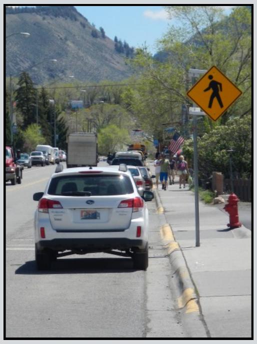
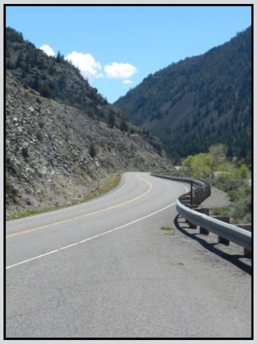
# Appendix 3

*Planning Study Documentation*





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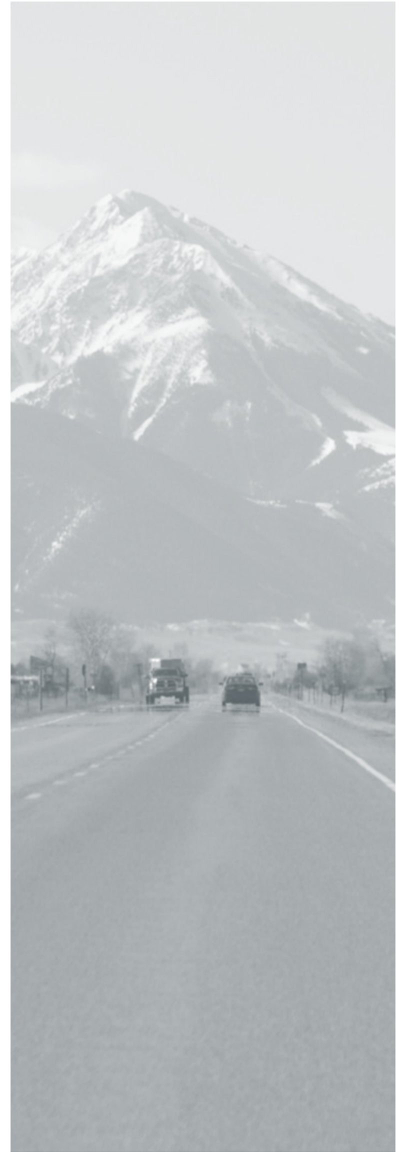
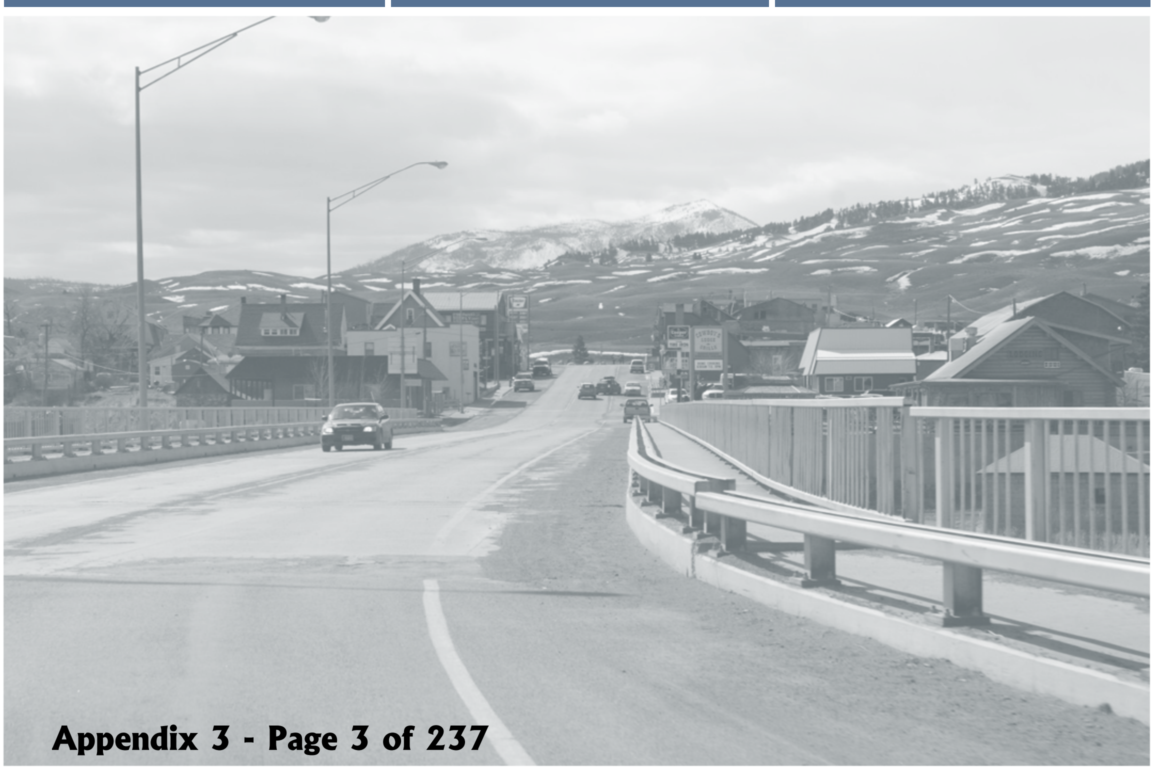
# PUBLIC AND AGENCY INVOLVEMENT PLAN (PAIP)

*Paradise Valley Corridor Planning Study*
*US 89 (Gardiner to Livingston)*



Prepared for:
**MONTANA DEPARTMENT OF TRANSPORTATION**

**June 4, 2013**



Prepared by:
**ROBERT PECCIA & ASSOCIATES**
Helena, Montana

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## FIGURES

# ABBREVIATIONS/ACRONYMS

| | |
|---|---|
| **ADA** | Americans with Disabilities Act |
| **MDT** | Montana Department of Transportation |
| **MEPA** | Montana Environmental Policy Act |
| **NEPA** | National Environmental Policy Act |
| **PAIP** | Public and Agency Involvement Plan |
| **RP** | reference post |
| **RPA** | Robert Peccia and Associates |
| **MAP-21** | Moving Ahead for Progress in the 21st Century Act |
| **US** | United States |

# *PUBLIC AND AGENCY INVOLVEMENT PLAN (PAIP)*

## 1.0 INTRODUCTION

The Montana Department of Transportation (MDT), in partnership with Park County, has initiated a Corridor Planning Study of United States (US) Highway 89. The study will examine the highway from reference post (RP) 0.0 at the Yellowstone National Park boundary in Gardiner, north to RP 52.5, which is south of Livingston.

The study, referred to as the *Paradise Valley Corridor Planning Study*, will identify feasible improvement options to address safety and geometrical concerns (i.e. road width, horizontal curves, vertical grades, approach density, etc.) within the transportation corridor based on needs presented by the community, the study partners, and resource agencies. Geometric characteristics (road widths, curves, approaches, etc.), crash history, and existing and projected operational characteristics of the corridor will be examined. Existing and projected land uses and environmental resources will also be analyzed.

The study will include a comprehensive package of short- and long-term recommendations intended to address the transportation needs of highway users over the next twenty years (i.e. planning horizon year 2033). Developing these recommendations will help the study partners define the most critical needs and allocate resources.

An initial step in the corridor planning process is to develop a *Public and Agency Involvement Plan (PAIP)* that provides for and identifies public, stakeholder, and other interested parties involvement activities needed to communicate information about existing and future corridor needs. The purpose of the *PAIP* is to establish a process that provides opportunities for interested parties to participate in all phases of the corridor planning process. Providing complete information, timely notices, and opportunities to comment, as well as ensuring full access to key decisions, will help achieve the *PAIP* objectives.

### 1.1 Corridor Planning Process

MDT established the corridor planning process to investigate improvement options for the corridor via the Pre-National Environmental Policy Act (NEPA) / Montana Environmental Policy Act (MEPA) Study, as provided for in the Moving Ahead for Progress in the 21st Century Act (MAP-21). If improvement options move into project development, the corridor planning process will yield information and help advance viable improvement options for use in the NEPA / MEPA process, as well as providing an opportunity for partner involvement at all stages.

The purposes for a corridor study are to analyze existing data to determine current and future deficiencies and needs within the corridor and to identify potential environmental issues and mitigation opportunities. The *Paradise Valley Corridor Planning Study* is a pre-NEPA/MEPA study that allows flexibility in examining improvement options for the roadway system should any project move forward. Public, stakeholder, and interested-party involvement are important components of any successful corridor planning process. For this study, a number of proposed involvement strategies will aid in reaching the most people possible to elicit meaningful participation. These opportunities will achieve the following goals:

- Educate corridor users regarding the critical elements included in the Pre-NEPA/MEPA Corridor Planning Study process for the US 89 corridor between Gardiner and Livingston.

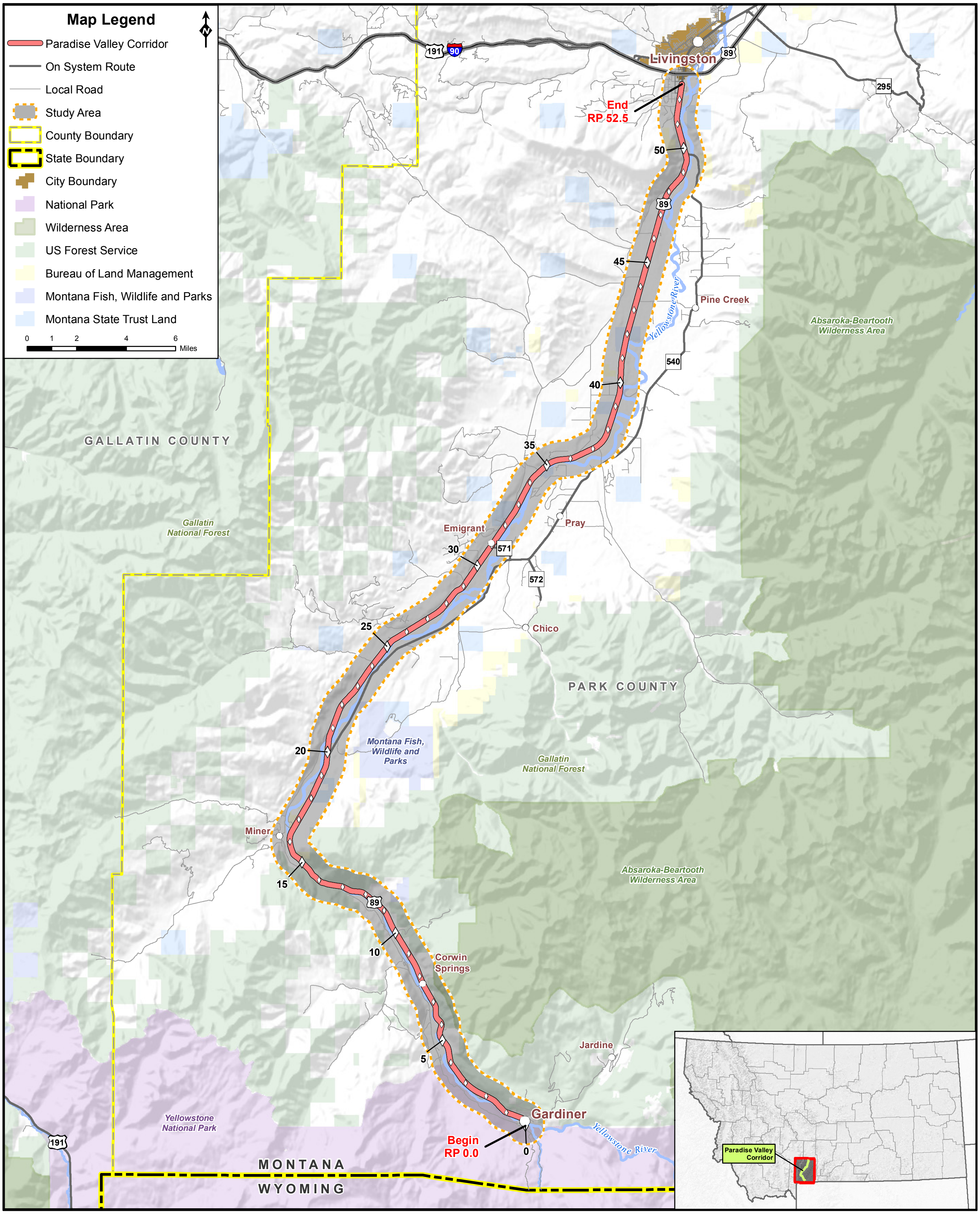
- Increase ability to provide input and ask questions throughout the corridor planning study.
- Present findings and recommendations.

## 1.2 Study Area

MDT established the termini of the *Paradise Valley Corridor Planning Study* as beginning at RP 0.0 in Gardiner, ending at RP 52.5, south of Livingston. A vicinity map (Figure 1) shows the location of the corridor and the surrounding area. The study area includes a 0.75-mile buffer on each side of US 89.

## 1.3 Goals of Public and Agency Outreach Effort

The goal of the study partners and the consultant is to provide ongoing opportunities for involvement by members of the public, stakeholders, and resource agency representatives throughout the planning study process. Education and outreach are essential elements in successfully informing individuals about the planning study process.




## Figure 1: Vicinity Map

# 2.0 PARTICIPATION PROCEDURES

The *PAIP* describes the information and input opportunities that will be provided while developing the *Paradise Valley Corridor Planning Study*. This plan encourages active participation in identifying and commenting on study issues at every stage of the planning process. Participant involvement includes the following:

- The general public—residents of Park County, the cities of Livingston and Gardiner, and adjacent areas
- Landowners and business owners within the study area boundary
- Resource agencies
- Stakeholders and outreach groups
- Other interested parties

This document contains descriptions of notification of informational meetings and other information. MDT, Park County, and RPA will provide information regarding all aspects of the planning study to the public and interested parties and will seek their input throughout the process.

## 2.1 Study Contacts

All information published regarding the *Paradise Valley Corridor Planning Study* will have contact information for MDT, Park County, and RPA. This information is provided below.

- **Montana Department of Transportation (MDT)** – Statewide and Urban Planning
  2960 Prospect Avenue (PO Box 201001), Helena, MT 59620-1001
  Contact: **Sheila Ludlow** – *MDT Project Manager*
  (406) 444-9193
  sludlow@mt.gov

- **Park County** – Planning Department
  414 E. Callender Street, Livingston, MT 59047
  Contact: **Mike Inman** – *Senior Planner*
  (406) 222-4102
  wminman@parkcounty.org

- **Robert Peccia and Associates (RPA)** – Consultant
  825 Custer Avenue (PO Box 5653), Helena, MT 59604
  Contact: **Jeff Key, PE** – *RPA Project Manager*
  (406) 447-5000
  jeff.key@rpa-hln.com

## 2.2 Publications

MDT and RPA will jointly develop meeting announcements, and MDT will advertise the announcements at least twice before informational meetings (three weeks and one week before the meeting). The ads will contain the meeting location, time and date, meeting format and purpose, and locations for document review (if applicable). The following print publications will carry the display ads:

- **Livingston Enterprise** – print and online: http://www.livingstonenterprise.com/
- **Gardiner Community Newsletter** – print and online: http://www.gardinerchamber.com/newsletter.cfm

In addition, RPA will publish newsletters, flyers, or both, one month before each informational meeting. The newsletters will describe work in progress, results achieved, preliminary recommendations, and other related topics. RPA will deliver each newsletter and flyer to Park County, MDT, and select stakeholders for distribution and posting to their individual internet sites. Print copies of newsletters will be available at the public meetings.

## 2.3 Radio and Television

Meetings may also be announced on local radio and/or television stations. Planning Team input will identify the most popular radio and television stations for announcements.

## 2.4 Stakeholder Contact List

A stakeholder contact list will include individuals, businesses, or groups identified by Park County and MDT. The stakeholder list will identify individuals and groups with likely project interests and will enable actively seeking out and engaging them in all phases of the study process. A sign-in sheet for individuals who attend informational meetings will facilitate expanding the stakeholder list. The groups or businesses (at a minimum) listed below will be included in the initial list:

- Park County Commission
- Park County Rural Fire District
- Park County Sheriff's Office
- Park County Road Department
- Park County Planning Department
- Park County Public Schools
- Park County Airport Board
- Park County Planning and Development Board
- City of Livingston
- Gardiner Chamber of Commerce
- Greater Gardiner Community Council
- Northern Rocky Mountain Economic Development District
- Montana Fish, Wildlife, and Parks (*also resource agency contact*)
- US Forest Service (*also resource agency contact*)
- US National Park Service (*also resource agency contact*)
- US Bureau of Land Management (*also resource agency contact*)
- Gallatin Valley Land Trust
- Montana Land Reliance
- Rocky Mountain Elk Foundation
- The Nature Conservancy
- Montana Wild Sheep Foundation
- Montanan's for Safe Wildlife Passage
- Northern Plains Resource Council
- Trout Unlimited – Joe Brooks Chapter
- MSU Extension

## 2.5 Document Availability

Electronic copies of study deliverables and technical memorandums will be posted on the study website at the following address: www.mdt.mt.gov/pubinvolve/paradisevalley/

Hard copy materials may also be made available at the following locations:

- Park County Planning Department (414 E. Callender Street, Livingston, MT 59047)
- MDT Bozeman Area Office (907 North Rouse Avenue, Bozeman, MT 59771)

The following required Americans with Disabilities Act (ADA) statement will be included on all published materials:

*"Park County, MDT, and RPA attempt to provide accommodations for any known disability that may interfere with a person participating in any service, program, or activity associated with this study. Alternative accessible formats of this information will be provided upon request. For further information, call (406) 447-5000, TTY (800) 335-7592, or Montana Relay at 711. Accommodation requests must be made at least 48 hours prior to the scheduled activity and / or meeting."*

# 3.0 MEETINGS

## 3.1 Planning Team Meetings

MDT will schedule Planning Team meetings every three weeks over the 12-month study period (16 Planning Team meetings). Groups included in the meetings will be Park County, MDT, Federal Highway Administration, RPA, and others as needed. The meetings will track progress and address study development issues and questions. The meetings are important for the exchange of technical information and ideas during the development of the study. Throughout the meetings, the Planning Team will identify and discuss issues, problems, and possible solutions.

The Planning Team will consider all public comments received over the duration of the study. As comments are received from the public, they will be logged into a public comment matrix and provided to the Planning Team for consideration. Written responses will not be offered to the individual making the comment unless a specific question or response is warranted. After the draft report is published, an additional public comment matrix will be created to log public comments received specific to the draft report, and will contain written responses as applicable. All public comments received, and any provided responses, will be duly considered and placed in the appendices to the final report.

## 3.2 Informational Meetings

Two informational meetings will take place throughout the study. Each will occur in two locations, Gardiner and Livingston, and they will be similar in form and content. The first informational meeting will take place early to introduce the study, describe relevant features, and explain the process. This meeting will also enable obtaining information about the study area from interested parties. The second informational meeting will occur following completion of the draft *Paradise Valley Corridor Planning Study.* The purpose of this meeting will be to present the types of recommended improvements and to receive feedback. Staff will record comments and concerns at all meetings for consideration throughout the planning process.

## 3.3 Resource Agency Meeting/Involvement

A meeting will be scheduled and held with Resource Agencies. MDT will organize the meeting, and RPA will facilitate it with assistance from the study partners, as necessary.

## 3.4 Consideration for Traditionally Underserved Populations

Additional efforts are necessary to involve traditionally underserved segments of the population, including the disabled, minorities, and low-income residents. Including these groups helps to ensure planning that reflects everyone's needs. The steps listed below will help with these efforts.

- **Plan meeting locations carefully:** Hold Informational meetings in locations that are accessible and compliant with ADA. If a targeted population is located in a certain geographic part of a city or county, then the meeting location should be close to the area for convenience.
- **Seek help from community leaders and organizations:** To facilitate involvement of traditionally underserved populations, consult with community leaders and organizations representing these groups about the most effective ways to reach their members.
- **Be sensitive to diverse audiences:** At informational meetings, study partner staff and the Consultant will attempt to communicate as effectively as possible. Presenters will avoid using technical jargon, and staff will wear appropriate dress and adhere to common rules of conduct.

## 3.5 Study Schedule

Adherence to the study schedule is important to stay on track and to keep all participating parties engaged. Figure 2 contains the study schedule for the *Paradise Valley Corridor Planning Study*. It is RPA's intent to adhere to this schedule.

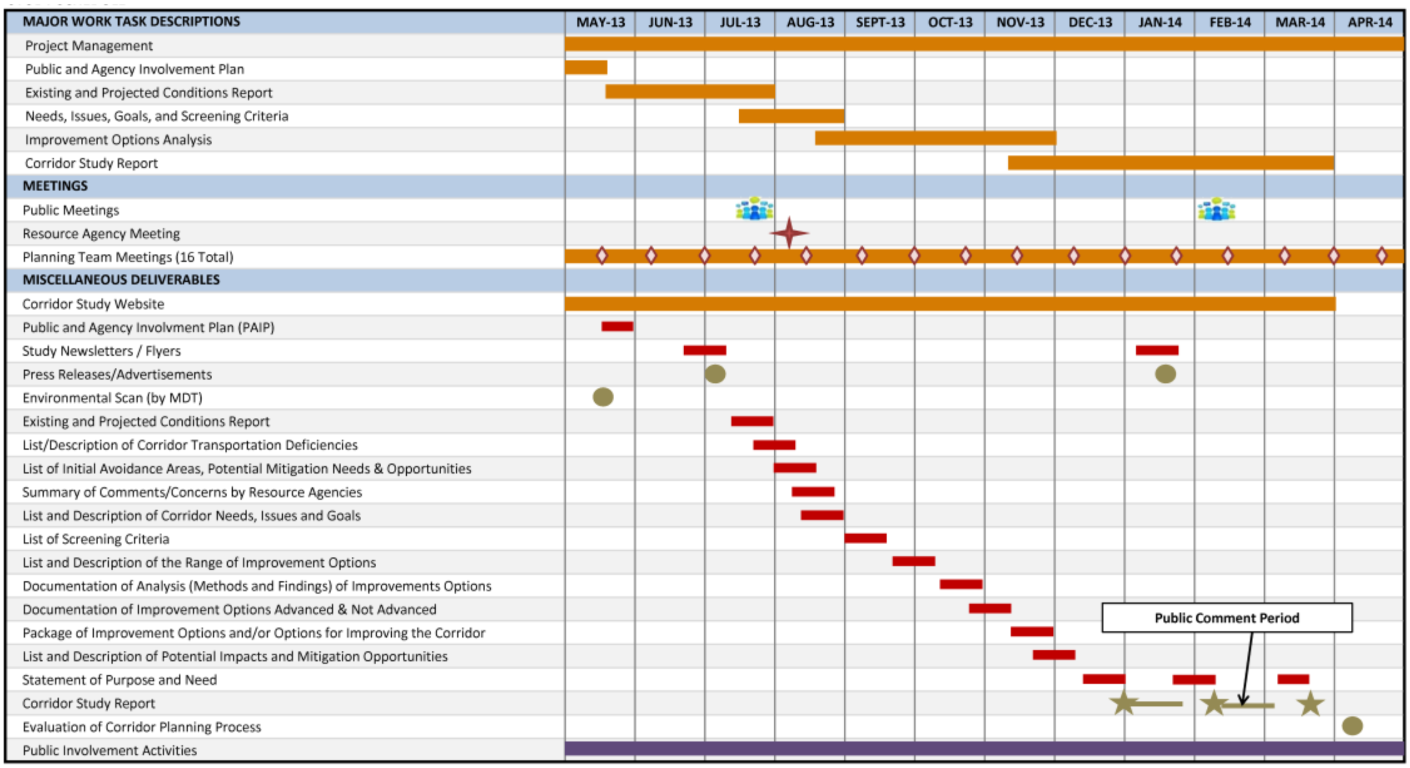



**Figure 2: Study Schedule**

# 4.0 OVERALL STUDY COMMUNICATION

The *PAIP* establishes guidelines and procedures for encouraging participation. The following communication strategies and techniques will be used to distribute study information to the community at large and to seek a higher level of engagement. RPA will apply the techniques that best suit the *Paradise Valley Corridor Planning Study* development.

- All relevant deliverables and associated materials will be posted on the study website at the following address:
    - www.mdt.mt.gov/pubinvolve/paradisevalley/
- Public service announcements and interviews on radio and television may be conducted to explain the subject matter and promote participation.
- Newsletters will be provided at least one month before each informational meeting.
- Press releases for the newspaper or other widely circulated publications will be developed.
- Technical memorandums will be provided to MDT for posting to the study's internet site. They will also be distributed to the Planning Team to provide a better understanding of proposed issues and recommendations and, in return, to provide the study partners with feedback and an opportunity for continual comment.
- Hard copies of all materials will be made available at the locations described in Section 2.5, as well as at the MDT Statewide and Urban Planning Section (2960 Prospect Avenue).
- Upon request, special presentations may be made to groups and organizations.
- Fact sheets may be developed to help explain or describe study-related issues.
- Special issues documents may be announced or reported on at meetings and/or via email.

Questions and comments from interested parties concerning the participation process, working draft technical memorandums, the draft *Paradise Valley Corridor Planning Study* documents, and other work products will be included in an appendix to the actual documents.

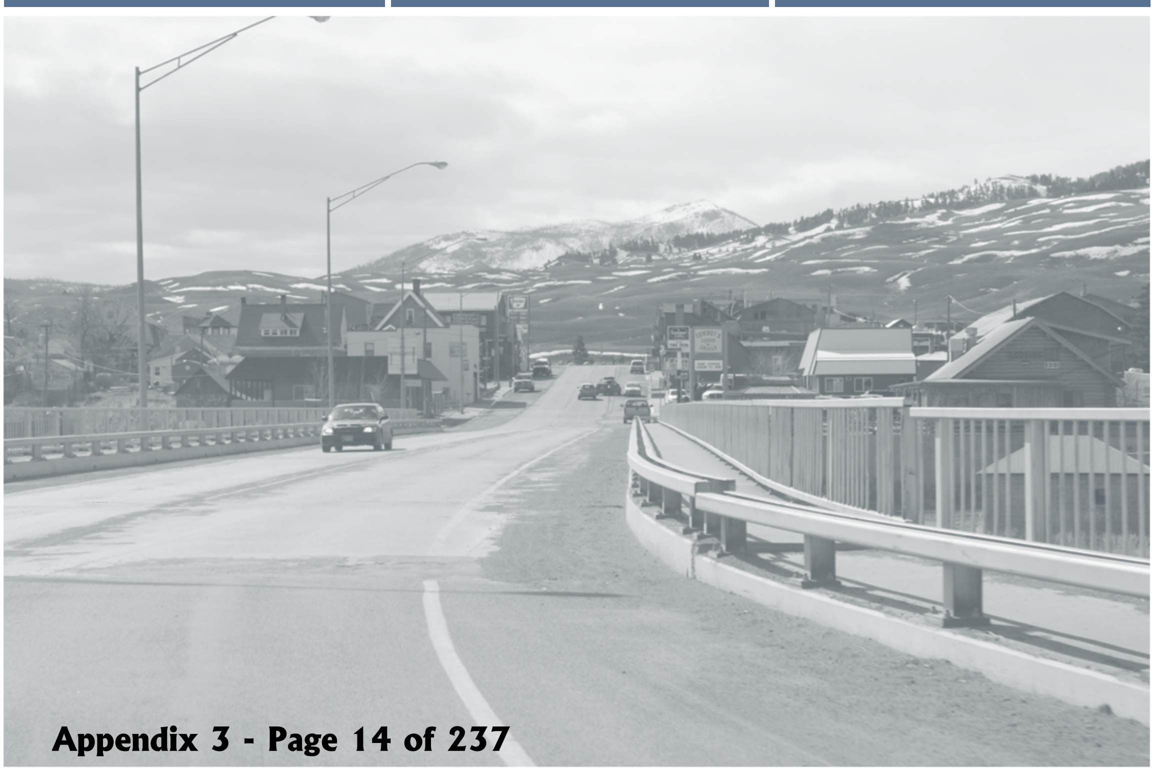
# EXISTING AND PROJECTED CONDITIONS

*Paradise Valley Corridor Planning Study*
*US 89 (Gardiner to Livingston)*

FINAL

Prepared for:
**MONTANA DEPARTMENT OF TRANSPORTATION**

**Sept. 16, 2013**



Prepared by:
**ROBERT PECCIA & ASSOCIATES**
Helena, Montana

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# ABBREVIATIONS/ACRONYMS

| | |
|---|---|
| **AADT** | Average Annual Daily Traffic |
| **AAGR** | Average Annual Growth Rate |
| **AASHTO** | American Association of State Highway and Transportation Officials |
| **ATR** | Automatic Traffic Recorder |
| **CAPS** | Crucial Areas Planning Systems |
| **CDP** | Census Designated Place |
| **CRF** | Code of Federal Regulations |
| **CO** | Carbon Monoxide |
| **DEQ** | Department of Environmental Quality |
| **EA** | Environmental Assessment |
| **EO** | Executive Order |
| **EPA** | U. S. Environmental Protection Agency |
| **FHWA** | Federal Highway Administration |
| **FONSI** | Finding of no Significant Impact |
| **FWP** | Montana Fish, Wildlife, and Parks |
| **GIS** | Geographic Information Systems |
| **HBP** | Highway Bridge Program |
| **HRDC** | Human Resource Development Council |
| **LUST** | Leaking Underground Storage Tank |
| **LWCFA** | Land and Water Conservation Fund Act |
| **LWQD** | Local Water Quality District |
| **LOS** | Level of Service |
| **MBMG** | Montana Bureau of Mines and Geology |
| **MDT** | Montana Department of Transportation |
| **MFISH** | Montana Fisheries Information System |
| **MRL** | Montana Rail Link |
| **mtons** | Metric Tons |
| **MSAT** | Mobile Source Air Toxics |
| **NAAQS** | National Ambient Air Quality Standards |
| **NHS** | National Highway System |
| **NPS** | National Park Service |
| **NRCS** | Natural Resource Conservation Service (United States Dept. of Agriculture) |

| | |
|---|---|
| **PM** | Particulate Matter |
| **REMI** | Regional Economic Models, Inc. |
| **RHRS** | Rockfall Hazard Rating System |
| **RP** | Reference Post |
| **SAMP** | Special Area Management Plan |
| **SOC** | Species of Concern |
| **SRMZ** | Special River Management Zone |
| **STIP** | Surface Transportation Improvement Program |
| **T&E** | Threatened and Endangered |
| **TMDL** | Total Maximum Daily Loads |
| **USACOE** | US Army Corps of Engineers |
| **USFS** | US Forest Service |
| **USFWS** | US Fish and Wildlife Service |
| **UST** | Underground Storage Tank |
| **vpd** | Vehicles per Day |
| **YNP** | Yellowstone National Park |

# EXISTING AND PROJECTED CONDITIONS

## 1.0 INTRODUCTION

The US Highway 89 (N-11) corridor provides the primary surface transportation link between Livingston and Yellowstone National Park (YNP). US 89 is one of the major routes in Montana used to access YNP through Gardiner. The highway passes through the "Paradise Valley" situated between Livingston and Yankee Jim Canyon in Park County, and generally parallels the Yellowstone River.

This report identifies existing and projected roadway conditions and social, economic and environmental factors for US 89 between Gardiner and Livingston. The analysis performed includes a planning level examination of the corridor by applying technical and environmental factors to determine known issues and/or areas of concern.

### 1.1 Study Area and Background

The study area for the *Paradise Valley Corridor Planning Study* includes a 0.75-mile buffer on each side of US 89 beginning at Reference Point (RP) 0.0 at the YNP Boundary in Gardiner and extending north through the communities of Corwin Springs and Emigrant to RP 52.5 just south of the City of Livingston. **Figure 1** shows the study area boundary, which is located entirely within Park County.

US 89 is classified as a Rural Principal Arterial Highway on the Non-Interstate National Highway System (NHS) within the study area. The highway is an integral part of the regional rural transportation network connecting local population and commerce to the NHS. While most of the land adjoining the corridor is undeveloped, cultivated and ranch lands, year-round and seasonal businesses, outdoor recreation sites, and residences also exist within the study area.

US 89 connects Interstate 90 (I-90) at Livingston to YNP at Gardiner. Gardiner is situated at the original entrance to YNP and is the only year-round vehicular entrance into the park. The Gardiner Entrance (also known as the North Entrance) is one of the most heavily used entrances into the park. The entrance provides access to the northern portion of YNP and year-round access to the Cooke City/Silver Gate areas.

National Park Service (NPS) visitation statistics for 2012 show that June through September traffic counts at the North Entrance ranged from approximately 27,000 to more than 58,000 vehicles each month. Peak traffic counts occurred in July. Traffic counts at the North Entrance during the fall and winter months ranged from 5,000 to 6,000 vehicles each month during 2012.

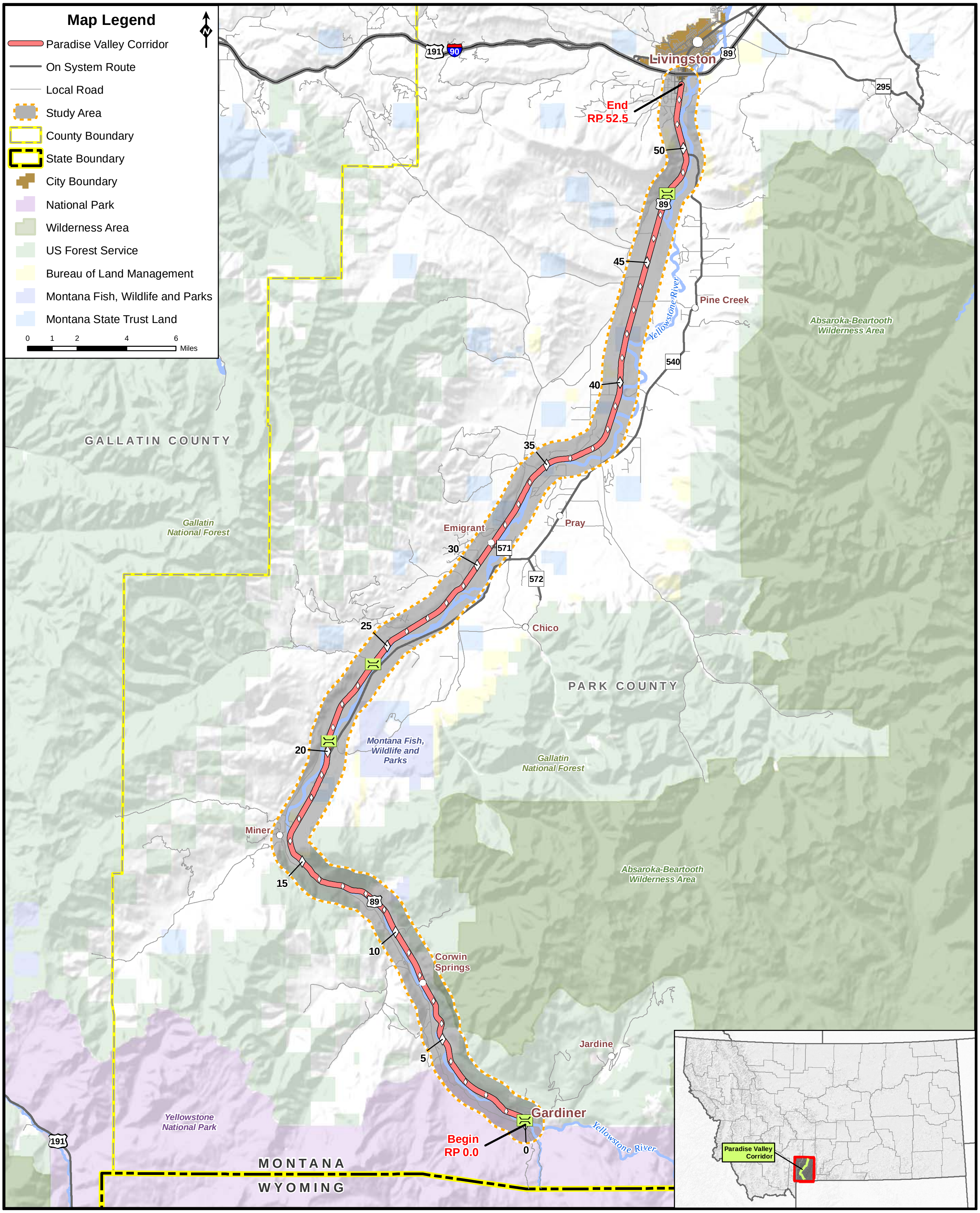



Figure 1: Vicinity Map

## 1.2 Past, Current, and Planned Projects in the Corridor

The Montana Department of Transportation's (MDT) online summary of road and bridge construction projects awarded since July 23, 1987, were reviewed to identify projects previously implemented on US 89 within the study area. Since 1987 MDT has completed thirteen projects along the corridor such as construction of the Emigrant Rest Area, the non-motorized path just south of Livingston, and various pavement preservation projects. **Table 1** lists these projects, along with a brief description of the scope if it was available in MDT's Program and Project Management System.

**Table 1: MDT Projects on US 89 Since 1987**

| MDT Project Name | Description |
|---|---|
| **Emigrant Rest Area – Park County** | Rest area construction |
| **4 Mi. So. of Livingston – Park County** | N/A - no information available |
| **South of Emigrant, Park County** | N/A - no information available |
| **Emigrant North & South** | N/A - no information available |
| **Yankee Jim Canyon – North** | N/A - no information available |
| **Emigrant – North** | Asphalt overlay |
| **Carter's Bridge Path – Livingston** | Non-motorized path construction |
| **Scott Street – Gardiner** | Asphalt mill and fill |
| **Turn Bay – 13 Km S of Livingston** | Left turn lane construction |
| **Livingston – South** | Asphalt chip seal |
| **Emigrant – South** | Asphalt chip seal |
| **South of Livingston - South** | Asphalt chip seal |
| **Livingston - South (US-89)** | Asphalt mill and fill |

*Source: MDT Project List accessible at* http://www3.mdt.mt.gov:7782/mttplc/mttplc.tplk0007.project_init

MDT's online summary of road and bridge construction projects shows two other projects on East River Road (S-540) that adjoin US 89 within the study area. These projects include:

- **Carters Bridge – South**: This project was let in February 2010 and included a seal and cover and pavement markings on S-540 east of US 89.
- **East River Road – South of Emigrant**: This project was recently completed and realigned a section of East River Road to provide a "T" intersection with US 89.
- **US 89 Slide N of Corwin Spring**: This emergency project is located at RP 8.6 to 8.7 and will repair damage from the recent wash out.

The Montana 2013-2017 *Final Surface Transportation Improvement Program* (STIP) is a federally-required publication that shows funding obligations over the next five years. This program identifies improvement projects to preserve and improve Montana's transportation system. The Montana 2013-2017 Final STIP identifies the following future projects for US 89 within the study area:

- **SF 110-Rumble Strips N-11**: This project involves installation of shoulder rumble strips along both sides of US 89 from the north end of the Gardiner Urban Limits (RP 1.2) to the south end of the Livingston Urban Limits (RP 49.5). Rumble strips will not be built across bridges, adjacent to guardrails, and at specified approaches, and they will be limited in locations close to residential homes. A modified rumble strip will be used in locations where the shoulder width is less than 4 feet.

- **Gardiner North**: This project involves a 0.15-foot mill and fill and full-width seal and cover treatment on US 89 between Gardiner and the Big Creek Bridge (RP 0 to RP 1.0). The project also includes ADA upgrades at the intersections and bridge deck repair.
- **North of Gardiner North**: This 12-mile-long project on US 89 involves a mill and fill and full-width seal and cover treatment on US 89 beginning at RP 1.10.
- **Yankee Jim Canyon-North**: This 10.9-mile-long project on US 89 involves a mill and fill and full-width seal and cover treatment on US 89 beginning at RP 13.17.
- **Cedar Cr – 16 km N of Gardiner**: Cedar Creek is currently conveyed under US 89 in culverts at RP 10.2. The project which will remove and replace the culverts.
- **SF 129 – Left Turn Ln Emigrant RA**: This safety project would provide a left-turn lane for southbound vehicles on US 89 at the Emigrant Rest Area (RP 23.5).

# 2.0 DEMOGRAPHICS

This section provides an overview of socioeconomic characteristics of the study area. Historic and recent trends in area demographics help define existing conditions and aid in forecasting techniques as there is a direct correlation between motor vehicle travel and socioeconomic indicators.

Demographic and socioeconomic information was reviewed to help determine recent trends in population, age distribution, employment, economic status, and commuting for area residents. Socioeconomic data sources do, however, often lag considerably behind the actual years of interest. This analysis presents the most recent data and statistics available and indicates recent and potential changes in the area.

## 2.1 Population Characteristics

A review of demographics within the study area is appropriate to gain an understanding of historical trends in population, age, race, and ethnicity. Understanding population composition is necessary, as the data may influence the types of improvements identified. For example, an aging population may indicate a need for specific types of transportation improvements such as transit services and/or non-motorized infrastructure improvements. The presence of a disadvantaged population may warrant other considerations.

**Table 2** shows total population and growth statistics for the City of Livingston, the Gardiner Census Designated Place, and Park County. A comparison with similar statistics for the State of Montana and the United States is also provided. Census Designated Places (CDP) are delineated by the Census Bureau to provide data for settled concentrations of population that are identifiable by name, but that are not legally incorporated areas. The Gardiner CDP was created during the 2000 Census; thus data for earlier censuses are not available for this subdivision of Park County.

### Table 2: Population Growth and Density

| Area | Population (2000) | Population (2010) | Percent Growth (2000-2010) | Persons per Square Mile (2010) | Current Population (2012 Estimate) |
|---|---|---|---|---|---|
| City of Livingston | 6,851 | 7,044 | 2.8% | 1,170.50 | (i) |
| Gardiner CDP | 851 | 875 | 2.8% | 152.4 | (i) |
| Park County | 15,694 | 15,636 | -0.4% | 5.6 | 15,592 |
| State of Montana | 902,195 | 989,415 | 9.7% | 6.8 | 1,010,921 |
| United States | 281,421,906 | 308,745,538 | 9.7% | 87.4 | 313,914,040 |

*Source: US Bureau of the Census, Census of the Population*
*(i) Data Not Available*

Between 2000 and 2010, the population in Park County remained generally flat. The City of Livingston and the Gardiner CDP, however, experienced a population growth of approximately 3 percent over this period. This contrasts with the 9.7 percent growth experienced in the State of Montana and the entire United States over the same period. In the 2010 Census, Park County has a density of 5.6 persons per square mile. This is slightly below the population density for the State of Montana as a whole.

**Table 3** depicts the race and ethnicity characteristics in Park County, the City of Livingston, the State of Montana, and the United States at the time of the 2010 Census. The populations of both Park County and the City of Livingston are predominately white with percentages of minority populations well below those seen for the State of Montana and the nation. Data from the 2000 and 2010 censuses shows the ethnic composition of residents of the Gardiner CDP closely mirrors that of the county. Please note the population numbers for ethnic groups presented in the table may not match the Census total percentages and percentages may not add up to 100 percent.

### Table 3: Population Race and Ethnicity Data (2010)

| Race / Ethnicity | City of Livingston | | Park County | | State of Montana | | United States | |
|---|---|---|---|---|---|---|---|---|
| White | 6,777 | 96.2% | 15,090 | 96.5% | 884,961 | 89.4% | 223,553,265 | 72.4% |
| Black or African American | 6 | 0.1% | 21 | 0.1% | 4,027 | 0.4% | 38,929,319 | 12.6% |
| American Indian and Alaska Native | 56 | 0.8% | 131 | 0.8% | 62,555 | 6.3% | 2,932,248 | 0.9% |
| Asian | 21 | 0.3% | 52 | 0.3% | 6,253 | 0.6% | 14,674,252 | 4.8% |
| Native Hawaiian and Other Pacific Islander | 3 | 0.0% | 5 | 0.0% | 668 | 0.1% | 540,013 | 0.2% |
| Some Other Race | 43 | 0.6% | 80 | 0.5% | 5,975 | 0.6% | 19,107,368 | 6.2% |
| Two or More Races | 138 | 2.0% | 257 | 1.6% | 24,976 | 2.5% | 9,009,073 | 2.9% |
| Hispanic or Latino (of any race) | 175 | 2.5% | 325 | 2.1% | 28,565 | 2.9% | 50,477,594 | 16.3% |
| Total Population | 7,044 | | 15,636 | | 989,415 | | 308,745,538 | |

*Source: US Bureau of the Census, Census of the Population*

**Table 4** depicts the change in total population and age composition for Park County since 1980. The population in Park County increased by nearly 3,000 residents between 1980 and 2010. Between 1980 and 2010, the percentage of county residents in the 18-64 Years and the 65+ Years categories showed notable increases. During this same time, the number of residents in the <18 Years category decreased by approximately 10 percent. The median age of Park County residents also increased from 32.6 years in 1980 to 45.4 years in 2010. These statistics point to the aging of the population and follow similar trends within Montana and the United States.

**Table 4: Park County Age Distribution (1980 – 2012)**

| Year | <18 Years | | 18-64 Years | | 65+ Years | | Total Population | Median Age |
|---|---|---|---|---|---|---|---|---|
| **1980** | 3,443 | 27.2% | 7,380 | 58.3% | 1,837 | 14.5% | 12,660 | 32.6 |
| **1990** | 3,684 | 25.3% | 8,592 | 59.0% | 2,286 | 15.7% | 14,562 | 37.1 |
| **2000** | 3,665 | 23.4% | 9,700 | 61.8% | 2,329 | 14.8% | 15,694 | 40.6 |
| **2010** | 3,086 | 19.7% | 9,961 | 63.7% | 2,589 | 16.6% | 15,636 | 45.4 |
| **Change (1980 – 2010)** | **-357** | **-10.4%** | **2,581** | **35.0%** | **752** | **40.9%** | **2,976** | **12.8** |

*Source: US Bureau of the Census, Census of the Population*

While specific data about the number of seasonal residents in Park County are unavailable, it is possible to extract numbers of seasonal residents by reviewing Census information about housing units and occupancy. **Table 5** presents information about housing units within Park County, the City of Livingston, and the Gardiner CDP at the time of the 2010 Census.

Park County had 9,375 housing units in 2010; these units consisted of 7,310 occupied housing units and 2,065 vacant housing units. Countywide, 63 percent (1,308) of the vacant housing units were considered to be seasonal, recreational, or occasional residences. More than 59 percent of the vacant housing units in the Gardiner CDP in 2010 were classified for seasonal, recreational, or occasional use. This trend is notably different for the City of Livingston where 21 percent of the vacant housing units were for seasonal, recreational, or occasional use.

**Table 5: Housing Occupancy and Tenure in Park County (2010)**

| Area | Total Housing Units | Occupied Housing Units | | | Vacant Housing Units | |
|---|---|---|---|---|---|---|
| | | Total Occupied | Owner Occupied | Renter Occupied | Total Vacant | For Seasonal, recreational or occasional use |
| **Park County** | **9,375** | 7,310 | 4,938 | 2,372 | 2,065 | 1,308 |
| **City of Livingston** | **3,779** | 3,356 | 2,051 | 1,305 | 423 | 92 |
| **Gardiner CDP** | **556** | 460 | 257 | 203 | 96 | 57 |

*Source: US Bureau of the Census, Census of the Population*

## 2.2 Population Projections

The Montana Department of Commerce Census & Economic Information Center released county-level population projections through 2060 in April 2013. The projections were developed by Regional Economic Models, Inc. (REMI) for the State of Montana using the firm's *eREMI* model. Projections for Park County based on the *eREMI* model show the county's population increasing by more than 4 percent by 2060. In comparison, the model projects that the State of Montana's population will grow by more than 25 percent by 2060.

**Table 6** shows the total populations for Park County and the State of Montana in the 2010 Census, and it provides population estimates for key years from 2012 through 2035 based on the *eREMI* model. The projections suggest Park County's population will increase slowly with an overall increase of approximately 2 percent by 2035.

**Table 6: Population Projections through 2035**

| Area | 2010 | 2012 | Projected Population | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2015 | 2020 | 2025 | 2030 | 2035 |
| Park County | 15,636 | 15,592 | 15,653 | 15,760 | 15,884 | 15,939 | 15,883 |
| State of Montana | 989,415 | 1,010,921 | 1,043,653 | 1,094,712 | 1,134,324 | 1,156,494 | 1,162,253 |

*Source: US Bureau of the Census, Census of the Population and eREMI for Montana and Counties by Regional Economic Models, Inc.*

## 2.3 Employment and Income Characteristics

Tourism and recreation are important parts of Park County's economy due to the presence of YNP and abundant public lands. Other important industries within the county include agriculture, logging, mining, and health care. Livingston Healthcare is the largest private employer. Chico Hot Springs Resort, the Mountain Sky Guest Ranch, and the Best Western Mammoth Hot Springs Hotel in Gardiner rank among the top ten employers.

Gardiner relies on recreation, tourism, and the service industry to support its economy. Primary employers in the area include NPS, Xanterra Parks & Resorts (a park concessioner), and the US Forest Service (USFS). NPS headquarters for YNP are located at Mammoth Hot Springs approximately 5 miles south of Gardiner within YNP.

**Table 7** shows Park County employment by industry for the milestone years between 1980 and 2011. The most recent available data show that total full- and part-time employment in the county was 9,339 in 2011 with approximately 94 percent of the jobs being non-farm-related employment. Total employment in Park County in 2011 was nearly 50 percent higher than that recorded in 1980.

The data in **Table 7** shows the most notable net increase in employment between 1980 and 2011 occurred in the services industry where the total number of jobs nearly doubled. Other industry sectors showing sizable increases in employment since 1980 include finance, insurance, and real estate; construction; and state and local government. These trends likely reflect growth in the county's tourism and recreation-based service economy, as well as the boom in real estate development and building seen in portions of southwest Montana during the early 2000s. Notable declines in employment were seen in the transportation and public utilities sector, retail trade, and manufacturing.

The attractiveness of YNP as a tourist destination and the recreational opportunities available have created a tourist-based economy in Gardiner. The community receives significant income by providing goods and services to park visitors and to NPS employees residing in the area. Local businesses also benefit from annual NPS and concession expenditures for salaries, goods, and services from facilities at or near Gardiner.

### Table 7: Employment Trends for Park County (1980 - 2011)

| Industry | 1980 | 1990 | 2000 | 2010 | 2011 | Net Change (1980 - 2011) | |
|---|---|---|---|---|---|---|---|
| Agricultural Services & Forestry | 71 | 125 | 251 | (I) | 175 | 104 | 146% |
| Mining | 14 | 128 | 30 | (I) | 44 | 30 | 214% |
| Construction | 294 | 379 | 734 | 703 | 660 | 366 | 124% |
| Manufacturing | 414 | 347 | 451 | 331 | 341 | -73 | -18% |
| Transportation & Public Utilities | 1,371 | 322 | 356 | 223 | 226 | -1,145 | -84% |
| Wholesale Trade | 55 | 132 | 208 | 55 | 89 | 34 | 62% |
| Retail Trade | 1,052 | 1,236 | 1,808 | 927 | 928 | -124 | -12% |
| Finance, Insurance & Real Estate | 409 | 461 | 598 | 941 | 956 | 547 | 134% |
| Services | 1,413 | 2,214 | 2,934 | 4,126 | 4,193 | 2,780 | 197% |
| Federal & Civilian Government | 80 | 89 | 99 | 82 | 75 | -5 | -6% |
| Military | 77 | 113 | 82 | 77 | 78 | 1 | 1% |
| State & Local Government | 514 | 547 | 642 | 662 | 687 | 173 | 34% |
| Farm Employment | 523 | 505 | 631 | 545 | 560 | 37 | 7% |
| **Total Full/Part time Employment** | **6,287** | **6,598** | **8,824** | **9,244** | **9,339** | **3,052** | **49%** |

*Source: US Department of Commerce Bureau of Economic Analysis – Table CA25 and Table CA25N.*
*(I) Not shown to avoid disclosure of confidential information.*

**Table 8** shows unemployment rates current as of May 2013. The data show a Park County unemployment rate above that for the State of Montana (5.3 percent versus 4.9 percent), but lower than the unemployment rate of 7.3 percent for the United States.

### Table 8: Employment Statistics (2013)

| Area | Total Labor Force | Employed | Unemployed | Unemployment Rate |
|---|---|---|---|---|
| Park County | 8,658 | 8,200 | 458 | 5.3% |
| State of Montana | 509,660 | 482,200 | 27,460 | 4.9% |
| United States | 155,734,000 | 143,724,000 | 11,302,000 | 7.3% |

*Source: MT Department of Labor and Industry, Research and Analysis Bureau – Labor Force Statistics, May 2013 (data are not seasonally adjusted).*

According to the 2007–2011 *American Community Survey* five-year estimates, median household income levels for Park County and residents of the City of Livingston and the Gardiner area were below those for the State of Montana and the United States. Park County's per capita income level was near the average for the State of Montana, but only 88 percent of the national average. The per capita income level for residents of the City of Livingston was below that of the county, state, and nation. The per capita income level for residents of the Gardiner CDP was estimated to be slightly higher than that of the United States. Park County, the City of Livingston, and the community of Gardiner all have a lower percentage of persons living below poverty than the State of Montana and United States. **Table 9** contains a summary of the income statistics data.

**Table 9: Income Statistics (2007 - 2011)**

| Area | Median Household Income | Per Capita Income | Persons Below Poverty Level (%) |
|---|---|---|---|
| Gardiner CDP | $41,875 | $28,346 | 4.4% |
| City of Livingston | $36,767 | $21,358 | 11.7% |
| Park County | $41,232 | $24,466 | 11.3% |
| State of Montana | $45,324 | $24,640 | 14.6% |
| United States | $52,762 | $27,915 | 14.3% |

*Source: US Bureau of the Census, American Community Survey 2007-2011, http://factfinder2.census.gov*

## 2.4 Economic Development Trends

The economy of Park County has evolved as different industries have risen and fallen, including farming and ranching, mining, timber, railroad transportation and tourism. Agriculture has been a stable component of Park County's economy over the years, while tourism is currently one of its strongest elements, accounting for sales, jobs, and income for many residents. Economic growth in the tourism and service sectors will likely continue for the foreseeable future due to the recreational and tourism opportunities available in the county.

Park County, particularly in the Paradise Valley, has seen a persistent decline in the profitability of agricultural operations, while the value of lands historically used for agriculture has sharply increased. This has contributed to sales of agricultural land for conversion to residential and commercial development. This trend is likely to continue due to the perceived high quality of life and recreational amenities available in the county.

Gardiner has benefited from visitors who pass through and stay in the community due to its proximity to YNP. Growth has occurred in Gardiner's seasonal lodging and services businesses. YNP will likely continue to be an employer for local residents and a consumer of local goods and services.

# 3.0 PLANNING WITHIN THE US 89 CORRIDOR

Planning for lands in the study area is primarily the responsibility of Park County, the USFS (Gallatin National Forest), and NPS (for lands in YNP at Gardiner).

## 3.1 Park County Planning

The Park County Planning Department is responsible for all land-use planning activities in the county. The Planning Department administers the county's Subdivision Regulations, the regulations of all zoning districts, code enforcement, administration of the sign ordinance, and implementation of the Park County Growth Policy. The county's Planning and Development Board serves in an advisory capacity to Park County Commissioners. The board helps review community development proposals and is authorized to prepare and administer the growth policy.

### 3.1.1 Park County Comprehensive Plan (1998)

In 1998, Park County adopted its first Comprehensive Plan. The Comprehensive Plan examined data and trends relating to the economy, government, environment, wildlife, history, public services, transportation, schools, and land use. The Plan defined six planning areas throughout the county—Clyde Park, Wilsall, Springdale, Paradise Valley, Gardiner, and Cooke City—and outlined land-use goals and objectives for each area. The Park County Growth Policy replaced the 1998 document.

### 3.1.2 Park County Growth Policy (2008)

The 1999 Legislature revised state laws governing planning documents, requiring local governments to develop growth policies. A growth policy is an official public document adopted and used by Montana local governments as a general guide for decisions about the community's physical development. The document is not regulatory; it serves as an official statement of public policy to guide growth and manage change for the betterment of the community. State law requires growth policies contain several notable elements including the following:

- Community goals and objectives
- Information about existing conditions and trends
- A description of the policies, regulations, and other tools to be implemented in order to achieve the identified goals and objectives
- A strategy for development, maintenance, and replacement of public infrastructure

The focus of Park County's Growth Policy differs slightly from the 1998 Comprehensive Plan in that countywide goals, objectives, and implementation measures were developed instead of developing such elements for each planning area. The City of Livingston and the Town of Clyde Park are excluded from the scope of the Growth Policy. The Park County Growth Policy generally supports and promotes the following:

- Respect for and preservation of private property rights
- Protection of public health and safety
- Efficient delivery of services
- Encouragement of development near existing services and infrastructure
- Protection of the right to farm and ranch
- Protection of natural resources

Growth policies may include neighborhood plans, as long as the plans are consistent with the Growth Policy. A neighborhood plan is a plan for a geographic area within the boundaries of the jurisdictional area that addresses one or more of the elements of the growth policy in more detail. The Park County Growth Policy includes a Livingston Neighborhood Plan. The Livingston Neighborhood Plan applies to the 4.5-mile jurisdictional area that surrounds the City of Livingston (known colloquially as the "donut" area). The Livingston Neighborhood Plan recognizes the characteristics of the transitional area around the City of Livingston, and incorporates additional goals and objectives specific to the planning area. The Neighborhood Plan contains goals and objectives for transportation that stress the desire for a balanced transportation system that provides infrastructure for bicyclists, pedestrian, and special needs users (senior citizens, school children, etc.). Livingston developed and adopted its own Growth Policy in 2004.

## 3.2 Gallatin National Forest Plan

Gallatin National Forest lands in the Yellowstone and Gardiner Ranger Districts exist to the east and west of US 89. The Yellowstone District includes portions of the National Forest south of Livingston and east of the Yellowstone River, as well as land to the west of the Yellowstone River adjacent to the east side of the Bozeman Ranger District. The Gardiner District covers the southeast part of Gallatin National Forest, bordering YNP and includes the community of Gardiner. A portion of the West Unit of the Absaroka-Beartooth Wilderness Area is east of US 89 near Corwin Springs.

USFS administers Gallatin National Forest lands according to the goals and objectives and management direction established in the *1987 Gallatin National Forest Plan*. Amendments to the Forest Plan were completed in September 2009.

## 3.3 National Park Service Planning at Gardiner

NPS plans for and manages lands within YNP. The agency prepares a variety of planning and environmental documents to help guide management of park resources. In 2011, NPS prepared the *North Entrance & Park Street Improvement Plan/Environmental Assessment,* which examined potential actions to relieve traffic congestion and improve safety at the historic North Entrance to YNP, which is located in Gardiner. NPS identified a preferred improvement option that will be implemented as funding permits. The proposed improvements will include the following:

- Development of a new North Entrance station complex to speed up visitor entry to YNP
- Providing options for visitors to use a new access road to bypass congestion in the North Entrance area or to enter YNP through the historic Roosevelt Arch
- Expanded parking, new pedestrian walkways, and improved traffic circulation for visitors to access businesses along Park Street in Gardiner
- Moving the NPS administrative road in front of the Gardiner Transportation Center

**Figure 2** illustrates the planned improvement concept for the North Entrance. A Finding of No Significant Impact (FONSI) on the *North Entrance & Park Street Improvement Plan/Environmental Assessment* was issued in October 2011.

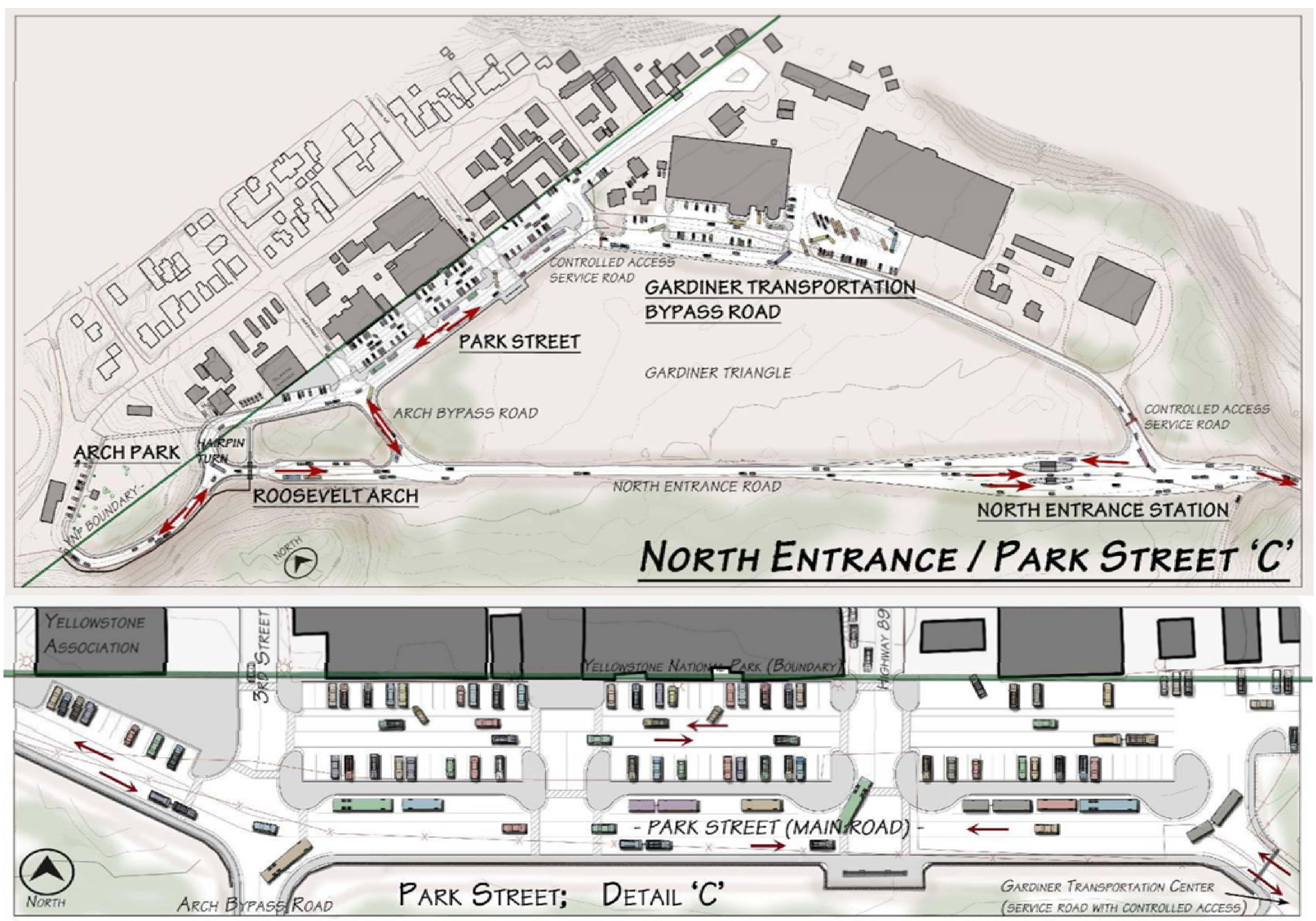



**Figure 2: NPS North Entrance / Park Street Redevelopment Concept**

## 3.4 Gardiner Gateway Project

Following the completion of the *North Entrance & Park Street Improvement Plan/Environmental Assessment*, the community of Gardiner and Park County saw an opportunity to work with NPS to develop a master plan for a revitalization project in the community that complemented NPS's planned improvements. These local efforts resulted in the Gardiner Gateway Project. The Gardiner Gateway Project is intended not only to help relieve traffic congestion and improve safety, but to enhance the experience of visitors to Gardiner and the North Entrance through beautification of the area and increased visitor services. Implementation of the project will provide essential upgrades to community infrastructure and additional economic opportunities for residents of Gardiner and Park County. A Preliminary Engineering Report for the project was completed in March 2013.

Park County is one of approximately 15 project partners, including NPS, the Gardiner Chamber of Commerce, the Yellowstone Association, the Greater Gardiner Community Council, MDT, the Montana Department of Commerce, and non-profit organizations. The project partners signed a memorandum of understanding in June 2012. The goal is to have components of the three-phase revitalization project completed by 2016, which marks the 100th anniversary of the creation of NPS. More information can be found on the Gardiner Gateway Project website at: http://gardinergatewayproject.org/.

# 4.0 TRANSPORTATION SYSTEM

US 89 from Gardiner to Livingston follows the upper Yellowstone River through the Paradise Valley. The road's origins date back to the 1880s when a miner from Cooke City built the first road between Gardiner and Livingston. The original road was abandoned, and portions were taken over by Yankee Jim George and operated as a toll road. Park County acquired much of the roadway in 1893 after the public became dissatisfied with the condition of the roadway. In 1915, YNP opened to automobile traffic. Through the efforts of the Yellowstone Trail Association at approximately the same time, an automobile route from Livingston to Gardiner was built along and over the Yankee Jim Toll Road. The roadway was constructed or improved at various times, beginning in 1924.

## 4.1 Existing Roadway Users

Primary users of the roadway consist of local residents, commuters between Gardiner and Livingston, recreationists on lands and waters in the Paradise Valley, tourists visiting YNP and other attractions in the region, and commercial users. Land uses in the study area are mixed. They include commercial, industrial, crop/pasture, mine/quarry, mixed urban, and recreational uses. Numerous recreation sites exist along US 89, and others are reachable from the highway. These sites include public fishing access sites, picnic areas, and campgrounds.

## 4.2 Traffic Data

MDT collects annual traffic count data are at seven locations on US 89 within the study area. An Automatic Traffic Recorder (ATR) is located on US 89 approximately 17 miles north of Gardiner. The ATR collects traffic year-round from sensors imbedded in the roadway. Data from the other traffic count sites on US 89 are collected periodically for limited times by using pneumatic tube counters.

MDT provided historic data for the traffic count sites. **Table 10** shows the most recent 20 years of traffic data for each count location. The Average Annual Daily Traffic (AADT) ranges from approximately 4,700 vehicles per day (vpd) near the communities of Gardiner and Livingston, to as low as 1,700 vpd near RP 17.

**Table 10: Average Annual Daily Traffic Data**

| Site ID | Location | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-3-10 | RP 0.12 | 4,350 | 4,470 | 4,680 | 3,600 | 3,910 | 4,840 | 4,550 | 3,600 | 3,270 | 3,630 |
| 34-3-9 | RP 0.64 | 3,380 | 3,640 | 2,990 | 2,680 | 2,900 | 4,060 | 3,660 | 2,900 | 2,790 | 2,980 |
| 34-3-1 | RP 4.0 | 1,450 | 2,000 | 2,030 | 1,300 | 1,550 | 2,310 | 2,110 | 1,660 | 1,560 | 1,690 |
| 34-3-2/A-20[(i)] | RP 16.8 | 1,590 | 1,640 | 1,780 | 1,750 | 1,640 | 1,630 | 1,650 | 1,810 | 1,580 | 1,610 |
| 34-3-3 | RP 32.0 | 2,120 | 2,080 | 1,960 | 1,840 | 1,870 | 2,570 | 2,290 | 2,040 | 1,780 | 2,040 |
| 34-2-2 | RP 49.6 | 2,600 | 2,530 | 3,120 | 2,770 | 2,360 | 3,500 | 3,280 | 2,920 | 2,470 | 2,870 |
| 34-2A-5 | RP 52.0 | 3,940 | 3,820 | 5,200 | 4,670 | 5,000 | 6,400 | 5,950 | 6,570 | 6,570 | 4,490 |

| Site | Location | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34-3-10 | RP 0.12 | 4,280 | 4,140 | 4,020 | 4,020 | 4,150 | 4,080 | 4,490 | 4,710 | 4,640 | 3,260 |
| 34-3-9 | RP 0.64 | 3,320 | 3,540 | 3,410 | 3,410 | 3,520 | 3,440 | 3,740 | 3,920 | 3,870 | 2,680 |
| 34-3-1 | RP 4.0 | 1,830 | 2,080 | 2,040 | 2,040 | 2,100 | 2,030 | 2,120 | 2,220 | 2,190 | 1,830 |
| 34-3-2/A-20[(i)] | RP 16.8 | 1,590 | 1,600 | 1,550 | 1,540 | 1,630 | 1,550 | 1,680 | 1,740 | 1,670 | 1,710 |
| 34-3-3 | RP 32.0 | 2,460 | 2,370 | 2,300 | 2,300 | 2,370 | 2,190 | 2,140 | 2,250 | 2,220 | 1,840 |
| 34-2-2 | RP 49.6 | 3,850 | 3,420 | 3,290 | 3,290 | 3,390 | 3,320 | 3,350 | 3,510 | 3,460 | 2,710 |
| 34-2A-5 | RP 52.0 | 6,720 | 4,980 | 4,700 | 4,700 | 4,850 | 5,020 | 5,150 | 4,770 | 4,700 | 3,970 |

*Source: MDT Data and Statistics Bureau, Traffic Data Collection Section, 2013*
*[(i)] Automatic Traffic Recorder (ATR)*

In addition to providing traffic volume data, the ATR counter located at RP 16.8 provides large truck volume percentages (RV's are not considered large trucks). For the year 2012, large trucks accounted for 2.4 percent of traffic at this location. Between 1993 and 2012, large trucks account for an average of 1.8 percent of traffic.

### 4.2.1 Future Traffic Projections

Projected transportation conditions were analyzed to estimate how traffic volumes and characteristics may change compared to existing conditions. The analysis was based on known existing conditions, and it extended out to 2035.

Average Annual Growth Rates (AAGR) were calculated at each traffic count location during multiple periods based on historic traffic data. Weighted AAGRs were calculated based on recent AADTs. The weighted AAGRs provide a representative picture of traffic growth on US 89 within the study area. Traffic volumes fluctuate throughout the study area, resulting in both positive and negative growth rates, as shown in **Table 11**.

**Table 11: Average Annual Growth Rates**

| Site | Location | Average Annual Growth Rate | | | | |
|---|---|---|---|---|---|---|
| | | 1993 - 2012 | 1993 - 1999 | 2000 - 2005 | 2006 - 2012 | 2000 - 2012 |
| 34-3-10 | RP 0.12 | -0.17% | 0.41% | 4.15% | -0.93% | 1.30% |
| 34-3-9 | RP 0.64 | 0.51% | 1.54% | 4.77% | -1.43% | 1.43% |
| 34-3-1 | RP 4.0 | 1.33% | 4.17% | 5.80% | -0.54% | 2.11% |
| 34-3-2/A-20[i] | RP 16.8 | -0.08% | 0.06% | -2.12% | 1.72% | 0.22% |
| 34-3-3 | RP 32.0 | 0.39% | 2.19% | 4.81% | -2.72% | 0.18% |
| 34-2-2 | RP 49.6 | 1.19% | 3.88% | 5.48% | -1.72% | 0.88% |
| 34-2A-5 | RP 52.0 | -0.19% | 8.29% | -5.83% | -2.19% | -2.82% |
| Average | | 0.35% | 3.37% | 1.88% | -1.29% | 0.21% |

[i] *Automatic Traffic Recorder (ATR), A-020*

AAGRs were estimated based on the values in **Table 11** for low-, medium-, and high-growth scenarios. The low-growth scenario represents average conditions experienced over the past 20 years. The medium-growth scenario reflects conditions experienced during the early 2000s, and the high-growth scenario describes the traffic growth during the 1990s. These growth scenarios were used to project AADT values for 2035 as seen in **Table 12**.

**Table 12: Projected Traffic Data (2035)**

| Site | Location | Existing AADT[ii] | Projected AADT (2035) | | |
|---|---|---|---|---|---|
| | | | Low Growth (0.35%) | Medium Growth (1.5%) | High Growth (3.3%) |
| 34-3-10 | RP 0.12 | 4,203 | 4,571 | 6,009 | 9,162 |
| 34-3-9 | RP 0.64 | 3,490 | 3,795 | 4,989 | 7,607 |
| 34-3-1 | RP 4.0 | 2,080 | 2,262 | 2,973 | 4,534 |
| 34-3-2/A-20[i] | RP 16.8 | 1,707 | 1,856 | 2,440 | 3,601 |
| 34-3-3 | RP 32.0 | 2,103 | 2,287 | 3,007 | 4,585 |
| 34-2-2 | RP 49.6 | 3,227 | 3,509 | 4,613 | 7,033 |
| 34-2A-5 | RP 52.0 | 4,480 | 4,872 | 6,404 | 9,765 |
| Average | | 3,041 | 3,307 | 4,348 | 6,630 |

[i] *Automatic Traffic Recorder (ATR), A-020*

[ii] *Existing AADT based on an average of 2010 and 2012 values to account for yearly variation.*

### 4.2.2 Seasonal Variations in Traffic

Due to the high recreational use of lands in the area and access the route affords to YNP, notable seasonal peaks in traffic volumes occur due to recreational travel. **Figure 3** shows the variation in traffic on US 89 at ATR Station A-020 by month for 2012 and 2000. The highest traffic volumes of the year occur from June through August. The lowest amount of travel occurs in January and December. Traffic volumes for July are nearly double those of the AADT volume at the ATR site. In 2012, the peak average volume was approximately 175 percent of the AADT. During the lowest travel months, the volumes were slightly more than half of the AADT volume at the ATR site.

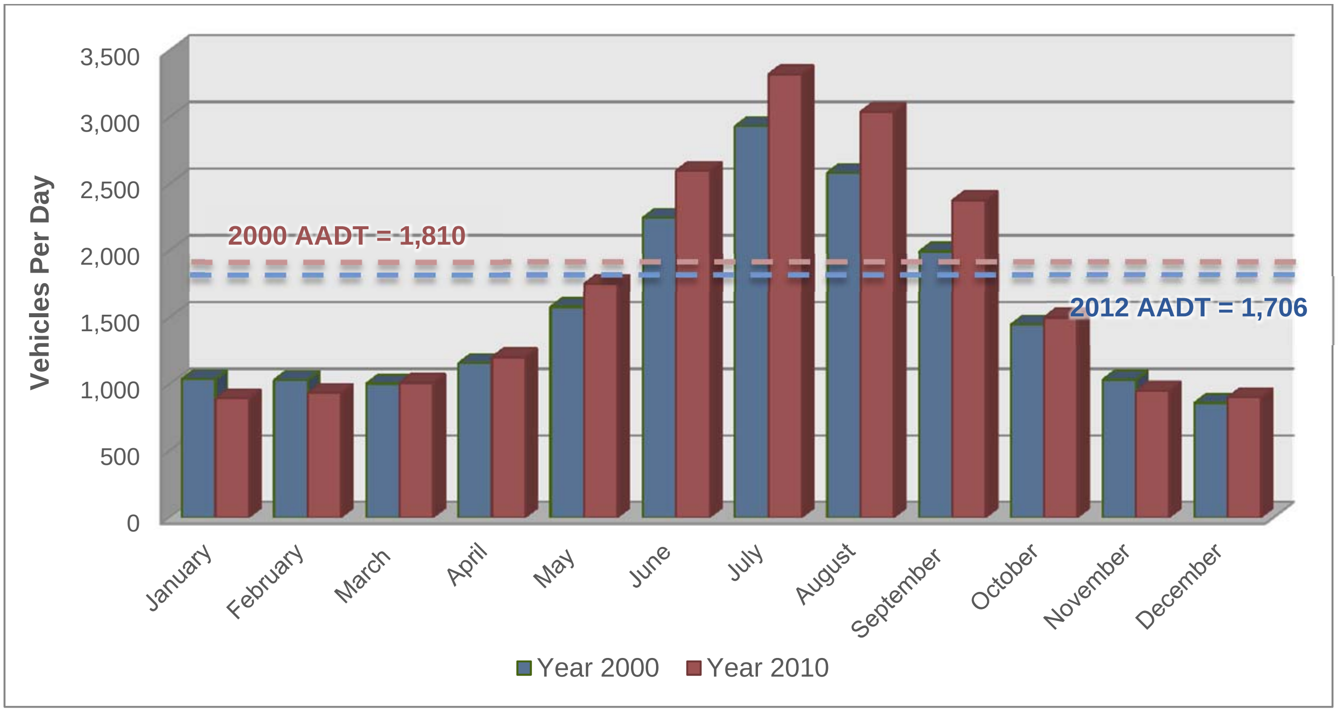



**Figure 3: Monthly Variations in Traffic at ATR Station A-020**

**Table 13** shows the AAGR at the ATR station during the peak season. In general, traffic volumes increased at a lower rate during the peak seasons than during the entire year as represented by the AADT. Between 1993 and 2012, peak traffic volumes showed a negligible, or even negative, growth rate at the ATR station.

**Table 13: ATR Station A-020 Average Annual Growth Rate – Peak Season**

| Month | Existing AADT | Average Annual Growth Rate | | | | |
|---|---|---|---|---|---|---|
| | | 1993 - 2012 | 1993 - 1999 | 2000 - 2005 | 2006 - 2012 | 2000 - 2012 |
| June | 2,599 | 0.03% | -1.27% | 1.14% | 1.96% | 1.03% |
| July | 3,321 | 0.02% | -1.14% | 0.50% | 2.61% | 1.02% |
| August | 3,040 | -0.25% | -1.15% | -0.46% | 3.78% | 1.10% |
| **Peak Average** | **2,987** | **-0.07%** | **-1.18%** | **0.36%** | **2.81%** | **1.05%** |

Peak season traffic volumes increased since 2000, with the highest AGR occurring over the past seven years. **Table 14** provides projected 2035 peak season traffic volumes for the ATR site under low-, medium-, and high-growth scenarios.

**Table 14: ATR Station A-20 Projected Traffic Data (2035) – Peak Season**

| Month | Existing AADT | Projected AADT (2035) | | |
|---|---|---|---|---|
| | | Low Growth (0.35%) | Medium Growth (1.00%) | High Growth (2.8%) |
| June | 2,599 | 2,816 | 3,267 | 4,905 |
| July | 3,321 | 3,599 | 4,175 | 6,268 |
| August | 3,040 | 3,294 | 3,822 | 5,737 |
| **Peak Average** | **2,987** | **3,237** | **3,755** | **5,637** |

## 4.2.3 Highway Capacity and Level of Service

Capacity and Level of Service (LOS) are two terms used to describe traffic conditions and corridor operation. Capacity is intended to represent the theoretical ability of the roadway to handle a defined amount of traffic. LOS is used to describe the performance of the roadway from the driver's perspective. Both of these parameters are looked at when comparing corridor performance.

Individual roadway capacity varies greatly and is calculated based on the procedures identified in the *Highway Capacity Manual*. For planning and comparison purposes, a discussion about the relationship between highway capacity and LOS is provided. This discussion is not intended to be used to set any thresholds for roadway performance, but rather provide some general information to be used to compare roadway performance.

**Table 15** shows generalized daily service volumes for use in planning and preliminary design. The daily service volumes shown in the table represent the maximum traffic volume that can theoretically be accommodated by the roadway segment. The values shown in this table are intended as generalized planning values. For example, for this class of roadway, an upper range traffic volume between 5,600 vpd and 7,300 vpd may be accommodated while achieving a LOS C.

**Table 15: Generalized Daily Service Volumes**

| Level of Service | Daily Capacity Range Limit |
|---|---|
| LOS B | **3,300 - 4,000** |
| LOS C | **5,600 - 7,300** |
| LOS D | **11,500 - 13,100** |
| LOS E | **24,100 - 24,900** |

*Source: Highway Capacity Manual 2010, Chapter 15 / Two-Lane Highways, page 15-42*

The maximum number of vehicles that could theoretically be accommodated on a roadway (i.e. physical capacity) is generally greater than the number typically acceptable to driver perception. The physical capacity of a roadway is based on roadway geometrics and other design factors and is generally higher than what a typical driver in a rural community would anticipate.

Roadway LOS is intended to provide a comparison value to represent the driver's perception of the roadway performance. The LOS is based on a combination of factors, all of which play a part in the driver's perception of how the roadway is performing. When drivers experience delays due to reduced travel speeds, lack of passing opportunities, heavy vehicles in the traffic stream, and steep roadway grades, the roadway LOS deteriorates. The following provides a description of each LOS as defined by the *Highway Capacity Manual.*

- **LOS A:** Represents free-flow conditions. Motorists experience high operating speeds and little difficulty in passing. Platoons of three or more vehicles are rare.

- **LOS B:** Passing demand and passing capacity are balanced. The degree of platooning becomes noticeable. Some speed reductions are present but are still relatively small.
- **LOS C:** Most vehicles are traveling in platoons. Speeds are noticeably curtailed.
- **LOS D:** Platooning increases significantly. Passing demand is high, but passing capacity approaches zero. A high-percentage of vehicles travel in platoons, and the time-spent-following is quite noticeable.
- **LOS E:** Demand is approaching capacity. Passing is virtually impossible, and the time-spent-following is more than 80 percent. Speeds are seriously curtailed.
- **LOS F:** Exists whenever demand flow in one or both directions exceeds the capacity of the segment. Operating conditions are unstable, and heavy congestion exists.

A LOS analysis was conducted using *Highway Capacity Software 2010* for two-lane highways. The results of the analysis are shown in **Table 16**. More detailed data is contained in **Appendix D**.

**Table 16: Highway Segment Level of Service**

| Site | Begin RP | End RP | Segment Length (mi) | 2012 AADT | % No-Passing | Access Point Density (per mile) | Level of Service | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Average Annual | | Peak Season(ii) | |
| | | | | | | | 2012 | 2035 | 2012 | 2035 |
| 34-3-10 | 0 | 0.4 | 0.4 | 3,260 | 100 | 40 | C | C | C | D |
| 34-3-9 | 0.4 | 2.4 | 2.0 | 2,680 | 73 | 21 | B | B | C | C |
| 34-3-1 | 2.4 | 10.4 | 8.0 | 1,830 | 53 | 9 | C | C | D | D |
| 34-3-2/A-20(i) | 10.4 | 24.4 | 14.0 | 1,710 | 55 | 4 | C | C | C | D |
| 34-3-3 | 24.4 | 40.7 | 16.3 | 1,840 | 28 | 4 | B | C | C | C |
| 34-2-2 | 40.7 | 50.6 | 9.9 | 2,710 | 38 | 6 | C | D | D | D |
| 34-2A-5 | 50.6 | 52.4 | 1.8 | 3,970 | 100 | 20 | C | C | C | D |

*Highway Capacity Software 2010*

(i) *Automatic Traffic Recorder (ATR), A-020*

(ii) *Peak season rates were determined based on data from the ATR site (A-020); see* ***Section 4.2.2*** *for more detail.*

Note that the MDT *Traffic Engineering Manual* lists a target LOS of B for a NHS Non-Interstate with level / rolling terrain. Based on the analysis shown in **Table 16**, segments of US 89 are currently operating at, or near, the target LOS for this facility.

The LOS of the highway can be improved by reducing vehicular traffic and/or increasing roadway capacity. The capacity can be increased by providing additional passing opportunities and by reducing access density. Additional passing opportunities may be provided by decreasing the no passing zones (through pavement striping), or by constructing dedicated passing lanes.

## 4.3 Right-of-Way and Jurisdiction

Ownership of the land in the corridor is a mix of private and public. Various state and federal entities hold public land. There are also many areas held in easement for nongovernmental conservation groups such as the Gallatin Valley Land Trust, Montana Land Reliance, the Rocky Mountain Elk Foundation, and the Nature Conservancy. Montana Fish, Wildlife & Parks (FWP) also holds easements along the corridor. Adjacent to the highway, much of the land is in private ownership with low to moderate intensity development. Right-of-way widths vary within the corridor and typically range from 160 to 200 feet or more.

## 4.4 Crash Analysis

The MDT Traffic and Safety Bureau provided crash data for US 89 between RPs 0.0 and 52.5 from July 1, 2007, through June 30, 2012. Records show 286 crashes occurring on this section of roadway during the crash analysis period. One crash resulted in a fatality, 19 crashes produced incapacitating injuries, 35 crashes produced non-incapacitating injuries, and 11 crashes produced possible injuries. An incapacitating injury is defined as an injury, other than a fatality, which prevents the injured person from walking, driving, or normally continuing the activities they were capable of performing before the injury.

**Table 17** provides a comparison of the crash rate, crash severity index, and crash severity rate on US 89 within the study area to the statewide averages for Non-Interstate NHS Routes. Information in the table comes from the Traffic and Safety Bureau. A percent difference between the statewide and US 89 rates was calculated for comparison purposes. The crash data presented in the table are based on crashes occurring from calendar years 2007 through 2011.

Crash rates are defined as the number of crashes per million vehicle miles of travel. For the US 89 corridor, the calculated crash rate was 1.27 crashes per million vehicle miles travelled. By comparison, the statewide crash rate for Non-Interstate NHS Routes in Montana was 1.01 crashes per million vehicle miles.

The crash severity index is the ratio of the sum of the level of crash degree to the total number of crashes. A crash severity index of 1.84 was calculated for the US 89 corridor, compared to the statewide average severity index of 2.05.

Crash severity rate is determined by multiplying the crash rate by the crash severity index. The US 89 corridor was determined to have a crash severity rate of 2.34 as compared to the statewide average rate of 2.07.

**Table 17: Crash Data Analysis (2007 – 2011)**

| Crash Data Location | Crash Rate | Crash Severity Index | Crash Severity Rate |
|---|---|---|---|
| **US 89 (RP 0.0 to 52.5)** | 1.27 | 1.84 | 2.34 |
| **Statewide Average for Non-Interstate NHS Routes** | 1.01 | 2.05 | 2.07 |

*Source: MDT Traffic and Safety Bureau, 2013*

### 4.4.1 Crash Trends, Contributing Factors, and Crash Clusters

On average, approximately 57 crashes occurred each year during the crash analysis period. Most of the crashes involved single vehicles (82 percent) and occurred on dry roads during clear or cloudy weather conditions. More than half (53 percent) of the crashes occurred in darkness or during low-light conditions (dawn or dusk). About 18 percent of the crashes during the analysis period happened when roads were icy, snowy, or wet. The primary contributing factors listed in crashes during the analysis period included alcohol or drug involvement (8 percent of crashes), driving too fast for conditions (6 percent of crashes), careless driving (5 percent of crashes), and failure to yield (5 percent of crashes).

Most of the crashes (95 percent) involved passenger vehicles (automobiles, pickups, SUVs, etc.). Records show seven crashes involving motorcycles, four involving trucks with trailers, and one each involving a bicycle and bus.

The main observed crash trend is wild animal encounters (142), 119 of which were deer, and 16 of which were elk. The second main observed crash trend is single-vehicle, run-off-the-road crashes (77). Of the single-vehicle, run-off-the-road crashes, 34 resulted in overturning. There have been 15 sideswipe crashes, 8 right-angle crashes, 9 rear-end crashes, and 9 domestic animal crashes.

About 6 percent of the reported crashes resulted in rollovers. The locations of these incidents were reviewed, and it was determined that these crashes were not concentrated in specific areas of the corridor.

MDT Safety Engineering Section personnel reviewed the section of US 89 from RP 1.2 to RP 49.7in 2010. As a result, a corridor-wide, shoulder-rumble-strip improvement was developed. The project is currently being completed under project SF 110 – Rumble Strips; UPN 7760000.

The section from RP 23.5 to RP 24.1 was identified as a crash cluster in 2012. As a result, the MDT Safety Engineering Section recommended installing a left-turn lane at the location. This modification is being advanced under project SF 129-Lft Turn Ln Emigrant RA, UPN 8024000.

Several other sections were identified as crash clusters over the 2009 through 2012 period, based on crash records. These areas are identified below:

- RP 13.623 to RP 14.124
- RP 24.95 to RP 25.51
- RP 33.3 to RP 33.8
- RP 39.7 to RP 40.25

After further review and analysis, the MDT Safety Engineering Section determined there were no specific crash trends at these locations.

## 4.4.2 Animal Carcasses

A review of the MDT Maintenance Animal Incident Database indicates that a minimum of 1,659 animal carcasses were collected on the corridor between January 2002 and December 2012. The carcass information from the database represents the number of animal carcasses recovered from the roadway and differs from Montana Highway Patrol (MHP) crash records presented in section 4.4.1. For starters, the period of record is different between the two. For MHP crash records, section 4.4.1 is based on a five-year data period (July 1, 2007, through June 30, 2012). For the carcass data, the period of record is for an eleven-year period. Also, the number of carcasses recovered is higher than the number of reported crashes involving animals as not all animal-vehicle collisions are reported to MHP. The 1,659 carcasses does not indicate 1,659 collisions. **Table 18** summarizes the large mammal species involved in the animal-vehicle collisions.

**Table 18: Large Mammal Carcasses**

| Large Animal | Carcasses Collected | % by Species |
|---|---|---|
| Antelope | 1 | 0.06% |
| Bighorn Sheep | 6 | 0.36% |
| Bison | 2 | 0.12% |
| Black Bear | 1 | 0.06% |
| Elk | 94 | 5.67% |
| Moose | 1 | 0.06% |
| Deer (unknown species) | 21 | 1.27% |

| | | |
|---|---|---|
| **Mule Deer** | 1,116 | 67.27% |
| **White-tailed Deer** | 417 | 25.13% |
| **TOTAL** | **1,659** | **100%** |

*Source: MDT Animal Incident Database, Jan 01, 2002 to Dec 31, 2012*

Deer accounted for over 93 percent of the carcasses collected along this section of US 89, with mule deer being the most common species. **Figure 4** shows the deer carcass density, per half mile segment, along the corridor. Peaks in recorded deer carcass density occur between RP 3 and RP 6, between RP 7 and RP 14, between RP 24 and RP 25, between RP 27 and RP 29, and near RPs 36, 40 and 52.

Other large mammal carcass data for the eleven-year period is shown on **Figure 5**. Of particular note on this figure is the portrayal of six bighorn sheep carcass locations. All six carcasses were collected between the months of November and July, near RPs 1.8, 4.8, 6.7, 12.8, and 14.2. There are also two bison carcasses noted on **Figure 5**, collected near RP 5 and RP 11. In order to limit bison movements to the area south of Yankee Jim Canyon, bison guards have been installed in the US 89 roadway as well as the county road on the west side of the Yellowstone River. Fencing was constructed adjacent to the bison guards, with gates that can be opened when bison are not present in Gardiner Basin. Currently the bison guards are installed and adjacent gates are closed from November through May, however FWP has an EA currently in progress proposing to allow bison to roam freely year-round. Refer to the MDT *Environmental Scan* for more detailed information on animal carcass data and large mammal migration routes and habitat.

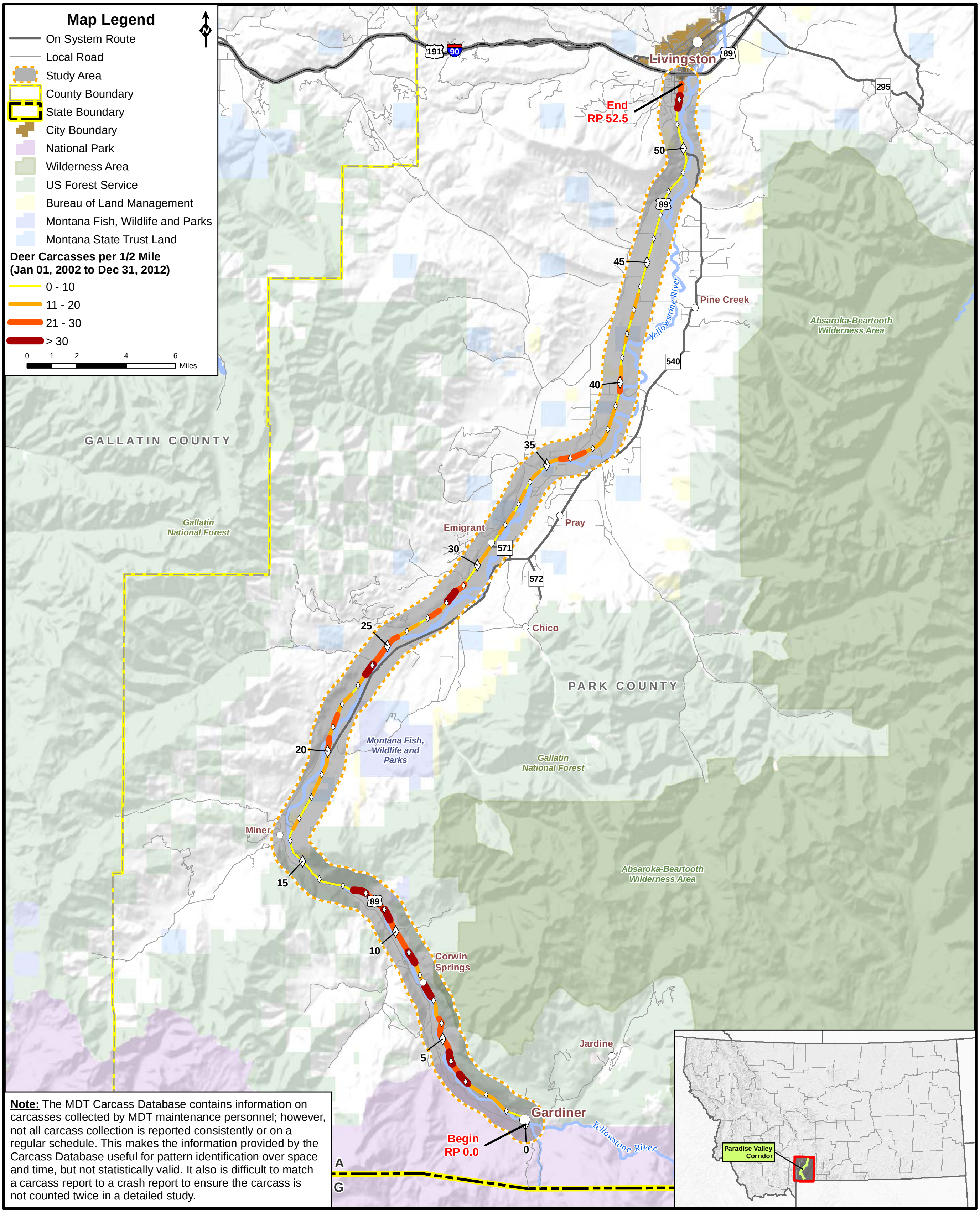
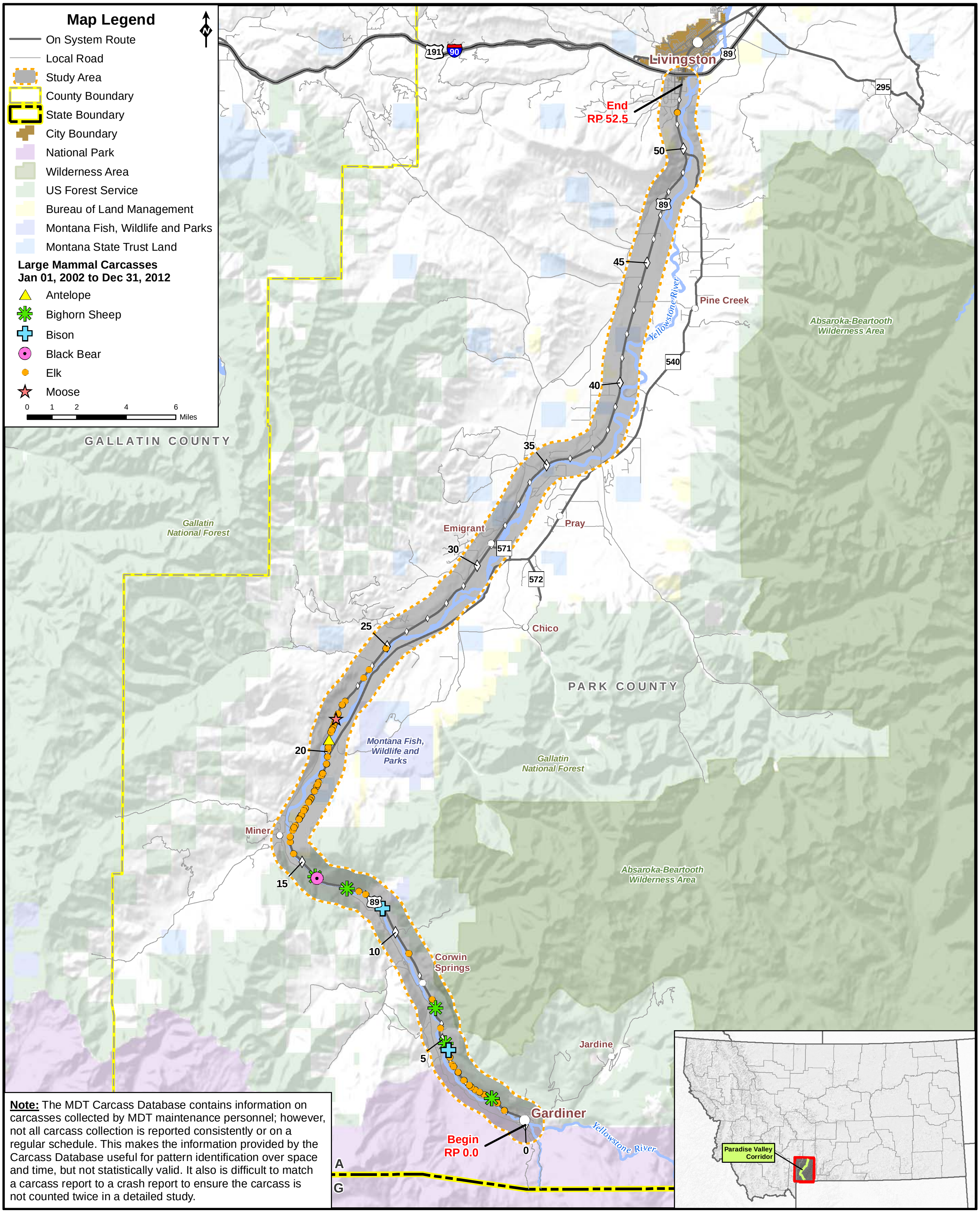



Figure 4: Deer Carcass Density - Per Half Mile




**Note:** The MDT Carcass Database contains information on carcasses collected by MDT maintenance personnel; however, not all carcass collection is reported consistently or on a regular schedule. This makes the information provided by the Carcass Database useful for pattern identification over space and time, but not statistically valid. It also is difficult to match a carcass report to a crash report to ensure the carcass is not counted twice in a detailed study.

**Figure 5: Large Mammal Carcasses**

## 4.5 Design Standards

The MDT *Road Design Manual* specifies general design principles and controls that determine the overall operational characteristics of the roadway and enhance its aesthetic appearance. The geometric design criteria for the study corridor are based on the current MDT design criteria for a "Rural Principal Arterials (National Highway System-Non-Interstate) Highway." Arterial highways are characterized by a capacity to move relatively large volumes of traffic quickly and a restricted-access-point function to serve adjoining properties. In both rural and urban areas, the principal arterials provide the highest traffic volumes and the greatest trip lengths. **Table 19** lists the current design standards for rural principal arterial (NHS-Non-Interstate) routes according to MDT design criteria.

The design speed for a rural principal arterial roadway ranges between 50 and 70 mph, depending on terrain. MDT's *Road Design Manual* contains the following definitions for each terrain type:

- **Level Terrain** – The available stopping sight distances are generally long or can be made to be so without construction difficulty or major expense.
- **Rolling Terrain** – The natural slopes consistently fall below and rise above the roadway and occasional steep slopes offer some restriction to horizontal and vertical alignment.
- **Mountainous Terrain** – Longitudinal and traverse changes in elevation are abrupt and extensive grading is frequently needed to obtain acceptable alignments.

Based on these definitions, most of the study area appears to be level terrain (70-mph design speed) with some areas of rolling terrain (60-mph design speed). A determination of terrain type (i.e., level or rolling) has not however, been made for the study corridor. For the purposes of this study, areas that do not meet MDT's minimum design standards for level terrain were considered areas of concern.

A facility's design speed and its operating speed differ. The design speed is a selected speed used to determine the various geometric design features of the roadway. The operating speed is the highest overall speed at which a driver can travel on a given section of roadway under favorable weather conditions and under prevailing traffic conditions without at any time exceeding the safe speed as determined by the design speed. Speed limit postings are typically determined by measuring the speeds 85 percent of the drivers are travelling at or below, and establishing signing for that speed within 5 mph of the result. This is typically referred to as the 85th percentile speed.

**Table 19: Geometric Design Criteria**

| Design Element | | | Design Criteria | | |
|---|---|---|---|---|---|
| Design Controls | Design Forecast Year (Geometrics) | | 20 Years | | |
| Design Controls | Design Speed (i) | Level | 70 mph | | |
| Design Controls | Design Speed (i) | Rolling | 60 mph | | |
| Design Controls | Design Speed (i) | Mountainous | 50 mph | | |
| Design Controls | Level of Service | | Level/Rolling: B Mountainous: C | | |
| Roadway Elements | Travel Lane Width | | 12' | | |
| Roadway Elements | Shoulder Width | | Varies | | |
| Roadway Elements | Cross Slope | Travel Lane (i) | 2% | | |
| Roadway Elements | Cross Slope | Shoulder | 2% | | |
| Roadway Elements | Median Width | | Varies | | |
| Earth Cut Sections | Ditch | Inslope | 6:1 (Width: 10') | | |
| Earth Cut Sections | Ditch | Width | 10' Min. | | |
| Earth Cut Sections | Ditch | Slope | 20:1 towards back slope | | |
| Earth Cut Sections | Back Slope; Cut Depth at Slope Stake | 0' - 5' | 5:01 | | |
| Earth Cut Sections | Back Slope; Cut Depth at Slope Stake | 5' - 10' | Level/Rolling: 4:1; Mountainous: 3:1 | | |
| Earth Cut Sections | Back Slope; Cut Depth at Slope Stake | 10' - 15' | Level/Rolling: 3:1; Mountainous: 2:1 | | |
| Earth Cut Sections | Back Slope; Cut Depth at Slope Stake | 15' - 20' | Level/Rolling: 2:1; Mountainous: 1.5:1 | | |
| Earth Cut Sections | 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 | DESIGN SPEED | | 50mph | 60 mph | 70 mph |
| Alignment Elements | Stopping Sight Distance (i) | | 425' | 570' | 730' |
| Alignment Elements | Passing Sight Distance | | 1835' | 2135' | 2480' |
| Alignment Elements | Minimum Radius (e=8.0%) (i) | | 760' | 1200' | 1810' |
| Alignment Elements | Superelevation Rate (i) | | $e_{max}$ = 8.0% | | |
| Alignment Elements | Vertical Curvature (K-value) (i) | Crest | 84 | 151 | 247 |
| Alignment Elements | Vertical Curvature (K-value) (i) | Sag | 96 | 136 | 181 |
| Alignment Elements | Maximum Grade (i) | Level | 3% | | |
| Alignment Elements | Maximum Grade (i) | Rolling | 4% | | |
| Alignment Elements | Maximum Grade (i) | Mountainous | 7% | | |
| Alignment Elements | Minimum Vertical Clearance (i) | | 17.0' | | |

*Source: MDT Road Design Manual, Chapter 12, Figure 12-3, "Geometric Design Criteria for Rural Principal Arterials (National Highway System-Non-Interstate), 2008*

*(i) Controlling design criteria (see Section 8.8 of the MDT Road Design Manual)*

## 4.6 Roadway Geometrics

Existing roadway geometrics were evaluated and compared to current MDT standards. The analysis was conducted based on a review of public information, MDT as-built drawings, Geographic Information Systems (GIS) data, and field observations. As-built drawings were available and were reviewed for most of the study corridor. Current as-built drawings were unavailable for the sections between RP 0.0 to RP 5.6, RP 10.7 to RP 16.6, and RP 49.9 to RP 52.5. Field reviews of the study corridor took place in May 2013 and July 2013 to confirm and supplement information contained in as-built drawings, as well as to identify additional areas of concern within the study area. **Appendix A** provides a log of photos taken during the field review. **Appendix B** contains summary tables of data from available as-built drawings.

### 4.6.1 Horizontal Alignment

Elements comprising horizontal alignment include curvature, superelevation (i.e., the bank on the road), and sight distance. These horizontal alignment elements influence traffic operation and safety and are directly related to the design speed of the corridor. MDT's standards for horizontal curves are defined in terms of curve radius, and they vary based on design speed. For a 70-mph design speed (level terrain) the maximum recommended radius is 1,810 feet. The minimum recommended radius for a 60-mph design speed (rolling terrain) is 1,200 feet.

Horizontal curve radius was determined based either on as-built drawings, or, for areas where current as-built drawings were unavailable, on estimates made by using aerial photography. Eight horizontal curves were identified that do not meet current MDT standards. **Table 20** provides a summary of the eight substandard horizontal curves.

**Table 20: Substandard Horizontal Curves**

| RP | Element | Value (ft) | Standard(s) Not Met |
|---|---|---|---|
| 0.24 | Radius | 450 [i] | Level, Rolling, Mountainous |
| 5.75 | Radius | 1,146 | Level, Rolling |
| 6.50 | Radius | 1,637 | Level |
| 13.85 | Radius | 1,000 [i] | Level, Rolling |
| 14.35 | Radius | 1,200 [i] | Level |
| 15.42 | Radius | 1,200 [i] | Level |
| 49.10 | Radius | 1,433 | Level |
| 49.35 | Radius | 1,433 | Level |

[i] *Current as-built drawings not available; values estimated based on aerial photography*

### 4.6.2 Vertical Alignment

Vertical alignment is a measure of elevation change of a roadway. The length and steepness of grades directly affect the operational characteristics of the roadway. The MDT *Road Design Manual* lists recommendations for vertical alignment elements such as grade, rate of vertical curvature (K-value), and stopping sight distance. Recommendations are made based on roadway classification and terrain type.

According to the *Road Design Manual*, the maximum allowable grades are 3 percent for level terrain and 4 percent for rolling terrain. For vertical curves, stopping sight distance, and K-values are controlling design criteria. K-values are defined as a function of the length of the curve compared to the algebraic change in grade, which comprises either a sag or a crest vertical curve. **Table 21** provides a list of substandard vertical alignment areas based on current as-built drawings. Vertical alignment was not analyzed for areas where current as-built drawings were unavailable.

**Table 21: Substandard Vertical Alignment Areas**

| RP | Element | Value | Standard Not Met |
|---|---|---|---|
| 8.33 | Vertical Curvature | 149.4 | Level |
| 8.33 - 8.56 | Grade | 4.06% | Rolling |
| 8.97 - 9.37 | Grade | -3.82% | Level |
| 9.37 | Vertical Curvature | 162.5 | Level |
| 18.94 - 19.17 | Vertical Curvature | 3.06% | Level |
| 49.19 | Vertical Curvature | 138.9 | Level |
| | Stopping Sight Distance | 574.7 | Level |

### 4.6.3 Roadside Clear Zone

The roadside clear zone, starting at the edge of the traveled way, is the total roadside border area available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a recovery area. The desired clear zone width varies depending on traffic volumes, speeds and roadside geometry. Clear zones are evaluated individually based on the roadside cross section. According to MDT, clear zone should be attained by removing or shielding obstacles, if costs are reasonable.

In certain instances within the study area, it may be impractical to protect or remove certain obstacles within the clear zone. As improvement options develop, roadside clear zones should be designated, to a practical extent, to meet current MDT design standards.

## 4.7 Passing Zones

Passing opportunities are provided along the corridor in areas where roadway geometrics allow. Passing areas are designated by broken yellow center pavement markings. No passing zones are established in areas where there is insufficient passing sight distance or near public approaches. The following information summarizes the guidelines for no-passing zones as contained in the MDT *Road Design*[1] *Manual*:

- For determining a no-passing zone, the distance along a driver's line-of-sight is measured from a 3.5-foot height of eye to a 3.5-foot height of object.
- For 2-lane rural highways on the NHS, the no-passing zone design speed will be 70 mph.
- The minimum passing sight distance required for a 70-mph no-passing zone design speed is 1,200 feet.
- The minimum length for a no-passing zone is 500 feet.
- If the length between successive no-passing zones in the same direction of travel is less than 1,000 feet, then the gap between the no-passing zones should be closed.
- A no-passing zone should be marked in advance of intersections at a minimum distance of 500 feet.

**Figure 6** shows the passing zones along the corridor as documented through on-site field review, aerial imagery from July 2011, and *Google Street View* imagery from August 2011. An analysis of the existing passing zones reveals that there are seven locations where passing zones are less than 1,000 feet long and one location where passing is allowed in front of a public approach.

[1] MDT Road Design Manual, Section 13.3, November 2007.

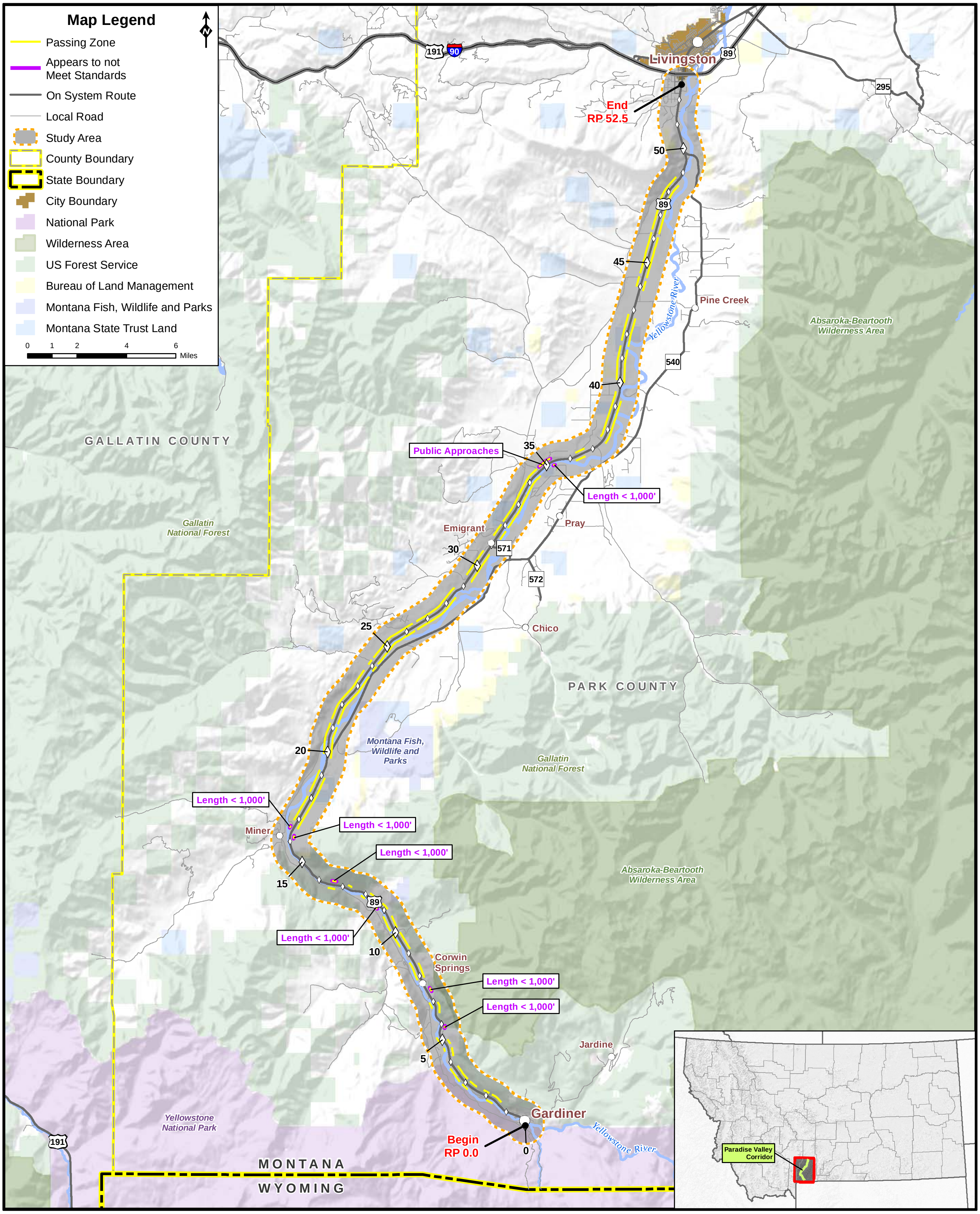



Figure 6: Existing Passing Zones

## 4.8 Roadway Surfacing

The corridor consists of paved roadway of varying widths, from 44 feet to 32 feet. Existing roadway surfacing characteristics were determined from MDT's *Montana Road Log* and on-site field review. The *Road Log* contains information for surface width, lane width, shoulder width, surfacing thickness, and base thickness. **Table 22** shows the typical width of the existing roadway and the surfacing type.

The MDT *Road Design Manual* requires a minimum travel lane width of 12 feet. The MDT *NHS Route Segment Plan* suggests a width of 40 feet or greater for the corridor. However, the *NHS Route Segment Plan* no longer defines the standard roadway width. The MDT Roadway Width Committee is responsible for determining the appropriate width during future project development. According to the *Road Log*, US 89 has a road width less than 40 feet from RP 1.1 to RP 53.048.

**Table 22: Existing Roadway Surfacing**

| Begin RP | End RP | Lanes | Typical Width | | | Surfacing | Last Surface | Last Treatment |
|---|---|---|---|---|---|---|---|---|
| | | | Surface | Lane | Shoulder | | | |
| 0 | 1.1 | 2 | 40 | 12 | 8 | Asphalt | 2003 | 2003 |
| 1.1 | 14 | 2 | 32 | 12 | 4 | Asphalt | 1998 | 2010 |
| 14 | 24 | 2 | 32 | 12 | 4 | Asphalt | 1998 | 2010 |
| 24 | 34 | 2 | 32 | 12 | 4 | Asphalt | 1998 | 2008 |
| 34 | 40.712 | 2 | 32 | 12 | 4 | Asphalt | 2001 | 2010 |
| 40.712 | 48.98 | 2 | 32 | 12 | 4 | Asphalt | 1999 | 2008 |
| 48.98 | 53.048 | 2 | 32 | 12 | 4 | Asphalt | 1999 | 2008 |

*Source: MDT Road Log, 2011*

## 4.9 Pavement Condition

Pavement condition indices are measured and tracked annually in the corridor by MDT. MDTs pavement management system (PvMS) is used to analyze the collected data to determine the relative performance of the pavement. Items of primary interest include the presence and degree of cracking and rutting, and overall ride quality. By understanding the condition of pavement, MDT can identify the most appropriate treatments and resources to extend pavement life. Several pavement condition indices are monitored through MDTs PvMS. The performance measures and corresponding indices are such that the numerical value of 100 is assigned to a new pavement with no flaws and zero is assigned to a highly degraded pavement. The following performance measures are routinely used to track pavement conditions:

- 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 associate cracking, and converting the index into a 0 to 100 scale
- Overall Performance Index (OPI) - Determined by combing 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 23: Pavement Condition Indices**

| Begin RP | End RP | Ride Index (IRI) | Rut Index (RI) | Alligator Crack Index (ACI) | Miscellaneous Cracking Index (MCI) | Overall Performance Index (OPI) |
|---|---|---|---|---|---|---|
| 0 | 1.1 | 62.00 | 67.67 | 93.42 | 98.48 | 58.50 |
| 1.1 | 14 | 73.08 | 67.48 | 97.80 | 94.92 | 64.92 |
| 14 | 24 | 81.27 | 74.64 | 95.60 | 97.32 | 71.89 |
| 24 | 34 | 78.95 | 74.19 | 96.34 | 97.21 | 70.94 |
| 34 | 40.712 | 80.62 | 75.69 | 95.69 | 97.58 | 72.26 |
| 40.712 | 48.98 | 81.75 | 68.99 | 97.78 | 97.56 | 70.49 |
| 48.98 | 53.048 | 78.59 | 63.92 | 94.45 | 97.67 | 64.83 |

*Source: MDT Pavement Management System, 2012*

The various pavement condition performance measures indicate a well maintained roadway with little immediate concern for surface treatment. For example, for the ride index performance measure, a ride index of 80 to 100 is considered “good”, 60 to 79.9 is “fair”, and 0 to 59.9 is “poor”. All of the sections noted in **Table 23** for ride index are in the good category or the upper end of the fair category. The exception is the first 1.1 miles of US 89 in Gardiner.

The most important performance measure is the overall performance index (OPI) as this is an index that includes all the aforementioned indices. All of the segments presented are in the fair to good category, again with the exception of the first 1.1 miles in Gardiner.

## 4.10 Access Points

Access points were identified through a review of available GIS data accessed in June 2011, and aerial photography from July 2011. Based on this review, there are approximately 341 access points along the corridor. Most of the access points are private/farm field approaches.

The angle of approach is the angle at which the approaching road intersects the major road. Desirably, approaching roadways should intersect at or as close to 90° as practical. Intersection skews greater than 30° from perpendicular are undesirable, as the driver’s line of sight for one of the sight triangles becomes restricted. Accordingly, based on MDT standards[2], the approach angle should be between 60° and 120°. **Table 24** provides a summary of access points grouped in incremental segments along the study area.

[2] Montana Department of Transportation, *Approach Standards for Montana Highways*, 1983.

**Table 24: Access Points**

| Location (RP) | | Length (mi) | Access Points | Density (Access / mi) | Skewed < 60° Angle | Comments |
|---|---|---|---|---|---|---|
| Begin | End | | | | | |
| 0 | 4 | 4.0 | 67 | 16.8 | 2 | Gardiner |
| 4 | 8 | 4.0 | 30 | 7.5 | 3 | Gardiner to Corwin Springs |
| 8 | 12 | 4.0 | 50 | 12.5 | 0 | North of Corwin Springs |
| 12 | 17 | 5.0 | 9 | 1.8 | 0 | Yankee Jim Canyon |
| 17 | 23 | 6.0 | 19 | 3.2 | 0 | East River Road |
| 23 | 29 | 6.0 | 32 | 5.3 | 1 | |
| 29 | 35 | 6.0 | 16 | 2.7 | 0 | Emigrant |
| 35 | 42 | 7.0 | 25 | 3.6 | 0 | Mill Creek |
| 42 | 49 | 7.0 | 24 | 3.4 | 5 | Pine Creek |
| 49 | 52.5 | 3.5 | 69 | 19.7 | 0 | South of Livingston |
| TOTAL | | 52.5 | 341 | 6.5 | 11 | |

## 4.11 Parking

On-street parking is provided in the Gardiner urban area. The MDT *Traffic Engineering Manual* provides guidelines for on-street parking facilities. The guidelines are shown in **Figure 7** and are summarized below[3]:

- Prohibit parking within 20 feet of any crosswalk.
- Prohibit parking at least 10 feet from the beginning of the curb radius at mid-block approaches.
- Prohibit parking from areas designated by local traffic and enforcement regulations.
- Prohibit parking within 30 feet from end of curb return on the approach leg to any intersection with a flashing beacon, stop sign or traffic signal.
- Prohibit parking on bridges.
- Eliminate parking across from a T-intersection.

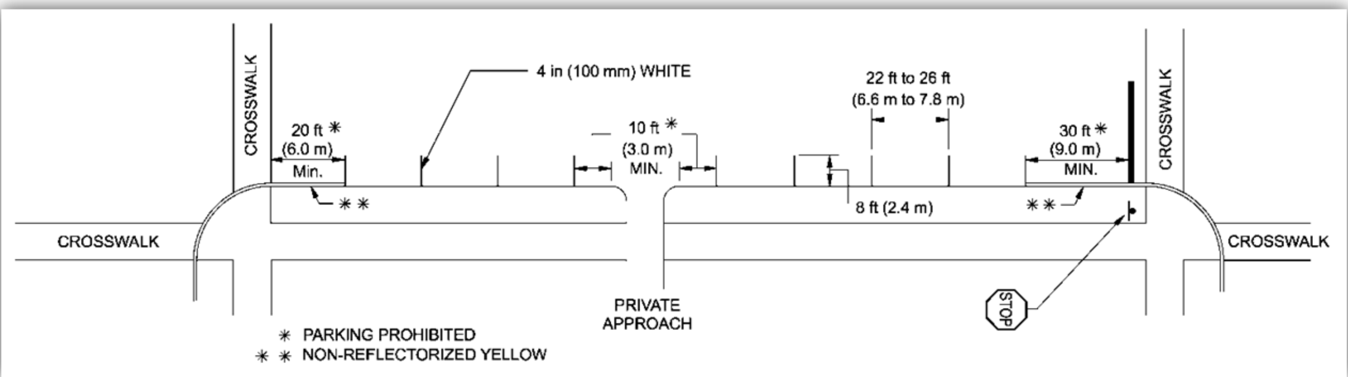



**Figure 7: Typical Markings for On-Street Parking[4]**

An inventory of existing on-street parking areas and crosswalk locations was conducted through on-site field review, aerial photography from July 2013, and *Google Street View* imagery from August 2011. **Figure 8** shows the existing parking areas and crosswalks in the Gardiner urban area.

[3] MDT Traffic Engineering Manual, Section 31.4.1.3, November 2007.
[4] MDT Traffic Engineering Manual, Figure 19.5i, November 2007

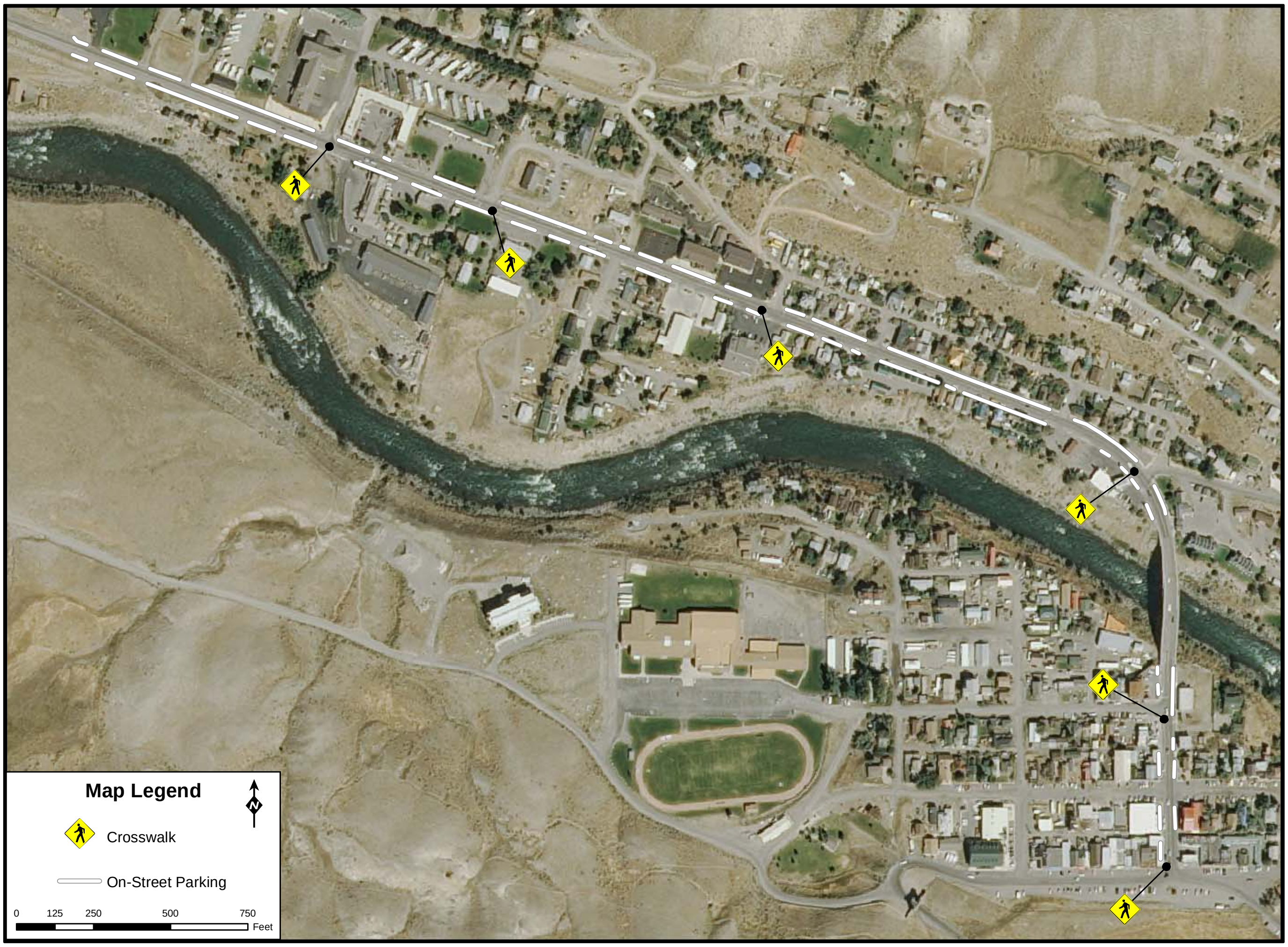



Figure 8: Existing On-Street Parking and Crosswalks

## 4.12 Special Speed Zones

Speed zones were reviewed by comparing on-the-ground speed limit signage with adopted statutory and special speed zones on record with MDT's Traffic and Safety Bureau. The intent of this review was to confirm speed limit signage on US 89 within the study area matches special speed zone beginning and ending reference posts. To perform this review, Google aerial imagery and field observations were utilized to confirm speed limit sign compliance with termini points of the special speed zones as documented by past Montana Transportation Commission resolutions. This review found that all special speed zones were signed in compliance with the Montana Transportation Commission resolutions. **Table 25** shows the locations of the special speed zones and the statutory speed areas, by reference post range.

**Table 25: Statutory and Special Speed Zones**

| Location (RP) | | Length (mi) | Area Name | Speed Limit |
|---|---|---|---|---|
| Begin | End | | | |
| 0.00 | 0.66 | 0.66 | Gardiner | 25 MPH |
| 0.66 | 0.87 | 0.21 | Gardiner | 35 MPH |
| 0.87 | 1.21 | 0.34 | Gardiner | 45 MPH |
| 1.21 | 1.45 | 0.24 | Gardiner | 55 MPH |
| 1.45 | 7.42 | 5.97 | | 70 MPH |
| 7.42 | 7.90 | 0.48 | Corwin Springs | 60 MPH |
| 7.90 | 30.78 | 22.88 | | 70 MPH |
| 30.78 | 31.17 | 0.39 | Emigrant | 55 MPH |
| 31.17 | 49.17 | 18.00 | | 70 MPH |
| 49.17 | 52.36 | 3.19 | Livingston | 55 MPH |
| 52.36 | 52.65 | 0.29 | Livingston | 45 MPH |
| 52.65 | 53.74 | 1.09 | Livingston | 35 MPH |

*Source: MDT Traffic and Safety Bureau, August 29, 2013.*
*Note: Corridor study terminus is RP 52.50. Speed information is shown to RP 53.74 to show continuity of 45 mph to 35 mph step-down thru Livingston.*

## 4.13 Hydraulics

### 4.13.1 Drainage Conditions

US 89 crosses the Yellowstone River at two locations within the study area. The corridor also crosses 11 named streams and several unnamed drainages. Runoff from the highway is typically directed to either or both shoulders depending on location and subsequently conveyed to outfall locations via graded roadside slopes and constructed roadside ditches.  A review of as-built plans identified more than 50 locations along the corridor where culverts were installed to convey runoff beneath US 89.

### 4.13.2 Bridges

Three bridge crossings and an arch culvert are located along the corridor according to the MDT *Bridge Management System*.  All structures have recent inspection reports available (**Appendix C**).  **Table 26** shows each structure, and lists the location, type, size, year constructed, and feature crossed.  All of the structures are open to full legal loads.

**Table 26: Bridge Locations and Type**

| Bridge Information | |
|---|---|
|  | **P00011000+01651 - GARDINER**<br>**Location:** RP 0.16<br>**Type of Bridge:** 3-span steel truss structure<br>**Dimensions:** 38' wide x 409'' long<br>**Year Constructed:** 1930<br>**Feature Crossed:** Yellowstone River |
|  | **P00011020+04171 - 11 MI SW OF EMIGRANT**<br>**Location:** RP 20.36<br>**Type of Bridge:** 4-span steel girder structure<br>**Dimensions:** 28' wide x 455' long<br>**Year Constructed:** 1958<br>**Feature Crossed:** Yellowstone River |
|  | **P00011024+00721 - 7 MI SW OF EMIGRANT**<br>**Location:** RP 24.02<br>**Type of Bridge:** 3-span concrete T-beam structure<br>**Dimensions:** 28' wide x 90' long<br>**Year Constructed:** 1960<br>**Feature Crossed:** Big Creek |
|  | **P00011047+09001 - 10 KM S LIVINGSTON**<br>**Location:** RP 47.74<br>**Type of Bridge:** Steel Culvert<br>**Dimensions:** 32' wide x 15' long<br>**Year Constructed:** 1964<br>**Feature Crossed:** Farm Access |

*Source: MDT Bridge Management System, 2012*

MDT's Highway Bridge Program (HBP) emphasizes asset management and preservation. This emphasis promotes a "right treatment at the right time" philosophy in prioritizing and selecting projects on MDTs bridge system. MDT has defined bridge program objectives and performance measures. The objectives and measures are intended to identify the right treatments for Montana's bridge assets, and are intended to promote cost effective bridge preservation, appropriate safety related work, and economic growth.

MDT uses a Structure Condition Performance Measure and a Deck Performance Condition Measure. These measures categorize bridge condition as Good, Fair, or Poor based on the condition rating given to the bridge Deck (riding surface), Superstructure (generally beams underneath the riding surface), and Substructure (support structure extending into the ground). These elements are ranked on a 0-9 scale during routine bridge condition inspections. Additionally, the Structure Condition Performance Measure assigns a Poor rating to a bridge that is Structurally Deficient. **Figure 9** illustrates the Structure Condition performance measure.

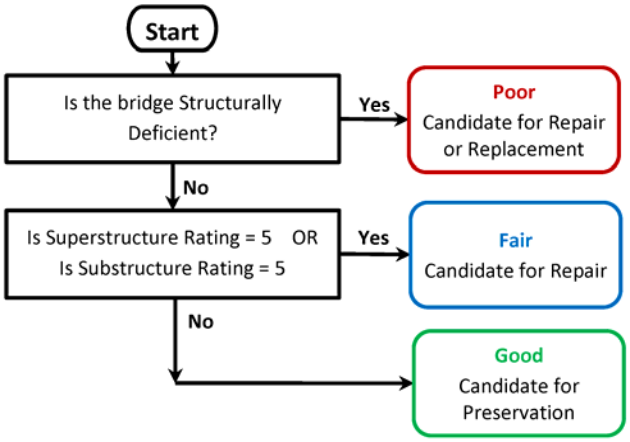



**Figure 9: Structure Condition Performance Measure**

A bridge is considered Structurally Deficient if load carrying elements have deteriorated enough to be considered to be in "poor condition" or the adequacy of the waterway opening provided by the bridge is insufficient causing intolerable traffic interruptions. When a bridge is classified as Structurally Deficient, it doesn't mean that it is unsafe. A Structurally Deficient bridge typically requires increased maintenance and repair to remain in service and eventual rehabilitation or replacement to address the overall deficiencies.

The Deck Condition performance measure uses the NBI deck rating to give an indication of the deck condition and a planning level indication of needed preservation treatment. The Deck Condition rankings are a general indicator of the condition of any individual deck. The rankings are useful for planning purposes on a system wide basis. **Figure 10** illustrates the Deck Condition performance measure.

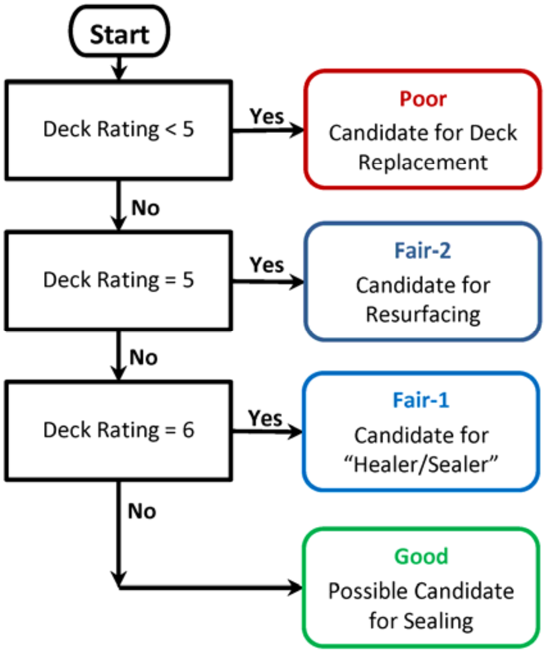



**Figure 10: Deck Condition Performance Measure**

**Table 27** shows the performance measure rankings, for the four structures within the study area. None of the bridges within the study are structurally deficient

The three bridges in the study area rank "good" for the Structure Condition performance measure, indicating they are candidates for continued preservation. The bridge decks (riding surfaces) are candidates for preservation treatments ranging from crack sealing to resurfacing.

**Table 27: Bridge Sufficiency Rating**

| Criteria | Bridge at RP 0.16 | Bridge at RP 20.36 | Bridge at RP 24.02 | Culvert at RP 47.74 |
|---|---|---|---|---|
| **Based on Inspection Form** | 04/18/2013 | 10/02/2012 | 01/02/2013 | 08/23/2011 |
| **Structure Condition Performance Measure** | GOOD | GOOD | GOOD | N/A* |
| **Deck Condition Performance Measure** | FAIR-2 | FAIR-1 | GOOD | N/A* |

** The Performance Measures are not applicable to culverts. This culvert is considered to be in "Good" condition.*
*Source: MDT Bridge Management System, 2012*

The Yellowstone River Bridge in Gardiner is a steel truss. Truss bridges are typically "fracture critical" meaning if one part of the truss should fail, the entire bridge span may fail. The bridge requires special fracture critical inspections to help safeguard against the possibility of a failure.

## 4.14 Geotechnical Considerations

### 4.14.1 Landslide Areas

The Montana Bureau of Mines and Geology (MBMG), in cooperation with MDT, completed a study and compilation of landslide data for MDT's Butte District (District 2) during 2002. The study identified more than 4,600 landslides within the district through field mapping, aerial reconnaissance, aerial photograph interpretation, and literature references. MBMG produced a database for identified landslide areas with key characteristics like location, type, geologic aspect, and size. A priority rating system was developed and assigned to areas with landslide clusters. The rating system (using values ranging from 1 to 5) helped determine areas with the highest priorities for more detailed landslide hazard investigations.

The study indicated that formations containing volcanic materials (due to the ash and clay content) and areas with poorly consolidated sediments are particularly prone to landslides. Causes and contributing factors to landslides are steep topography, previous glaciations, orientation of bedding, human activities, and stream undercutting. Landslide triggers can include earthquakes, increased moisture or water, and toe excavation. There was also a strong relationship between the locations of faults and landslides in the Butte District.

A portion of the study examined landslide occurrences and conditions in the Livingston and Gardiner areas. Landslides in the Livingston area are most often associated with debris flows, debris slides, and earth slides. In the Gardiner area, landslides include both debris and rockslides, as well as earth; debris; and rock flows. The Landslide Report identifies three landslide cluster areas adjoining US 89 within the study area. These cluster areas are discussed below.

- **Gardiner-Area 7**: Includes an area where landslides are located along tributaries of the Yellowstone and Gardiner Rivers. The area contains a large earth flow, debris slides, and very large debris flows. US 89 from RP 0 to approximately RP 5 lies within this cluster area which contains numerous faults and intrusive volcanic dikes that contribute to landslides. The earth flow and a debris slide are located immediately east of US 89 and the remaining landslides are on or near tributaries of the Yellowstone River. New or renewed movement could affect any or all of these features. This cluster area was assigned a medium priority (Priority 3) for more detailed study and risk assessment.

- **Gardiner-Area 1**: Parallels the Yellowstone River Valley and landslides occur on both sides of the valley. The cluster area contains a large debris slide/flow complex, large debris flows, and debris slides. US 89 from approximately RP 10 to RP 24 is located in the central portion of this landslide cluster area. New or renewed movement in this slide area could affect Big Creek, Tom Minor Creek, the Yellowstone River, and US 89. This cluster area was identified as a medium-high priority (Priority 2) for more detailed study and risk assessment.

- **Livingston-Area 12**: Includes the portion of US 89 from RP 47 to RP 51, and the majority of the landslide cluster is located west of the highway. Numerous faults and tight fold structures are present and there are debris slides and flows, and earth slides and flows found within the area. This cluster area was assigned a high priority (Priority 1) for more detailed study and risk assessment.

### 4.14.2 Rockfall Hazard Areas

MDT completed a Rockfall Hazard Classification and Mitigation System research project in September 2005[5]. As a result of the project, MDT implemented the Rockfall Hazard Rating System (RHRS) to provide the information needed to help the agency make informed decisions on where to invest the limited funding available for rockfall mitigation.

As part of the research project, an initial review of the state highway system (including US 89) was conducted, and more than 2,600 potential rockfall sites were identified using MDT's extensive photo log system. Input on the rockfall history and behavior information was then solicited from MDT Maintenance staff for each site. All identified sites were visited and categorized as being "A," "B," or "C" sites, denoting a high, moderate, or low potential to develop a hazardous rockfall situation. The project categorized 1,869 sites on the road system as either "A" or "B" sites, indicating their moderate to high potential to develop a hazardous rockfall situation. Sites in the "C" category were eliminated from further consideration due to their low rockfall hazard threat. Additional and more detailed ratings were conducted on the 869 "A" sites to narrow the list of sites and ultimately identify the top 100 A-rated sites on the state highway system.

The US 89 corridor contains 12 "A" or "B" rockfall hazard sites that were examined in the Rockfall Hazard Classification and Mitigation System research project and were incorporated into MDT's RHRS Database. **Table 28** identifies the RHRS sites that occur in the study area. Three of the sites along US 89 were included in the top 100 A-rated sites identified through the project.

[5] Landslide Technology, *Rockfall Hazard Classification and Mitigation System, Final Report*, FHWA/MT-05-011/8174, Prepared for State of Montana Department of Transportation Research Programs, September 2005.

**Table 28: Rockfall Hazard Rating System Sites**

| RP Start | RP End | Side of Road | Maintenance Rating | Preliminary Rating | Type |
|---|---|---|---|---|---|
| 6.01 | 6.06 | Right | B | B | B |
| 6.57 | 6.96 | Right | A | A | A |
| 12.2 | 12.46 | Right | A | B | B |
| 13.22 | 13.32 | Right | A | B | B |
| 13.32 | 13.66 | Right | A | A | A (TOP 100) |
| 13.66 | 13.84 | Right | A | B | B |
| 13.84 | 13.96 | Right | A | A | A (TOP 100) |
| 13.96 | 14.61 | Right | A | A | A (TOP 100) |
| 15.03 | 15.71 | Right | -- | B | B |
| 15.71 | 15.84 | Right | A | A | A |
| 48.99 | 49.17 | Left | B | B | B |
| 49.32 | 49.38 | Left | B | B | B |

*Source: Rockfall Hazard Classification and Mitigation System, Final Report, September 2005.*

## 4.15 Other Transportation Modes

### 4.15.1 Pedestrians and Bicyclists

A pedestrian/bicyclist path exists along the west side of US 89, from the roadway's intersection with East River Road (S-540) at RP 49.8, north past the end of the study area at Merrill Lane (approximately RP 52.5). A sidewalk was installed along US 89 north of Merrill Lane. Within Gardiner, sidewalks are provided along US 89 from about Hellroaring Street (RP 0.8), across the Yellowstone River Bridge, to RP 0.0 at Park Street. In the rural portions of the corridor, no dedicated pedestrian facilities exist along US 89. Pedestrians and bicyclists use the roadway shoulder for travel.

Recreational opportunities, including fishing access sites, trailheads, and the close proximity to YNP, bring occasional pedestrians and bicyclists to this corridor. The communities of Gardiner, Corwin Springs, and Emigrant are located along US 89, and activities within these areas may also generate some pedestrian and bicyclist use of the highway.

When the rail line from Livingston to YNP was abandoned, adjoining landowners generally acquired the easement for the line. USFS maintains a portion of the former rail easement for use as a walking path in Yankee Jim Canyon north of Gardiner.

Portions of US 89 within the study area are on the route of the Cycle Greater Yellowstone tour, a seven-day, fully supported bicycle tour of the Greater Yellowstone area in Montana and Wyoming. The 2013 tour will occur in August, and participants will begin in Livingston and travel to Gardiner via US 89 and S-540 on one day of the tour (August 19, 2013). Other communities along the tour include West Yellowstone, Ennis, Silver Gate/Cooke City, Cody, and Red Lodge. The event may accommodate up to 1,000 riders.

### 4.15.2 Transit

Currently there are no transit services within the study area. Between Livingston and Bozeman, five-day-per-week commuter bus service is available from the Human Resource Development Council (HRDC)/Streamline. Attempts by HRDC/Streamline to expand public transportation options into the study area have been unsuccessful.

Angel Line Transportation provides transportation to Senior Citizens (over 60) and disabled persons (all ages) needing special care in Park County. Angel Line transports people for various purposes that include medical appointments, recreation, shopping, and work. Transportation services typically are available Monday through Friday (except holidays) from 8:00am to 4:30pm. Services are available one or two days per month for Gardiner. This service must be requested at least one business day in advance.

The study area experiences considerable seasonal use by local, regional, and national tour bus and charter bus operators between April and October. Karst Stage and Rimrock Stages charter transportation for seasonal visitors to YNP from Livingston. Karst Stage also offers daily trips into YNP from Livingston. The trips depart from Livingston at 6:30 daily and travel to Bozeman, West Yellowstone, and through YNP before exiting at Gardiner and returning to Livingston 12 hours later.

At least one company offers private wildlife and scenic tours originating from Gardiner.

### 4.15.3 Air Service

There are two landing strips/airports within the study area: Gardiner Airport and the Flying Y Ranch Airport. Gardiner Airport is a public-use airport located 2 miles northwest of the community. The Gardiner Airport is located west of US 89 and is accessed via Airport Road at RP 1.9. Approximately 7,600 annual operations (takeoffs or landings) occur at the airport consisting of itinerant general aviation (53 percent of the operations), local general aviation (39 percent of the operations), and air taxi (8 percent of the operations).[6]

Flying Y Ranch Airport is a private airport, and permission is required before using the landing strip at the airfield. The facility is located approximately 14 miles south of Livingston (0.3-mile northwest of Mill Creek Road intersection with US 89 at RP 37.2).

Mission Field is a public use airport located 2 miles east of Livingston and is outside of the study area.

### 4.15.4 Rail

Montana Rail Link (MRL) owns and operates the railroad facilities at Livingston. A rail spur, located along the west side of US 89, begins north of Merrill Lane (at RP 52.5) and continues northward along US 89 to join the MRL main line in Livingston. A spur line to a lumber company crosses US 89 at RP 52.7. Railroad crossing warning signals with appropriate roadway signing and pavement markings exist at the spur line crossing. The crossing is beyond the northern boundary of the study area, but it was noted due to its close proximity.

## 4.16 Utilities

Park Electric Cooperative and Northwestern Energy Electric provide power. Overhead power lines are present intermittently along both sides of the highway within the study area and occasionally cross over the roadway. Large electrical substations exist east of the highway north of Gardiner at RP 1.6 and southwest of the intersection of US 89 and Tom Miner Creek Road near RP 16.6. NorthWestern Energy also provides natural gas service within the study area. Century Link provides telecommunication services to the study area and has intermittently been installing fiber-optic cable to provide upgraded communications infrastructure to Yellowstone National Park and the community of Gardiner. Individuals obtain water and sewer service by wells and septic tanks, respectively.

[6] AirNav, LLC, 2012, www.airnav.com.

# 5.0 ENVIRONMENTAL SETTING

This section provides a summary of the *Environmental Scan* developed by MDT[7]. The primary objective of the *Environmental Scan* is to determine potential constraints and opportunities within the study area. As a planning-level scan, the information is obtained from various reports, websites, and other documentation. This scan is not a detailed environmental investigation. Refer to the MDT *Environmental Scan* for more detailed information.

## 5.1 Physical Environment

### 5.1.1 Soil Resources and Prime Farmland

Information on soils was obtained to determine the presence of prime and unique farmland in the study area to demonstrate compliance with the Farmland Protection Policy Act. This act 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."

Farmland is defined by the act (in Section 4201) as including prime farmland; prime if irrigated farmland; unique farmland; and farmland, other than prime or unique farmland, that is of statewide or local 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 either can be 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, fiber, forage, and oilseed crops.

The CPA-106 Farmland Conversion Impact Rating Form for Linear Projects is a way for the Natural Resource Conservation Service (NRCS) to keep inventory of the prime and important farmlands within the state. Soil map units found within the study area have been classified as prime and important farmlands. If a project is forwarded and lands are acquired from these areas, and the project is funded with federal funds, MDT would complete a CPA-106 Farmland Conversion Impact Rating Form for Linear Projects and will coordinate with NRCS. NRCS uses information from that form to keep an inventory of the Prime and Important Farmlands within the state.

### 5.1.2 Geologic Resources

Information was obtained on geology in the study area. Seismic information was reviewed for fault lines and seismic hazard areas. This geologic information can help determine potential design and construction issues related to embankments and road design.

There are three designated faults within the study area, the Northern Section of the Emigrant fault, the Southern Section of the Emigrant fault, and the East Gallatin – Reese Creek fault system. Improvements brought forward from the study should be developed based on sufficient borings to evaluate the soils at the location where work is proposed to ensure suitability for the planned project. If unsuitable soil is encountered, increased costs for excavation, haul-off, and import of materials should be expected. Seismic design of highway infrastructure takes place in accordance with American Association of State Highway and Transportation Officials (AASHTO) guidelines.

[7] MDT Environmental, *Environmental Scan – Paradise Valley Corridor Study*, 2013.

### 5.1.3 Surface Waters

Maps and GIS data were reviewed to identify the location of surface water bodies within the study area, including rivers, streams, lakes, or reservoirs.

The main surface water in the study area is the Yellowstone River. Additionally, various surface waters, including streams, natural drainages, and wetlands, are also present in the area. Impacts on these surface waters may occur from project improvements such as culverts under the roadway, or rip rap armoring of banks. If a project is forwarded impacts should be avoided and minimized to the maximum extent practicable.

#### *5.1.3.1 Total Maximum Daily Loads Information*

US 89 travels through the Upper Yellowstone Watershed (Hydrologic Unit Code: 10070002) within the study area. Information on the Yellowstone River and its tributaries was obtained from DEQ's website. Section 303, subsection "d," of the Clean Water Act requires the State of Montana to develop a list, subject to US Environmental Protection Agency (EPA) approval, of water bodies that do not meet water quality standards. When water quality fails to meet state water quality standards, the Montana Department of Environmental Quality (DEQ) determines the causes and sources of pollutants in a sub-basin assessment and sets maximum pollutant levels, called total maximum daily loads (TMDLs).

A TMDL sets maximum pollutant levels in a watershed. The TMDLs become the basis for implementation plans to restore the water quality to a level that supports its designated beneficial 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.

The Upper Yellowstone watershed is listed in the 2012 Integrated 303(d)/305(b) Water Quality Report for Montana by DEQ. The water bodies within the Upper Yellowstone Watershed that are located in the study area are Category 5 and Category 4C. Category 5 water bodies are waters where one or more applicable beneficial uses have been assessed as being impaired or threatened, and a TMDL is required to address the factors causing the impairment or threat. Category 4C water bodies are waters where TMDLs are not required as no pollutant-related use impairment is identified. TMDLs have not yet been written for water bodies in this watershed. When TMDLs are prepared, and implementation plans are in place, if a project is forwarded, any construction practices would have to comply with the requirements set forth in the plan.

#### *5.1.3.2 Upper Yellowstone River Special Area Management Plan*

The US Army Corps of Engineers (USACOE) is responsible for issuing permits for work in the upper Yellowstone River in accordance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. The Yellowstone River is considered a Section 10 water from Emigrant to its confluence with the Missouri River.

The Upper Yellowstone River Special Area Management Plan (SAMP) covers the 86-mile stretch from the boundary of YNP to approximately seven river miles upstream of Springdale. The SAMP directs the USACOE to evaluate how a project may affect the entire watershed, floodplain, and valley before approving a permit.

The SAMP process created a Special River Management Zone (SRMZ), which is intended to provide enhanced protection within the 48-mile reach that is most susceptible to forced morphology. The SRMZ extends from approximately four river miles upstream Emigrant (river mile 531.8) to approximately seven river miles upstream of Springdale (river mile 483.6). If a project is forwarded, impacts on Waters of the United States associated project developments would require permitting from the USACOE. Impacts on

Waters of the United States within the SAMP/SRMZ would require specialized permitting from the USACOE. The USACOE will evaluate proposed transportation projects and potential impacts in detail, possibly making it more difficult to secure a Section 404 Permit. This difficulty and the potential increase in permitting time should be considered if improvements are forwarded from the study.

#### 5.1.3.3 Wild and Scenic Rivers

Congress created the Wild and Scenic Rivers Act in 1968 to provide for the protection of certain selected rivers, and their immediate environments, that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. The NPS website was accessed for information on river segments that may be located within the study area with a wild and scenic river designation. At this time, neither the Yellowstone River, nor any one of its tributaries, carries the wild and scenic designation.

#### 5.1.3.4 Groundwater

There are 5,444 wells are currently on record in Park County, and some of these wells exist within the study area. The wells in Park County have many different uses, with domestic use most common. If a project is forwarded from the study, impacts on existing wells would have to be considered.

#### 5.1.3.5 Wetlands

The USACOE 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.

Most of the wetland areas logically occur within the riparian bottomlands associated with the Yellowstone River, its tributaries, and the major draws coming out from the mountains. A notable amount of potential wetland area occurs in the valley, adjacent to the current highway alignment. Any project forwarded from this study has the potential to impact wetland areas, riparian areas, and streams.

If projects that could impact wetlands are forwarded from the study, formal wetland delineations would have to be completed. Future projects in the corridor would have to incorporate project design features to avoid and minimize adverse impacts on wetlands to the maximum extent practicable.

#### 5.1.3.6 Floodplains (EO 11988) and Floodways

Executive Order (EO) 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 flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. EO 11988 and 23 Code of Federal Regulations (CFR) 650 Part A requires an evaluation of project alternatives to determine the extent of any encroachment into the base floodplain. The base flood (100-year flood) is the regulatory standard used by federal agencies and most states to administer floodplain management programs. A floodplain is defined as lowland and relatively flat areas adjoining inland and coastal waters, including flood-prone areas of offshore islands, with a 1 percent or greater chance of flooding in a given year. As described in FHWA's floodplain regulation (23 CFR 650 Part A), floodplains provide natural and beneficial values serving as areas for fish, wildlife, plants, open space, natural flood moderation, water quality maintenance, and groundwater recharge.

#### 5.1.3.7 Irrigation

Irrigated grazing land exists in Park County adjacent to US 89 within the study area. Impacts on irrigation facilities should be avoided to the greatest extent practicable. However, depending on the improvement option(s) identified during the study, there is a potential to impact irrigation facilities. Irrigation canals, ditches, or pressurized systems that require modifications to the existing facilities will be redesigned and constructed in consultation with the owners to minimize impacts on agricultural operations. Additional expenses could be created if projects carried forward from the study create impacts on irrigation facilities.

### 5.1.4 Air Quality

EPA designates communities that do not meet National Ambient Air Quality Standards (NAAQS) as "non-attainment areas." States are then required to develop a plan to control source emissions and ensure future attainment of NAAQS. The Paradise Valley corridor is not located in a non-attainment area for Particulate Matter (PM-2.5 or PM-10) or Carbon Monoxide (CO). Additionally, there are no nearby PM-2.5, PM-10, or CO non-attainment areas. As a result, special considerations will not be required in future project designs to accommodate NAAQS non-attainment issues.

Depending on the scope of the project being considered along this corridor, an evaluation of Mobile Source Air Toxics (MSATs) may be required. MSATs are compounds emitted from highway vehicles and off-road equipment that are known or suspected to cause cancer or other serious health and environmental effects.

### 5.1.5 Hazardous Substances

The Montana Natural Resource Information System database was searched for underground storage tank (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 in the vicinity of the study.

There is a cluster of the before mentioned sites around the City of Livingston and the unincorporated community of Gardiner. These sites can be found intermittently throughout the entire study area. The following is a brief synopsis of the three main types of sites within the study area identified with potential contamination impacts, which should be avoided if possible. If a project is forwarded and UST, LUST, or contaminated soils are encountered, removal and cleanup is required, which would increase costs.

#### *5.1.5.1 Underground Storage Tanks*

Approximately 29 USTs were identified. Most of the USTs are from agricultural farms with limited site assessment data and imprecise GIS location data. In agricultural situations such as seen in the study area, the USTs usually are located within the farm, near the shop, and away from the highway. Additional investigation of the precise locations of the USTs may be warranted if a project progresses.

#### *5.1.5.2 Leaking Underground Storage Tanks*

Approximately 29 LUSTs were identified. Most of the releases from these LUST sites have been resolved or characterized by previous investigations. Only one LUST site is designated as having a high priority ranking assigned by DEQ, and it is not located directly adjacent to the study area. Therefore, it is not anticipated that LUST sites would adversely impact future projects that may advance from the study. However, further review and potential investigation may be necessary if the highway alignment changes.

#### *5.1.5.3 Abandoned and Inactive Mine Sites*

Abandoned and inactive mine sites were identified. Most of the mine sites are underground mines, and they could cause subsidence issues underneath or on the embankment above the highway if the horizontal alignment shifts considerably. Some of the mines have been reclaimed by the DEQ Abandoned Mine Section. It is not anticipated that mines identified during the environmental scan will adversely impact highway expansion, but additional investigation may be necessary if a project progresses.

## 5.2 Noise

Traffic noise may have to be evaluated if improvements to US 89 are forwarded within the study area. Noise analysis is necessary for Type I projects. If the roadway improvements are limited (e.g., the horizontal and vertical alignments are not changed, and the highway remains a two-lane facility), then the project would not be considered a Type I project. If the improvements planned for the road would include a substantial shift in the horizontal or vertical alignments, increasing the number of through-lanes, passing lanes, or turning lanes, or increasing the traffic speed and volume, then the project would be considered a Type I project.

A detailed noise analysis would be required if the forwarded project is considered a Type I project. The analysis would include measuring ambient noise levels at selected receivers and modeling design-year noise levels using projected traffic volumes. Noise abatement measures would be considered for the project if noise levels would approach or substantially exceed the noise abatement criteria. The noise abatement measures must be considered reasonable and feasible before implementation.

## 5.3 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.

The landscape throughout the study area contains an array of biological, scientific, historic, wildlife, ecological, geologic and cultural resources mixed with a remote location. The Roosevelt Arch marks the entrance to YNP near RP 0.0. YNP creates a large draw for many visitors to travel US 89 along the edge of the scenic Yellowstone River. The area along US 89 is a blended landscape that has been mildly developed, while still allowing the natural beauty to persevere. Evaluation of the potential effects on visual resources would have to be conducted if improvement options are forwarded from this study.

## 5.4 Biological Environment

Biological resources in the study area were identified using maps, aerial photographs, the endangered, threatened, proposed, and candidate species list for Montana counties (June 2013) from the US Fish and Wildlife Service (USFWS), Montana Natural Heritage Program data, and windshield surveys of the project site. This limited survey is in no way intended to be a complete and accurate biological survey of the study area. If a project is forwarded from the improvement option(s), consultations with FWP and USFWS field biologists on techniques to perpetuate the riparian corridor, promote fish passage, and accommodate wildlife movement and connectivity would occur, and a complete biological survey of the study area would have to be completed. Project costs may be higher than typically expected due to potential mitigation measures and should be budgeted in the planning process.

### 5.4.1 Wildlife

The information reflects a baseline natural resource condition of the study area. Depending on the level of detail available through the high-level baseline scan, some of the information has been provided at the county level, some at the corridor level (US 89 from RP 0.0 to RP 52.5), and some within the study area.

#### 5.4.1.1 Mammals

The study area is home to a variety of mammal species, including whitetail deer, mule deer, elk, moose, bison, bighorn sheep, black bear, mountain lion, gray wolf, mountain lion, and coyote. A herd of bighorn sheep occupy habitat in and around Corwin Springs and are frequently observed on or adjacent to US 89, especially during winter. Other common mammals potentially occurring in the project area include porcupine, raccoon, striped skunk, badger, bobcat, red fox, beaver, muskrat, Richardson's ground squirrel, deer mouse, vole species, and a variety of bat species.

A migratory population of bison resides within YNP during the summer months. The bison migrate to lower elevation wintering range within and adjacent to the Park during winter. Bison have a tendency to use road systems for travel. During winter months, they frequently are observed on or immediately adjacent to US 89 south of Yankee Jim Canyon. In order to limit bison movements to the area south of Yankee Jim Canyon, cattle guards have been installed along US 89 as well as on the county road on the west side of the Yellowstone River. Fencing was constructed adjacent to the cattle guards, with gates that can be opened when bison are not present in Gardiner Basin. Currently the cattle guards are installed, and adjacent gates are closed from November through May; however, FWP has an Environmental Assessment in progress to allow bison to roam freely year-round.

A bighorn sheep herd exists in the study area. Bighorn sheep can be found on both sides of US 89 from RP 4.0 to RP 23.0, but especially during the winter months in three areas: 1) from RP 0.0 to RP 2.0 (Gardiner area), 2) RP 4.0 to RP 9.0 (Corwin Springs area), and 3) between RP 14.0 and RP 21.0 (Tom Miner Basin area).

A discussion about animal-vehicle collisions is provided in **Section 4.4.2**.

#### 5.4.1.2 Amphibians and Reptiles

According to the Montana Natural Heritage Program - Natural Heritage Tracker database, which records and maps documented observations of species in a known location, amphibian species known to occur in Park County and potentially occurring in the study area include, but are not limited to, the Columbia spotted frog western toad, boreal chorus frog, northern leopard frog, barred tiger salamander, and plains spadefoot. More than a dozen invertebrate species, some listed as Montana Species of Concern (SOCs), have also been observed in the study area.

#### 5.4.1.3 Birds

According to the Natural Heritage database, a few hundred different species of birds documented in Park County have the potential to occur and nest in the study area. These species include representative songbirds, birds of prey, waterfowl, owls, and shorebirds, including several state SOCs. Most avian observations occur in the riparian draws and hillsides associated with the numerous drainages within the study area.

There are multiple bald and golden eagle nests located within the study area. Bald and golden eagles are protected under the Migratory Birds Treaty Act and are managed under the Bald and Golden Eagle Protection Act. Any improvements forwarded from this study should consider potential constraints that may result from nesting times of migratory birds and the presence of bald and golden eagles' nests.

#### 5.4.1.4 Threatened and Endangered Species

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

**Table 29: Threatened and Endangered Species in Park County**

| Common Name | Status |
|---|---|
| **Canada Lynx** | Listed Threatened, Critical Habitat |
| **Grizzly Bear** | Listed Threatened |
| **Greater Sage-Grouse** | Candidate |
| **Sprague's Pipit** | Candidate |
| **Wolverine** | Proposed |
| **Whitebark Pine** | Candidate |

A search of the Montana Natural Heritage Program's National Heritage Tracker database revealed that three of the six T&E species potentially in Park County have occurrence buffers overlapping the study area. These species are listed in **Table 30**.

**Table 30: Threatened and Endangered Species within the Study Area**

| Common Name | Status |
|---|---|
| **Canada Lynx** | Listed Threatened, Critical Habitat |
| **Grizzly Bear** | Listed Threatened |
| **Wolverine** | Proposed |

An evaluation of potential impacts on all endangered, threatened, proposed, or candidate species will have to be completed during the project development process.

#### 5.4.1.5 Species of Concern

Montana SOCs are 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 to address conservation needs proactively. Each species is assigned a state rank that ranges from S1 (greatest concern) to S5 (least concern).

A search of the Montana Heritage Program was conducted for Park County (March 14, 2013). Fifteen species of concern identified in Park County had the potential to occur in the study area based on the presence of suitable habitat and occurrence.

If a project is forwarded a field investigation for the presence and extent of these species should be conducted during the project design phase. If present, special conditions for project design or construction should be considered to avoid or minimize impacts on these species.

### 5.4.2 Fish

The Yellowstone River is the major water body that parallels and is crossed by US 89 within the study area. Multiple tributaries to the Yellowstone River also are crossed by the highway. The Montana Fisheries Information System (MFISH) database was reviewed for the Yellowstone River and numerous tributaries within the study area. The following fish species were noted as historically or currently occurring in the various waterbodies:

- Brook Trout
- Brown Trout

- Rainbow Trout
- Mottled Sculpin
- Longnose Dace
- Longnose Sucker
- Mountain Whitefish
- White Sucker
- Yellowstone Cutthroat Trout
- Rainbow Trout

Fish passage and/or barrier opportunities should be considered at affected drainages if a project is forwarded from this study. Permitting by regulatory and resource agencies would likely require incorporation of design measures to facilitate aquatic species passage.

### 5.4.3 Vegetation

A combination of predominantly coniferous forests and sagebrush steppe habitat dominate the hillsides and foothills. Riparian woodland and shrub land line the riparian corridors of the drainages, especially the Yellowstone River. Practices outlined in both Standard Specification 201, and any related supplemental specifications should be followed to minimize adverse impacts on vegetation.

### 5.4.4 Noxious Weeds

Noxious weeds can degrade native vegetative communities, choke streams, 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 114 exotic plant species and 15 noxious weed species documented in Park County, some of which may be present in the study area.

The study area will have to be surveyed for noxious weeds. County Weed Control Supervisors should be contacted regarding specific measures for weed control during project development if a project is forwarded.

### 5.4.5 Crucial Areas Planning System

The Crucial Areas Planning System (CAPS) is a resource intended to provide useful and non-regulatory information during the early planning stages of development projects, conservation opportunities, and environmental review. The finest data resolution within CAPS is at the square-mile section scale or waterbody. 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. CAPS was consulted to provide a general overview of the study area. CAPS results are presented in the *Environmental Scan*.

CAPS provides general recommendations and recommendations specific to transportation projects for both terrestrial and aquatic species and habitat. These recommendations can be applied generically to possible project locations carried forward from the study.

## 5.5 Cultural and Archaeological Environment

### 5.5.1 Recreational Resources

The Yellowstone River and its tributaries provide a variety of recreational opportunities for floaters and fishers. These recreational areas may be protected under federal law. Section 4(f) of the U.S. Department of Transportation Act of 1966 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 these properties unless there are no feasible and prudent avoidance alternatives and all possible planning to minimize harm has occurred.

Before 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 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 4(f) are substantially impacted. Section 4(f) resource information was gathered by review of both Montana Fish Wildlife and Parks resources list for Park County.

There are possible 4(f) recreational resources within the study area. These resources will have to be evaluated more in depth if improvements will affect these locations. The following camping and picnic areas were identified within the study area:

- Yankee Jim Picnic Area
- La Duke Picnic Area
- Cinnabar Picnic Area
- Sphinx Creek Picnic Area
- Canyon Campground
- Gardiner Community Park

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 land and water conservation funds. The Secretary of the Interior must approve any conversion of LWCFA-encumbered property to a use other than public, outdoor recreation. At this time, there are Section 6(f) resources identified in the study corridor, with most being fishing accesses (refer to the Environmental Scan for a complete list of 6(f) resources. Impacts on 6(f) resources should be avoided; 6(f) use is a lengthy process involving rigorous mitigation requirements and approvals from several resource agencies.

### 5.5.2 Cultural Resources

If a project is federally funded, MDT will conduct a cultural resource survey of the Area of Potential Effect for this project 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 any adverse effects on historic properties. Special protections for these properties are also afforded under Section 4(f) of the Transportation Act.

The study area contains several known cultural resources. Cultural resources will not likely be a substantial issue, but the issue is important to address as planning progresses.

A file search of the Montana State Historic Preservation Office revealed eight historic properties located within the study area. **Table 31** lists the properties, their approximate locations, and National Register of Historic Places (NRHP) eligibility. All of the sites have been previously recorded, and their NRHP status established. In addition, 13 NRHP historic and archaeological properties are located within 1 mile of US 89, but are likely outside the impact area for this study.

**Table 31: Historic Properties**

| Site | Site No. | NRHP Eligibility | RP± |
|---|---|---|---|
| Roosevelt Arch | 24PA0765 | Listed | N/A |
| Yellowstone R. Bridge at Gardiner | 24PA0790 | Yes | 0.1 |
| Electric Mines/Electric HD | 24PA0483 | Yes | 7± |
| OTO Homestead and Dude Ranch | 24PA1227 | Listed | 15± |
| Carbella Bridge | 24PA1237 | Listed | 15± |
| Emigrant Crossroad Arch. | 24PA0969 | Yes | |
| Park Branch Canal | 24PA1114 | Yes | 40± |
| Carter Bridge | 24PA0817 | Listed | S-540 |

If a project is forwarded from the study, a cultural resource survey for unrecorded historic and archaeological properties within the Area of Potential Effect will be completed during the project development process. Flexibility in design will be important to avoid and/or minimize impacts on historically significant sites.

# 6.0 AREAS OF CONCERN AND CONSIDERATION SUMMARY

This section provides a list and description of areas of concern and consideration within the study area. These areas were identified through review of as-built drawings, field review, public databases, and other resources. More discussion has been provided in the previous sections, and it is reiterated here as appropriate.

## 6.1 Transportation System

The following transportation system areas of concern were noted:

**Level of Service**

- Segments of US 89 are currently operating at, or near, the target LOS for this facility.

**Horizontal Alignment**

- Eight horizontal curves do not meet current standards.

**Vertical Alignment**

- Four vertical curves do not meet current standards.
- Two locations have grades that do not meet current standards.

**Safety**

- Numerous animal-vehicle collisions occurred between January 2002 and December 2012.

**Passing**

- Seven passing zone locations do not meet current standards based on length.
- One passing zone does not meet standards near public approaches.

**Surfacing**

- US 89 from RP 1.1 to the end of the study area has a 32 foot roadway width which is less than the recommended standard of 40 feet or greater.

**Access Points**

- Eleven approaches do not meet current standards based on intersection angles.

**Parking**

- Locations with on-street parking in the Gardiner urban area do not appear to meet current standards.

**Geotechnical**

- Three landslide cluster areas were identified within the study area.
- Twelve rockfall hazard sites were identified, including three “top 100” sites.

## 6.2 Environmental Considerations

The following environmental considerations were noted:

**Prime Farmland**

- Areas of prime farmland are located within the study area.

**Geologic Resources**

- Three designate faults are located within the study area.

**Surface Waters**

- A Special River Management Zone exists for the Yellowstone River from Emigrant to Springdale.

**Hazardous Substances**

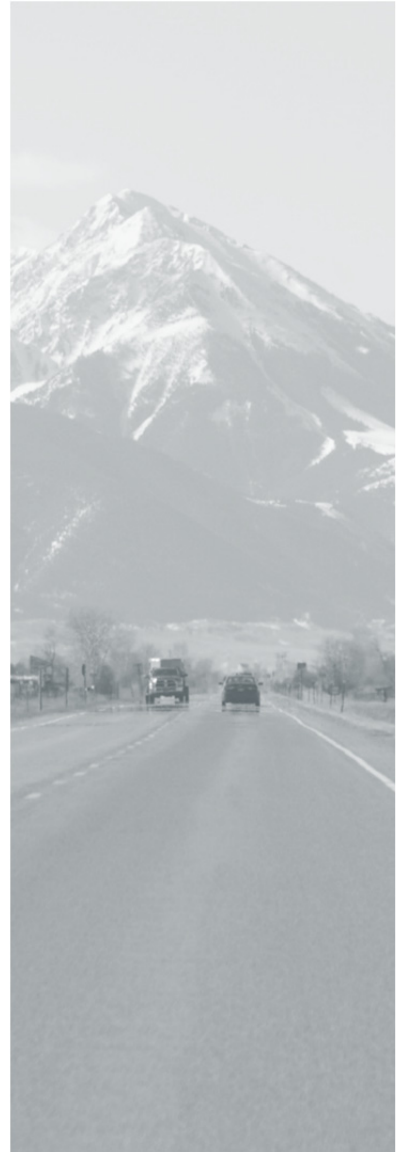
- One leaking UST is designated as having a priority ranking assigned by DEQ within the study area.
- Abandoned and inactive mine sites were identified within the study area.

**Wildlife**

- Six endangered, threatened, proposed, or candidate species are listed for Park County.
- Three endangered, threatened, proposed, or candidate species occur in the study area.
- Fifteen species of concern have the potential to occur in the study area.

**Cultural and Archaeological Environment**

- There are multiple 4(f) and 6(f) resources located within the study area.
- Eight historic properties were identified within the study area.



# APPENDIX A

*Field Review Photo Log*

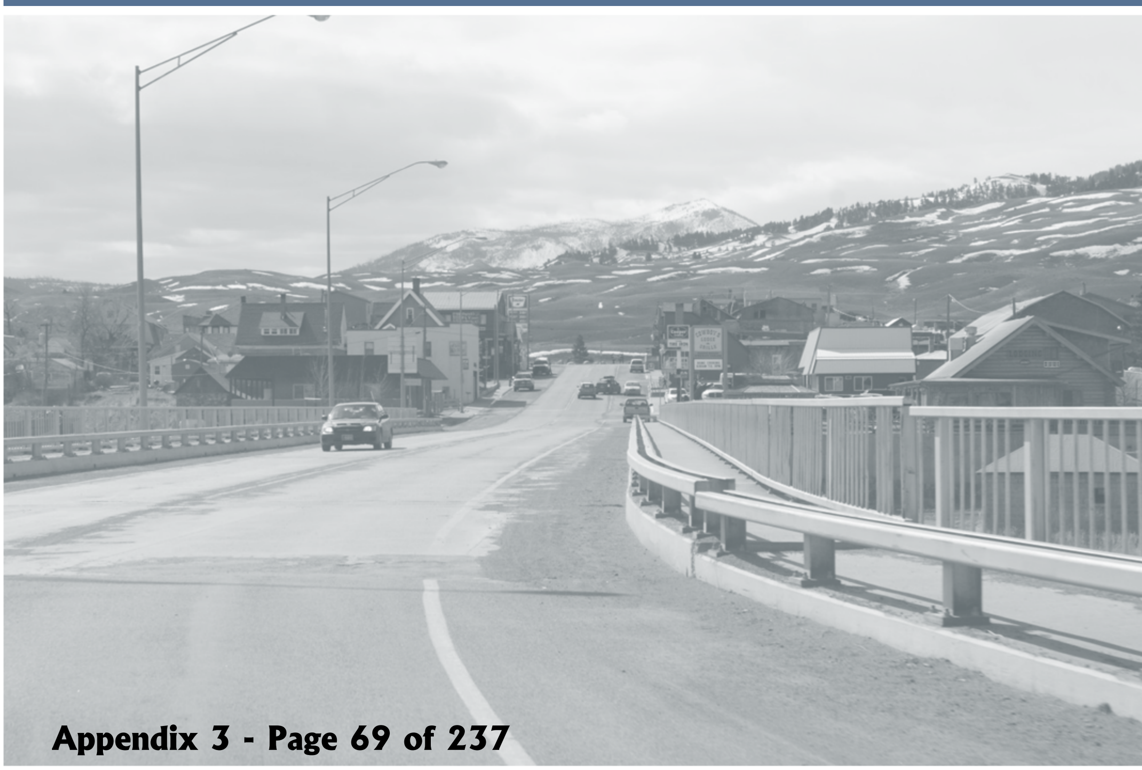



PHOTO 1: RP 0.0, IN GARDINER LOOKING NORTH AT THE INTERSECTION WITH PARK STREET


PHOTO 2: RP 0.3, IN GARDINER LOOKING WEST


PHOTO 3: RP 0.4, IN GARDINER LOOKING WEST (NOTE PARKING)


PHOTO 4: RP 0.6, IN GARDINER LOOKING WEST


**PHOTO 5: RP 1.0, LEAVING GARDINER IN A WESTERLY DIRECTION**

**PHOTO 6: RP 2.0, US 89 NEAR THE GARDINER AIRPORT (LOOKING WEST)**

PHOTO 7: RP 3.1, LOOKING NORTHWEST

PHOTO 8: RP 4.3, LOOKING NORTH

PHOTO 9: RP 5.2, LOOKING NORTHWEST

PHOTO 10: RP 6.0, LOOKING NORTH

PHOTO 11: RP 6.8, LOOKING NORTHWEST

PHOTO 12: RP 8.0, LOOKING NORTH


**PHOTO 13: RP 8.9, LOOKING NORTHWEST (NOTE CHANGE IN ROAD GRADE)**

**PHOTO 14: RP 10.0, LOOKING NORTHWEST**

PHOTO 15: RP 10.8, LOOKING NORTHWEST

PHOTO 16: RP 12.0, LOOKING WEST

PHOTO 17: RP 13.0, LOOKING WEST (ENTERING YANKEE JIM CANYON)

PHOTO 18: RP 13.5, LOOKING WEST (NOTE ROCKFALL ON RIGHT)

PHOTO 19:  RP 13.5, LOOKING WEST (NOTE ROCKFALL ON RIGHT)

PHOTO 20: RP 13.5, LOOKING WEST (NOTE ROCKFALL ON RIGHT)

PHOTO 21: RP 13.5, LOOKING WEST (NOTE ROCKFALL ON RIGHT)

PHOTO 22: RP 13.9, LOOKING EAST (IN YANKEE JIM CANYON)

PHOTO 23: RP 14.9, LOOKING WEST

PHOTO 24: RP 15.9, LOOKING NORTH (YELLOWSTONE RIVER IS ON THE LEFT)


PHOTO 25: RP 16.6, LOOKING NORTHEAST (NOTE PUBLIC ROAD INTERSECTION)


PHOTO 26: RP 17.0, LOOKING NORTHEAST


PHOTO 27: RP 18.0, LOOKING NORTHEAST

PHOTO 28: RP 19.5, LOOKING NORTH


PHOTO 29: RP 19.9, LOOKING NORTH (NOTE INTERSECTION WITH S-540)

PHOTO 30: RP 19.9, LOOKING NORTH (NOTE INTERSECTION WITH S-540)

PHOTO 31: RP 20.9, LOOKING NORTHEAST

PHOTO 32: RP 22.0, LOOKING NORTHEAST

PHOTO 33: RP 23.0, LOOKING NORTHEAST

PHOTO 34: RP 23.0, LOOKING NORTHEAST


PHOTO 35: RP 23.9, LOOKING NORTHEAST

PHOTO 36: RP 25.0, LOOKING NORTHEAST


PHOTO 37: RP 26.0, LOOKING EAST

PHOTO 38: RP 26.9, LOOKING EAST

PHOTO 39: RP 28.0, LOOKING NORTHEAST

PHOTO 40: RP 29.3, LOOKING NORTHEAST

PHOTO 41: RP 29.9, LOOKING NORTHEAST

PHOTO 42: RP 30.6, LOOKING NORTHEAST (NEAR EMIGRANT)

PHOTO 43: RP 31.9, LOOKING NORTHEAST

PHOTO 44: RP 32.9, LOOKING NORTHEAST

PHOTO 45: RP 34.7, LOOKING EAST

PHOTO 46: RP 35.1, LOOKING EAST (NOTE RV PARK ON RIGHT SIDE)

PHOTO 47: RP 36.1, LOOKING EAST

PHOTO 48: RP 36.9, LOOKING EAST

PHOTO 49: RP 37.9, LOOKING NORTH

PHOTO 50: RP 38.9, LOOKING NORTH

PHOTO 51: RP 40.0, LOOKING NORTH

PHOTO 52: RP 40.9, LOOKING NORTH

PHOTO 53: RP 41.9, LOOKING NORTH

PHOTO 54: RP 42.8, LOOKING NORTH

PHOTO 55: RP 43.9, LOOKING NORTH


PHOTO 56: RP 45.0, LOOKING NORTHEAST


PHOTO 57: RP 46.0, LOOKING NORTHEAST

PHOTO 58: RP 46.9, LOOKING NORTHEAST

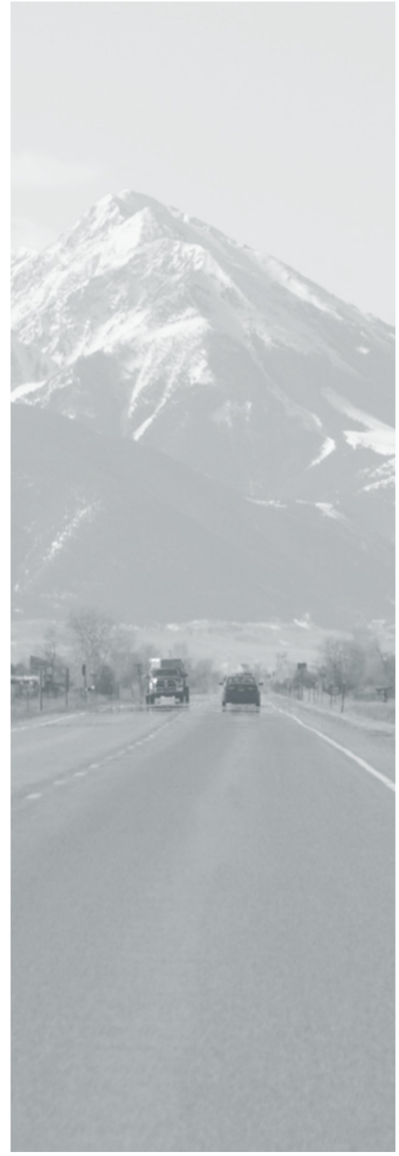
PHOTO 59: RP 48.4, LOOKING EAST

PHOTO 60: RP 48.9, LOOKING NORTHEAST


PHOTO 61: RP 50.0, LOOKING NORTH

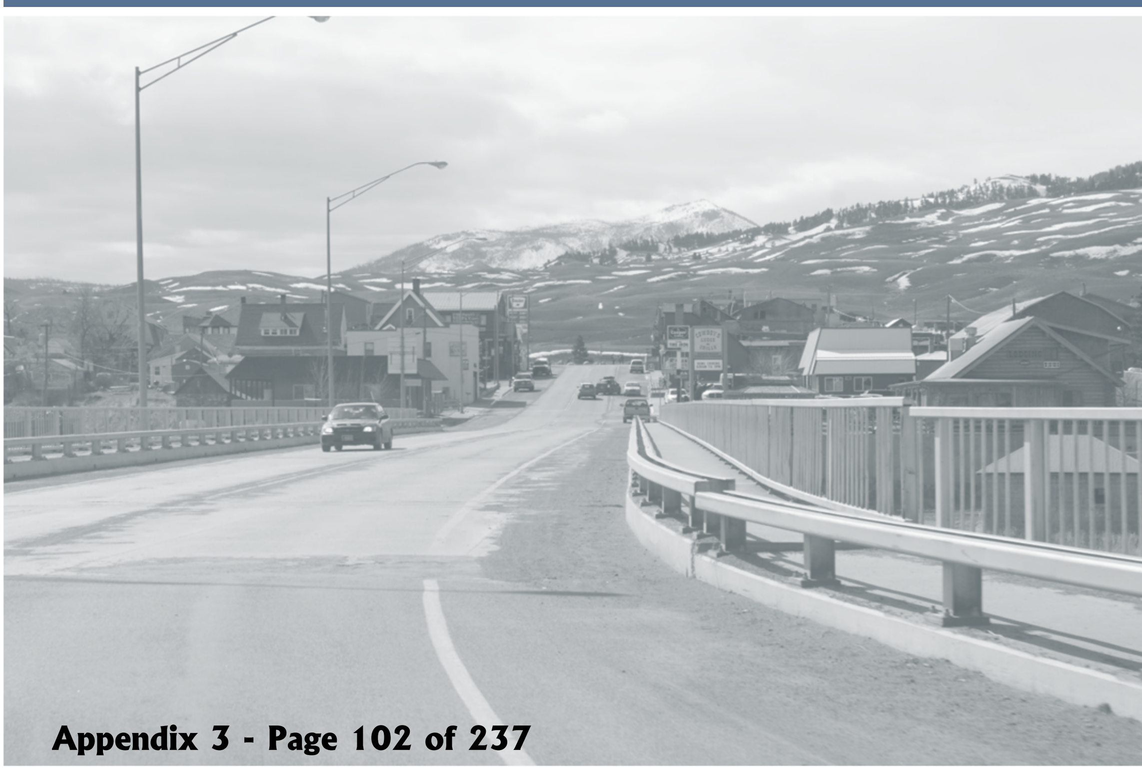
PHOTO 62: RP 51.0, LOOKING NORTH


PHOTO 63: RP 52.0, LOOKING NORTH (NOTE NON-MOTORIZED PATH ON LEFT)



# *APPENDIX B*

*As-Built Data Summary*



## Hydraulic Data Summary

| F 43-1(2) | | | | | |
|---|---|---|---|---|---|
| **Station (ft)** | **RP** | **Size (in)** | | **Type** | **Stream Name** |
| 344+00 | 9.94 | 70 | 92 | SPPS | |
| 346+25 | 9.90 | 2(78) | | CMP | Cedar Creek |
| 352+00 | 9.79 | 70 | 92 | SPPS | |
| 418+63 | 8.53 | 48 | | CMP | |
| 427+15 | 8.37 | 30 | | CMP | |
| 480+36 | 7.36 | 60 | | CMP | Basset Creek |
| 489+23 | 7.19 | 36 | | CMP | |
| 493+32 | 7.11 | 30 | | CMP | |

| F-217(13) | | | | | |
|---|---|---|---|---|---|
| **Station (ft)** | **RP** | **Size (in)** | | **Type** | **Stream Name** |
| NONE | | | | | |

| F-217(9) | | | | | |
|---|---|---|---|---|---|
| **Station (ft)** | **RP** | **Size (in)** | | **Type** | **Stream Name** |
| 47+00 | 20.21 | 70 | 91 | SPPS | |
| 61+12 | 20.48 | 48 | | RCP | |
| 84+55 | 20.92 | 84 | 61 | SPPAC | |
| 146+96 | 22.10 | 30 | | RCP | |
| 154+75 | 22.25 | 36.25 | 22.5 | RCPAC | |
| 169+82 | 22.54 | 28.5 | 18 | RCPAC | |
| 184+90 | 22.82 | 48 | | RCP | |
| 231+70 | 23.71 | 42 | | RCP | |
| 246+00 | 23.98 | 36.25 | 22.5 | RCPAC | |
| 278+06 | 24.59 | 142 | 91 | SPPAC | No. Fork Big Cr |
| 295+46 | 24.92 | 36 | | RCP | |
| 313+80 | 25.26 | 139 | 89 | SPPAC | |
| 386+12 | 26.63 | 36 | | RCP | |
| 388+42 | 26.68 | 30 | | RCP | |
| 419+50 | 27.27 | 58.5 | 36 | RCPAC | |
| 505+80 | 28.90 | 114 | 77 | SPPAC | Fridley Cr |
| 546+56 | 29.67 | 43.75 | 26.625 | RCAPC | Irrigation Dt |
| 557+94 | 29.89 | 70 | 91 | SPPS | Spring |
| 560+13 | 29.93 | 36 | | RCP | |
| 575+00 | 30.21 | 73.5 | 45 | RCAP | No. Fork Fridley Cr |
| 602+60 | 30.73 | 36 | | RCP | |

| F-217(10) | | | | | |
|---|---|---|---|---|---|
| **Station (ft)** | **RP** | **Size (in)** | | **Type** | **Stream Name** |
| 621+40 | 31.12 | 154 | 100 | SPPAC | Park Branch Canal |
| 664+00 | 31.92 | 43.75 | 26.625 | RCAP | |
| 734+22 | 33.25 | 36 | 22 | CMAP | |
| 734+40 | 33.26 | 91 | 70 | SPP | |
| 785+00 | 34.21 | 199 | 121 | SPPAC | Eight Mile Creek |
| 848+00 | 35.41 | 91 | 70 | SPP | |
| 863+05 | 35.69 | 36 | | RCP | |
| 1056+50 | 39.36 | 91 | 70 | SPP | |

| F-217(11) | | | | | |
|---|---|---|---|---|---|
| Station (ft) | RP | Size (in) | | Type | Stream Name |
| 1166+50 | 41.44 | 36 | | CMP | |
| 1192+23 | 41.93 | 72 | | RCP | |
| 1193+02 | 41.94 | 72 | | RCP | |
| 1207+70 | 42.22 | 81 | 59 | SPPAC | |
| 1249+65 | 43.01 | 36 | | RCP | |
| 1304+28 | 44.05 | 36 | | RCP | |
| 1325+18 | 44.44 | 65 | 40 | RCPA | |
| 1416+61 | 46.18 | 30 | | CMP | |
| 1505+70 | 47.86 | 72 | | CMP | |
| 1519+70 | 48.13 | 36 | | RCP | |
| 1537+05 | 48.46 | 72 | | RCP | |
| 1558+00 | 48.85 | 60 | | CMP | |
| 1585+98 | 49.38 | 112 | 75 | SPPAC | |

## Horizontal Curve Summary

| F 43-1(2) | | | |
|---|---|---|---|
| PI (STA ft) | PI (RP) | Radius (ft) | Length (ft) |
| 291+82.26 | 10.93 | 11,459.20 | 952.50 |
| 300+84.96 | 10.76 | 4,583.68 | 1,174.67 |
| 334+73.45 | 10.12 | 5,729.60 | 701.67 |
| 431+60.58 | 8.28 | 11,459.20 | 2,166.67 |
| 469+93.65 | 7.56 | 22,918.40 | 3,760.00 |
| 528+93.77 | 6.44 | 1,637.03 | 350.00 |
| 549+97.98 | 6.04 | 1,909.87 | 300.00 |
| 568+61.81 | 5.69 | 1,145.92 | 250.00 |
| 592+98.89 | 5.23 | 1,909.87 | 300.00 |

| F-217(13) | | | |
|---|---|---|---|
| PI (STA ft) | PI (RP) | Radius (ft) | Length (ft) |
| 76+98.90 | 18.07 | 5,730.00 | 520.00 |

| F 217(9) | | | |
|---|---|---|---|
| PI (STA ft) | PI (RP) | Radius (ft) | Length (ft) |
| 6+78.20 | 19.45 | 3,820.00 | 1,263.30 |
| 67+25.00 | 20.59 | 2,865.00 | 745.80 |
| 139+64.80 | 21.97 | 5,730.00 | 2,243.30 |
| 182+64.00 | 22.78 | 5,730.00 | 906.70 |
| 236+44.60 | 23.80 | 11,460.00 | 810.00 |
| 315+37.00 | 25.29 | 2,865.00 | 1,103.30 |
| 327+75.90 | 25.53 | 11,460.00 | 375.00 |
| 436+72.80 | 27.59 | 7,640.00 | 2,686.70 |
| 490+12.70 | 28.60 | 1,910.00 | 936.70 |
| 503+98.50 | 28.87 | 1,910.00 | 1,061.90 |

| F 217(10) | | | |
|---|---|---|---|
| PI (STA ft) | PI (RP) | Radius (ft) | Length (ft) |
| 704+56.20 | 32.69 | 5,730.00 | 762.50 |
| 759+65.60 | 33.73 | 5,730.00 | 220.00 |
| 780+92.70 | 34.14 | 6,250.70 | 2,019.90 |
| 839+53.20 | 35.25 | 5,730.00 | 3,700.00 |
| 881+93.70 | 36.05 | 2,292.00 | 790.00 |
| 955+07.30 | 37.44 | 5,730.00 | 4,688.30 |
| 1066+18.80 | 39.54 | 5,730.00 | 1,515.80 |
| 1130+97.20 | 40.77 | 5,730.00 | 880.80 |

| F 217(11) | | | |
|---|---|---|---|
| PI (STA ft) | PI (RP) | Radius (ft) | Length (ft) |
| 1189+01.20 | 41.87 | 11,460.00 | 830.00 |
| 1504+34.30 | 47.84 | 7,640.00 | 3,546.70 |
| 1551+32.20 | 48.73 | 3,820.00 | 1,433.50 |
| 1569+20.00 | 49.07 | 1,432.50 | 329.80 |
| 1573+78.20 | 49.15 | 1,432.50 | 329.80 |
| 1588+34.00 | 49.43 | 2,546.70 | 1,594.80 |

## Vertical Curve Summary

| F 43-1(2)* | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Center (STA ft) | Center (RP) | Length (ft) | G1 | G2 | A | K-Value | Type | SSD (S<L) | SSD (S>L) | SSD | L (Driver Comfort) |
| 297+00.00 | 10.83 | 2,000.00 | 2.30% | -0.48% | 2.78 | 718.7 | Crest | 1245.4 | 1387.7 | 1245.4 | - |
| 374+00.00 | 9.37 | 700.00 | -0.48% | 3.82% | 4.31 | 162.5 | Sag | - | - | - | 333.4 |
| 395+50.00 | 8.97 | 1,600.00 | 3.82% | 0.24% | 3.58 | 446.5 | Crest | 981.6 | 1101.1 | 981.6 | - |
| 417+00.00 | 8.56 | 1,600.00 | 0.24% | -4.06% | 4.30 | 372.4 | Crest | 896.5 | 1051.1 | 896.5 | - |
| 429+00.00 | 8.33 | 800.00 | -4.06% | 1.30% | 5.36 | 149.4 | Sag | - | - | - | 414.6 |
| 451+00.00 | 7.92 | 2,400.00 | 1.30% | -1.02% | 2.32 | 1032.9 | Crest | 1493.0 | 1664.4 | 1493.0 | - |
| 472+00.00 | 7.52 | 1,000.00 | -1.02% | 1.08% | 2.10 | 475.5 | Sag | - | - | - | 162.8 |
| 511+20.00 | 6.78 | 1,600.00 | 1.08% | -2.24% | 3.32 | 482.6 | Crest | 1020.5 | 1125.4 | 1020.5 | - |
| 534+35.00 | 6.34 | 800.00 | -2.24% | 1.71% | 3.95 | 202.6 | Sag | - | - | - | 305.7 |
| 547+00.00 | 6.10 | 1,600.00 | 1.71% | -0.86% | 2.57 | 623.0 | Crest | 1159.5 | 1220.1 | 1159.5 | - |
| 566+00.00 | 5.74 | 1,600.00 | -0.86% | 2.56% | 3.42 | 467.8 | Sag | - | - | - | 264.8 |

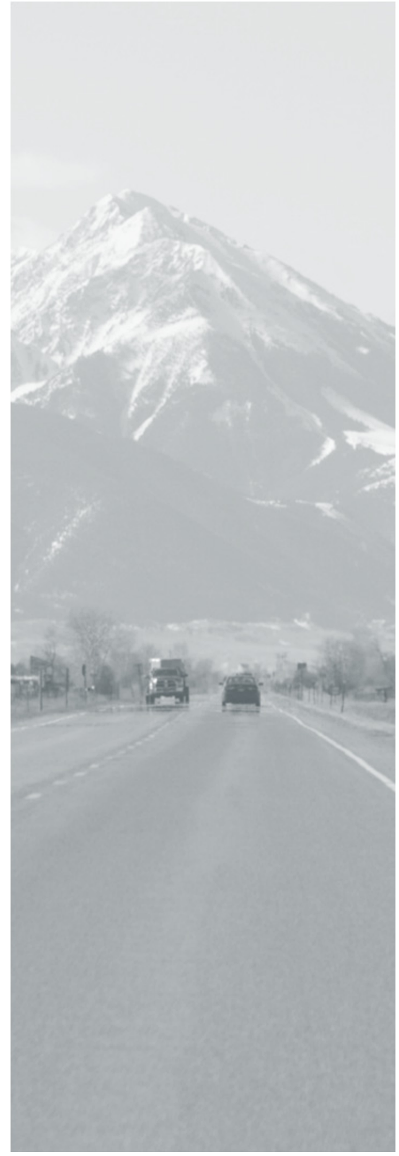
*Stationing in opposite direction of Reference Points, therefore grades are reversed

| F-217(13) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Center (STA ft) | Center (RP) | Length (ft) | G1 | G2 | A | K-Value | Type | SSD (S<L) | SSD (S>L) | SSD | L (Driver Comfort) |
| 31+00.00 | 17.20 | 800.00 | -0.95% | 0.55% | 1.50 | 533.3 | Sag | - | - | - | 116.1 |
| 47+00.00 | 17.50 | 1,000.00 | 0.55% | -0.80% | 1.35 | 740.7 | Crest | 1264.3 | 1299.3 | 1299.3 | - |
| 56+00.00 | 17.67 | 800.00 | -0.80% | 1.05% | 1.85 | 431.7 | Sag | - | - | - | 143.5 |
| 71+00.00 | 17.95 | 800.00 | 1.05% | -0.65% | 1.70 | 471.1 | Crest | 1008.3 | 1035.5 | 1035.5 | - |
| 93+00.00 | 18.37 | 1,000.00 | -0.65% | -1.77% | 1.13 | 888.9 | Crest | 1385.0 | 1459.1 | 1459.1 | - |
| 103+00.00 | 18.56 | 800.00 | -1.77% | -0.43% | 1.35 | 594.8 | Sag | - | - | - | 104.1 |
| 123+00.00 | 18.94 | 800.00 | -0.43% | 3.06% | 3.48 | 229.7 | Sag | - | - | - | 269.7 |
| 135+00.00 | 19.17 | 1,200.00 | 3.06% | 0.24% | 2.81 | 426.4 | Crest | 959.3 | 983.4 | 959.3 | - |

| F-217(9) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Center (STA ft) | Center (RP) | Length (ft) | G1 | G2 | A | K-Value | Type | SSD (S<L) | SSD (S>L) | SSD | L (Driver Comfort) |
| 6+00.00 | 19.43 | 1,000.00 | 0.66% | -2.68% | 3.34 | 299.0 | Crest | 803.3 | 822.7 | 803.3 | - |
| 23+00.00 | 19.76 | 800.00 | -2.68% | -1.20% | 1.48 | 539.1 | Sag | - | - | - | 114.9 |
| 45+00.00 | 20.17 | 800.00 | -1.20% | -0.30% | 0.90 | 888.9 | Sag | - | - | - | 69.7 |
| 79+50.00 | 20.83 | 800.00 | -0.30% | 0.97% | 1.27 | 629.1 | Sag | - | - | - | 98.4 |
| 102+00.00 | 21.25 | 800.00 | 0.97% | -0.12% | 1.09 | 732.9 | Crest | 1257.6 | 1388.5 | 1388.5 | - |
| 128+00.00 | 21.75 | 800.00 | -0.12% | -1.15% | 1.03 | 777.1 | Crest | 1295.0 | 1448.1 | 1448.1 | - |
| 149+00.00 | 22.14 | 800.00 | -1.15% | 0.34% | 1.49 | 535.5 | Sag | - | - | - | 115.7 |
| 172+00.00 | 22.58 | 1,200.00 | 0.34% | -0.96% | 1.30 | 920.0 | Crest | 1409.0 | 1427.2 | 1427.2 | - |
| 203+00.00 | 23.17 | 1,200.00 | -0.96% | 0.15% | 1.11 | 1081.5 | Sag | - | - | - | 85.9 |
| 229+00.00 | 23.66 | 800.00 | 0.15% | 1.06% | 0.91 | 878.3 | Sag | - | - | - | 70.5 |
| 245+50.00 | 23.97 | 1,600.00 | 1.06% | -0.74% | 1.80 | 889.1 | Crest | 1385.2 | 1399.6 | 1385.2 | - |
| 320+00.00 | 25.38 | 800.00 | -0.15% | 0.76% | 0.91 | 878.3 | Sag | - | - | - | 70.5 |
| 348+00.00 | 25.91 | 800.00 | 0.76% | 0.15% | 0.61 | 1309.8 | Crest | 1681.2 | 2166.5 | 2166.5 | - |
| 385+00.00 | 26.61 | 800.00 | 0.15% | -0.47% | 0.62 | 1300.8 | Crest | 1675.5 | 2154.5 | 2154.5 | - |
| 395+00.00 | 26.80 | 600.00 | -0.47% | -0.20% | 0.26 | 2294.3 | Sag | - | - | - | 20.2 |
| 418+00.00 | 27.24 | 800.00 | -0.20% | -0.52% | 0.32 | 2527.5 | Crest | 2335.4 | 3808.9 | 3808.9 | - |
| 439+00.00 | 27.64 | 1,000.00 | -0.52% | -1.64% | 1.12 | 892.9 | Crest | 1388.1 | 1463.4 | 1463.4 | - |
| 456+00.00 | 27.96 | 800.00 | -1.64% | -0.24% | 1.40 | 571.4 | Sag | - | - | - | 108.4 |
| 473+00.00 | 28.28 | 800.00 | -0.24% | 0.51% | 0.75 | 1063.8 | Sag | - | - | - | 58.2 |
| 493+00.00 | 28.66 | 800.00 | 0.51% | 0.70% | 0.19 | 4255.3 | Sag | - | - | - | 14.6 |
| 503+00.00 | 28.85 | 800.00 | 0.70% | 1.82% | 1.12 | 714.3 | Sag | - | - | - | 86.7 |
| 520+00.00 | 29.17 | 1,400.00 | 1.82% | -1.84% | 3.66 | 382.5 | Crest | 908.6 | 994.8 | 908.6 | - |
| 533+00.00 | 29.42 | 1,000.00 | -1.84% | -0.13% | 1.71 | 584.4 | Sag | - | - | - | 132.5 |
| 550+00.00 | 29.74 | 800.00 | -0.13% | -0.90% | 0.77 | 1035.1 | Crest | 1494.5 | 1796.0 | 1796.0 | - |
| 563+33.00 | 29.99 | 800.00 | -0.90% | -0.46% | 0.44 | 1811.2 | Sag | - | - | - | 34.2 |
| 582+80.00 | 30.36 | 1,000.00 | -0.46% | -1.37% | 0.91 | 1098.9 | Crest | 1539.9 | 1685.7 | 1685.7 | - |
| 603+00.00 | 30.74 | 2,000.00 | -1.37% | 0.62% | 1.99 | 1005.0 | Sag | - | - | - | 154.1 |

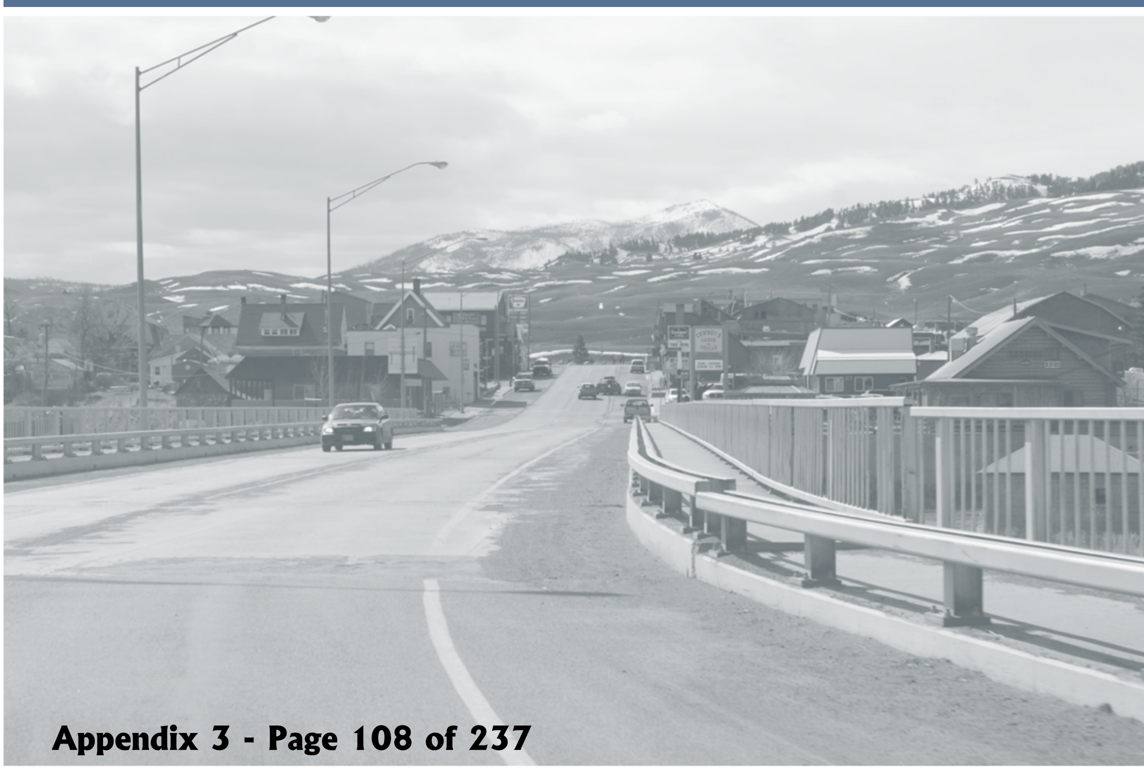
| F-217(10) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Center (STA ft) | Center (RP) | Length (ft) | G1 | | A | K-Value | Type | SSD (S<L) | SSD (S>L) | SSD | L (Driver Comfort) |
| 617+50.00 | 31.04 | 900.00 | 0.62% | -1.36% | 1.98 | 453.8 | Crest | 989.6 | 994.1 | 994.1 | - |
| 627+00.00 | 31.22 | 1,000.00 | -1.36% | -0.26% | 1.10 | 906.5 | Sag | - | - | - | 85.4 |
| 677+00.00 | 32.17 | 800.00 | -0.26% | -0.16% | 0.10 | 8113.6 | Sag | - | - | - | 7.6 |
| 749+00.00 | 33.53 | 600.00 | 0.46% | 1.17% | 0.71 | 845.1 | Sag | - | - | - | 55.0 |
| 760+00.00 | 33.74 | 1,600.00 | 1.17% | 0.00% | 1.17 | 1367.5 | Crest | 1717.9 | 1722.2 | 1722.2 | - |
| 773+00.00 | 33.99 | 1,000.00 | 0.00% | -1.18% | 1.18 | 847.5 | Crest | 1352.3 | 1414.4 | 1414.4 | - |
| 785+00.00 | 34.21 | 1,000.00 | -1.18% | -0.17% | 1.01 | 987.2 | Sag | - | - | - | 78.4 |
| 835+00.00 | 35.16 | 1,000.00 | -0.17% | -0.66% | 0.49 | 2028.4 | Crest | 2092.2 | 2688.6 | 2688.6 | - |
| 854+50.00 | 35.53 | 1,000.00 | -0.64% | 1.15% | 1.78 | 560.6 | Sag | - | - | - | 138.1 |
| 868+00.00 | 35.79 | 1,000.00 | 1.15% | -0.14% | 1.28 | 780.6 | Crest | 1297.9 | 1342.3 | 1342.3 | - |
| 905+00.00 | 36.49 | 1,000.00 | -0.14% | -0.32% | 0.18 | 5409.5 | Crest | 3416.7 | 6336.8 | 6336.8 | - |
| 930+00.00 | 36.96 | 1,000.00 | -0.32% | 0.07% | 0.39 | 2564.1 | Sag | - | - | - | 30.2 |
| 945+00.00 | 37.24 | 1,000.00 | 0.07% | -0.40% | 0.47 | 2127.7 | Crest | 2142.8 | 2795.7 | 2795.7 | - |
| 995+00.00 | 38.19 | 1,000.00 | -0.40% | -0.64% | 0.24 | 4166.7 | Crest | 2998.6 | 4995.8 | 4995.8 | - |
| 1012+00.00 | 38.51 | 1,000.00 | -0.64% | -0.22% | 0.42 | 2360.2 | Sag | - | - | - | 32.8 |
| 1056+00.00 | 39.35 | 1,200.00 | -0.22% | 2.32% | 2.54 | 473.1 | Sag | - | - | - | 196.4 |
| 1075+50.00 | 39.72 | 1,600.00 | 2.32% | -0.42% | 2.74 | 583.9 | Crest | 1122.6 | 1193.8 | 1122.6 | - |
| 1118+00.00 | 40.52 | 800.00 | -0.42% | -0.66% | 0.24 | 3340.3 | Crest | 2684.8 | 4905.2 | 4905.2 | - |

| F-217(11) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Center (STA ft) | Center (RP) | Length (ft) | G1 | G2 | A | K-Value | Type | SSD (S<L) | SSD (S>L) | SSD | L (Driver Comfort) |
| 1140+00.00 | 40.94 | 1,000.00 | -0.66% | -0.74% | 0.08 | 12345.7 | Crest | 5161.6 | 13821.0 | 13821.0 | - |
| 1157+00.00 | 41.26 | 800.00 | -0.74% | -0.51% | 0.23 | 3463.2 | Sag | - | - | - | 17.9 |
| 1170+00.00 | 41.51 | 1,000.00 | -0.51% | -0.98% | 0.47 | 2127.7 | Crest | 2142.8 | 2795.7 | 2795.7 | - |
| 1203+00.00 | 42.13 | 1,000.00 | -0.98% | -0.61% | 0.37 | 2702.7 | Sag | - | - | - | 28.6 |
| 1231+00.00 | 42.66 | 1,000.00 | -0.61% | -0.55% | 0.06 | 16666.7 | Sag | - | - | - | 4.6 |
| 1250+00.00 | 43.02 | 1,000.00 | -0.55% | -0.38% | 0.17 | 5882.4 | Sag | - | - | - | 13.2 |
| 1270+00.00 | 43.40 | 800.00 | -0.38% | -0.27% | 0.11 | 7272.7 | Sag | - | - | - | 8.5 |
| 1280+00.00 | 43.59 | 800.00 | -0.27% | -0.51% | 0.24 | 3333.3 | Crest | 2682.0 | 4895.8 | 4895.8 | - |
| 1320+00.00 | 44.35 | 1,000.00 | -0.51% | -0.53% | 0.02 | 50000.0 | Crest | 10387.5 | 54450.0 | 54450.0 | - |
| 1351+00.00 | 44.93 | 1,000.00 | -0.53% | -0.41% | 0.12 | 8333.3 | Sag | - | - | - | 9.3 |
| 1400+00.00 | 45.86 | 400.00 | -0.41% | -0.36% | 0.05 | 8602.2 | Sag | - | - | - | 3.6 |
| 1440+00.00 | 46.62 | 800.00 | -0.36% | -0.52% | 0.16 | 5111.8 | Crest | 3321.3 | 7294.6 | 7294.6 | - |
| 1468+00.00 | 47.15 | 800.00 | -0.52% | -0.77% | 0.25 | 3200.0 | Crest | 2627.9 | 4716.0 | 4716.0 | - |
| 1487+00.00 | 47.51 | 800.00 | -0.77% | -0.25% | 0.52 | 1538.5 | Sag | - | - | - | 40.3 |
| 1504+00.00 | 47.83 | 1,400.00 | -0.25% | -0.97% | 0.72 | 1955.3 | Crest | 2054.2 | 2207.0 | 2207.0 | - |
| 1520+00.00 | 48.13 | 800.00 | -0.97% | -0.48% | 0.49 | 1649.5 | Sag | - | - | - | 37.5 |
| 1547+00.00 | 48.65 | 400.00 | -0.48% | -2.20% | 1.72 | 232.7 | Crest | 708.6 | 827.7 | 827.7 | - |
| 1552+85.00 | 48.76 | 450.00 | -2.20% | 1.03% | 3.23 | 139.3 | Sag | - | - | - | 250.1 |
| 1563+50.00 | 48.96 | 600.00 | 1.03% | 0.34% | 0.69 | 869.6 | Crest | 1369.9 | 1863.8 | 1863.8 | - |
| 1575+80.00 | 49.19 | 400.00 | 0.34% | -2.54% | 2.88 | 138.9 | Crest | 547.5 | 574.7 | 574.7 | - |
| 1582+60.00 | 49.32 | 500.00 | -2.54% | -0.72% | 1.82 | 275.3 | Sag | - | - | - | 140.6 |
| 1589+84.00 | 49.46 | 500.00 | -0.72% | -0.33% | 0.39 | 1276.2 | Sag | - | - | - | 30.3 |
| 1609+00.00 | 49.82 | 400.00 | -0.33% | -0.58% | 0.25 | 1612.9 | Crest | 1865.6 | 4550.8 | 4550.8 | - |



# APPENDIX C

*Bridge Inspection Reports*



# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**Location : GARDINER Structure Name: none**

## General Location Data

MDT Maintenance Section : **None**

District Code, Number, Location : **02 Dist 2 BUTTE**

Division Code, Location : **22 BOZEMAN**

County Code, Location : **067 PARK**

City Code, Location : **00000 RURAL AREA**

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

Signed Route Number : **00089**

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

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

Intersecting Feature : **YELLOWSTONE RIVER**

Kilometer Post, Mile Post : **0.26 km 0.16**

Structure on the State Highway System : **X**

Latitude : **45°01'56"**

Structure on the National Highway System : **X**

Longitude : **110°42'20"**

Str Meet or Exceed NBIS Bridge Length : **X**

## Construction Data

Construction Project Number : **FHP 43 D**

Construction Station Number : **397+31.00**

Construction Drawing Number : **RECORDSE**

Construction Year : **1930**

Reconstruction Year : **1975**

## Traffic Data

Current ADT : **4,490** 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 : | **17.2 mton** | **2 AS Allowable Stress** |
| Operating Load, Design : | **27.2 mton** | **2 AS Allowable Stress** |
| 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 : | **52** | | |

## Structure, Roadway and Clearance Data

### Structure Deck, Roadway and Span Data :

Structure Length : **124.66 m**

Deck Area : **1,900.00 m sq**

Deck Roadway Width : **11.58 m**

Approach Roadway Width : **11.58 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 : **4 Steel continuous**

Span Design Code, Description : **9 Truss - Deck**

### Approach Span

Number of Spans : **2**

Material Type Code, Description : **1 Concrete**

Span Design Code, Description : **4 Tee Beam**

### 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 : **15.24 m**

(50A) Curb Width : **1.22 m**

(50B) Curb Width : **1.22 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 | P00011 | Both | 99.99 m | 11.58 m | N/A | | |
| | | | | | | | |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**Continue**

## Inspection Data

Sufficiency Rating : **55.7**
Structure Status : **Not Deficient**

**Inspection Due Date : 18 April 2015**
(91) Inspection Fequency (months) : **24**
Next Fracture Critical Due Date : **17 Apr 2015**
Fracture Critical Detail : **Steel trusses**

## NBI Inspection Data

(90) Date of Last Inspection : 18 April 2013
Last Inspected By : Daniel Gravage - 71

(90) Inspection Date :
Inspected By :

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (58) Deck Rating : | 5 | | (68) Deck Geometry : | 5 | | (36A) Bridge Rail Rating : | 1 | | (62) Culvert Rating : | N | |
| (59) Superstructure Rating : | 7 | | (67) Structure Rating : | 4 | | (36B) Transition Rating : | 0 | | (61) Channel Rating : | 8 | |
| (60) Substructure Rating : | 7 | | (69) Under Clearance : | N | | (36C) Approach Rail Rating : | N | | (71) Waterway Adequacy : | 8 | |
| (72) App Rdwy Align : | 8 | | (41) Posting Status : | A | | (36D) End Rail Rating : | 0 | | (113) Scour Critical : | 5 | |

Unrepaired Spalls : 10 m sq
Deck Surfacing Depth : 0.00 in

## Inspection Hours

| | | |
|---|---|---|
| Crew Hours for inspection : | 1 | |
| Helper Hours : | 0 | |
| Special Crew Hours : | 28 | |
| Special Equipment Hours : | -1 | |

Snooper Required : **Y**

| | | |
|---|---|---|
| Snooper Hours for inspection : | 1 | |
| Flagger Hours : | 1 | |

## Inspection Work Candidates

| Candidate ID | Date Requested | Status | Priority | Effected Structure Unit | Scope of Work | Action | Covered Condition States |
|---|---|---|---|---|---|---|---|
| **D21-FY2013-000011** | **23 April 2013** | **Not Approved** | **Low** | All Spans | Bridge | Pr Maint | |
| A large ash tree has grown into the framework of the truss. It is causing paint failure in numerous locations. Recommend trimming or removal. The snooper truck will be required. | | | | | | | |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**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 12 - Bare Concrete Deck | | | | | | | | | | |
| | 1 | 4 | 1440 | sq.m. | X | 0 | 100 | 0 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - Deck surface in much the same condition as previous. Will continue with State 2. SGIH

04/17/2013 - None SFIG

04/30/2011 - Random 1/8 inch wide cracks spaced approximately 1 to 5 feet apart. VZEE

04/17/2009 - Minor increase of spalled and delaminated areas of deck, left in State 2 for this inspection. YEDI

03/08/2007 - An aspahlt patch covers the cracked approach section on the north end, but is ravelling. Note photo of the underside of the deck in this location. The rest of the deck has light random/transverse cracking throughout. IZCZ

02/01/2005 - Conditions are unchanged from previous inspection. HZLZ

09/10/2002 - The expansion joint at Bt.2 is now 'aligator' cracking also. Spall has increased in the areas around the construction joints. TZKK

07/19/2000 - Cracking at the east end seems to be getting worse, some settlement appears. This also is creating a "duckpond" after rain or snowmelt occurrs. BHBQ

04/24/1998 - Minor delamination at east bridge end. Two small delaminations at midspan eastbound lane. Light random cracking throughout deck surface. VBDL

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 113 - Paint Stl Stringer | | | | | | | | | | |
| | 1 | 2 | 800 | m. | | 95 | 0 | 5 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - Minor rust areas, primarily along top flanges of stringers. SGIH

04/17/2013 - None SFIG

04/30/2011 - Stringers exhibited a loss of paint coating on approximately 5 percent of the surface area with moderate surface corrosion and negligible loss of section. VZEE

04/17/2009 - None YEDI

03/08/2007 - None IZCZ

02/01/2005 - None HZLZ

09/10/2002 - None TZKK

07/19/2000 - None BHBQ

04/24/1998 - _ VBDL

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**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 131 - Paint Stl Deck Truss | | | | | | | | | | |
| | 1 | 4 | 300 | m. | | 95 | 0 | 5 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

| | |
|---|---|
| 04/18/2013 - No changes to previous condition states. | SGIH |
| 04/17/2013 - None | SFIG |
| 04/30/2011 - The trusses exhibited a loss of painted coating on approximately 5 percent of the surface area with moderate surface corrosion and negligible loss of section. Small amounts of pack rust were observed at a few lower chord gusset connections. | VZEE |
| 04/17/2009 - None | YEDI |
| 03/08/2007 - Except for some very minor rusting on a few of the lower connection plates, the truss system is in very good condition. | IZCZ |
| 02/01/2005 - None | HZLZ |
| 09/10/2002 - None | TZKK |
| 07/19/2000 - None | BHBQ |
| 04/24/1998 - _ | VBDL |

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 163 - Paint Gusset Plate | | | | | | | | | | |
| | 1 | 3 | 192 | ea. | | 50 | 45 | 5 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

| | |
|---|---|
| 04/18/2013 - None | SGIH |
| 04/17/2013 - None | SFIG |
| 04/30/2011 - Areas of pack rust observed in random locations along the lower chord. There are two 1/2 inch by 1/2 inch gouges in the south face of the gusset at L6'-west. | VZEE |

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 | | | | | | | | | | |
| | 1 | 2 | 6 | ea. | | 90 | 10 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

| | |
|---|---|
| 04/18/2013 - See photo of tree growth. | SGIH |
| 04/17/2013 - None | SFIG |
| 04/30/2011 - Random hairline to 1/32nd inch wided cracking. There is heavy tree overgrowth on the north face of pier 2. | VZEE |
| 04/17/2009 - None | YEDI |
| 03/08/2007 - None | IZCZ |
| 02/01/2005 - None | HZLZ |
| 09/10/2002 - None | TZKK |
| 07/19/2000 - No change. | BHBQ |
| 04/24/1998 - Hairline cracking throughout concrete columns and struts bents 3 and 4. | VBDL |

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**Continue**

********** Span : **Main-0 - -1 (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 | | | | | | | | | | |
| | 1 | 4 | 9 | m. | | 90 | 10 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - There is random hairline to 1/32nd inch cracking. VZEE
04/17/2009 - None YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - None BHBQ
04/24/1998 - Hairline cracking of concrete column caps. VBDL

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 304 - Open Expansion Joint | | | | | | | | | | |
| | 1 | 4 | 24 | m. | | 100 | 0 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - There are minor scrapes from snowplows. VZEE
04/17/2009 - (2) expansion joints on main span. Sliding plate joints are part of approach spans YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - None BHBQ
04/24/1998 - Dirt buildup under sliding plate but joints are still tight. VBDL

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**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 311 - Moveable Bearing | | | | | | | | | | |
| | 1 | 4 | 3 | ea. | | 95 | 5 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - Bearings exhibited a loss of paint coating on approximately 5 percent of the surface area with moderate corrosion and less than 5 percent loss of section. VZEE
04/17/2009 - None YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - None BHBQ
04/24/1998 - _ VBDL

Inspection Notes:

| Element 313 - Fixed Bearing | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 4 | 3 | ea. | | 90 | 10 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - Bearings exhibited a loss of paint coating on approximately 10 percent of the surface area with moderate corrosion and less than 5 percent loss of section. VZEE
04/17/2009 - None YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - None BHBQ
04/24/1998 - _ VBDL

Inspection Notes:

Montana Department of Transportation

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**Continue**

********** Span : **Main-0 - -1 (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 334 - Metal Rail Coated | | | | | | | | | | |
| | 1 | 4 | 499 | m. | | 100 | 0 | 0 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Element Description

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - There are minor scrapes on the rail. VZEE
04/17/2009 - None YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - A couple of loose bolts, otherwise good. BHBQ

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 358 - Deck Cracking SmFlag | | | | | | | | | | |
| X | 1 | 3 | 1 | ea. | X | 0 | 100 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - There were unsealed 1/8th inch wide transverse cracks spaced from 1 to 5 feet apart. VZEE
04/17/2009 - None YEDI

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 359 - Soffit Smart Flag | | | | | | | | | | |
| X | 1 | 3 | 1 | ea. | X | 0 | 0 | 100 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - Large areas of map cracking and heavy efflorescence primarily in the southbound lanes of the approach spans, which are the orignial truss spans before the widening. The areas of cracking observed on the soffit directly correlate with the topside cracking. VZEE

Inspection Notes:

********** Span : **Appr-1 - -1** **********

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 |
|---|---|---|---|---|---|---|---|---|---|---|

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**Continue**

* * * * * * * * * * Span : **Appr-1 - -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 62 - Bare Top Flang | | | | | | | | | | |
| | 1 | 3 | 276 | sq.m. | X | 0 | 0 | 100 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - No apparent change to previous conditions, continuing with State 3. SGIH

04/17/2013 - None SFIG

04/30/2011 - Large areas of map cracking primarily in the southbound lane which is the original truss, in the approach spans only. The areas of heavy cracking exhibited delamination and potholes hat have been patched with asphalt. VZEE

04/17/2009 - (2)spans, 11.5 x 12.0 ea.
Extensive "alligator" cracking and delamination on each of the approach spans, with heavy cracking and efflorescence seen on the underside of the deck (photos). YEDI

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 110 - R/Conc Open Girder | | | | | | | | | | |
| | 1 | 4 | 146 | m. | | 95 | 0 | 5 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH

04/17/2013 - None SFIG

04/30/2011 - Girder haunch repairs made since the last inspection. There is random hairline cracking on all girders and a small spall above the second column from the west at bent 3. VZEE

04/17/2009 - Repairs to girder haunch are planned for summer 2009. YEDI

03/08/2007 - See photo of current condition of girder haunch. IZCZ

02/01/2005 - No apparent change from previous conditions of girder beam seats (photo). HZLZ

09/10/2002 - Concrete deterioration of the outer (south) girder haunch/beam-seat has increased since last inspection - see photo comparisons. TZKK

07/19/2000 - Delamination at the beam seat continues (see photo). BHBQ

04/24/1998 - Hairline cracking of poured in place concrete girder light deterioration of concrete beam brg upstream side column cap. VBDL

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 | | | | | | | | | | |
| | 1 | 2 | 8 | ea. | | 90 | 10 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH

04/17/2013 - None SFIG

04/30/2011 - There is random hairline cracking. VZEE

04/17/2009 - None YEDI

03/08/2007 - None IZCZ

02/01/2005 - None HZLZ

09/10/2002 - None TZKK

07/19/2000 - None BHBQ

04/24/1998 - Minor spalls with some scaling and cracking of concrete. VBDL

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

**Continue**

********** Span : **Appr-1 - -1 (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 215 - R/Conc Abutment** | | | | | | | | | | |
| | 1 | 2 | 50 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - No defects noted at this inspection. VZEE
04/17/2009 - None YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - None BHBQ
04/24/1998 - Hairline cracks showing in concrete wingwalls. VBDL

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 234 - R/Conc Cap** | | | | | | | | | | |
| | 1 | 2 | 6 | m. | | 90 | 10 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - There is random hairline cracking. VZEE
04/17/2009 - None YEDI
03/08/2007 - None IZCZ
02/01/2005 - None HZLZ
09/10/2002 - None TZKK
07/19/2000 - None BHBQ
04/24/1998 - Scaling of concrete caps with light cracking. VBDL

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 305 - Assm Jt w/o Seal** | | | | | | | | | | |
| | 1 | 3 | 24 | m. | | 100 | 0 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH
04/17/2013 - None SFIG
04/30/2011 - No defects noted at this inspection. VZEE
04/17/2009 - Sliding plate joints appear to be functioning. YEDI

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011000+01651

Continue

* * * * * * * * * * Span : **Appr-1 - -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 334 - Metal Rail Coated | | | | | | | | | | |
| | 1 | 3 | 48 | m. | | 100 | 0 | 0 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

04/18/2013 - None SGIH

04/17/2013 - None SFIG

04/30/2011 - Minor scrapes to the rail. VZEE

04/17/2009 - None YEDI

Inspection Notes:

## General Inspection Notes

04/18/2013 - None SGIH

04/17/2013 - None SFIG

04/30/2011 - This inspection was a climbing fracture critical inspection performed by Todd Demski and Drew Garceau of Collins Engineers. The bridge is labeled from north to south per the original bridge drawings. VZEE

Deleted the cross-frame element 7/12/2012. AKJ

04/17/2009 - None YEDI

03/08/2007 - None IZCZ

02/01/2005 - None HZLZ

09/10/2002 - None TZKK

07/19/2000 - None BHBQ

04/24/1998 - None VBDL

08/06/1996 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 11:34:34 APVE
Sufficiency Rating Calculation Accepted by OPS$U9004 at 2/19/97 14:34:21
OPS$U5963 inspection comments -
Structure P00011000+01651 -
Date 8/6/96 -
Previous comments > (none)

05/01/1994 - REFI

02/01/1992 - Updated with tape 1994 NB94

04/01/1990 - Updated with tape 1992 NB92

02/01/1988 - Updated with tape 1989 NB89

07/01/1985 - Updated with tape 1987 NB87

12/01/1982 - Updated with tape 1984 NB84

02/01/1980 - Updated with tape 1982 NB82

MONTANA MDT DEPARTMENT OF TRANSPORTATION

# Inspection Photos

## P00011000+01651

**Location GARDINER Stucture Name: none**

**South profile**

## Notes

None

**N appr, view South**

## Notes

None

MONTANA MDT DEPARTMENT OF TRANSPORTATION

# Inspection Photos

## P00011000+01651

**Location GARDINER Stucture Name: none**

**Superstructure**

**Notes**

None

**S. Appr. span**

**Notes**

Asphalt patching hides heavy "aligator" cracking of deck.

# Inspection Photos

## P00011000+01651

**Location GARDINER Stucture Name: none**

**S. Appr. span soffit**

**Notes**

Extensive cracking and efflorescence. Note (full-depth)spall and rusting rebar exposed in left bay.

**N. Appr. soffit**

**Notes**

Much the same conditions exist on the north approach span.

Montana Department of Transportation

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011020+04171

**Location : 11M SW EMIGRANT Structure Name: none**

## General Location Data

District Code, Number, Location : **02 Dist 2 BUTTE**
County Code, Location : **067 PARK**
Kind fo Hwy Code, Description : **2 2 U.S. Numbered Hwy**
Str Owner Code, Description : **1 State Highway Agency**
Intersecting Feature : **YELLOWSTONE RIVER**
Structure on the State Highway System : **X**
Structure on the National Highway System : **X**
Str Meet or Exceed NBIS Bridge Length : **X**
Latitude : **45°15'15"**
Longitude : **110°52'05"**

MDT Maintenance Section : **None**
Division Code, Location : **22 BOZEMAN**
City Code, Location : **00000 RURAL AREA**
Signed Route Number : **00089**
Maintained by Code, Description : **1 State Highway Agency**
Kilometer Post, Mile Post : **32.85 km 20.41**

## Construction Data

Construction Project Number : **F 217-9**
Construction Station Number : **57+31.00**
Construction Drawing Number : **3892**
Construction Year : **1958**
Reconstruction Year :

## Traffic Data

Current ADT : **2,140** 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 : | **75.2 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 : | **99** | | |

## Structure, Roadway and Clearance Data

### Structure Deck, Roadway and Span Data :

Structure Length : **138.68 m**
Deck Area : **1,340.00 m sq**
Deck Roadway Width : **8.53 m**
Approach Roadway Width : **9.75 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 : **4**
Material Type Code, Description : **4 Steel continuous**
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 : **9.66 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 | P00011 | Both | 99.99 m | 8.53 m | N/A | | |
| | | | | | | | |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011020+04171

Continue

## Inspection Data

Sufficiency Rating : **65.5**
Structure Status : **Not Deficient**

**Inspection Due Date : 02 October 2014**
(91) Inspection Fequency (months) : **24**

Next Under Water Insp : **02 Oct 2016**
Under Water Insp Type : **Type I**

## NBI Inspection Data

(90) Date of Last Inspection : 02 October 2012

Last Inspected By : Daniel Gravage - 71

(90) Inspection Date :

Inspected By :

(58) Deck Rating : 6
(59) Superstructure Rating : 7
(60) Substructure Rating : 7
(72) App Rdwy Align : 8

(68) Deck Geometry : 4
(67) Structure Rating : 7
(69) Under Clearance : N
(41) Posting Status : A

(36A) Bridge Rail Rating : 1
(36B) Transition Rating : 1
(36C) Approach Rail Rating : 1
(36D) End Rail Rating : 1

(62) Culvert Rating : N
(61) Channel Rating : 8
(71) Waterway Adequacy : 8
(113) Scour Critical : 5

Unrepaired Spalls : 2 m sq

Deck Surfacing Depth : 0.00 in

## Inspection Hours

Crew Hours for inspection : 2
Helper Hours : -1
Special Crew Hours : -1
Special Equipment Hours : -1

Snooper Required : Y
Snooper Hours for inspection : 1
Flagger Hours : -1

| Inspection Work Candidates | | Status | Priority | Effected Structure Unit | Scope of Work | Action | Covered Condition States |
|---|---|---|---|---|---|---|---|
| Candidate ID | Date Requested | | | | | | |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011020+04171

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 12 - Bare Concrete Deck | | | | | | | | | | |
| | 1 | 3 | 1340 | sq.m. | X | 0 | 100 | 0 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

10/02/2012 - Agree with Sttae 2 condition. FZKZ
10/13/2010 - New HMWM surface treatment since last inspection. TZJC
10/01/2008 - No apparent changes to previous conditions. GICO
03/06/2007 - Small spall area at Pier 3 joint hasn't changed much, thanks to periodic asphalt patching. (138.68 X 9.66 = 1339.649) HZIF
02/10/2005 - Conditions remain much the same, with slight increase of spalled areas mentioned previously. PNJZ
09/10/2002 - None TZKZ
07/19/2000 - No changes. BHBN
04/27/1998 - Several small spall areas thru out deck surface showing delamination, spall in deck surface over pier 3 at compression joint at edge of driving lanes. Underside of deck showing some efflor. VJJX
06/06/1996 - None CSBZ
05/01/1994 - 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 107 - Paint Stl Opn Girder | | | | | | | | | | |
| | 1 | 2 | 549 | m. | | 95 | 5 | 0 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

10/02/2012 - Minor paint chips with associated light rusting. FZKZ
10/13/2010 - None TZJC
10/01/2008 - None GICO
03/06/2007 - None HZIF
02/10/2005 - None PNJZ
09/10/2002 - None TZKZ
07/19/2000 - None BHBN
04/27/1998 - None VJJX
06/06/1996 - None CSBZ
05/01/1994 - None REFI

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011020+04171

**Continue**

********** Span : **Main-0 - -1 (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 205 - R/Conc Column | | | | | | | | | | |
| | 1 | 3 | 6 | ea. | | 90 | 10 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

| | |
|---|---|
| 10/02/2012 - None | FZKZ |
| 10/13/2010 - Typical exposed aggregate along the waterline of columns and web walls. | TZJC |
| 10/01/2008 - None | GICO |
| 03/06/2007 - None | HZIF |
| 02/10/2005 - None | PNJZ |
| 09/10/2002 - None | TZKZ |
| 07/19/2000 - Piers 2, 3 & 4 are two columns joined by a web wall and spanned with a cap. | BHBN |
| 04/27/1998 - None | VJJX |
| 06/06/1996 - None | CSBZ |
| 05/01/1994 - 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 215 - R/Conc Abutment | | | | | | | | | | |
| | 1 | 2 | 29 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

| | |
|---|---|
| 10/02/2012 - None | FZKZ |
| 10/13/2010 - None | TZJC |
| 10/01/2008 - None | GICO |
| 03/06/2007 - None | HZIF |
| 02/10/2005 - None | PNJZ |
| 09/10/2002 - None | TZKZ |
| 07/19/2000 - None | BHBN |
| 04/27/1998 - None | VJJX |
| 06/06/1996 - None | CSBZ |
| 05/01/1994 - None | REFI |

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011020+04171

**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 234 - R/Conc Cap | | | | | | | | | | |
| | 1 | 2 | 31 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |
| Previous Inspection Notes : | | | | | | | | | | |
| 10/02/2012 - None | | | | | | | | | | FZKZ |
| 10/13/2010 - None | | | | | | | | | | TZJC |
| 10/01/2008 - None | | | | | | | | | | GICO |
| 03/06/2007 - None | | | | | | | | | | HZIF |
| 02/10/2005 - None | | | | | | | | | | PNJZ |
| 09/10/2002 - None | | | | | | | | | | TZKZ |
| 07/19/2000 - _ | | | | | | | | | | BHBN |
| Inspection Notes: | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
| Element 305 - Assm Jt w/o Seal | | | | | | | | | | |
| | 1 | 3 | 22 | m. | | 100 | 0 | 0 | | |
| | | | | | | % | % | % | % | % |
| Previous Inspection Notes : | | | | | | | | | | |
| 10/02/2012 - None | | | | | | | | | | FZKZ |
| 10/13/2010 - Clean and in working condition. | | | | | | | | | | TZJC |
| 10/01/2008 - None | | | | | | | | | | GICO |
| 03/06/2007 - None | | | | | | | | | | HZIF |
| 02/10/2005 - None | | | | | | | | | | PNJZ |
| 09/10/2002 - None | | | | | | | | | | TZKZ |
| 07/19/2000 - None | | | | | | | | | | BHBN |
| 04/27/1998 - None | | | | | | | | | | VJJX |
| 06/06/1996 - None | | | | | | | | | | CSBZ |
| 05/01/1994 - None | | | | | | | | | | REFI |
| Inspection Notes: | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011020+04171

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 311 - Moveable Bearing | | | | | | | | | | |
| | 1 | 2 | 16 | ea. | | 95 | 5 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

10/02/2012 - Five pct. State 2 for rusting of rockers. FZKZ
10/13/2010 - None TZJC
10/01/2008 - None GICO
03/06/2007 - None HZIF
02/10/2005 - None PNJZ
09/10/2002 - None TZKZ
07/19/2000 - Same. BHBN
04/27/1998 - Light rusting of rocker bearings under sliding plate joints at abut 1 and 5. VJJX
06/06/1996 - None CSBZ
05/01/1994 - 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 313 - Fixed Bearing | | | | | | | | | | |
| | 1 | 2 | 4 | ea. | | 100 | 0 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

10/02/2012 - None FZKZ
10/13/2010 - None TZJC
10/01/2008 - None GICO
03/06/2007 - None HZIF
02/10/2005 - None PNJZ
09/10/2002 - None TZKZ
07/19/2000 - None BHBN
04/27/1998 - None VJJX
06/06/1996 - None CSBZ
05/01/1994 - None REFI

Inspection Notes:

## INITIAL ASSESSMENT FORM FOR STRUCTURE :

**P00011020+04171**
**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 331 - Conc Bridge Railing | | | | | | | | | | |
| | 1 | 2 | 277 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

10/02/2012 - None FZKZ
10/13/2010 - None TZJC
10/01/2008 - None GICO
03/06/2007 - None. (138.68 X 2 = 277.36) HZIF
02/10/2005 - None PNJZ
09/10/2002 - None TZKZ
07/19/2000 - None BHBN
04/27/1998 - None VJJX
06/06/1996 - None CSBZ
05/01/1994 - None REFI

Inspection Notes:

### General Inspection Notes

10/02/2012 - None FZKZ
10/13/2010 - Deleted cross-frame element 7/12/2012. AKJ TZJC
10/01/2008 - None GICO
03/06/2007 - None HZIF
02/10/2005 - None PNJZ
09/10/2002 - None TZKZ
07/19/2000 - None BHBN
04/27/1998 - None VJJX
06/06/1996 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 11:34:34 CSBZ
Sufficiency Rating Calculation Accepted by OPS$U9004 at 2/19/97 14:34:23
U5963 inspection comments -
Structure P00011020+04171 -
Date 9/4/96 -
Previous comments > (none)
05/01/1994 - REFI
11/01/1991 - Updated with tape 1994 NB94
04/01/1990 - Updated with tape 1992 NB92
02/01/1988 - Updated with tape 1989 NB89
07/01/1985 - Updated with tape 1988 NB88
12/01/1982 - Updated with tape 1984 NB84
02/01/1980 - Updated with tape 1982 NB82

MONTANA MDT DEPARTMENT OF TRANSPORTATION

# Inspection Photos

## P00011020+04171

**Location 11M SW EMIGRANT Stucture Name: none**

**West profile**

**Notes**

View downstream.

**N appr, view South**

**Notes**

None

MONTANA DEPARTMENT OF TRANSPORTATION

# Inspection Photos

## P00011020+04171

**Location 11M SW EMIGRANT Stucture Name: none**

**Superstructure**

## Notes

None

Montana Department of Transportation

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

**P00011024+00721**

**Location : 7M SW EMIGRANT Structure Name: none**

## General Location Data

District Code, Number, Location : **02 Dist 2 BUTTE**

County Code, Location : **067 PARK**

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

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

Intersecting Feature : **BIG CREEK**

Structure on the State Highway System : **X**

Structure on the National Highway System : **X**

Str Meet or Exceed NBIS Bridge Length : **X**

Latitude : **45°17'57"**

Longitude : **110°49'53"**

MDT Maintenance Section : **None**

Division Code, Location : **22 BOZEMAN**

City Code, Location : **00000 RURAL AREA**

Signed Route Number : **00089**

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

Kilometer Post, Mile Post : **38.74 km 24.07**

## Construction Data

Construction Project Number : **F 217-9**

Construction Station Number : **250+21.00**

Construction Drawing Number : **3903**

Construction Year : **1960**

Reconstruction Year :

## Traffic Data

Current ADT : **2,140** 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 : | **37.1 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 : | **74** | | |

## Structure, Roadway and Clearance Data

### Structure Deck, Roadway and Span Data :

Structure Length : **27.43 m**

Deck Area : **267.00 m sq**

Deck Roadway Width : **8.53 m**

Approach Roadway Width : **9.80 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 : **4 Tee Beam**

### Approach Span

Number of Spans : **0**

Material Type Code, Description :

Span Design Code, Description :

### Deck

Deck Structure Type : **N Not applicable**

Deck Surfacing Type : **0 None (no additional concrete thickness or wearing s**

Deck Protection Type : **0 None**

Deck Membrain Type : **0 None**

(52) Out-to-Out Width : **9.74 m**

(50A) Curb Width : **0.55 m**

(50B) Curb Width : **0.55 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 | P00011 | Both | 99.99 m | 8.53 m | N/A | | |
| | | | | | | | |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011024+00721

**Continue**

## Inspection Data

Sufficiency Rating : **65.5**
Structure Status : **Not Deficient**

**Inspection Due Date : 29 December 2014**
(91) Inspection Fequency (months) : **24**

## NBI Inspection Data

(90) Date of Last Inspection : 02 January 2013
Last Inspected By : Daniel Gravage - 71
(90) Inspection Date :
Inspected By :

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (58) Deck Rating : | 7 | (68) Deck Geometry : | 4 | (36A) Bridge Rail Rating : | 1 | (62) Culvert Rating : | N |
| (59) Superstructure Rating : | 7 | (67) Structure Rating : | 7 | (36B) Transition Rating : | 1 | (61) Channel Rating : | 8 |
| (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 : | 5 |

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

## Inspection Hours

| | | | |
|---|---|---|---|
| Crew Hours for inspection : | 1 | 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 |

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011024+00721

**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 62 - Bare Top Flang deck surface** | | | | | | | | | | |
| | 1 | 3 | 267 | sq.m. | X | 100 | 0 | 0 | 0 | 0 |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None — EOJN
12/29/2010 - HMWM seal surface in 2009. — ZZLS
01/16/2009 - Minor transverse and random hairline cracking throughout deck surface. No delamination noted w/chain drag. (27.43 X 9.74 = 267.168) — WZCG

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 110 - R/Conc Open Girder** | | | | | | | | | | |
| | 1 | 3 | 110 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None — EOJN
12/29/2010 - None — ZZLS
01/16/2009 - None — WZCG
12/26/2006 - None — ZZLW
12/08/2004 - None — KPKZ
09/09/2002 - None — TZKZ
02/07/2000 - No change. — JBJS
12/04/1997 - Deck has several small spall areas with minor transverse and random cracking thru out deck surface. 4" long section of exposed rebar B-3 area. Chain drag did not reveal any delamination. — VJKF
11/01/1995 - None — YDNF
10/01/1993 - 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** | | | | | | | | | | |
| | 1 | 2 | 4 | ea. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None — EOJN
12/29/2010 - None — ZZLS
01/16/2009 - None — WZCG
12/26/2006 - None — ZZLW
12/08/2004 - None — KPKZ
09/09/2002 - None — TZKZ
02/07/2000 - None — JBJS
12/04/1997 - Minor scaling of concrete at waterline. — VJKF
11/01/1995 - None — YDNF
10/01/1993 - None — REFI

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011024+00721

**Continue**

********** Span : **Main-0 - -1 (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 215 - R/Conc Abutment | | | | | | | | | | |
| | 1 | 2 | 23 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None EOJN
12/29/2010 - None ZZLS
01/16/2009 - None WZCG
12/26/2006 - None ZZLW
12/08/2004 - None KPKZ
09/09/2002 - None TZKZ
02/07/2000 - None JBJS
12/04/1997 - None VJKF
11/01/1995 - None YDNF
10/01/1993 - 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 234 - R/Conc Cap | | | | | | | | | | |
| | 1 | 2 | 18 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None EOJN
12/29/2010 - None ZZLS
01/16/2009 - None WZCG
12/26/2006 - None ZZLW
12/08/2004 - None KPKZ
09/09/2002 - None TZKZ
02/07/2000 - None JBJS
12/04/1997 - None VJKF
11/01/1995 - None YDNF
10/01/1993 - None REFI

Inspection Notes:

********** Span : **Main-0 - -1 (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 313 - Fixed Bearing** | | | | | | | | | | |
| | 1 | 2 | 8 | ea. | | 100 | 0 | 0 | | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None EOJN
12/29/2010 - None ZZLS
01/16/2009 - None WZCG
12/26/2006 - None ZZLW
12/08/2004 - None KPKZ
09/09/2002 - None TZKZ
02/07/2000 - None JBJS
12/04/1997 - None VJKF
11/01/1995 - None YDNF
10/01/1993 - 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 331 - Conc Bridge Railing** | | | | | | | | | | |
| | 1 | 2 | 55 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None EOJN
12/29/2010 - None ZZLS
01/16/2009 - None WZCG
12/26/2006 - None. (27.43 X 2 = 54.86) ZZLW
12/08/2004 - None KPKZ
09/09/2002 - None TZKZ
02/07/2000 - New reinforced concrete barrier rail was constructed in front of structure's original metal rail Aug 1998. Also installed was approach railing both sides of structure and roadway tieing into new barrier rail. ELEMENT 334 (METAL BRIDGE RAIL) WAS DELETED FROM INVENTORY. BRIDGE RAIL RATINGS WERE ALL CHANGED TO 1. (BGN) JBJS

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 358 - Deck Cracking SmFlag** | | | | | | | | | | |
| X | 1 | 3 | 1 | ea. | X | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

01/02/2013 - None EOJN
12/29/2010 - None ZZLS
01/16/2009 - HMWM surface protectant added in 2008 WZCG

Inspection Notes:

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011024+00721

Continue

### General Inspection Notes

| | |
|---|---|
| 01/02/2013 - None | EOJN |
| 12/29/2010 - None | ZZLS |
| 01/16/2009 - None | WZCG |
| 12/26/2006 - None | ZZLW |
| 12/08/2004 - None | KPKZ |
| 09/09/2002 - None | TZKZ |
| 02/07/2000 - None | JBJS |
| 12/04/1997 - None | VJKF |
| 11/01/1995 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 11:34:34<br>Sufficiency Rating Calculation Accepted by OPS$U9004 at 2/19/97 14:34:24 | YDNF |
| 10/01/1993 - | REFI |
| 11/01/1991 - Updated with tape 1994 | NB94 |
| 02/01/1990 - Updated with tape 1992 | NB92 |
| 02/01/1988 - Updated with tape 1989 | NB89 |
| 07/01/1985 - Updated with tape 1988 | NB88 |
| 12/01/1982 - Updated with tape 1984 | NB84 |
| 02/01/1980 - Updated with tape 1982 | NB82 |

# Inspection Photos

## P00011024+00721

**Location 7M SW EMIGRANT Stucture Name: none**

**East profile**

**Notes**

None

**S appr, view North**

**Notes**

None

MONTANA MDT DEPARTMENT OF TRANSPORTATION

# Inspection Photos

## P00011024+00721

**Location 7M SW EMIGRANT Stucture Name: none**

**Superstructure**

## Notes

None

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011047+09001

**Location : 10 KM S LIVINGSTON Structure Name:**

## General Location Data

District Code, Number, Location : **02 Dist 2 BUTTE**

County Code, Location : **067 PARK**

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

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

Intersecting Feature : **FARM ACCESS**

Structure on the State Highway System : **X**

Structure on the National Highway System : **X**

Str Meet or Exceed NBIS Bridge Length : ☐

Latitude : **45°34'27"**

Longitude : **110°35'13"**

MDT Maintenance Section : **None**

Division Code, Location : **22 BOZEMAN**

City Code, Location : **00000 RURAL AREA**

Signed Route Number : **00089**

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

Kilometer Post, Mile Post : **77.00 km 47.85**

## Construction Data

Construction Project Number :

Construction Station Number :

Construction Drawing Number :

Construction Year : **1964**

Reconstruction Year :

## Traffic Data

Current ADT : **3,350** 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 : | **32.6 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 : **4.80 m**

Deck Area : **0.00 m sq**

Deck Roadway Width : **0.00 m**

Approach Roadway Width : **9.10 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 : **4.50 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 : **1**

Material Type Code, Description : **3 Steel**

Span Design Code, Description : **19 Culvert (includes frame culverts)**

### Approach Span

Number of Spans : **0**

Material Type Code, Description :

Span Design Code, Description :

### 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**

(52) Out-to-Out Width : **0.00 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 | P00011 | Both | 99.99 m | 9.10 m | N/A | | |
| FARM ACCESS | | | | | | | |

Montana Department of Transportation

# INITIAL ASSESSMENT FORM FOR STRUCTURE :

## P00011047+09001
Continue

## Inspection Data

Sufficiency Rating : ***80**
Structure Status : **Not Deficient**

**Inspection Due Date : 23 August 2013**
(91) Inspection Fequency (months) : **24**

## NBI Inspection Data

(90) Date of Last Inspection : 23 August 2011
Last Inspected By : Daniel Gravage - 71
(90) Inspection Date :
Inspected By :

(58) Deck Rating : N
(59) Superstructure Rating : N
(60) Substructure Rating : N
(72) App Rdwy Align : 6

(68) Deck Geometry : N
(67) Structure Rating : 7
(69) Under Clearance : N
(41) Posting Status : A

(36A) Bridge Rail Rating : N
(36B) Transition Rating : N
(36C) Approach Rail Rating : N
(36D) End Rail Rating : N

(62) Culvert Rating : 7
(61) Channel Rating : N
(71) Waterway Adequacy : N
(113) Scour Critical : N

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

## Inspection Hours

Crew Hours for inspection : 2
Helper Hours : 0
Special Crew Hours : 0
Special Equipment Hours : 0

Snooper Required :
Snooper Hours for inspection : 0
Flagger Hours : 0

| Inspection Work Candidates | | Status | Priority | Effected Structure Unit | Scope of Work | Action | Covered Condition States |
|---|---|---|---|---|---|---|---|
| Candidate ID | Date Requested | | | | | | |

## Element Inspection Data

* * * * * * * * * * Span : **Main-0 - Update Description** * * * * * * * * * *

| 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 240 - Steel Culvert | | | | | | | | | | |
| | 1 | 2 | 32 | m. | | 100 | 0 | 0 | 0 | |
| | | | | | | % | % | % | % | % |

Previous Inspection Notes :

08/23/2011 - None ZMCZ
08/25/2009 - None RZBZ

Inspection Notes:

## General Inspection Notes

08/23/2011 - None ZMCZ
08/25/2009 - None RZBZ

# Inspection Photos

## P00011047+09001

**Location 10 KM S LIVINGSTON Stucture Name:**

**E appr view West**

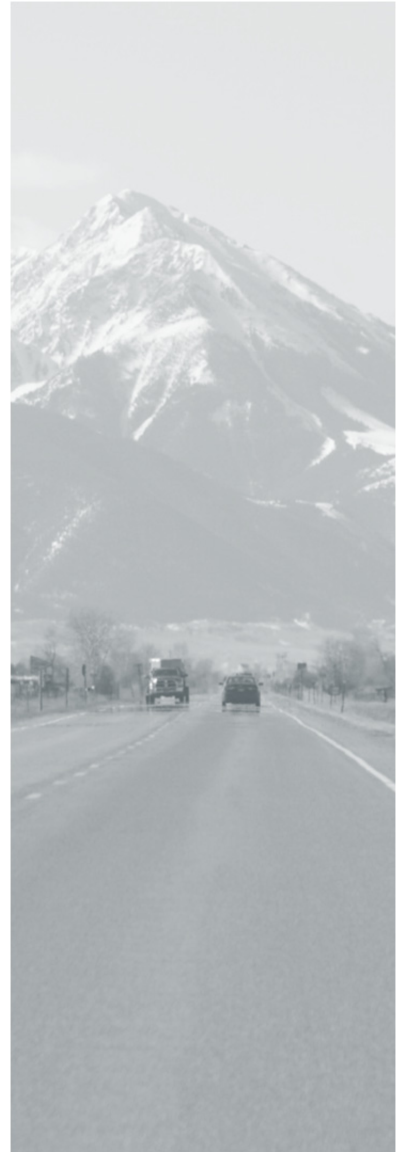
**W appr view East**

### Notes

None

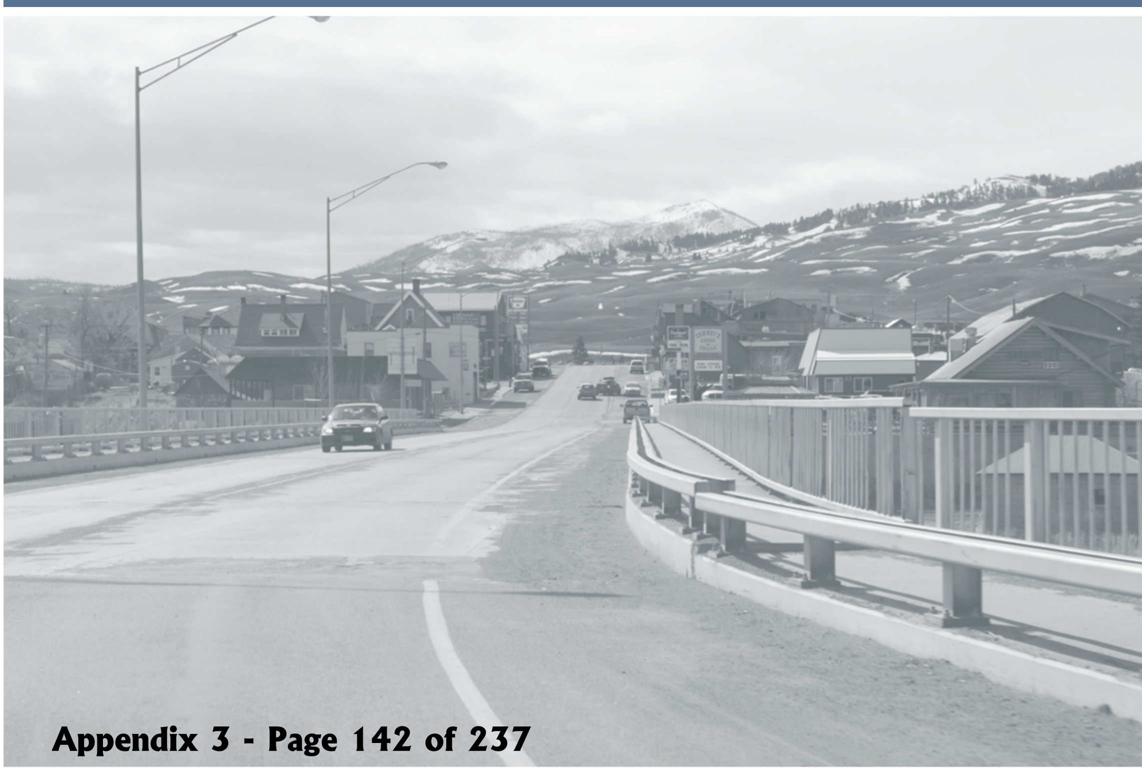
### Notes

None



# APPENDIX D

*Highway LOS Analysis*

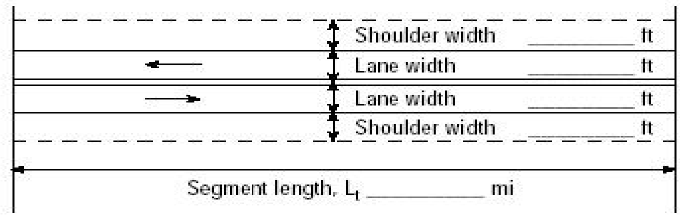


# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| ***General Information*** | | ***Site Information*** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.0 to 0.4 (34-3-10)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***




Analysis direction vol., $V_d$ *329*veh/h

Opposing direction vol., $V_o$ *219*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *0.4*


☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *100%*

% Trucks and Buses , $P_T$ *6* %

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *40*/mi

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.3* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.982* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *381* | *256* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *10.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.6 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *48.7 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *40.1 mi/h* |
| | | Percent free flow speed, PFFS | *82.4 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *376* | *250* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *38.0* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *52.8* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *69.7* | |

| ***Level of Service and Other Performance Measures*** | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.22* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *82.4* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *373.9* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.09* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

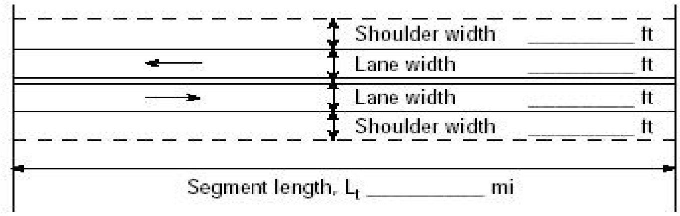
 *HCS 2010*™ Version 6.41 Generated: 9/5/2013 11:51 AM

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| **General Information** | | **Site Information** | |
|---|---|---|---|
| Analyst | Scott Randall | Highway / Direction of Travel | US 89 |
| Agency or Company | RPA | From/To | RP 0.4 to 2.4 (34-3-9) |
| Date Performed | 9/5/2013 | Jurisdiction | MDT |
| Analysis Time Period | Average Annual | Analysis Year | Existing (2012) |

Project Description: Paradise Valley

***Input Data***





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | 270veh/h |
| Opposing direction vol., $V_o$ | 180veh/h |
| Shoulder width ft | 4.0 |
| Lane Width ft | 12.0 |
| Segment Length mi | 2.0 |
| Peak-hour factor, PHF | 0.88 |
| No-passing zone | 73% |
| % Trucks and Buses , $P_T$ | 6 % |
| % Recreational vehicles, $P_R$ | 4% |
| Access points *mi* | 21/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | 1.4 | 1.5 |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | 1.0 | 1.0 |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | 0.977 | 0.971 |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | 1.00 | 1.00 |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | 314 | 211 |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | 60.0 mi/h |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | 1.3 mi/h |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | 5.3 mi/h |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | 3.7 mi/h | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | 53.5 mi/h |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | 45.7 mi/h |
| | | Percent free flow speed, PFFS | 85.5 % |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | 1.1 | 1.1 |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | 1.0 | 1.0 |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | 0.994 | 0.994 |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | 1.00 | 1.00 |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$ | 309 | 206 |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | 30.7 | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | 53.2 | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | 62.6 | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | B |
| Volume to capacity ratio, *v/c* | 0.18 |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *85.5* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *306.8* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.99* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

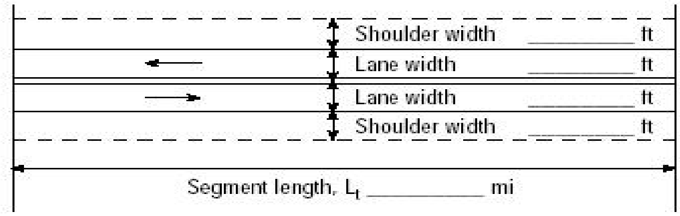
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 2.4 to 10.4 (34-3-1)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *53%*

% Trucks and Buses, $P_T$ *6 %*

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *9/mi*

Analysis direction vol., $V_d$ *184*veh/h

Opposing direction vol., $V_o$ *123*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *8.0*

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.5* | *1.7* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.971* | *0.960* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *215* | *146* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *2.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.5 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *56.5 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *51.1 mi/h* |
| | | Percent free flow speed, PFFS | *90.6 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$ | *210* | *141* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *22.5* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *49.8* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *52.3* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.13* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1632* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *90.6* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *209.1* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.79* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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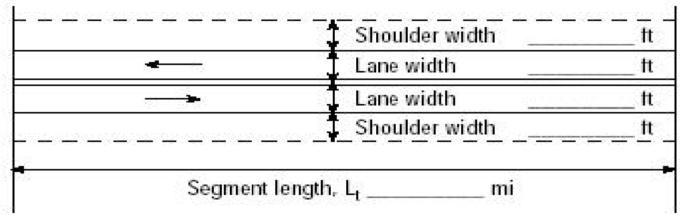
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| ***General Information*** | | ***Site Information*** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 10.4 to 24.4 (34-3-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Analysis direction vol., $V_d$ | *172*veh/h |
| Opposing direction vol., $V_o$ | *115*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *13.9* |
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *55%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *4*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.5* | *1.8* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.971* | *0.954* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *201* | *137* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.6 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *52.5 mi/h* |
| | | Percent free flow speed, PFFS | *91.0 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *197* | *131* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *21.3* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *50.4* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *51.6* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.12* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1622* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *91.0* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *195.5* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.76* |
| Bicycle level of service (Exhibit 15-4) | *E* |
| ***Notes*** | |

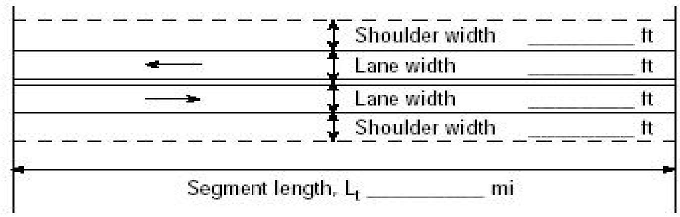
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 24.4 to 40.7 (34-3-3)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *28%*

% Trucks and Buses , $P_T$ *6 %*

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *4/mi*

Analysis direction vol., $V_d$ *185*veh/h

Opposing direction vol., $V_o$ *124*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *16.3*

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.5* | *1.7* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.971* | *0.960* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *217* | *147* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *1.5 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *53.4 mi/h* |
| | | Percent free flow speed, PFFS | *92.5 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$ | *211* | *142* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *22.6* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *38.5* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *45.6* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *B* |
| Volume to capacity ratio, *v/c* | *0.13* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1632* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *92.5* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *210.2* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.80* |
| Bicycle level of service (Exhibit 15-4) | *E* |
| ***Notes*** | |

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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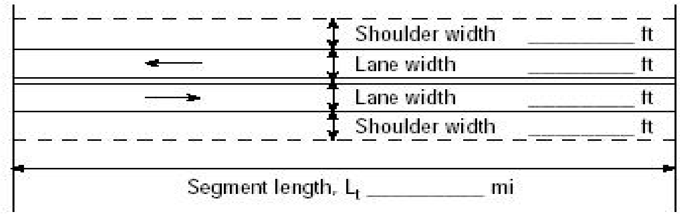
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 40.7 to 50.6 (34-2-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

**Input Data**





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | *273*veh/h |
| Opposing direction vol., $V_o$ | *182*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *9.9* |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *38%* |
| % Trucks and Buses , $P_T$ | *6* % |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *6*/mi |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.4* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.977* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$ | *318* | *213* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0* *mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3* *mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.5* *mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.5* *mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.2* *mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *50.6* *mi/h* |
| | | Percent free flow speed, PFFS | *88.5* *%* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$ | *312* | *208* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *30.9* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *43.5* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *57.0* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.19* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *88.5* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *310.2* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.99* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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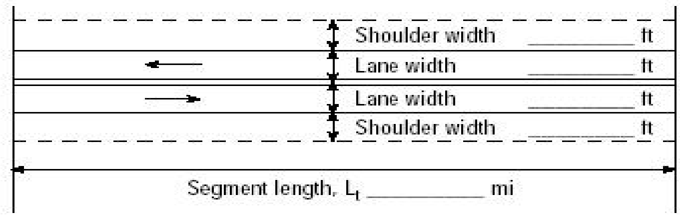
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| ***General Information*** | | ***Site Information*** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 50.6 to 52.4 (34-2A-5)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *100%*

% Trucks and Buses , $P_T$ *6* %

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *20*/mi

Analysis direction vol., $V_d$ *400*veh/h

Opposing direction vol., $V_o$ *267*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *1.8*

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.2* | *1.4* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.988* | *0.977* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *460* | *311* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.4 mi/h* | Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$ | *53.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *44.4 mi/h* |
| | | Percent free flow speed, PFFS | *82.6 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$ | *455* | *305* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *44.7* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *44.0* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *71.0* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.27* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *82.6* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *454.5* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.19* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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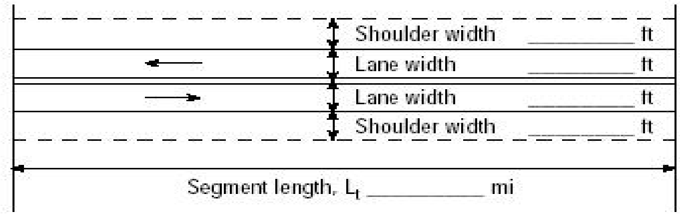
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.0 to 0.4 (34-3-10)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

***Input Data***





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | *463*veh/h |
| Opposing direction vol., $V_o$ | *309*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *0.4* |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *100%* |
| % Trucks and Buses , $P_T$ | *6* % |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *40*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.2* | *1.3* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.988* | *0.982* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *533* | *358* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *10.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.0 mi/h* | Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$) | *48.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *38.8 mi/h* |
| | | Percent free flow speed, PFFS | *79.7 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$ | *526* | *353* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *50.3* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *39.5* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *73.9* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.31* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1669* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *79.7* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *526.1* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.26* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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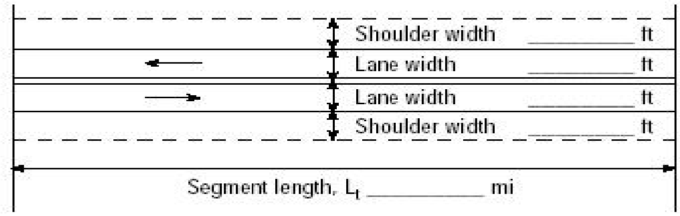
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| *General Information* | | *Site Information* | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.4 to 2.4 (34-3-9)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

### *Input Data*




Analysis direction vol., $V_d$ *380*veh/h

Opposing direction vol., $V_o$ *254*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *2.0*


☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *73%*

% Trucks and Buses , $P_T$ *6* %

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *21*/mi

### *Average Travel Speed*

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.3* | *1.4* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$ ($E_T$ -1)+$P_R$ ($E_R$ -1) ) | *0.982* | *0.977* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *440* | *295* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.2 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *53.5 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *44.6 mi/h* |
| | | Percent free flow speed, PFFS | *83.4 %* |

### *Percent Time-Spent-Following*

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *432* | *290* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *43.9* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *44.4* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *70.5* | |

### *Level of Service and Other Performance Measures*

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *B* |
| Volume to capacity ratio, *v/c* | *0.26* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *83.4* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *431.8* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.16* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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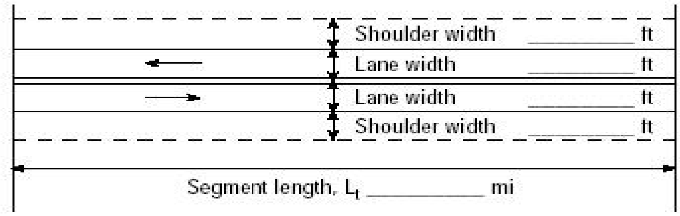
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 2.4 to 10.4 (34-3-1)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**





Analysis direction vol., $V_d$ *260*veh/h

Opposing direction vol., $V_o$ *173*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *8.0*

☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *53%*

% Trucks and Buses , $P_T$ *6 %*

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *9/mi*

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.4* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.977* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *302* | *202* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, $v$ | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *2.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.2 mi/h* | Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$ | *56.5 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *49.3 mi/h* |
| | | Percent free flow speed, PFFS | *87.4 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$ | *297* | *198* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *30.0* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *49.5* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *59.7* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.18* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *87.4* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *295.5* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.97* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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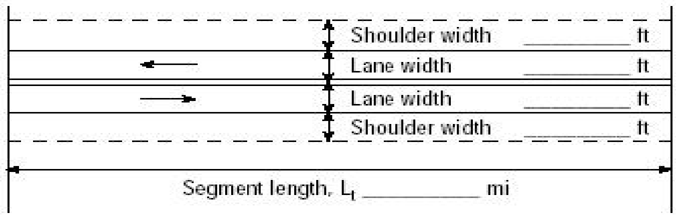
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 10.4 to 24.4 (34-3-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**





| | |
|---|---|
| Analysis direction vol., $V_d$ | *243*veh/h |
| Opposing direction vol., $V_o$ | *162*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *13.9* |

☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *55%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *4/mi* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.4* | *1.6* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.977* | *0.965* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF* f_{g,ATS} * f_{HV,ATS})$ | *283* | *191* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.3 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *50.8 mi/h* |
| | | Percent free flow speed, PFFS | *88.0 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$ | *278* | *185* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *28.4* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *50.6* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *58.8* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.17* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1641* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *88.0* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *276.1* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.93* |
| Bicycle level of service (Exhibit 15-4) | *E* |
| ***Notes*** | |

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i(v_d$ or $v_o)$ >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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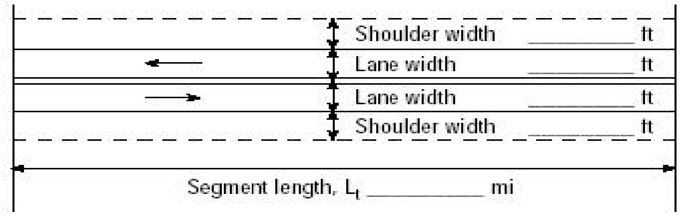
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| **General Information** | | **Site Information** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 24.4 to 40.7 (34-3-3)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Analysis direction vol., $V_d$ | *261*veh/h |
| Opposing direction vol., $V_o$ | *174*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *16.3* |
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *28%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *4/mi* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.4* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.977* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *304* | *204* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.1 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *51.7 mi/h* |
| | | Percent free flow speed, PFFS | *89.6 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *298* | *199* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *30.1* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *39.7* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF} / v_{d,PTSF} + v_{o,PTSF})$ | *53.9* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.18* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *89.6* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *296.6* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *4.97* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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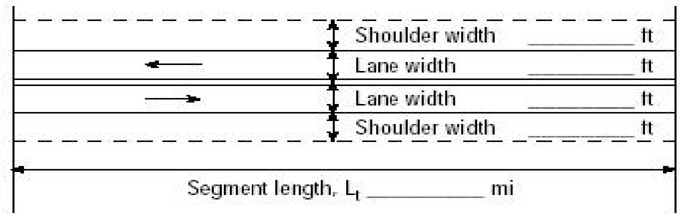
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

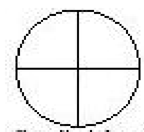
| **General Information** | | **Site Information** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 40.7 to 50.6 (34-2-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**




| | |
|---|---|
| Analysis direction vol., $V_d$ | *385*veh/h |
| Opposing direction vol., $V_o$ | *256*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *9.9* |




☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *38%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *6/mi* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.3* | *1.4* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.982* | *0.977* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *446* | *298* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.5 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.2 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.2 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *49.2 mi/h* |
| | | Percent free flow speed, PFFS | *86.0 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *438* | *293* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *44.1* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *36.4* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *65.9* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.26* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *86.0* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *437.5* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.17* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

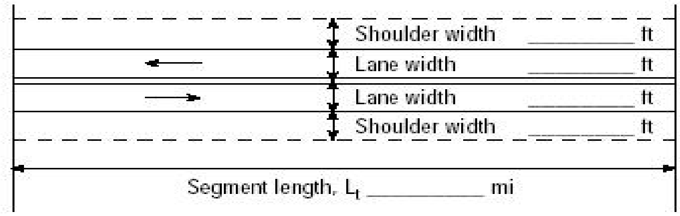
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 50.6 to 52.4 (34-2A-5)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Average Annual* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *100%* |
| % Trucks and Buses, $P_T$ | *6* % |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *20*/mi |

| | |
|---|---|
| Analysis direction vol., $V_d$ | *564*veh/h |
| Opposing direction vol., $V_o$ | *376*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *1.8* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.1* | *1.3* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.994* | *0.982* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *645* | *435* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.6 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *53.7 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *42.7 mi/h* |
| | | Percent free flow speed, PFFS | *79.5 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *641* | *427* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *57.5* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *35.0* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *78.5* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.38* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1669* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *79.5* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *640.9* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.36* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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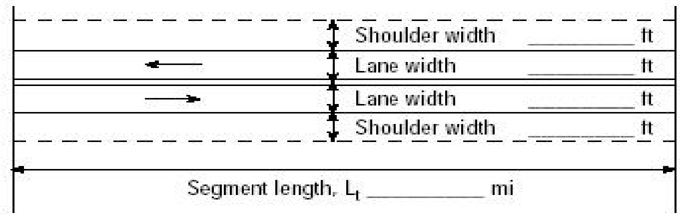
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.0 to 0.4 (34-3-10)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





| | | | |
|---|---|---|---|
| Analysis direction vol., $V_d$ | *574*veh/h | ☐ Class I highway ☐ Class II highway ☑ Class III highway | |
| Opposing direction vol., $V_o$ | *383*veh/h | Terrain ☑ Level ☐ Rolling | |
| Shoulder width ft | *4.0* | Grade Length mi | Up/down |
| Lane Width ft | *12.0* | Peak-hour factor, PHF | *0.88* |
| Segment Length mi | *0.4* | No-passing zone | *100%* |
| | | % Trucks and Buses , $P_T$ | *6* % |
| | | % Recreational vehicles, $P_R$ | *4%* |
| | | Access points *mi* | *40*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.1* | *1.3* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.982* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *656* | *443* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *10.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.5 mi/h* | Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$ | *48.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *37.6 mi/h* |
| | | Percent free flow speed, PFFS | *77.3 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$ | *652* | *435* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *59.2* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *34.6* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *80.0* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.39* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1669* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *77.3* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *652.3* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.37* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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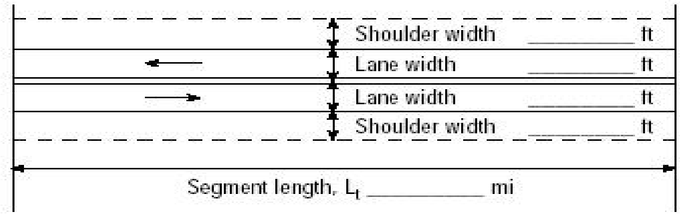
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.4 to 2.4 (34-3-9)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

**Input Data**





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *73%* |
| % Trucks and Buses , $P_T$ | *6* % |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *21*/mi |
| Analysis direction vol., $V_d$ | *472*veh/h |
| Opposing direction vol., $V_o$ | *315*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *2.0* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.2* | *1.3* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$ ($E_T$ -1)+$P_R$ ($E_R$ -1) ) | *0.988* | *0.982* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *543* | *365* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.8 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *53.5 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *43.6 mi/h* |
| | | Percent free flow speed, PFFS | *81.7 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *536* | *360* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *50.5* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *37.3* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *72.8* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.32* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1669* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *81.7* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *536.4* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.27* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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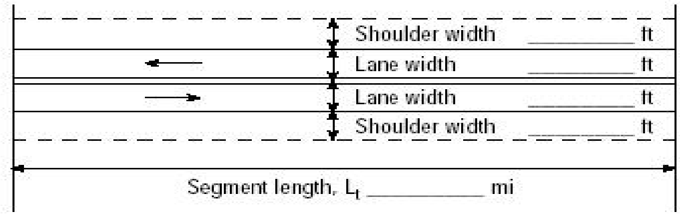
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| **General Information** | | **Site Information** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 2.4 to 10.4 (34-3-1)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

**Input Data**





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | *322*veh/h |
| Opposing direction vol., $V_o$ | *215*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *8.0* |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *53%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *9/mi* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.3* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.982* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$ | *373* | *252* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *2.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.0 mi/h* | Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$ | *56.5 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *48.6 mi/h* |
| | | Percent free flow speed, PFFS | *86.2 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$ | *368* | *246* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *37.4* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *47.8* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *66.0* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.22* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *86.2* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *365.9* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.08* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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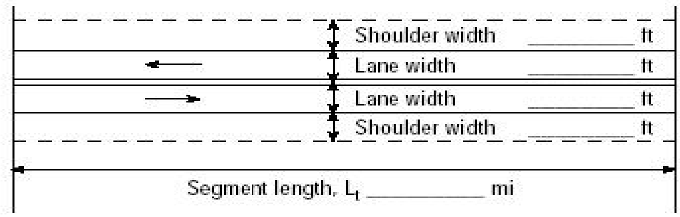
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| ***General Information*** | | ***Site Information*** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 10.4 to 24.4 (34-3-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | *301*veh/h |
| Opposing direction vol., $V_o$ | *201*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *13.9* |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *55%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *4*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.4* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.977* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *350* | *235* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *3.2 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *50.0 mi/h* |
| | | Percent free flow speed, PFFS | *86.6 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$ | *344* | *230* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *34.3* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *49.6* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *64.0* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.21* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *86.6* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *342.0* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.04* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

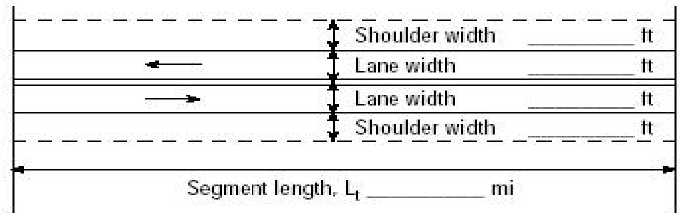
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 24.4 to 40.7 (34-3-3)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

**Input Data**





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *28%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *4/mi* |

| | |
|---|---|
| Analysis direction vol., $V_d$ | *324*veh/h |
| Opposing direction vol., $V_o$ | *216*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *16.3* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.3* | *1.5* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.982* | *0.971* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *375* | *253* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.0 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *50.9 mi/h* |
| | | Percent free flow speed, PFFS | *88.2 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.1* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$ | *370* | *247* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *37.5* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *38.9* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *60.8* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.22* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1651* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *88.2* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *368.2* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.08* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

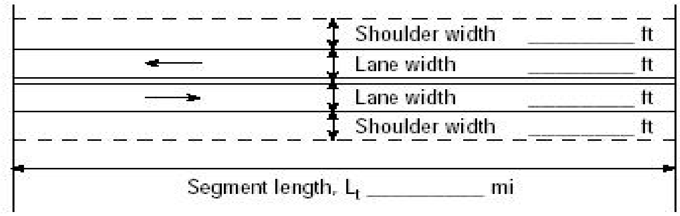
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

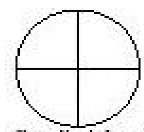
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 40.7 to 50.6 (34-2-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

**Input Data**




☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | *477*veh/h |
| Opposing direction vol., $V_o$ | *318*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *9.9* |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *38%* |
| % Trucks and Buses , $P_T$ | *6* % |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *6*/mi |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.2* | *1.3* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.988* | *0.982* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *549* | *368* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.5 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.0 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.2 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *48.1 mi/h* |
| | | Percent free flow speed, PFFS | *84.1 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$ | *542* | *364* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *52.4* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *30.9* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *70.9* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.32* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1669* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *84.1* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *542.0* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.28* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

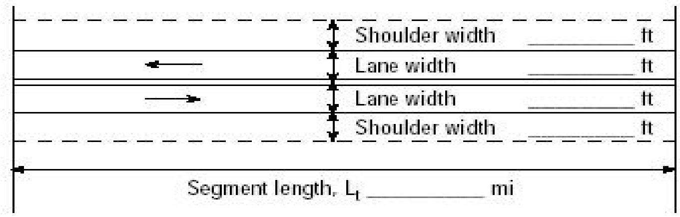
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 50.6 to 52.4 (34-2A-5)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Existing (2012)* |

Project Description: *Paradise Valley*

***Input Data***





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

| | |
|---|---|
| Analysis direction vol., $V_d$ | *699*veh/h |
| Opposing direction vol., $V_o$ | *466*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *1.8* |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *100%* |
| % Trucks and Buses , $P_T$ | *6* % |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *20*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.1* | *1.2* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.988* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *799* | *536* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.2 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *53.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *41.2 mi/h* |
| | | Percent free flow speed, PFFS | *76.6 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$ | *794* | *530* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *66.6* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *29.1* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *84.1* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.47* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1680* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *76.6* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *794.3* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.47* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

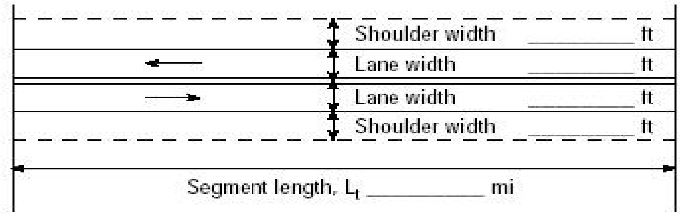
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.0 to 0.4 (34-3-10)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

***Input Data***





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *100%*

% Trucks and Buses , $P_T$ *6* %

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *40*/mi

Analysis direction vol., $V_d$ *722*veh/h

Opposing direction vol., $V_o$ *481*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *0.4*

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.1* | *1.2* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.994* | *0.988* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i$=$V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *825* | *553* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *10.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.1 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *48.7 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *35.9 mi/h* |
| | | Percent free flow speed, PFFS | *73.8 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i$=$V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *820* | *547* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *67.7* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *28.1* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *84.6* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.49* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1680* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *73.8* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *820.5* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.49* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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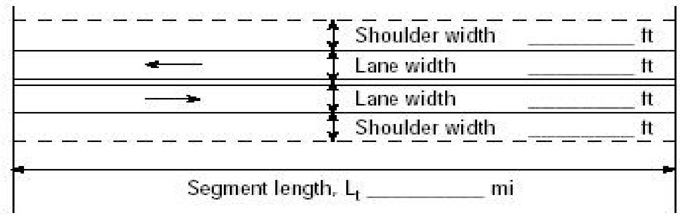
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 0.4 to 2.4 (34-3-9)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

***Input Data***





☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Analysis direction vol., $V_d$ | *593*veh/h |
| Opposing direction vol., $V_o$ | *395*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *2.0* |
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *73%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *21*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.1* | *1.3* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.994* | *0.982* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *678* | *457* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.3 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *53.5 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *42.3 mi/h* |
| | | Percent free flow speed, PFFS | *79.2 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$ | *674* | *449* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *60.8* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *32.2* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *80.1* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.40* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1669* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *79.2* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *673.9* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.39* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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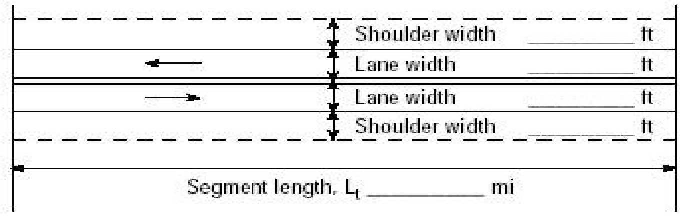
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| **General Information** | | **Site Information** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 2.4 to 10.4 (34-3-1)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

***Input Data***





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *53%*

% Trucks and Buses , $P_T$ *6 %*

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *9*/mi

Analysis direction vol., $V_d$ *405*veh/h

Opposing direction vol., $V_o$ *270*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *8.0*

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.2* | *1.4* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.988* | *0.977* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *466* | *314* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *2.3 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.7 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *56.5 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *47.7 mi/h* |
| | | Percent free flow speed, PFFS | *84.6 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *460* | *309* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *44.8* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *38.6* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *67.9* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.27* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *84.6* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *460.2* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.19* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

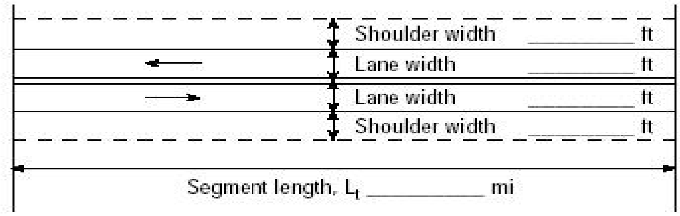
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i(v_d$ or $v_o)$ >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 10.4 to 24.4 (34-3-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**




Analysis direction vol., $V_d$ *379*veh/h

Opposing direction vol., $V_o$ *252*veh/h

Shoulder width ft *4.0*

Lane Width ft *12.0*

Segment Length mi *13.9*


☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.88*

No-passing zone *55%*

% Trucks and Buses , $P_T$ *6 %*

% Recreational vehicles, $P_R$ *4%*

Access points *mi* *4*/mi

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.3* | *1.4* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$ | *0.982* | *0.977* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *439* | *293* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Mean speed of sample[3], $S_{FM}$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *49.1 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *2.9 mi/h* | Percent free flow speed, PFFS | *85.2 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$ | *431* | *288* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *43.8* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *42.1* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF} / v_{d,PTSF} + v_{o,PTSF})$ | *69.0* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.26* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *85.2* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *430.7* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.16* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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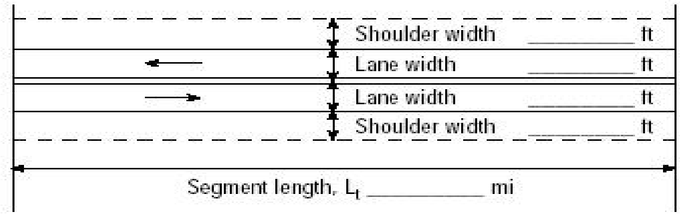
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| **General Information** | | **Site Information** | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 24.4 to 40.7 (34-3-3)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**





☑ Class I highway ☐ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Analysis direction vol., $V_d$ | *407*veh/h |
| Opposing direction vol., $V_o$ | *272*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *16.3* |
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *28%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *4/mi* |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.2* | *1.4* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *0.988* | *0.977* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$ | *468* | *316* |

| **Free-Flow Speed from Field Measurement** | | **Estimated Free-Flow Speed** | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$ | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *1.8 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.7 mi/h* |
| | | Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$ | *49.8 mi/h* |
| | | Percent free flow speed, PFFS | *86.3 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}*f_{g,PTSF})$ | *463* | *311* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *44.8* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *31.5* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$ | *63.6* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *C* |
| Volume to capacity ratio, *v/c* | *0.28* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1661* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1690* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *86.3* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *462.5* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.20* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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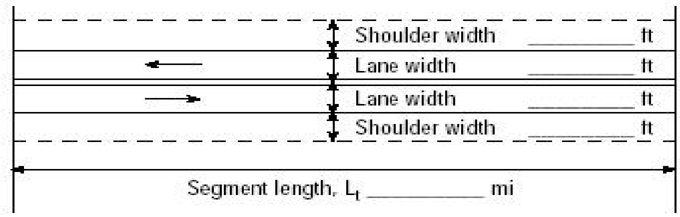
# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| General Information | | Site Information | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 40.7 to 50.6 (34-2-2)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

**Input Data**





| | |
|---|---|
| Analysis direction vol., $V_d$ | *600*veh/h |
| Opposing direction vol., $V_o$ | *400*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *9.9* |

☑ Class I highway ☐ Class II highway ☐ Class III highway

| | |
|---|---|
| Terrain | ☑ Level ☐ Rolling |
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *38%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *6*/mi |

**Average Travel Speed**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.1* | *1.2* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *0.994* | *0.988* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *686* | *460* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *1.5 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *1.7 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *57.2 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *46.6 mi/h* |
| | | Percent free flow speed, PFFS | *81.5 %* |

**Percent Time-Spent-Following**

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}$=1/ (1+ $P_T$($E_T$-1)+$P_R$($E_R$-1) ) | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$) | *682* | *455* |
| Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$) | *60.8* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *26.6* | |
| Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$) | *76.8* | |

**Level of Service and Other Performance Measures**

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.40* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1680* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *81.5* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *681.8* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.39* |
| Bicycle level of service (Exhibit 15-4) | *E* |

***Notes***

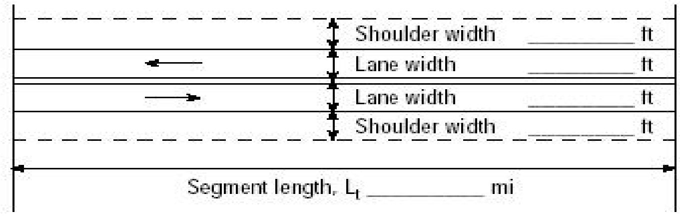
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

# DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

| *General Information* | | *Site Information* | |
|---|---|---|---|
| Analyst | *Scott Randall* | Highway / Direction of Travel | *US 89* |
| Agency or Company | *RPA* | From/To | *RP 50.6 to 52.4 (34-2A-5)* |
| Date Performed | *9/5/2013* | Jurisdiction | *MDT* |
| Analysis Time Period | *Peak Season* | Analysis Year | *Future (2035)* |

Project Description: *Paradise Valley*

***Input Data***





| | |
|---|---|
| Analysis direction vol., $V_d$ | *879*veh/h |
| Opposing direction vol., $V_o$ | *586*veh/h |
| Shoulder width ft | *4.0* |
| Lane Width ft | *12.0* |
| Segment Length mi | *1.8* |

☐ Class I highway ☐ Class II highway ☑ Class III highway

Terrain ☑ Level ☐ Rolling

| | |
|---|---|
| Grade Length mi | Up/down |
| Peak-hour factor, PHF | *0.88* |
| No-passing zone | *100%* |
| % Trucks and Buses , $P_T$ | *6 %* |
| % Recreational vehicles, $P_R$ | *4%* |
| Access points *mi* | *20*/mi |

***Average Travel Speed***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$ (Exhibit 15-11 or 15-12) | *1.0* | *1.1* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-11 or 15-13) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *0.994* |
| Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9) | *1.00* | *1.00* |
| Demand flow rate[2], $v_i$ (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$) | *999* | *670* |

| Free-Flow Speed from Field Measurement | | Estimated Free-Flow Speed | |
|---|---|---|---|
| Mean speed of sample[3], $S_{FM}$ | | Base free-flow speed[4], BFFS | *60.0 mi/h* |
| Total demand flow rate, both directions, *v* | | Adj. for lane and shoulder width,[4] $f_{LS}$(Exhibit 15-7) | *1.3 mi/h* |
| Free-flow speed, FFS=$S_{FM}$+0.00776(*v*/ $f_{HV,ATS}$ ) | | Adj. for access points[4], $f_A$ (Exhibit 15-8) | *5.0 mi/h* |
| Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) | *1.7 mi/h* | Free-flow speed, FFS (FSS=BFFS-$f_{LS}$-$f_A$) | *53.7 mi/h* |
| | | Average travel speed, $ATS_d$=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$ | *39.0 mi/h* |
| | | Percent free flow speed, PFFS | *72.7 %* |

***Percent Time-Spent-Following***

| | Analysis Direction (d) | Opposing Direction (o) |
|---|---|---|
| Passenger-car equivalents for trucks, $E_T$(Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Passenger-car equivalents for RVs, $E_R$ (Exhibit 15-18 or 15-19) | *1.0* | *1.0* |
| Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$ | *1.000* | *1.000* |
| Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17) | *1.00* | *1.00* |
| Directional flow rate[2], $v_i$(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$ | *999* | *666* |
| Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$ | *75.0* | |
| Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21) | *22.9* | |
| Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF} / v_{d,PTSF} + v_{o,PTSF})$ | *88.7* | |

***Level of Service and Other Performance Measures***

| | |
|---|---|
| Level of service, LOS (Exhibit 15-3) | *D* |
| Volume to capacity ratio, *v/c* | *0.59* |

| | |
|---|---|
| Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h | *1690* |
| Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h | *1700* |
| Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only) | *72.7* |
| ***Bicycle Level of Service*** | |
| Directional demand flow rate in outside lane, $v_{OL}$ (Eq. 15-24) veh/h | *998.9* |
| Effective width, Wv (Eq. 15-29) ft | *16.00* |
| Effective speed factor, $S_t$ (Eq. 15-30) | *4.79* |
| Bicycle level of service score, BLOS (Eq. 15-31) | *5.59* |
| Bicycle level of service (Exhibit 15-4) | *F* |

***Notes***

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i$($v_d$ or $v_o$) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

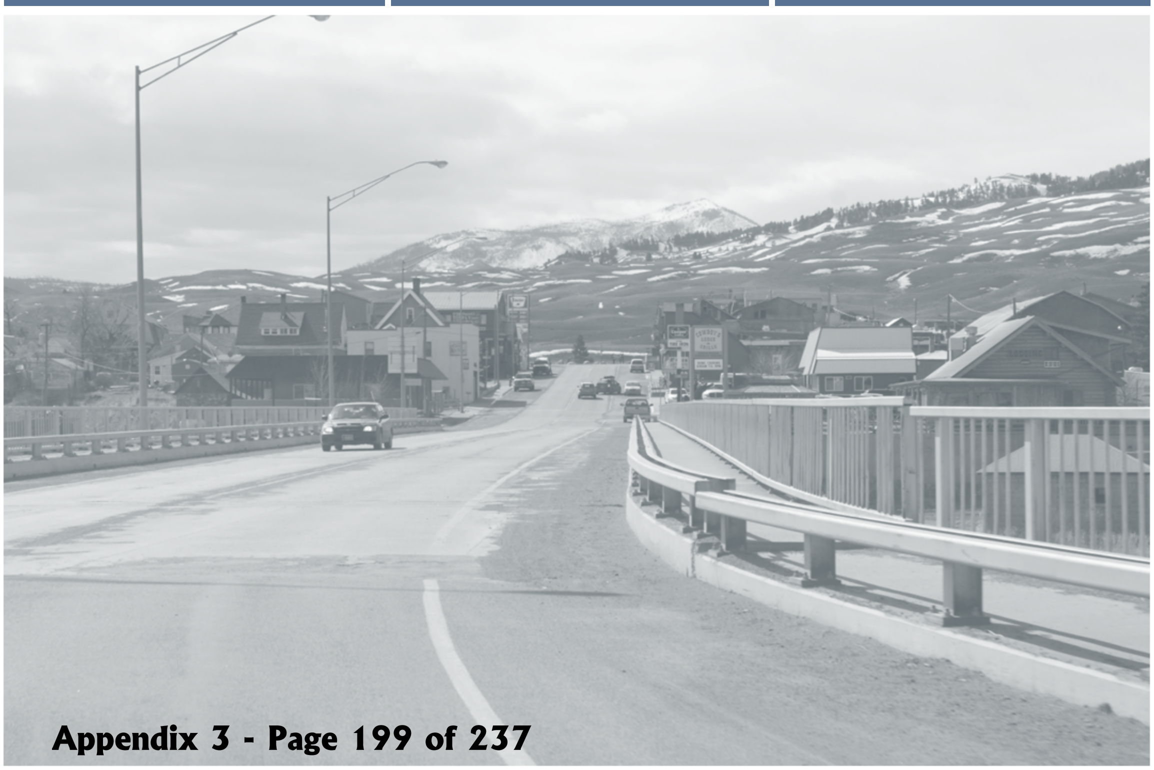
# NEEDS AND OBJECTIVES

*Paradise Valley Corridor Planning Study*
*US 89 (Gardiner to Livingston)*

FINAL

Prepared for:
**MONTANA DEPARTMENT OF TRANSPORTATION**

**Sept. 11, 2013**




Prepared by:
**ROBERT PECCIA & ASSOCIATES**
Helena, Montana

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# ABBREVIATIONS/ACRONYMS

| | |
|---|---|
| **MDT** | Montana Department of Transportation |
| **YNP** | Yellowstone National Park |

# NEEDS AND OBJECTIVES

# 1.0 CORRIDOR NEEDS AND OBJECTIVES

Needs and objectives for the US 89 Corridor Planning Study were developed based on a review of existing data, local plans, and input from resource agencies, stakeholders and the public. The needs and objectives explain why an improvement option, or options, may be necessary. The process includes analyzing the social, environmental, and engineering conditions described in the *Existing and Projected Conditions Report* and recognizing the character of the corridor.

The following needs and objectives will be used to develop improvement options. Improvement options identified in this study may lead to future transportation projects that improve safety and operations, or address infrastructure concerns. The "Purpose and Need" statement for any future project should be consistent with the needs and objectives contained in this study.

## 1.1 Need 1

**Improve the safety of US 89 in the study area for all users.**

Objectives (To the Extent Practicable)

- Improve roadway elements to meet current design standards.
- Review signing and passing opportunites based on current design standards.
- Evaluate best practice mitigation strategies as appropriate to reduce potential animal-vehicle conflicts.
- Evaluate existing access density impacts.

## 1.2 Need 2

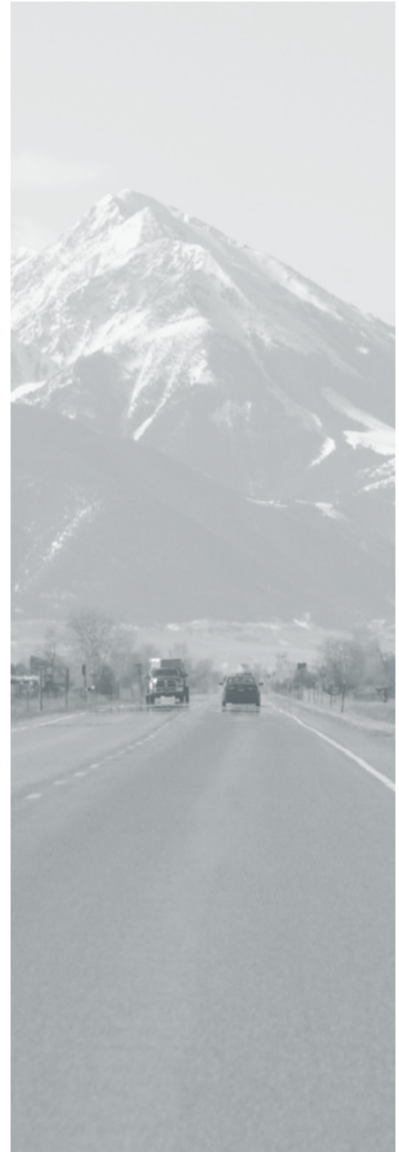
**Improve the operations of US 89 within the study area.**

Objectives (To the Extent Practicable)

- Accommodate existing and future capacity demands within the corridor.
- Minimize future access density impacts.
- Consider access to recreational sites in the corridor.

## 1.3 Other Considerations

- Minimize the environmental resource impacts of improvement options.
- Limit disruptions during construction as much as practicable.
- Provide appropriate speeds within the study area per statutory and special speed zones established by the Montana Transportation Commission.
- Review maintenance practices.
- Recognize the environmental, scenic, cultural, recreational, and agricultural nature of the corridor.
- Consider local planning efforts.
- Availability and feasibility of funding.
- Construction feasibility.



# IMPROVEMENT OPTIONS REPORT

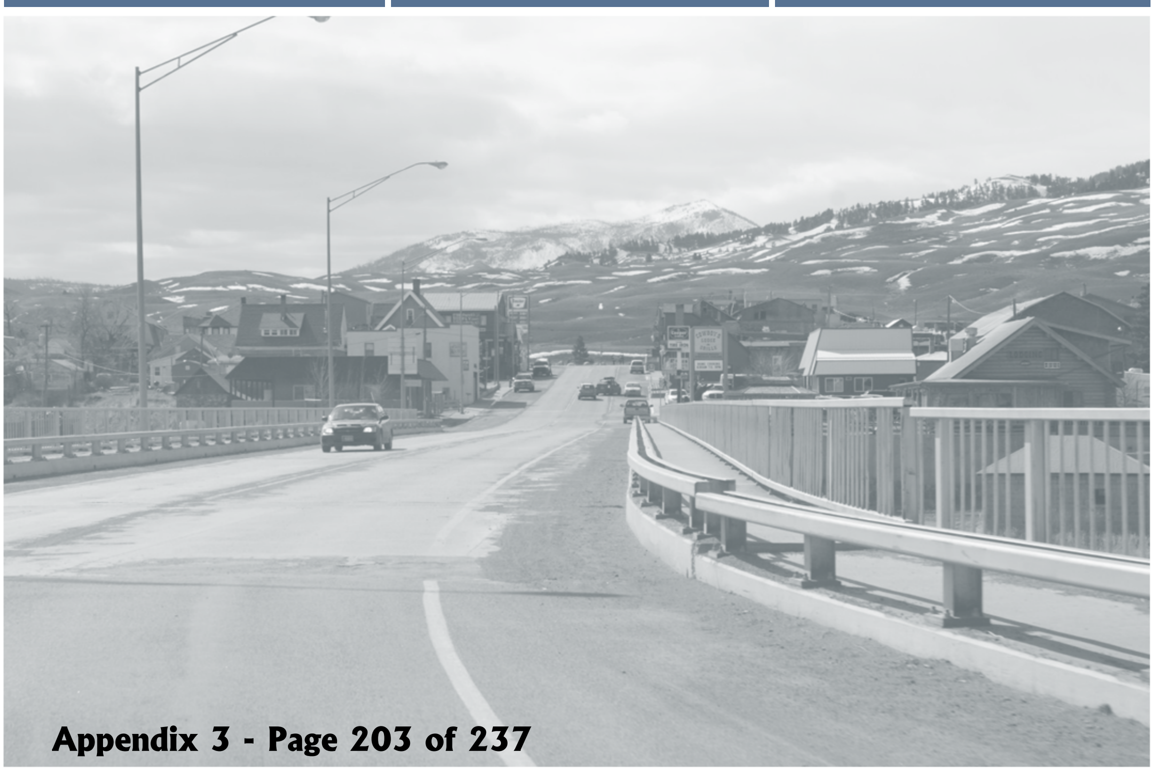
*Paradise Valley Corridor Planning Study*
*US 89 (Gardiner to Livingston)*

**FINAL**

MONTANA MDT DEPARTMENT OF TRANSPORTATION

Prepared for:
**MONTANA DEPARTMENT OF TRANSPORTATION**

***December 24, 2013***



Prepared by:
**ROBERT PECCIA & ASSOCIATES**
Helena, Montana

RPA

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## FIGURES



## TABLES

# ABBREVIATIONS/ACRONYMS

| | |
|---|---|
| **LOS** | Level of Service |
| **MDT** | Montana Department of Transportation |
| **RHRS** | Rockfall Hazard Rating System |
| **RP** | Reference Post |
| **TA** | Transportation Alternatives Program |
| **TWLTL** | Two-Way Left-Turn Lane |
| **YNP** | Yellowstone National Park |

# *IMPROVEMENT OPTIONS REPORT*

## 1.0 INTRODUCTION

The US Highway 89 corridor provides the primary surface transportation link between Livingston and Yellowstone National Park (YNP) in Park County. US 89 is one of the major routes in Montana used to access YNP through Gardiner. The highway passes through "Paradise Valley," which lies between Livingston and Yankee Jim Canyon. The roadway generally parallels the Yellowstone River over the length of the corridor. **Figure 1** shows the study area.

Recommended improvement options considered in this report reflect input from stakeholders and the public, as well as a thorough evaluation of the existing conditions of US 89 within the study area. Three steps are applied to develop improvement options:

1. Identify roadway issues and areas of concern based on field review, engineering analysis of as-built drawings, crash data analysis, consultation with resource agencies, and information provided by the public.
2. Identify overall corridor needs and objectives.
3. Analyze the information gathered to develop a range of improvement options that address the roadway issues and areas of concern, as well as satisfying corridor needs and objectives.

The purpose of this memorandum is to describe and evaluate each improvement option considered and to highlight potential benefits and drawbacks. This, in turns, enables assessing whether an improvement option will receive further consideration.

Implementation of improvement options depends on available personnel resources, funding availability, right-of-way needs, and other project delivery elements. Recommended timeframes for implementation are defined as follows:

- Short-term: Implementation is recommended within a 0- to 5-year period.
- Mid-term: Implementation is recommended within a 5- to 10-year period.
- Long-term: Implementation is recommended within a 10- to 20-year period.
- As needed: Implementation could occur based on observed need throughout the planning horizon.

Planning level cost estimates are listed in 2013 dollars for each improvement option. The planning level costs include estimates for right-of-way, preliminary engineering, construction engineering, construction, and indirect and incidental costs (IDIC). In addition, an inflationary factor of 3 percent per year was applied to the planning level costs to account for estimated year of expenditure. Cost ranges are provided in some cases, indicating unknown factors at the particular planning level stage. **Appendix A** contains planning level cost estimates, including all assumptions.

The following sections discuss general strategies explored, recommended improvement options (and associated planning level cost estimates), potential implementation timeframes, benefits, limitations, and drawbacks.

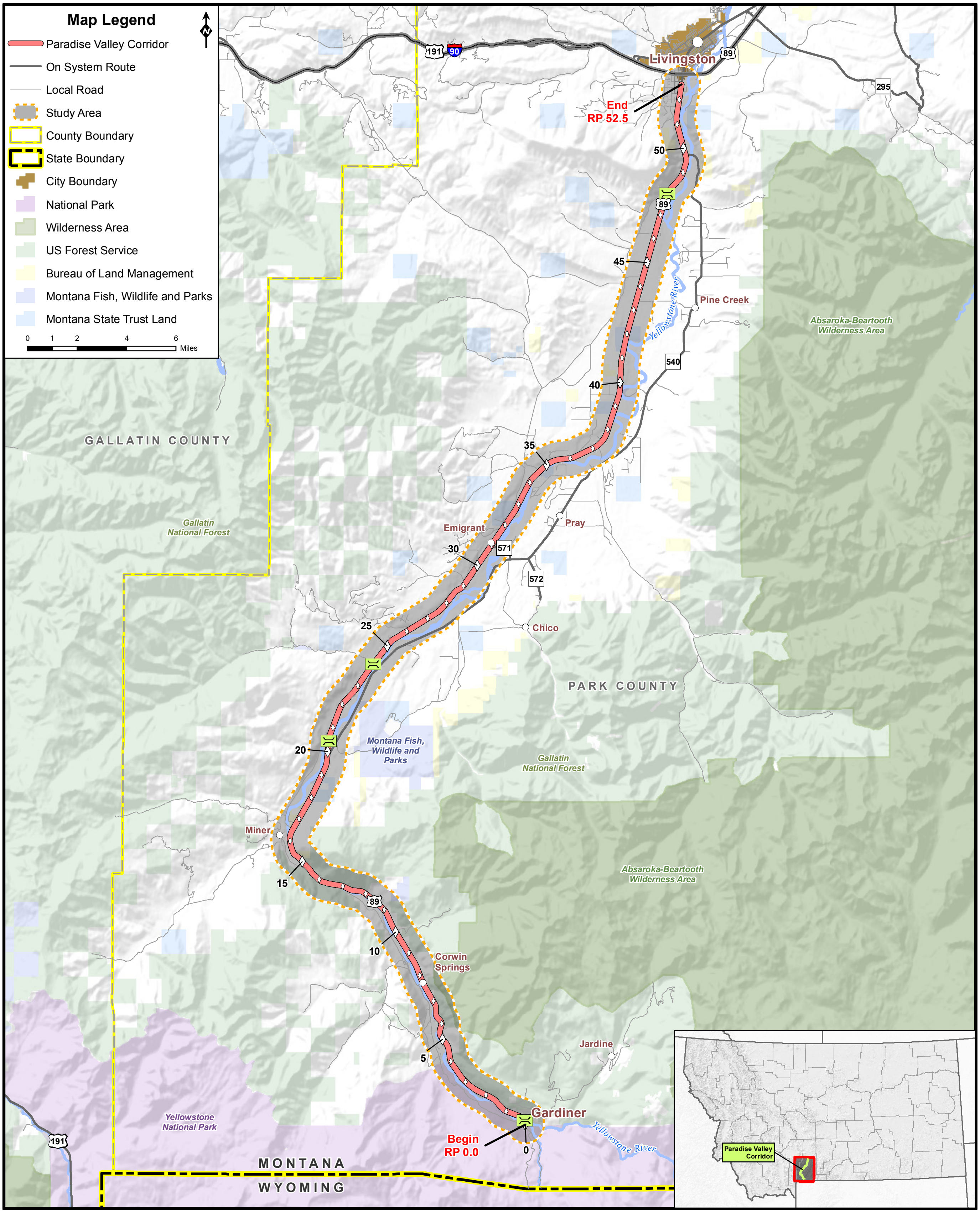



Figure 1: Study Area

# 2.0 IMPROVEMENT OPTIONS CONSIDERED

This section contains descriptions of the improvement options developed for the US 89 corridor, their potential benefits, limitations/drawbacks, and recommendations regarding whether the improvement options should be advanced for further consideration. The improvement options address previously defined issues or areas of concern and are intended to satisfy the corridor needs and objectives. For ease of identification, the improvement options receive unique identifiers via a numbering scheme.

Five general strategies for developing improvement options were identified in response to previously defined areas of concern. The various improvement options based on each general strategy are discussed in the following sections. The strategies explored were derived from a full assessment of the previously developed needs and objectives for the corridor, which are as follows:

**Need 1 – Improve the safety of US 89 in the study area for all users.**

- Improve roadway elements to meet current design standards.
- Review signing and passing opportunities based on current design standards.
- Evaluate best practice mitigation strategies as appropriate to reduce potential animal-vehicle conflicts.
- Evaluate existing access density impacts.

**Need 2 – Improve the operations of US 89 within the study area.**

- Accommodate existing and future capacity demands within the corridor.
- Minimize future access density impacts.
- Consider access to recreational sites in the corridor.

## 2.1 Geometrics

Roadway geometrics were compared to current Montana Department of Transportation (MDT) standards. A list of areas that do not meet current standards was developed previously in the *Existing and Projected Conditions Report.* The analysis identified potential strategies that correct some of the identified issues and may minimize potential effects. In some circumstances, it may not be cost-effective to address minor geometric issues unless there are safety concerns directly attributable to roadway geometry. Some of the strategies examined are listed below:

- Expand roadway widths via shoulder widening.
- Modify sub-standard curves with future improvements to meet current standards.
- Install advisory signs at sub-standard horizontal curves.
- Improve intersections by adding turn bays and enhanced signage.
- Improve clear zones.

Improvement options that arise from this strategy tie directly to ***Need 1 – Improve the safety of US 89 in the study area for all users***.

### 2.1.1 Improvement Options – Geometrics

#### 1. Shoulder Widening

The corridor generally consists of 12-foot travel lanes with 4-foot shoulders. Recreational and bicycle tourist traffic commonly occurs along the corridor. Widening roadway shoulders to 8 feet would increase both available space for bicyclists and roadside clear zones. A recent safety project resulted in installation of rumble strips along the shoulders of the corridor, which reduced the available shoulder space for bicyclists.

**Recommendation:**

- Consider constructing 8-foot shoulders incrementally as projects develop along the corridor.

**Benefits:**

- Would improve accommodations for bicyclists.
- Would improve geometrics and safety.

**Limitations/Drawbacks:**

- Would create potential for increased vehicle speeds.
- Land constraints may prohibit widening in some areas.

**Estimated Cost:**

- $910,000 per mile

**Recommended Action:**

- **ADVANCE** – Consider during project-level design.

**Implementation Timeframe:**

- Implement as needed, depending on future project development and location limitations. Can be assessed on a case-by-case basis during project-level design.

## 2. Maiden Basin Road Intersection (Reference Post [RP] 5.15)

The intersection of Maiden Basin Road with US 89, located at RP 5.15, serves local residents and the Yellowstone Basin Inn. The intersection currently has poor sight distance for northbound motorists on US 89 due to intersection geometrics and a hillside along the east side of the highway. A pull-off area just south of the intersection serves a mailbox facility and is a local bus stop, both of which add to the potential for conflicts with through traffic.

### *2(a). Advance Warning Signs (RP 5.15)*

This improvement option would result in the installation of advance intersection warning signs in both directions along US 89 at the intersection with Maiden Basin Road.

**Recommendation:**

- Install advance intersection warning signs along US 89.

**Benefits:**

- Would increase driver awareness of the intersection.
- Would improve safety.

**Limitations/Drawbacks:**

- Would not address intersection geometrics and sight distance limitations.

**Estimated Cost:**

- $600 EA

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Short-term

### *2(b). Right-turn Lane (RP 5.15)*

A northbound right-turn lane at this intersection would allow turning vehicles to exit from the traffic stream.

**Recommendation:**

- Construct a northbound right-turn lane along US 89 when appropriate warrants are met.

**Benefits:**

- Would separate turning vehicles from traffic stream.
- Would improve safety.

**Limitations/Drawbacks:**

- None were identified.

**Estimated Cost:**

- $270,000

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Mid-term

### *2(c). Slope Flattening (RP 5.15)*

Sight distance is limited from Maiden Basin Road looking north along US 89 due to cut slopes on the east side of the highway.

**Recommendation:**

- Flatten the slopes on the east side of US 89 north of the intersection with Maiden Basin Road to increase sight distances.

**Benefits:**

- Would increase sight distances.
- Would improve safety.

**Limitations/Drawbacks:**

- May impact adjacent roadway at top of cut slope.
- Topographical constraints may prohibit viability of flattening slopes.

**Estimated Cost:**

- $70,000

**Recommended Action:**

- **DO NOT ADVANCE** – It is not recommended that this improvement option be advanced for further consideration. It is unlikely that sight distances could feasibly be increased to meet existing standards given existing topography and roadway geometrics.

## 3. Rockfall Hazards (RP 13.3 to RP 14.6)

Rockfall hazard sites were identified in the *Rockfall Hazard Classification and Mitigation System* research project administered by MDT. The report identified 12 rockfall hazard sites along the corridor that were incorporated into MDT's Rockfall Hazard Rating System (RHRS) database. Three of the sites along the corridor were included in the top 100 rockfall hazard sites for Montana.

### 3(a). Rockfall Hazard Section #307 (RP 13.32 to RP 13.66)

Identified mitigation would include excavating using controlled blasting, installing guardrail and rockfall barrier, and construction of a Mechanically Stabilized Earth (MSE) wall.

**Recommendation:**

- Implement the recommendations contained in the *Rockfall Hazard Classification and Mitigation System*.

**Benefits:**

- Would improve roadside safety.

**Limitations/Drawbacks:**

- Would require excavation along US 89.

**Estimated Cost:**

- $4,000,000

**Recommended Action:**

- **DO NOT ADVANCE** – This improvement option was not advanced for further consideration. The high cost of this mitigation is disproportionate to the likely safety benefits. MDT normal maintenance practices respond to any ongoing rockfall concerns at this location. Crash characteristics pointing to safety concerns were not identified at this location.

### 3(b). Rockfall Hazard Section #309 (RP 13.84 to RP 13.96)

Identified mitigation would include slope scaling, draped cable nets, and rock bolts.

**Recommendation:**

- Implement the recommendations contained in the *Rockfall Hazard Classification and Mitigation System*.

**Benefits:**

- Would improve roadside safety.

**Limitations/Drawbacks:**

- None were identified.

**Estimated Cost:**

- $2,200,000

**Recommended Action:**

- **DO NOT ADVANCE** – This improvement option was not advanced for further consideration. The high cost of this mitigation is disproportionate to the likely safety benefits. MDT normal maintenance practices respond to any ongoing rockfall concerns at this location. Crash characteristics pointing to safety concerns were not identified at this location.

### 3(c). Rockfall Hazard Section #310 (RP 13.96 to RP 14.61)

Identified mitigation would include installing draped mesh with a catch fence.

**Recommendation:**

- Implement the recommendations contained in the *Rockfall Hazard Classification and Mitigation System*.

**Benefits:**

- Would improve roadside safety.

**Limitations/Drawbacks:**

- None were identified.

**Estimated Cost:**

- $3,000,000

**Recommended Action:**

- **DO NOT ADVANCE** – This improvement option was not advanced for further consideration. The high cost of this mitigation is disproportionate to the likely safety benefits. MDT normal maintenance practices respond to any ongoing rockfall concerns at this location. Crash characteristics pointing to safety concerns were not identified at this location.

## 4. East River Road Intersection – Turn Lanes (RP 19.8)

East River Road (S-540) serves as a parallel route to US 89, and provides access to recreational areas and local residences. The intersection of East River Road with US 89, located at RP 19.8, was reconstructed recently to eliminate the skewed approach where East River Road joins US 89. There are currently no dedicated turn lanes at this intersection. A southbound left-turn lane and northbound right-turn lane at this intersection would allow turning vehicles to exit from the traffic stream. The two turn lanes could be constructed at the same time or separately, depending on traffic volumes and when turn lane warrants are met.

**Recommendation:**

- Construct a southbound left-turn lane and northbound right-turn lane along US 89 when appropriate warrants are met.

**Benefits:**

- Would separate turning vehicles from traffic stream.
- Would improve safety.

**Limitations/Drawbacks:**

- May require additional right-of-way.

**Estimated Cost:**

- $650,000 (both turn lanes)
  - $370,000 (southbound left-turn lane only)
  - $280,000 (northbound right-turn lane only)

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Mid-term

## 5. Mill Creek Road Intersection – Right-turn Lane (RP 37.2)

The intersection of Mill Creek Road with US 89, located at RP 37.2, serves local residents, provides access to recreational areas, and connects to East River Road (S-540). The intersection currently has a southbound left-turn lane. A northbound right-turn lane at this intersection would allow turning vehicles to exit from the traffic stream.

**Recommendation:**

- Construct a northbound right-turn lane along US 89 when appropriate warrants are met.

**Benefits:**

- Would separate turning vehicles from traffic stream.
- Would improve safety.

**Limitations/Drawbacks:**

- May require additional right-of-way.

**Estimated Cost:**

- $280,000

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Mid-term

## 6. Geometric Improvements (RP 49.0 to RP 49.8)

This location consists of two horizontal curves and a vertical curve that do not meet current standards. Substandard roadway elements may pose safety concerns if left unaddressed.

### *6(a). Advance Warning Signs (RP 49.10 and RP 49.35)*

Horizontal curves at RP 49.10 and RP 49.35 were identified as having radii that do not meet current MDT design standards. Currently there are no advance warning signs for the curves.

**Recommendation:**

- Install horizontal curve warning signs for the horizontal curves located at RP 49.10 and RP 49.35.

**Benefits:**

- Inform drivers to reduce speed along the curves.
- Would increase driver awareness.
- Would increase safety.

**Limitations/Drawbacks:**

- Does not address the geometric issues.

**Estimated Cost:**

- $600 EA

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Short-term

### *6(b). Geometric Reconstruction (RP 49.0 to RP 49.8)*

Two existing horizontal curves do not meet standards based on curve radii. In addition, the vertical curve at RP 49.2 does not meet standards for both stopping sight distance and rate of curvature.

**Recommendation:**

- Reconstruct the roadway to meet current standards for horizontal and vertical curvature.

**Benefits:**

- Would improve safety by addressing roadway geometrics and increased sight distances.

**Limitations/Drawbacks:**

- Would potentially impact adjacent waterbodies.
- Would require additional right-of-way.
- May impact the hillside on the west side of the roadway.
- Is an identified landslide area with faults and tight fold structures.

**Estimated Cost:**

- $3,100,000

**Recommended Action:**

- **DO NOT ADVANCE** – This improvement option was not advanced for further consideration. The cost of reconstruction of this section of the corridor would likely exceed the overall benefit. There has been no identified safety trend associated with the substandard geometrics at this location. Appropriate advance warning signage would likely increase driver awareness in the area at a much lower cost.

## 2.2 Vehicle Congestion and Passing Opportunities

The performance of a roadway is expressed in terms of level of service (LOS), which accounts for vehicle congestion and roadway capacity. Roadway LOS also provides a measure of the driver's perception of the roadway's performance. When drivers experience delays due to reduced travel speeds, lack of passing opportunities, heavy vehicles in the traffic stream, and steep roadway grades, the roadway LOS deteriorates.

The LOS analysis conducted for the corridor shows that portions of the highway currently exhibit, or are projected to exhibit, poor levels of service that are below current standards. The performance of the highway can be improved by reducing vehicular traffic (unlikely) and/or increasing roadway capacity. Roadway capacity can be increased by providing additional passing opportunities, reducing access density, or adding additional travel lanes. Additional passing opportunities may be provided by increasing passing zones (through pavement striping), or by constructing dedicated passing lanes.

A "Highway Capacity and Level of Service Analysis" for both current and future year conditions was previously completed to document congestion and levels of service. Relevant information from this analysis is located in the *Existing and Projected Conditions Report.*

Improvement options that arise from this strategy address a myriad of concerns, and directly tie to ***Need 1 – Improve the safety of US 89 in the study area for all users*** and ***Need 2 – Improve the operations of US 89 within the study area***.

## 2.2.1 Improvement Options – Vehicle Congestion and Passing Opportunities

### 7. Passing Opportunities and Increased Capacity

Passing opportunities are currently provided by passing zones designated with dashed yellow centerlines. Passing zones are typically located where there is adequate sight distance and away from public approaches. Passing opportunities are limited by terrain and the volume of opposing vehicles. As traffic volumes increase, the effectiveness of passing zones decreases.

In addition to passing zones, dedicated passing lanes can be constructed in the form of additional travel lanes. Passing lanes allow for unobstructed passing without having to cross into the opposing travel lane, and they can help reduce long platoons behind slow-moving vehicles. Passing lanes should be installed at incremental locations along the highway to maximize their effectiveness.

Actions to increase highway capacity can also improve the corridor's LOS. The most apparent means of increasing the roadway's capacity would be to construct additional travel lanes. The corridor currently consists of one travel lane in each direction.

#### *7(a). Evaluate No-Passing Zones*

Passing opportunities are provided along the corridor in areas where roadway geometrics allow. No-passing zones are designated by solid yellow lines, and they are established in areas where there is insufficient passing sight distance or near public approaches. An engineering study to evaluate passing zones to determine if removal or addition of no-passing zones is warranted should be completed and recommendations implemented.

**Recommendation:**

- Evaluate existing no-passing signing and striping for compliance with current standards.

**Benefits:**

- Would improve safety for passing vehicles.

**Limitations/Drawbacks:**

- Would create potential for decreased passing opportunities.

**Estimated Cost:**

- $45,000

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Short-term

#### *7(b). Pullouts for Slow-moving Vehicles*

Pullouts for slow-moving vehicles were identified as a potential mechanism to improve traffic flow. Pullouts can be found along various types of roadways to allow vehicles to exit the traffic stream quickly as queues form behind them. Pullouts already exist in Yankee Jim Canyon along US 89. US 191 through the Gallatin Canyon south of Bozeman also contains sporadic pullouts that allow traffic separation of slow-moving vehicles, plus improved recreational access to the Gallatin River and trailheads.

The following are potential locations reviewed for pullouts based on preliminary review of roadway geometrics, terrain, and known use areas. In some cases, informal pullouts are starting to become established at river access points.

- RP 5.7 (west side of Yellowstone River)
- RP 6.8 (east side of Yellowstone River)
- RP 28.6 (east side of Yellowstone River)
- RP 38.6 (east side of Yellowstone River)
- RP 48.8 (east side of Yellowstone River)
- RP 49.3 (east side of Yellowstone River)

**Recommendation:**

- Construct pullouts at suitable locations along the corridor to allow slow-moving vehicles to exit the traffic stream.

**Benefits:**

- Would increase passing opportunities.
- Would increase safety for thru-movement vehicles as RV's and slow-moving vehicles could exit the thru-travel lane, thereby improving flow characteristics for other vehicles.
- Would improve level of service.

**Limitations/Drawbacks:**

- Would create potential impacts on environmental resources.
- Would likely require additional right-of-way.
- Would create unintended recreational river access points.
- Would potentially decrease safety due to speed differentials when exiting or entering mainline traffic.

**Estimated Cost:**

- $220,000 EA

**Recommended Action:**

- **DO NOT ADVANCE** – This option was not advanced for further consideration. The posted speeds along much of US 89 do not allow for quick and safe ingress/egress to periodic pullouts along the corridor. Those already in place in Yankee Jim Canyon, and others along US 191 in Gallatin Canyon, are located in lower posted speed areas.

### *7(c). Passing Lanes at Spot Locations*

Dedicated passing lanes provide opportunities to pass slower-moving vehicles without the need to cross into the opposing travel lane. Passing lanes can be constructed as three, four, or five-lane roadway sections with a center two-way, left-turn lane (TWLTL) and left-turn bays at major intersections.

The location and length of passing lanes are determined based on vehicle demand, roadway geometrics, and known constraints. Ideally, passing lanes would be constructed at regular intervals throughout the corridor. Further study is needed to determine the appropriate locations for passing lanes. The following are potential locations for passing lanes based on preliminary review of roadway geometrics, terrain, known environmental resource constraints, and public approaches:

- RP 16.6 (Tom Miner Creek Road) to RP 19.8 (East River Road)
- RP 25.6 to RP 28.4
- RP 40.0 (Inverness Road) to RP 42.0
- RP 44.4 (Old Yellowstone Trail) to RP 47.9 (Farm Access Overpass)

**Recommendation:**

- Construct passing lanes at incremental locations along the corridor, with primary focus on the bulleted areas above.

**Benefits:**

- Would increase passing opportunities.
- Would increase safety.
- Would improve level of service.

**Limitations/Drawbacks:**

- May create potential impacts on environmental resources.
- Would likely require additional right-of-way.

**Estimated Cost:**

- $12,400,000 EA

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Long-term

### 7(d). Four- or Five-lane Typical Section

This improvement option would increase highway capacity by providing a four- or five-lane roadway. The addition of a center TWLTL or dedicated left-turn bays would result in areas with a five-lane typical section. This option allows for higher capacities and increased unopposed passing opportunities.

**Recommendation:**

- Reconstruct the corridor to include two travel lanes in each direction and a center TWLTL, or designated left-turn bays at major intersections.

**Benefits:**

- Would increase capacity.
- Would improve level of service.
- Would reduce travel times.

**Limitations/Drawbacks:**

- May create potential impacts on environmental resources.
- May require additional right-of-way.

**Estimated Cost:**

- $6,200,000 per mile

**Recommended Action:**

- **DO NOT ADVANCE** – This option was not advanced for further consideration. Traffic volumes during most of the year do not warrant a full four- or five-lane facility. This option would require substantial new right-of-way acquisition and would result in greater environmental impacts than other options. In addition, a four- or five-lane highway would be considered out of context with the scenic nature of the corridor.

### *7(e). Alternating Passing Lanes*

This improvement option would result in alternating sections of the highway being reconstructed to add an additional passing lane in one direction. This type of facility, known as a "Super 2 Highway," would create directional passing areas along the corridor. This option would require a narrower roadway than a four-lane facility, but would have fewer passing opportunities and a lower capacity.

**Recommendation:**

- Reconstruct portions of the corridor to include directional passing lanes at incremental locations.

**Benefits:**

- Would increase opportunities for unopposed passing.
- Would improve level of service.
- Would increase capacity.
- Would reduce travel times.

**Limitations/Drawbacks:**

- May create potential impacts on environmental resources.
- May require additional right-of-way.
- May result in overall reduction in passing opportunities within the corridor.

**Estimated Cost:**

- $4,200,000 per mile

**Recommended Action:**

- **DO NOT ADVANCE** – This improvement option was not advanced for further consideration. This option would result in a reduction in overall passing opportunities because no passing zones would exist for traffic on the opposite side of the passing zone. In addition, this option would likely result in greater environmental impacts than other options.

## 2.3 Access Management

Access management is the careful planning of the location, design, and operations of approaches and road connections. The purpose of access management is to improve safety, preserve function and mobility, and manage existing and future accesses in a consistent manner. Access management is implemented through the adoption of an Access Control Resolution executed by the Montana Transportation Commission.

Safety and operational benefits of controlling access points are well documented. As access density (or the number of access points per mile) increases, there is generally a corresponding increase in crashes and travel times. Appropriate management of access within a highway corridor can improve traffic flow and reduce driveway related crashes.

Reasonable access should be maintained for all existing parcels adjacent to the highway, but some existing direct accesses could be relocated, combined, or eliminated if alternate reasonable access is available or can be provided. Some access management techniques include, but are not limited to, the following:

- **Access/Driveway Spacing:** Increasing the distance between intersecting roadways and driveways improves the flow of traffic and reduces congestion for heavily traveled corridors. Fewer access points spaced further apart allow the orderly merging of traffic and present fewer challenges to drivers. Consolidation of existing driveways and use of frontage or backage roads can reduce the number of direct access points on a road facility.

- **Turning Lanes/Medians:** Dedicated left- and right-turn lanes prioritize the flow of through traffic. TWLTLs and non-traversable, raised medians are effective ways to regulate access and reduce crashes.

The Gardiner and Livingston areas have higher densities of approaches than the rest of the corridor. Potential exists to consolidate or eliminate approaches through access management or when roadway improvements or reconstruction occurs in these areas.

Improvement options that arise from this strategy address a myriad of concerns and tie directly to ***Need 1 – Improve the safety of US 89 in the study area for all users*** and ***Need 2 – Improve the operations of US 89 within the study area***.

## 2.3.1 Improvement Options – Access Management

### 8. Access Management Plan

In advance of long-term improvement options identified later in this report, an *Access Management Plan* could be developed to address the high density of accesses within the corridor, especially near Gardiner and Livingston. The plan could explore ways to eliminate, reduce, or combine access to individual properties. In addition, the plan could identify opportunities to realign driveways and approaches, regulate the size and operations of driveways, and identify appropriate access for planned future development in the corridor in compliance with local land use planning regulations.

An *Access Management Plan* could assist local and state land use planners over the long-term planning horizon by establishing context appropriate access control guidelines, and specifying appropriate access for different segments of the corridor. This may be especially useful as future residential, commercial and industrial developments are contemplated.

**Recommendation:**
- Develop an *Access Management Plan* for the corridor.

**Benefits:**
- Would improve safety by controlling access points and limiting conflicts between thru- and turning- vehicles.
- Would improve traffic and operational characteristics.

**Limitations/Drawbacks:**
- Would reduce access points.

**Estimated Cost:**
- $180,000

**Recommended Action:**
- **DO NOT ADVANCE** – This improvement option was not advanced for further consideration. During the subdivision review process, Park County should coordinate with MDT when new development occurs that either directly accesses MDT routes or could substantially impact MDT

routes via public or private roadways. MDT will comment and recommend potential mitigations for impacts to Park County when requested.

## 9. Livingston Rural/Urban Interface (RP 49.8 to RP 52.5)

This section of US 89 has a high density of public approaches and access points. North of Merrill Lane (RP 52.5) US 89 consists of a three-lane typical section (one travel lane in each direction and a center TWLTL). South of Merrill Lane, the roadway transitions to a standard two-lane section.

A desire for an extension of the three-lane typical section to the intersection with East River Road (RP 49.8) has been expressed. This area has numerous public and private approaches, particularly on the east side of the highway. A multi-use path exists along the west side of the roadway north of East River Road.

A three-lane facility would allow left-turning vehicles to exit from the traffic stream along the mainline. In addition, right-turn lanes at major intersections (Wineglass Road, Cedar Bluffs Road, and Shamrock Lane) would provide further reduction in conflicts resulting from turning vehicles. The termini of this improvement at RP 52.5 would match the existing roadway geometry traveling north into Livingston. At RP 49.8 (intersection with East River Road), both a southbound left-turn lane and a northbound right-turn lane would be considered as part of the project.

The speed limit for US 89 is currently posted at 45 mph from RP 52.5 to RP 52.36 and 55 mph from RP 52.36 to RP 49.17. If a three-lane section is constructed (Figure 2), a speed study should be conducted to determine the appropriate speed limit following improvements.

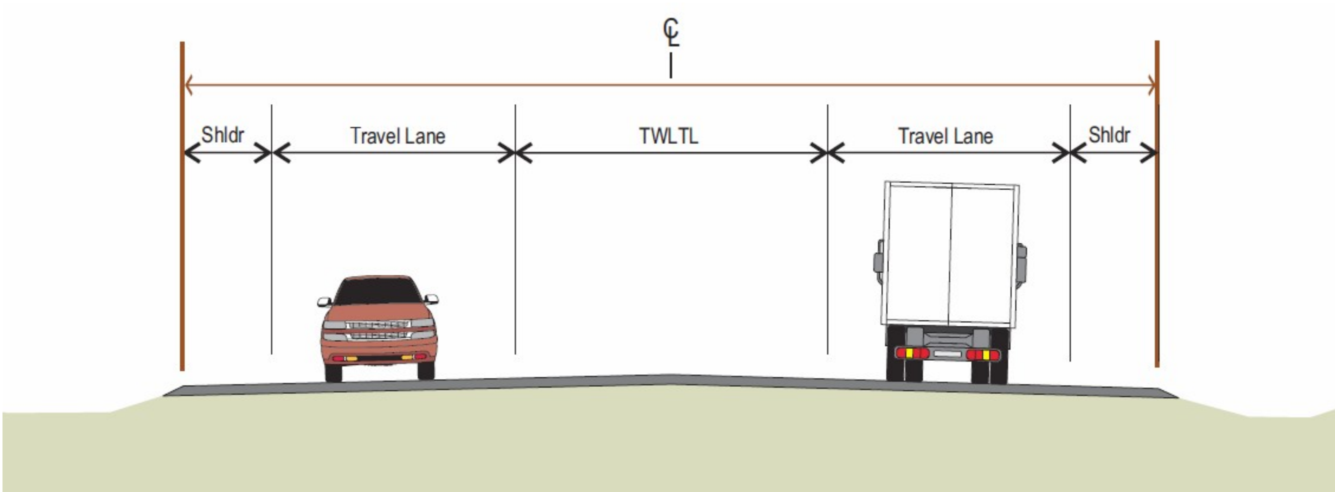



**Figure 2: Three-lane Typical Section Concept**

**Recommendation:**

- Extend a three-lane typical section of US 89 from Merrill Lane to East River Road. Include right-turn lanes at major intersections if appropriate warrants are met.

**Benefits:**

- Would increase safety due to left-turning traffic being removed from the traffic stream.
- Would create potential for reduction/consolidation of approaches to reduce conflict points.
- Would increase roadway capacity.

**Limitations/Drawbacks:**

- May create potential impact on wetlands.

- May require additional right-of-way at some locations.
- May impact some business or residential accesses.

**Estimated Cost:**
- $8,500,000

**Recommended Action:**
- **ADVANCE**

**Implementation Timeframe:**
- Mid-term

## 2.4 Alternative Travel Modes

Stakeholder input suggests the desire to improve safety and accommodate alternative (non-motorized) travel modes within the US 89 corridor. Park County's long-term vision for trails within the corridor includes a separated path between the current termini of the existing path south of Livingston all the way to Gardiner. Preliminary concepts for such a path suggest the path would leave the US 89 corridor near Yankee Jim Canyon and would cross the Yellowstone River by heading west. Strategies applicable to alternative travel modes initially reviewed for the corridor included the following:

- Developing a separated multi-use path
- Increasing minimum shoulder widths along the roadway for the entire length of US 89 of at least 8 feet (each side)
- Installing appropriate signage

Improvement options that arise from this strategy directly tie to ***Need 1 – Improve the safety of US 89 in the study area for all users***.

A cursory examination of transit opportunities that may connect Livingston to Gardiner was made. Transit options could include, but are not limited to: vanpool / carpool programs; park and ride facilities; and fixed route bus service. Currently there is charter bus service within the corridor provided by various tour operators accessing YNP. Development of viable transit options within the corridor was dismissed from further consideration due to lack of potential commuter transit riders and limitations on funding.

### 2.4.1 Improvement Options – Alternative Travel Modes

#### 10. Multi-use Trail

A multi-use path exists along the west side of US 89 between RP 49.8 and RP 52.5. In addition, sidewalks are located in the urban areas of Gardiner and Livingston. In rural portions of the corridor, no dedicated pedestrian or bicycle facilities exist along the highway. Pedestrians and bicyclists commonly use the roadway shoulder for travel. Local desire exists for a multi-use trail to connect Livingston with YNP in Gardiner. The abandoned railroad bed within the corridor presents an opportunity to develop a multi-use trail. Funding for this improvement option is limited. The MDT funding program applicable to this improvement option is the Transportation Alternatives (TA) Program, and funding from this program would have to be pursued by Park County or others via the TA nomination process.

**Recommendation:**
- Investigate opportunities for development of a multi-use trail between Gardiner and Livingston.

**Benefits:**
- Would improve safety for non-motorized users.

- Would create potential for increased economic activity and recreational use.

**Limitations/Drawbacks:**
- Would likely require additional right-of-way.
- May result in potential landowner opposition.

**Estimated Cost:**
- $390,000 per mile

**Recommended Action:**
- **ADVANCE**

**Implementation Timeframe:**
- Long-term

## 11. Gardiner Area (RP 0.0 to RP 1.0)

The Gardiner area experiences large seasonal peaks in traffic due to recreational use and access to YNP. The US 89 corridor through Gardiner provides access to a multitude of local businesses and residents. The Gardiner Gateway Project identifies a desire for improvements along US 89 entering Gardiner in terms of better lighting along the corridor and traffic calming for pedestrians.

### 11(a). On-street Parking

On-street parking is provided along US 89 in the Gardiner area. There are locations where on-street parking appears to have been delineated by adjacent property owners and is not in compliance with the MDT *Traffic Engineering Manual*. The guidelines and requirements were identified in the *Existing and Projected Conditions Report* and are summarized below:

- Prohibit parking within 20 feet of any crosswalk.
- Prohibit parking at least 10 feet from the beginning of the curb radius at mid-block approaches.
- Prohibit parking from areas designated by local traffic and enforcement regulations.
- Prohibit parking within 30 feet from end of curb return on the approach leg to any intersection with a flashing beacon, stop sign, or traffic signal.
- Prohibit parking on bridges.
- Eliminate parking across from a T-intersection.

Areas that do not meet these guidelines should be marked as no-parking locations.

**Recommendation:**
- Modify existing on-street parking in the Gardiner area, based on MDT guidelines, during a future resurfacing project.

**Benefits:**
- Would adhere to existing standards.
- Would increase safety.

**Limitations/Drawbacks:**
- May cause potential loss of on-street parking.
- May require heightened enforcement.

**Estimated Cost:**
- LABOR

**Recommended Action:**

- **ADVANCE**

**Implementation Timeframe:**

- Short-term

### *11(b). Lighting Improvements*

Pedestrian traffic is common during seasonal peaks. While corridor lighting exists between RP 0.0 and RP 1.0, the Gardiner Gateway Project partners have expressed a desire to evaluate new, decorative lighting concepts along US 89 in Gardiner to coincide with lighting planned for the various other phases of the Gardiner Gateway Project.

**Recommendation:**

- Coordinate with Gardiner Gateway Project partners to evaluate the need to upgrade existing street lighting to reflect lighting consistency with other phases of the project and to increase night-time visibility. Funding over and above standard MDT street lighting would be provided by non-MDT entities.

**Benefits:**

- Would increase nighttime visibility.
- Would improve safety.

**Limitations/Drawbacks:**

- May increase utility and maintenance costs.

**Estimated Cost:**

- TO BE DETERMINED

**Recommended Action:**

- **ADVANCE (BY OTHERS)**

**Implementation Timeframe:**

- Short-term

## 2.5 Wildlife-vehicle Conflicts

Mitigation strategies to reduce wildlife-vehicle collisions were assessed through a variety of measures. Carcass data between January 2002 and December 2012 were obtained for the corridor and were reviewed to identify areas with concentrations of animal mortalities. This information was measured against formal crash report data between July 2007 and June 2012, which was provided by law enforcement agencies, via MDT.

Comments received from the resource agencies were used to develop potential improvement options to benefit wildlife and help reduce collision potential for the travelling public. The publication, titled *Wildlife-Vehicle Collision Reduction Study*[1], was reviewed for applicable mitigation strategies. Wildlife connectivity was also reviewed on a high level by examining carcass locations and comparing them to available mapping of individual species ranges.

Mitigation strategies attempting to reduce wildlife-vehicle collisions can be grouped into four distinct categories, as follows:

[1] *Wildlife-Vehicle Collision Reduction Study: Report to Congress*, FHWA-HRT-08-034, August 2008

- Influence driver behavior.
- Influence animal behavior.
- Reduce wildlife population size.
- Physically separate animals from the roadway.

Any improvement option relevant to wildlife mitigation should be reviewed on a project case-by-case basis; i.e., as part of the normal transportation project development process, wildlife connectivity issues and concerns should be reviewed with project-level design.

Improvement options that arise from this strategy directly tie to ***Need 1 – Improve the safety of US 89 in the study area for all users***.

### 2.5.1 Improvement Options – Wildlife-vehicle Conflicts

#### 12. Vegetation Management Plan

Areas of unmaintained or dense vegetation were identified due to decreased sight distances and clear zones. Before vegetation removal activities are initiated, a *Vegetation Management Plan* could be developed for the entire corridor. The goals of the *Vegetation Management Plan* would include maintenance of quality wildlife habitat along the corridor, providing cover for animal movements across the highway in appropriate locations, improved sight distance for driver detection of animals in the clear zone, maintenance of riparian zone integrity and wetland function, and sediment/runoff control along the Yellowstone River and its tributaries adjacent to the highway.

**Recommendation:**

- Develop and implement a *Vegetation Management Plan* for the corridor.

**Benefits:**

- Would increase the possibility for driver detection of wildlife within roadside clear zones.
- Would improve sight distances.

**Limitations/Drawbacks:**

- May create potentially negative wildlife habitat and aquatic resource effects.

**Estimated Cost:**

- $60,000

**Recommended Action:**

- **DO NOT ADVANCE** – This option was not advanced for further consideration. Vegetation concerns are not a corridor-wide issue and can be assessed on a case-by-case basis during project-level design. Additionally, MDT maintenance personnel perform routine vegetative maintenance within the corridor periodically throughout each year, in accordance with established protocol.

#### 13. Reduce Wildlife-vehicle Conflicts

Wildlife-vehicle conflicts commonly occur throughout the study area and present a danger to human safety, as well as to wildlife survival. Improvements were explored to help reduce the number and severity of these types of collisions. Grade separation, fencing, advance animal detection, signing, or speed reduction strategies may have merit in areas of the corridor. Due to the complexities and numerous variables to consider when evaluating the feasibility of wildlife mitigation strategies, these should be explored in sufficient detail during project-level design as part of the project development process.

After an initial review of potential strategies to reduce wildlife-vehicle conflicts, the following were identified as being possible counter-measures to consider during project-level design as part of the project development process. A determination of their viability and effectiveness will be determined as specific projects begin to materialize.

### Grade-separated Crossing Structures–Overpasses

Grade-separated structures are increasingly being explored as a feasible strategy to physically separate animals from the road environment. Wildlife overpasses are designed primarily to provide connectivity for wildlife species, especially ungulate prey species, at critical locations. Their use is often combined with wildlife fencing. When combined with wildlife fencing, they reduce wildlife movements into the road corridor as animals are provided with a safe crossing opportunity above the roadway, thereby decreasing wildlife-vehicle conflicts.

Costs for overpasses can range between $1.5 million and $3.0 million, depending on the width and length of the structure. For purposes of this corridor planning study, a planning level cost of $2,800,000 was estimated for an overpass structure with associated amenities.

Topography can present a challenge to overpass placement, in that enough relief must be available to provide a structure within the confines of adjacent development and access points. Fencing is almost always used to guide animals to and over the structure, increasing its effectiveness. Fencing can alter natural animal movements, change pedestrian travel movements, impact adjacent landowners, and in some cases negatively impact scenic views.

### Grade-separated Crossing Structures–Underpasses

A wildlife underpass is another form of grade-separated crossing structure. Underpasses can be provided underneath bridge structures, or via a variety of culvert shapes and sizes. Wildlife underpasses typically are constructed at locations where the roadway is relatively high compared to the surrounding terrain. This reduces the need to raise the roadbed or to lower the approaches to the underpass. Somewhat unique to underpasses as compared to overpasses is that animals prefer to see through to the other side, do not want to descend into a "cave" that would create a tunnel effect, and do not want to have to climb out on the other side. This is why, depending on its dimension, an underpass may be a more effective strategy for predator species. However, if large enough to provide sufficient clearance and clear line of sight, underpasses can be an effective means to pass ungulate prey species beneath the roadway, especially when combined with wildlife fencing.

The cost of a wildlife underpass depends highly on the type considered (i.e., under a bridge, within a concrete box culvert, within a corrugated steel pipe, etc.) and the width and length of the structure. Costs can range from $500,000 to $1,000,000 for an underpass structure. For purposes of this corridor planning study, a planning level cost of $750,000 was estimated for an underpass structure with associated amenities. Topography can dictate where an underpass may be placed and animals' level of success in using it. The potential for flooding within the underpass and the need for increased maintenance can be drawbacks. The fencing considerations described for the wildlife overpass are also applicable to the wildlife underpass.

### Animal Detection System (At-grade Crossing)

Animal detection systems use sensors to detect animals near roadways. When an animal is detected, warning signals and/or signs are activated to alert drivers that an animal may be on or near the roadway. Wildlife fencing is usually considered in tandem with animal detection systems. The animal detection system and fencing guide the animals to a known crossing location and influence driver behavior through real-time warning. These measures may serve to reduce wildlife-vehicle collisions. Animal detection systems may be less restrictive to wildlife movement than grade-separated crossing structures. They allow animals to use existing paths to the road or to change them over time, whereas grade-separated structure locations may depend on adjacent topography and road grade, rather than the actual locations of animal movement patterns. The cost of an at-grade animal detection system with appropriate fencing is estimated to be $220,000 per mile.

There are limitations to animal detection systems. They do not physically separate the animals from the highway, and they rely on driver response to the warning signs. They are, therefore, only effective if drivers reduce their speed and increase their awareness based on the warning. Animal detection systems only detect large animals (e.g., deer, elk, or moose). Small animals are hard to detect, so drivers may not be warned about their presence on or near the road. Also, animal detection systems usually require the presence of poles and equipment in the right-of-way, sometimes within the clear zone, presenting a safety hazard of their own. Animal detection systems may have complicated maintenance requirements for both function and effectiveness over time.

#### Wildlife Signage

Signage indicating the regular presence of wildlife in the area is intended to alert drivers regarding potential animal conflicts. Deer occur throughout the corridor, while elk commonly are seen between RP 1.0 and RP 5.0 and between RP 15.0 and RP 25.0. Bighorn sheep also frequent the area between RP 4.0 and RP 15.0. Static signage has proved to be relatively ineffective at reducing wildlife-vehicle collisions (as compared to mitigation strategies that actually separate animal and roadway or present real-time detection and warning). As with the other mitigation strategies previously described, wildlife fencing may or may not be used in conjunction with wildlife signage. The limitations previously described with respect to fencing also apply if used in conjunction with signing. The cost of signage is modest; it is estimated at $600 per sign.

The following improvement option was initially considered, but was ultimately removed from further consideration as the strategies described above will be examined on a case-by-case basis during project-level design as part of the project development process:

#### Wildlife Conflict Mitigation Study

A detailed wildlife conflict mitigation study was considered. Based on the data analyzed through the corridor study process, however, MDT and Park County agree and are committed to evaluating wildlife mitigation via examination of best-practice, wildlife mitigation strategies on a project-by-project basis. The estimated cost of such a study is $270,000.

# 3.0 SUMMARY

This memorandum identifies improvement options for the US 89 corridor between RP 0.0 and RP 52.5. The improvement options were based on the evaluation of several factors, including but not limited to field review, engineering analysis of as-built drawings, crash data analysis, consultation with resource agencies, and information provided by the general public.

The improvement options identified for advancement are intended to offer a range of potential mitigation strategies for corridor issues and areas of concern. Small scale improvement options were identified and may be as simple as adding advance warning signs at intersections. Larger, more complex reconstruction improvements are also envisioned. Note that the potential may exist to combine improvement options during project development for ease of implementation and other efficiencies.

Wildlife collisions have been noted to occur throughout the corridor. Certain areas of the corridor realize unique issues between wildlife and drivers. The recommended improvement options recognize the impact of the roadway on wildlife resources, and offers potential mitigation strategies that may be candidates for further exploration during project development activities. These include wildlife signing and wildlife fencing.

Tabular summaries of the improvement options, both advanced and not advanced, are included in **Table 1**. Those improvement options recommended for advancement are shown graphically in **Figure 3**.

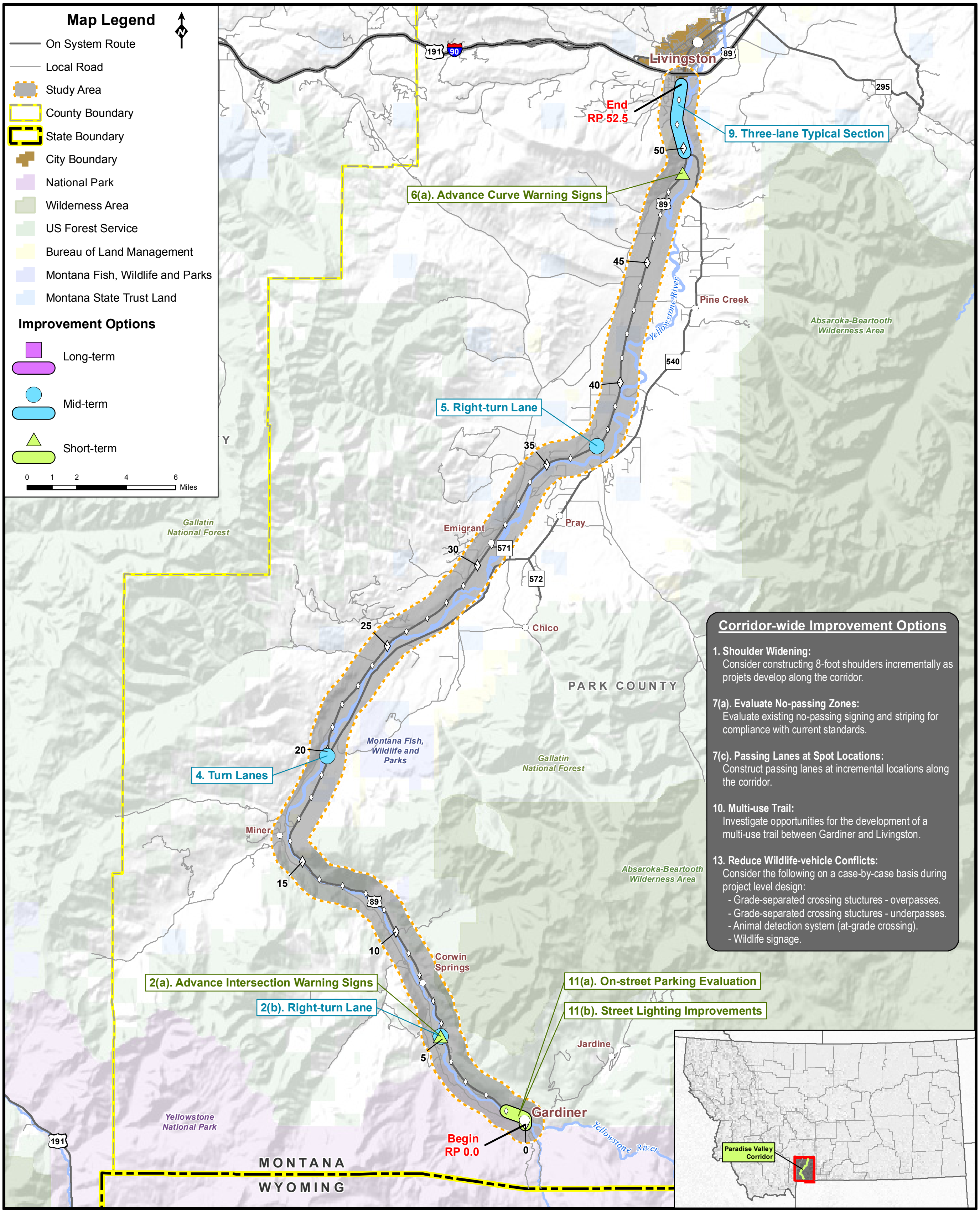
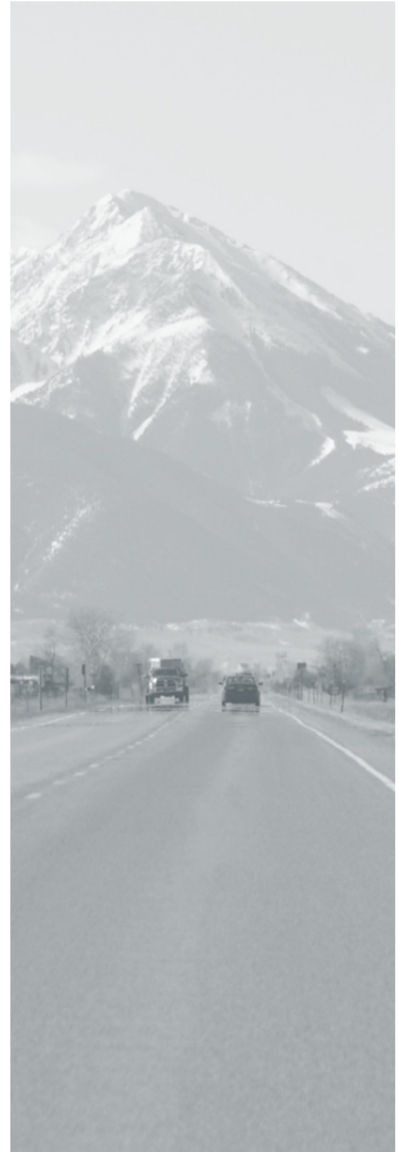



Figure 3: Recommended Improvement Options

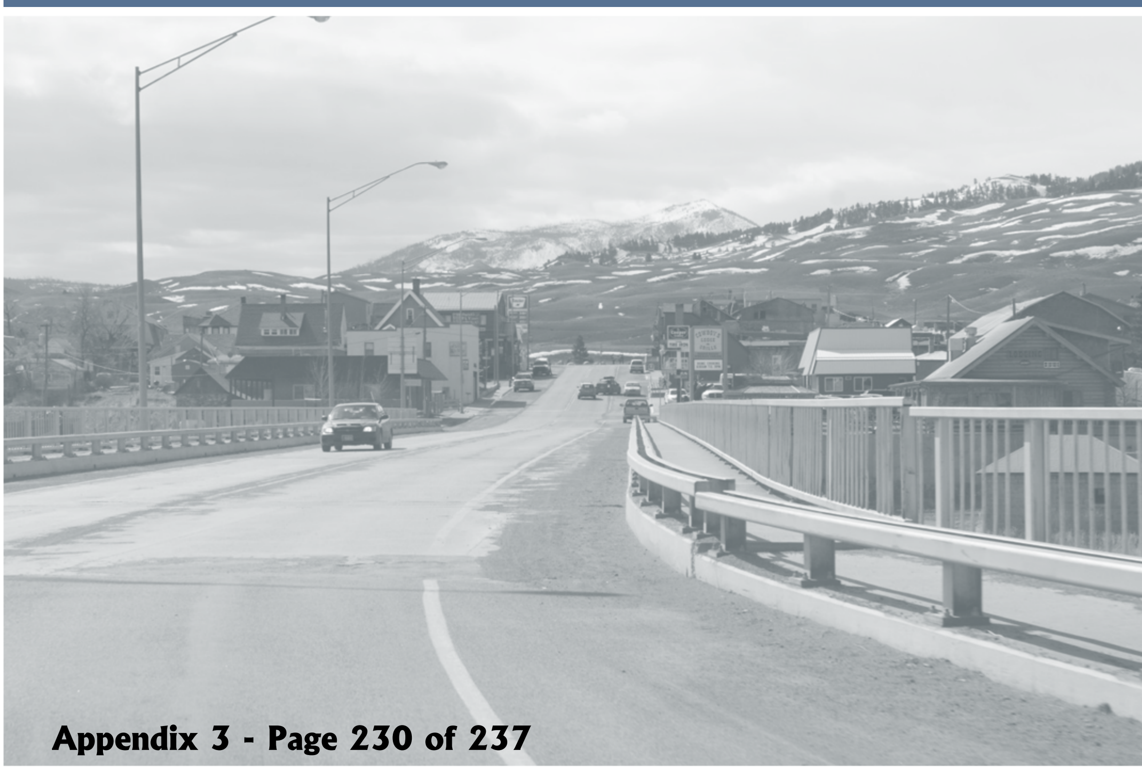
## Table 1: Improvement Options

| | Improvement Option | Location | Description | Recommended Action | Implementation Timeframe | Cost Estimate |
|---|---|---|---|---|---|---|
| **GEOMETRICS** | | | | | | |
| 1 | **Shoulder Widening** | Corridor-wide | Consider constructing 8-foot shoulders incrementally as projects develop along the corridor. | **ADVANCE** - Consider during project-level design | As Needed | $910,000 per mile |
| 2(a) | **Maiden Basin Road Intersection Advance Warning Signs** | RP 5.15 | Install advance intersection warning signs along US 89. | **ADVANCE** | Short-term | $600 EA |
| 2(b) | **Maiden Basin Road Intersection Right-turn Lane** | RP 5.15 | Construct a northbound right-turn lane along US 89 when appropriate warrants are met. | **ADVANCE** | Mid-term | $270,000 |
| 2(c) | **Maiden Basin Road Intersection Slope Flattening** | RP 5.15 | Flatten the slopes on the east side of US 89 north of the intersection with Maiden Basin Road to increase sight distances. | **DO NOT ADVANCE** | N/A | $70,000 |
| 3(a) | **Rockfall Hazard Section #307** | RP 13.32 to 13.66 | Identified mitigation would include excavating using controlled blasting, installing guardrail and rockfall barrier, and construction of a Mechanically Stabilized Earth (MSE) wall. | **DO NOT ADVANCE** | N/A | $4,000,000 |
| 3(b) | **Rockfall Hazard Section #309** | RP 13.84 to 13.96 | Identified mitigation would include slope scaling, draped cable nets, and rock bolts. | **DO NOT ADVANCE** | N/A | $2,200,000 |
| 3(c) | **Rockfall Hazard Section #310** | RP 13.96 to 14.61 | Identified mitigation would include installing draped mesh with a catch fence. | **DO NOT ADVANCE** | N/A | $3,000,000 |
| 4 | **East River Road Intersection Turn Lanes** | RP 19.8 | Construct a southbound left-turn lane and northbound right-turn lane along US 89 when appropriate warrants are met. | **ADVANCE** | Mid-term | $650,000 (both turn lanes) |
| 5 | **Mill Creek Road Intersection Right-turn Lane** | RP 37.2 | Construct a northbound right-turn lane along US 89 when appropriate warrants are met. | **ADVANCE** | Mid-term | $280,000 |
| 6(a) | **Advance Warning Signs** | RP 49.10 to 49.35 | Install horizontal curve warning signs for the horizontal curves located at RP 49.10 and RP 49.35. | **ADVANCE** | Short-term | $600 EA |
| 6(b) | **Geometric Reconstruction** | RP 49.0 to 49.8 | Reconstruct the roadway to meet current standards for horizontal and vertical curvature. | **DO NOT ADVANCE** | N/A | $3,100,000 |
| **VEHICLE CONGESTION AND PASSING OPPORTUNITIES** | | | | | | |
| 7(a) | **Evaluate No-passing Zones** | Corridor-wide | Evaluate existing no-passing signing and striping for compliance with current standards. | **ADVANCE** | Short-term | $45,000 |
| 7(b) | **Pull-outs for Slow-moving Vehicles** | Potential Spot Locations:<br>• RP 5.7<br>• RP 6.8<br>• RP 28.6<br>• RP 38.6<br>• RP 48.8<br>• RP 49.3 | Construct pullouts at suitable locations along the corridor to allow slow-moving vehicles to exit the traffic stream. | **DO NOT ADVANCE** | N/A | $220,000 EA |
| 7(c) | **Passing Lanes at Spot Locations** | Potential Spot Locations:<br>• RP 16.6 to 19.8<br>• RP 25.6 to 28.4<br>• RP 40.0 to 42.0<br>• RP 44.4 to 47.9 | Construct passing lanes at incremental locations along the corridor. | **ADVANCE** | Long-term | $12,400,000 EA |
| 7(d) | **Four- or Five-lane Typical Section** | Corridor-wide | Reconstruct the corridor to include two travel lanes in each direction and a center TWLTL, or designated left-turn bays at major intersections. | **DO NOT ADVANCE** | N/A | $6,200,000 per mile |
| 7(e) | **Alternating Passing Lanes** | Corridor-wide | Reconstruct portions of the corridor to include directional passing lanes at incremental locations. | **DO NOT ADVANCE** | N/A | $4,200,000 per mile |
| **ACCESS MANAGEMENT** | | | | | | |
| 8 | **Access Management Plan** | Corridor-wide | Develop an Access Management Plan for the corridor. | **DO NOT ADVANCE** | N/A | $180,000 |
| 9 | **Livingston Rural / Urban Interface** | RP 49.8 to 52.5 | Extend a three-lane typical section of US 89 from Merrill Lane to East River Road. Include right-turn lanes at major intersections if appropriate warrants are met. | **ADVANCE** | Mid-term | $8,500,000 |
| **ALTERNATIVE TRAVEL MODES** | | | | | | |
| 10 | **Multi-use Trail** | Corridor-wide | Investigate opportunities for the development of a multi-use trail between Gardiner and Livingston. | **ADVANCE** | Long-term | $390,000 per mile |
| 11(a) | **Gardiner Area On-Street Parking** | RP 0.0 to 1.0 | Modify existing on-street parking in the Gardiner area based on MDT guidelines. | **ADVANCE** | Short-term | LABOR |
| 11(b) | **Gardiner Area Lighting Improvements** | RP 0.0 to 1.0 | Coordinate with Gardiner Gateway Project partners to evaluate the need to upgrade existing street lighting to reflect lighting consistency with other phases of the project, and to increase night-time visibility. | **ADVANCE (BY OTHERS)** | Short-term | TO BE DETERMINED |
| **WILDLIFE-VEHICLE CONFLICTS** | | | | | | |
| 12 | **Vegetation Management Plan** | Corridor-Wide | Develop and implement a Vegetation Management Plan for the corridor. | **DO NOT ADVANCE** | N/A | $60,000 |
| 13 | ***Grade Separated Crossing Structures*** | As Needed | Consider grade separated crossing structures (overpass and/or underpass) on a case-by-case basis during project-level design. | **ADVANCE** - Consider during project-level design | As Needed | $2,800,000 EA (overpass) $750,000 EA (underpass) |
| | ***Animal Detection System (At-grade Crossing)*** | As Needed | Consider animal detection system installation on a case-by-case basis during project-level design. | **ADVANCE** - Consider during project-level design | As Needed | $220,000 per mile |
| | ***Wildlife Signage*** | As Needed | Consider additional wildlife signing on a case-by-case basis during project-level design. | **ADVANCE** - Consider during project-level design | As Needed | $600 EA |
| | ***Wildlife Mitigation Study*** | Corridor-Wide | Conduct a wildlife conflict mitigation study for the corridor. | **DO NOT ADVANCE** | N/A | $ 270,000 |



# APPENDIX A

*Planning Level Cost Estimates*



## 1 SHOULDER WIDENING — $ 910,000 PER MILE

| | |
|---|---|
| WIDTH (FT) | 8 |
| SURFACING (IN) | 5 |
| BASE (IN) | 12 |

| TYPE | UNITS | QUANTITY / STA | | UNIT PRICE | | COST / MI |
|---|---|---|---|---|---|---|
| Embankment in Place | CUYD | 148.15 | $ | 7.49 | $ | 58,588 |
| Crushed Aggregate Course | CUYD | 76.14 | $ | 22.49 | $ | 90,414 |
| Commercial Mix-PG 64-28 | TON | 32.29 | $ | 78.03 | $ | 133,034 |
| Drainage Pipe - Rural | LS | 0.02 | $ | 25,000.00 | $ | 25,000 |
| *Subtotal 1* | | | | | *$* | *307,037* |
| Traffic Control | | | | 5% | $ | 15,352 |
| *Subtotal 2* | | | | | *$* | *322,389* |
| Mobilization | | | | 8% | $ | 25,791 |
| *Subtotal 3* | | | | | *$* | *348,180* |
| Indirect and Incidental Costs (IDIC) | | | | 10% | $ | 34,818 |
| Construction Engineering (CE) | | | | 10% | $ | 34,818 |
| *Subtotal 4* | | | | | *$* | *417,816* |
| Contingency | | | | 20% | $ | 83,563 |
| *Subtotal 5* | | | | | $ | 501,379 |
| Estimated Right-of-Way (ROW) | ACRE | 0.00 | $ | 15,000 | $ | - |
| *Subtotal 6* | | | | | $ | 501,379 |
| Long-Term Inflation | % PER YEAR | 20.00 | | 3% | $ | 404,167 |
| **Total** | | | | | **$** | **905,546** |

## 2 MAIDEN BASIN ROAD INTERSECTION (RP 5.15)

### 2(a) ADVANCE WARNING SIGNS (RP 5.15) — $ 600 EA

| TYPE | UNITS | QUANTITY / SIGN | | UNIT PRICE | | COST / EA |
|---|---|---|---|---|---|---|
| Signs - Alum Sheet Invr IV | SQFT | 9.0 | $ | 25.06 | $ | 226 |
| Poles - Treated Timber - Barn 4 IN | LNFT | 12 | $ | 13.47 | $ | 162 |
| Subtotal 1 | | | | | $ | 387 |
| Contingency | | | | 20% | $ | 77 |
| *Subtotal 2* | | | | | $ | 465 |
| Short-Term Inflation | % PER YEAR | 5.00 | | 3% | $ | 74 |
| **Total** | | | | | **$** | **539** |

### 2(b) RIGHT-TURN LANE (RP 5.15) — $ 270,000 TOT

| | |
|---|---|
| LENGTH (FT) | 950 |
| WIDTH (FT) | 16 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | | UNIT PRICE | | COST |
|---|---|---|---|---|---|---|
| Excavation-Unclassified | CUYD | 599.96 | $ | 3.56 | $ | 20,291 |
| Excavation-Unclass Borrow | CUYD | 60.00 | $ | 5.85 | $ | 3,334 |
| Crushed Aggregate Course | CUYD | 177.69 | $ | 22.49 | $ | 37,964 |
| Cover - Type 1 | SQYD | 178.00 | $ | 0.52 | $ | 879 |
| Traffic Gravel | CUYD | 11.85 | $ | 14.99 | $ | 1,687 |
| Commercial Mix-PG 64-28 | TON | 56.08 | $ | 78.03 | $ | 41,571 |
| Emulsified Asphalt CRS-2P | TON | 0.40 | $ | 621.17 | $ | 2,360 |
| Drainage Pipe - Rural | LS | 0.02 | $ | 82,000.00 | $ | 14,754 |
| *Subtotal 1* | | | | | *$* | *122,842* |
| Traffic Control | | | | 5% | $ | 6,142 |
| *Subtotal 2* | | | | | *$* | *128,984* |
| Mobilization | | | | 8% | $ | 10,319 |
| *Subtotal 3* | | | | | *$* | *139,302* |
| Indirect and Incidental Costs (IDIC) | | | | 10% | $ | 13,930 |
| Construction Engineering (CE) | | | | 10% | $ | 13,930 |
| *Subtotal 4* | | | | | *$* | *167,163* |
| Contingency | | | | 20% | $ | 33,433 |
| *Subtotal 5* | | | | | $ | 200,595 |
| Estimated Right-of-Way (ROW) | ACRE | 0.00 | $ | 15,000 | $ | - |
| *Subtotal 6* | | | | | $ | 200,595 |
| Mid-Term Inflation | % PER YEAR | 10.00 | | 3% | $ | 68,988 |
| **Total** | | | | | **$** | **269,583** |

### 2(c) SLOPE FLATTENING (RP 5.15) — $ 70,000 TOT

| | |
|---|---|
| AREA (CUYD) | 7,176 |
| RATIO | 50% |
| LENGTH (FT) | 775 |
| HEIGHT (FT) | 10 |
| DEPTH (FT) | 50 |

| TYPE | UNITS | QUANTITY | | UNIT PRICE | | COST |
|---|---|---|---|---|---|---|
| Excavation-Unclassified | CUYD | 7,176 | $ | 3.56 | $ | 25,546 |

| | | | | | |
|---|---|---|---|---|---|
| *Subtotal 1* | | | | $ | *25,546* |
| Contingency | | | 35% | $ | 8,941 |
| *Subtotal 2* | | | | $ | 34,488 |
| Estimated Right-of-Way (ROW) | ACRE | 0.00 | $ 15,000 | $ | - |
| *Subtotal 3* | | | | $ | 34,488 |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ | 27,801 |
| **Total** | | | | **$** | **62,288** |

**3 ROCKFALL HAZARDS (RP 13.3 TO RP 14.6)**

| | | | | |
|---|---|---|---|---|
| 3(a) ROCKFALL HAZARD SECTION #307 (RP 13.32 to RP 13.66) | | $ | 4,000,000 | TOT |
| | 2005 ESTIMATE | $ | 1,706,000 | |
| | INFLATION (PER YEAR) | | 3% | |
| | YEARS | | 28 | |
| | **TOTAL** | **$** | **3,903,205** | |
| 3(b) ROCKFALL HAZARD SECTION #309 (RP 13.84 to RP 13.96) | | $ | 2,200,000 | TOT |
| | 2005 ESTIMATE | $ | 945,000 | |
| | INFLATION (PER YEAR) | | 3% | |
| | YEARS | | 28 | |
| | **TOTAL** | **$** | **2,162,092** | |
| 3(c) ROCKFALL HAZARD SECTION #310 (RP 13.96 to RP 14.61) | | $ | 3,000,000 | TOT |
| | 2005 ESTIMATE | $ | 1,311,000 | |
| | INFLATION (PER YEAR) | | 3% | |
| | YEARS | | 28 | |
| | **TOTAL** | **$** | **2,999,473** | |

**4 EAST RIVER ROAD INTERSECTION - TURN LANES (RP 19.8)** **$ 650,000 TOT**

**LEFT-TURN LANE**

| | |
|---|---|
| LENGTH (FT) | 1250 |
| WIDTH (FT) | 16 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | | COST |
|---|---|---|---|---|---|
| Embankment in Place | CUYD | 296.30 | $ 7.49 | $ | 27,741 |
| Crushed Aggregate Course | CUYD | 177.69 | $ 22.49 | $ | 49,953 |
| Cover - Type 1 | SQYD | 178.00 | $ 0.52 | $ | 1,157 |
| Traffic Gravel | CUYD | 11.85 | $ 14.99 | $ | 2,220 |
| Commercial Mix-PG 64-28 | TON | 56.08 | $ 78.03 | $ | 54,699 |
| Emulsified Asphalt CRS-2P | TON | 0.40 | $ 621.17 | $ | 3,106 |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ | 19,413 |
| *Subtotal 1* | | | | $ | *158,289* |
| Traffic Control | | | 5% | $ | 7,914 |
| *Subtotal 2* | | | | $ | *166,203* |
| Mobilization | | | 8% | $ | 13,296 |
| *Subtotal 3* | | | | $ | *179,500* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ | 17,950 |
| Construction Engineering (CE) | | | 10% | $ | 17,950 |
| *Subtotal 4* | | | | $ | *215,400* |
| Contingency | | | 20% | $ | 43,080 |
| *Subtotal 5* | | | | $ | 258,480 |
| Estimated Right-of-Way (ROW) | ACRE | 0.90 | $ 15,000 | $ | 13,430 |
| *Subtotal 6* | | | | $ | 271,909 |
| Mid-Term Inflation | % PER YEAR | 10.00 | 3% | $ | 93,514 |
| **Total** | | | | **$** | **365,423** |

**RIGHT-TURN LANE**

| | |
|---|---|
| LENGTH (FT) | 950 |
| WIDTH (FT) | 16 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | | COST |
|---|---|---|---|---|---|
| Embankment in Place | CUYD | 296.30 | $ 7.49 | $ | 21,083 |
| Crushed Aggregate Course | CUYD | 177.69 | $ 22.49 | $ | 37,964 |
| Cover - Type 1 | SQYD | 178.00 | $ 0.52 | $ | 879 |
| Traffic Gravel | CUYD | 11.85 | $ 14.99 | $ | 1,687 |
| Commercial Mix-PG 64-28 | TON | 56.08 | $ 78.03 | $ | 41,571 |
| Emulsified Asphalt CRS-2P | TON | 0.40 | $ 621.17 | $ | 2,360 |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ | 14,754 |
| *Subtotal 1* | | | | $ | *120,300* |
| Traffic Control | | | 5% | $ | 6,015 |
| *Subtotal 2* | | | | $ | *126,315* |
| Mobilization | | | 8% | $ | 10,105 |
| *Subtotal 3* | | | | $ | *136,420* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ | 13,642 |

| | | | | |
|---|---|---|---|---|
| Construction Engineering (CE) | | | 10% | $ 13,642 |
| *Subtotal 4* | | | | *$ 163,704* |
| Contingency | | | 20% | $ 32,741 |
| *Subtotal 5* | | | | $ 196,444 |
| Estimated Right-of-Way (ROW) | ACRE | 0.69 | $ 15,000 | $ 10,331 |
| *Subtotal 6* | | | | $ 206,775 |
| Mid-Term Inflation | % PER YEAR | 10.00 | 3% | $ 71,113 |
| **Total** | | | | **$ 277,888** |

**5 MILL CREEK ROAD INTERSECTION - RIGHT-TURN LANE (RP 37.2)** **$ 280,000 TOT**

| | |
|---|---|
| LENGTH (FT) | 950 |
| WIDTH (FT) | 16 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | COST |
|---|---|---|---|---|
| Embankment in Place | CUYD | 296.30 | $ 7.49 | $ 21,083 |
| Crushed Aggregate Course | CUYD | 177.69 | $ 22.49 | $ 37,964 |
| Cover - Type 1 | SQYD | 178.00 | $ 0.52 | $ 879 |
| Traffic Gravel | CUYD | 11.85 | $ 14.99 | $ 1,687 |
| Commercial Mix-PG 64-28 | TON | 56.08 | $ 78.03 | $ 41,571 |
| Emulsified Asphalt CRS-2P | TON | 0.40 | $ 621.17 | $ 2,360 |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ 14,754 |
| *Subtotal 1* | | | | *$ 120,300* |
| Traffic Control | | | 5% | $ 6,015 |
| *Subtotal 2* | | | | *$ 126,315* |
| Mobilization | | | 8% | $ 10,105 |
| *Subtotal 3* | | | | *$ 136,420* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 13,642 |
| Construction Engineering (CE) | | | 10% | $ 13,642 |
| *Subtotal 4* | | | | *$ 163,704* |
| Contingency | | | 20% | $ 32,741 |
| *Subtotal 5* | | | | $ 196,444 |
| Estimated Right-of-Way (ROW) | ACRE | 0.69 | $ 15,000 | $ 10,331 |
| *Subtotal 6* | | | | $ 206,775 |
| Mid-Term Inflation | % PER YEAR | 10.00 | 3% | $ 71,113 |
| **Total** | | | | **$ 277,888** |

**6 GEOMETRIC IMPROVEMENTS (RP 49.0 TO RP 49.8)**

6(a) ADVANCE WARNING SIGNS $ 600 EA

| TYPE | UNITS | QUANTITY / SIGN | UNIT PRICE | COST / EA |
|---|---|---|---|---|
| Signs - Alum Sheet Invr IV | SQFT | 9.0 | $ 25.06 | $ 226 |
| Poles - Treated Timber - Barn 4 IN | LNFT | 12 | $ 13.47 | $ 162 |
| *Subtotal 1* | | | | $ 387 |
| Contingency | | | 20% | $ 77 |
| *Subtotal 2* | | | | $ 465 |
| Short-Term Inflation | % PER YEAR | 5.00 | 3% | $ 74 |
| **Total** | | | | **$ 539** |

6(b) GEOMETRIC RECONSTRUCTION (RP 49.0 TO RP 49.8) $ 3,100,000 TOT

| | |
|---|---|
| LENGTH (MI) | 0.8 |
| WIDTH (FT) | 32 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | COST |
|---|---|---|---|---|
| Excavation-Unclassified | CUYD | 1240.69 | $ 3.56 | $ 186,568 |
| Excavation-Unclass Borrow | CUYD | 124.07 | $ 5.85 | $ 30,658 |
| Special Borrow-Excavation | CUYD | 62.03 | $ 15.20 | $ 39,829 |
| Crushed Aggregate Course | CUYD | 266.57 | $ 22.49 | $ 253,236 |
| Cover - Type 1 | SQYD | 356.00 | $ 0.52 | $ 7,819 |
| Traffic Gravel | CUYD | 23.70 | $ 14.99 | $ 15,006 |
| Commercial Mix-PG 64-28 | TON | 103.68 | $ 78.03 | $ 341,728 |
| Emulsified Asphalt CRS-2P | TON | 0.70 | $ 621.17 | $ 18,367 |
| Guard Rail - Steel | LNFT | 100.00 | $ 15.48 | $ 65,388 |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ 65,600 |
| *Subtotal 1* | | | | *$ 1,024,199* |
| Traffic Control | | | 5% | $ 51,210 |
| *Subtotal 2* | | | | *$ 1,075,409* |
| Mobilization | | | 8% | $ 86,033 |
| *Subtotal 3* | | | | *$ 1,161,441* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 116,144 |
| Construction Engineering (CE) | | | 10% | $ 116,144 |
| *Subtotal 4* | | | | *$ 1,393,729* |
| Contingency | | | 20% | $ 278,746 |
| *Subtotal 5* | | | | $ 1,672,475 |

| | | | | | |
|---|---|---|---|---|---|
| Estimated Right-of-Way (ROW) | ACRE | 0.97 | $ 15,000 | $ 14,545 | |
| *Subtotal 6* | | | | $ 1,687,021 | |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 1,359,926 | |
| **Total** | | | | **$ 3,046,947** | |

## 7 PASSING OPPORTUNITIES AND INCREASED CAPACITY

### 7(a) EVALUATE NO-PASSING ZONES — $ 45,000

### 7(b) PULL-OUTS FOR SLOW MOVING VEHICLES — $ 220,000 EA

| | |
|---|---|
| LENGTH (FT) | 300.0 |
| WIDTH (FT) | 36 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | COST |
|---|---|---|---|---|
| Embankment in Place | CUYD | 666.67 | $ 7.49 | $ 14,980 |
| Crushed Aggregate Course | CUYD | 288.80 | $ 22.49 | $ 19,485 |
| Cover - Type 1 | SQYD | 400.00 | $ 0.52 | $ 624 |
| Traffic Gravel | CUYD | 26.67 | $ 14.99 | $ 1,199 |
| Commercial Mix-PG 64-28 | TON | 115.57 | $ 78.03 | $ 27,054 |
| Emulsified Asphalt CRS-2P | TON | 0.80 | $ 621.17 | $ 1,491 |
| Drainage Pipe - Rural | LS | 0.02 | $ 20,000.00 | $ 1,136 |
| *Subtotal 1* | | | | *$ 65,970* |
| Traffic Control | | | 5% | $ 3,298 |
| *Subtotal 2* | | | | *$ 69,268* |
| Mobilization | | | 8% | $ 5,541 |
| *Subtotal 3* | | | | *$ 74,810* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 7,481 |
| Construction Engineering (CE) | | | 10% | $ 7,481 |
| *Subtotal 4* | | | | *$ 89,771* |
| Contingency | | | 20% | $ 17,954 |
| *Subtotal 5* | | | | $ 107,726 |
| Estimated Right-of-Way (ROW) | ACRE | 0.57 | $ 15,000 | $ 8,609 |
| *Subtotal 6* | | | | $ 116,335 |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 93,779 |
| **Total** | | | | **$ 210,113** |

### 7(c) PASSING LANES AT SPOT LOCATIONS — $ 12,400,000 EA

| | |
|---|---|
| LENGTH (MI) | 2.0 |
| WIDTH (FT) | 78 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | COST |
|---|---|---|---|---|
| Embankment in Place | CUYD | 851.85 | $ 7.49 | $ 673,767 |
| Crushed Aggregate Course | CUYD | 522.13 | $ 22.49 | $ 1,240,030 |
| Cover - Type 1 | SQYD | 867.00 | $ 0.52 | $ 47,609 |
| Traffic Gravel | CUYD | 57.78 | $ 14.99 | $ 91,463 |
| Plant Mix Bit Surf GR S - 3/4" | TON | 240.50 | $ 28.00 | $ 711,110 |
| Hydrated Lime | TON | 4.00 | $ 173.97 | $ 73,485 |
| Asphalt Cement PG 64-28 | TON | 12.99 | $ 707.20 | $ 970,097 |
| Emulsified Asphalt CRS-2P | TON | 1.60 | $ 621.17 | $ 104,953 |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ 164,000 |
| *Subtotal 1* | | | | *$ 4,076,513* |
| Traffic Control | | | 5% | $ 203,826 |
| *Subtotal 2* | | | | *$ 4,280,339* |
| Mobilization | | | 8% | $ 342,427 |
| *Subtotal 3* | | | | *$ 4,622,766* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 462,277 |
| Construction Engineering (CE) | | | 10% | $ 462,277 |
| *Subtotal 4* | | | | *$ 5,547,319* |
| Contingency | | | 20% | $ 1,109,464 |
| *Subtotal 5* | | | | $ 6,656,783 |
| Estimated Right-of-Way (ROW) | ACRE | 12.12 | $ 15,000 | $ 181,818 |
| *Subtotal 6* | | | | $ 6,838,602 |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 5,512,673 |
| **Total** | | | | **$ 12,351,275** |

### 7(d) FOUR- OR FIVE-LANE TYPICAL SECTION — $ 6,200,000 PER MILE

| | |
|---|---|
| WIDTH (FT) | 78 |
| SURFACING (IN) | 5 |
| BASE (IN) | 18 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | COST / MI |
|---|---|---|---|---|
| Embankment in Place | CUYD | 851.85 | $ 7.49 | $ 336,884 |
| Crushed Aggregate Course | CUYD | 522.13 | $ 22.49 | $ 620,015 |

| | | | | | |
|---|---|---|---|---|---|
| Cover - Type 1 | SQYD | 867.00 | $ 0.52 | $ 23,804 | |
| Traffic Gravel | CUYD | 57.78 | $ 14.99 | $ 45,731 | |
| Plant Mix Bit Surf GR S - 3/4" | TON | 240.50 | $ 28.00 | $ 355,555 | |
| Hydrated Lime | TON | 4.00 | $ 173.97 | $ 36,742 | |
| Asphalt Cement PG 64-28 | TON | 12.99 | $ 707.20 | $ 485,049 | |
| Emulsified Asphalt CRS-2P | TON | 1.60 | $ 621.17 | $ 52,476 | |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ 82,000 | |
| *Subtotal 1* | | | | *$ 2,038,257* | |
| Traffic Control | | | 5% | $ 101,913 | |
| *Subtotal 2* | | | | *$ 2,140,170* | |
| Mobilization | | | 8% | $ 171,214 | |
| *Subtotal 3* | | | | *$ 2,311,383* | |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 231,138 | |
| Construction Engineering (CE) | | | 10% | $ 231,138 | |
| *Subtotal 4* | | | | *$ 2,773,660* | |
| Contingency | | | 20% | $ 554,732 | |
| *Subtotal 5* | | | | $ 3,328,392 | |
| Estimated Right-of-Way (ROW) | ACRE | 6.06 | $ 15,000 | $ 90,909 | |
| *Subtotal 6* | | | | $ 3,419,301 | |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 2,756,337 | |
| **Total** | | | | **$ 6,175,637** | |

| 7(e) ALTERNATING PASSING LANES | | | | $ 4,200,000 | PER MILE |
|---|---|---|---|---|---|
| | | WIDTH (FT) | 52 | | |
| | | SURFACING (IN) | 5 | | |
| | | BASE (IN) | 18 | | |
| **TYPE** | **UNITS** | **QUANTITY / STA** | **UNIT PRICE** | **COST / MI** | |
| Embankment in Place | CUYD | 370.37 | $ 7.49 | $ 146,471 | |
| Crushed Aggregate Course | CUYD | 377.69 | $ 22.49 | $ 448,496 | |
| Cover - Type 1 | SQYD | 578.00 | $ 0.52 | $ 15,870 | |
| Traffic Gravel | CUYD | 38.52 | $ 14.99 | $ 30,488 | |
| Plant Mix Bit Surf GR S - 3/4" | TON | 163.17 | $ 28.00 | $ 241,231 | |
| Hydrated Lime | TON | 3.00 | $ 173.97 | $ 27,557 | |
| Asphalt Cement PG 64-28 | TON | 8.81 | $ 707.20 | $ 328,967 | |
| Emulsified Asphalt CRS-2P | TON | 1.10 | $ 621.17 | $ 36,078 | |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ 82,000 | |
| *Subtotal 1* | | | | *$ 1,357,156* | |
| Traffic Control | | | 5% | $ 67,858 | |
| *Subtotal 2* | | | | *$ 1,425,014* | |
| Mobilization | | | 8% | $ 114,001 | |
| *Subtotal 3* | | | | *$ 1,539,015* | |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 153,902 | |
| Construction Engineering (CE) | | | 10% | $ 153,902 | |
| *Subtotal 4* | | | | *$ 1,846,818* | |
| Contingency | | | 20% | $ 369,364 | |
| *Subtotal 5* | | | | $ 2,216,182 | |
| Estimated Right-of-Way (ROW) | ACRE | 3.64 | $ 15,000 | $ 54,545 | |
| *Subtotal 6* | | | | $ 2,270,727 | |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 1,830,459 | |
| **Total** | | | | **$ 4,101,186** | |

| **8 ACCESS MANAGEMENT PLAN** | | | | **$ 180,000** | **TOT** |
|---|---|---|---|---|---|
| *Subtotal 1* | | | | $ 150,000 | |
| Short-Term Inflation | % PER YEAR | 5.00 | 3% | $ 23,891 | |
| **Total** | | | | **$ 173,891** | |

| **9 LIVINGSTON RURAL / URBAN INTERFACE (RP 49.8 TO RP 52.5)** | | | | **$ 8,500,000** | **TOT** |
|---|---|---|---|---|---|
| | | LENGTH (MI) | 2.7 | | |
| | | WIDTH (FT) | 54 | | |
| | | SURFACING (IN) | 5 | | |
| | | BASE (IN) | 18 | | |
| **TYPE** | **UNITS** | **QUANTITY / STA** | **UNIT PRICE** | **COST** | |
| Embankment in Place | CUYD | 407.41 | $ 7.49 | $ 435,019 | |
| Crushed Aggregate Course | CUYD | 388.80 | $ 22.49 | $ 1,246,561 | |
| Cover - Type 1 | SQYD | 600.00 | $ 0.52 | $ 44,479 | |
| Traffic Gravel | CUYD | 40.00 | $ 14.99 | $ 85,479 | |
| Plant Mix Bit Surf GR S - 3/4" | TON | 169.11 | $ 28.00 | $ 675,033 | |
| Hydrated Lime | TON | 3.00 | $ 173.97 | $ 74,403 | |
| Asphalt Cement PG 64-28 | TON | 9.13 | $ 707.20 | $ 920,472 | |
| Emulsified Asphalt CRS-2P | TON | 1.10 | $ 621.17 | $ 97,409 | |
| Drainage Pipe - Rural | LS | 0.02 | $ 82,000.00 | $ 221,400 | |
| *Subtotal 1* | | | | *$ 3,800,256* | |
| Traffic Control | | | 5% | $ 190,013 | |
| *Subtotal 2* | | | | *$ 3,990,268* | |
| Mobilization | | | 8% | $ 319,221 | |

| TYPE | UNITS | QUANTITY | UNIT PRICE | COST |
|---|---|---|---|---|
| *Subtotal 3* | | | | *$ 4,309,490* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 430,949 |
| Construction Engineering (CE) | | | 10% | $ 430,949 |
| *Subtotal 4* | | | | *$ 5,171,388* |
| Contingency | | | 20% | $ 1,034,278 |
| *Subtotal 5* | | | | $ 6,205,666 |
| Estimated Right-of-Way (ROW) | ACRE | 3.27 | $ 15,000 | $ 49,091 |
| *Subtotal 6* | | | | $ 6,254,756 |
| Long-Term Inflation | % PER YEAR | 10.00 | 3% | $ 2,151,113 |
| **Total** | | | | **$ 8,405,870** |

**10 MULTI-USE TRAIL** **$ 390,000 PER MILE**

| | |
|---|---|
| WIDTH (FT) | 8 |
| SURFACING (IN) | 2 |
| BASE (IN) | 6 |

| TYPE | UNITS | QUANTITY / STA | UNIT PRICE | COST / MI |
|---|---|---|---|---|
| Embankment in Place | CUYD | 59.26 | $ 7.49 | $ 23,435 |
| Crushed Aggregate Course | CUYD | 27.50 | $ 22.49 | $ 32,655 |
| Commercial Mix-PG 64-28 | TON | 10.88 | $ 78.03 | $ 44,825 |
| Drainage Pipe - Rural | LS | 0.02 | $ 7,500.00 | $ 7,500 |
| *Subtotal 1* | | | | *$ 108,416* |
| Traffic Control | | | 5% | $ 5,421 |
| *Subtotal 2* | | | | *$ 113,837* |
| Mobilization | | | 8% | $ 9,107 |
| *Subtotal 3* | | | | *$ 122,944* |
| Indirect and Incidental Costs (IDIC) | | | 10% | $ 12,294 |
| Construction Engineering (CE) | | | 10% | $ 12,294 |
| *Subtotal 4* | | | | *$ 147,533* |
| Contingency | | | 20% | $ 29,507 |
| *Subtotal 5* | | | | $ 177,039 |
| Estimated Right-of-Way (ROW) | ACRE | 2.42 | $ 15,000 | $ 36,364 |
| *Subtotal 6* | | | | $ 213,403 |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 172,027 |
| **Total** | | | | **$ 385,430** |

**11 GARDINER AREA (RP 0.0 TO RP 1.0)**

11(a) ON-STREET PARKING — LABOR

11(b) LIGHTING IMPROVEMENTS — TO BE DETERMINED

**12 VEGETATION MANAGEMENT PLAN** **$ 60,000 TOT**

| | | | | |
|---|---|---|---|---|
| *Subtotal 1* | | | | $ 50,000 |
| Short-Term Inflation | % PER YEAR | 5.00 | 3% | $ 7,964 |
| **Total** | | | | **$ 57,964** |

**13 WILDLIFE-VEHICLE CONFLICTS**

GRADE SEPARATED CROSSING STRUCTURES - OVERPASSES **$ 2,800,000 EA**

| TYPE | UNITS | QUANTITY / SIGN | UNIT PRICE | COST / EA |
|---|---|---|---|---|
| Grade Separated Crossing Structure (with Associated Fencing)* | EA | 1.0 | $ 1,250,000.00 | $ 1,250,000 |
| *Subtotal 1* | | | | $ 1,250,000 |
| Contingency | | | 20% | $ 250,000 |
| *Subtotal 2* | | | | $ 1,500,000 |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 1,209,167 |
| **Total** | | | | **$ 2,709,167** |

* *Reference MT-1 Anaconda Corridor Planning Study &*
*WVC Report cost ranges (adjusted for inflation 2007-2013)*

GRADE SEPARATED CROSSING STRUCTURES - UNDERPASSES **$ 750,000 EA**

| TYPE | UNITS | QUANTITY / SIGN | UNIT PRICE | COST / EA |
|---|---|---|---|---|
| Grade Separated Crossing Structure (with Associated Fencing)* | EA | 1.0 | $ 345,000.00 | $ 345,000 |
| *Subtotal 1* | | | | $ 345,000 |
| Contingency | | | 20% | $ 69,000 |
| *Subtotal 2* | | | | $ 414,000 |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 333,730 |
| **Total** | | | | **$ 747,730** |

* *Reference MT-1 Anaconda Corridor Planning Study*
*WVC Report cost ranges (adjusted for inflation 2007-2013)*

ANIMAL DETECTION SYSTEM (AT-GRADE CROSSING) **$ 220,000 PER MILE**

| TYPE | UNITS | QUANTITY / SIGN | UNIT PRICE | COST / EA |
|---|---|---|---|---|
| Animal Detection System (with Associated Fencing) * | MI | 1 | $ 100,000.00 | $ 100,000 |
| *Subtotal 1* | | | | $ 100,000 |

| | | | | | |
|---|---|---|---|---|---|
| Contingency | | | 20% | $ 20,000 | |
| *Subtotal 2* | | | | $ 120,000 | |
| Long-Term Inflation | % PER YEAR | 20.00 | 3% | $ 96,733 | |
| **Total** | | | | **$ 216,733** | |

** Reference MT-1 Anaconda Corridor Planning Study*
*WVC Report cost ranges (adjusted for inflation 2007-2013)*

| WILDLIFE SIGNAGE | | | | **$ 600** | **EA** |
|---|---|---|---|---|---|
| **TYPE** | **UNITS** | **QUANTITY / SIGN** | **UNIT PRICE** | **COST / EA** | |
| Signs - Alum Sheet Invr IV | SQFT | 9.0 | $ 25.06 | $ 226 | |
| Poles - Treated Timber - Barn 4 IN | LNFT | 12 | $ 13.47 | $ 162 | |
| *Subtotal 1* | | | | $ 387 | |
| Contingency | | | 20% | $ 77 | |
| *Subtotal 2* | | | | $ 465 | |
| Short-Term Inflation | % PER YEAR | 5.00 | 3% | $ 74 | |
| **Total** | | | | **$ 539** | |

** Reference MT-1 Anaconda Corridor Planning Study*
*WVC Report cost ranges (adjusted for inflation 2007-2013)*

| WILDLIFE CONFLICT MITIGATION STUDY | | | | **$ 270,000** | **TOT** |
|---|---|---|---|---|---|
| *Subtotal 1* | | | | $ 200,000 | |
| Mid-Term Inflation | % PER YEAR | 10.00 | 3% | $ 68,783 | |
| **Total** | | | | **$ 268,783** | |