declining to 50 percent by 2030. The decrease in the proportion of working aged members is because of a slower growth rate than the rest of the population.

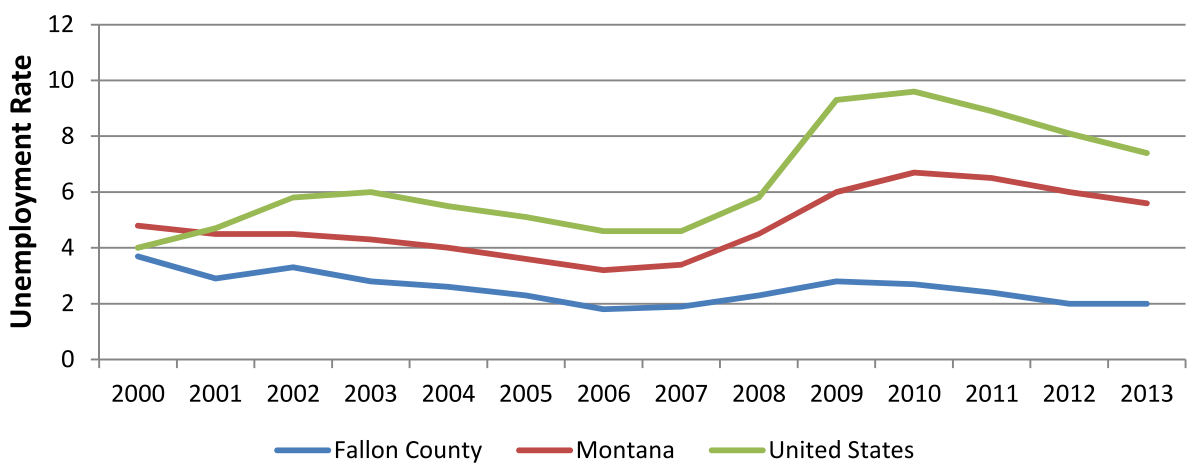
The 19 and under age group is expected to increase at a moderate rate from current levels and eventually hit about 30 percent of the population by 2030. On a similar note, the population category of 65 and older is also expected to experience a slight increase in proportion of the population, eventually converging at about 20 percent. Figure 2 illustrates the projected age distribution.



Source: US Census Bureau, 2010.

Figure 2: Age Distribution of the Study Counties (Projected after 2013)

Figure 3 illustrates the unemployment rate comparison from 2000 to 2013. Unemployment in the Fallon County region has experienced about the same fluctuations as the statewide rate for the last decade, but has continuously been below the state and national rate. As the recession began in 2007, the region continued to maintain low unemployment levels and did not face the rapid increases seen at the state and national levels. The sustained levels of low unemployment can likely be attributed to the economic boom from oil and gas in the Bakken region.



Source: US Census Bureau, ACS Survey, 2000-2013.

Figure 3: Unemployment Rate Comparison

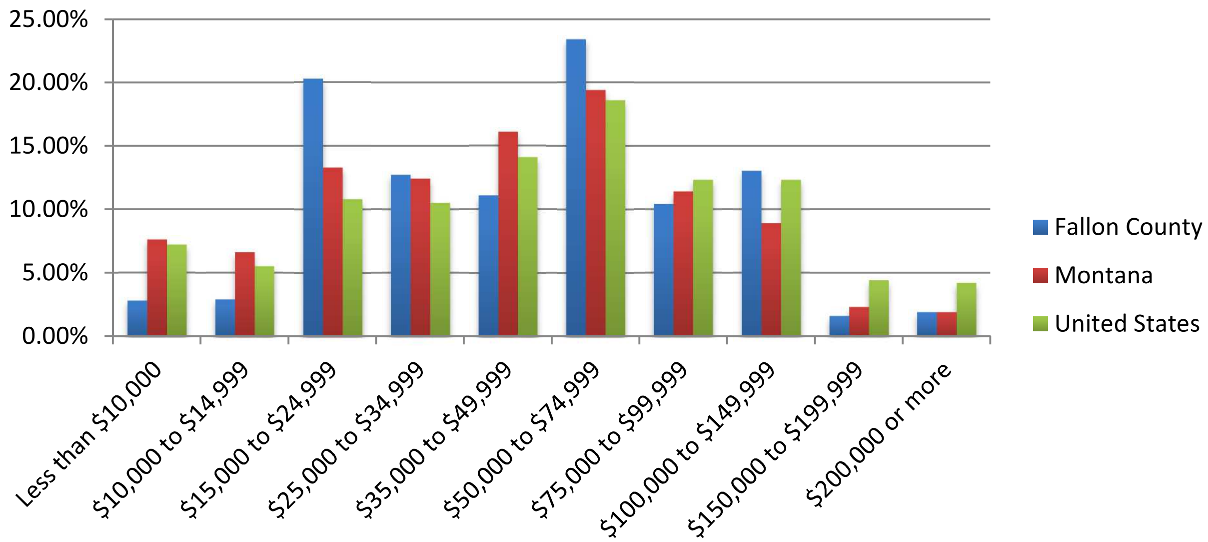
The Fallon County Growth Policy used the US Census data and produced the following summary of employment by industry for the City of Baker. The study indicated that City of Baker has approximately 1,618 employed individuals in the labor force. For the City of Baker, the top fields of employment are agriculture, forestry, fishing and hunting, mining; followed by education and health care services. Table 7 displays employment within the City of Baker by industry, according to the Fallon Growth Policy and US Census Bureau.

Table 7: County Employment by Industry (2006-2010)

Industry	Total Estimate Baker
Agriculture, forestry, fishing, and hunting	398 (24.6%)
Construction	142 (8.8 %)
Manufacturing	45 (2.8%)
Wholesale trade	20 (1.2%)
Retail trade	131 (8.1%)
Transportation and warehousing, and utilities	161 (10.0%)
Information	42 (2.6%)
Finance and insurance, and real estate and rental and leasing	85 (5.3%)
Professional, scientific, and management , and administrative and waste management services	57 (3.5%)
Educational Services, health care and social assistance	284 (17.6%)
Arts, entertainment, recreation, and accommodation and food services	125 (7.7%)
Other services, except public administration	56 (3.5%)
Public Administration	72 (4.4%)
Civilian employed population (16 years and over)	1,618

Source: US Census Bureau 2010.

Figure 4 (following page) shows the percentage of the population in Fallon County, Montana, and the United States in 10 income categories from the 2010 Census. Fallon County generally has a smaller percentage of the population in the lower and higher income categories compared to the state of Montana and the United States, with the majority of the population falling in the middle of the distribution. In particular, an almost combined 50 percent of the population falls into the $15,000 to $24,999 and $50,000 to $74,999 income categories. For both of those categories, Fallon County has a considerably higher percentage than either the state or the nation.



Source: U.S. Census Bureau, 2010.

Figure 4: Income Distribution by Household 2010

In summary, it appears that the population of Fallon County and the City of Baker is growing in a similar manner to the industry of the region. This growth will continue to add heavy hauling trucks and other vehicles to the current road system in the Study Area. The increased vehicular traffic load and population growth is consistent with the potential need identified by the City of Baker to review the possibility of a bypass road around the City. With high percentage of households in the $15,000 to $24,000 income bracket, further investigation should take place to determine the possibility of low-income person(s) being disproportionately isolated, displaced, or otherwise subjected to adverse effects by any forwarded improvements.

4.2 Land Ownership

Ownership of land in the Study Area is predominantly private, with some interspersed state and federal owners. The specific public landowners are the City of Baker, Fallon County, Montana Department of Transportation, Montana State Trust lands, US Bureau of Land Management, and US Government. The majority of these publicly owned lands are to the south of US 12, with a collection directly in the City of Baker. Much of the private land throughout the Study Area are undeveloped grassland, and agricultural. Land ownership maps for the Study Area are provided in Exhibit 14 (in Attachment 1).

Mixed land use arises from the varied land ownership throughout the Study Area. These land uses include commercial, industrial, crop/pasture, mixed urban, and recreational (see Exhibit 11 in Attachment 1). The large amount of privately owned land in the Study Area may create the need to purchase right-of-way for construction of a bypass route around the City of Baker. This will add land acquisition costs that will depend on the per acre price at the time of purchase. If improvements are forwarded from this study, land use at and adjacent to possible projects will need to be considered during design for determining overall project costs.

4.3 Recreational Resources

The Baker area offers a variety of year round activities including fishing, boating, and swimming at Baker Lake in the summer. In the winter, snowmobiling, ice-skating, and cross-country skiing take over Baker Lake and the surrounding area. There are a collection of city parks within the confines of the City of Baker, Fallon County Rifle Range & Trapshoot facility to the southwest of town and a public golf course.

Recreational resource information was gathered through review of both USFS and FWP resource lists for Fallon County, and the Fallon County Growth Policy. Table 8 lists publically owned recreational resources identified in the Study Area. These recreational areas may be protected under Section 4(f) of the U.S. Department of Transportation Act of 1966, which was enacted to protect publically owned parks, recreation areas, wildlife and waterfowl refuges, and public and private historic sites of local, state, and national significance. Federally funded transportation projects cannot impact Section 4(f)-protected properties unless there are no feasible and prudent avoidance alternatives and all possible planning to minimize harm has occurred. Prior to approving a project that "uses" a Section 4(f) resource, FHWA must find that there is no prudent or feasible alternative that completely avoids the 4(f) resource. "Use" can occur when land is permanently incorporated into a transportation facility or when there is a temporary occupancy of the land that is adverse to a Section 4(f) resource. Constructive "use" can also occur when a project's proximity impacts are so severe that the protected activities, features, or attributes that qualify a resource for protection under Section 4(f) are "substantially impacted." Potential effects on recreational use would need to be considered in accordance with Section 4(f) if improvements are forwarded from this study. Recreational resources potentially protected under Section 4(f) are mapped in relation to the Study Area in Exhibit 14 (in Attachment 1).

Table 8: Recreational Resources

Resource
Mangold Sports Complex
Triangle Park
Iron Horse Park
Senior Citizens Centennial Park
Eastside Park
Fallon County Fairgrounds
County Golf Course
Steve McClain Memorial Park
Baker Lake Recreation Area

Source: Fallon Growth Policy, 2012.

From a high level evaluation, some of the resources listed in Table 8 may not be considered a Section 4(f) resource, yet it is apparent from the Fallon Growth Policy and the high amount of recreational programs that the City of Baker places a high value its recreational resources. Efforts should be made with projects advanced from the study to avoid adverse impacts to or right-of-way acquisitions from the community recreational resources.

The National Land and Water Conservation Fund Act (LWCFA), or Section 6(f), was enacted to preserve, develop, and assure the quality and quantity of outdoor recreation resources. Section 6(f) protection applies to all projects that impact recreational lands purchased or improved with LWCFA funds. The Secretary of the Interior must approve any conversion of LWCFA property to a use other than public, outdoor recreation. According to FWP LWCFA Sites by County, there are three distinct Section 6(f) resources located within the Study Area: Baker Lake Recreation Area, Baker Pool Improvement, and the Fallon County Rifle Range & Trapshoot facility (see exhibit 14 in Attachment 1). The Baker Lake Recreation Area includes the Baker Pool improvement and two other LWCFA improvements within the boundaries of Baker Lake Recreation Area. All the 6(f) and the possible 4(f) resources except the Fallon County Rife Range & Trapshoot facility are inside the city limits of Baker, most likely not making them a concern to forwarded improvements. These resources can be a difficult and time-consuming task to convert to a non-recreational purpose property and should be avoided if practicable.

4.4 Cultural Resources

For federally funded transportation projects, a cultural resource survey must be conducted for the area of potential effect as specified in Section 106 of the National Historic Preservation Act (NHPA) (36 CFR 800). Section 106 requires federal agencies to “take into account the effects of their undertakings on historic properties.” The purpose of the Section 106 process is to identify historic and archaeological properties that could be affected by the undertaking; assess the effects of the project; and investigate methods to avoid, minimize, or mitigate adverse effects on historic properties. These historic resources properties are also generally afforded protection under Section 4(f) of the Transportation Act.

A file search through the Montana State Historic Preservation Office (SHPO) revealed approximately 25 historic or archaeological properties located within the Study Area (Attachment 12). Historic buildings, bridges, a railroad line, pre-contact buried campsites, and lithic scatters are all located in the area. These sites represent approximately 5% of the archaeological sites and historic properties that can be expected within the Study Area boundaries. With the Baker area having minimal ground surveys to date, the current data of known archaeological and historical resources within the Study Area is likely incomplete. On the-ground archaeological field inventory will be necessary to understand and increase the awareness of what cultural resources are located within the Study Area or a project specific location. Direct and indirect impacts (such as visual, noise, and access impacts) to eligible or listed properties would need to be considered if improvements options are carried forward.

A brief discussion of a possible historic private irrigation system and ditch are presented in section 2.7 Irrigation.

4.5 Noise

Evaluation of traffic noise may need to occur for any future improvements in the Study Area. Noise analysis is necessary for “Type I”-classified projects. A Type I project includes a substantial shift in the horizontal or vertical alignments, increasing the number of through lanes, providing passing lanes, or increasing traffic speed and volume. The construction of a bypass route around the City of Baker contains most of the aspects in the definition and would be considered a Type I project.

Type I projects require a detailed noise analysis, consistent with FHWA requirements and MDT policy, which includes measuring ambient noise levels at selected receivers and modeling design year noise levels using projected traffic volumes. If noise levels approach or substantially exceed noise abatement criteria for the project, noise abatement measures may be necessary. A number of possible abatement measures available for consideration include but are not limited to the following:

- alternating the horizontal or vertical alignment;
- constructing noise barriers such as sound walls or earthen berms; and/or
- decreasing traffic speed limits.

Noise abatement measures must be considered reasonable and feasible prior to implementation.

Construction activities in the Study Area may cause localized, short-duration noise impacts. These impacts can be minimized by using standard MDT specifications for the control of noise sources during construction.

4.6 Visual Resources

The visual resources of an area include landforms, vegetation, water features, and physical modifications caused by human activities that give the landscape its visual character and aesthetic qualities. Visual resources are typically assessed based on the landscape character (what is seen), visual sensitivity (human preferences and values regarding what is seen), scenic integrity (degree of intactness and wholeness in landscape character), and landscape visibility (relative distance of seen areas) of a geographically defined view shed.

Baker is on the eastern edge of Montana, the surrounding area is fields and rolling hills with sandstone out croppings. There are minimal view-obstructing man made items other than the City of Baker itself. To the north and east of Baker oil rigs dot the horizon. As a whole package, the landscape in the Study Area presents itself as a natural prairie/sagebrush environment with scattered agricultural fields and minimal urbanization.

Evaluation of the potential effects on visual resources would need to be conducted if improvement options are forwarded from this study.

5. Conclusion

This environmental scan report identifies physical, biological, social, and cultural resources within the Study Area that may be affected by potential future improvements in the Baker Study Area.

Project-level environmental analysis would be required for any improvements forwarded from this study. Information contained in this report may be used to support future NEPA/MEPA environmental documentation.

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BAKER CORRIDOR
PLANNING STUDY

APPENDIX D: Field Review and Photo Log

Baker Corridor Planning Study

Date:	Tuesday, November 25, 2014
Project:	Baker Corridor Planning Study
To:	Corrina Collins, MDT Project Manager
From:	Jon Schick, HDR Project Manager
Subject:	Field Review and Photo Log Documentation from November 04, 2014 Site Visit

Purpose:

HDR conducted a field review of the Baker Corridor Planning Study Area on November 4, 2014. The field review entailed photo and written documentation of the existing transportation conditions and constraint areas within the study area. The photos and conditions noted are representative of the existing conditions within the study area and should not be considered a comprehensive account.

A GPS-enabled camera was used during the field review and photo points were imported into GIS. Where noted for U.S. Highway 12 (US 12), Montana Highway 7 (MT 7), and Secondary Highway 493 (S-493), photo locations were compared against the MDT Reference Marker (RM) spatial file for approximate locations. Figure 1 depicts the photo locations and site photographs and captions are included below. The field review did not entail detailed inspections or testing.

US Highway 12: RM 79 to 88.1

The study area includes US 12, from approximately RM 79 to RM 88.1. Representative photos taken along US 12 are numbered1 through 27 and are ordered west to east.

General observations and additional information not pictured includes the following:

- US 12 had a recent pavement preservation job done west of city limits, from approximately RM 77 to the western city limit boundary, RM 82.45.
- Side slopes along US 12 outside of Baker city limits (both east and west of Baker) were approximately 5:1.
- Highway fatality markers were observed at: RM 79.85, RM 83.48, RM 85.23, RM 87.63 (double fatality), and RM 87.97.
- Minimal evidence of wildlife/vehicle collisions was observed. Dead pheasants were observed at RM 79.48 and RM 82.05.

MT Highway 7: RM 31.9 to 37.6

The study area includes MT 7, from approximately RM 31.9 to RM 37.6. Representative photos taken along MT 7 are numbered 28 through 44 and are ordered south to north.

General observations and additional information not pictured includes the following:

- Side slopes along MT 7 outside of Baker city limits (both north and south of Baker) were approximately 5:1. Steeper slopes exist north of town where roadway gains elevation, north of the S-493 intersection.

- One dead rabbit was observed along MT 7 within the study area at approximately RM 37.6.

Secondary Highway 493 (Pennel Road): RM 0 to RM 2.1

The study area includes Secondary Highway 493, from RM 0 to approximately RM 2.1. Representative photos taken along S-493 are numbered 45 through 50 and are ordered generally east to west.

General observations and additional information not pictured includes the following:

- Side slopes along S-493 were approximately estimated at 2:1 and steeper in some locations.
- The highway is paved from RM 0 to approximately RM 1 then transitions to dirt immediately north of the first 90 degree turn.

U.S. Highway 12, RM 79 to RM 88.1

Photo 1: Looking east on US 12, RM 79. West study area boundary.

Photo 2: Looking northeast, US 12 and Latigo Trail intersection, RM 79.2.

Photo 3: Looking south, unnamed drainage, RM 79.35.

Photo 4: Looking south, utilities adjacent R/W with potential pipeline underneath US 12, RM 79.45.

Photo 5: Looking south, Red Butte Creek, RM 79.77.

Photo 6: Looking northeast, large-diameter double culvert on Red Butte Creek, RM 79.77.

Photo 7: Looking south, Fallon County Shooting Range, RM 80.75.

Photo 8: Looking northeast, culvert under US 12 at unnamed drainage, RM 81.4.

Photo 9: Looking south, utilities adjacent R/W with potential pipeline underneath US 12, RM 81.76.

Photo 10: Looking east, culvert under US 12 at unnamed drainage, RM 81.9.

Photo 11: Looking west, culvert under US 12 on unnamed drainage, RM 82.

Photo 12: Looking southeast, City of Baker sign, RM 82.06.

Photo 13: Looking east, 45 mph warning sign, RM 82.2.

Photo 14: Looking east, start 45 mph zone, RM 82.33.

Photo 15: Looking northeast, US 12 bridge spanning tributary to Sandstone Creek, approximate western city limits boundary, RM 82.43.

Photo 16: Looking east, start of 25 mph zone, US 12 and 5th Street intersection, RM 82.68.

Photo 17: Looking east on US 12 towards downtown Baker, RM 82.9.

Photo 18: Looking west, US 12/MT 7 intersection, RM 83.07. The US 12/MT 7 intersection is stop controlled and has a blinking light. Note semi trailer turning eastbound on MT 7 and occupying a portion of the oncoming travel lane.

Photo 19: Looking west, fatality marker adjacent US 12, BNSF railroad, RM 83.48.

Photo 20: Looking northwest, Berwald Road at-grade rail crossing, RM 83.75.

Photo 20: Looking north, Willow Lane at-grade railroad crossing, RM 84.16.

Photo 21: Looking east, Motor Carrier Services (MCS) weighing pad and pullout on US 12, RM 84.48.

Photo 22: Looking northwest, BNSF railroad, eastern limit of railroad double track, RM 84.95.

Photo 23: Looking west, ontop the US 12/BNSF railroad bridge, RM 85.77.

Photo 24: Looking north, unnamed tributary to Sandstone Creek flows underneath US 12, RM 86.

Photo 25: Looking west, US 12 east of railroad bridge, RM 86.07.

Photo 26: Looking east, US 12, RM 87.51.

Photo 27: Looking north, US 12/Sheep Corner Road intersection, RM 88.12.

Montana Highway 7, RM 31.9 to RM 37.6

Photo 28: Looking north, MT 7, southern study area boundary, RM 31.9 .

Photo 29: Looking northeast, waterbody adjacent right-of-way, RM 32.28.

Photo 30: Looking west, MDT wetland mitigation site adjacent MT 7 and unnamed tributary of Red Butte Creek flows underneath highway, RM 32.68.

Photo 31: Looking south, culvert underneath MT 7 conveying Red Butte Creek, RM 33.05.

Photo 32: Looking north on MT 7, RM 33.12.

Photo 33: Looking north on MT 7, beginning of no passing zone, RM 33.4.

Photo 34: Looking east from MT 7, Fallon County Fairgrounds entrance, RM 34.51.

Photo 35: Looking north, MT 7 and Harriet Avenue intersection, RM 35.39.

Photo 36: Looking north on MT 7 towards US 12/MT 7 intersection, RM 35.44.

Photo 37: Looking north towards at-grade railroad crossing on MT 7, MT 7 and Railroad Avenue intersection, RM 35.56.

Photo 38: Looking southeast on MT 7 at the at-grade railroad crossing, RM 35.6.

Photo 39: Looking south towards downtown on MT 7, RM 35.82.

Photo 40: Looking northwest, MT 7 bridge over Sandstone Creek, RM 35.86.

Photo 41: Looking north, industrial development along MT 7, RM 36.1

Photo 42: Looking northwest, MT 7/ S-493 (Pennel Rd)/Shell Oil Road intersection, RM 36.54.

Photo 43: Looking south on MT 7 towards Mitchell's Oil Field Service, RM 37

Photo 44: Looking south on MT 7, approximate northern limits of study area, RM 37.6. This intersection appeared to receive higher volumes of traffic turning from the oil/gas access road onto MT 7, as evidenced by the tire marks and amount of gravel/dirt on the highway.

Montana Secondary Highway 493 (Pennel Road), RM 0 to RM 2.4

Photo 45: Looking west, MT 7/ S-493 (Pennel Road) intersection, RM 0. S-493 is paved until approximately RM 1 and unpaved beyond.

Photo 46: Looking north, S-493 (Pennel Road), probable wetlands adjacent roadway, RM 0.21. Unnamed tributary to Sandstone Creek flows underneath S-493.

Photo 47: Looking south onto Bonnievale Road from S-493, RM 0.42. Note recent drainage improvements along S-493.

Photo 48: Looking southwest from S-493/Bonnievale Road intersection, RM 0.42. Substation on southwest corner of intersection.

Photo 49: Looking south on S-493, RM 1.15. Left curve warning sign located before 90 degree turn.

Photo 50: Looking south on S-493, RM 2.4.

OFF SYSTEM ROUTES - **Shell Oil Road**

Photo 51: Looking northeast, MT 7/Shell Oil Road intersection.

Photo 52: Looking north from Shell Oil Road. Montana Dakota Utilities substation.

Photo 53: Looking southeast from Shell Oil Road. Drainage issues noted adjacent roadway.

Photo 54: Looking east on Shell Oil Road. Road is unpaved beyond photo location.

Photo 55: Looking east, large box culvert underneath Shell Oil Road conveying an unnamed tributary of Sandstone Creek.

Photo 56: Looking east from intersection of Shell Oil Road and School House Road.

Photo 57: Looking east, probable wetland areas abutting Shell Oil Road.

Miscellaneous Photos

Photo 58: Looking southeast, Bonnievale Road bridge spanning Sandstone Creek. A Weight Limit of 12 Tons sign located at either end of the structure.

Photo 59: Looking south towards the at-grade railroad crossing on West End Crossover Road.

Photo 60: Looking north from Sandstone Road.

Photo 61: Looking south, quadruple culverts underneath Sandstone Road on Red Butte Creek.

Photo 62: Looking east, left curve warning sign on Sandstone Road.

Photo 63: Looking north, Brackett Butte Road transitions from dirt to asphalt.

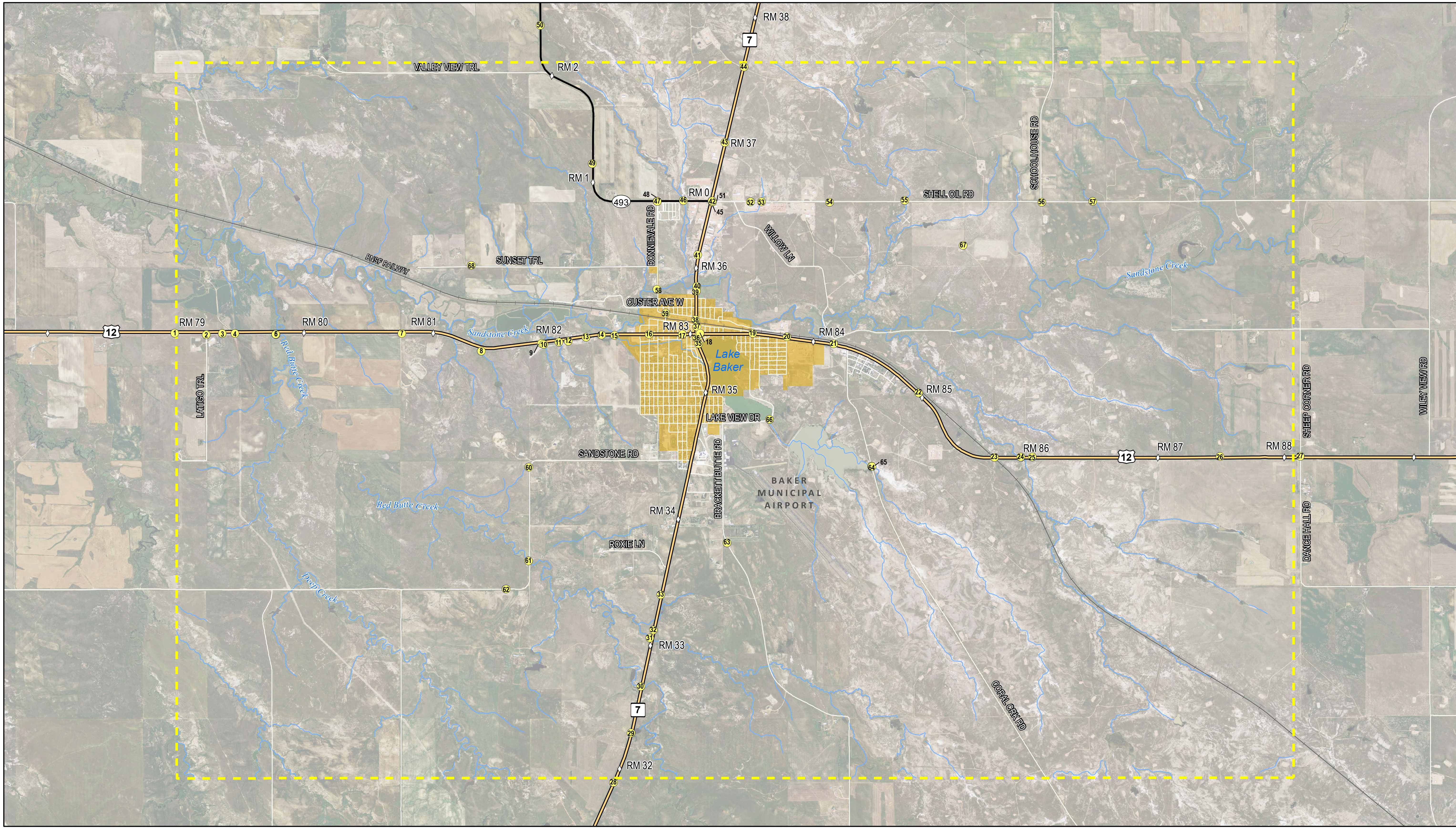
Photo 64: Looking west from Coral Creek Road towards inundation area and USACE dam.

Photo 65: Looking east from Coral Creek Road at headgates and culverts on east side of the road.

Photo 66: Looking northwest from Lake View Drive, southeast corner of Baker Lake. A separated bike/ped path wraps around the lake.

Photo 67: Looking southwest from an unnamed access road south of Shell Oil Road.

Photo 68: Looking east on Sunset Trail Road towards the city lagoons (in background). New transmission poles erected; transmission lines not yet mounted.



0 0.25 0.5 1 Miles

Date: November 24, 2014
Projection: MT Stateplane, NAD83 Ft
Sources: MDT, HDR, ESRI

LEGEND

- Photo Location and Number
- Reference Markers (RM)
- Environmental Scan Boundary
- BNSF Railroad
- Stream/Irrigation Ditch
- Baker City Limits
- Primary On System Route
- Secondary On System Route
- Off System Route

BAKER CORRIDOR PLANNING STUDY

City of Baker, Fallon County, MT

FIGURE 1: STUDY AREA and FIELD REVIEW PHOTO LOCATIONS

BAKER CORRIDOR
PLANNING STUDY

APPENDIX E: Miscellaneous Reports

Baker Corridor Planning Study

2014 PAVEMENT DATA FOR BAKER CORRIDOR PLANNING STUDY AREA

Route	Direction	Lane	Begin Mile	End Mile	Pavement Type	Length	Width	# of Lanes	Financial District	Maintenance Division	AADT	ESAL	cesal	Pavement Age	IRI Index	Rut Index	ACI Index	MCI - ACP Index	OPI	Raveling Index	Base Thicknes s	Surface Type	O'Lay Thick	TOTAL THICK	Flexible Thicknes s	Road Structure Category	Year Constructed	Year of Last Surface	Last Treatment Year	County	NHS/STP	System	MDT_SYS_NHS STP_ID	ROUTE DESCRIPTION
C000002	All	All	77.2	82.6	ASPHALT	5.40	28	2	GLENDIVE	MILES CITY	1,291	46	247,936	15	65.09	53.91	95.47	95.17	54.07	99.66	3.23	PMS-B	0.34	3.57	0.34	AC Reconstruction	1998	1998	1998	FAL	STP	Prim	Primary STP	P-2
C000002	All	All	82.6	83.749	ASPHALT	1.15	46	2	GLENDIVE	MILES CITY	3,240	82	331,416	11	48.00	74.67	100.00	100.00	57.41	92.57	0.9	PMS-D	0.4	1.3	0.4	AC Reconstruction	2002	2002	2002	FAL	STP	Prim	Primary STP	P-2
C000002	All	All	83.749	95.514	ASPHALT	11.77	33	2	GLENDIVE	MILES CITY	1,004	98	288,490	8	80.33	75.46	99.25	97.68	74.09	100.00	1	PMS-S	0.143	1.893	0.893	AC Minor Rehabilitation	1968	2005	2005	FAL	STP	Prim	Primary STP	P-2
C000027	All	All	29	35.4	ASPHALT	6.40	28	2	GLENDIVE	MILES CITY	1,065	99	108,419	3	72.07	75.71	98.35	97.99	69.57	99.73	1.07	PMS-S	0.32	1.39	0.32	AC Reconstruction	2010	2010	2010	FAL	STP	Prim	Primary STP	P-27
C000027	All	All	35.4	44.5	ASPHALT	9.10	28	2	GLENDIVE	MILES CITY	1,288	92	302,646	9	67.95	70.79	98.19	95.58	64.64	98.37	0	PMS-S	0.15	0.55	0.55	AC Thin Overlay	1983	2004	2004	FAL	STP	Prim	Primary STP	P-27

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002082+06161

Location : WEST EDGE BAKER Structure Name: none

General Location Data

District Code, Number, Location : **04** **Dist 4** **GLENDIVE**

County Code, Location : **025** **FALLON**

Kind fo Hwy Code, Description : **2** **2 U.S. Numbered Hwy**

Str Owner Code, Description : **1** **State Highway Agency**

Intersecting Feature : **DRAINAGE**

Structure on the State Highway System : X

Structure on the National Highway System :

Str Meet or Exceed NBIS Bridge Length : X

Latitude : **46°22'04"**

Longitude : **104°17'18"**

MDT Maintenance Section : **43-14 Baker**

Division Code, Location : **43** **MILES CITY**

City Code, Location : **03475** **BAKER**

Signed Route Number : **00012**

Maintained by Code, Description : **1** **State Highway Agency**

Kilometer Post, Mile Post : **132.70 km** **82.46**

Construction Data

Construction Project Number : **STPP 2-2(9)77**

Construction Station Number : **1782+12.00**

Construction Drawing Number : **16560**

Construction Year : **1998**

Reconstruction Year :

Traffic Data

Current ADT : **3,730** ADT Count Year : **2009** Percent Trucks : **2 %**

Structure Loading, Rating and Posting Data

Loading Data :

Design Loading :		**5 MS 18 (HS 20)**
Inventory Load, Design :	**32.6 mton**	**B ASD Assigned**
Operating Load, Design :	**36.2 mton**	**B ASD Assigned**
Posting :		**5 At/Above Legal Loads**

Rating Data :	Operating	Inventory	Posting
Truck 1 Type 3 :			
Truck 2 Type 3-S3 :			
Truck 3 Type 3-3 :	**40**		

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **19.56 m**

Deck Area : **228.00 m sq**

Deck Roadway Width : **10.97 m**

Approach Roadway Width : **8.50 m**

Median Code, Description : **0** **No median**

Structure Vertical and Horizontal Clearance Data :

Vertical Clearance Over the Structure : **99.99 m**

Reference Feature for Vertical Clearance : **N Feature not hwy or RR**

Vertical Clearance Under the Structure : **0.00 m**

Reference Feature for Lateral Underclearance : **N Feature not hwy or RR**

Minimum Lateral Under Clearance Right : **0.00 m**

Minimum Lateral Under Clearance Left : **0.00 m**

Span Data

Main Span

Number Spans : **3**

Material Type Code, Description : **2** **Concrete continuous**

Span Design Code, Description : **1** **Slab**

Approach Span

Number of Spans : **0**

Material Type Code, Description :

Span Design Code, Description :

Deck

Deck Structure Type : **1 Concrete Cast-in-Place**

Deck Surfacing Type : **1 Monolithic concrete (concurrently placed with struct**

Deck Protection Type : **1 Epoxy Coated Reinforcing**

Deck Membrain Type : **0 None**

(52) Out-to-Out Width : **11.68 m**

(50A) Curb Width : **0.00 m**

(50B) Curb Width : **0.00 m**

Skew Angle : °

Structure Vertical and Horizontal Clearance Data Inventory Route :

Over / Under Direction Name	Inventory Route	South, West or Bi-directional Travel			North or East Travel		
		Direction	Vertical	Horizontal	Direction	Vertical	Horizontal
Route On Structure US 12	P00002	Both	99.99 m	8.50 m	N/A		

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002082+06161
Continue

Inspection Data

Sufficiency Rating : **83**
Structure Status : **Not Deficient**

Inspection Due Date : 16 October 2014
(91) Inspection Frequency (months) : **24**

NBI Inspection Data

(90) Date of Last Inspection : 16 October 2012
Last Inspected By : Troy Hafele - 2056
(90) Inspection Date :
Inspected By :

Item	Value	Item	Value	Item	Value	Item	Value
(58) Deck Rating :	7	(68) Deck Geometry :	5	(36A) Bridge Rail Rating :	1	(62) Culvert Rating :	N
(59) Superstructure Rating :	7	(67) Structure Rating :	7	(36B) Transition Rating :	1	(61) Channel Rating :	7
(60) Substructure Rating :	7	(69) Under Clearance :	N	(36C) Approach Rail Rating :	1	(71) Waterway Adequacy :	8
(72) App Rdwy Align :	8	(41) Posting Status :	A	(36D) End Rail Rating :	1	(113) Scour Critical :	8

Unrepaired Spalls : 0 m sq
Deck Surfacing Depth : 0.00 in

Inspection Hours

Item	Value	Item	Value
Crew Hours for inspection :	1.5	Snooper Required :	N
Helper Hours :	-1	Snooper Hours for inspection :	-1
Special Crew Hours :	-1	Flagger Hours :	-1
Special Equipment Hours :	-1		

Inspection Work Candidates		Status	Priority	Effected Structure Unit	Scope of Work	Action	Covered Condition States
Candidate ID	Date Requested						

Late Reason:
Inspection Date: 10/16/2012

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002082+06161
Continue

Element Inspection Data

********** Span : **Main-0 - concrete slab, Spans 1 thru 3** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 52 - Conc Slab/Coatd Bars epoxy, (plan, 19.56m x 11.68m = 228.46m, pave notch and width)										
	1	1	228	sq.m.	X	100	0	0	0	0
						%	%	%	%	%

Element Description

Previous Inspection Notes :

10/16/2012 - longitudinal cracks plus efflorescence on bottom side. Underside Abut 1 right and Abut 4 left, fillets have minor spalls. TH	RLHZ
11/04/2010 - some transverse cracks, some scaling concrete and few small spalls at tined marks. TH	PDLJ
09/16/2008 - None	ZXBZ
01/10/2007 - None.	QIKT
02/09/2005 - None	KAHZ
02/07/2003 - None	LDBZ
01/12/2001 - None	ZAAV
01/20/1999 - None	JBBU

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 202 - Paint Stl Column Bents 2 and 3 each have 4, 16 inch outside diameter x 1/2 inch wall thickness										
	1	2	8	ea.		90	5	5	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - (photo Bent 2 looking back West). TH	RLHZ
11/04/2010 - some peeling paint at bottom of columns with surface rust. TH	PDLJ
09/16/2008 - None	ZXBZ
01/10/2007 - None	QIKT
02/09/2005 - None	KAHZ
02/07/2003 - None	LDBZ
01/12/2001 - None	ZAAV
01/20/1999 - _	JBBU

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 215 - R/Conc Abutment 1 / West and 4 / East (plan, 48' 4 inch x 2 = 29.46m)										
	1	2	29	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - None	RLHZ
11/04/2010 - both abutments have riprap(photo Abut 1). TH	PDLJ
09/16/2008 - None	ZXBZ
01/10/2007 - None	QIKT
02/09/2005 - Same as previously reported.	KAHZ
02/07/2003 - None	LDBZ
01/12/2001 - Light spall in fillet at lt side of abut. 3.	ZAAV
01/20/1999 - _	JBBU

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002082+06161

Continue

********** Span : **Main-0 - concrete slab, Spans 1 thru 3 (cont.)** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 234 - R/Conc Cap Bents 2 and 3 (plan, 37' 4 inch x 2 = 22.76m)										
	1	2	23	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - None RLHZ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 334 - Metal Rail Coated T101, all galvanized W beam with 3w x 4h inch tube rail stiffeners and 6 inch I beam posts										
	1	1	39	m.		100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - (plan, 127.8m = 38.95m). TH RLHZ
11/04/2010 - None PDLJ
09/16/2008 - Damaged boxing glove. ZXBZ
01/10/2007 - None. QIKT
02/09/2005 - None KAHZ
02/07/2003 - None LDBZ
01/12/2001 - None ZAAV
01/20/1999 - _ JBBU

Inspection Notes:

General Inspection Notes

10/16/2012 - entire bridge opening is lined with riprap. TH (Drainage flows to the North. TH 8-27-13) RLHZ
QA 9-10-13 AJ, CH, JP, TH, DO, AE

11/04/2010 - 12' underclearance to water and 13' to bottom of channel. TH PDLJ
09/16/2008 - None ZXBZ
01/10/2007 - None QIKT
02/09/2005 - None KAHZ
02/07/2003 - None LDBZ
01/12/2001 - None ZAAV
01/20/1999 - None JBBU

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002085+07161

Location : 2M SE BAKER Structure Name: none

General Location Data

District Code, Number, Location : **04 Dist 4 GLENDIVE**

County Code, Location : **025 FALLON**

Kind fo Hwy Code, Description : **2 2 U.S. Numbered Hwy**

Str Owner Code, Description : **1 State Highway Agency**

Intersecting Feature : **BN RAILROAD**

Structure on the State Highway System : **X**

Structure on the National Highway System :

Str Meet or Exceed NBIS Bridge Length : **X**

Latitude : **46°21'14"**

Longitude : **104°13'37"**

MDT Maintenance Section : **43-14 Baker**

Division Code, Location : **43 MILES CITY**

City Code, Location : **00000 RURAL AREA**

Signed Route Number : **00012**

Maintained by Code, Description : **1 State Highway Agency**

Kilometer Post, Mile Post : **138.00 km 85.75**

Construction Data

Construction Project Number : **F FG 86-30**

Construction Station Number : **1525+44.00**

Construction Drawing Number : **8172**

Construction Year : **1968**

Reconstruction Year :

Traffic Data

Current ADT : **880** ADT Count Year : **2009** Percent Trucks : **2 %**

Structure Loading, Rating and Posting Data

Loading Data :

Design Loading :		**5 MS 18 (HS 20)**
Inventory Load, Design :	**32.6 mton**	**A LFD Assigned**
Operating Load, Design :	**45.3 mton**	**A LFD Assigned**
Posting :		**5 At/Above Legal Loads**

Rating Data :	Operating	Inventory	Posting
Truck 1 Type 3 :	**48**		
Truck 2 Type 3-S3 :	**64**		
Truck 3 Type 3-3 :	**73**		

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **65.28 m**

Deck Area : **697.00 m sq**

Deck Roadway Width : **9.14 m**

Approach Roadway Width : **11.60 m**

Median Code, Description : **0 No median**

Structure Vertical and Horizontal Clearance Data :

Vertical Clearance Over the Structure : **99.99 m**

Reference Feature for Vertical Clearance : **R Railroad beneath struc**

Vertical Clearance Under the Structure : **7.32 m**

Reference Feature for Lateral Underclearance : **R Railroad beneath struc**

Minimum Lateral Under Clearance Right : **5.79 m**

Minimum Lateral Under Clearance Left : **5.79 m**

Span Data

Main Span

Number Spans : **3**

Material Type Code, Description : **5 Prestressed concrete**

Span Design Code, Description : **2 Stringer/Multi-beam or Girder**

Approach Span

Number of Spans : **0**

Material Type Code, Description :

Span Design Code, Description :

Deck

Deck Structure Type : **1 Concrete Cast-in-Place**

Deck Surfacing Type : **1 Monolithic concrete (concurrently placed with struct**

Deck Protection Type : **0 None**

Deck Membrain Type : **0 None**

(52) Out-to-Out Width : **10.67 m**

(50A) Curb Width : **0.00 m**

(50B) Curb Width : **0.00 m**

Skew Angle : **30°**

Structure Vertical and Horizontal Clearance Data Inventory Route :

Over / Under Direction Name	Inventory Route	South, West or Bi-directional Travel			North or East Travel		
		Direction	Vertical	Horizontal	Direction	Vertical	Horizontal
Route On Structure US 12	P00002	Both	99.99 m	9.14 m	N/A		

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002085+07161
Continue

Inspection Data

Sufficiency Rating : **77.1**
Structure Status : **Not Deficient**

Inspection Due Date : 07 May 2016
(91) Inspection Frequency (months) : **24**

NBI Inspection Data

(90) Date of Last Inspection :	07 May 2014	Last Inspected By :	Debra Ohm - 2070
(90) Inspection Date :		Inspected By :	

(58) Deck Rating :	7	(68) Deck Geometry :	6	(36A) Bridge Rail Rating :	1	(62) Culvert Rating :	N
(59) Superstructure Rating :	8	(67) Structure Rating :	7	(36B) Transition Rating :	1	(61) Channel Rating :	N
(60) Substructure Rating :	7	(69) Under Clearance :	7	(36C) Approach Rail Rating :	1	(71) Waterway Adequacy :	N
(72) App Rdwy Align :	6	(41) Posting Status :	A	(36D) End Rail Rating :	1	(113) Scour Critical :	N

Unrepaired Spalls : 0 m sq

Deck Surfacing Depth : 0.00 in

Inspection Hours

Crew Hours for inspection :	2	Snooper Required :	N
Helper Hours :	-1	Snooper Hours for inspection :	-1
Special Crew Hours :	-1	Flagger Hours :	-1
Special Equipment Hours :	-1		

Inspection Work Candidates: Candidate ID	Date Requested	Status	Priority	Effected Structure Unit	Scope of Work	Action	Covered Condition States
D41-FY2008-000030	**05 June 2008**	**Approved**	**High**	M Main	Bridge	Repl Joint	

Seal bridge-pavement joint at West Abut 1 and East Abut 4(updated photos 2012). TH

Approved. DRC

Updated picture. Bearings below on abutment 4 are rusting out because of it. (see photo). 5-7-14 DO

Late Reason:
Inspection Date: 05/07/2014

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002085+07161

Continue

Element Inspection Data

********** Span : **Main-0 - -1** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element Description										
Element 12 - Bare Concrete Deck (plan = 65.28m x 10.67m = 696.54m, pave notch and width)										
	1	1	697	sq.m.	X	100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - None on this inspection. (Element 359 - soffit smart flag deleted per last QA) DO HTDZ

05/09/2012 - some exposed aggregate at Bent 3(photo). TH KZEZ

05/20/2010 - deck has some cracking. See element 359 soffit smart flag for Abut 1 left(photo 2010) and Abut 4 right(photo 2008) underside. TH UIDZ

05/29/2008 - Popouts are rock pockets. (64.92 X 10.06 = 653.095) FDJZ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 109 - P/S Conc Open Girder 6 Type A I beams at 70' each per Spans 1 thru 3										
	1	1	384	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - None on this inspection. HTDZ

05/09/2012 - None KZEZ

05/20/2010 - 6 I beams. TH UIDZ

05/29/2008 - None FDJZ

11/17/2004 - None BZBZ

01/12/2001 - None ZAAX

12/04/1996 - None QGAE

12/01/1992 - None REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 205 - R/Conc Column Bents 2 and 3 each have 2 square columns										
	1	2	4	ea.		95	5	0	0	
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - None on this inspection. HTDZ

05/09/2012 - Bent 3 Span 2(photo) left column 3/4 up has 4" diameter x 1/8" depth shotgun impact; right column lower end has 3, 2" diameter x 1/4" depth bullet impacts. TH KZEZ

05/20/2010 - Bent 2 has some spalls, changed from 100,0 to 95,5 percent. TH UIDZ

05/29/2008 - None FDJZ

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002085+07161

Continue

* * * * * * * * * * Span : **Main-0 - -1 (cont.)** * * * * * * * * * *

Element Description										
Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 215 - R/Conc Abutment 1 / West and 4 / East (plan = 48.583' x 2 = 29.6m)										
	1	2	30	m.		90	5	5	0	
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - Abutment 1 girder 6 outside 10in x 4in delam. Bay 5 16in x 6in delam. Bay 4 girder 4 20in x 6in delam and 4in x 3in x 1/2in spall. Bay 3 girder 3 17in x 7in delam. Bay 2 girder 2 15in x 6in delam and 8in x 4in x 1/4in spall. Abutment 4 bay 1 girder 2 17in x 10in delam. Bay 2 girder 3 16in x 6in delam and 9in x 3in x 1/2in deep spall. Bay 3 14in x 7in delam. Bay 5 9in x 6in delam with spalling around it. DO HTDZ

05/09/2012 - Abut 1 right corner is sloughing away and is starting to seperate FETS from drain pipe(photo). Abut 4 right has water seeping out of backwall/cap (work order). Abut 4 left corner is sloughing fill/plant mix away from transition posts(photo). TH
QA 9-10-13 Spalls likely caused by rusting of anchor bolts embedded in the concrete. DO KZEZ

05/20/2010 - Abut 1 and 4 both have some spalls where the beam embedment meets the backwall. TH UIDZ

05/29/2008 - 12 bearings in backwalls. Spalls at bearings. Bent 4 bearings heavy active corrosion with section loss. FDJZ

11/17/2004 - None BZBZ

01/12/2001 - None ZAAX

12/04/1996 - None QGAE

12/01/1992 - None REFI

Inspection Notes:

Element 234 - R/Conc Cap Bents 2 and 3 (plan = 34.17' x 2 = 20.8m)										
	1	1	21	m.		95	5	0	0	
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - None on this inspection. HTDZ

05/09/2012 - Bent 3 Span 3 left end has had concrete patch previously added for G1 right bearing bolt embeddment(photo 2008). Bent 3 Span 2 right face above right columns has 3 bullet impacts(photo). TH KZEZ

05/20/2010 - Changed from 100,0 to 95,5 percent. TH UIDZ

05/29/2008 - None FDJZ

11/17/2004 - Same as previously reported. BZBZ

01/12/2001 - RTside of cap at bent 3 has a small spalled area. ZAAX

12/04/1996 - None QGAE

12/01/1992 - None REFI

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002085+07161

Continue

********** Span : **Main-0 - -1 (cont.)** **********

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 313 - Fixed Bearing Abut 1 = 6, Bent 2 = 6 / 6, Bent 3 = 6 / 6, Abut 4 = 6										
	1	1	36	ea.		70	30	0		
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - Abutment 4 girder 6 bearing (see photo) typical of all the abutment 4 bearings. DO HTDZ

05/09/2012 - None KZEZ

05/20/2010 - Abut 4 bearings have scaling rust, some other bearings have some surface rust. Changed quantity from 24 to 36 to include bearings with 1 bolt visible in both backwalls and changed from 100,0 to 70,30 percent. TH UIDZ

05/29/2008 - None FDJZ

11/17/2004 - None BZBZ

01/12/2001 - None ZAAX

12/04/1996 - None QGAE

12/01/1992 - None REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 334 - Metal Rail Coated Galv thrie beam and 6 in painted I beam posts and 7 3/4 in wood blockouts on top 30w x 12h conc curb										
	1	1	139	m.		90	5	5	0	0
						%	%	%	%	%

Previous Inspection Notes :

05/07/2014 - None on this inspection. HTDZ

05/09/2012 - posts have some freckled and surface rust. TH (as-built plan summary = 456.94' = 139.28m) KZEZ

05/20/2010 - Galvanized thrie beam. TH UIDZ

05/29/2008 - None. (64.92 X 2 = 129.84) FDJZ

11/17/2004 - None BZBZ

01/12/2001 - None ZAAX

12/04/1996 - None QGAE

12/01/1992 - None REFI

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00002085+07161

Continue

General Inspection Notes

05/07/2014 - Inspection runs West to East. Settlement in front of abutment 4 on the roadway and a little in front of abutment 1. (see photos) Abutment 1 right erosion under wing wall and abutment 4 left erosion under wing wall. Element 359 soffit smart flag was deleted last QA. DO	HTDZ
05/09/2012 - QA 9-10-13 AJ, CH, JP, TH, MK, DO, AE	KZEZ
05/20/2010 - Last snoopered 5/28/2008. TH 3-7-11	UIDZ
05/29/2008 - None	FDJZ
11/17/2004 - Same as previously reported.	BZBZ
01/12/2001 - Bridge is in a hump vertical.	ZAAX
12/04/1996 - Sufficiency Rating Calculation Accepted by ops$a0241 at 8/14/97 16:18:40 OPS$A0241 inspection comments - Structure P00002085+07161 - Date 12/4/96 - Previous comments > Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 14:27:51 Sufficiency Rating Calculation Accepted by ops$u9004 at 2/19/97 14:58:21	QGAE
12/01/1992 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 14:27:51 Sufficiency Rating Calculation Accepted by ops$u9004 at 2/19/97 14:58:21	REFI
11/01/1990 - Updated with tape 1992	NB92
11/01/1988 - Updated with tape 1990	NB90
01/01/1987 - Updated with tape 1988	NB88
02/01/1985 - Updated with tape 1986	NB86
01/01/1983 - Updated with tape 1984	NB84
02/01/1981 - Updated with tape 1982	NB82
04/01/1979 - Updated with tape 1980	NB80

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+01721

Location : BAKER Structure Name: none

General Location Data

District Code, Number, Location : **04 Dist 4 GLENDIVE**

County Code, Location : **025 FALLON**

Kind fo Hwy Code, Description : **3 3 State Hwy**

Str Owner Code, Description : **1 State Highway Agency**

Intersecting Feature : **BAKER LAKE OVERFLOW**

Structure on the State Highway System : **X**

Structure on the National Highway System :

Str Meet or Exceed NBIS Bridge Length : **X**

Latitude : **46°21'51"**

Longitude : **104°16'25"**

MDT Maintenance Section : **43-14 Baker**

Division Code, Location : **43 MILES CITY**

City Code, Location : **03475 BAKER**

Signed Route Number : **00007**

Maintained by Code, Description : **1 State Highway Agency**

Kilometer Post, Mile Post : **56.70 km 35.23**

Construction Data

Construction Project Number : **STPP 27-2(14)29**

Construction Station Number : **195+47.00**

Construction Drawing Number :

Construction Year : **2009**

Reconstruction Year :

Traffic Data

Current ADT : **2,070** ADT Count Year : **2009** Percent Trucks : **2 %**

Structure Loading, Rating and Posting Data

Loading Data :

Design Loading :		**2 M 13.5 (H 15)**
Inventory Load, Design :	**25.1 mton**	**2 AS Allowable Stress**
Operating Load, Design :	**36.7 mton**	**2 AS Allowable Stress**
Posting :		**5 At/Above Legal Loads**

Rating Data :	Operating	Inventory	Posting
Truck 1 Type 3 :	**33.51**	**22.88**	
Truck 2 Type 3-S3 :	**52.93**	**36.14**	
Truck 3 Type 3-3 :	**65.11**	**44.46**	

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **10.70 m**

Deck Area : **0.00 m sq**

Deck Roadway Width : **0.00 m**

Approach Roadway Width : **12.70 m**

Median Code, Description : **0 No median**

Structure Vertical and Horizontal Clearance Data :

Vertical Clearance Over the Structure : **99.99 m**

Reference Feature for Vertical Clearance : **N Feature not hwy or RR**

Vertical Clearance Under the Structure : **0.00 m**

Reference Feature for Lateral Underclearance : **N Feature not hwy or RR**

Minimum Lateral Under Clearance Right : **0.00 m**

Minimum Lateral Under Clearance Left : **0.00 m**

Span Data

Main Span

Number Spans : **2**

Material Type Code, Description : **1 Concrete**

Span Design Code, Description : **19 Culvert (includes frame culverts)**

Deck

Deck Structure Type : **N Not applicable**

Deck Surfacing Type : **N Not Applicable (applies only to strutures with no dec**

Deck Protection Type : **N Not applicable (applies only to structures with no de**

Deck Membrain Type : **N Not applicable (applies only to structures with no de**

Approach Span

Number of Spans : **0**

Material Type Code, Description :

Span Design Code, Description :

(52) Out-to-Out Width : **0.00 m**

(50A) Curb Width : **0.00 m**

(50B) Curb Width : **0.00 m**

Skew Angle : **36°**

Structure Vertical and Horizontal Clearance Data Inventory Route :

Over / Under Direction Name	Inventory Route	South, West or Bi-directional Travel			North or East Travel		
		Direction	Vertical	Horizontal	Direction	Vertical	Horizontal
Route On Structure MT 7	P00027	Both	99.99 m	12.70 m	N/A		

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+01721

Continue

Inspection Data

Sufficiency Rating : ***91.4**
Structure Status : **Not Deficient**

Inspection Due Date : 16 October 2014
(91) Inspection Frequency (months) : **24**

NBI Inspection Data

(90) Date of Last Inspection : 16 October 2012
Last Inspected By : Troy Hafele - 2056
(90) Inspection Date :
Inspected By :

(58) Deck Rating :	N	(68) Deck Geometry :	N	(36A) Bridge Rail Rating :	N	(62) Culvert Rating :	8
(59) Superstructure Rating :	N	(67) Structure Rating :	6	(36B) Transition Rating :	N	(61) Channel Rating :	8
(60) Substructure Rating :	N	(69) Under Clearance :	N	(36C) Approach Rail Rating :	N	(71) Waterway Adequacy :	8
(72) App Rdwy Align :	4	(41) Posting Status :	A	(36D) End Rail Rating :	N	(113) Scour Critical :	8

Unrepaired Spalls : 0 m sq
Deck Surfacing Depth : 0.00 in

Inspection Hours

Crew Hours for inspection :	1.5	Snooper Required :	N
Helper Hours :	-1	Snooper Hours for inspection :	-1
Special Crew Hours :	-1	Flagger Hours :	-1
Special Equipment Hours :	-1		

Inspection Work Candidates							
Candidate ID	Date Requested	Status	Priority	Effected Structure Unit	Scope of Work	Action	Covered Condition States

Late Reason:
Inspection Date: 10/16/2012

Element Inspection Data

********** Span : **Main-0 - -1** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 241 - Concrete Culvert double RCB 4.8s x 1.2r x 36.9m										
	1	2	74	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - (photo culvert info stamp). TH RZHZ

11/08/2010 - new in 2009, 67' from inlet end flowable fill leaked through joint in South cell on North wall(photo). Flowable fill between culverts is eroding away(photo). Both inlet and outlet ends have concrete slope protection. TH QZDZ

Inspection Notes:

General Inspection Notes

10/16/2012 - (Drainage flows to the West. TH 8-28-13)
QA 9-10-13 AJ, CH, JP, MK, TH, DO, AE RZHZ

11/08/2010 - None QZDZ

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+08231

Location : NORTH EDGE BAKER Structure Name: none

General Location Data

District Code, Number, Location : **04 Dist 4 GLENDIVE**
County Code, Location : **025 FALLON**
Kind fo Hwy Code, Description : **3 3 State Hwy**
Str Owner Code, Description : **1 State Highway Agency**
Intersecting Feature : **SANDSTONE CREEK**
Structure on the State Highway System : **X**
Structure on the National Highway System :
Str Meet or Exceed NBIS Bridge Length : **X**
Latitude : **46°22'24"**
Longitude : **104°16'32"**

MDT Maintenance Section : **43-14 Baker**
Division Code, Location : **43 MILES CITY**
City Code, Location : **03475 BAKER**
Signed Route Number : **00007**
Maintained by Code, Description : **1 State Highway Agency**
Kilometer Post, Mile Post : **57.71 km 35.86**

Construction Data

Construction Project Number : **2 A 2**
Construction Station Number : **19+81.00**
Construction Drawing Number : **2279**
Construction Year : **1941**
Reconstruction Year :

Traffic Data

Current ADT : **3,660** ADT Count Year : **2009** Percent Trucks : **2 %**

Structure Loading, Rating and Posting Data

Loading Data :

Design Loading :		**2 M 13.5 (H 15)**
Inventory Load, Design :	**24.0 mton**	**2 AS Allowable Stress**
Operating Load, Design :	**34.8 mton**	**2 AS Allowable Stress**
Posting :		**5 At/Above Legal Loads**

Rating Data :	Operating	Inventory	Posting
Truck 1 Type 3 :	**30.22**	**20.81**	
Truck 2 Type 3-S3 :	**45.63**	**31.41**	
Truck 3 Type 3-3 :	**58.72**	**40.43**	

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **19.66 m**
Deck Area : **156.00 m sq**
Deck Roadway Width : **7.63 m**
Approach Roadway Width : **7.90 m**
Median Code, Description : **0 No median**

Structure Vertical and Horizontal Clearance Data :

Vertical Clearance Over the Structure : **99.99 m**
Reference Feature for Vertical Clearance : **N Feature not hwy or RR**
Vertical Clearance Under the Structure : **0.00 m**
Reference Feature for Lateral Underclearance : **N Feature not hwy or RR**
Minimum Lateral Under Clearance Right : **0.00 m**
Minimum Lateral Under Clearance Left : **0.00 m**

Span Data

Main Span

Number Spans : **3**
Material Type Code, Description : **7 Wood or Timber**
Span Design Code, Description : **2 Stringer/Multi-beam or Girder**

Deck

Deck Structure Type : **8 Wood or Timber**
Deck Surfacing Type : **6 Bituminous**
Deck Protection Type : **0 None**
Deck Membrain Type : **0 None**

Approach Span

Number of Spans : **0**
Material Type Code, Description :
Span Design Code, Description :

(52) Out-to-Out Width : **7.92 m**
(50A) Curb Width : **0.00 m**
(50B) Curb Width : **0.00 m**
Skew Angle : °

Structure Vertical and Horizontal Clearance Data Inventory Route :

Over / Under Direction Name	Inventory Route	South, West or Bi-directional Travel			North or East Travel		
		Direction	Vertical	Horizontal	Direction	Vertical	Horizontal
Route On Structure MT 7	P00027	Both	99.99 m	7.63 m	N/A		

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+08231
Continue

Inspection Data

Sufficiency Rating : **70.6**
Structure Status : **Func Obs - Elg Rehab**

Inspection Due Date : 16 October 2014
(91) Inspection Frequency (months) : **24**

NBI Inspection Data

(90) Date of Last Inspection : 16 October 2012
Last Inspected By : Troy Hafele - 2056
(90) Inspection Date :
Inspected By :

(58) Deck Rating :	6		(68) Deck Geometry :	2		(36A) Bridge Rail Rating :	1		(62) Culvert Rating :	N	
(59) Superstructure Rating :	6		(67) Structure Rating :	6		(36B) Transition Rating :	1		(61) Channel Rating :	7	
(60) Substructure Rating :	7		(69) Under Clearance :	N		(36C) Approach Rail Rating :	1		(71) Waterway Adequacy :	4	
(72) App Rdwy Align :	8		(41) Posting Status :	A		(36D) End Rail Rating :	1		(113) Scour Critical :	5	

Unrepaired Spalls : 0 m sq
Deck Surfacing Depth : 6.00 in

Inspection Hours

Crew Hours for inspection :	1.5		Snooper Required :	N	
Helper Hours :	-1		Snooper Hours for inspection :	-1	
Special Crew Hours :	-1		Flagger Hours :	-1	
Special Equipment Hours :	-1				

Inspection Work Candidates							
Candidate ID	Date Requested	Status	Priority	Effected Structure Unit	Scope of Work	Action	Covered Condition States

Late Reason:
Inspection Date: 10/16/2012

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+08231

Continue

Element Inspection Data

* * * * * * * * * * Span : **Main-0 - wood, Spans 1 thru 3** * * * * * * * * * *

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 32 - Timber Deck/AC Ovly 1 5/8 x 3 1/2 inch creosote boards on edge (plan plus 18 inch = 19.66m x 7.92m = 155.7m)										
	1	3	156	sq.m.	X	0	100	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - repaired potholes at Abut 1 left(photo) and Bent 2 right(photo of edge) are breaking up. TH RZHZ
11/08/2010 - plant mix surfacing is cracking and has 4 patched areas. TH QREZ
09/16/2008 - Patches less than 2 pct. ZZLX
01/10/2007 - None. QZKC
02/09/2005 - New A/C overlay 2004 KEHX
01/30/2003 - The a/c is still in the same condition. VIBZ
01/12/2001 - A/C overlay is badly crackesd and breaking up. MBHQ
01/20/1999 - A/C overlay is cracking and breaking up. HBKN
wearing surface is not considered in the deck rating. I raised rating from 6 to 7. bgn
11/26/1996 - None AXHC
03/01/1995 - None YDNF
11/01/1992 - None REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 111 - Timber Open Girder 13, 5 3/4 x 17 1/2 inch creosote beams per spans 1 and 2, plus Span 2 = 13, 7 3/4 x 17 1/2 inch										
	1	1	254	m.		85	10	5	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - None RZHZ
11/08/2010 - None QREZ
09/16/2008 - Span 1, 2nd and 5th RT split, 7th RT cracked(split TH 11-8-10), photo. ZZLX
Span2, 2nd RT split.
01/10/2007 - Revision: Span 1. 7th from RT. diaginal crack. QZKC
Span 2. 2nd from RT. diaginal crack. Beams have some checking.
02/09/2005 - Same as previously reported. KEHX
01/30/2003 - Same condition as last insp. VIBZ
01/12/2001 - Same as the last report. MBHQ
01/20/1999 - (span 1) 3rd, 5th and 7th rt and 3rd lt has diagonal cracks. (span 2) 2nd rt diagonal crack 4th rt horizontal crack. (span 3) 5th and 6th lt horizontal cracks. HBKN
11/26/1996 - None AXHC
03/01/1995 - None YDNF
11/01/1992 - None REFI

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+08231

Continue

********** Span : **Main-0 - wood, Spans 1 thru 3 (cont.)** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 206 - Timber Column Abuts 1 thru 4 each have 5, 12 inch diameter creosote pile										
	1	2	20	ea.		90	10	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - Bents 2(photo looking back South) and 3 have riprap plus are in water. TH RZHZ
QA 9-10-13 Light vertical checks. NO cracks. DO

11/08/2010 - None QREZ

09/16/2008 - None ZZLX

01/10/2007 - None QZKC

02/09/2005 - Same as previously reported. KEHX

01/30/2003 - Bent 2 has 2 piling with deep vertical cracks. VIBZ

01/12/2001 - Same as the last report. MBHQ

01/20/1999 - PILIING AT BENTS 2 AND 3 ARE WEATHERED WITH LIGHT VERTICAL CRACKS. HBKN

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 216 - Timber Abutment 1 / South and 4 / North each have 3 x 12 inch creosote planks										
	1	2	22	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - Abut 4(photo) has 6 inch gap below backwall plank plus erosion at P1 and P5. TH RZHZ

11/08/2010 - None QREZ

09/16/2008 - None ZZLX

01/10/2007 - None QZKC

02/09/2005 - None KEHX

01/30/2003 - None VIBZ

01/12/2001 - None MBHQ

01/20/1999 - None HBKN

11/26/1996 - None AXHC

03/01/1995 - None YDNF

11/01/1992 - None REFI

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00027035+08231

Continue

* * * * * * * * * * Span : **Main-0 - wood, Spans 1 thru 3 (cont.)** * * * * * * * * * *

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 235 - Timber Cap Abuts 1 thru 4 each have 11 3/4 inch square creosote beam										
	1	1	34	m.		95	5	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - None	RZHZ
11/08/2010 - some checks. TH	QREZ
09/16/2008 - None	ZZLX
01/10/2007 - Revision: Not crushing over bent 2 and 3.	QZKC
02/09/2005 - Same as previously reported.	KEHX
01/30/2003 - Same as last insp.	VIBZ
01/12/2001 - All the caps have light crushing over the piling.	MBHQ
01/20/1999 - Caps at bents 2 and 3 are crushing over piling in areas.	HBKN
11/26/1996 - None	AXHC
03/01/1995 - None	YDNF
11/01/1992 - None	REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 334 - Metal Rail Coated T101, all galvanized W beam with 3w x 4h inch tube rail stiffeners and 6 inch I beam posts										
	1	2	39	m.		100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/16/2012 - (photo Abut 1 left) (photo Bent 2 right backside). TH	RZHZ
11/08/2010 - None	QREZ
09/16/2008 - None	ZZLX
01/10/2007 - New rail (and posts. TH 10-22-12).	QZKC
02/09/2005 - Same as previously reported.	KEHX
01/30/2003 - Same as last insp.	VIBZ
01/12/2001 - Same as the last report. Plus the Lt. post at abut 4 is broken. Rt. rail post has heavey rot at the top. Numerous other posts are cracking and have deep splits. Rt, appr. sections near abut. 1 has a 2' tear.	MBHQ
01/20/1999 - RT side rail blocks are broken out. RT appr. section near abut. 1 has a two foot tear in it.	HBKN
11/26/1996 - None	AXHC
03/01/1995 - None	YDNF
11/01/1992 - None	REFI

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

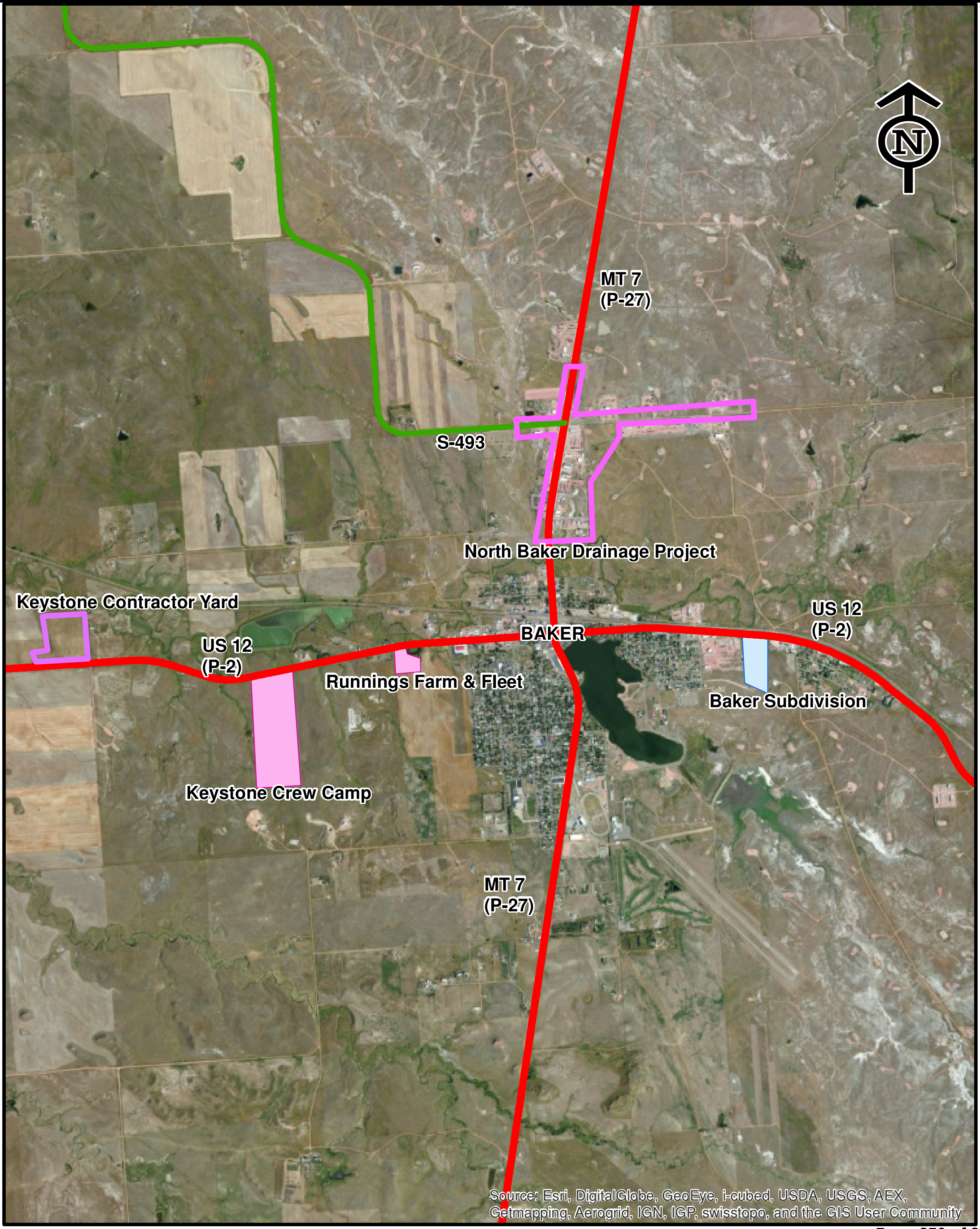
P00027035+08231

Continue

General Inspection Notes

10/16/2012 - (Sandstone Creek flows to the West. TH 8-28-13) QA 9-10-13 Changed Super Structure Rating from a 5 to a 6. DO AJ, CH, JP, TH, MK, DO, AE	RZHZ
11/08/2010 - 7' underclearance to water and 9' to bottom of channel. TH	QREZ
09/16/2008 - None	ZZLX
01/10/2007 - None	QZKC
02/09/2005 - None	KEHX
01/30/2003 - None	VIBZ
01/12/2001 - None	MBHQ
01/20/1999 - None	HBKN
11/26/1996 - Sufficiency Rating Calculation Accepted by ops$a0241 at 8/15/97 16:19:29 OPS$A0241 inspection comments - Structure P00027035+08231 - Date 11/26/96 - Previous comments > Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 14:36:05 Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 14:31:36 Sufficiency Rating Calculation Accepted by ops$u9004 at 2/19/97 15:00:35	AXHC
03/01/1995 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 14:36:05 Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 14:31:36 Sufficiency Rating Calculation Accepted by ops$u9004 at 2/19/97 15:00:35	YDNF
11/01/1992 -	REFI
02/01/1991 - Updated with tape 1993	NB93
11/01/1988 - Updated with tape 1991	NB91
01/01/1987 - Updated with tape 1988	NB88
02/01/1985 - Updated with tape 1986	NB86
01/01/1983 - Updated with tape 1984	NB84
02/01/1981 - Updated with tape 1983	NB83
04/01/1979 - Updated with tape 1980	NB80

Baker Area Development Map November 2014



BAKER CORRIDOR
PLANNING STUDY

Needs and Objectives

Baker Corridor Planning Study

April 2015

Prepared for:

Montana Department of Transportation

MONTANA MDT DEPARTMENT OF TRANSPORTATION

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1. Needs and Objectives

The following document identifies the needs and objectives for the Baker Corridor Planning Study. Needs and objectives are necessary to provide a framework for identifying improvements. The needs and objectives have been developed based on a review of findings from the Existing and Projected Conditions Report and Environmental Scan documents, as well as input received from the public, local government, and resource agencies. The needs, objectives, and other considerations listed below are in no specific order.

1.1 Need # 1: Improve operations and safety of US 12 and MT 7 within the study area to the extent practicable.

Objectives

1.a. Improve the operation of US 12/MT 7 intersection to accommodate an acceptable level of service (LOS C).

1.b. Improve operation of the US 12/MT 7 intersection to accommodate all design vehicles.

1.c. Improve roadway elements to meet current MDT design criteria.

1.2 Need #2: Improve mobility on US 12 and MT 7 for people and freight within the study area to the extent practicable.

Objectives

2.a. Reduce delay due to at-grade railroad crossing closures.

2.b. Accommodate existing and future capacity demands within the corridor.

2.c. Preserve and maintain roadway surfacing and bridges on US 12 and MT 7 to accommodate future transportation demands.

1.3 Other Considerations to the extent practicable

- Minimize the resource[1] impacts of improvement options.
- Minimize impacts during construction.
- Consider construction feasibility of improvement options.
- Consistency with local plans.

[1] Includes environmental, social, cultural, and economic resources.

BAKER CORRIDOR
PLANNING STUDY

Improvement Options Report

Baker Corridor Planning Study

August 2015

Prepared for:

Montana Department of Transportation

MONTANA MDT DEPARTMENT OF TRANSPORTATION

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1. Introduction

The purpose of this report is to identify improvement options that address the identified transportation needs and areas of concern within the study area. The study area includes a 9.1-mile segment of US 12 approximately between Reference Marker (RM) 79 and RM 88.1, a 5.7-mile segment of MT 7 approximately between RM 31.9 and RM 37.6, and a 2.1 mile segment of S-493 between RM 0 and RM 2.1. Figure 1 provides an overview of the study area.

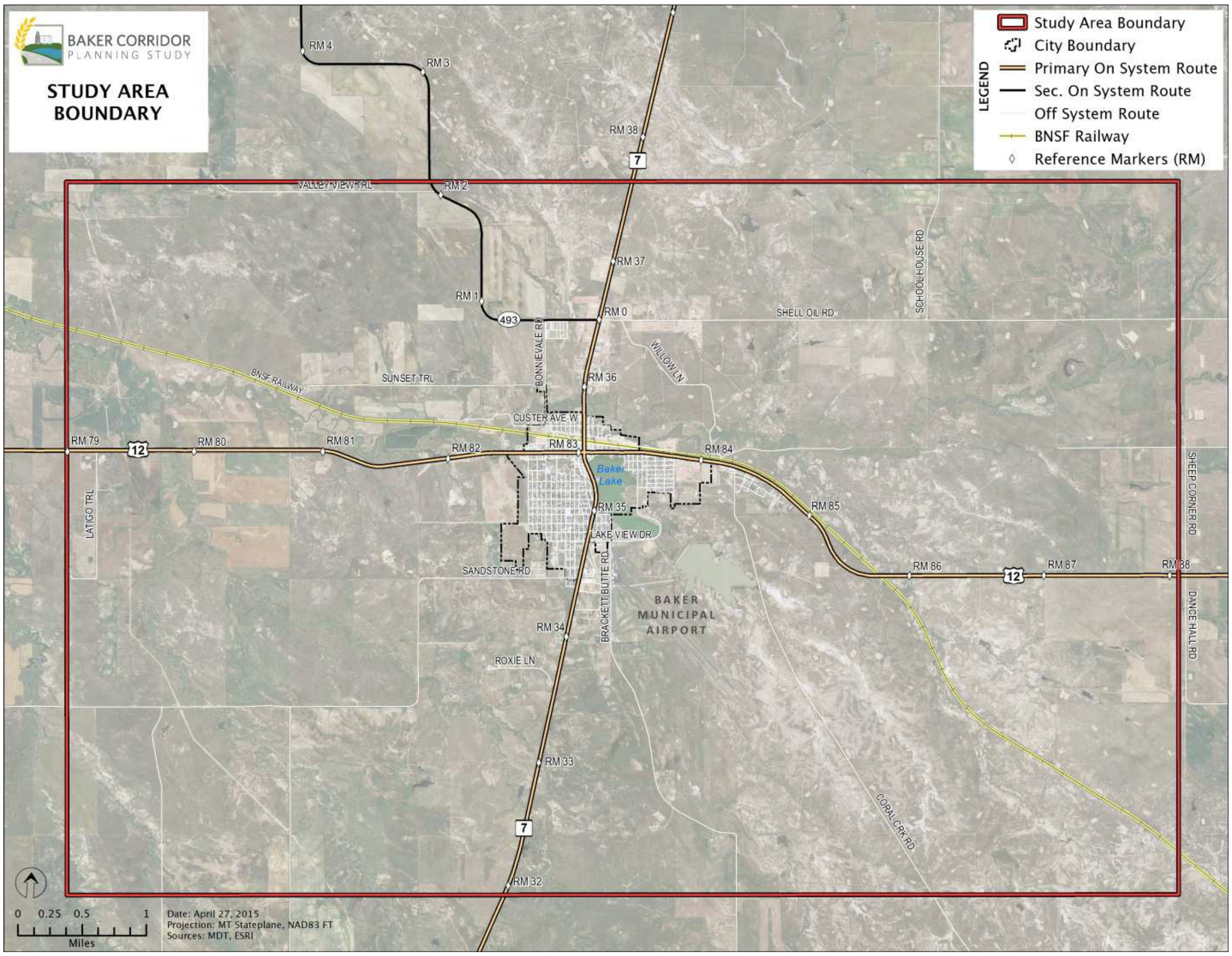


Figure 1: *Baker Corridor Planning Study* Area

The following sections identify a range of improvement options that may be considered for future implementation within the study area. The improvement options have been developed based on the evaluation of the existing conditions within the study area. Roadway issues and areas of concern were identified based on field review, engineering analysis of as-built drawings, crash data analysis, and information provided by the planning study team.

The recommended improvement options were grouped into the following categories:

- Geometrics and Pavement Marking Improvements
- Intersection Improvements

- Alternative Truck Routes
- Bridge Improvements
- Corridor Planning

This planning study identifies and evaluates new alignment options supported through the use of Quantm route optimization software. Additional information on the development of new alignment options is presented in the New Alignment Identification Using Quantm report. With the exception of Improvement Option 13, the improvement options contained in this report are provided in the context of a no-build scenario for a new alignment option. Improvement Option 13 describes potential new alignment options developed by Quantm and provides an operational analysis of the new alignments in combination with the recommended intersection improvement options for the US 12/MT 7 and MT 7/Shell Oil Road/S-493 intersections.

The information that follows provides descriptions, evaluations, and planning-level cost estimates of recommended improvement options. Planning-level cost estimates are for all phase costs and uses 2015 dollars as a base. The cost estimates also include right-of-way, utilities, and inflation based on the associated project timeframe.

2. Improvement Options

The improvement options were developed consistent with the previously identified needs and objectives for the corridor, which are as follows:

Need 1: Improve operations and safety of US 12 and MT 7 within the study area to the extent practicable.

- Improve the operation of US 12/MT 7 intersection to accommodate an acceptable level of service (LOS C).
- Improve operation of the US 12/MT 7 intersection to accommodate all design vehicles.
- Improve roadway elements to meet current MDT design criteria.

Need 2: Improve mobility on US 12 and MT 7 for people and freight within the study area to the extent practicable.

- Reduce delay due to at-grade railroad crossing closures (i.e., trains blocking crossing).
- Accommodate existing and future capacity demands within the corridor.
- Preserve and maintain roadway surfacing and bridges on US 12 and MT 7 to accommodate future transportation demands.

2.1 Project Implementation Considerations

Project Timeframe
Improvement option implementation depends on several factors, including funding availability, right-of-way requirements, project complexity, and local priorities, among others. The improvement options have been grouped into general timeframes:

- Short-term Improvements: 0 to 5 year timeframe

- Mid-term Improvements: 5 to 10 year timeframe
- Long-term Improvements: 10 or more year timeframe
- As needed: Improvement options would be implemented based on required need and available funding such as regularly scheduled maintenance and spot treatments.

Short-term improvements are generally those that can address an immediate need identified within the study area and can be implemented at a relatively low cost. These may include spot improvements such as installing additional guard rail or improved pavement markings and signing. Mid-term improvements are those that may require additional time for project development or address a need anticipated within the 5 to 10 year timeframe. Long-term improvements are improvements that address areas of concerns based on anticipated future conditions or may include improvements that address immediate needs but due to cost or other concerns cannot be constructed in the short- to mid-term. Long-term improvements are generally more costly to implement than short- and mid-term improvements. As needed improvements can be implemented based on observed needs throughout the planning horizon and could include spot treatments or pavement preservation projects.

Estimated Cost

The estimated costs shown for the following alternatives include estimated costs for all project phases including preliminary engineering, utility relocations, right-of-way acquisition and construction cost. These planning-level costs utilized the Montana Department of Transportation (MDT) Preliminary Estimating Tool (PET) spreadsheet, last revised in July 2014, as a base for establishing preliminary estimated quantities and improvement costs. Additional contingency was added to the planning level cost estimates to account for project unknown costs. Inflation was also included in the estimates, with an assumed inflation rate of 3%, based on the MDT Cost Estimation Procedure for Highway Design Projects. The inflation costs for each improvement option are based on the associated project timeframe. Projects recommended as a short-term improvement include a 5-year inflation period, mid-term and long-term improvements include an inflation period of 10 years. In areas where major rehabilitation would be required, a pavement section of four inches of asphalt over 12 inches of crushed aggregate course was assumed. Additional information on the cost for each alternative can be found in Appendix A.

Potential funding sources for the various improvements are also provided below; however, no funding has been identified for any of the improvement options. Refer to Table 4 for more information.

2.2 Geometric and Pavement Condition Improvements

Roadway geometrics were compared to current MDT design standards. A list of areas that do not meet current MDT standards was developed previously in the Existing and Projected Conditions Report. The analysis identified potential strategies that may help correct some of the identified issues and/or minimize the potential effects. Areas not meeting current MDT design standards do not necessarily represent unsafe conditions or warrant improvements. It may not be cost effective to reconstruct the roadway to address geometric issues unless there are documented safety issues. Improvement options are further discussed in the following sections.

Improvement Option 1: Pavement Marking Improvements at US 12/MT 7 Intersection

The existing geometric layout at the main intersection of US 12 and MT 7 does not accommodate the turning movements for WB-50 and larger design vehicles. Trucks with a 50' and larger wheelbase encounter conflicts making turning movements at this intersection. The location of this intersection is in downtown Baker with buildings in close proximity to the intersection on all four corners. Due to the existing structures and right-of-way constraints at this intersection, major geometric improvements are not likely. However, pavement marking improvements could be made at this intersection to improve conditions. This improvement option includes pavement marking improvements to meet current MDT design standards to accommodate the WB-67 design vehicle. Improvements are depicted in Figure 2.

Recommendation:

- Add a narrow striped median at all approaches for additional separation between turning vehicles and stopped vehicles at the intersection.
- Relocate the stop bar farther back from the intersection while maintaining adequate sight distance for stopped vehicles at all approaches.
- Remove on-street parking spaces near the intersection to allow for additional turning space. Parallel parking spaces would be removed from the east approach (north and south side) and west approach (north and south side).

Project Timeline:

- Short-term

Estimated Cost:

- $10,000 to $11,000

Potential Funding Source:

- STPP, TA

Benefits:

- Improved intersection operations
- Improved turning movements by reducing conflicts with opposing traffic and parked vehicles
- No environmental resource impacts anticipated

Concerns:

- Impacts to available parking near intersection, potentially 12 spaces along MT 7 and eight spaces along US 12, or an estimated 20 spaces for the intersection.
- The revised configuration still presents problems for right-turning WB-67 vehicles and may require curb mounting at the corners.

Figure 2: Pavement Marking Improvements at US 12/MT 7 Intersection

Improvement Option 2: Clear Zone on US 12 near RM 86.18

The drainage structure on US 12 located at approximately RM 86.18 includes concrete cutoff walls in the existing fill slope approximately 32 feet from the edge of travel way. Based on current MDT standards and the existing fill slope of approximately 4:1, these cutoff walls are located within the 40 foot clear zone. The recommended clear zone distance discussed in the MDT Road Design Manual is to accommodate run-off-road vehicles and provide enough distance to regain control of the vehicle. Since the cutoff walls are located within the recommended clear zone, the cutoff walls could be protected with a roadside barrier or be moved farther from the edge of travel. Extending the drainage structure to relocate the headwalls outside of the clear zone could be costly due to the size of the culvert.

Recommendation:

- Extend the existing guardrail or place a new guardrail section at this location in order to provide additional roadside protection from the existing concrete cutoff walls.

Project Timeline:

- Short-term

Estimated Cost:

- $40,000 to $42,000

Potential Funding Source:
- STPP, HSIP

Benefits:
- Consistent with current MDT design standards
- Improved safety
- No environmental resource impacts anticipated

Concerns:
- Additional maintenance of guardrail

Improvement Option 3: Horizontal Curve Warning Signs

One curve on S-493 does not meet current MDT design standards for level terrain while an additional ten horizontal curves throughout the study area failed to meet current design standards for horizontal stopping sight distance (refer to Table 3 for locations). Complete reconstruction of the horizontal curve at RM 0.86 on S-493 would require right-of-way and potential utility relocations and is not recommended due to the relatively low annual average daily traffic (AADT) of the roadway and a lack of documented safety concerns. A feasible improvement option to address horizontal stopping sight distance issues is to provide advanced curve warning signs at these locations.

Recommendation:
- Update signing at the ten horizontal curves (2 signs per curve) to provide advanced curve warning signs that meet current MDT and the Manual on Uniform Traffic Control Devices (MUTCD) standards.

Project Timeline:
- Short-term

Estimated Cost:
- $11,000 to $12,000

Potential Funding Source:
- STPP, HSIP

Benefits:
- Consistent with current MDT design standards
- Increased driver awareness
- Improved safety
- No environmental resource impacts anticipated

Concerns:
- Does not address geometric issues on S-493
- Does not address sight distance concerns at curves

Improvement Option 4: Vertical Curvature Improvements

One sag vertical curve located north of Baker at RM 37.10 on MT 7 does not meet current MDT design standards for the recommended minimum K-value, which is the horizontal distance needed to produce a 1% change in gradient. There are also two vertical curves between RM 37.10 (sag vertical curve) and 37.83 (crest vertical curve) that fail to meet current design standards for stopping sight distance and maximum grade. While there are currently no documented safety issues, improving sight distance along these sections of roadway would reduce the likelihood of future safety concerns as vehicular and truck traffic increase.

Recommendation:

- Improvements to the roadway grade/slope and length of the vertical curves to meet current MDT vertical curvature standards could be made at these three locations to improve safety through this area of MT 7.

Project Timeline:

- Mid-term

Estimated Cost:

- $1,500,000 to $1,700,000

Potential Funding Source:

- STPP, HSIP

Benefits:

- Consistent with current MDT design standards
- Increased stopping sight distances
- Improved safety

Concerns:

- Potential right-of-way constraints due to surfacing widening
- Potential wetland areas located adjacent the highway

Improvement Option 5: Extend Pavement on S-493 (Pennel Road)

The existing pavement on S-493 ends and continues with a gravel surfacing one mile west of the intersection with MT-7 at approximately RM 1.0. The planned Keystone XL Pipeline pump station and on-ramp is located approximately 10 miles from the study area along Pennel Road. Extending the pavement in this area would provide dust control with the anticipated heavy vehicle traffic along this part of the study area. Improvements to S-493 could be implemented on an as-needed basis, depending on the outcome and anticipated construction schedule of the pipeline project. Existing right-of-way along this section of S-493 varies from 120' wide to 180' wide. Further examination would be required to identify specific right-of-way constraints within this area and the recommended pavement thickness. If little or no widening is needed and pavement slopes can match existing conditions, right-of-way concerns would be reduced.

Recommendation:

- Increase paved roadway limits along S-493

Project Timeline:

- As needed

Estimated Cost:

- $1,700,000 to $1,800,000 per mile

Potential Funding Source:

- STPS

Benefits:

- Improved surfacing condition
- Provide dust control

Concerns:

- Potential impacts to adjacent wetlands and water bodies during construction
- May increase driving speeds which could affect safety along S-493

2.3 Intersection Improvements

The following improvement options include traffic improvements at two major intersections within the study area: US12/MT 7 intersection and MT7/Shell Oil Rd/S-493 intersection. The recommendation for these two intersections is based on the 2034 projected traffic conditions for the three growth scenarios examined. The growth scenarios project traffic conditions over the 20-year planning horizon (2034) and were estimated to account for low-, medium-, and high-growth rates, which include:

- Low: 2% growth rate for all vehicles (passenger and heavy vehicles)
- Medium: 5% growth rate for all vehicles (passenger and heavy vehicles)
- High: 5% growth rate for standard vehicles, 10% growth rate for heavy vehicles

More information can be found in the Existing and Projected Conditions Report. These recommended improvements are discussed below.

Improvement Option 6: Future Signalization of US 12/MT 7

The current configuration of the intersection of US 12/MT 7 will operate at a failing level of service (LOS F) under projected traffic conditions. Geometric improvements such as signalization and left-turn lanes will improve operations under future conditions.

Current traffic patterns show consistent volumes through all movements at this intersection, with volumes utilizing turning movements from all legs. Heavy vehicles also make up a large percentage of vehicles traversing the intersection which require additional time and adequate gaps in oncoming traffic to make turning movements.

Table 1 compares the current configuration (without signalization) to two potential improvements for the projected 2034 traffic levels using the three identified growth scenarios. The first improvement is to use the existing geometric configuration while signalizing the intersection. The second is to reconfigure the approach lanes to include left-turn lanes on all four approaches in addition to signalizing the intersection. Lane reconfigurations are depicted in Figure 3.

Several signal phasing configurations were considered in the analysis including split-phasing, left-turn protected phasing, and permitted phasing. The results in Table 1 represent the optimized signal phasing and timings for the projected conditions. The left-turn lane configuration scenario used leading left-turn protected phasing. All three of the results shown in Table 1 assume no other projects or improvements within the study area. As a result, the three growth scenarios have all projected volumes, including heavy vehicles. Should any other improvement options be implemented, operations at this intersection may be impacted.

Table 1: Existing Stop Controlled, Signalized, and Signalized with Left-Turn Lanes LOS Results (2034) for the US 12 / MT 7 Intersection

US 12/MT 7 Intersection	LOS (Delay[1])			
	Existing Condition (2014)	Low Growth	Medium Growth	High Growth
Under Existing Geometry (Stop Controlled)	B (14.4)	F (71.3)	F (>100)	F (>100)
With Signalization		B (17.9)	F (>100)	F (>100)
With Signalization and Left-Turn Lanes	-	B (10.2)	C (29.7)	D (51.3)

Note: The worst-performing leg LOS is shown under stop controlled operations.
Low Growth = 2% growth rate for all vehicles; Medium Growth = 5% for all vehicles; High Growth = 5% for cars/trucks and 10% for heavy vehicles
[1]Delay is shown in seconds. Refer to Appendix B for LOS worksheets.

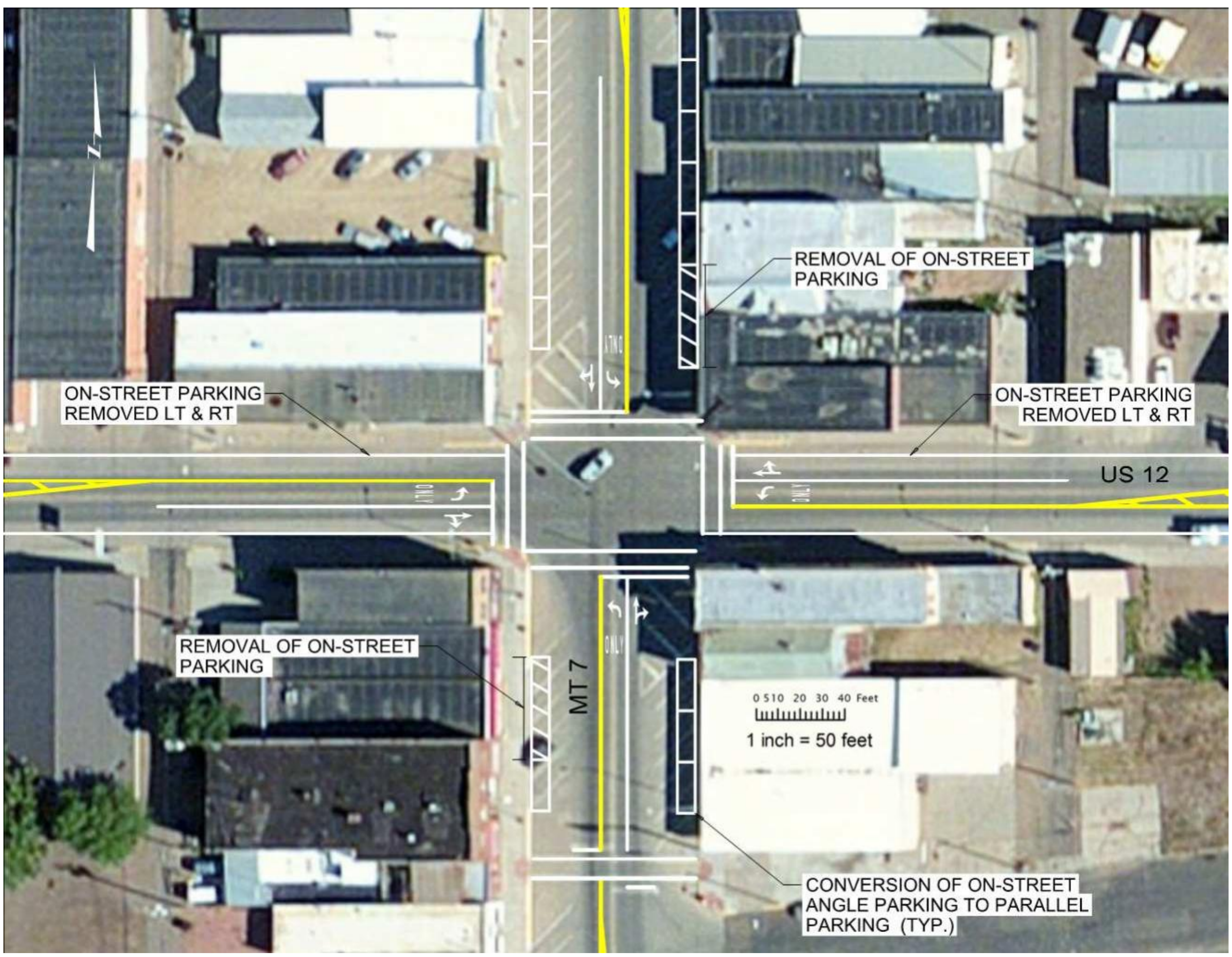


Figure 3: Left Turn Lane Reconfiguration at US 12/MT 7 Intersection

As can be seen in Table 1, the intersection will continue to operate at failing conditions under the two higher growth scenarios when simply adding signalization to the intersection. The addition of left-turn lanes greatly increases operations at the intersection under these growth scenarios.

In addition, should the intersection be signalized, the at-grade railroad crossing on MT 7 within 500 feet north of the intersection with US 12 can be improved. Queuing from crossing events as well as from the intersection of MT 7 with US 12 can impact operations and create a safety concern within the area. Railroad pre-signals in addition to crossing gates can be used to interconnect the rail system to stop vehicles north of the crossing to avoid potential queues backing onto the tracks from the intersection at US 12. A pre-signal adds an additional stop light at or in advance of the crossing gates. Pre-signals would also be effective in clearing vehicles south of the crossing that may be backed onto the tracks as a crossing event is starting.

By adding left-turn lanes at all four approaches, on-street parking is reduced to accommodate the additional lane. When looking at truck-turning movements at this intersection, both the WB-67 and WB-50 will encroach in the neighboring receiving lane when making the left-turn. In addition, the right-turn movements at this intersection also require tracking on the sidewalk by the WB-67 and WB-50. In an effort to maximize lane widths along MT 7, the angled parking could be converted to parallel parking on the first block north and south of the intersection. The overall number of parking spaces would be reduced by half on these two approaches but the thru lane width would increase to approximately 23.5 feet, which would allow for additional turning area for truck clearance.

Signalization of this intersection will be necessary under the medium- and high-growth scenarios regardless of projected truck use. Operations would improve by simply diverting truck trips from the intersection, but signalization and left-turn lanes would be needed to ensure acceptable operations. As there are geometric design concerns for the implementation of turn-lanes at this intersection, providing alternate truck routes in addition to these improvements is recommended.

<u>Recommendation:</u>

- Add left-turn lanes on all approach legs
- Signalize the intersection (signal improvements must meet signal warrants)
- Remove adjacent on-street parking on US 12 and convert angled parking to parallel parking on MT 7 in order to ensure all lanes and movements can be accommodated as per MDT design standards

<u>Project Timeline:</u>

- Long-term

<u>Estimated Cost:</u>

- $600,000 to $650,000

<u>Potential Funding Source:</u>

- STPP, TA

<u>Benefits:</u>

- Improved future year intersection operations
- No environmental resource impacts anticipated

Concerns:

- Conflicting turning movements with large vehicles
- Intersection improvements required in order to accommodate large turning vehicles
- Loss of on-street parking near the US 12/MT 7 intersection. Assuming a storage length of 150 feet, approximately 26 parking spaces would be impacted on the north and south approaches, and 20 spaces on the east and west approaches. Estimated total loss of parking is 26 spaces, negatively affecting downtown businesses. This total assumes the angled parking along MT 7 would be converted to parallel parking to minimize on-street parking north and south of the intersection.

Improvement Option 7: Intersection Improvements at MT 7/Shell Oil Rd/S-493

The current configuration of the intersection of MT 7/Shell Oil Road/S-493 will operate at a failing level of service (LOS F) under projected medium- and high-growth traffic growth scenarios. Geometric improvements such as left-turn lanes and signalization or construction of a roundabout will improve operations under future conditions.

Current traffic patterns show heavy volumes using the northbound to westbound left movement as well as many heavy vehicles making turning movements throughout all four legs. Heavy vehicles require additional time and adequate gaps in oncoming traffic to make turning movements.

Table 2 compares the current configuration (without signalization) to two potential improvement options for the projected 2034 traffic levels using the three defined growth scenarios. The first improvement option is to add a northbound left-turn lane and signalize the intersection. The second is to reconfigure the intersection as a single-lane roundabout.

Table 2: Existing Non-signalized, Signalized and Roundabout LOS Results (2034) for the MT 7/Shell Oil Rd/S-493 Intersection

MT 7/Shell Oil Road/S-493 Intersection	LOS (Delay[1])			
	Existing Condition (2014)	Low Growth	Medium Growth	High Growth
Under Existing Geometry (Non-Signalized)	C (15.2)	D (28.2)	F (>100)	F (>100)
With Signalization and Left-turn Lane	-	A (6.3)	B (12.1)	C (22.3)
With Single Lane Roundabout	-	A	C	F

Note: The worst-performing leg LOS is shown under stop-controlled and roundabout operations.
Low Growth = 2% growth rate for all vehicles; Medium Growth = 5% for all vehicles; High Growth = 5% for cars/trucks and 10% for heavy vehicles
[1]Delay is shown in seconds. Note the roundabout analysis does not accurately report delay so is not included here. Refer to Appendix B for LOS worksheets.

With the addition of a traffic signal and a left-turn lane to the northbound approach of MT 7, the future operations of the MT 7/Shell Oil Rd/S-493 intersection will improve from a failing level of service (medium and high growth scenarios) as shown in Table 2.

Under a single-lane roundabout scenario (see Figure 4), the intersection will perform at acceptable levels under the low- and medium-growth scenarios but will continue to fail under the high-growth scenario. Although not depicted in Figure 4, the addition of a 50-foot right turn lane on the south leg for northbound right-turn movements would reduce queuing and improve the LOS from F to C under the high-growth scenario by diverting the northbound to eastbound traffic movement.

The roundabout analysis assumes conservative factors for driver populations. These factors represent how comfortable and knowledgeable the driving population is in navigating roundabouts. As a driver becomes more knowledgeable in the navigation of a roundabout, overall operations will improve as gap acceptance is improved. In addition, as the driver population becomes more knowledgeable of roundabout navigation, these factors would be expected to decrease, creating more favorable LOS results, even without the addition of a dedicated right-turn lane.

Figure 4: Roundabout Concept at MT 7/Shell Oil Rd/S-493

<u>Recommendation:</u>

- Signalization:
  - Add a left-turn lane on MT 7 in the northbound direction
  - Signalize the intersection (signal improvements must meet signal warrants)
  - Ensure all lanes and movements can be accommodated as per MDT design standards
- Roundabout:
  - Construct a single-lane roundabout
  - Ensure all lanes and movements can be accommodated as per MDT design standards

<u>Project Timeline:</u>

- Long-term

Estimated Cost:

- Signal: $600,000 to $625,000
- Roundabout: $3,200,000 to $3,300,000

Potential Funding Source:

- STPP

Benefits:

- Improved future year intersection operations
- Would separate turning vehicles from highway traffic stream
- Roundabout operations typically improve safety at intersections

Concerns:

- Likely right-of-way requirements for intersection improvements
- Potential wetland areas located adjacent the highway

Improvement Option 8: US 12/Willow Lane Turn Lane Storage and Railroad Crossing Improvements

The private oil field road connecting US 12 to Shell Oil Road has been identified within the 2012 Fallon County Growth Policy as a potential alternate truck route (refer to Figure 9.2. in the Growth Policy). Willow Lane has an intersection with US 12 at approximately RM 84.1, crosses the railroad at an at-grade crossing, at which point Willow Lane splits from the private road and veers east. The private oil field road travels in a north-northeast direction to its intersection with Shell Oil Road. During railroad crossing closures, trucks desiring to utilize this road as an alternate route lack storage space along the shoulder of US 12 while waiting for trains to clear the crossing. Additional storage could be provided by creating a widened shoulder on the north side of US 12 to allow trucks a parking area to wait during crossing closures. Providing additional storage space could result in fewer trucks stacking up at the MT 7 railroad crossing during crossing closures.

The approaches would require widening as well as roadway improvements from US 12 to Willow Lane. The existing approach is approximately 24 feet wide, which limits the allowable usable area for truck turning traffic. By widening the approach and roadway to a minimum of 32 feet, a WB-67 can navigate the right-turn more efficiently and reduce conflicts with oncoming southbound traffic at the crossing.

This option also includes improving the grades to the approaches of the at-grade railroad crossing. This crossing has been identified as having steep approaches which can make crossing difficult for longer or lowboy type trucks. The problematic approaches likely discourage use by some heavy vehicles that may otherwise use this route to avoid the US 12/MT 7 intersection. Approaches would be improved on both the north and south side of the railroad crossing to better accommodate trucks attempting to use this alternative route.

The assumed cost for shoulder widening includes 12 feet of widening for a length of 500 feet, which would provide storage for approximately six WB-67 trucks. See Figure 5 for detail.

Recommendation:

- Widen shoulder along US 12 at Willow Lane to provide vehicle storage
- Improve grades at the north and south approaches of Willow Lane at-grade railroad crossing
- Widen the private oil road approach and intersecting roadway to a minimum of 32 feet from US 12 to Willow Lane

Project Timeline:

- Short-term

Estimated Cost:

- $550,000 to $600,000

Potential Funding Source:

- STPP, Local

Benefits:

- May improve operations at US 12/MT 7 intersection by decreasing the number of trucks making turns at the US 12/MT 7 intersection
- Provides alternate route for northbound truck traffic on US 12.

Concerns:

- May require additional right-of-way. Existing right-of-way at this location extends 40 feet north of the centerline, which neighbors railroad right-of-way.
- May increase truck traffic on the private road
- Potential wetland areas located between highway and railroad in this location

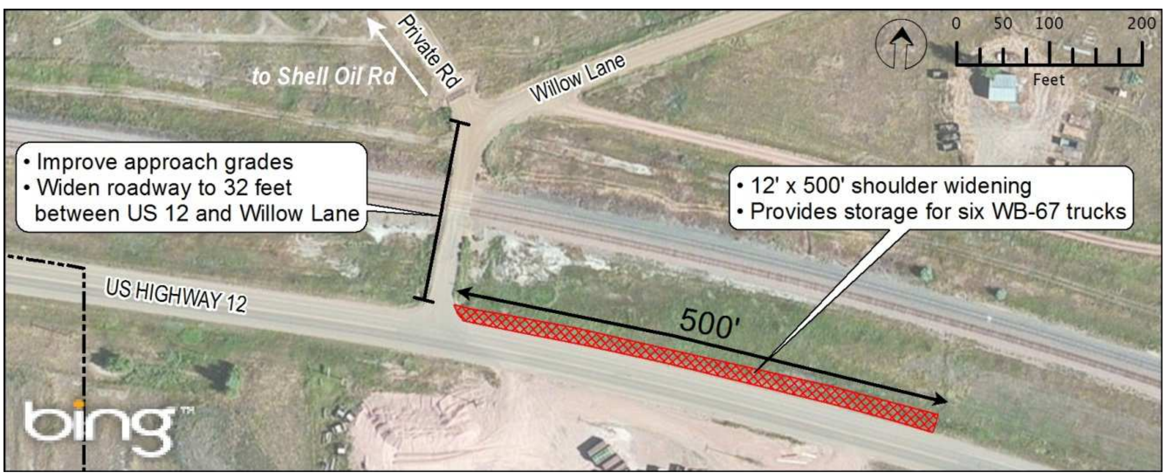


Figure 5: US 12/Willow Lane Turn Lane Storage and Railroad Crossing Improvements

2.4 Alternative Truck Routes

The junction of US 12 and MT 7 is Baker's main intersection, which is used by passenger vehicles both traveling through town and for local access as well as truck traffic traveling to and from oil and gas development and other commercial and agricultural areas in the region. Baker has experienced increased truck traffic through town due to the increasing level of oil and gas development and associated development in and around the study area. Improvement options in this section have the potential to address the study need of improving mobility on US 12 and MT 7 through minimizing the impacts of truck traffic at the US 12/MT 7 intersection by providing improvements that encourage alternate truck routes in the study area.

Improvement Option 9: Railroad Avenue Improvements

This option provides for improvements to Railroad Avenue and its intersections with US 12 and MT 7 to provide an alternate route for trucks traveling westbound on US 12 and turning northbound on MT 7 and southbound on MT 7 traffic turning eastbound on US 12. With an estimated 238 trucks per day, this westbound to northbound and southbound to eastbound movement represents the most frequently used turning movements at the US 12/MT 7 intersection.

Intersection improvements would be required along Railroad Avenue at US 12, MT 7, and 3rd Street E. Pavement limits would be increased to accommodate truck turning movements onto Railroad Avenue from US 12. The pavement on Railroad Avenue currently terminates at 3rd Street E, which would require surfacing improvements and minor grading. Refer to Figure 6 for detail.

Recommendation:

- Pave Railroad Avenue east of S. 3rd Street E to its intersection with US 12
- Include signage indicating a truck route on US 12 and MT 7
- Intersection improvements at US 12/MT 7, Railroad Avenue/3rd Street E, and Railroad Avenue/US 12

Project Timeline:

- Mid-term

Estimated Cost:

- $300,000 to $325,000

Potential Funding Source:

- Local

Benefits:

- May reduce truck volumes at the US 12/MT 7 intersection by providing an alternate route (approximately 238 trucks daily)
- May reduce passenger vehicle volumes at the US 12/MT 7 intersection
- Provides storage for northbound trucks during rail crossing closures
- Improvements to operations at the intersection of US 12/MT 7

Concerns:

- Following a crossing closure, southbound trucks on MT 7 attempting to make the left-hand turn onto Railroad Avenue would be delayed as northbound vehicles along MT 7 proceed through the crossing. This would likely create a queuing of vehicles on MT 7 north of the railroad in the southbound direction.

Improvement Option 10: Milwaukee Avenue and 3rd Street SW Improvements

This option would provide for improvements on Milwaukee Avenue and its intersections with US 12 and MT 7, as well as the N. 3rd Street W at-grade railroad crossing. Similar to Option 8, this option would provide an alternate route for trucks traveling eastbound on US 12 turning northbound on MT 7 and southbound on MT 7 turning westbound on US 12. Trucks would turn west on Milwaukee Ave, north of the railroad tracks, and use the 3rd Street at-grade crossing to access US 12. The grain elevator is located along Milwaukee Ave and trucks currently access this area and use this alternate route to bypass the US 12/MT 7 intersection. This eastbound to northbound and southbound to westbound movement represents the second most frequent turning movements at the US 12/MT 7 intersection and accounts for an estimated 172 trucks per day. This option could be combined with Option 8: Railroad Avenue Improvements to create a truck route to alleviate truck traffic from the main US 12 and MT 7 intersection. See Figure 6 for detail.

Recommendation:

- Pave 3rd Street railroad crossing between Milwaukee Avenue and Railroad Avenue
- Include signage indicating a truck route on US 12 and MT 7
- Intersection improvements at Milwaukee Avenue/MT 7 and Milwaukee Avenue/US 12

Project Timeline:

- Mid-term

Estimated Cost:

- $120,000 to $130,000

Potential Funding Source:

- Local

Benefits:

- Reduction in truck volumes at the US 12/MT 7 intersection by providing an alternate route (approximately 172 trucks daily)
- May reduce passenger vehicle volumes at the US 12/MT 7 intersection
- Provides storage for southbound trucks during rail crossing closures
- Improvements to operations at the intersection of US 12/MT 7

Concerns:

- The 3rd Street at-grade railroad crossing does not align with 3rd Street SW and trucks are required to negotiate two additional turns south of the railroad to access US 12.
- Introduction of additional traffic and noise to adjacent residences along Milwaukee Avenue and 3rd Street SW.

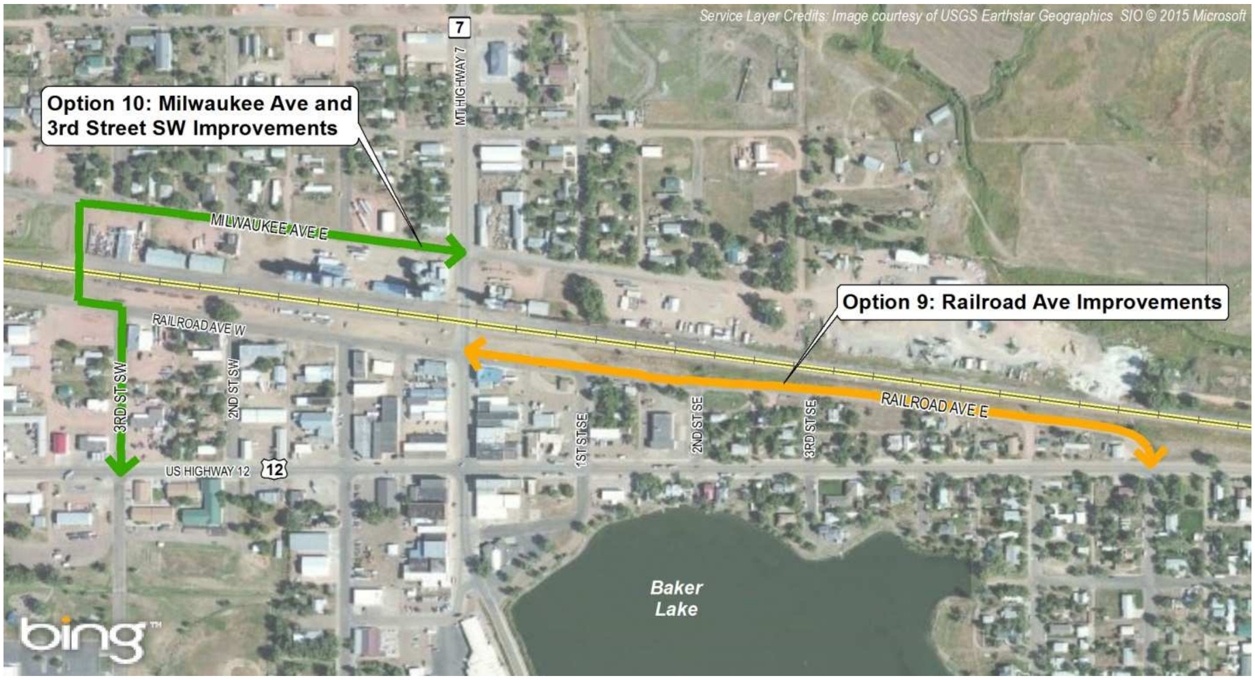


Figure 6: Railroad Avenue (Option 9) and Milwaukee Avenue (Option 10) Conceptual Truck Routes

Improvement Option 11: Montana Avenue (US 12) and Railroad Avenue One-way Couplet
Converting Montana Avenue (US 12) and Railroad Avenue to a one-way couplet within the Baker city limits could improve truck circulation through downtown. US 12 between 3rd Street SW and Railroad Avenue would be converted to a two-lane one-way facility in the eastbound direction and Railroad Avenue from its intersection with US 12 and 3rd Street SW would operate as a two-lane one-way street in the westbound direction. See Figure 7 for detail.

Additional traffic counts and analysis would be needed should this option be forwarded from this study. Signalization of both US 12 and Railroad Avenue with MT 7 would likely be necessary to ensure operations at the two intersections as well as the at-grade railroad crossing can occur safely and efficiently given the close proximity to the railroad crossing. The potential for improved geometry at the intersections, such as right- or left-turn lanes on US 12 at the intersection with MT 7, could ease traffic delay that would be experienced in the no-build conditions. However, additional delay and degraded LOS may be experienced at the new intersection of Railroad Avenue with MT 7 as well as the terminus locations of the couplet. The close proximity of the at-grade railroad crossing to Railroad Avenue may create queuing, safety and operational concerns during crossing events. Additional analysis could show the impacts of these concerns and benefits with detail to truck operations within the couplet.

Figure 7: Montana Avenue (US 12) and Railroad Avenue One-way Couplet Concept

Recommendation:

- Add signalization at the following intersections (signal improvements must meet signal warrants):
  - US 12 and MT 7
  - MT 7 and Railroad Avenue
- Update signing and striping for one-way traffic on US 12 and Railroad Avenue within couplet limits
- Pave Railroad Avenue east of S. 3rd Street E to its intersection with US 12

Project Timeline:

- Mid-term

Estimated Cost:

- $1,600,000 to $1,700,000

Potential Funding Source:

- STPP, Local

Benefits:

- Improved operations at the US 12/MT 7 intersection
- Eliminates the volume of truck traffic making turning movements at the US 12/MT intersection for southbound-westbound flows on MT 7 and westbound-northbound flows on US 12.
- May reduce passenger vehicle volumes at the US 12/MT 7 intersection

Concerns:

- Likely right-of-way requirements for intersection improvements at the couplet termini.
- Potential decrease in exposure to businesses along US 12 due to one-way traffic flow
- Major traffic pattern adjustment for area residents and other roadway users
- Potential safety and operational concerns during crossing events at the at-grade railroad crossing given the close proximity of crossing and turning movements at the newly created Railroad Avenue couplet intersection

Improvement Option 12: Private Oil Field Road Improvements
The private oil field road connecting US 12 to Shell Oil Road has been identified within the 2012 Fallon County Growth Policy as a potential alternate truck route. Improvements to the private road may serve to alleviate traffic issues, including weight load limits, delays from stopped trains, and congestion of the US 12/MT 7 intersection. Improvements could include a combination of or all of the following: widening of the surface, realignment or reconstruction of the problematic horizontal curves (one 90° turn in particular), paving the roadway, and truck route signing.

Because the road is privately owned, the County is not responsible for maintenance or roadway improvements. Transfer of ownership of the road to the County would be required to provide the County with implementation responsibility to seek out local funding options and make any desired improvements.

Recommendation:
- Potential surface widening, realignment, paving, and truck route signing

Project Timeline:
- Long-term

Estimated Cost:
- Unknown, variable depending on level of improvements

Potential Funding Source:
- Local

Benefits:
- May reduce truck volumes at the US 12/MT 7 intersection by providing an alternate route (approximately 238 trucks daily)

Concerns:
- Potential impacts to wetlands and streams, depending on level of improvements
- Potential impact to existing oil/gas pad access road

Improvement Option 13: New Alignment Option(s) Using Quantm Tool
This improvement includes new alignment options developed from the Quantm alignment planning tool. These alignments are recommended as potential new alternative truck routes to address the study need of improving mobility on US 12 and MT 7 through minimizing the impacts of truck traffic at the US 12/MT 7 intersection. The Quantm analysis and results are detailed in the New Alignment Identification Using Quantm report. The alignment options and estimated costs are summarized below and are depicted in Figure 8.

Potential new alignments will impact traffic operations through Baker and at the intersection of US 12 with MT 7 as well as at the terminus locations of the new alignments with the existing roadway network. Additional traffic analysis was conducted to examine how the new alignments, in combination with other recommended improvements for the US 12/MT 7 and MT 7/Shell Oil Road/S-493 intersections, would affect operations at these two intersections. Traffic redistribution from existing corridors assumed conservative estimates for the amount of potential diversion of traffic. The analysis assumed most trucks would utilize the new facilities and a smaller proportion of regular traffic would also take advantage of the new facility. Those trips making turning movements between US 12 and MT 7 within the northwest and northeast quadrants were redistributed from the main intersection to the new route at a rate of 90 percent of heavy vehicle traffic and 30 percent of all other traffic. For example, reassigned trips from building the northwest alignment moved trips making left turns from US 12 eastbound to MT 7 northbound and right turns from MT 7 southbound to US 12 westbound. Table 3 shows the intersection LOS results of potential new northwest and northeast alignments in combination with recommended traffic control from earlier improvement options.

Table 3: Intersection LOS Results (2034) with New Alignments

Intersection	LOS (Delay[1])		
	Low Growth	Medium Growth	High Growth
US 12/MT 7 Signalized with Left-turn Lanes (Option 6) No Alternative Route	B (10.2)	C (29.7)	D (51.3)
US 12/MT 7 Signalized with Left-turn Lanes (Option 6) With Alternative Routes	B (10.4)	B (19.4)	C (23.5)
MT 7/Shell Oil Road/S-493 Signalized with Left-turn Lane (Option 7) No Alternative Route	A (6.3)	B (12.1)	C (22.3)
MT 7/Shell Oil Road/S-493 Signalized with Left-turn Lane (Option 7) With Alternative Routes	A (5.5)	A (9.5)	C (21.1)
MT 7/Shell Oil Road/S-493 with single lane roundabout (Option 7) No Alternative Route	A	C	F
MT 7/Shell Oil Road/S-493 with single lane roundabout (Option 7) With Alternative Routes	A	C	E

Note: The worst-performing leg LOS is shown under stop-controlled and roundabout operations.
Low Growth = 2% growth rate for all vehicles; Medium Growth = 5% for all vehicles; High Growth = 5% for cars/trucks and 10% for heavy vehicles
[1]Delay is shown in seconds. Note the roundabout analysis does not accurately report delay so is not included here. Refer to Appendix B for LOS worksheets.

When coupled with other intersection improvements (i.e., Options 6 and 7), new alignments in the northwest and northeast quadrants will ease traffic congestion at the US 12/MT 7 and MT 7/Shell Oil Road/S-493 intersections. Under the new alignment scenarios examined, traffic volumes would increase at the MT 7/Shell Oil Road/S-493 intersection with a corresponding decrease in traffic at the US 12/MT 7 intersection. Benefits to traffic operations are greatest for the mid- to high-growth traffic scenarios. When considering the improvement options under Option 7, the new alignments will more evenly distribute volumes through the four legs of the MT 7/Shell Oil Road/S-493 intersection, maintaining or improving operations at the intersection relative to the no build conditions.

Planning-level costs were developed by taking the Quantm cost estimate, which includes construction costs, right-of-way, and wetland mitigation costs (if applicable), and combining costs associated with traffic control, mobilization, preliminary and construction engineering, indirect costs, miscellaneous items, inflation, and a contingency percentage. Cost was added to the estimates to account for surfacing and widening improvements along S-493 for NW-5 and Shell Oil Road for NE-5 as well as intersection improvements at the alignment termini.

IMPROVEMENT OPTION 13.A: ALIGNMENT NW-5

Alignment NW-5 provides for an alternate route in the northwest quadrant between US 12 and MT 7 via S-493. The alignment departs US 12 at approximately RM 82.1, includes an overpass over the BNSF Railway, and then joins S-493 at RM 0.8. The alignment intersects two public roads north of the railroad: Prairie View Drive and Sunset Trail. Additional improvements would be required to S-493 from the junction of the new alignment to the intersection at MT 7 including surfacing improvements and widening to a 32-ft. roadway width as well as intersection improvements at the south terminus with US 12 and the north terminus with S-493.

Recommendation:

- Construct new alignment between US 12 and S-493, including a grade separated crossing of the railroad
- Make additional improvements to S-493 to include surfacing improvements and widening to a 32-ft. roadway width as well as intersection improvements

Project Timeline:

- Long-term

Estimated Cost:

- $17,000,000 to $17,500,000

Potential Funding Source:

- STPP

Benefits:

- May reduce truck volumes at the US 12/MT 7 intersection by providing an alternate route (approximately 172 trucks daily)
- Would provide a grade separated railroad crossing within one mile of downtown, which would improve emergency vehicle access north of the railroad and reduce delays experienced during crossing closures

Concerns:

- Potential impacts to wetlands, streams, floodplains, and farmland
- Requires right-of-way acquisition

IMPROVEMENT OPTION 13.B: ALIGNMENT NE-5

Alignment NE-5 provides for an alternate route in the northeast quadrant between US 12 and MT 7 via Shell Oil Road. This alignment departs US 12 at RM 86.2 at the west edge of state-owned section and connects to Shell Oil Road to the north at its junction with School House Road. Additional improvements would be required to Shell Oil Road from the junction of the new alignment and School House Road to the intersection at MT 7 to meet minimum design criteria for rural minor arterials. Additional improvements to Shell Oil Road include surfacing improvements and widening to a 32-ft. roadway width as well as intersection improvements at the south terminus with US 12 and the north terminus with Shell Oil Road.

Recommendation:

- Construct a new alignment between US 12 and Shell Oil Road

- Make additional improvements to Shell Oil Road to include surfacing improvements and widening to a 32-ft. roadway width as well as intersection improvements

Project Timeline:
- Long-term

Estimated Cost:
- $16,300,000 to $16,800,000

Potential Funding Source:
- STPP

Benefits:
- May reduce truck volumes at the US 12/MT 7 intersection by providing an alternate route (approximately 238 trucks daily)
- Potential for reduced travel times (depending on vehicle movements)

Concerns:
- Potential impacts to wetlands, streams, floodplains, and farmland
- Requires right-of-way acquisition

2.5 Bridge Improvements

Improvement Option 14: Replace Bridge on MT 7, RM 35.86 (Sandstone Creek)
The bridge located just north of Baker on MT 7 at RM 35.86 spanning Sandstone Creek (P00027035+08231) has substandard roadway clearances between the faces of the guard rail (25'-0"). Built in 1941, this bridge is approximately 64.5 feet long and contains three spans. In order to remedy this deficiency, a bridge widening or replacement would need to be undertaken. The bridge is composed of timber components including a timber deck structure with asphalt surfacing, timber stringers, and timber bents. These items may be able to accommodate a widening, however a cost-benefit analysis may indicate it is more cost effective to replace the structure. Considering the age of the structure and timber construction, as well as the anticipated increases in AADT and annual average daily truck traffic (ADTT), a full replacement of the bridge would provide the greatest long-term benefit.

Recommendation:
- Replace bridge on MT 7 at RM 35.86

Project Timeline:
- Mid-term

Estimated Cost:
- $850,000 to $900,000

Potential Funding Source:
- STPB

Benefits:
- Increased structure life and improved structure rating
- Consistent with current MDT design standards

Concerns:

- Potential impacts to Sandstone Creek and adjacent wetlands
- Floodplain modeling and permitting required
- Section 404 permitting requirements and potential mitigation

2.6 Corridor Planning

Improvement Option 15: Access Management Plan
The number and location of access points within the study area is a concern. Too many access points along the highway and access points located too close to an intersection create potentially unsafe conflict points. A high density of access points exist within the Baker city limits, primarily along US 12. Recent growth along MT 7 north of Baker has increased the number of access points to commercial and industrial uses. The Fallon County Growth Policy also recommends completing an *Access Management Plan* for improved safety and traffic characteristics and enhancing community character along the highway corridors.

MDT's current approach to regulating driveway access is specified in the Administrative Rules of Montana (ARM 18.5.105) and requires action by the Montana Transportation Commission.

An *Access Management Plan* should be developed to address the high density of accesses within the US 12 and MT 7 corridors. The plan should explore ways to eliminate, reduce or combine existing or future accesses to individual properties.

Recommendation:

- Develop an *Access Management Plan* for MT 7 and US 12 within the corridor study area

Project Timeline:

- Short-term

Estimated Cost:

- $100,000 to $150,000

Potential Funding Source:

- Local

Benefits:

- Improve safety through limiting/consolidating access points on US 12 and MT 7
- Improve traffic and operations along corridor
- Enhance community character through development of consistent control guidelines
- No environmental resource impacts anticipated

Concerns:

- Impact to business and property access

Improvement Option 16: Grade Separation Feasibility Study
A grade separation feasibility study could be conducted in order to examine potential locations within the City of Baker where a grade separation of the BNSF Railway may be constructed. The feasibility study could evaluate in greater depth the anticipated levels of vehicular, rail, and

pedestrian and bicycle traffic; conduct a detailed traffic analysis in order to evaluate the effects of the new crossing; and determine right-of-way requirements and potential impacts to adjacent properties and other resources. This feasibility study could look at a number of crossings within the Baker city limits and include preliminary engineering to determine alternate grade separated concepts, address storm drainage concerns, and include planning-level cost estimates for each option. MDT is currently updating the Rail/Highway Grade Separation Study. Information from the statewide study may serve to inform this feasibility study.

Recommendation:
- Conduct study to examine feasibility of constructing a grade separation within city limits

Project Timeline:
- Short-term

Estimated Cost:
- $100,000 to $125,000

Potential Funding Source:
- Local

Benefits:
- Would develop build scenarios and cost estimates
- No environmental resource impacts anticipated

Concerns:
- None identified

2.7 Improvement Options Considered But Not Advanced

The following improvement options were developed and investigated and were ultimately not advanced into recommended improvement options.

Roundabout at US 12/MT 7 Intersection
A roundabout at the intersection of US 12 & MT 7 would not be feasible due to right-of-way constraints and the proximity of existing buildings. The existing right-of-way along US 12 is approximately 66 feet, building-to-building width. Existing MT 7 right-of-way is approximately 100 feet. If a minimum inscribed diameter of 90 feet for a single-lane roundabout is assumed, the buildings on northeast and southeast corners would be impacted with this option.

Street Widening at US 12/MT 7 Intersection
Street widening at the intersection of US 12 & MT 7 would not be feasible due to right-of-way constraints and the proximity of existing buildings. Similar to the previous option, the right-of-way widths on US 12 and MT 7 are building-to-building widths and any modifications to the curb and gutter, sidewalk or roadway width would result in existing building modifications, or possible removal.

Grade Separated Railroad Crossing on MT 7
Replacing the existing at-grade railroad crossing with an overpass/underpass on MT 7, north of the intersection with US 12 is likely not feasible. The railroad crossing is approximately 500 feet

north of the US 12 intersection and would not allow enough room for the vertical grades to meet standard railroad clearances prior to the railroad tracks. There is also limited right-of-way at this location.

3. Summary

This report identifies improvement options that have been developed for the US 12, MT 7, and S-493 corridors within the study area. The improvement options have been developed based on the evaluation of the existing conditions within the study area and ability to address needs previously identified during development of the study.

The improvement options are displayed on Figure 8 and presented in tabular form in Table 4.

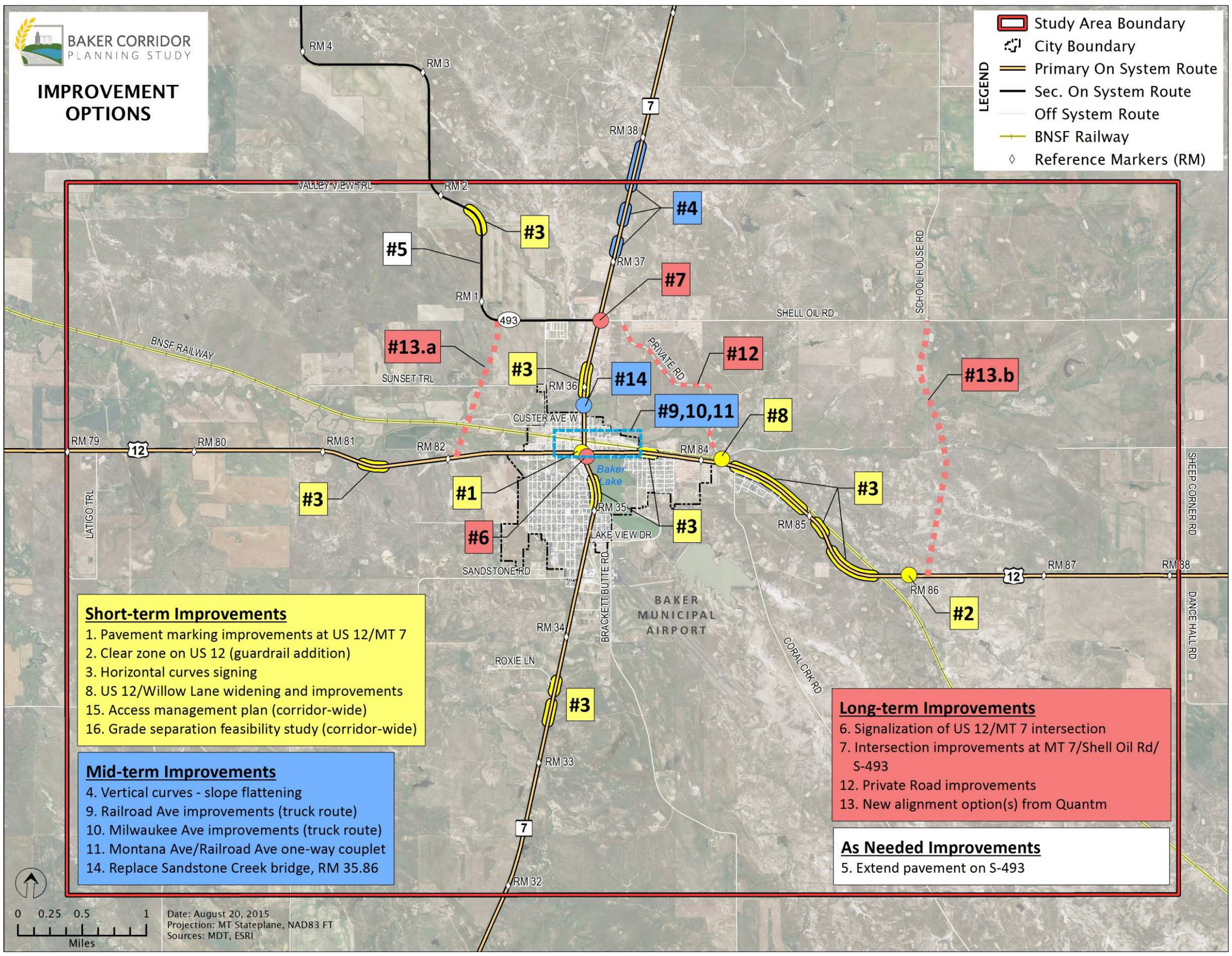


Figure 8: Study Area Improvement Options

Table 4: Improvement Options Summary

	Improvement Option	Location	Description	Timeframe	Potential Funding Source[1]	Agency Responsibility	Cost Estimate[2]
			GEOMETRIC AND PAVEMENT MARKING IMPROVEMENTS				
1	Pavement Marking Improvements at US 12/MT 7 Intersection	US 12/MT 7 Intersection	▪ Add a narrow striped median at all approaches ▪ Relocate the stop bar farther back from the intersection at all approaches ▪ Remove on-street parking near the intersection	Short-term	STPP, TA	MDT	$10k to $11k
2	Clear Zone on US 12 near RM 86.18	RM 86.18	Extend the existing guardrail or place a new guardrail section at this location	Short-term	STPP, HSIP	MDT	$40k to $42k
3	Horizontal Curve Warning Signs	US 12, RM 81.4, 83.51, 84.65, 85.32, 85.72; MT 7, RM 33.41, 33.55, 35.15, 36.03; S-493, RM 1.65	Update signing at these locations to provide advanced curve warning signs	Short-term	STPP, HSIP	MDT	$11k to $12k
4	Vertical Curves	Between RM 37.10 and 37.83	Improve length of the vertical curves and stopping sight distance	Mid-term	STPP, HSIP	MDT	$1.5M to $1.7M
5	Extend Pavement on S-493 (Pennel Rd.)	RM 1.0 and beyond	Increase limits of paved roadway along S-493	As needed	STPS	MDT	$1.7M to $1.8M per mile
			INTERSECTION IMPROVEMENTS				
6	Future Signalization of US 12/MT 7	US 12/MT 7 Intersection	▪ Add left-turn lanes on all approach legs ▪ Signalize the intersection ▪ Remove adjacent on-street parking per MDT design standards	Long-term	STPP, TA	MDT	$600k to $650k
7	Intersection Improvements at MT 7/Shell Oil Rd./S-493	MT 7/Shell Oil Rd./S-493 Intersection	▪ Signalization: Add left-turn lane on northbound approach on MT 7, Signalize the intersection ▪ Roundabout: Single-lane roundabout	Long-term	STPP	MDT	$600k to $625k (Signal); $3.2M to $3.3M (Round-About)
8	US 12/Willow Lane Turn Lane Storage and Railroad Crossing Improvements	US 12/Willow Lane intersection, RM 84.1	▪ Widen shoulder along US 12 to provide vehicle storage ▪ Improve approaches of Willow Lane at-grade railroad crossing ▪ Widen road approach to a minimum of 32 feet	Short-term	STPP Local	MDT Local	$550k to $600k
			ALTERNATIVE TRUCK ROUTES				
9	Railroad Ave. Improvements	Railroad Ave. between US 12 and MT 7	▪ Pave Railroad Ave. east of S. 3rd St. E to its intersection with US 12 ▪ Include signage indicating a truck route on US 12 and MT 7 ▪ Intersection Improvements at US 12/MT 7, Railroad Ave./3rd St. E, and Railroad Ave./US 12	Mid-term	Local	Local	$300k to $325k
10	Milwaukee Ave. / 3rd St. SW Improvements	Milwaukee Ave W/3rd St SW	▪ Pave 3rd St. railroad crossing between Milwaukee Ave. and Railroad Ave. ▪ Include signage indicating a truck route on US 12 and MT 7	Mid-term	Local	Local	$120k to $130k

Improvement Option			Location	Description	Timeframe	Potential Funding Source[1]	Agency Responsibility	Cost Estimate[2]
				▪ Intersection improvements at Milwaukee Ave./MT 7 and Milwaukee Ave./US 12				
11	Montana Ave. (US12) and Railroad Ave. One-way Couplet		US12 and Railroad Ave	▪ Intersection signals at US 12/MT 7 and MT 7/Railroad Ave. ▪ Update signing and striping for one-way traffic within couplet limits ▪ Pave Railroad Ave. east of S. 3rd St. E to its intersection with US 12	Mid-term	STPP Local	MDT Local	$1.6M to $1.7M
12	Private Oil Field Road Improvements		Private Road between US 12 and Shell Oil Rd.	▪ Widen road, straighten curves, paving, signing	Long-term	Local	Local	NA
13	New Alignment Options from Quantm	13.a: NW-5	Between US 12, RM 82.1 and S-493, RM 0.8	▪ Construct new alignment including a grade separated crossing of the railroad ▪ Widen S-493 from RM 0.8 to MT 7 to 32-ft. roadway width; intersection improvements at alignment termini	Long-term	STPP Local	MDT Local	$17M to $17.5M
		13.b: NE-5	Between US 12, RM 86.2 and Shell Oil Rd	▪ Construct a new alignment between US 12 and Shell Oil Road ▪ Surfacing improvements and widen Shell Oil Rd. to a 32-ft. roadway width from School House Rd. to MT 7; intersection improvements at alignment termini				$16.3M to $16.8M
BRIDGE IMPROVEMENTS								
14	Replace Bridge on MT 7, RM 35.86 (Sandstone Creek)		RM 35.86	Replace bridge on MT 7 at RM 35.86	Mid-term	STPB	MDT	$850k to $900k
CORRIDOR PLANNING								
15	Access Management Plan		Corridor-wide	Develop an *Access Management Plan* for the corridor	Short-term	Local	Local	$100k to $150k
16	Grade Separation Feasibility Study		Corridor-wide	Conduct grade separation study within city limits; preliminary engineering	Short-term	Local	Local	$100k to $125k

[1] STPP = Surface Transportation Program – Primary; STPS = Surface Transportation Program – Secondary; STPB = Surface Transportation Program – Bridge Program; HSIP = Highway Safety Improvement Program; TA = Transportation Alternatives. Table lists potential federal and state funding sources. Local funding sources include multiple potential city/county sources. All improvements could potentially be funded through a public/private partnership.
[2] Planning-level cost estimates are for all phase costs and use 2015 dollars as a base. The cost estimates include right-of-way, utilities, and inflation based on the associated project timeframe and rounded for planning purposes. Refer to Appendix A for cost estimate spreadsheets.

BAKER CORRIDOR
PLANNING STUDY

APPENDIX A: Improvement Option Cost Estimates

Baker Corridor Planning Study

August 2015

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning-Level Cost Estimate

HDR

Option 1 - Pavement Marking Improvements at US 12/MT 7 Intersection

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2014 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Striping & Pavement Markings	1	LS			$5,000.00	$5,000.00
Traffic Control (5%)	1	LS			$250.00	$250.00
Option 1 Subtotal						$5,250.00
Miscellaneous Items					5%	$262.50
Mobilization					10%	$525.00
Subtotal						$6,037.50
Contingency					20%	$1,207.50
Construction Total						$7,245.00
Preliminary Engineering					10%	$603.75
Construction Engineering					10%	$603.75
Subtotal						$8,452.50
Indirect Cost (IDC)					9.13%	$771.71
Total w/ IDC						$9,224.21
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	5	Years	$1,469.18
Total Improvement Option 1						**$10,693.39**

Planning-Level Cost Estimate

Option 2 - Clear Zone on US 12 near RM 86.18

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Guardrail - Steel	350	LF	$18.17	$6,359.50		$6,359.50
Guardrail - Optional Term Sect	4	EA	$2,884.51	$11,538.04		$11,538.04
Traffic Control (6%)	1	LS			$1,073.85	$1,073.85
Option 2 Subtotal						$18,971.39
Miscellaneous Items					5%	$948.57
Mobilization					12%	$2,276.57
Subtotal						$22,196.53
Contingency					25%	$5,549.13
Construction Total						$27,745.66
Preliminary Engineering					10%	$2,219.65
Construction Engineering					10%	$2,219.65
Subtotal						$32,184.97
Indirect Cost (IDC)					9.13%	$2,938.49
Total w/ IDC						$35,123.45
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	5 Years		$5,594.26
Total Improvement Option 2						**$40,717.71**

Planning-Level Cost Estimate

Option 3 - Horizontal Curve Warning Signs

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Curve Warning Signs	1	LS			$5,000.00	$5,000.00
Traffic Control (6%)	1	LS			$300.00	$300.00
Option 3 Subtotal						$5,300.00
Miscellaneous Items					5%	$265.00
Mobilization					12%	$636.00
Subtotal						$6,201.00
Contingency					25%	$1,550.25
Construction Total						$7,751.25
Preliminary Engineering					10%	$620.10
Construction Engineering					10%	$620.10
Subtotal						$8,991.45
Indirect Cost (IDC)					9.13%	$820.92
Total w/ IDC						$9,812.37
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	5 Years		$1,562.86
Total Improvement Option 3						**$11,375.23**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning-Level Cost Estimate

HDR

Option 4 - Vertical Curvature Improvements

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices Unit Prices Dollars	2015 Average Bid Prices Amount Dollars	Adjusted Unit Prices Unit Prices Dollars	Adjusted Unit Prices Amount Dollars
Finish Grade Control	8448	CRFT	$ 0.44	$ 3,717.12		$3,717.12
Excavation - Unclassified	5000	CUYD	$ 4.07	$ 20,350.00		$20,350.00
Topsoil - Salvaging and Placing	7185	CUYD	$ 4.17	$ 29,961.45		$29,961.45
Temporary Erosion Control	1	LS			$ 5,000.00	$5,000.00
Crushed Aggregate Course	6170	CUYD	$ 21.63	$ 133,457.10		$133,457.10
Cover - Type I	13140	SQYD	$ 0.53	$ 6,964.20		$6,964.20
Traffic Gravel	876	CUYD	$ 17.00	$ 14,893.51		$14,893.51
Plant Mix Bit Surf GR S-3/4 IN	3044	TON	$ 33.15	$ 100,906.81		$100,906.81
Hydrated Lime	43	TON	$ 223.86	$ 9,625.98		$9,625.98
Asphalt Cement PG 64-28	164	TON	$ 697.91	$ 114,717.62		$114,717.62
Emuls Asphalt CRS-2P	24	TON	$ 610.88	$ 14,355.68		$14,355.68
Guardrail - Steel	211	LNFT	$ 18.17	$ 3,837.50		$3,837.50
GD Rail - Stl Int Rdwy Term Sect	21	LNFT	$ 47.60	$ 1,005.31		$1,005.31
Guardrail - Optional Term Sect	1	EACH	$ 2,884.51	$ 1,856.47		$1,856.47
Farm Fence - Type F5W & F5M	8448	LNFT	$ 3.33	$ 28,131.84		$28,131.84
Seeding and Fertilizing	1.00	LS			$ 26,000.00	$26,000.00
Striping & Pavement Markings - Rural	0.8	MILE	$ 8,000.00	$ 6,400.00		$6,400.00
Drainage Pipe - Rural	0.8	MILE	$ 82,000.00	$ 65,600.00		$65,600.00
Signing - Rural	0.8	MILE	$ 8,000.00	$ 6,400.00		$6,400.00
Traffic Control (6%)	1	LS			$ 35,590.84	$35,590.84
Option 4 Subtotal						$628,771.44
Miscellaneous Items					5%	$31,438.57
Mobilization					15%	$94,315.72
Subtotal						$754,525.73
Contingency					25%	$188,631.43
Construction Total						$943,157.16
Preliminary Engineering					10%	$75,452.57
Construction Engineering					10%	$75,452.57
Subtotal						$1,094,062.30
Indirect Cost (IDC)					9.13%	$99,887.89
Total w/ IDC						$1,193,950.19
Right-of-Way				0.0 Acres	$50,000.00	$0.00
Inflation			3.00%	10 Years		$410,619.03
Total Improvement Option 4						**$1,604,569.22**

Planning-Level Cost Estimate

Option 5 - Extend Pavement on S-493 (Pennel Road)

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Finish Grade Control	10560	CRFT	$ 0.44	$ 4,646.40		$4,646.40
Excavation - Unclassified	5475	CUYD	$ 4.07	$ 22,283.25		$22,283.25
Topsoil - Salvaging and Placing	8980	CUYD	$ 4.17	$ 37,446.60		$37,446.60
Temporary Erosion Control	1	LS			$ 5,000.00	$5,000.00
Crushed Aggregate Course	7710	CUYD	$ 21.63	$ 166,767.30		$166,767.30
Cover - Type I	16427	SQYD	$ 0.53	$ 8,706.31		$8,706.31
Traffic Gravel	1095	CUYD	$ 17.00	$ 18,615.00		$18,615.00
Plant Mix Bit Surf GR S-3/4 IN	3805	TON	$ 33.15	$ 126,135.75		$126,135.75
Hydrated Lime	54	TON	$ 223.86	$ 12,088.44		$12,088.44
Asphalt Cement PG 64-28	205	TON	$ 697.91	$ 143,071.55		$143,071.55
Emuls Asphalt CRS-2P	29	TON	$ 610.88	$ 17,715.52		$17,715.52
Guardrail - Steel	264	LNFT	$ 18.17	$ 4,796.88		$4,796.88
GD Rail - Stl Int Rdwy Term Sect	26	LNFT	$ 47.60	$ 1,237.60		$1,237.60
Guardrail - Optional Term Sect	1	EACH	$ 2,884.51	$ 2,884.51		$2,884.51
Farm Fence - Type F5W & F5M	10560	LNFT	$ 3.33	$ 35,164.80		$35,164.80
Seeding and Fertilizing	1.00	LS			$ 33,000.00	$33,000.00
Striping & Pavement Markings - Rural	1	MILE	$ 8,000.00	$ 8,000.00		$8,000.00
Signing	1	MILE	$ 8,000.00	$ 8,000.00		$8,000.00
Traffic Control (6%)	1	LS			$ 39,333.59	$39,333.59
Option 5 Subtotal						$694,893.50
Miscellaneous Items					5%	$34,744.68
Mobilization					15%	$104,234.03
Subtotal						$833,872.21
Contingency					25%	$208,468.05
Construction Total						$1,042,340.26
Preliminary Engineering					10%	$83,387.22
Construction Engineering					10%	$83,387.22
Subtotal						$1,209,114.70
Indirect Cost (IDC)					9.13%	$110,392.17
Total w/ IDC						$1,319,506.87
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10 Years		$453,800.03
Total Improvement Option 5						**$1,773,306.90**

Planning-Level Cost Estimate

Option 6 - Future Signalization of US 12/MT 7

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Signals	1	EACH			$ 225,000.00	$225,000.00
Striping & Pavement Markings	1	LS			$ 10,000.00	$10,000.00
Traffic Control (5%)	1	LS			$ 11,750.00	$11,750.00
Option 6 Subtotal						$246,750.00
Miscellaneous Items					5%	$12,337.50
Mobilization					15%	$37,012.50
Subtotal						$296,100.00
Contingency					25%	$74,025.00
Construction Total						$370,125.00
Preliminary Engineering					10%	$29,610.00
Construction Engineering					10%	$29,610.00
Subtotal						$429,345.00
Indirect Cost (IDC)					9.13%	$39,199.20
Total w/ IDC						$468,544.20
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%		10 Years	$161,140.02
Total Improvement Option 6						**$629,684.22**

Planning-Level Cost Estimate

Option 7A - Signalization of MT 7/Shell Oil Rd/S-493

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Signals	1	EACH			$ 225,000.00	$225,000.00
Striping & Pavement Markings	1	LS			$ 5,000.00	$5,000.00
Traffic Control (5%)	1	LS			$ 11,500.00	$11,500.00
Option 7A Subtotal						$241,500.00
Miscellaneous Items					5%	$12,075.00
Mobilization					15%	$36,225.00
Subtotal						$289,800.00
Contingency					25%	$72,450.00
Construction Total						$362,250.00
Preliminary Engineering					10%	$28,980.00
Construction Engineering					10%	$28,980.00
Subtotal						$420,210.00
Indirect Cost (IDC)					9.13%	$38,365.17
Total w/ IDC						$458,575.17
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$157,711.51
Total Improvement Option 7A						**$616,286.69**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning-Level Cost Estimate

HDR

Option 7B - Roundabout at MT 7/Shell Oil Rd/S-493

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Finish Grade Control	4000	CRFT	$ 0.44	$ 1,760.00		$1,760.00
Excavation - Unclassified	10000	CUYD	$ 4.07	$ 40,700.00		$40,700.00
Excavation - Unclassified Borrow	1000	CUYD	$ 4.07	$ 4,070.00		$4,070.00
Special Borrow - Excavation	500	CUYD		$ -	$ 8.00	$4,000.00
Topsoil - Salvaging and Placing	6824	CUYD	$ 4.17	$ 28,456.08		$28,456.08
Temporary Erosion Control	1	LS			$ 5,000.00	$5,000.00
Crushed Aggregate Course	10020	CUYD	$ 21.63	$ 216,732.60		$216,732.60
Cover - Type I	12000	SQYD	$ 0.53	$ 6,360.00		$6,360.00
Traffic Gravel	950	CUYD	$ 17.00	$ 16,150.00		$16,150.00
Plant Mix Bit Surf GR S-3/4 IN	1540	TON	$ 33.15	$ 51,051.00		$51,051.00
Hydrated Lime	22	TON	$ 223.86	$ 4,924.92		$4,924.92
Asphalt Cement PG 64-28	84	TON	$ 697.91	$ 58,624.44		$58,624.44
Emuls Asphalt CRS-2P	18	TON	$ 610.88	$ 10,995.84		$10,995.84
Port Cem Conc Pavement	2410	SQYD			$ 150.00	$361,500.00
Farm Fence - Type F5W & F5M	4013	LNFT	$ 3.33	$ 13,363.29		$13,363.29
Concrete 4 in	856	SQYD	$ 54.23	$ 46,420.88		$46,420.88
Curb and Gutter - Conc	6900	LNFT	$ 17.07	$ 117,783.00		$117,783.00
Seeding and Fertilizing	1	LS			$ 25,000.00	$25,000.00
Landscaping	1	LS			$ 20,000.00	$20,000.00
Striping & Pavement Markings	1	LS		$ -	$ 20,000.00	$20,000.00
Drainage Pipe - Rural	1	LS		$ -	$ 30,000.00	$30,000.00
Signing	1	LS		$ -	$ 30,000.00	$30,000.00
Lighting	1	LS			$ 50,000.00	$50,000.00
Traffic Control (5%)	1	LS			$ 55,644.60	$55,644.60
Option 7B Subtotal						$1,218,536.65
Miscellaneous Items					5%	$60,926.83
Mobilization					15%	$182,780.50
Subtotal						$1,462,243.98
Contingency					30%	$438,673.19
Construction Total						$1,900,917.18
Preliminary Engineering					10%	$146,224.40
Construction Engineering					10%	$146,224.40
Subtotal						$2,193,365.97
Indirect Cost (IDC)					9.13%	$200,254.31
Total w/ IDC						$2,393,620.29
Right-of-Way			0.7	Acres	$50,000.00	$34,500.00
Inflation			3.00%		10 Years	$823,205.22
Total Improvement Option 7B						**$3,251,325.51**

Planning-Level Cost Estimate

Option 8 - US 12/Willow Lane Improvements

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Finish Grade Control	1584	CRFT	$ 0.44	$ 696.96		$696.96
Excavation - Unclassified	4201	CUYD	$ 4.07	$ 17,098.07		$17,098.07
Excavation - Unclassified Borrow	420	CUYD	$ 4.07	$ 1,709.40		$1,709.40
Special Borrow - Excavation	210	CUYD			$ 8.00	$1,680.00
Topsoil - Salvaging and Placing	914	CUYD	$ 4.17	$ 3,811.38		$3,811.38
Temporary Erosion Control	1	LS			$ 7,500.00	$7,500.00
Crushed Aggregate Course	1743	CUYD	$ 21.63	$ 37,701.09		$37,701.09
Cover - Type I	8919	SQYD	$ 0.53	$ 4,727.07		$4,727.07
Traffic Gravel	282	CUYD	$ 17.00	$ 4,794.00		$4,794.00
Plant Mix Bit Surf GR S-3/4 IN	1450	TON	$ 33.15	$ 48,067.50		$48,067.50
Hydrated Lime	23	TON	$ 223.86	$ 5,148.78		$5,148.78
Asphalt Cement PG 64-28	79	TON	$ 697.91	$ 55,134.89		$55,134.89
Emuls Asphalt CRS-2P	16	TON	$ 610.88	$ 9,774.08		$9,774.08
Farm Fence - Type F5W & F5M	1584	LNFT	$ 3.33	$ 5,274.72		$5,274.72
Seeding and Fertilizing	1	LS			$ 2,500.00	$2,500.00
Signing - Rural	0.15	MILE	$ 8,000.00	$ 1,200.00		$1,200.00
Striping & Pavement Markings - Rural	0.15	MILE	$ 8,000.00	$ 1,200.00	$ 20,000.00	$3,000.00
Railroad Grade Crossing Panels	1	LS			$ 12,000.00	$12,000.00
Traffic Control (5%)	1	LS			$ 11,090.90	$11,090.90
Option 8 Subtotal						$232,908.84
Miscellaneous Items					5%	$11,645.44
Mobilization					15%	$34,936.33
Subtotal						$279,490.60
Contingency					25%	$69,872.65
Construction Total						$349,363.26
Preliminary Engineering					10%	$27,949.06
Construction Engineering					10%	$27,949.06
Subtotal						$405,261.38
Indirect Cost (IDC)					9.13%	$37,000.36
Total w/ IDC						$442,261.74
Right-of-Way			0.0 Acres		$50,000.00	$0.00
Inflation			3.00%	10 Years		$152,101.06
Total Improvement Option 8						**$594,362.80**

Planning-Level Cost Estimate

Option 9 - Railroad Avenue Improvements

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Finish Grade Control	2323	CRFT	$ 0.44	$ 1,022.12		$1,022.12
Excavation - Unclassified	1200	CUYD	$ 4.07	$ 4,884.00		$4,884.00
Topsoil - Salvaging and Placing	1975	CUYD	$ 4.17	$ 8,235.75		$8,235.75
Temporary Erosion Control	1	LS			$ 5,000.00	$5,000.00
Crushed Aggregate Course	832	CUYD	$ 21.63	$ 17,996.16		$17,996.16
Cover - Type I	3227	SQYD	$ 0.53	$ 1,710.31		$1,710.31
Traffic Gravel	215	CUYD	$ 17.00	$ 3,655.00		$3,655.00
Plant Mix Bit Surf GR S-3/4 IN	691	TON	$ 33.15	$ 22,906.65		$22,906.65
Hydrated Lime	10	TON	$ 223.86	$ 2,238.60		$2,238.60
Asphalt Cement PG 64-28	37	TON	$ 697.91	$ 25,822.67		$25,822.67
Emuls Asphalt CRS-2P	6	TON	$ 610.88	$ 3,665.28		$3,665.28
Seeding and Fertilizing	1	LS			$ 7,200.00	$7,200.00
Signing - Urban	0.22	MILE		$ -	$ 20,000.00	$4,400.00
Striping & Pavement Markings - Urban	0.22	MILE	$ 20,000.00	$ 4,400.00		$4,400.00
Traffic Control (5%)	1	LS			$ 5,656.83	$5,656.83
Option 9 Subtotal						$118,793.37
Miscellaneous Items					5%	$5,939.67
Mobilization					15%	$17,819.01
Subtotal						$142,552.04
Contingency					25%	$35,638.01
Construction Total						$178,190.05
Preliminary Engineering					10%	$14,255.20
Construction Engineering					10%	$14,255.20
Subtotal						$206,700.46
Indirect Cost (IDC)					9.13%	$18,871.75
Total w/ IDC						$225,572.21
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10 Years		$77,577.98
Total Improvement Option 9						**$303,150.19**

Planning-Level Cost Estimate

Option 10 - Milwaukee Avenue and 3rd Street SW Improvements

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Finish Grade Control	634	CRFT	$ 0.44	$ 278.96		$278.96
Excavation - Unclassified	300	CUYD	$ 4.07	$ 1,221.00		$1,221.00
Topsoil - Salvaging and Placing	540	CUYD	$ 4.17	$ 2,251.80		$2,251.80
Temporary Erosion Control	1	LS			$ 2,500.00	$2,500.00
Crushed Aggregate Course	227	CUYD	$ 21.63	$ 4,910.01		$4,910.01
Cover - Type I	880	SQYD	$ 0.53	$ 466.40		$466.40
Traffic Gravel	59	CUYD	$ 17.00	$ 1,003.00		$1,003.00
Plant Mix Bit Surf GR S-3/4 IN	188	TON	$ 33.15	$ 6,232.20		$6,232.20
Hydrated Lime	3	TON	$ 223.86	$ 671.58		$671.58
Asphalt Cement PG 64-28	10	TON	$ 697.91	$ 6,979.10		$6,979.10
Emuls Asphalt CRS-2P	2	TON	$ 610.88	$ 1,221.76		$1,221.76
Seeding and Fertilizing	1	LS			$ 2,000.00	$2,000.00
Signing - Urban	0.06	MILE	$ 52,000.00	$ 3,120.00		$3,120.00
Striping & Pavement Markings - Urban	0.06	MILE	$ 20,000.00	$ 1,200.00		$1,200.00
Railroad Grade Crossing Panels	1	LS			$ 12,000.00	$12,000.00
Traffic Control (5%)	1	LS			$ 2,302.79	$2,302.79
Option 10 Subtotal						$48,358.60
Miscellaneous Items					5%	$2,417.93
Mobilization					15%	$7,253.79
Subtotal						$58,030.32
Contingency					25%	$14,507.58
Construction Total						$72,537.90
Preliminary Engineering					10%	$5,803.03
Construction Engineering					10%	$5,803.03
Subtotal						$84,143.96
Indirect Cost (IDC)					9.13%	$7,682.34
Total w/ IDC						$91,826.31
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$31,580.57
Total Improvement Option 10						**$123,406.88**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Planning-Level Cost Estimate

HDR

Option 11 - US 12 and Railroad Avenue One-Way Couplet

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Finish Grade Control	2323	CRFT	$ 0.44	$ 1,022.12		$1,022.12
Excavation - Unclassified	1200	CUYD	$ 4.07	$ 4,884.00		$4,884.00
Topsoil - Salvaging and Placing	1975	CUYD	$ 4.17	$ 8,235.75		$8,235.75
Temporary Erosion Control	1	LS			$ 5,000.00	$5,000.00
Crushed Aggregate Course	832	CUYD	$ 21.63	$ 17,996.16		$17,996.16
Cover - Type I	3227	SQYD	$ 0.53	$ 1,710.31		$1,710.31
Traffic Gravel	215	CUYD	$ 17.00	$ 3,655.00		$3,655.00
Plant Mix Bit Surf GR S-3/4 IN	691	TON	$ 33.15	$ 22,906.65		$22,906.65
Hydrated Lime	10	TON	$ 223.86	$ 2,238.60		$2,238.60
Asphalt Cement PG 64-28	37	TON	$ 697.91	$ 25,822.67		$25,822.67
Emuls Asphalt CRS-2P	6	TON	$ 610.88	$ 3,665.28		$3,665.28
Seeding and Fertilizing	1	LS			$ 7,200.00	$7,200.00
Striping & Pavement Markings	1	LS		$ -	$ 20,000.00	$20,000.00
Signs	1	LS			$ 25,000.00	$25,000.00
Signals	2	EACH			$ 225,000.00	$450,000.00
Traffic Control (5%)	1	LS			$ 29,966.83	$29,966.83
Option 11 Subtotal						$629,303.37
Miscellaneous Items					5%	$31,465.17
Mobilization					15%	$94,395.51
Subtotal						$755,164.04
Contingency					25%	$188,791.01
Construction Total						$943,955.05
Preliminary Engineering					10%	$75,516.40
Construction Engineering					10%	$75,516.40
Subtotal						$1,094,987.86
Indirect Cost (IDC)					9.13%	$99,972.39
Total w/ IDC						$1,194,960.25
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10 Years		$410,966.40
Total Improvement Option 11						**$1,605,926.65**

Planning-Level Cost Estimate

Option 13.a: NW-5 ESTIMATE

Baker Corridor Planning Study | 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-5		SF		$ -		$4,771,416.00
Shell Oil Road/S-493 Improvements	1	LS			$ 600,500.00	$600,500.00
New Intersection w/ S-493	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 370,314.96	$370,314.96
NW-5 Subtotal						$6,542,230.96
Miscellaneous Items					5%	$327,111.55
Mobilization					18%	$1,177,601.57
Subtotal						$8,046,944.08
Contingency					25%	$2,011,736.02
Construction Total						$10,058,680.10
Preliminary Engineering					10%	$804,694.41
Construction Engineering					10%	$804,694.41
Subtotal						$11,668,068.92
Indirect Cost (IDC)					9.13%	$1,065,294.69
Total w/ IDC						$12,733,363.61
Right-of-Way			2.0	Acres	$10,000.00	$20,000.00
Inflation			3.00%	10	Years	$4,379,212.31
Total Improvement NW-5						**$17,132,575.92**

Planning-Level Cost Estimate

Option 13.b: NE-5 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-5		SF		$ -		$3,190,054.00
Shell Oil Road Improvements	1	LS			$ 1,919,000.00	$1,919,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 354,543.24	$354,543.24
NE-5 Subtotal						$6,263,597.24
Miscellaneous Items					5%	$313,179.86
Mobilization					18%	$1,127,447.50
Subtotal						$7,704,224.61
Contingency					25%	$1,926,056.15
Construction Total						$9,630,280.76
Preliminary Engineering					10%	$770,422.46
Construction Engineering					10%	$770,422.46
Subtotal						$11,171,125.68
Indirect Cost (IDC)					9.13%	$1,019,923.77
Total w/ IDC						$12,191,049.45
Right-of-Way			27.3	Acres	$10,000.00	$273,000.00
Inflation			3.00%	10	Years	$4,192,701.59
Total Improvement NE-5						**$16,656,751.04**

Planning-Level Cost Estimate

Option 14 - Bridge Replacement on MT 7, RM 35.86

Baker Corridor Planning Study 7/13/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Bridge Replacement	2153	SF		$ -	$ 146.00	$314,338.00
Traffic Control (6%)	1	LS			$ 18,860.28	$18,860.28
Option 14 Subtotal						$333,198.28
Miscellaneous Items					5%	$16,659.91
Mobilization					18%	$59,975.69
Subtotal						$409,833.88
Contingency					25%	$102,458.47
Construction Total						$512,292.36
Preliminary Engineering					10%	$40,983.39
Construction Engineering					10%	$40,983.39
Subtotal						$594,259.13
Indirect Cost (IDC)					9.13%	$54,255.86
Total w/ IDC						$648,514.99
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$223,034.93
Total Improvement Option 14						**$871,549.92**

BAKER CORRIDOR
PLANNING STUDY

APPENDIX B: Level of Service (LOS) Analysis

Baker Corridor Planning Study

August 2015

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	91	77	92	104	72	76	97	77	89	210	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		0.99			0.99			0.99			0.99	
Flpb, ped/bikes		1.00			1.00			1.00			1.00	
Frt		0.96			0.96			0.95			0.96	
Flt Protected		0.98			0.98			0.98			0.99	
Satd. Flow (prot)		1491			1424			1430			1480	
Flt Permitted		0.79			0.80			0.80			0.87	
Satd. Flow (perm)		1194			1159			1160			1303	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	125	120	89	107	118	82	101	113	107	95	244	125
RTOR Reduction (vph)	0	29	0	0	29	0	0	40	0	0	29	0
Lane Group Flow (vph)	0	305	0	0	278	0	0	281	0	0	435	0
Confl. Peds. (#/hr)	10		16	16		10	9		9	9		9
Heavy Vehicles (%)	4%	7%	0%	5%	4%	22%	0%	15%	8%	18%	3%	3%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		16.0			16.0			21.0			21.0	
Effective Green, g (s)		16.0			16.0			21.0			21.0	
Actuated g/C Ratio		0.36			0.36			0.47			0.47	
Clearance Time (s)		4.0			4.0			4.0			4.0	
Lane Grp Cap (vph)		424			412			541			608	
v/s Ratio Prot												
v/s Ratio Perm		c0.26			0.24			0.24			c0.33	
v/c Ratio		0.72			0.67			0.52			0.71	
Uniform Delay, d1		12.6			12.3			8.4			9.6	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		10.1			8.6			3.5			7.0	
Delay (s)		22.6			20.9			12.0			16.6	
Level of Service		C			C			B			B	
Approach Delay (s)		22.6			20.9			12.0			16.6	
Approach LOS		C			C			B			B	

Intersection Summary			
HCM 2000 Control Delay	17.9	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.4%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	91	77	92	104	72	76	97	77	89	210	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.98		1.00	0.99		1.00	0.98		1.00	0.99	
Flpb, ped/bikes	0.99	1.00		0.99	1.00		0.99	1.00		0.99	1.00	
Frt	1.00	0.94		1.00	0.94		1.00	0.93		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1510	1471		1482	1390		1569	1360		1327	1516	
Flt Permitted	0.63	1.00		0.63	1.00		0.47	1.00		0.62	1.00	
Satd. Flow (perm)	1005	1471		978	1390		772	1360		867	1516	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	125	120	89	107	118	82	101	113	107	95	244	125
RTOR Reduction (vph)	0	53	0	0	49	0	0	64	0	0	46	0
Lane Group Flow (vph)	125	156	0	107	151	0	101	156	0	95	323	0
Confl. Peds. (#/hr)	10		16	16		10	9		9	9		9
Heavy Vehicles (%)	4%	7%	0%	5%	4%	22%	0%	15%	8%	18%	3%	3%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.0	16.0		16.0	16.0		16.0	16.0		16.0	16.0	
Effective Green, g (s)	16.0	16.0		16.0	16.0		16.0	16.0		16.0	16.0	
Actuated g/C Ratio	0.40	0.40		0.40	0.40		0.40	0.40		0.40	0.40	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	402	588		391	556		308	544		346	606	
v/s Ratio Prot		0.11			0.11			0.11			c0.21	
v/s Ratio Perm	c0.12			0.11			0.13			0.11		
v/c Ratio	0.31	0.26		0.27	0.27		0.33	0.29		0.27	0.53	
Uniform Delay, d1	8.2	8.1		8.1	8.1		8.3	8.1		8.1	9.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		0.93	0.94	
Incremental Delay, d2	2.0	1.1		1.7	1.2		2.8	1.3		1.9	3.3	
Delay (s)	10.2	9.2		9.8	9.3		11.1	9.5		9.5	11.9	
Level of Service	B	A		A	A		B	A		A	B	
Approach Delay (s)		9.6			9.5			10.0			11.4	
Approach LOS		A			A			A			B	

Intersection Summary			
HCM 2000 Control Delay	10.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	52.9%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	3	4	12	67	4	10	75	193	124	14	114	14
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00			1.00	
Frt		0.93			0.97		1.00	0.93			0.98	
Flt Protected		0.99			0.97		0.95	1.00			0.99	
Satd. Flow (prot)		1395			1625		1530	1635			1729	
Flt Permitted		0.97			0.80		0.70	1.00			0.91	
Satd. Flow (perm)		1365			1346		1125	1635			1589	
Peak-hour factor, PHF	0.50	0.25	0.50	0.75	0.38	0.44	0.80	0.74	0.55	0.50	0.77	0.50
Adj. Flow (vph)	6	16	24	89	11	23	94	261	225	28	148	28
RTOR Reduction (vph)	0	14	0	0	14	0	0	77	0	0	14	0
Lane Group Flow (vph)	0	32	0	0	109	0	94	409	0	0	190	0
Heavy Vehicles (%)	10%	33%	25%	10%	10%	10%	18%	10%	6%	10%	6%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		16.0			16.0		16.0	16.0			16.0	
Effective Green, g (s)		16.0			16.0		16.0	16.0			16.0	
Actuated g/C Ratio		0.40			0.40		0.40	0.40			0.40	
Clearance Time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Grp Cap (vph)		546			538		450	654			635	
v/s Ratio Prot								c0.25				
v/s Ratio Perm		0.02			c0.08		0.08				0.12	
v/c Ratio		0.06			0.20		0.21	0.62			0.30	
Uniform Delay, d1		7.4			7.8		7.9	9.6			8.2	
Progression Factor		1.00			1.00		1.07	1.10			1.00	
Incremental Delay, d2		0.2			0.9		1.0	4.4			1.2	
Delay (s)		7.6			8.7		9.4	15.0			9.4	
Level of Service		A			A		A	B			A	
Approach Delay (s)		7.6			8.7			14.1			9.4	
Approach LOS		A			A			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.0	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.41		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	43.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	86	77	92	98	72	76	97	77	89	210	91
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.98		1.00	0.98		1.00	0.98		1.00	0.99	
Flpb, ped/bikes	0.98	1.00		0.97	1.00		0.99	1.00		0.99	1.00	
Frt	1.00	0.93		1.00	0.94		1.00	0.93		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1491	1453		1477	1376		1531	1354		1319	1512	
Flt Permitted	0.64	1.00		0.63	1.00		0.47	1.00		0.62	1.00	
Satd. Flow (perm)	999	1453		981	1376		754	1354		862	1512	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	125	113	89	107	111	82	101	113	107	95	244	125
RTOR Reduction (vph)	0	53	0	0	49	0	0	64	0	0	46	0
Lane Group Flow (vph)	125	149	0	107	144	0	101	156	0	95	323	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	4%	6%	2%	4%	3%	22%	2%	15%	8%	18%	3%	3%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.0	16.0		16.0	16.0		16.0	16.0		16.0	16.0	
Effective Green, g (s)	16.0	16.0		16.0	16.0		16.0	16.0		16.0	16.0	
Actuated g/C Ratio	0.40	0.40		0.40	0.40		0.40	0.40		0.40	0.40	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	399	581		392	550		301	541		344	604	
v/s Ratio Prot		0.10			0.10			0.12			c0.21	
v/s Ratio Perm	c0.13			0.11			0.13			0.11		
v/c Ratio	0.31	0.26		0.27	0.26		0.34	0.29		0.28	0.53	
Uniform Delay, d1	8.2	8.0		8.1	8.0		8.3	8.1		8.1	9.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.0	1.1		1.7	1.2		3.0	1.3		2.0	3.4	
Delay (s)	10.3	9.1		9.8	9.2		11.3	9.5		10.1	12.5	
Level of Service	B	A		A	A		B	A		B	B	
Approach Delay (s)		9.5			9.4			10.1			12.0	
Approach LOS		A			A			B			B	

Intersection Summary			
HCM 2000 Control Delay	10.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.42		
Actuated Cycle Length (s)	40.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	53.0%	ICU Level of Service	A
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	19	16	3	59	16	28	64	159	113	35	80	32
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00			1.00	
Frt		0.99			0.96		1.00	0.94			0.97	
Flt Protected		0.98			0.97		0.95	1.00			0.99	
Satd. Flow (prot)		1546			1603		1543	1701			1660	
Flt Permitted		0.85			0.79		0.63	1.00			0.88	
Satd. Flow (perm)		1339			1309		1029	1701			1480	
Peak-hour factor, PHF	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Adj. Flow (vph)	25	21	4	79	21	37	85	212	151	47	107	43
RTOR Reduction (vph)	0	3	0	0	31	0	0	46	0	0	18	0
Lane Group Flow (vph)	0	47	0	0	106	0	85	317	0	0	179	0
Heavy Vehicles (%)	11%	25%	33%	2%	13%	29%	17%	6%	3%	26%	3%	9%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		5.0			5.0		17.0	17.0			17.0	
Effective Green, g (s)		5.0			5.0		17.0	17.0			17.0	
Actuated g/C Ratio		0.17			0.17		0.57	0.57			0.57	
Clearance Time (s)		4.0			4.0		4.0	4.0			4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)		223			218		583	963			838	
v/s Ratio Prot								c0.19				
v/s Ratio Perm		0.03			c0.08		0.08				0.12	
v/c Ratio		0.21			0.49		0.15	0.33			0.21	
Uniform Delay, d1		10.8			11.3		3.1	3.5			3.2	
Progression Factor		1.00			1.00		1.00	1.00			1.00	
Incremental Delay, d2		0.5			1.7		0.1	0.2			0.1	
Delay (s)		11.3			13.0		3.2	3.7			3.3	
Level of Service		B			B		A	A			A	
Approach Delay (s)		11.3			13.0			3.6			3.3	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	5.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.36		
Actuated Cycle Length (s)	30.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	41.0%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

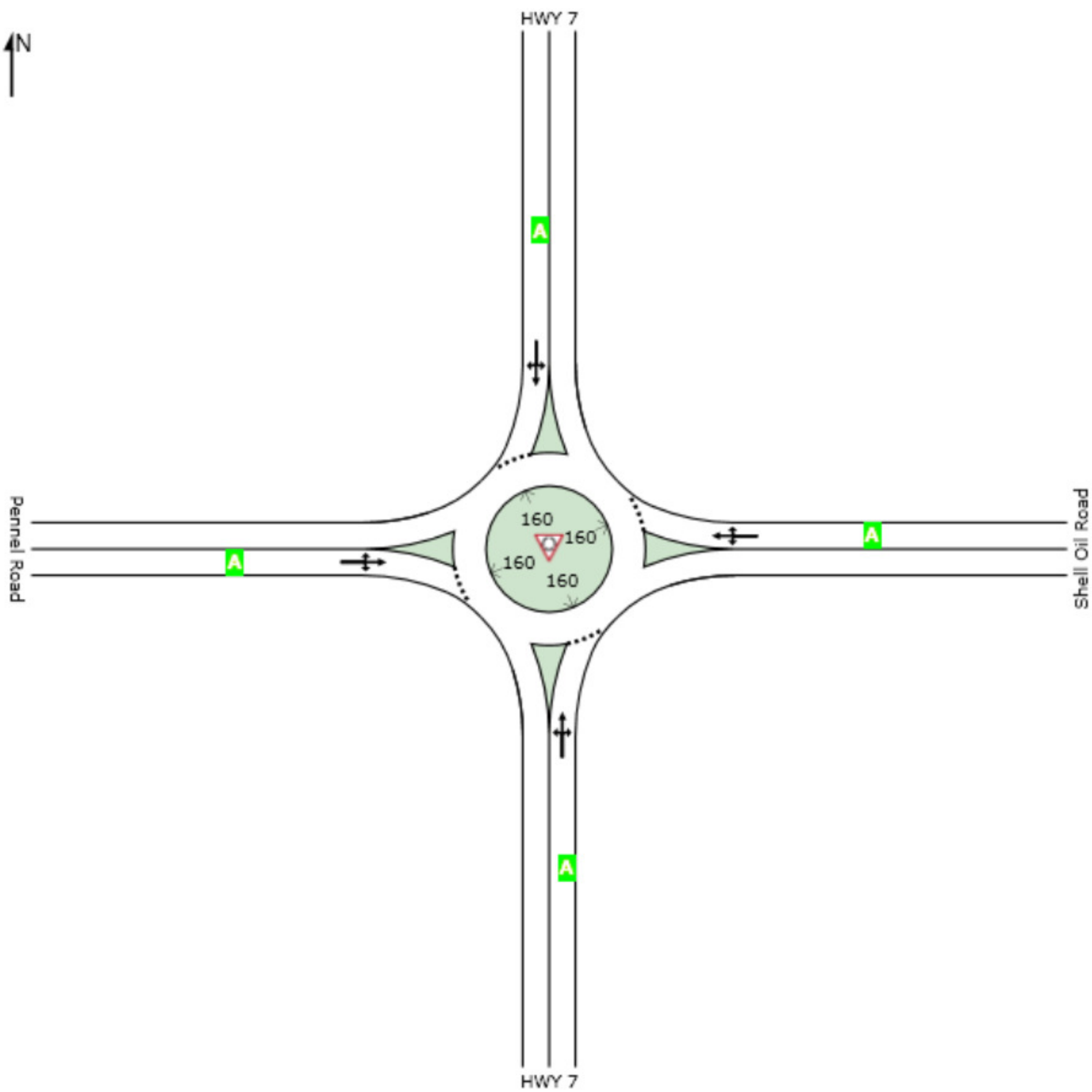
LEVEL OF SERVICE

Site: Build Both - 2.2

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	A	A	A	A	A



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

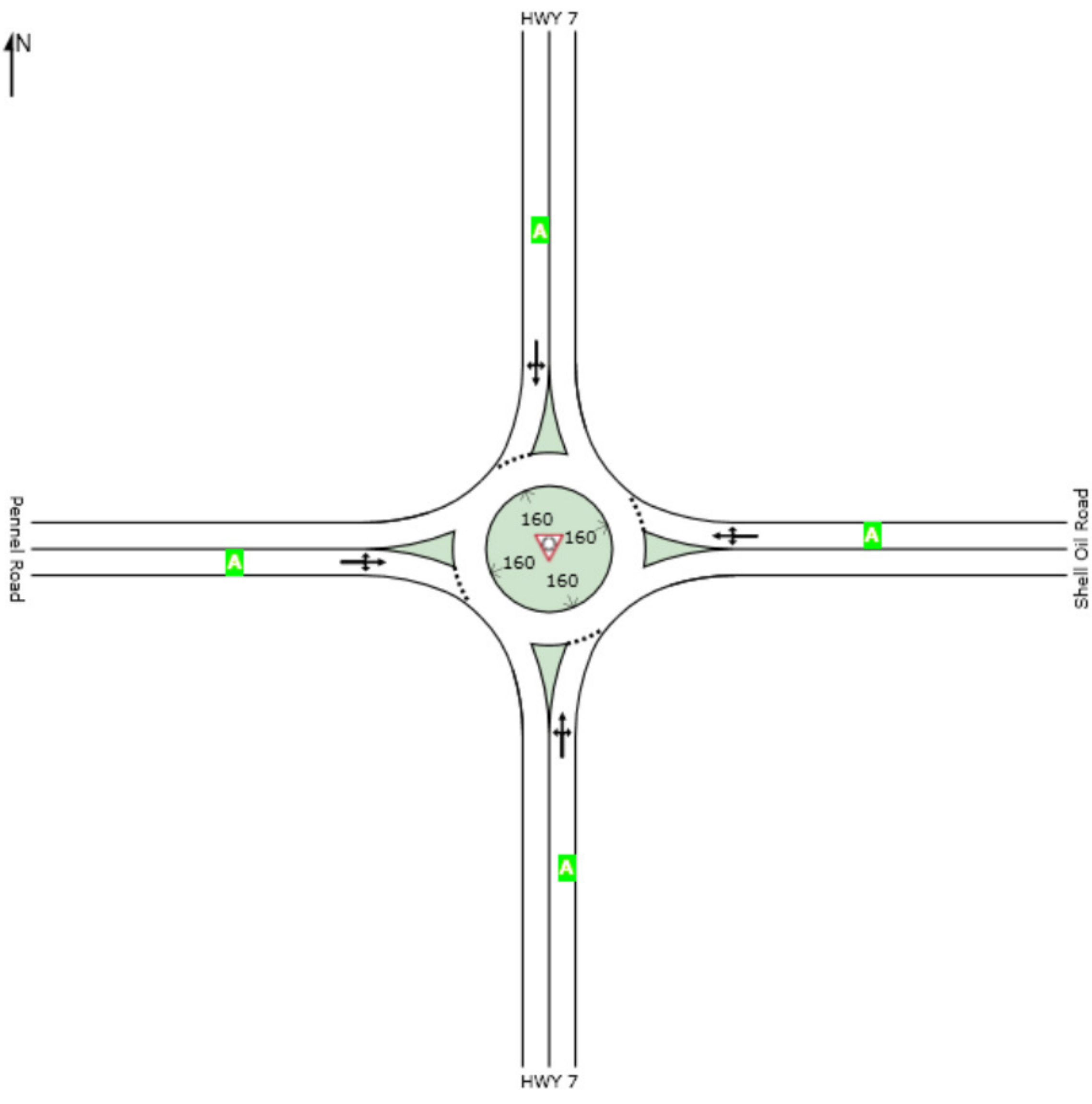
LEVEL OF SERVICE

Site: Horizon - default

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	A	A	A	A	A



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	143	162	138	165	186	130	135	173	138	159	375	162
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		0.97			0.98			0.98			0.98	
Flpb, ped/bikes		1.00			1.00			1.00			1.00	
Frt		0.96			0.96			0.95			0.96	
Flt Protected		0.98			0.98			0.98			0.99	
Satd. Flow (prot)		1466			1414			1400			1466	
Flt Permitted		0.63			0.65			0.56			0.76	
Satd. Flow (perm)		938			929			795			1129	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	223	213	159	192	211	148	180	201	192	169	436	222
RTOR Reduction (vph)	0	15	0	0	15	0	0	20	0	0	15	0
Lane Group Flow (vph)	0	580	0	0	536	0	0	553	0	0	813	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	3%	7%	3%	5%	4%	22%	3%	16%	8%	18%	3%	3%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		37.0			37.0			45.0			45.0	
Effective Green, g (s)		37.0			37.0			45.0			45.0	
Actuated g/C Ratio		0.41			0.41			0.50			0.50	
Clearance Time (s)		4.0			4.0			4.0			4.0	
Lane Grp Cap (vph)		385			381			397			564	
v/s Ratio Prot												
v/s Ratio Perm		c0.62			0.58			0.70			c0.72	
v/c Ratio		1.51			1.41			1.39			1.44	
Uniform Delay, d1		26.5			26.5			22.5			22.5	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		241.4			198.5			191.7			208.2	
Delay (s)		267.9			225.0			214.2			230.7	
Level of Service		F			F			F			F	
Approach Delay (s)		267.9			225.0			214.2			230.7	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	234.4	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.47		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	143	162	138	165	186	130	135	173	138	159	375	162
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.97		1.00	0.98		1.00	0.98		1.00	0.98	
Flpb, ped/bikes	0.98	1.00		0.98	1.00		0.99	1.00		0.99	1.00	
Frt	1.00	0.94		1.00	0.94		1.00	0.93		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1509	1437		1469	1371		1523	1345		1321	1509	
Flt Permitted	0.41	1.00		0.39	1.00		0.24	1.00		0.47	1.00	
Satd. Flow (perm)	653	1437		610	1371		388	1345		649	1509	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	223	213	159	192	211	148	180	201	192	169	436	222
RTOR Reduction (vph)	0	53	0	0	51	0	0	69	0	0	37	0
Lane Group Flow (vph)	223	319	0	192	308	0	180	324	0	169	622	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	3%	7%	3%	5%	4%	22%	3%	16%	8%	18%	3%	3%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	17.0	17.0		17.0	17.0		25.0	25.0		25.0	25.0	
Effective Green, g (s)	17.0	17.0		17.0	17.0		25.0	25.0		25.0	25.0	
Actuated g/C Ratio	0.34	0.34		0.34	0.34		0.50	0.50		0.50	0.50	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	222	488		207	466		194	672		324	754	
v/s Ratio Prot		0.22			0.22			0.24			0.41	
v/s Ratio Perm	c0.34			0.31			c0.46			0.26		
v/c Ratio	1.00	0.65		0.93	0.66		0.93	0.48		0.52	0.82	
Uniform Delay, d1	16.5	14.0		15.9	14.0		11.7	8.2		8.5	10.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	61.6	6.7		46.1	7.2		48.1	2.5		5.9	9.9	
Delay (s)	78.1	20.6		62.0	21.3		59.7	10.7		14.4	20.6	
Level of Service	E	C		E	C		E	B		B	C	
Approach Delay (s)		42.2			35.5			26.1			19.3	
Approach LOS		D			D			C			B	

Intersection Summary			
HCM 2000 Control Delay	29.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.96		
Actuated Cycle Length (s)	50.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	78.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis
4: MT 7 & MT 493/Shell Oil Road

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	8	21	119	8	19	135	344	223	27	204	27
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00			1.00	
Frt		0.93			0.97		1.00	0.93			0.98	
Flt Protected		0.99			0.97		0.95	1.00			0.99	
Satd. Flow (prot)		1386			1702		1530	1634			1721	
Flt Permitted		0.96			0.79		0.56	1.00			0.76	
Satd. Flow (perm)		1332			1385		901	1634			1315	
Peak-hour factor, PHF	0.50	0.25	0.50	0.75	0.38	0.44	0.80	0.74	0.55	0.50	0.77	0.50
Adj. Flow (vph)	10	32	42	159	21	43	169	465	405	54	265	54
RTOR Reduction (vph)	0	32	0	0	15	0	0	50	0	0	10	0
Lane Group Flow (vph)	0	52	0	0	208	0	169	820	0	0	363	0
Heavy Vehicles (%)	5%	38%	24%	5%	5%	5%	18%	10%	6%	11%	6%	11%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		12.4			12.4		32.9	32.9			32.9	
Effective Green, g (s)		12.4			12.4		32.9	32.9			32.9	
Actuated g/C Ratio		0.23			0.23		0.62	0.62			0.62	
Clearance Time (s)		4.0			4.0		4.0	4.0			4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)		309			322		556	1008			811	
v/s Ratio Prot								c0.50				
v/s Ratio Perm		0.04			c0.15		0.19				0.28	
v/c Ratio		0.17			0.64		0.30	0.81			0.45	
Uniform Delay, d1		16.3			18.5		4.8	7.8			5.4	
Progression Factor		1.00			1.00		1.00	1.00			1.00	
Incremental Delay, d2		0.3			4.4		0.3	5.1			0.4	
Delay (s)		16.6			22.8		5.1	12.9			5.8	
Level of Service		B			C		A	B			A	
Approach Delay (s)		16.6			22.8			11.7			5.8	
Approach LOS		B			C			B			A	

Intersection Summary			
HCM 2000 Control Delay	12.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.77		
Actuated Cycle Length (s)	53.3	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
1: MT 7 & US 12

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	97	154	138	165	177	74	135	173	138	94	375	110
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.97		1.00	0.99		1.00	0.98		1.00	0.99	
Flpb, ped/bikes	0.98	1.00		0.98	1.00		0.99	1.00		0.99	1.00	
Frt	1.00	0.93		1.00	0.96		1.00	0.93		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1522	1451		1471	1507		1537	1346		1515	1539	
Flt Permitted	0.53	1.00		0.43	1.00		0.28	1.00		0.46	1.00	
Satd. Flow (perm)	852	1451		670	1507		457	1346		736	1539	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	152	203	159	192	201	84	180	201	192	100	436	151
RTOR Reduction (vph)	0	63	0	0	34	0	0	76	0	0	28	0
Lane Group Flow (vph)	152	299	0	192	251	0	180	317	0	100	559	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	2%	6%	2%	5%	4%	4%	2%	16%	8%	3%	3%	2%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.0	16.0		16.0	16.0		21.0	21.0		21.0	21.0	
Effective Green, g (s)	16.0	16.0		16.0	16.0		21.0	21.0		21.0	21.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.47	0.47		0.47	0.47	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Grp Cap (vph)	302	515		238	535		213	628		343	718	
v/s Ratio Prot		0.21			0.17			0.24			0.36	
v/s Ratio Perm	0.18			c0.29			c0.39			0.14		
v/c Ratio	0.50	0.58		0.81	0.47		0.85	0.50		0.29	0.78	
Uniform Delay, d1	11.4	11.8		13.1	11.2		10.6	8.4		7.4	10.1	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	5.9	4.7		24.6	2.9		31.7	2.9		2.1	8.2	
Delay (s)	17.3	16.5		37.7	14.2		42.3	11.2		9.6	18.2	
Level of Service	B	B		D	B		D	B		A	B	
Approach Delay (s)		16.7			23.6			21.0			17.0	
Approach LOS		B			C			C			B	

Intersection Summary			
HCM 2000 Control Delay	19.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	74.5%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	33	31	4	103	29	53	115	282	201	66	144	58
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00			1.00	
Frt		0.99			0.96		1.00	0.94			0.97	
Flt Protected		0.98			0.97		0.95	1.00			0.99	
Satd. Flow (prot)		1547			1581		1543	1717			1643	
Flt Permitted		0.83			0.78		0.58	1.00			0.72	
Satd. Flow (perm)		1319			1264		939	1717			1206	
Peak-hour factor, PHF	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Adj. Flow (vph)	44	41	5	137	39	71	153	376	268	88	192	77
RTOR Reduction (vph)	0	4	0	0	31	0	0	50	0	0	19	0
Lane Group Flow (vph)	0	86	0	0	216	0	153	594	0	0	338	0
Heavy Vehicles (%)	9%	29%	25%	2%	17%	30%	17%	5%	2%	29%	3%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		11.6			11.6		22.0	22.0			22.0	
Effective Green, g (s)		11.6			11.6		22.0	22.0			22.0	
Actuated g/C Ratio		0.28			0.28		0.53	0.53			0.53	
Clearance Time (s)		4.0			4.0		4.0	4.0			4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)		367			352		496	908			637	
v/s Ratio Prot								c0.35				
v/s Ratio Perm		0.07			c0.17		0.16				0.28	
v/c Ratio		0.24			0.61		0.31	0.65			0.53	
Uniform Delay, d1		11.6			13.1		5.5	7.1			6.4	
Progression Factor		1.00			1.00		1.00	1.00			1.00	
Incremental Delay, d2		0.3			3.2		0.4	1.7			0.9	
Delay (s)		11.9			16.2		5.9	8.8			7.3	
Level of Service		B			B		A	A			A	
Approach Delay (s)		11.9			16.2			8.2			7.3	
Approach LOS		B			B			A			A	

Intersection Summary			
HCM 2000 Control Delay	9.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.64		
Actuated Cycle Length (s)	41.6	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

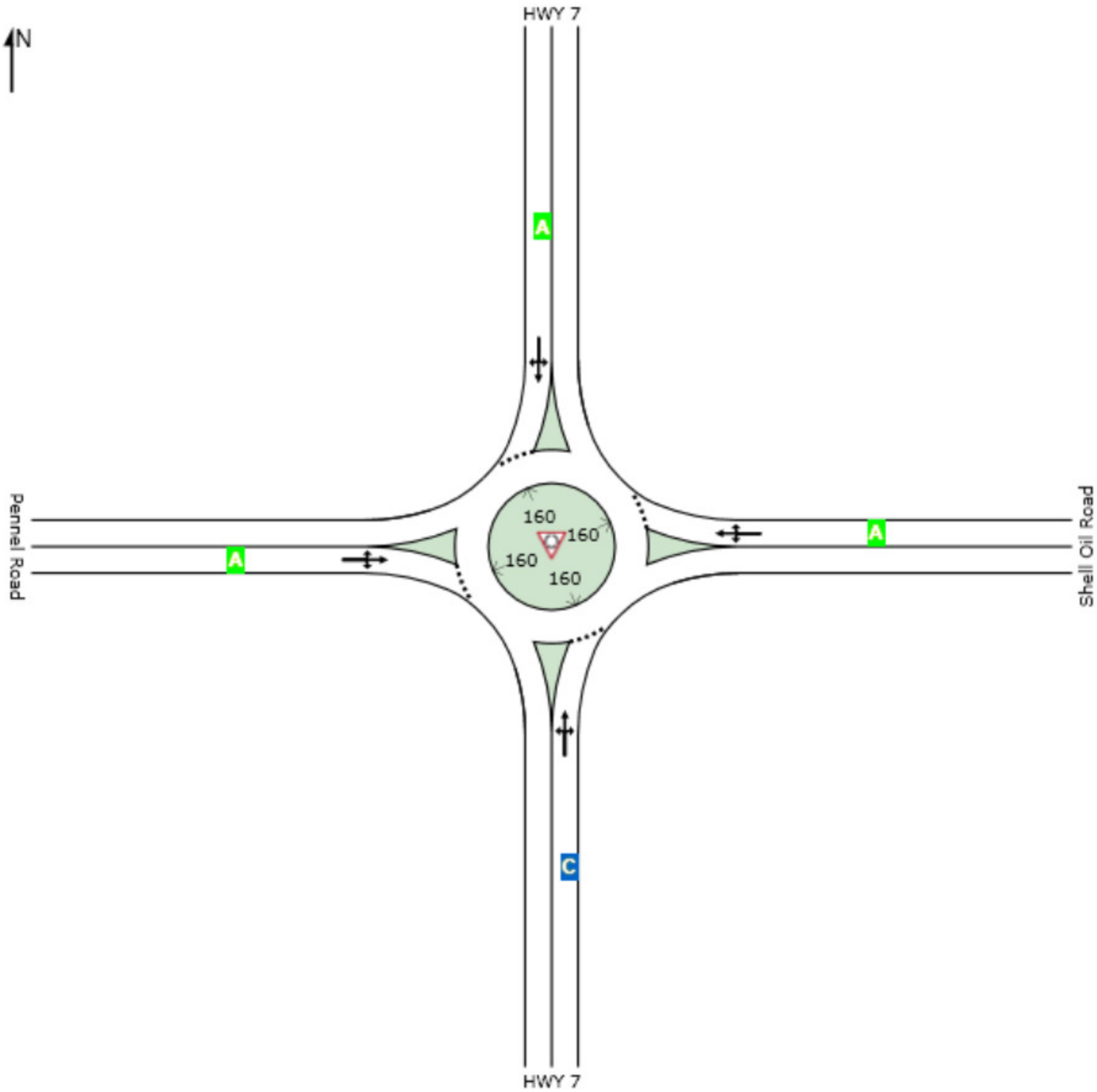
LEVEL OF SERVICE

Site: Horizon - 5.5

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	C	A	A	A	C



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

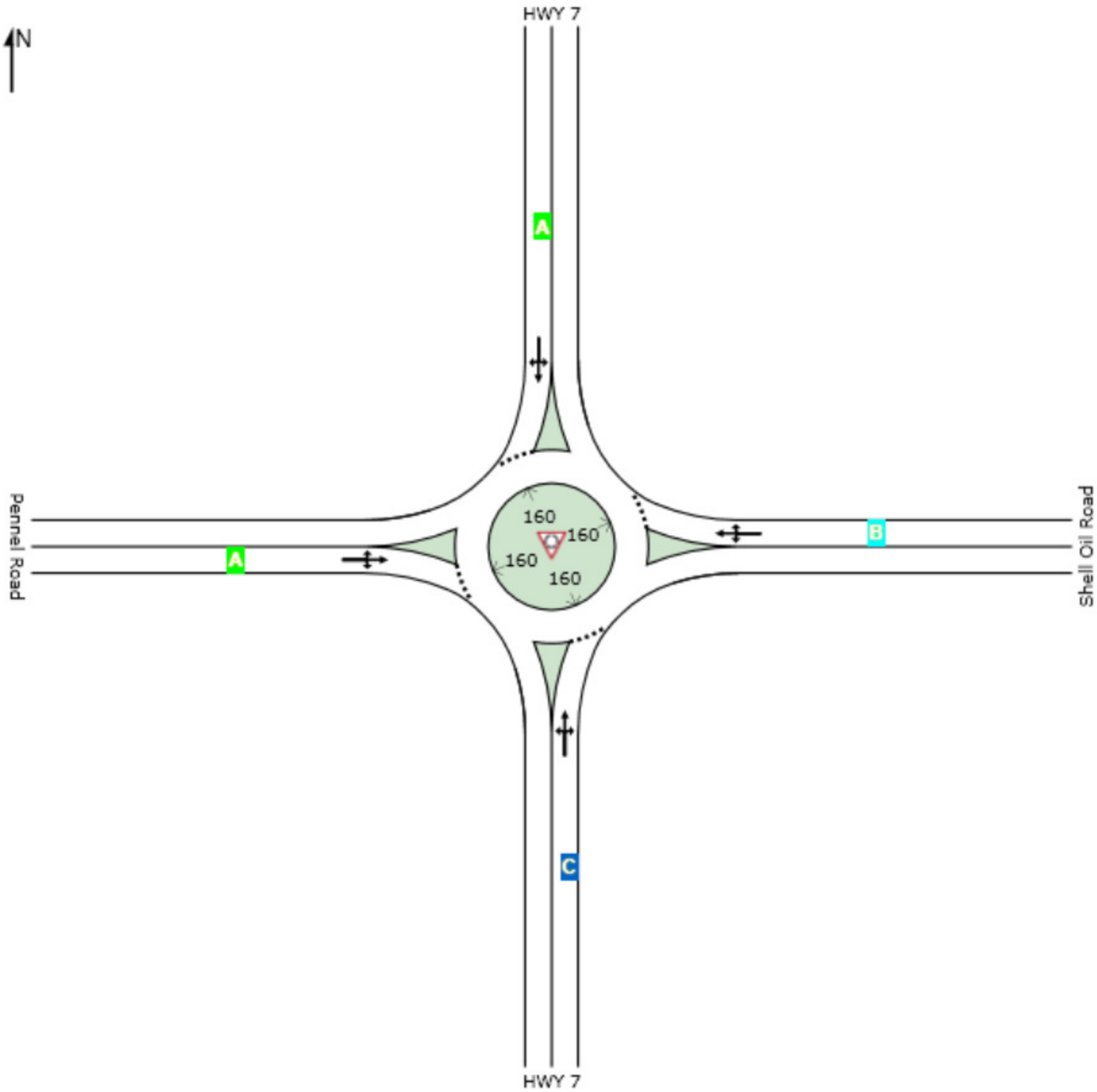
LEVEL OF SERVICE

Site: Build Both - 5.5

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	C	B	A	A	B



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	151	178	138	177	198	175	135	213	154	204	391	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0			4.0			4.0	
Lane Util. Factor		1.00			1.00			1.00			1.00	
Frpb, ped/bikes		0.97			0.98			0.98			0.98	
Flpb, ped/bikes		1.00			1.00			1.00			1.00	
Frt		0.97			0.96			0.95			0.97	
Flt Protected		0.98			0.98			0.99			0.99	
Satd. Flow (prot)		1397			1268			1281			1364	
Flt Permitted		0.59			0.65			0.58			0.69	
Satd. Flow (perm)		846			841			758			957	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	236	234	159	206	225	199	180	248	214	217	455	233
RTOR Reduction (vph)	0	12	0	0	17	0	0	18	0	0	12	0
Lane Group Flow (vph)	0	617	0	0	613	0	0	624	0	0	893	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	9%	15%	3%	11%	10%	42%	5%	31%	18%	36%	7%	8%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		40.0			40.0			52.0			52.0	
Effective Green, g (s)		40.0			40.0			52.0			52.0	
Actuated g/C Ratio		0.40			0.40			0.52			0.52	
Clearance Time (s)		4.0			4.0			4.0			4.0	
Lane Grp Cap (vph)		338			336			394			497	
v/s Ratio Prot												
v/s Ratio Perm		c0.73			0.73			0.82			c0.93	
v/c Ratio		1.83			1.83			1.58			1.80	
Uniform Delay, d1		30.0			30.0			24.0			24.0	
Progression Factor		1.00			1.00			1.00			1.00	
Incremental Delay, d2		382.9			382.7			274.3			366.1	
Delay (s)		412.9			412.7			298.3			390.1	
Level of Service		F			F			F			F	
Approach Delay (s)		412.9			412.7			298.3			390.1	
Approach LOS		F			F			F			F	

Intersection Summary			
HCM 2000 Control Delay	379.3	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.81		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	104.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	151	178	138	177	198	175	135	213	154	204	391	170
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.97		1.00	0.97		1.00	0.97		1.00	0.98	
Flpb, ped/bikes	0.98	1.00		0.97	1.00		1.00	1.00		0.99	1.00	
Frt	1.00	0.94		1.00	0.93		1.00	0.93		1.00	0.95	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1425	1371		1384	1201		1504	1207		1145	1443	
Flt Permitted	0.34	1.00		0.37	1.00		0.20	1.00		0.38	1.00	
Satd. Flow (perm)	508	1371		543	1201		317	1207		461	1443	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	236	234	159	206	225	199	180	248	214	217	455	233
RTOR Reduction (vph)	0	35	0	0	45	0	0	45	0	0	27	0
Lane Group Flow (vph)	236	358	0	206	379	0	180	418	0	217	662	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	9%	15%	3%	11%	10%	42%	5%	31%	18%	36%	7%	8%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	27.0	27.0		27.0	27.0		35.0	35.0		35.0	35.0	
Effective Green, g (s)	27.0	27.0		27.0	27.0		35.0	35.0		35.0	35.0	
Actuated g/C Ratio	0.39	0.39		0.39	0.39		0.50	0.50		0.50	0.50	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	195	528		209	463		158	603		230	721	
v/s Ratio Prot		0.26			0.32			0.35			0.46	
v/s Ratio Perm	c0.46			0.38			c0.57			0.47		
v/c Ratio	1.21	0.68		0.99	0.82		1.14	0.69		0.94	0.92	
Uniform Delay, d1	21.5	17.9		21.3	19.3		17.5	13.4		16.6	16.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	132.5	3.4		57.7	10.7		113.9	6.4		46.3	18.5	
Delay (s)	154.0	21.3		79.0	30.0		131.4	19.8		62.9	34.7	
Level of Service	F	C		E	C		F	B		E	C	
Approach Delay (s)		71.1			46.0			51.1			41.4	
Approach LOS		E			D			D			D	

Intersection Summary			
HCM 2000 Control Delay	51.3	HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	70.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	82.6%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	5	12	29	127	8	19	172	397	244	31	225	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00			1.00	
Frt		0.93			0.98		1.00	0.93			0.98	
Flt Protected		1.00			0.97		0.95	1.00			0.99	
Satd. Flow (prot)		1197			1625		1337	1496			1574	
Flt Permitted		0.97			0.71		0.52	1.00			0.66	
Satd. Flow (perm)		1171			1191		739	1496			1045	
Peak-hour factor, PHF	0.50	0.25	0.50	0.75	0.38	0.44	0.80	0.74	0.55	0.50	0.77	0.50
Adj. Flow (vph)	10	48	58	169	21	43	215	536	444	62	292	62
RTOR Reduction (vph)	0	46	0	0	11	0	0	40	0	0	8	0
Lane Group Flow (vph)	0	70	0	0	222	0	215	940	0	0	408	0
Heavy Vehicles (%)	10%	58%	45%	10%	10%	10%	35%	22%	14%	23%	15%	23%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		15.4			15.4		49.4	49.4			49.4	
Effective Green, g (s)		15.4			15.4		49.4	49.4			49.4	
Actuated g/C Ratio		0.21			0.21		0.68	0.68			0.68	
Clearance Time (s)		4.0			4.0		4.0	4.0			4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)		247			251		501	1015			709	
v/s Ratio Prot								c0.63				
v/s Ratio Perm		0.06			c0.19		0.29				0.39	
v/c Ratio		0.28			0.88		0.43	0.93			0.57	
Uniform Delay, d1		24.1			27.8		5.3	10.1			6.2	
Progression Factor		1.00			1.00		1.00	1.00			1.00	
Incremental Delay, d2		0.6			28.6		0.6	13.7			1.1	
Delay (s)		24.7			56.4		5.9	23.9			7.3	
Level of Service		C			E		A	C			A	
Approach Delay (s)		24.7			56.4			20.6			7.3	
Approach LOS		C			E			C			A	

Intersection Summary			
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	72.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.5%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	98	167	138	177	187	78	135	213	154	98	391	111
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	0.97		1.00	0.99		1.00	0.98		1.00	0.99	
Flpb, ped/bikes	0.98	1.00		0.98	1.00		0.99	1.00		0.99	1.00	
Frt	1.00	0.94		1.00	0.96		1.00	0.93		1.00	0.96	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1523	1394		1393	1438		1537	1214		1461	1497	
Flt Permitted	0.51	1.00		0.41	1.00		0.26	1.00		0.40	1.00	
Satd. Flow (perm)	819	1394		603	1438		429	1214		609	1497	
Peak-hour factor, PHF	0.64	0.76	0.87	0.86	0.88	0.88	0.75	0.86	0.72	0.94	0.86	0.73
Adj. Flow (vph)	153	220	159	206	212	89	180	248	214	104	455	152
RTOR Reduction (vph)	0	58	0	0	34	0	0	69	0	0	27	0
Lane Group Flow (vph)	153	321	0	206	267	0	180	393	0	104	580	0
Confl. Peds. (#/hr)	19		29	29		19	16		16	16		16
Heavy Vehicles (%)	2%	14%	2%	11%	9%	9%	2%	31%	18%	7%	7%	2%
Parking (#/hr)	5	5	5	5	5	5	5	5	5	5	5	5
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)	16.0	16.0		16.0	16.0		21.0	21.0		21.0	21.0	
Effective Green, g (s)	16.0	16.0		16.0	16.0		21.0	21.0		21.0	21.0	
Actuated g/C Ratio	0.36	0.36		0.36	0.36		0.47	0.47		0.47	0.47	
Clearance Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	291	495		214	511		200	566		284	698	
v/s Ratio Prot		0.23			0.19			0.32			0.39	
v/s Ratio Perm	0.19			c0.34			c0.42			0.17		
v/c Ratio	0.53	0.65		0.96	0.52		0.90	0.69		0.37	0.83	
Uniform Delay, d1	11.5	12.1		14.2	11.5		11.0	9.5		7.7	10.5	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	1.7	2.9		50.6	1.0		41.9	6.9		3.6	11.1	
Delay (s)	13.2	15.1		64.8	12.5		53.0	16.4		11.3	21.6	
Level of Service	B	B		E	B		D	B		B	C	
Approach Delay (s)		14.5			33.7			26.6			20.1	
Approach LOS		B			C			C			C	

Intersection Summary			
HCM 2000 Control Delay	23.5	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	45.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	76.7%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	37	44	7	105	35	77	146	307	210	94	151	66
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0		4.0	4.0			4.0	
Lane Util. Factor		1.00			1.00		1.00	1.00			1.00	
Frt		0.99			0.95		1.00	0.94			0.97	
Flt Protected		0.98			0.98		0.95	1.00			0.99	
Satd. Flow (prot)		1339			1419		1347	1620			1479	
Flt Permitted		0.84			0.82		0.52	1.00			0.53	
Satd. Flow (perm)		1142			1186		739	1620			792	
Peak-hour factor, PHF	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Adj. Flow (vph)	49	59	9	140	47	103	195	409	280	125	201	88
RTOR Reduction (vph)	0	4	0	0	25	0	0	49	0	0	19	0
Lane Group Flow (vph)	0	113	0	0	265	0	195	640	0	0	395	0
Heavy Vehicles (%)	19%	50%	57%	2%	31%	52%	34%	13%	6%	50%	7%	21%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8			2			6		
Actuated Green, G (s)		16.5			16.5		27.4	27.4			27.4	
Effective Green, g (s)		16.5			16.5		27.4	27.4			27.4	
Actuated g/C Ratio		0.32			0.32		0.53	0.53			0.53	
Clearance Time (s)		4.0			4.0		4.0	4.0			4.0	
Vehicle Extension (s)		3.0			3.0		3.0	3.0			3.0	
Lane Grp Cap (vph)		363			377		390	855			418	
v/s Ratio Prot								0.40				
v/s Ratio Perm		0.10			c0.22		0.26				c0.50	
v/c Ratio		0.31			0.70		0.50	0.75			0.95	
Uniform Delay, d1		13.4			15.5		7.9	9.6			11.5	
Progression Factor		1.00			1.00		1.00	1.00			1.00	
Incremental Delay, d2		0.5			5.8		1.0	3.6			30.2	
Delay (s)		13.9			21.4		8.9	13.2			41.7	
Level of Service		B			C		A	B			D	
Approach Delay (s)		13.9			21.4			12.2			41.7	
Approach LOS		B			C			B			D	

Intersection Summary			
HCM 2000 Control Delay	21.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	51.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	72.9%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

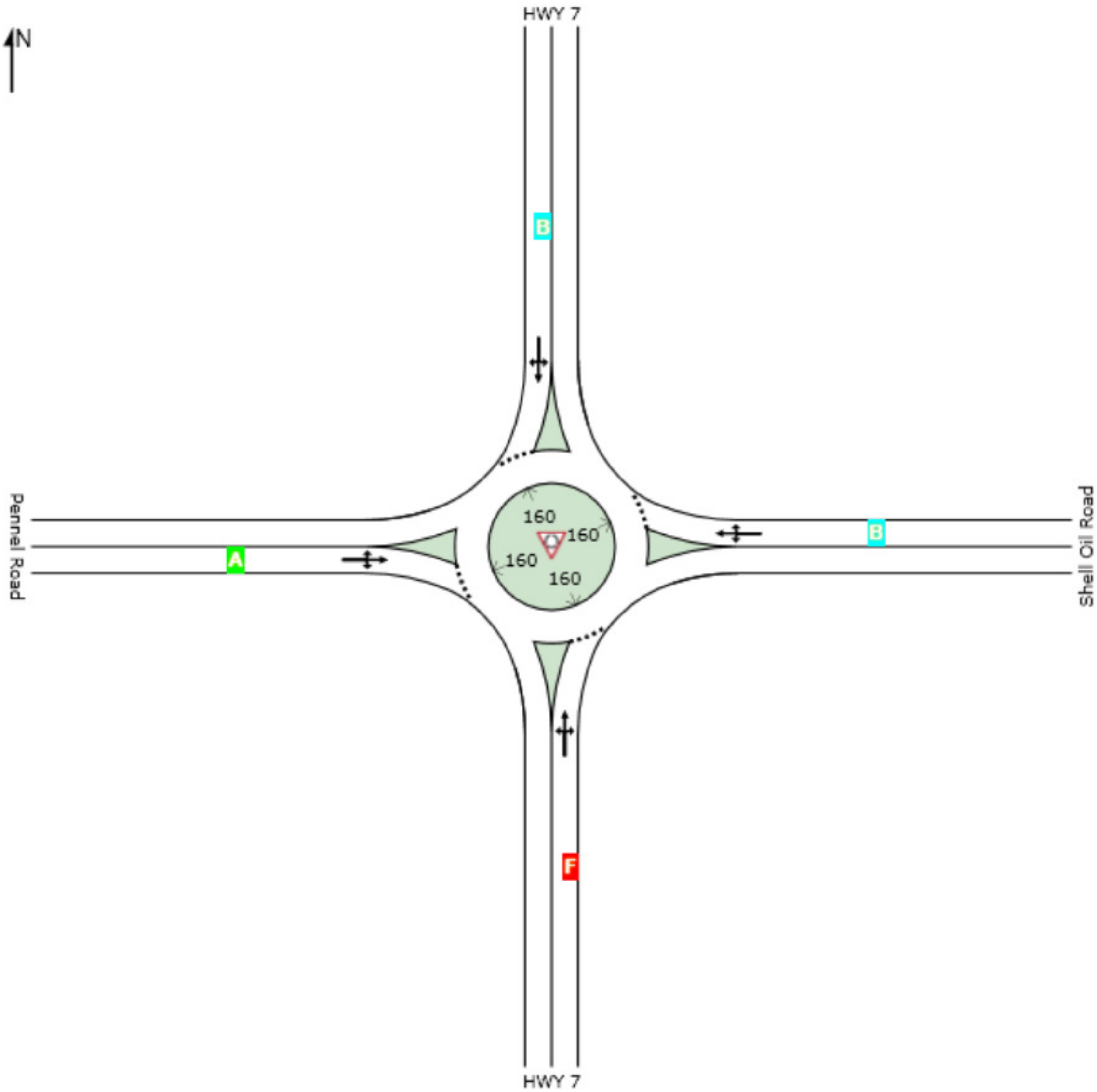
LEVEL OF SERVICE

Site: Horizon - 5.10 - single lane

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	F	B	B	A	E



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

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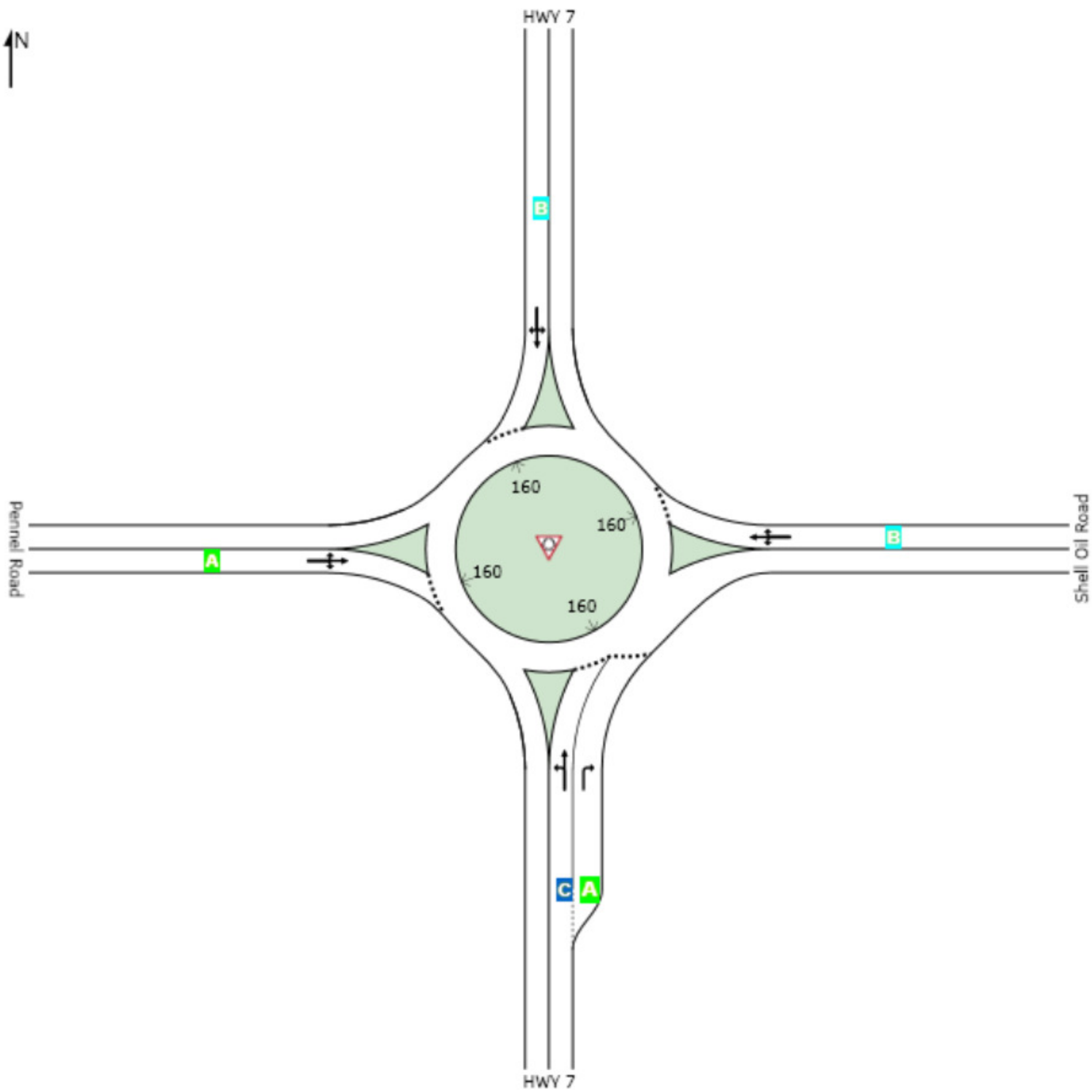
LEVEL OF SERVICE

Site: Horizon - 5.10

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	C	B	B	A	B



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

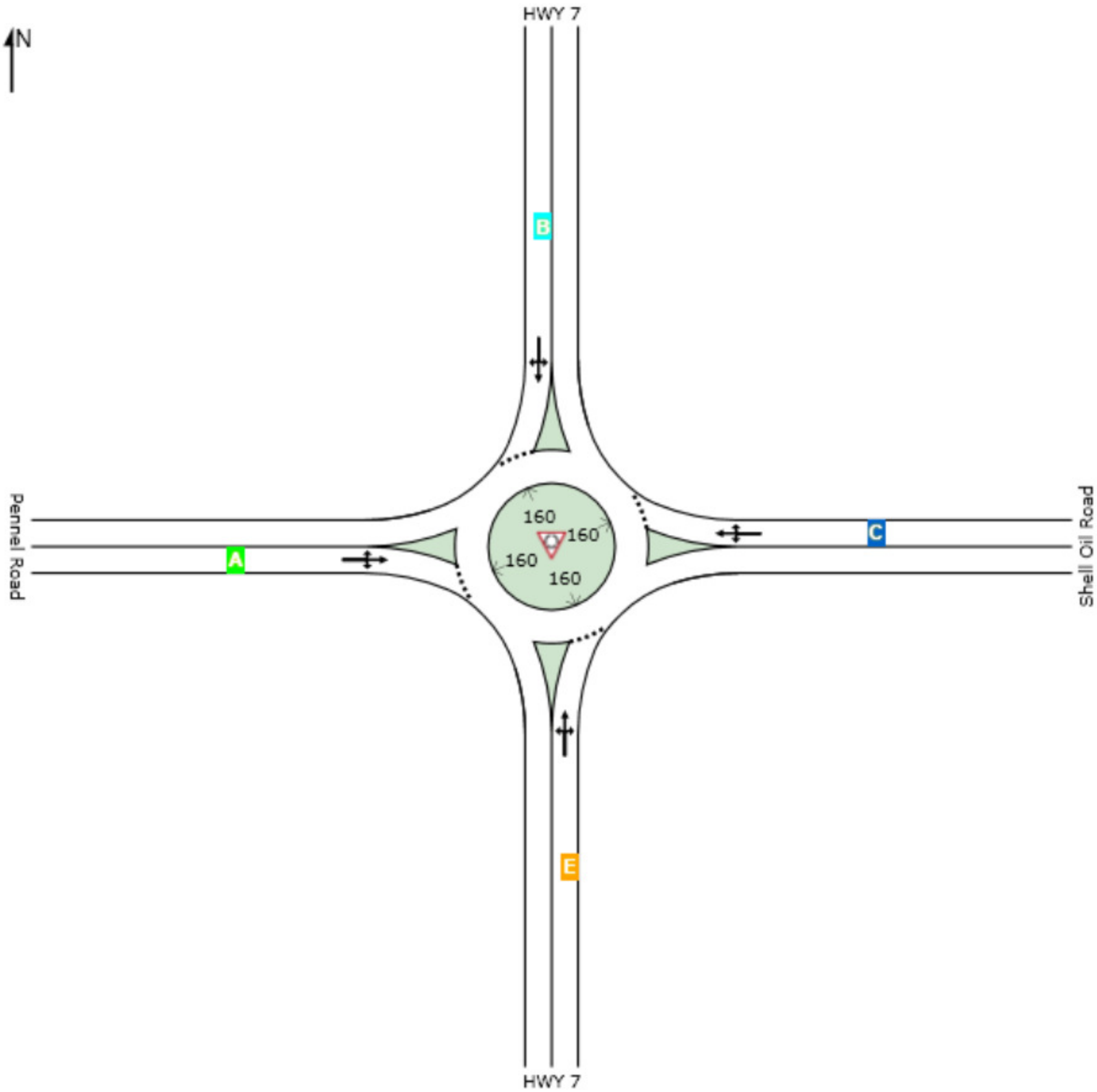
LEVEL OF SERVICE

Site: Build Both - 5.10

Baker, MT
Roundabout

All Movement Classes

	South	East	North	West	Intersection
LOS	E	C	B	A	D



Level of Service (LOS) Method: Delay & v/c (HCM 2010).
Roundabout LOS Method: Same as Sign Control.
Lane LOS values are based on average delay and v/c ratio (degree of saturation) per lane.
LOS F will result if v/c > irrespective of lane delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all lanes (v/c not used as specified in HCM 2010).
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.

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BAKER CORRIDOR
PLANNING STUDY

New Alignment Identification Using Quantm

Baker Corridor Planning Study

August 2015

Prepared for:

Montana Department of Transportation

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1. Introduction

The purpose of this report is to discuss potential alternate transportation alignments within the study area as a means to improve operations at the US 12/MT 7 intersection and lessen impacts within the community caused by the current high volumes of truck traffic. The identification of alternate alignments was developed through use of the Quantm Alignment Planning System (i.e., Quantm). The Quantm system is a planning tool that uses computer modeling to automatically generate low cost planning alignments that satisfy defined constraints. A planning-level analysis was conducted through a tiered screening process to evaluate options against the needs and objectives defined for the study area. The first level screening process determines the optimal study area quadrant to further examine alignment options. The second level screening process involves a more stringent application of quantitative screening criteria in order to evaluate and rank improvement options to ultimately determine a preferred alignment option(s).

2. First Level Screening Process for New Alignment Options Using the Quantm Tool

This section presents the first level screening process and results that support the identification of the study area quadrant(s) in which to evaluate alternate alignment options using the Quantm tool.

2.1 Transportation Quadrant Identification

US 12 and MT 7 both carry high volumes of heavy vehicles through the City of Baker. The two highways intersect in the city center at a four-way stop-controlled intersection. The US 12/MT 7 intersection has an insufficient geometric layout to accommodate turning movements of larger design vehicles. Heavy vehicle traffic is expected to increase in this region which can strain operations at this and other intersections within the study area as heavy vehicles create additional delay when making turning movements and accelerating from intersections.

US 12 and MT 7 divide the study area into four quadrants which are named by cardinal direction of where alternate alignment options would be in relation to the City of Baker: northwest, northeast, southeast, and southwest (Figure 1). In addition to reducing overall truck traffic volumes, alternate alignments developed within the study area quadrants would serve to eliminate a portion, but not all, right-angle turning movements at the US 12/MT 7 intersection by providing an alternate route for truck traffic. Determining which quadrant(s) could potentially alleviate the greatest volume of truck traffic is necessary to ensure the improvement options' ability to best meet the needs and objectives defined for the project. The study area quadrants are described below in clockwise order, beginning in the northwest quadrant.

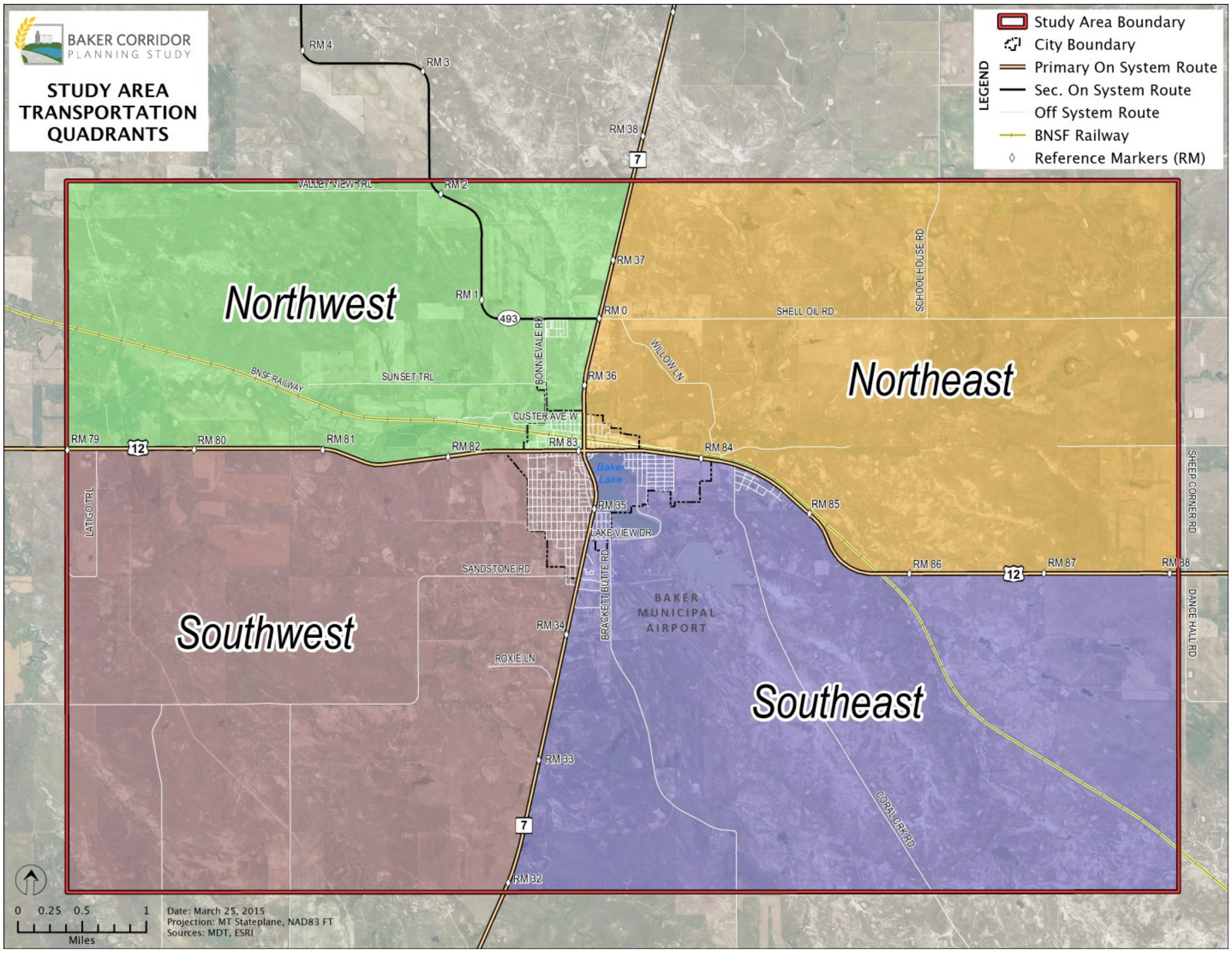

Figure 1: Study Area Transportation Quadrants

Northwest Quadrant

The northwest quadrant is located north of US 12 and west of MT 7. It includes a portion of Secondary Highway 493 and is divided by the BNSF Railway. Major constraints in this quadrant include the railroad, city lagoons, Sandstone Creek, a cemetery, and power distribution center at the S-493/Bonnievale Road intersection. A new alignment within this quadrant would link eastbound traffic on US 12 turning north or southbound traffic on MT 7 turning west.

Northeast Quadrant

The northeast quadrant is located north of US 12 and east of MT 7. It includes a section of the BNSF Railway which parallels US 12, and includes the existing grade separated crossing on US 12 on its southern edge. Major constraints within this quadrant include numerous oil and gas wells, Sandstone Creek, and businesses and industrial uses along Shell Oil Road. A new alignment within this quadrant would link westbound traffic on US 12 turning north or southbound traffic on MT 7 turning east.

Southeast Quadrant

The southeast quadrant is located south of US 12 and east of MT 7. It includes a portion of the BNSF Railway and the existing grade separated crossing on US 12 on its northern edge. Major constraints within this quadrant include the BNSF Railway, numerous oil and gas wells, the Baker Municipal Airport, Baker Lake and large expanses of wetlands, several potential Section 4(f) properties, and a large area of Greater Sage-grouse core area habitat. A new alignment within this quadrant would link westbound traffic on US 12 turning south or northbound traffic on MT 7 turning east.

Southwest Quadrant
The southwest quadrant is located south of US 12 and west of MT 7. It includes a large section of city limits and the highest amount of residential development. Major constraints within this quadrant include the residential area within city limits (including several parks) and the Fallon County Rifle Range & Trapshoot Section 6(f) property. A new alignment within this quadrant would link eastbound traffic on US 12 turning south or northbound traffic on MT 7 turning west.

2.2 Traffic Analysis by Transportation Quadrant

The following traffic analysis and information was developed to provide support for the first level quadrant screening process described in Section 2.3.

Existing traffic data was collected on October 22, 2014 within the study area. This data included turning movement counts for a 12-hour period at intersections and 24-hour count data along each approaching leg of the main two highways outside of Baker. Both total vehicle counts as well as heavy vehicle designations were collected. These data were used to calculate the turning level ADT at the main intersection of US 12 with MT 7 as well as determine the peak hour at this location. Figure 2 shows both the ADT and peak hour total as well as heavy vehicle volumes at the US 2/MT 7 intersection. The heavy vehicle volume as a percent of the total volume is also shown.

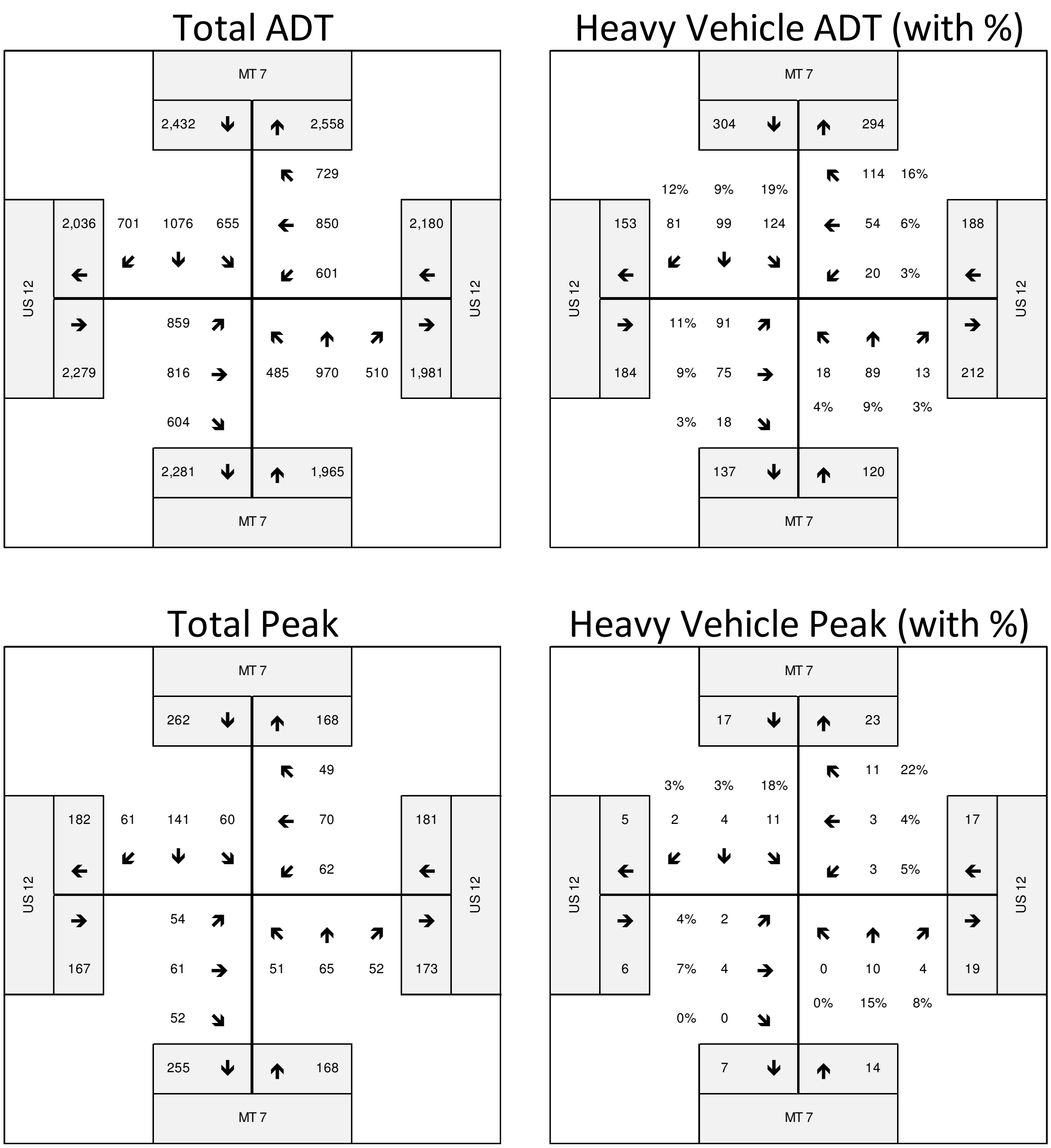

Figure 2: ADT and Peak Traffic at the US 12/MT 7 Intersection (Total and Heavy Vehicles)

Turning movements of heavy vehicles create operational issues and require adequate geometric conditions to safely perform these movements. Minimizing the number of heavy vehicles making turning movements at the US 12/MT 7 intersection can improve intersection operations. As shown in the figure, heavy vehicles make up a significant proportion of vehicles through the US 12/MT 7 intersection both during the peak period and throughout the full day. Alternate truck routes could improve operations by reducing or eliminating the need for the heavy vehicles to make certain turning movements at the US 12/MT 7 intersection in addition to reducing some trips by other vehicles making these same movements.

Each quadrant of the study area was examined in terms of a conceptual new alignment that would connect the two highways with a new roadway skirting the town and thereby reducing the movement of vehicles through the US 12/MT 7 intersection.

Using data from Figure 2, potential traffic improvements at the US 12/MT 7 intersection under each alternative could be determined through quantifying the heavy vehicle percentages. Table 1 shows the total and heavy vehicle ADT utilizing turning movements that correspond to each quadrant under current conditions.

Table 1: Existing Total and Heavy Vehicle ADT movements by Transportation Quadrant

Quadrant	Total Vehicles	Heavy Vehicles	Heavy Vehicle %
Northwest	1,560	172	11%
Northeast	1,384	238	17%
Southeast	1,111	33	3%
Southwest	1,089	36	3%

The transportation quadrants correspond to the following vehicular movements:

- **Northwest**: Eastbound vehicles on US 12 turning northbound on MT 7 or southbound on MT 7 turning westbound on US 12.
- **Northeast**: Westbound vehicles on US 12 turning northbound on MT 7 or southbound on MT 7 turning eastbound on US 12.
- **Southeast**: Westbound vehicles US 12 turning southbound on MT 7 or northbound on MT 7 turning eastbound on US 12.
- **Southwest**: Eastbound vehicles on US 12 turning southbound on MT 7 or northbound on MT 7 turning westbound on US 12.

While not all trips for total vehicles making turning movements at this intersection have origins and destinations outside of Baker, these volumes can be used as a rough guide to assess the number of vehicles that move through the four quadrants of the study area. As most heavy vehicles traversing the study area have origins and destinations outside the City of Baker, it is safe to assume a majority of the heavy vehicles could be redirected to alternate routes around the city.

2.3 First Level Screening

The first level screening process provides a qualitative analysis used to determine the optimal study area quadrant in which to further examine new alignment options. The process is intended to remove from further consideration options, or quadrants, which fail to meet the identified needs and objectives for the project, or those options that otherwise have a "fatal flaw."

The study has identified needs and objectives that provide the framework for identifying improvement options. The first level screening criteria directly relate to the study's needs and objectives. Consideration of the study area quadrant will be evaluated against the following screening criteria questions:

1. Would the option improve operations within the corridor? (Need #1)
2. Would the option improve mobility within the corridor? (Need #2)

Study area quadrants were evaluated against the above two screening criteria questions by allowing for a YES or NO answer, where a YES is best able to meet the screening criterion and a NO is least able to meet the screening criterion. The quadrant(s) passing the first level screening process will be considered for the development of new alignment options.

First Level Screening Criteria

CRITERION 1: OPERATION IMPROVEMENTS

Criterion number one was evaluated through determining which quadrant(s) has the greatest ability to improve operations within the corridor. Operation improvements will be best met through reducing the greatest volume of truck traffic at the US 12/MT 7 intersection as determined by the data presented in Section 2.2. Reducing the truck traffic within city limits will improve operations at the US 12/MT 7 intersection by reducing the overall volume of trucks traveling through the intersection and, more importantly, the number of trucks making turning movements at the intersection. This criterion is rated as:

- **YES**: The quadrant provides for the greatest reduction in truck traffic making turning movements at the US 12/MT 7 intersection.
- **NO**: The quadrant provides for the least reduction in truck traffic making turning movements at the US 12/MT 7 intersection.

Using the volumes in Table 1 and Figure 2 in Section 2.2, it was determined that more heavy vehicles use the US 12/MT 7 intersection to make movements through the northwest and northeast quadrants, with heavy vehicles accounting for 11% and 17% of the daily volumes, respectfully. The southeast and southwest quadrants see fewer heavy vehicles on a daily basis, with these vehicles only accounting for 3% of the total volume in each quadrant. Of the four quadrants, the largest volume of heavy vehicles is shown to use the northeast quadrant movements, with 238 daily heavy vehicle trips.

A new alignment in either or both the northwest and northeast quadrants would reduce the total volume of vehicles using the US 12/MT 7 intersection as well as reduce the volume of heavy vehicles traveling through Baker, but would not completely eliminate all trips through the intersection. For this reason, the potential impact on traffic operations would be greatest for those movements with the highest volumes of heavy vehicles, which would first be the northeast quadrant followed by the northwest quadrant. From a traffic improvement standpoint, it is recommended that these quadrants be analyzed further to determine the potential improvements in traffic operations that may be realized at the US 12/MT 7 intersection through development of new alignments. While alignments located in the southeast and southwest quadrants would reduce volumes through the main intersection, the improvements would have a minimal impact on operations at the US 12/MT 7 intersection.

CRITERION 2: MOBILITY IMPROVEMENTS

Criterion number two was evaluated through determining which quadrant(s) has the greatest ability to improve mobility within the corridor. Mobility improvements will be best met through accommodating existing and future capacity demands within the corridor as well as reducing delays due to closures at the at-grade railroad crossings within the study area. This criterion is rated as:

- **YES**: The quadrant provides for the greatest improvement to mobility within the study area.
- **NO**: The quadrant provides for the least amount of improvement to mobility within the study area.

The future conditions LOS analysis conducted determined that, assuming existing geometric configurations, the US 12/MT 7 intersection will operate at a failing level of service (LOS F) in the future under all three growth scenarios analyzed. Additionally, the MT 7/Shell Oil Rd/S-493 intersection is projected to operate at a failing level under the medium- and high-growth scenarios. These projections demonstrate that future capacity demands will be greatest at the US 12/MT 7 intersection and along MT 7, north of downtown, at the MT 7/Shell Oil Rd/S-493 intersection. Total ADT by quadrant (Table 1) supports this conclusion with higher total vehicular volumes utilizing the northwest and northeast quadrants. The higher vehicular volumes and the significantly higher heavy vehicle volumes within these quadrants suggest that alignments within the northwest and northeast quadrants would provide a greater benefit to mobility within the corridor.

Mobility concerns relating to railroad crossing closures is primarily a concern for access from the downtown area to north of the railroad tracks. The BNSF Railway bisects the City of Baker and, during crossing closures, affects access to development north of the railroad (see Figure 3). Emergency vehicle access to areas north of the railroad tracks is also affected during crossing closures. All at-grade railroad crossings within the study area cross two tracks, the mainline and a siding track. In addition to temporary crossing closures during a passing train, the crossings can also all be blocked simultaneously due to a stationary train located on the rail siding. New alignments located in both the southeast and southwest quadrants would not improve mobility because emergency vehicle access to areas south of US 12 is not affected by railroad closures. As such, alignments within the northwest and northeast quadrants that provide access to areas north of the railroad would provide the greatest benefit to mobility within the corridor. Emergency vehicle access improvements would be most benefited by alignments that provide the shortest unobstructed route to developments north of the railroad tracks.

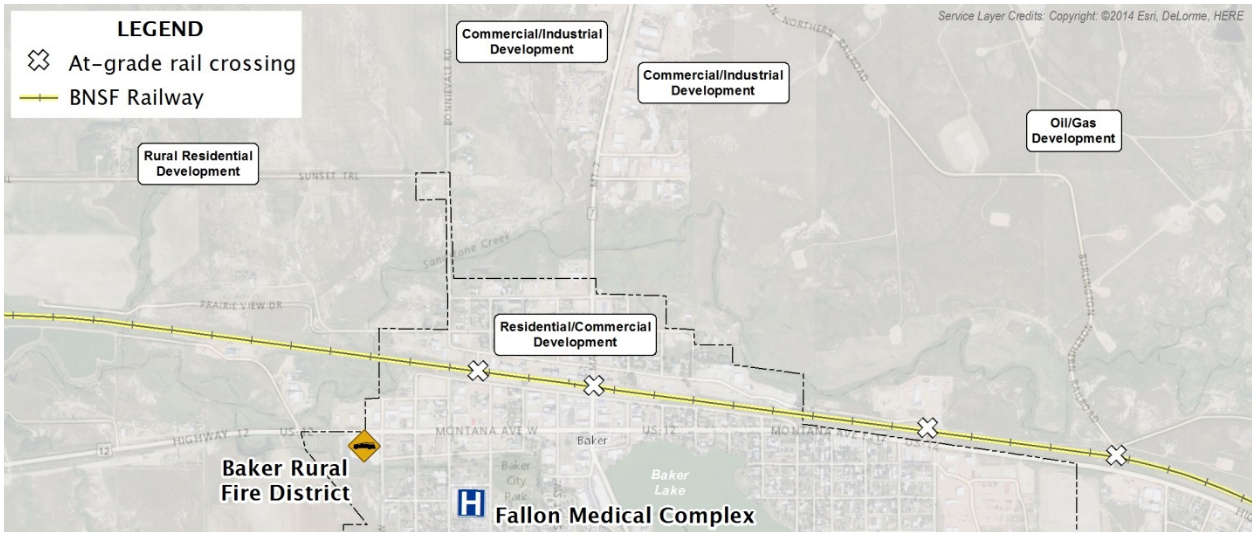

Figure 3: Emergency Vehicle Access to Development North of Railroad

First Level Screening Results

Table 2 shows the results of the first level screening. When evaluated against the first level screening criteria questions, the northwest and northeast quadrants both pass due to their ability to best meet the needs and objectives defined for the study. For this reason it is recommended to explore alignment options within both quadrants.

Table 2: First Level Screening Results

Quadrant	Screening Criteria 1. Would the option improve operations within the corridor?	2. Would the option improve mobility within the corridor?	Quadrant Advanced?
Northwest	YES	YES	**YES**
Northeast	YES	YES	**YES**
Southeast	NO	NO	NO
Southwest	NO	NO	NO

3. Preliminary Alignment Identification

Route planning with Quantm is a complex iterative process that incorporates user-defined constraints to develop a range of alternatives between defined start and end points. An important initial step in using Quantm is to identify study area constraints and input the spatial data into the model to inform the alignment identification process. This process includes identifying avoidance areas that Quantm then recognizes when creating alignments and attempts to route around these areas whenever possible. Avoidance areas include features such as potential 4(f) resources, 6(f) resources, oil/gas wells, city lagoons, and existing structures. Cost areas were also developed that represent areas where additional costs would be incurred should an alignment go through the area. Cost areas include wetlands and hazardous areas (underground storage tanks). Figure 4 and Figure 5 show the preliminary constraints mapping of the avoidance and cost zones. It should be noted that additional avoidance areas were created within Quantm that are not shown on the figures to account for existing structures and development based on depiction of the aerial imagery acquired in 2014.

The northwest and northeast quadrants, having passed the first level screening, were then examined to determine general corridors to begin running the Quantm alignment analysis. An initial step in developing general corridors involves determining alignment termini (i.e., alignment start/end points). General alignment termini were identified based on existing constraints mapping, input from the planning team, and professional judgment.

3.1 Corridor Identification

Northwest Quadrant Alignment Identification
Figure 4 focuses on the northwest quadrant and includes the preliminary constraints mapping of the avoidance and cost zones. Land ownership within the quadrant is predominantly privately owned. Major constraints in this quadrant include the BNSF Railway, city lagoons, Sandstone Creek, and a cemetery and power distribution center at the S-493/Bonnievale Road intersection. Additionally, the Fallon County Rifle Range & Trapshoot is located on either side of US 12 east of RM 81. This property has been identified as a Section 6(f) property and should be avoided.

Potential areas for termini of the new alignment are illustrated on the Figure 4. An alignment terminus from US 12 approximately between RM 82.2 and 82.5 (Terminus 1a) could provide a direct route north to connect to S-493. Alignments in this general location were examined to determine if shorter and more cost effective routes were feasible. The alignment would need to avoid the city lagoons and the development beginning on the western edge of city limits. A new alignment could potentially depart from US 12 approximately between RM 79.4 and RM 81 (Terminus 1b). An alignment beginning along this section of highway would avoid impacting the historic canal located near RM 79.4. Areas along US 12 east of RM 81 contain multiple constraints, making this area less suitable for new alignment options.

Potential termini areas for the north end of the alignment are shown as Termini 2a and 2b. An alignment tying into S-493 within the approximate area shown for Terminus 2a could utilize the existing S-493 alignment between approximately RM 1.0 and the MT 7/S-493 intersection. Alternatively, another option is an alignment terminus at MT 7, approximately between RM 37.2 and the study area boundary. A terminus in this area could potentially tie into Terminus 2c within the northeast quadrant (see Figure 5).

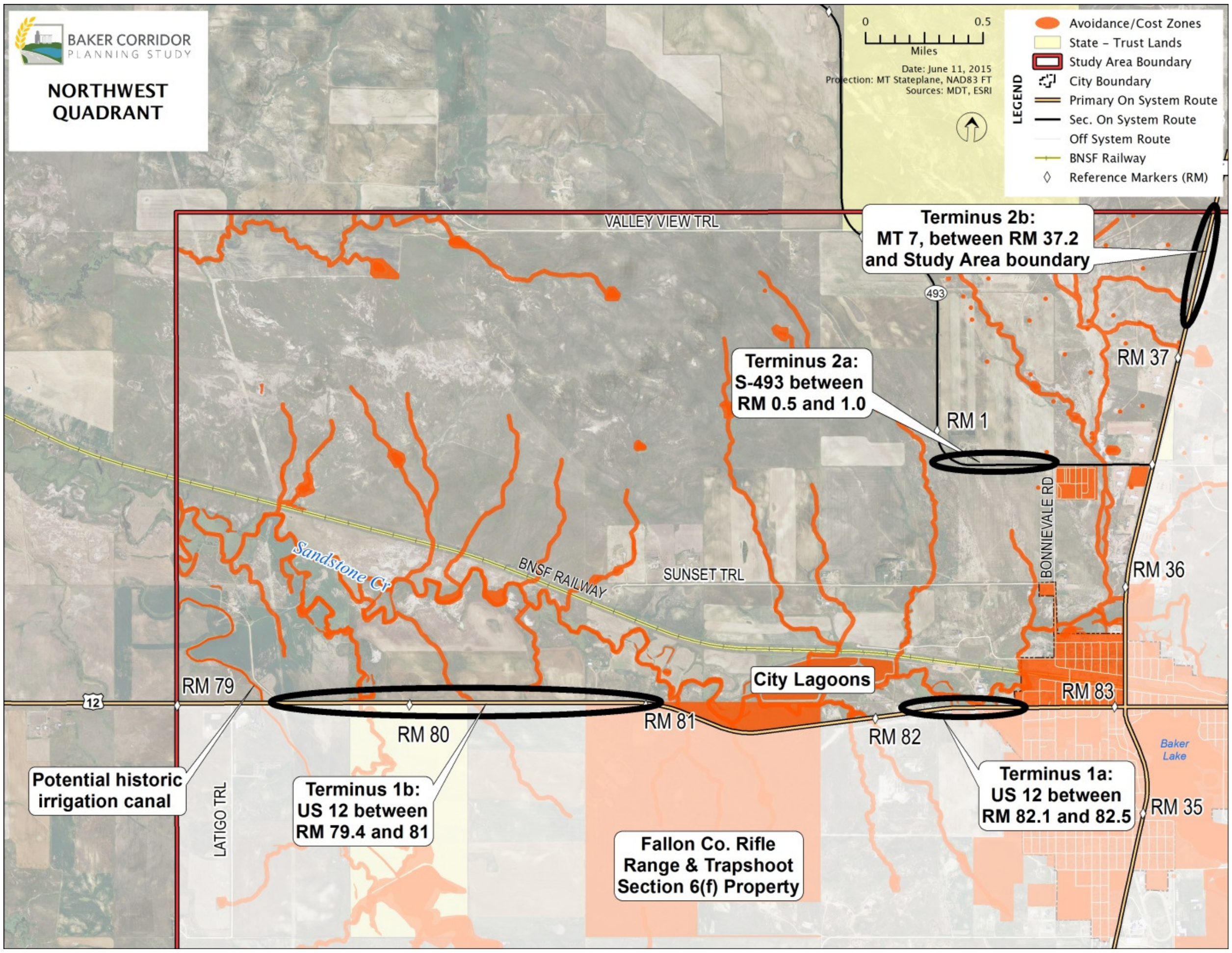

Figure 4: Potential Alignment Termini within the Northwest Quadrant

Northeast Quadrant Alignment Identification

Figure 5 focuses on the northeast quadrant and includes the preliminary constraints mapping of the avoidance and cost zones. Land ownership within the quadrant is predominantly privately owned with the exception of the state-owned property located along US 12 approximately between RM 86 and 87. Major constraints within this quadrant include numerous oil and gas wells, Sandstone Creek, and businesses and industrial uses along Shell Oil Road near its intersection with MT 7.

Potential areas for termini for a new alignment are illustrated in Figure 5. A new alignment could potentially depart from US 12 approximately between RM 86.2 and RM 87.1 (Terminus 1). This section of US 12 has been identified as favorable due to the adjacent state-owned property. Locating an alignment, at least partially, on state-owned property may be beneficial due to reduced right-of-way costs and minimizing impacts to privately owned property. The BNSF Railway closely parallels US 12 west of the overpass and constrains alignment development potential between the highway and railroad. Beginning the alignment east of the existing grade separation would also eliminate the need to cross the railroad, which, in turn, could reduce impacts and cost of potential alignments.

Three potential termini areas for the north end of the alignment are shown as Termini 2a, 2b, and 2c. An alignment tying into Shell Oil Road within the approximate area shown as Terminus 2a could maximize the existing road alignment between its connection to Shell Oil Road and the MT 7/Shell Oil Road intersection. Another option would be tying into the area shown as Termini 2b. This would increase the overall alignment length and care should be taken as to minimize or avoid impacts to the businesses along Shell Oil Road, including the Montana-Dakota Utilities substation. Another option is presented as Termini 2c, which would tie into MT 7, approximately between RM 37.2 and the study area boundary. A terminus in this area could potentially tie into Terminus 2b within the northwest quadrant (see Figure 4).

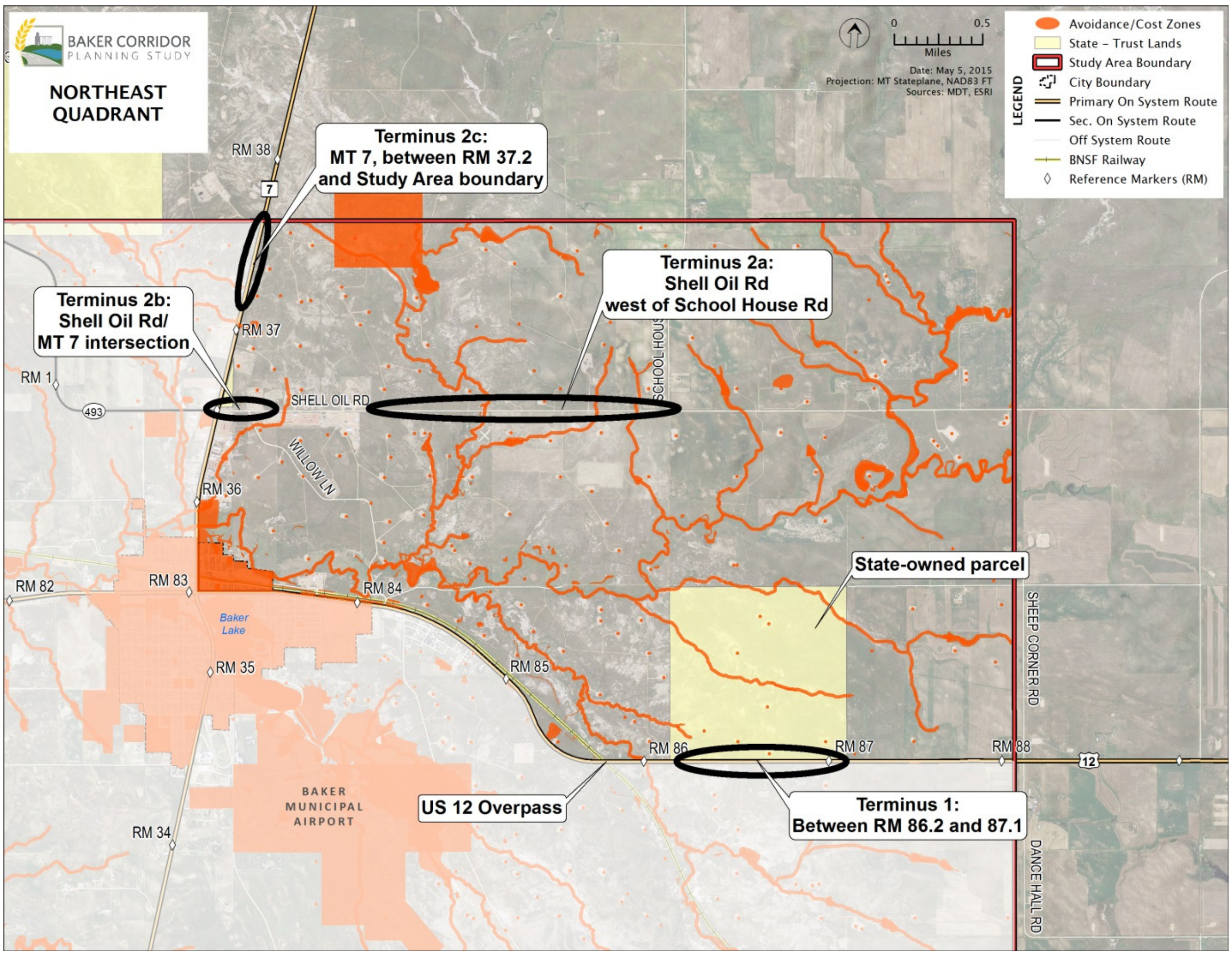

Figure 5: Potential Alignment Termini within the Northeast Quadrant

Multiple alignment scenarios were developed using Quantm for the northwest and northeast quadrants using different combinations of alignment termini.

3.2 Design Criteria

New alignments developed with the Quantm tool used the minimum geometric design criteria for rural minor arterials as specified in MDT's Road Design Manual (refer to Table 13 in the Existing and Projected Conditions Report). The alignments were developed using the following major design criteria:

- Maximum vertical grade: 3% (Level Terrain)
- Minimum horizontal radius: 1200 feet
- Paved surface width: 32 feet (includes two 12-foot travel lanes and 4-foot shoulders)

Figure 6 shows a typical section for the new alignment options.

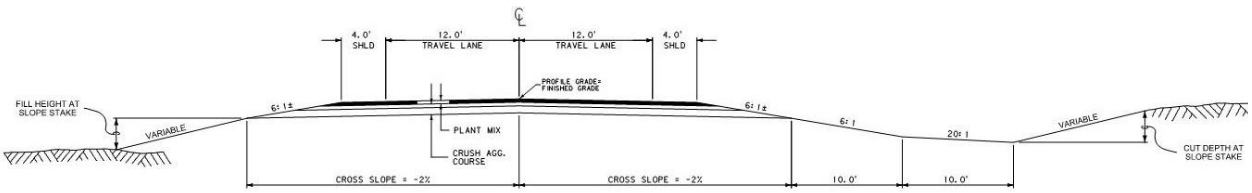

Figure 6: Typical Section for New Alignment Options

Improvements to either Shell Oil Road or S-493 would be required for several of the alignment options tying into these facilities. A conceptual footprint width of 70 feet (35 feet either side of centerline) was assumed for the road sections requiring widening. The total roadway footprint width was developed using the following assumptions:

- Paved surface width: 32 feet (includes two 12-foot travel lanes and 4-foot shoulders)
- Fill slope width (due to widening): 18' – 20'
    - Average fill slope: 4:1
    - Fill slope height: 4' – 5'

3.3 Northwest Quadrant Alignment Options

Alignment options within the northwest quadrant were developed using the general termini locations as depicted in Figure 4 as start/end points. In general the alignments had start points at three locations along US 12 and two end point locations at approximately RM 0.8 on S-493 and RM 37.6 on MT 7 near the northern edge of the study area boundary. The general termini include:

- **Terminus 1a**: US 12 RM 82.1±
- **Terminus 1b**: US 12 RM 80.6±
- **Terminus 1c**: US 12 RM 80.0±
- **Terminus 2a**: S-493 at RM 0.8±
- **Terminus 2b**: MT 7 at RM 37.6± near the north study area boundary

The northwest quadrant alignments all require crossing the BNSF Railway to access MT 7 to the north. The northwest quadrant alignments were developed as grade separated crossings only. No at-grade railroad crossings were explored through the Quantm system within this quadrant. This decision was supported by the need identified to improve mobility by reducing delays caused by railroad crossing closures. This decision also addresses community concerns with emergency vehicle access by improving access north of the railroad. Preliminary alignment options for the northwest quadrant are depicted in Figure 7.

Multiple alignment options were developed for each scenario. The alignments shown represent the preferred option under each scenario in terms of least impact and least cost. Alignments NW-1a and NW-1b and Alignments NW-3a and NW-3b include the two lowest cost alignments within these scenarios. The “a” and “b” options are provided for these scenarios because, although the overall cost variance is not significant, the alignment location and associated impacts vary widely between alignments generated under the same scenario. As stated previously, all alignments include a grade separation of the BNSF Railway utilizing the design standard for a rural minor arterial. The one exception is Alignment NW-5. In order to accommodate a grade separated crossing the maximum vertical grade was increased to 4%, which is the standard for rolling terrain. By utilizing a 4% maximum grade at this location, the alignment could provide the adequate vertical clearance for a new grade separated crossing.

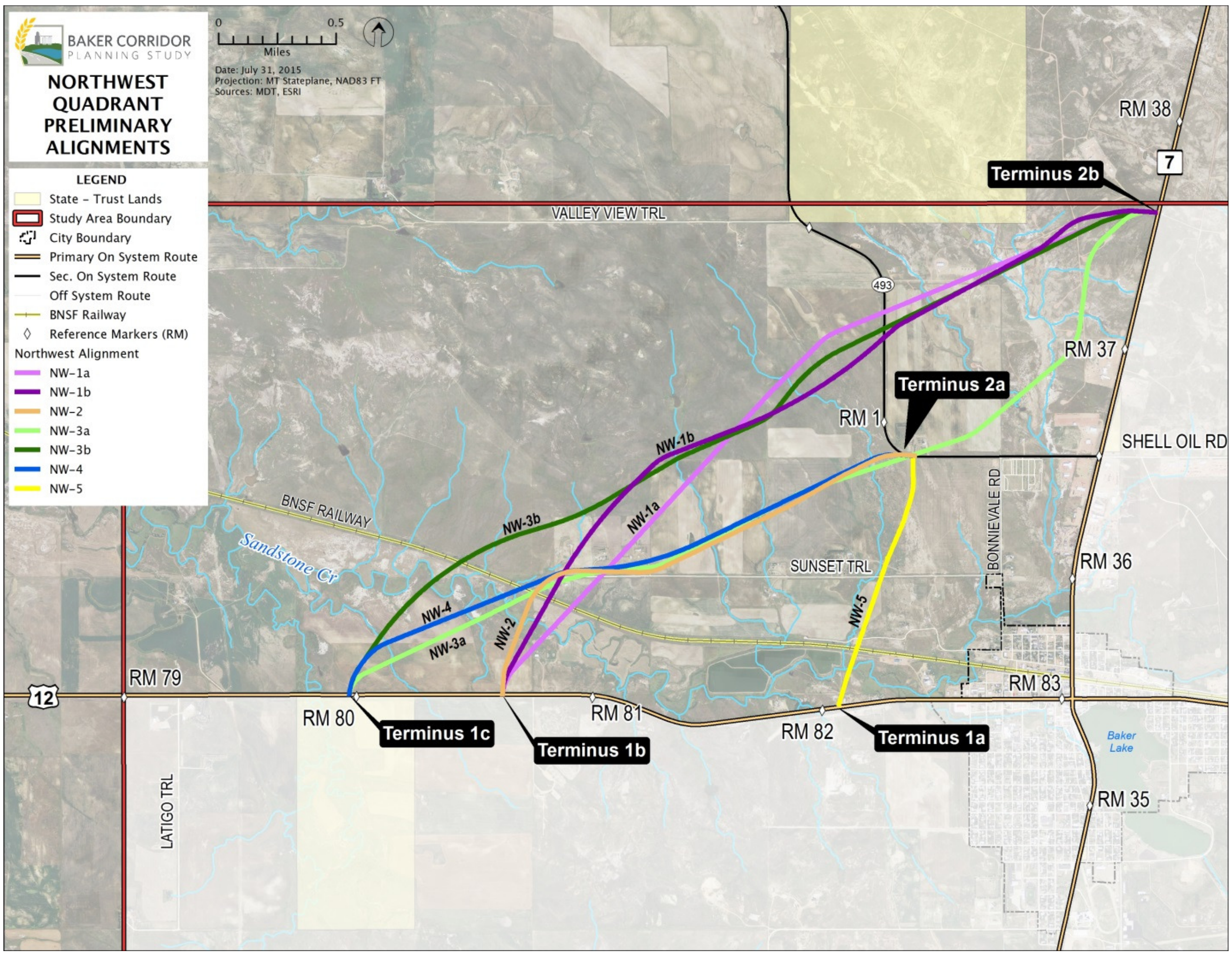

Figure 7: Northwest Quadrant Preliminary Alignment Options

3.4 Northeast Quadrant Alignment Options

Alignment options within the northeast quadrant were developed using the general termini locations as depicted in Figure 5 as start/end points. In general the alignments had start points at two locations along US 12 and end points at four locations: three of which were located along

Shell Oil Road and one located on MT 7 near the northern edge of the study area boundary. The general termini include:

- **Terminus 1a**: US 12 RM 86.4± (1450± ft. E of west edge of state-owned section)
- **Terminus 1b**: US 12 RM 86.2± (west edge of state-owned section)
- **Terminus 2a**: Intersection of School House Road and Shell Oil Road
- **Terminus 2b**: Shell Oil Road, approximately 4000 feet west of School House Road
- **Terminus 2c**: MT 7 RM 37.6± near north study area boundary
- **Terminus 2d**: Shell Oil Road, approximately 950 feet east of MT 7

All northeast quadrant alignment options were developed with termini departing from US 12 located east of the existing railroad overpass. A grade separation of the railroad west of the existing overpass is not feasible due to insufficient separation between US 12 and the railroad to reach vertical grades that meet standard railroad clearances. Moreover, alignments with an at-grade railroad crossing would not substantially improve operations or mobility within this quadrant and, therefore, do not meet the needs and objectives defined for the study. Preliminary alignment options for the northeast quadrant are depicted in Figure 8.

Multiple alignment options were developed for each scenario. The alignments shown represent the preferred option under each scenario in terms of least impact and least cost.

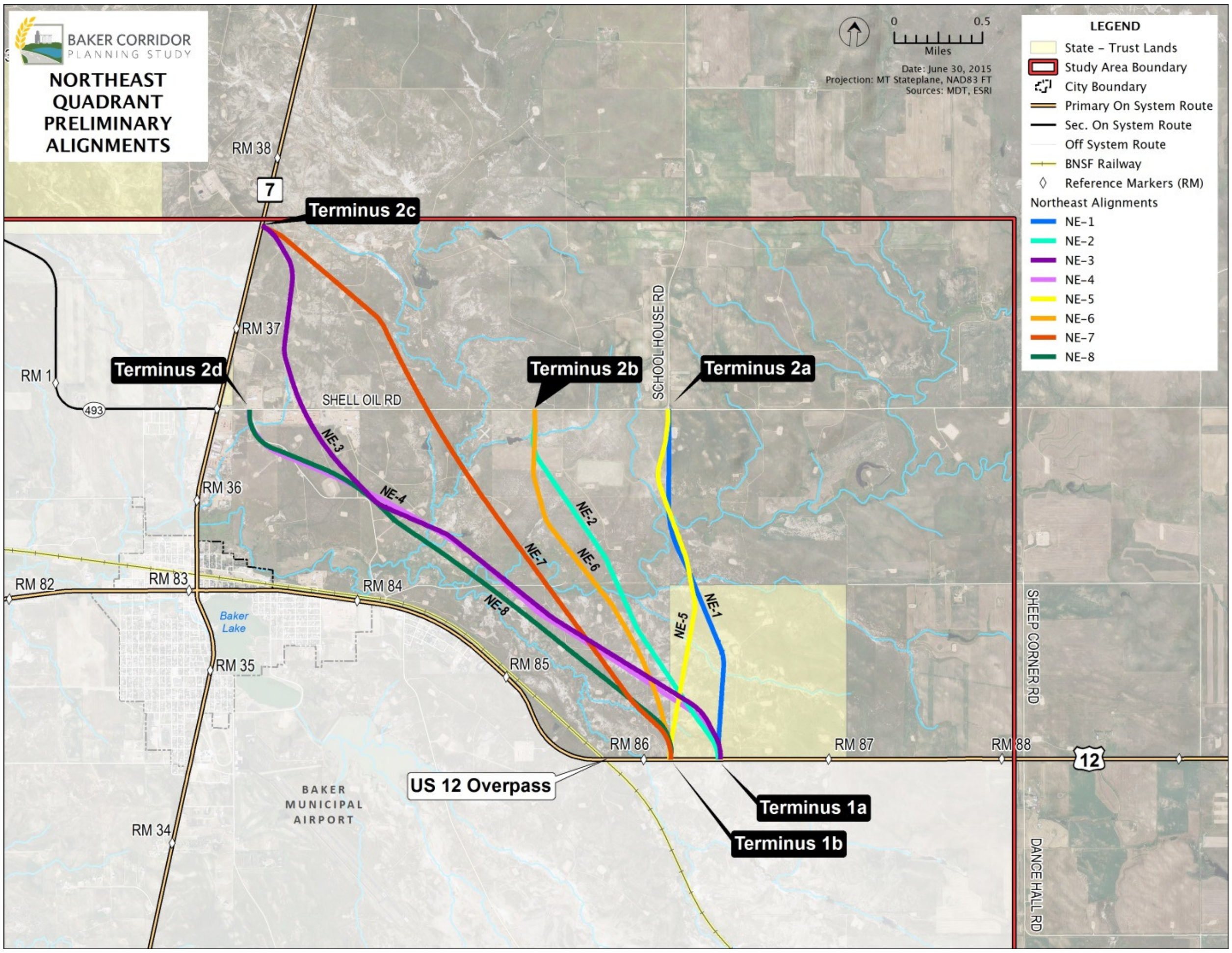

Figure 8: Northeast Quadrant Preliminary Alignment Options

3.5 Quantm Preliminary Alignments Summary

Summary information for the northwest and northeast quadrant alignments are provided in Table 3 as a comparison between the various alignments. The general alignment corridors and termini were located as to avoid and minimize impacts to existing development and mapped resources within the study area. Impacts to existing structures are not anticipated for the alignments shown.

Resource impacts were calculated using GIS. The construction footprint, as generated by Quantm, was used to calculate impacts to wetlands/waterbodies, floodplains, and prime farmland. Multiple alignments tie into either Shell Oil Road or S-493 to access MT 7 and widening of the existing roadway would be required to meet the design criteria established for the new alignments. A conceptual footprint 70 feet in width was assumed for these sections to accommodate widening of the roadway. Existing pavement width is approximately 28 feet; the additional footprint includes a 21-foot buffer on either side of the existing pavement for a total footprint width of 70 feet.

To calculate private property impacts required for new right-of-way a 160-foot-wide right-of-way boundary (80' either side of centerline) was developed consistent with MDT's Right-of-Way Manual for a Primary Highway and intersected with the parcel database. For the NW alignments (NW-1 through NW-4), the construction footprint extends beyond a 160-foot-wide right-of-way template in many areas. The private property impacts for these alignments include a minimum 160-foot-wide right-of-way width as well as the construction footprint extending beyond the 160-foot right-of-way boundary. Right-of-way along the existing Shell Oil Road alignment averages approximately 70 feet in width (35 feet either side of centerline). To calculate private property impacts along Shell Oil Road an additional width of 45 feet was added to the existing 35-foot right-of-way either side of the centerline for a total combined width of 160 feet. The existing right-of-way along S-493 west of MT-7 averages 140 feet in width (70 feet either side of centerline). To calculate private property impacts along this section of S-493 an additional width of 10 feet was added to the existing 70 feet right-of-way either side of the centerline for a combined width of 160 feet.

Planning-level costs were developed by taking the Quantm cost estimate, which includes construction costs, right-of-way, and wetland mitigation costs[1] (if applicable), and then combining costs associated with new intersections, traffic control, mobilization, preliminary and construction engineering, indirect costs, miscellaneous items, inflation, and a contingency percentage. For alignment options that tie into either Shell Oil Road or S-493, the estimates include costs associated with improvements to the existing roadways. Planning-level costs estimates for all alignments are provided in Appendix A.

[1] A wetland mitigation cost of $1 per square foot, or $43,560 per acre, was used within the Quantm model.

Table 3: Quantm Preliminary Alignments Summary

Quadrant	Alignment (Map ID)	New Alignment Length (miles)	Railroad Crossing Type	Total Bridge Length (feet)[1]	Number of Stream Crossings	Wetland and Water Body Impacts (acres)[2]	Floodplain Impacts (acres)	Prime Farmland impacts (acres)	Private Property Impacts (acres)[3]	Number of Public Road Crossings	Number of Private Road Crossings[4]	Planning-level Cost Estimate[5]
Northwest	NW-1a	3.58	Grade Separation	409	6	0.06	0.43	22.34	89.10	2	3	$40.03M
	NW-1b	3.63	Grade Separation	501	7	0.68	0.00	25.53	96.72	1	3	$37.09M
	NW-2	2.24	Grade Separation	441	4	0.16	0.70	23.92	51.21	0	3	$21.78M
	NW-3a	4.24	Grade Separation	524	10	0.21	0.00	38.67	115.13	2	9	$44.99M
	NW-3b	4.12	Grade Separation	538	9	0.46	0.00	24.49	108.95	1	2	$45.39M
	NW-4	2.69	Grade Separation	490	7	0.33	0.70	27.84	59.77	0	3	$25.23M
	NW-5	1.12	Grade Separation	500	1	0.19	3.73	15.48	27.13	2	1	$17.13M
Northeast	NE-1	2.05	NA	73	3	0.07	2.68	5.68	47.95	0	1	$16.19M
	NE-2	2.29	NA	84	2	0.19	2.71	4.93	53.46	0	4	$15.59M
	NE-3	4.30	NA	114	3	0.15	3.73	16.35	73.41	2	12	$17.20M
	NE-4	3.42	NA	116	4	0.22	4.97	14.42	59.10	1	9	$14.67M
	NE-5	2.04	NA	70	4	0.07	2.26	5.14	49.27	0	0	$16.66M
	NE-6	2.20	NA	126	3	0.18	3.09	4.24	61.30	0	6	$15.31M
	NE-7	3.87	NA	186	3	0.32	1.96	9.01	74.03	2	7	$17.10M
	NE-8	3.21	NA	112	4	0.29	6.73	10.62	62.63	1	10	$14.53M

[1] Bridge length is an overall measurement provided by Quantm and can include multiple structures.
[2] Wetland and water body impacts can include multiple water crossings along the alignments and are approximate. Wetland delineations would be required during project development. Impacts exceeding 0.5-ac. at a single crossing would need to demonstrate a Least Environmentally Damaging Preferred Alternative, or LEDPA, to obtain a USACE Section 404 permit. Alignment NW-1b is the only alignment with a single crossing exceeding the 0.5-ac. threshold.
[3] Impacts were measured using an assumed 160' wide R/W width. For alignments NW-1 through NW-4, the modeled construction footprint extends beyond a 160'-wide R/W template. Impacts for these alignments include a minimum 160-foot-wide right-of-way width as well as the construction footprint extending beyond the 160-foot right-of-way boundary.
[4] Includes private access roads (oil/gas pad access roads and residential driveways).
[5] Cost estimates include construction costs provided by Quantm as well as costs associated with new intersections, traffic control, mobilization, preliminary and construction engineering, indirect costs, miscellaneous items, inflation, and a contingency percentage. The estimate includes improvements to the existing Shell Oil Road or S-493 where applicable.

4. Second Level Screening

The preliminary alignments were screened through a second level of criteria to determine the preferred alignment(s). Alignments within the northwest and northeast quadrants were screened separately as a means to identify feasible options within both quadrants. Multiple screening criteria representing environmental resource and social impacts as well as cost were considered. The screening process included evaluating the alternate alignments using the following criteria:

- Environmental Resource Impacts: Environmental resources evaluated included the following resource categories:
    - *Wetlands and Water Bodies*
    - *Floodplains*
    - *Prime Farmland*
- Private Property Impacts: Right-of-way requirements of private property were estimated using the Fallon County cadastral data.
- Road Crossings: The total number of public and private road crossings was evaluated for each alternate alignment. Private roads evaluated include oil/gas access roads and residential driveways.
- Planning-level Cost Estimates: Estimated alignment costs were developed and used in the evaluation process.

The number of potential road crossings is included in the rating of alternatives. The local intersections within each quadrant are not expected to carry significant ADT; however, the intersection with existing roads, be it public roadways or private accesses, can reduce operations as vehicles make turning movements to and from these roadways. Safety can be impacted as vehicles accelerate, decelerate and have conflicting movements at the intersections.

Additional operational criteria were considered but were not used in the screening evaluation. Traffic impacts within each quadrant will be similar across the alignment options. Both passenger and heavy vehicle traffic reduction at the intersection of US 12 with MT 7 will likely be similar for all alignment options within each quadrant. Travel time savings are not included as a screening criterion as all of the alternatives within their respective quadrant will provide travel time savings as compared to using US 12 and MT 7 through Baker. It is assumed that the terminal intersections will be designed similarly for any alternative, with proper geometric sight distances and traffic control, and therefore does not provide for a measurable screening criterion.

4.1 Impacts Rating

The methodology for calculating impacts is described in Section 3.5 above. Note that no impacts to sensitive wildlife habitat (particularly Greater Sage-grouse) resulted from the alternatives developed. Impacts to potential Section 4(f) and known 6(f) resources were avoided for all alignments developed.

Impacts to wetlands were estimated using GIS by intersecting the alignment construction footprint with the National Wetlands Inventory (NWI) database to provide a planning-level estimate of potential wetland and waterbody impacts. Future wetland delineations would be required if improvement options are forwarded from the study that could potentially impact wetlands. Wetland impacts exceeding 0.5-ac. at a single crossing would need to demonstrate a Least Environmentally Damaging Preferred Alternative, or LEDPA, to obtain a USACE Section 404 permit.

For each criterion evaluated, the alternatives within each quadrant were given a numerical rating based on the number of alignments being evaluated, with a value of one (1) denoting the best option. The northwest quadrant includes 7 individual alternatives, resulting in a numerical rating of 1 through 7. The northeast quadrant includes 8 alternatives, for a numerical rating of 1 through 8. All criteria ratings were totaled into a composite rating which was then calculated as an overall rating. The second level screening evaluation and results are described in the following sections.

Table 4: Impacts Rating

Alignment (Map ID)	Wetland and Water Body Impacts[1] (acres)	Rating	Floodplain Impacts (acres)	Rating	Prime Farmland Impacts (acres)	Rating	Private Property Impacts (acres)[2]	Rating	Total Road Crossings[3]	Rating	Planning-level Cost Estimate[4]	Rating	Composite Rating	**Overall Rating**
Northwest Quadrant Alignments														
NW-1a	0.06	1	0.43	4	22.34	2	89.10	4	5	6	$40.03M	5	22	**3**
NW-1b	0.68	7	0.00	1	25.53	5	96.72	5	4	5	$37.09M	4	27	**6**
NW-2	0.16	2	0.70	5	23.92	3	51.21	2	3	1	$21.78M	2	15	**2**
NW-3a	0.21	4	0.00	1	38.67	7	115.13	7	11	7	$44.99M	6	32	**7**
NW-3b	0.46	6	0.00	1	24.49	4	108.95	6	3	1	$45.39M	7	25	**5**
NW-4	0.33	5	0.70	5	27.84	6	59.77	3	3	1	$25.23M	3	23	**4**
NW-5	0.19	3	3.73	7	15.48	1	27.13	1	3	1	$17.13M	1	14	**1**
Northeast Quadrant Alignments														
NE-1	0.07	1	2.68	3	5.68	4	47.95	1	1	2	$16.19M	5	16	**1**
NE-2	0.19	5	2.71	4	4.93	2	53.46	3	4	3	$15.59M	4	21	**3**
NE-3	0.15	3	3.73	6	16.35	8	73.41	7	14	8	$17.20M	8	40	**8**
NE-4	0.22	6	4.97	7	14.42	7	59.10	4	10	6	$14.67M	2	32	**5**
NE-5	0.07	2	2.26	2	5.14	3	49.27	2	0	1	$16.66M	6	16	**1**
NE-6	0.18	4	3.09	5	4.24	1	61.30	5	6	4	$15.31M	3	22	**4**
NE-7	0.32	8	1.96	1	9.01	5	74.03	8	9	5	$17.10M	7	34	**6**
NE-8	0.29	7	6.73	8	10.62	6	62.63	6	11	7	$14.53M	1	35	**7**

[1] Wetland and water body impacts can include multiple water crossings along the alignments and are approximate. Wetland delineations would be required during project development. Impacts exceeding 0.5-ac. at a single crossing would need to demonstrate a Least Environmentally Damaging Preferred Alternative, or LEDPA, to obtain a USACE Section 404 permit. Alignment NW-1b is the only alignment with a single crossing exceeding the 0.5-ac. threshold.

[2] Impacts were measured using an assumed 160' wide R/W width. For alignments NW-1 through NW-4, the modeled construction footprint extends beyond a 160'-wide R/W template. Impacts for these alignments include a minimum 160-foot-wide right-of-way width as well as the construction footprint extending beyond the 160-foot right-of-way boundary.

[3] Includes public roads and private access roads (oil/gas pad access roads and residential driveways).

[4] Cost estimates include construction costs provided by Quantm as well as costs associated with new intersections, traffic control, mobilization, preliminary and construction engineering, indirect costs, miscellaneous items, inflation, and a contingency percentage. The estimate includes improvements to the existing Shell Oil Road or S-493 where applicable.

4.2 Alignments to Carry Forward

The results of the second level screening showed alignment NW-5 as receiving the lowest overall numerical rating (i.e., most favorable alignment option) within the northwest quadrant and alignments NE-1 and NE-5 as receiving the lowest overall numerical rating within the northeast quadrant. Between alignments NE-1 and NE-5, NE-5 is recommended to be carried forward as the preferred alignment within the northeast quadrant because it minimizes impacts to the state-owned parcel located along US 12. NE-5 is located nearer to the section line and would leave a larger useable area east of the alignment for state use as compared to NE-1.

Alignments NW-5 and NE-5 are recommended to be carried forward as potential new alternate route alignment options to address the study need of improving operations and mobility on US 12 and MT 7 through minimizing the impacts of truck traffic at the US 12/MT 7 intersection. These alignments provide for an alternate route within both the northwest and northeast quadrants. Overall ADT and total heavy vehicle turning movements are substantial within both of these quadrants and providing a new alignment within both quadrants would provide the greatest benefit addressing the study needs. The recommended alternatives utilize the existing intersection of MT 7/Shell Oil Road/S-493, providing the potential for through trips on US 12 to easily utilize both the northwest and northeast alignments through the study area. In addition, the impact from the terminal intersections would be minimized by having both at the same location on MT 7.

Alignment NW-5

Alignment NW-5 provides for an alternate route between US 12 and MT 7 via S-493. The alignment departs US 12 at approximately RM 82.1, includes an overpass over the BNSF Railway, and then joins S-493 at RM 0.8. The alignment avoids impacts to structures along US 12 and the city lagoons south of the railroad. The alignment intersects two public roads north of the railroad: Prairie View Drive and Sunset Trail. Additional improvements would be required to S-493 from the junction of the new alignment to the intersection at MT 7 including surfacing improvements and widening to a 32-ft. roadway width as well as intersection improvements at the south terminus with US 12 and the north terminus with S-493.

Alignment NE-5

Alignment NE-5 provides for an alternate route between US 12 and MT 7 via Shell Oil Road. This alignment departs US 12 at RM 86.2 at the west edge of the state-owned section and connects to Shell Oil Road to the north at its junction with School House Road. Additional improvements would be required to Shell Oil Road from the junction of the NE-5 and School House Road to the intersection at MT 7 to meet minimum design criteria for rural minor arterials. Additional improvements to Shell Oil Road include surfacing improvements and widening to a 32-ft. roadway width as well as intersection improvements at the south terminus with US 12 and the north terminus with Shell Oil Road/School House Road.

The conceptual terminus of Alignment NE-5 with US 12 (at RM 86.2±) is located approximately 2,000 feet east of the existing highway overpass. Based on NE-5 being a stop-controlled intersection and current AASHTO design standards, adequate sight distance exists for vehicles making the southbound left turn or southbound right turn movement from the new alignment onto US 12. Additionally, a preliminary evaluation of an eastbound left-turn lane on US 12 indicates design standards can be met without affecting the overpass. Should Alignment NE-5 be forwarded from this study, evaluation of the need for a left-turn lane at this location would be necessary. If necessary, and depending on the required turn bay length on US 12, there is potential that the existing drainage structure located east of the overpass would need to be extended. Additional consideration during the design phase would be required to minimize or avoid impacts to the drainage structure, which could be accomplished by shifting the alignment terminus to the east.

Construction Phasing

No funding source has been identified to fund implementation of either of the new alignment options. Should a project be forwarded from this study, however, phasing of construction may be possible to maximize the limited funds available for transportation improvements. For example, both the recommended alignments connect with existing routes. The proposed improvements along existing S-493 and Shell Oil Road could be constructed at a later date in order to minimize the initial project costs. Another option would be to construct the new alignment as a 32-ft wide gravel road and plan for final grading and surfacing to be phased in at a later time. Also, if there are certain segments of the new alignment that would improve current conditions and mobility, these sections could be separated out into a standalone project to help address more immediate corridor needs. An example of this would be widening and/or paving 1-2 mile segments of Shell Oil Road for Alignment NE-5 or constructing the segment of NW-5 between Sunset Trail and S-493. These options could impact deliverables during final design and should be discussed with the design team at the beginning of the project should the improvements move forward.

New Alignment Implementation

Should a project be forwarded from this study, design of any alternative route could minimize traffic related problems such as the number of intersections with public roads and private accesses, skewed intersections, sharp horizontal or vertical curves, and other constrained geometric design.

It is possible that funding limitations may dictate selection of a single new alignment option. Both alignments have benefits. Future development and growth has potential to affect traffic conditions and heavy vehicle origins and destinations throughout the study area. Further consideration would be necessary during future project development should a project be forwarded from this study to re-evaluate existing conditions to determine which quadrant alignment would best meet the needs and objectives of this study. As presented in Section 2.2, current traffic movements show that a new alignment within the northeast quadrant would provide for the greatest reduction in truck turning movements at the US 12/MT 7 intersection. While Alignment NE-5 would benefit projected conditions at the US 12/MT 7 intersection, access to this alignment from US 12, which is located over 3 miles east of the US 12/MT 7 intersection, would provide little benefit to local mobility. Access to Alignment NW-5 from US 12, however, is located less than one mile west of the US 12/MT 7 intersection and would provide a greater benefit in terms of improving both emergency vehicle access north of the railroad and overall local mobility. Future implementation of either recommended new alignment options depend on community preference, funding availability, constructability, and other project delivery elements.

BAKER CORRIDOR
PLANNING STUDY

APPENDIX A: Planning-Level Cost Estimates for the Quantm Alignments

Baker Corridor Planning Study

August 2015

Planning Level Cost Estimate

NW-1a ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-1a		SF		$ -		$13,635,698.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ MT 7	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 866,141.88	$866,141.88
NW-1a Subtotal						$15,301,839.88
Miscellaneous Items					5%	$765,091.99
Mobilization					18%	$2,754,331.18
Subtotal						$18,821,263.05
Contingency					25%	$4,705,315.76
Construction Total						$23,526,578.82
Preliminary Engineering					10%	$1,882,126.31
Construction Engineering					10%	$1,882,126.31
Subtotal						$27,290,831.43
Indirect Cost (IDC)					9.13%	$2,491,652.91
Total w/ IDC						$29,782,484.34
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$10,242,684.18
Total Improvement NW-1a						**$40,025,168.52**

Planning Level Cost Estimate

NW-1b ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-1b		SF		$ -		$12,576,735.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ MT 7	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 802,604.10	$802,604.10
NW-1b Subtotal						$14,179,339.10
Miscellaneous Items					5%	$708,966.96
Mobilization					18%	$2,552,281.04
Subtotal						$17,440,587.09
Contingency					25%	$4,360,146.77
Construction Total						$21,800,733.87
Preliminary Engineering					10%	$1,744,058.71
Construction Engineering					10%	$1,744,058.71
Subtotal						$25,288,851.28
Indirect Cost (IDC)					9.13%	$2,308,872.12
Total w/ IDC						$27,597,723.41
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$9,491,309.11
Total Improvement NW-1b						**$37,089,032.52**

Planning Level Cost Estimate

NW-2 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-2		SF		$ -		$6,447,663.00
Shell Oil Road/S-493 Improvements	1	LS			$ 600,500.00	$600,500.00
New Intersection w/ S-493	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 470,889.78	$470,889.78
NW-2 Subtotal						$8,319,052.78
Miscellaneous Items					5%	$415,952.64
Mobilization					18%	$1,497,429.50
Subtotal						$10,232,434.92
Contingency					25%	$2,558,108.73
Construction Total						$12,790,543.65
Preliminary Engineering					10%	$1,023,243.49
Construction Engineering					10%	$1,023,243.49
Subtotal						$14,837,030.63
Indirect Cost (IDC)					9.13%	$1,354,620.90
Total w/ IDC						$16,191,651.53
Right-of-Way			2.0	Acres	$10,000.00	$20,000.00
Inflation			3.00%	10	Years	$5,568,574.17
Total Improvement NW-2						**$21,780,225.70**

Planning Level Cost Estimate

NW-3a ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-3a		SF		$ -		$15,426,667.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ MT 7	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 973,600.02	$973,600.02
NW-3a Subtotal						$17,200,267.02
Miscellaneous Items					5%	$860,013.35
Mobilization					18%	$3,096,048.06
Subtotal						$21,156,328.43
Contingency					25%	$5,289,082.11
Construction Total						$26,445,410.54
Preliminary Engineering					10%	$2,115,632.84
Construction Engineering					10%	$2,115,632.84
Subtotal						$30,676,676.23
Indirect Cost (IDC)					9.13%	$2,800,780.54
Total w/ IDC						$33,477,456.77
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$11,513,445.72
Total Improvement NW-3a						**$44,990,902.49**

Planning Level Cost Estimate

NW-3b ESTIMATE

Baker Corridor Planning Study | 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-3b		SF		$ -		$15,570,305.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ MT 7	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 982,218.30	$982,218.30
NW-3b Subtotal						$17,352,523.30
Miscellaneous Items					5%	$867,626.17
Mobilization					18%	$3,123,454.19
Subtotal						$21,343,603.66
Contingency					25%	$5,335,900.91
Construction Total						$26,679,504.57
Preliminary Engineering					10%	$2,134,360.37
Construction Engineering					10%	$2,134,360.37
Subtotal						$30,948,225.31
Indirect Cost (IDC)					9.13%	$2,825,572.97
Total w/ IDC						$33,773,798.28
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$11,615,362.42
Total Improvement NW-3b						**$45,389,160.70**

Planning Level Cost Estimate

NW-4 ESTIMATE

Baker Corridor Planning Study | 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-4		SF		$ -		$7,693,094.00
Shell Oil Road/S-493 Improvements	1	LS			$ 600,500.00	$600,500.00
New Intersection w/ S-493	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 545,615.64	$545,615.64
NW-4 Subtotal						$9,639,209.64
Miscellaneous Items					5%	$481,960.48
Mobilization					18%	$1,735,057.74
Subtotal						$11,856,227.86
Contingency					25%	$2,964,056.96
Construction Total						$14,820,284.82
Preliminary Engineering					10%	$1,185,622.79
Construction Engineering					10%	$1,185,622.79
Subtotal						$17,191,530.39
Indirect Cost (IDC)					9.13%	$1,569,586.72
Total w/ IDC						$18,761,117.12
Right-of-Way			2.0	Acres	$10,000.00	$20,000.00
Inflation			3.00%	10	Years	$6,452,255.47
Total Improvement NW-4						**$25,233,372.59**

Planning Level Cost Estimate

NW-5 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NW-5		SF		$ -		$4,771,416.00
Shell Oil Road/S-493 Improvements	1	LS			$ 600,500.00	$600,500.00
New Intersection w/ S-493	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 370,314.96	$370,314.96
NW-5 Subtotal						$6,542,230.96
Miscellaneous Items					5%	$327,111.55
Mobilization					18%	$1,177,601.57
Subtotal						$8,046,944.08
Contingency					25%	$2,011,736.02
Construction Total						$10,058,680.10
Preliminary Engineering					10%	$804,694.41
Construction Engineering					10%	$804,694.41
Subtotal						$11,668,068.92
Indirect Cost (IDC)					9.13%	$1,065,294.69
Total w/ IDC						$12,733,363.61
Right-of-Way			2.0	Acres	$10,000.00	$20,000.00
Inflation			3.00%	10	Years	$4,379,212.31
Total Improvement NW-5						**$17,132,575.92**

Planning Level Cost Estimate

NE-1 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-1		SF		$ -		$3,022,883.00
Shell Oil Road Improvements	1	LS			$ 1,919,000.00	$1,919,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 344,512.98	$344,512.98
NE-1 Subtotal						$6,086,395.98
Miscellaneous Items					5%	$304,319.80
Mobilization					18%	$1,095,551.28
Subtotal						$7,486,267.06
Contingency					25%	$1,871,566.76
Construction Total						$9,357,833.82
Preliminary Engineering					10%	$748,626.71
Construction Engineering					10%	$748,626.71
Subtotal						$10,855,087.23
Indirect Cost (IDC)					9.13%	$991,069.46
Total w/ IDC						$11,846,156.69
Right-of-Way			27.3	Acres	$10,000.00	$273,000.00
Inflation			3.00%	10	Years	$4,074,087.32
Total Improvement NE-1						**$16,193,244.01**

Planning Level Cost Estimate

NE-2 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-2		SF		$ -		$3,050,029.00
Shell Oil Road Improvements	1	LS			$ 1,699,000.00	$1,699,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 332,941.74	$332,941.74
NE-2 Subtotal						$5,881,970.74
Miscellaneous Items					5%	$294,098.54
Mobilization					18%	$1,058,754.73
Subtotal						$7,234,824.01
Contingency					25%	$1,808,706.00
Construction Total						$9,043,530.01
Preliminary Engineering					10%	$723,482.40
Construction Engineering					10%	$723,482.40
Subtotal						$10,490,494.81
Indirect Cost (IDC)					9.13%	$957,782.18
Total w/ IDC						$11,448,276.99
Right-of-Way			20.7	Acres	$10,000.00	$207,000.00
Inflation			3.00%	10	Years	$3,937,249.97
Total Improvement NE-2						**$15,592,526.96**

Planning Level Cost Estimate

NE-3 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-3		SF		$ -		$5,401,990.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ MT 7	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 372,119.40	$372,119.40
NE-3 Subtotal						$6,574,109.40
Miscellaneous Items					5%	$328,705.47
Mobilization					18%	$1,183,339.69
Subtotal						$8,086,154.56
Contingency					25%	$2,021,538.64
Construction Total						$10,107,693.20
Preliminary Engineering					10%	$808,615.46
Construction Engineering					10%	$808,615.46
Subtotal						$11,724,924.11
Indirect Cost (IDC)					9.13%	$1,070,485.57
Total w/ IDC						$12,795,409.69
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$4,400,550.97
Total Improvement NE-3						**$17,195,960.66**

Planning Level Cost Estimate

NE-4 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-4		SF		$ -		$4,492,314.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 317,538.84	$317,538.84
NE-4 Subtotal						$5,609,852.84
Miscellaneous Items					5%	$280,492.64
Mobilization					18%	$1,009,773.51
Subtotal						$6,900,118.99
Contingency					25%	$1,725,029.75
Construction Total						$8,625,148.74
Preliminary Engineering					10%	$690,011.90
Construction Engineering					10%	$690,011.90
Subtotal						$10,005,172.54
Indirect Cost (IDC)					9.13%	$913,472.25
Total w/ IDC						$10,918,644.79
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$3,755,100.78
Total Improvement NE-4						**$14,673,745.58**

Planning Level Cost Estimate

NE-5 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-5		SF		$ -		$3,190,054.00
Shell Oil Road Improvements	1	LS			$ 1,919,000.00	$1,919,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 354,543.24	$354,543.24
NE-5 Subtotal						$6,263,597.24
Miscellaneous Items					5%	$313,179.86
Mobilization					18%	$1,127,447.50
Subtotal						$7,704,224.61
Contingency					25%	$1,926,056.15
Construction Total						$9,630,280.76
Preliminary Engineering					10%	$770,422.46
Construction Engineering					10%	$770,422.46
Subtotal						$11,171,125.68
Indirect Cost (IDC)					9.13%	$1,019,923.77
Total w/ IDC						$12,191,049.45
Right-of-Way			27.3	Acres	$10,000.00	$273,000.00
Inflation			3.00%	10	Years	$4,192,701.59
Total Improvement NE-5						**$16,656,751.04**

Planning Level Cost Estimate

NE-6 ESTIMATE

Baker Corridor Planning Study 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-6		SF		$ -		$2,949,194.00
Shell Oil Road Improvements	1	LS			$ 1,699,000.00	$1,699,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 326,891.64	$326,891.64
NE-6 Subtotal						$5,775,085.64
Miscellaneous Items					5%	$288,754.28
Mobilization					18%	$1,039,515.42
Subtotal						$7,103,355.34
Contingency					25%	$1,775,838.83
Construction Total						$8,879,194.17
Preliminary Engineering					10%	$710,335.53
Construction Engineering					10%	$710,335.53
Subtotal						$10,299,865.24
Indirect Cost (IDC)					9.13%	$940,377.70
Total w/ IDC						$11,240,242.94
Right-of-Way			20.7	Acres	$10,000.00	$207,000.00
Inflation			3.00%	10	Years	$3,865,703.65
Total Improvement NE-6						**$15,312,946.59**

Planning Level Cost Estimate

NE-7 ESTIMATE

Baker Corridor Planning Study | 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-7		SF		$ -		$5,367,470.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ MT 7	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 370,048.20	$370,048.20
NE-7 Subtotal						$6,537,518.20
Miscellaneous Items					5%	$326,875.91
Mobilization					18%	$1,176,753.28
Subtotal						$8,041,147.39
Contingency					25%	$2,010,286.85
Construction Total						$10,051,434.23
Preliminary Engineering					10%	$804,114.74
Construction Engineering					10%	$804,114.74
Subtotal						$11,659,663.71
Indirect Cost (IDC)					9.13%	$1,064,527.30
Total w/ IDC						$12,724,191.01
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$4,376,057.70
Total Improvement NE-7						**$17,100,248.71**

Planning Level Cost Estimate

NE-8 ESTIMATE

Baker Corridor Planning Study | 8/24/2015

Item Description	Estimated Quantities	Unit	2015 Average Bid Prices		Adjusted Unit Prices	
			Unit Prices	Amount	Unit Prices	Amount
			Dollars	Dollars	Dollars	Dollars
Quantm NE-8		SF		$ -		$4,441,061.00
New Intersection w/ US 12	1	LS			$ 400,000.00	$400,000.00
New Intersection w/ Shell Oil Road	1	LS			$ 400,000.00	$400,000.00
Traffic Control (6%)	1	LS			$ 314,463.66	$314,463.66
NE-8 Subtotal						$5,555,524.66
Miscellaneous Items					5%	$277,776.23
Mobilization					18%	$999,994.44
Subtotal						$6,833,295.33
Contingency					25%	$1,708,323.83
Construction Total						$8,541,619.16
Preliminary Engineering					10%	$683,329.53
Construction Engineering					10%	$683,329.53
Subtotal						$9,908,278.23
Indirect Cost (IDC)					9.13%	$904,625.80
Total w/ IDC						$10,812,904.03
Right-of-Way			0.0	Acres	$50,000.00	$0.00
Inflation			3.00%	10	Years	$3,718,734.81
Total Improvement NE-8						**$14,531,638.84**