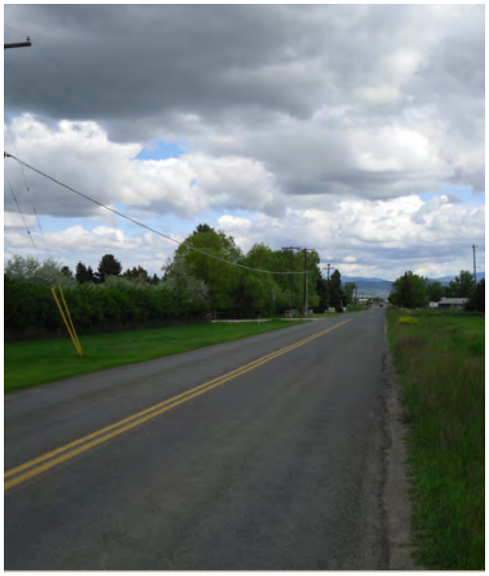
Preliminary Engineering Report

MCHUGH LANE—CITY LIMITS TO SIERRA ROAD

LEWIS AND CLARK COUNTY

RPA Project No. 10502.004



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February 2012

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Executive Summary

This roadway Preliminary Engineering Report (PER) was developed under contract administered by the Lewis and Clark County Public Works office. The PER is intended to provide an initial evaluation of the McHugh Lane corridor bound by the city limits of Helena on the southern end and Sierra Road on the northern end. The PER evaluates road deficiencies and identifies future needs, thereby providing an assessment of improvements necessary to meet or exceed current County road standards. This report is also intended to provide base reconstruction cost estimates to aid the county in funding development to meet the purpose and need for the desired road improvements.

ES.1. Summary of Findings

The existing roadway does not meet several minimum design criteria presented as guidance by the American Association of State Highway and Transportation Officials (AASHTO), or the minimum standards set by Lewis and Clark County. Corrections to fix these roadway deficiencies are proposed and discussed in detail in the report.

The current roadway surfacing structure is deficient to meet the needs of the projected loadings it will experience within the study's evaluation period. Although the horizontal and vertical alignments are within minimum accepted standards, the aspects of the highway measured from the edge of the traveled way outward to include cut and fill slopes are below safety standards in some areas for a facility classified as a Minor Collector under the Lewis and Clark County Subdivision Regulations, Appendix J, Road Standards. Despite being classified as a Major Collector in the Greater Helena Area Transportation Plan – 2004 Update, McHugh Lane was treated as a Minor Collector in this report since the projected 2031 traffic volumes are more indicative of a Minor Collector under the County road standards.

Based on the evaluation presented herein, we estimate the cost to reconstruct the road to meet assigned design criteria to be approximately **$1.18 million per mile**. This cost estimate includes further engineering, traffic control during construction, right-of-way acquisition, and other contingencies. Base construction cost is estimated to be approximately $800,000 per mile, excluding costs for additional right-or-way, final engineering, etc.

1. Introduction

This roadway Preliminary Engineering Report (PER) was prepared by Robert Peccia and Associates (RPA) under contract with Lewis and Clark County, Montana. The contract is administered by the Lewis and Clark County Public Works office. The study segment is a portion of McHugh Lane between the city limits of Helena and Sierra Road, approximately 2.3 miles in length.

This segment of McHugh Lane is considered a high-priority road by County staff to receive reconstructive improvements. The prioritization is in some part due to increasing roadway maintenance needs indicative of the impacts caused by current traffic use. Potential future development may add a proportional amount of new traffic, which would continue to contribute to the road's deterioration.

This PER is prepared as an initial task to analyze the deficiencies of the roadway. By evaluating the road's structural and geometric deficiencies or needs, and obtaining an initial snapshot of what improvements are necessary to meet or exceed County road standards, Lewis and Clark County can then better identify funding requirements, and begin subsequent planning for engineering and construction.

In accordance with Chapter XI of the current December 18, 2007 Lewis and Clark County Subdivision Regulations (Amended May 18, 2010), Part H Streets and Roads, the County will also utilize this document to calculate the pro-rata cost share of each new development that contributes traffic impacts to this study segment as a part of its impact corridor. The pro-rata share for each impact will then be reserved to help build the funding needed in part to ultimately reconstruct the roadway as a whole or in separate phases.

RPA has prepared this report with services rendered to meet or exceed those of the practicing consulting engineering industry under similar budget and time restraints. No warranty, expressed or implied, is made.

1.1. Location and Description

McHugh Lane lies within the northerly portion of what is locally known as the Helena Valley. The study area begins at the northern limits of the City of Helena, just south of Yuhas Avenue. The project extends northerly for approximately 2.3 miles, terminating at its intersection with Sierra Road West. Sierra Road is classified as a Major Collector in the Greater Helena Area Transportation Plan – 2004 Update. Refer to the project area map, **Figure 1.1**.

For the purpose of this study, Milepost [MP] 0.00 is considered the start of the project corridor at the city limits of Helena. The mileposts increase in a south to north direction. From MP 0.00, McHugh Lane continues north along center section lines (center of Sections 6, 7 and 18, Township 10 North, Range 3 West). The project corridor terminates at MP 2.30 at the intersection with Sierra Road.

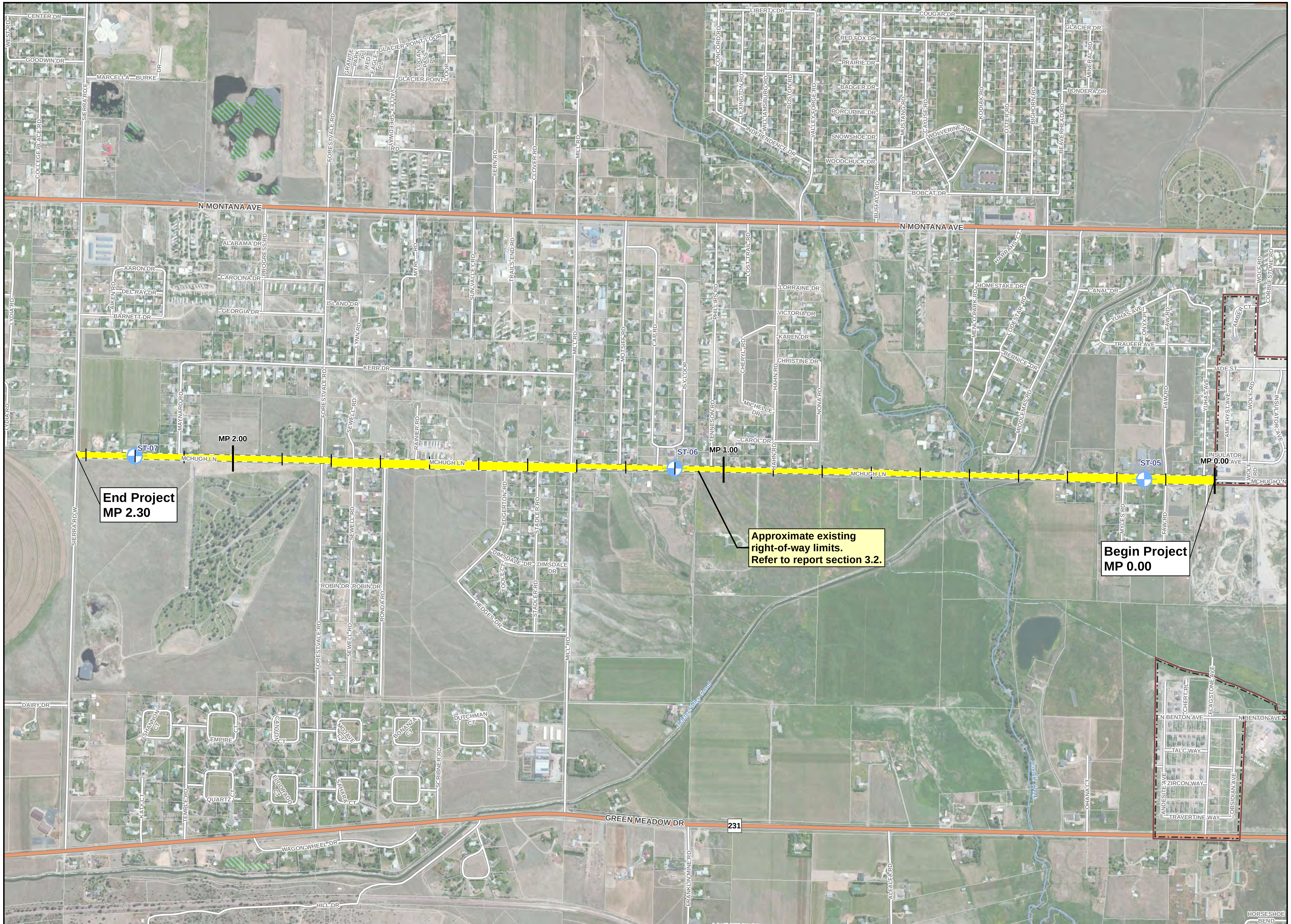
1.2. Methodology to Develop Report

Various field methods were used to obtain existing geometric information to aid in the development of this report. The work conducted is indicative of the preliminary nature of this project's current status and level of design and development. Explicitly, formal survey work of setting control and then completing instrumental topographical survey was not completed. As such, CADD based design work has not been undertaken, except for some basic diagramming.

Field reviews were completed in June 2011. For on-site field reviews, most measurements were taken with a steel tape. Longer measurements were obtained using a wheel tape. For slope or grade estimates, a four-foot long digital smart level was used to record the information in degrees or percent format. This then was converted to approximate slope rates, such as horizontal:vertical (h:v) for describing existing road fill or cut slope rates as an example. GIS information was used to supplement the field data collection effort as well as minimizing walking and windshield review time.

1.3. Reference Standards

The reference standards used in this study are those specified by the Lewis and Clark County Subdivision Regulations. Specifically, in the regulation's Appendix J, Road Standards, referenced documents include American Association of State Highway and Transportation Officials (AASHTO) and Montana Department of Transportation (MDT) publications among others. These standards were followed, with the County standards governing all others if design information is provided for the specific item being evaluated. If we deemed it appropriate to use other reference materials, then those materials are documented in this report.



MCHUGH LANE PROJECT AREA

Preliminary Engineering Report

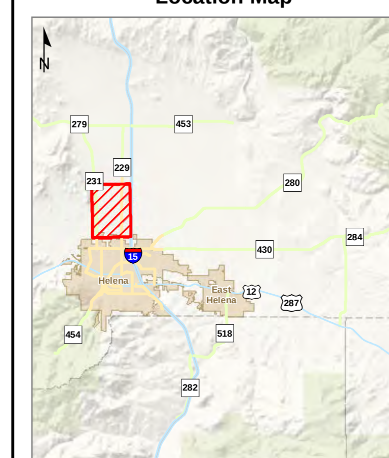
0 500 1,000 1,500 Feet

1 inch = 1,000 feet

Map Legend

- Approximate Existing Right-of-Way
- Soil Boring Location
- Local Route
- On-System Route
- Ownership
- City Boundary
- Wetland
- Waterbody
- Canal / Ditch
- Stream / River - Intermittent
- Stream / River - Perennial

Location Map



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Project: 10502.004 LewisClarkCo PERs - McHugh Lane

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Figure 1.1

2. Background Data

Background data was collected for the project corridor from various sources and was used to supplement the field data collection efforts discussed later in this report. The background data was used in conjunction with the field collected data to help establish baseline conditions and to assess areas deficient to current roadway standards. This section of the report provides a summary and analysis of the available background data.

2.1. Traffic

Lewis and Clark County completes annual traffic counts for roads under their jurisdiction. The County recognizes the importance of methodically collecting traffic data to analyze traffic growth characteristics and help assess each road's maintenance needs.

Abelin Traffic Services (ATS) of Helena has in recent years been contracted with the County to complete their Traffic Count Program. 2009 traffic counts for McHugh Lane north and south of Forestvale Road were completed by ATS in July 2009. 2009 data is used in this report as the geotechnical review for this project started at that time. The 2009 traffic data was also the most current available data posted on the Lewis and Clark County website. The county determined to proceed with this PER's preparation in 2010.

Additional 2009 traffic counts along three different points of McHugh Lane (north of Mill Road, south of Sierra Road, and at Helena city limits) were available from MDT and were included in this study. ATS and MDT convert the raw data traffic counts into Average Annual Daily Traffic (AADT) to provide an accurate traffic volume regardless of which month, day or hours the counts were performed.

For the road surfacing evaluation part of this PER, a heavy vehicle factor of less than 1.0% was assumed for McHugh Lane as the project's vehicle classification counts did not record a vehicle classified as a heavy vehicle. This was based on vehicle classification counts conducted in 2009 by ATS which show heavy buses and trucks accounting for 0% of daily traffic on McHugh Lane at the time data was gathered.

Lewis and Clark County and MDT also provided RPA with historical traffic counts for McHugh Lane. The AADT counts date back 20 years to give a good baseline of information to characterize traffic growth. RPA plotted the historical counts to assess the annual growth rate. An exponential growth trend line was established to represent historic traffic conditions and to project out to a future 20-year evaluation period to year 2031. The historic traffic counts, as well as the trend line evaluation, are included in **Appendix A** of this report.

Estimated 2011 AADT values, along with projected 2031 values, were calculated using the exponential growth trend calculated based on the historical traffic data previously discussed. In addition to showing existing and projected AADT traffic values, **Table 2.1** gives the estimated exponential growth rates experienced along each road segment based on the linear trend analysis. A weighted average growth rate combining all traffic count locations along the project corridor is also provided.

Table 2.1: Average Annual Daily Traffic (AADT)

McHugh Lane		AADT			
Site ID	**Location**	**2009**	**2011[3]**	**2031[3]**	**Growth[4]**
7B-25	at N Urban Limit[2]	2050	1902	3292	2.78%
7B-27	N of Mill Rd[2]	1540	1445	2527	2.83%
7B-44	S of Forestvale Rd[1]	879	995	1656	2.58%
7B-45	N of Forestvale Rd[1]	527	608	1036	2.70%
7B-28	S of Sierra Dr[2]	600	615	1202	3.41%
Weighted Average:					**2.82%**

(1) AADT values from Lewis and Clark County's Traffic Count Program.
(2) AADT values from MDT.
(3) AADT was projected based on historical counts assuming an exponential yearly growth rate.
(4) Estimated exponential growth rate based on historical traffic count data.

2.2. Crash History

The MDT Traffic and Safety Bureau provided crash information and data for the approximate 2.3-mile section of McHugh Lane between the Helena city limits and Sierra Road. The crash information covers a five-year time period from July 1, 2005 to June 30, 2010. A total of twenty-seven crashes were investigated on this segment of roadway. The crash information was analyzed to identify general crash characteristics and potential roadway deficiencies.

The majority of crashes occurred at, or were related to, intersections. In addition, the majority of crashes were the result of driver error, generally due to inattentive driving and/or failure to yield. Eight of the twenty-seven crashes were non-junction related and seventeen crashes involved multiple vehicles. Fourteen crashes resulted in injuries, none of which resulted in a fatality.

The analysis indicates that there is a problem with multi-vehicle crashes occurring at intersections. The most apparent cluster of crashes occurred at the intersection with Mill Road. To help with this problem, it may be beneficial to provide dedicated left-turn lanes or traffic control devices along McHugh Lane at high volume intersections such as Mill Road. Further engineering studies could be undertaken to assess the potential for modifying intersections to modernized single-lane urban roundabouts, which are considered a viable option to eliminate conflict maneuvers between turning vehicles.

3. Existing Conditions

Existing conditions for the McHugh Lane corridor are based on background data and a field review conducted on June 20th, 2011. During the field review, existing physical characteristics were analyzed and documented to help establish existing conditions along the project corridor. Weather conditions were favorable, although the field review was conducted immediately following the re-opening of McHugh Lane after two weeks of extensive flooding along the corridor. The flooding was a result of high-intensity, long-lasting precipitation (over three inches in a week dropped onto an above average mountain snowpack). The high volume of precipitation saturated the ground, causing an elevated groundwater table and high volumes of surface runoff in Tenmile Creek and other area surface drainages. The surface runoff eventually overtopped McHugh Lane and the surrounding areas, resulting in a road closure of McHugh Lane from approximately June 8th to June 17th between Motsiff Road and Sierra Road.

3.1. Physical Characteristics

Design criteria for assessing proposed roadway improvements are in some part governed by the terrain that the roadway traverses. Terrain classifications are level, rolling and mountainous. The terrain of this roadway is level for the entire project length. The road grades slope south to north and are very moderate and generally less than 2.0%

The area is a mix of irrigated and dry land agricultural tracts between parcels of developed suburban residential subdivisions. The area is semi-arid with few significant cross-draining structures. Surface runoff is predominately collected in roadside ditches on the west side of McHugh Lane and conveyed northerly to cross drains. The road drainage generally parallels the natural southwesterly to northeasterly drainage pattern of the valley in this location. The majority of the project corridor, from approximately MP 0.30 near the Helena Valley Canal to MP 2.10 at Maynard Road, is within a 500-year flood hazard area (Zone B). The Tenmile Creek crossing at MP 0.50 is within a 100-year flood hazard area (Zone A). The road between Motsiff Road (MP 1.20) and Sierra Road (MP 2.30) was closed due to floodwaters overtopping the road during the recent June 2011 flooding. The applicable Flood Insurance Rate Maps (FIRMs) showing the flood hazard areas for the project corridor are attached in **Appendix A** for reference.

McHugh Lane is functionally classified in the Greater Helena Area Transportation Plan – 2004 Update as a Major Collector. However, the projected 2031 traffic volumes for McHugh Lane shown in **Table 2.1** are all between 1,000 and 3,500 AADT. The Lewis and Clark County Road Standards describe Minor Collectors as typically carrying traffic volumes of 1,500 to 3,500 AADT, while Major Collectors would typically carry volumes greater than 3,500 AADT. As a result, the functional classification of McHugh Lane used for this report was that of a Minor Collector. This classification serves to collect traffic from abutting properties via local road intersections, and distribute to other roads of equal or higher classification.

3.2. Existing Right-of-Way

Existing right-of-way is considered approximate as it was determined based on field review and GIS data. During the field review, measurements were taken where right-of-way fence exists. This information supplemented available Cadastral GIS data.

Approximate right-of-way widths, measured from centerline, are shown in **Table 3.1**. These values are estimates and are only intended to provide a planning-level assessment to help determine the level of potential impact for road reconstruction beyond the existing public right-of-way.

Table 3.1: Approximate Right-of-Way Widths

Location		Width (from Centerline)
MP Begin	**MP End**	
East of Centerline		
0.00	0.30	52'
0.30	0.67	30'
0.67	0.80	40'
0.80	1.80	30'
1.80	2.30	36'
West of Centerline		
0.00	0.30	48’
0.30	1.30	30'
1.30	1.80	70’
1.80	2.30	34'

3.3. Design Speed

Design speed is a selected speed used to determine multiple aspects of roadway design criteria. Design speed is selected in relation to topography, vehicle operating speeds, roadside development, and the functional classification of the road or highway. The AASHTO publication “A Policy on Geometric Design of Highways and Streets - 2004” (the Green Book as commonly referred to by the industry) states that the selection of the design speed for roads other than constrained local streets, should be made to use the speed that is the highest practical to attain the desired degree of safety, mobility, and efficiency subject to environmental, economic and other social, political or aesthetic constraints. Further, the design speed should be higher than the running speed of a large proportion of drivers.

In Appendix J, Table A, Road Standards, of the Lewis and Clark County Subdivision Regulations, the specified design speed applicable to McHugh Lane in this segment is 50 miles per hour (mph) for level terrain. A copy of Table A is included in **Appendix B**. As noted previously, the functional classification of this road for the purposes of this PER is a Minor Collector. AASHTO guidance further states that designs should exceed their criteria where practical. Every effort should be made to obtain the best possible alignment, grade, sight distance, and improved road cross-sectional elements that are consistent with terrain, present and anticipated development, safety and available funds.

Exhibit 6-1 of the AASHTO Green Book, reproduced in **Appendix B**, is a table of suggested minimum design speeds for Rural Collectors. For over 2000 vehicles per day, AASHTO's minimum design speeds are 60 mph for level terrain; for 400 to 2000 vehicles per day, AASHTO's minimum design speeds are 50 mph for level terrain. In reference to this, the County's design speeds may be somewhat low when taking into consideration 20-year AADT growth. AASHTO recommends, where practical, to consider using design speeds higher than those shown in the exhibit.

Exhibit 6-4 of the Green Book, contained in **Appendix B**, specifies maximum suggested grades, in percent (%), for specified design speeds of Rural Collector highways. For 50 mph design speeds, level terrain can have recommended highway grades not to exceed 6%. For 60 mph in the same terrain, the maximum recommended grade is 5%. For the project corridor, there are no existing grades exceeding those recommended based on the terrain criteria.

The County has established a regulatory speed limit of 45 mph for the project corridor. The regulatory speed is less than the County standard design speeds, and is deemed appropriate by the County based on terrain, the road's surfacing condition, geometrics, and level of roadside development.

Based on the above comparisons, we believe the County's standard design speeds are appropriate for this facility. The 50 mph design speed is higher than the current regulatory speed, which is indicative of improving conditions to those of highest practical to attain the desired degree of safety, mobility, and efficiency subject to environmental, economic and other social, political or aesthetic constraints. The County does not intend to change the regulatory speed limit of 45 mph for the project corridor.

3.4. Alignment

The horizontal road alignment of McHugh Lane is tangential in a north/south direction. The tangent sections of the road are primarily a result of the road following the center section lines. There are no horizontal curves along the project corridor. The vertical alignment of McHugh Lane is very flat with grades much lower than those identified in the County road regulations.

A single horizontal alignment issue was noted at the intersection of McHugh Lane with Forestvale Road (MP 1.80). At this intersection, the horizontal alignments for McHugh Lane do not match, as the alignment north of the intersection is shifted to the west (**Photo 3.1**). A shift in alignment at an intersection is undesirable and the reconstruction of McHugh Lane would provide an opportunity to realign the intersection and improve traffic flow.

Photo 3.1: Skewed intersection alignment at Forestvale Road.

3.5. Sight Distance

Applicable to horizontal and vertical alignment geometric features is the design element of sight distance. The measure of a driver's sight distance is critical to safely avoid collisions with objects. This is measured by stopping sight distance in both horizontal and vertical planes.

As noted previously, the roadway lies on straight tangent center section lines for the entire project length. There do not appear to be any issues related to sight distance along vertical or horizontal curves. The skewed intersection angle of McHugh Lane at Forestvale Road may present difficult sight angles and it is recommended the intersection be realigned during reconstruction. We do not envision any other substantial improvements to be required to the present road grade and its associated sight distance.

3.6. Structures

Two existing concrete bridges are within the project area. An existing pre-stressed concrete bridge spans the Helena Valley Canal at approximately MP 0.40, just north of the Helena city limits. The overall deck width is 30 feet, while the bridge span is approximately 47 feet. The installation includes approximately 150 feet of steel guardrail on each side of the bridge. The guardrails reduce the clear width of the roadway to about 28 feet across the structure. The bridge clear width is approximately equal to the width of the road approaches just before and after the bridge, which undergo widening to match the bridge width from an otherwise 24-foot surfacing width. The bridge was constructed in 2000 and the structure, abutments, and guardrail all appear to be in good condition. MDT completed a bridge inspection in March 2011. The "Initial Assessment Form" from the inspection is attached in **Appendix A** for reference.

The second bridge is an existing cast-in-place concrete bridge spanning Tenmile Creek at approximately MP 0.50. The overall deck width is 42 feet, while the bridge span is approximately 39 feet. The installation includes approximately 130 feet of steel guardrail on each side of the bridge and 39 feet of concrete barrier rail on each side along the bridge span. The guardrails reduce the clear width of the roadway to about 39 feet across the structure. The bridge clear width is approximately equal to the width of the road approaches just before and after the bridge, which undergo widening to match the bridge width from an otherwise 24-foot surfacing width. The bridge was constructed in 1989 and the structure, abutments, and guardrail all appear to be in good condition. MDT completed a bridge inspection in March 2011. The "Initial Assessment Form" from the inspection is attached in **Appendix A** for reference. No evidence of substantial overtopping of the bridge was noted during the field review completed immediately following the June 2011 flooding of McHugh Lane. However, the County reports that in high runoff events the bridge span constricts the flow until the creek headwater rises to the elevation of discharging into the roadside ditch prior to overtopping the bridge deck.

Due to the level terrain in this area, we expect both the horizontal alignment and vertical grades to match the existing structures when the road is reconstructed. In terms of meeting minimum road width requirements, AASHTO recommends that the bridge clear width be equal to or greater than the approach traveled way width, wherever practical. For a bridge to remain in place with design traffic exceeding 2,000 vehicles per day, AASHTO further recommends a minimum 28-foot clear width as shown in Exhibit 6-7, as contained in **Appendix B**. Both existing bridges meet AASHTO minimum width criteria to remain in place.

However, AASHTO recommends meeting the new road approach width <u>if practical</u>, and the reconstructed road in this segment meets criteria to be built to an overall width of 32 feet wide. The Tenmile Creek bridge would meet this criteria, but the Helena Valley Canal structure would not (clear width of approximately 28 feet). The discussion on developing the new road typical sections follows in this report. Due to the apparent 4-foot difference in proposed road top-surface width vs. the Helena Valley Canal bridge clear width, the County will need to ascertain the practicality and cost-benefit of widening the structure. One means of determining need, or practicality, is by reference to the crash history. In the 5-year crash data obtained for this report there were no reported incidents in which the bridge has contributed to the circumstances of a crash.

3.7. Existing Roadway Surfacing

A pavement evaluation for the McHugh Lane corridor was initiated in July 2009 with field work, soil borings, and laboratory analysis. The evaluation concluded with a surfacing design and evaluation report completed on November 3, 2009. A discussion of the results of the pavement evaluation for each road section is provided. **Table 3.2** gives a summary of the pavement evaluation soil boring results. The detailed pavement evaluation report is contained in **Appendix C.**

It should be noted that this pavement analysis is conservative in nature due to the fact that complete reconstruction was assumed. Other options such as pulverizing, overlay, or other reconditioning methods were not analyzed.

The McHugh Lane corridor is asphalt-surfaced throughout the entire project length. Three soil borings were completed along this section. The borings, identified as ST-05, ST-06, and ST-07 were completed in approximately one-mile intervals. The thickness of the asphalt surfacing varies from 1 ¼ to 5 inches between the three samples. The asphalt surfacing is a composite of original material supplemented by maintenance blade patching and chip seal courses applied over the life of the present roadway. The variable asphalt thicknesses can correlate to County surface maintenance activities; in which built up layers of thicker asphalt represent efforts in areas to stabilize potentially soft and unstable subgrade soils or poor gravel bases that may be experiencing permanent deformation from vehicle loadings that exceed what the existing surfacing can support. All three base course samples varied to a similar degree, from 2 ¾ to 9 inches and from poor to good quality. One sample location, ST-07, also had an existing layer of subbase material.

With each boring, soil samples were also obtained for subgrade material directly below the aggregate base material. The subgrade soil consists of silty sand at two locations, and clayey gravel at the other boring location. The moisture content is considered to be near to or well over optimum at all three locations. The risk of subgrade failure at all three locations is considered to be moderate to high. **Table 3.2** gives a summary of the pavement evaluation soil boring results.

Table 3.2: Summary of Boring Conditions

	ST-05	ST-06	ST-07
Approximate Location	MP 0.15	MP 1.10	MP 2.20
Existing Surfacing Thickness	3 ½"	5"	1 ¼"
Existing Base Thickness	9"	4"	2 ¾"
Existing Subbase Thickness	-	-	14"
Existing Base Quality	Good	Poor	Moderate
Subgrade	SM	GC	SM

Blows Per Foot (BPF)	12, 6	9, 24	10, 5
Moisture Condition	Near to 10% Over	Over	Near to 5% Over
Risk of Subgrade Failure	High	Moderate	Moderate

SM = Silty Sand
GC = Clayey Gravel

Summary:

- The existing asphalt surfacing thickness for boring ST-07 is thin compared to minimum County standards;
- Existing base aggregate varies for borings ST-06 and ST-07 from poor to moderate quality and is 5 to 6 ¼ inches less in thickness than minimum County standards;
- The subgrade in this segment has a moderate to high risk of failure.

3.8. Existing Roadway Typical Sections

This section of the report discusses the primary features of each road segment's existing typical section characteristics. The project corridor is comprised of four distinct sections. Cross-sectional measurements of McHugh Lane were taken to include surfacing widths, cut and fill slope rates, ditch widths, and the depth of the roadside ditch.

3.8.1. Existing Typical Section E.1: City Limits to MP 0.30

Existing Typical Section E.1 runs from the Helena city limits (MP 0.0) to MP 0.30, just south of the Helena Valley Canal bridge. The overall top surface of this section was measured to be approximately 24 feet wide, with two 12-foot travel lanes and no distinguishable paved shoulders. A small section of roadway with curb and gutter on each side extends from the Helena city limits to Yuhas Avenue. A separate typical section was not developed for this section of road since it only exists for approximately 100 feet of the project corridor.

The roadside ditch foreslopes were measured to be approximately 4:1 (horizontal : vertical, i.e. four feet horizontal distance for each one foot vertical drop) on the east side of the roadway and 12:1 on the west side where there is no ditch. The ditch backslope on the east side was measured to be approximately 3:1. The roadside ditch depth on the east side was approximately three feet deep and appears to meet the County standards for ditch depths and slopes in most locations.

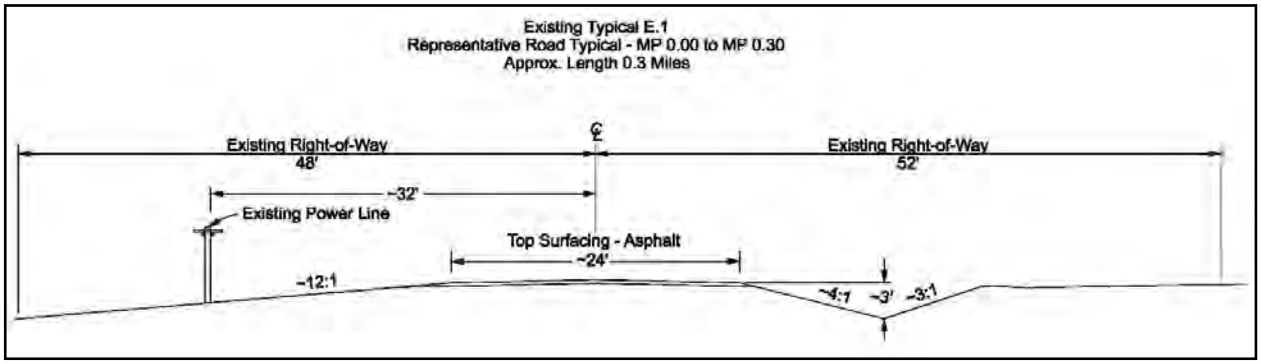


Figure 3.1: Existing Typical Section E.1 (MP 0.00 – MP 0.30) – Looking North.

Photo 3.2: Existing Typical Section E.1 – Looking North.

3.8.2. Existing Typical Section E.2: MP 0.30 to Mill Road

Existing Typical Section E.2 runs from MP 0.30, just south of the Helena Valley Canal bridge, to Mill Road (MP 1.30). The top surface of this section was measured to be approximately 24 feet wide, with two 12-foot travel lanes and, in general, no distinguishable paved shoulders. The road template does briefly widen between the Helena Valley Canal (MP 0.40) and Tenmile Creek (MP 0.50) bridges, where it widens to match the clear width of each respective bridge before quickly tapering back to the 24-foot roadway once past the Tenmile Creek structure.

The roadside ditch foreslopes were measured to be approximately 4:1 on both sides of the roadway. The ditch backslopes were measured to be approximately 3:1 on each side. The roadside ditch depths were about 3 feet deep on each side in most locations. The existing ditches appear to meet minimum County Standards for ditch slopes and depth in most locations.

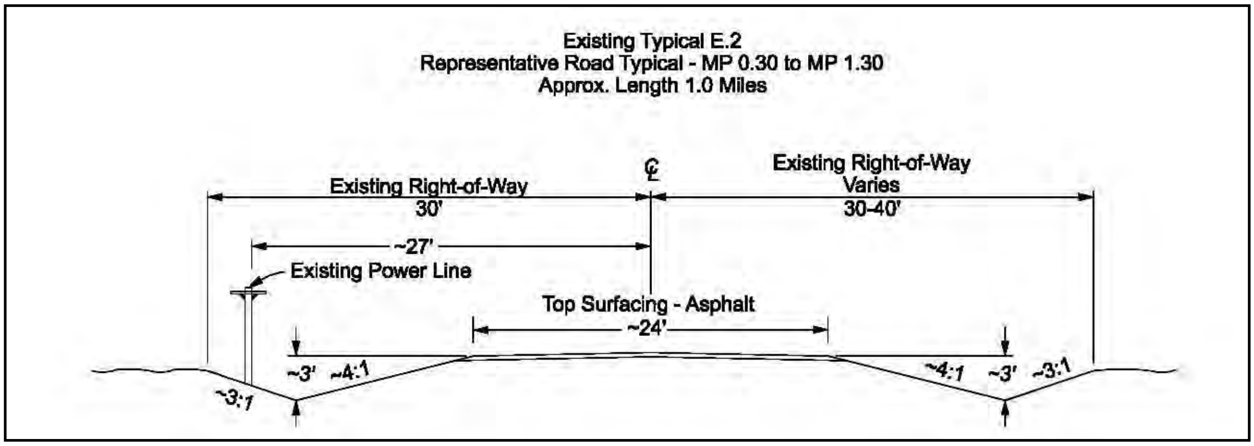


Figure 3.2: Existing Typical Section E.2 (MP 0.30 - MP 1.30) – Looking North.

Photo 3.3: Existing Typical Section E.2 – Looking North.

3.8.3. Existing Typical Section E.3: Mill Road to Forestvale Road

Existing Typical Section E.3 runs from Mill Road to Forestvale Road (MP 1.30 to MP 1.80). The overall top surface of this section measured to be approximately 24 feet wide, with two 12-foot travel lanes and no distinguishable paved shoulders.

The roadside ditch foreslopes were measured to be approximately 4:1 on the west side and 8:1 on the east side of the roadway. The ditch backslopes were measured to be approximately 3:1 on the west side and 6:1 on the east side. An approximate 3-foot deep roadside ditch continues from the previous typical section along the west side, while a 1.5-foot deep ditch is on the east side. The ditch on the east side is shallow in comparison to the County standards and does not provide adequate cover over approach culverts.

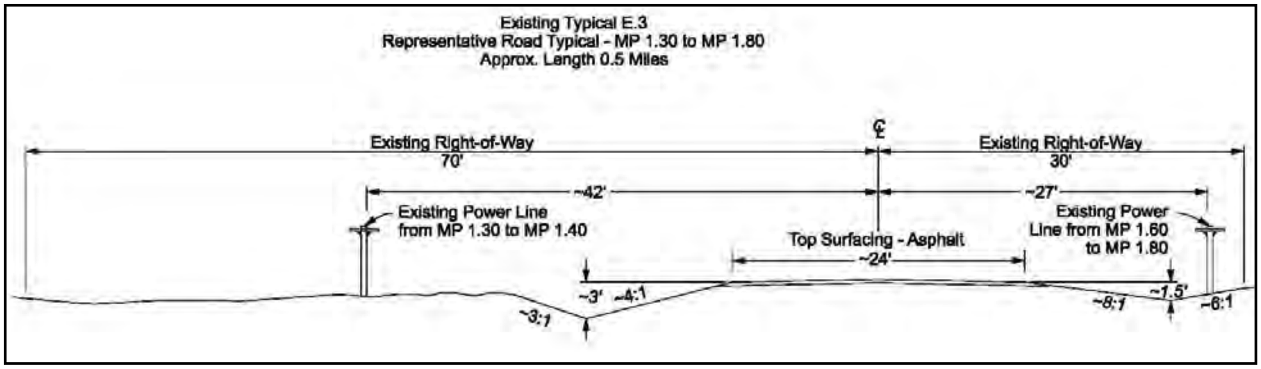


Figure 3.3: Existing Typical Section E.3 (MP 1.30 - MP 1.80) – Looking North.

Photo 3.4: Existing Typical Section E.3 – Looking North.

3.8.4. Existing Typical Section E.4: Forestvale Road to Sierra Road

Existing Typical Section E.4 runs from Forestvale Road to Sierra Road (MP 1.80 to MP 2.30). The overall top surface of this section measured to be approximately 24 feet wide, with two 12-foot travel lanes. There are no distinguishable paved shoulders.

The roadside ditch foreslopes were measured to be approximately 4:1 on both sides of the roadway. The ditch backslopes were measured to be approximately 6:1 on the west side and 4:1 on the east side. The roadside ditch depths were approximately 3 feet deep on both sides and appear to meet current County standards in most locations.

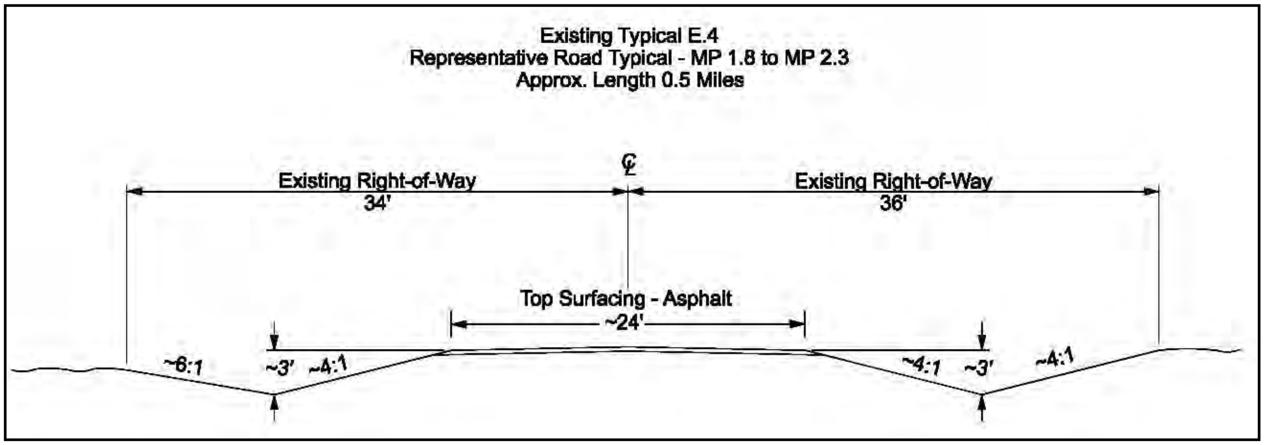


Figure 3.4: Existing Typical Section E.4 (MP 1.80 - MP 2.30) – Looking North.

Photo 3.5: Existing Typical Section E.4 – Looking North.

4. Proposed Conditions

This section of the PER discusses the proposed future conditions of the McHugh Lane corridor. Proposed conditions were determined based on applying Lewis and Clark County standards to the existing conditions based on information collected during the field review process.

4.1. Proposed Roadway Typical Sections

The proposed design typical sections are based on the design methodology previously discussed herein. The County Road Standards serve as the basis which was supplemented by AASHTO guidance as needed. The following sections provide detail as to how the proposed typical sections are developed.

4.1.1. Preliminary Surfacing Design

For this study, a preliminary surfacing section was developed based on the three soil borings and projected traffic data. This pavement design is used within this study to estimate reconstruction impacts and costs. As such, the preliminary surfacing design is developed to also meet or exceed the surfacing requirements of the Lewis and Clark County Road Standards for this Minor Collector roadway.

Based on the input parameters and the approach of analyzing the pavement designs to be in accordance with the County Subdivision Regulations, the recommended reconstruction should have a new pavement section meeting or exceeding the structural integrity of the following (refer to **Appendix C** for the full pavement design evaluation):

- 3” Thick (Compacted) New Asphalt Pavement
- 3” Thick (Compacted) Crushed Top Surfacing
- 6” Thick (Compacted) Select Base Course (3-Inch Minus Gradation)
- 0” thick (Compacted) Subbase Course (3-Inch Minus Gradation)
- **12” Total Thickness**

The proposed surfacing section coincides with the County’s minimum allowable surfacing section for a Minor Collector, as shown in Figure 3 of Appendix J of the County Subdivision Regulations.

As discussed previously, the soil borings taken along the project corridor indicated that the existing subgrade was wet and either near to or well over optimum moisture content. According to the surfacing evaluation contained in **Appendix C**, the subgrade is considered to have a moderate to high risk of failure during construction. As such, some areas may need stabilization as discussed in the surfacing evaluation.

4.1.2. Design Clear Zone

Typical highway crashes either involve incidents on the road, or collisions with fixed features off of the road, such as bridge piers, sign supports, overhead utility poles, culverts, and non-traversable ditches or embankments. To counteract the effects of off-road errant vehicles, agencies implement a traversable and unobstructed roadside area beyond the edge of the traveled way for higher volume, rural facilities. Obstacles within the “clear zone” are evaluated to be removed, relocated, redesigned or shielded. The basic parameters to establish the appropriate design clear zone is the road’s design speed, design traffic volume, and design roadside cut and fill slope rates.

Lewis and Clark County Road Standards references roadside clear zone requirements to those recommended by AASHTO. A portion of Table 3.1 of the AASHTO 2006 Roadside Design Guide is reproduced in **Table 4.1**. This shows the recommended clear zones based on the design speed and traffic volume parameters for McHugh Lane. The clear zones shown below are measured in feet from the edge of the traveled way.

Table 4.1: Roadside Clear Zone Guidelines (Feet)

		Foreslopes			Backslopes		
Design Speed	Design ADT	6H:1V or Flatter	5H:1V to 4H:1V	3H:1V	3H:1V	5H:1V to 4H:1V	6H:1V or Flatter
45 - 50 mph	750 - 1500	14 - 16	16 - 20	-	10 - 12	12 - 14	14 - 16
45 - 50 mph	1500 - 6000	16 - 18	20 - 26	-	12 - 14	14 - 16	16 - 18
55 mph	750 - 1500	16 - 18	20 - 24	-	10 - 12	14 - 16	16 - 18
55 mph	1500 - 6000	20 - 22	24 - 30	-	14 - 16	16 - 18	20 - 22

Pursuant to County standards, the 50 mph design speed is applicable to McHugh Lane traversing level terrain. A minimum foreslope rate of 4:1 is required as shown in Figure 3 of Appendix J of the County Subdivision Regulations.

Based on these values, a minimum clear zone of 20 feet is recommended along the roadside foreslope for areas with a design ADT of 1500 to 6000. This applies to the section of McHugh Lane between Helena city limits (MP 0.00) and Forestvale Road (MP 1.80) based on design life AADT.

A minimum clear zone of 16 feet is recommended along the roadside foreslope for areas with a design ADT of 750 to 1500. This applies to the section of McHugh Lane between Forestvale Road (MP 1.80) and Sierra Road (MP 2.30).

For the purposes of this study, we are applying the minimum recommended design clear zones to develop the proposed road template. This minimum recommended clear zone will limit construction impacts, road reconstruction costs, and reduce right-of-way acquisition.

4.1.3. Surfacing Width

Figure 3 contained in Appendix J of Lewis and Clark County's Subdivision Regulations depicts the County's minimum standard road typical for a two-lane Minor Collector. Each travel lane is to be 12-feet wide. The shoulder width can vary between 2 feet and 4 feet, as measured between the edge of the travel lane to the edge of the surfacing. Since the County standard in itself does not give guidance on what shoulder width to use, we referred to the AASHTO Green Book for guidance.

Exhibit 6-5 of the AASHTO policy specifies the minimum traveled way and shoulder widths for rural collector highways based on the factors of design speed and traffic volume. A copy of this exhibit is included in **Appendix B**. This exhibit recommends a 22-foot traveled way (minimum) for a design speed of 50 mph and either 6-foot shoulders on each side (34 feet top width) for AADT 1500 – 2000 or 8-foot shoulders on each side (38 feet top width) for over 2,000 AADT. However, for Minor Collector highways the County has adopted 4 feet as the maximum required shoulder width. Based on this, the recommended overall road surfacing width for reconstruction to accommodate two travel lanes and shoulders is 32 feet; accounting for two 12-foot travel lanes and two 4-foot shoulders.

4.1.4. Proposed Typical Section P.1

Proposed Typical Section P.1 (**Figure 4.1**) is for the portion of McHugh Lane between the Helena city limits and Forestvale Road (MP 0.00 to MP 1.80). Projected future traffic forecast along this section is between 1600 and 3300 AADT, which according to AASHTO policy suggests a minimum clear zone of 20 feet. The minimum County standard for a Minor Collector is 80 feet of right-of-way. This road section has existing power lines running along the west side of the roadway for the first 1.4 miles and along the east side for the final 0.2 miles. If the current road alignment is used, additional costs for sections of utility relocation would need to be considered. Associated costs for utility relocation were not included as part of the cost estimate presented later in this report.

As noted previously, the alignment of McHugh Lane will need to be shifted at the Forestvale Road intersection to eliminate the skewed angle across the intersection. Ideally, the entire alignment north of Forestvale Road (MP 1.80) would be shifted east to line up the horizontal alignment for the entire McHugh Lane corridor. However, cemetery tracts exist on each side of McHugh Lane north of Forestvale Road. As such, it was assumed that the an adjustment of the centerline to the west would be introduced between Mill Road and Forestvale Road (MP 1.30 to MP 1.80) to line up the intersection so no right-of-way impacts would be necessary north of Forestvale Road. Approximately 70 feet of right-of-way exists west of centerline between Mill Road and Forestvale Road, so any alignment shift in this section should not substantially increase right-of-way impacts on the west side and may limit the impacts on the east side.

Additional right-of-way would be needed on one or both sides of the road from MP 0.30 to MP 1.80 so that a minimum of 40 feet of right-of-way from centerline is available on each side. Several residential lots, predominantly on the east side of the road, would be impacted by the additional right-of-way requirement. Ultimately, the number of parcels impacted during reconstruction will depend on the type of realignment, if any, used for the Forestvale Road intersection.

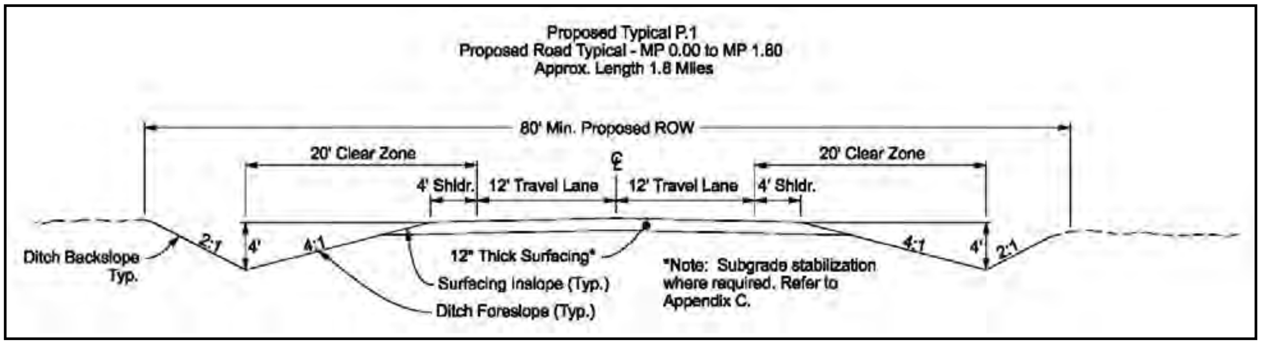


Figure 4.1: Proposed Typical Section P.1 (MP 0.00 - MP 1.80) – Looking North.

4.1.5. Proposed Typical Section P.2

Proposed Typical Section P.2 (**Figure 4.2**) is for the portion of McHugh Lane between Forestvale Road and Sierra Road (MP 1.80 to MP 2.30). Projected future traffic forecast along this section is between 1000 and 1200 AADT, which according to AASHTO policy suggests a minimum clear zone of 16 feet. The minimum County standard for a Minor Collector is 80 feet of right-of-way. However, there are cemetery tracts on either side of McHugh Lane throughout this section. Impacting existing cemetery land would be a highly-sensitive issue, due to the historical and environmental issues involved as well as a generally negative public opinion of doing so. As a result, the recommended typical section for this section of McHugh Lane would fit the widened roadway into the existing 70 feet of right-of-way as not to impact any cemetery tracts.

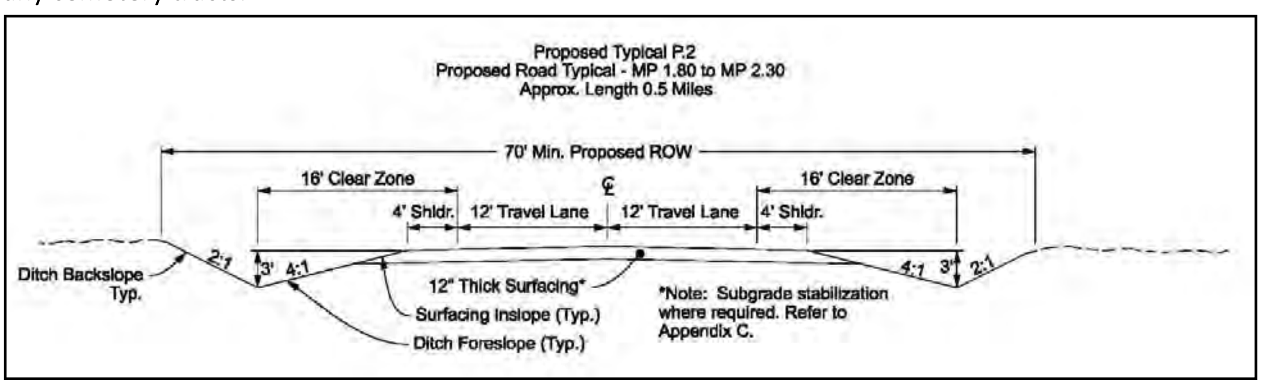


Figure 4.2: Proposed Typical Section P.2 (MP 1.80 - MP 2.30) – Looking North.

4.1.6. Miscellaneous Grading, Cut and Fill Slopes

To estimate earthwork and miscellaneous other feature impacts to reconstruct the roadway in level terrain, we applied the design typical sections, shown in **Figures 4.1** through **4.2** over the existing road templates estimated from field measurements, **Figures 3.1** through **3.4**. The estimate is based on proposed roadway centerlines following existing centerlines from Helena city limits to south of

Forestvale Road, then shifting to the west to line up the Forestvale Road intersection, and then following the existing roadway centerline from Forestvale Road to Sierra Road. The superimposed typical sections are shown in **Figure 4.3**.

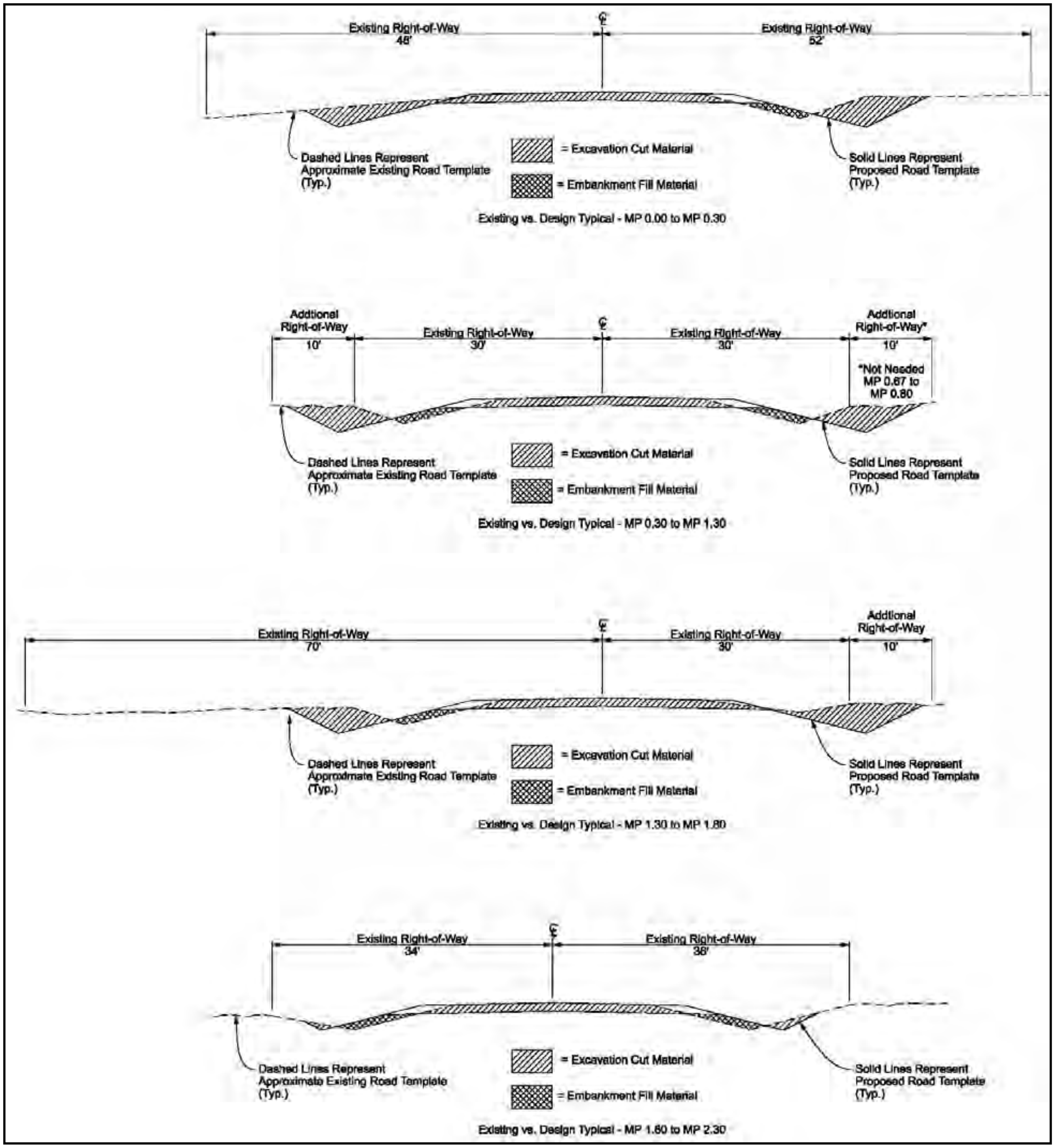


Figure 4.3: Estimated Reconstruction Cut / Fill Impacts

4.1.7. Geotechnical Considerations

Preliminary geotechnical evaluations undertaken include the soil borings and laboratory analysis needed to develop a preliminary pavement design. When further design engineering is undertaken in subsequent tasks to develop the roadway reconstruction project(s), additional geotechnical engineering is recommended to confirm such items as subgrade stabilization limits and techniques.

During the course of developing the pavement designs, two borings completed along the project corridor encountered silty sand subgrade that was near to or over optimum moisture content. The third boring encountered clayey gravel subgrade that was over optimum moisture content. The geotechnical engineer evaluated the locations to have moderate to high risks of subgrade failure during construction. The risk was based on the fact that the subgrade was wet and near to or well over optimum moisture content. The preliminary indications therefore are that approximately 50% of the roadway alignment can anticipate the need for some subgrade stabilization during the course of reconstruction. For the purpose of completing the road reconstruction cost estimate, we are including 14 inches of subbase in these locations as recommended in the surfacing evaluation. This additional bridging material will be applied over a geosynthetic fabric to complete the subgrade stabilization. Subgrade stabilization is further discussed in the pavement design contained in **Appendix C**.

4.2. Property Values

Previously in this report, we estimated the existing highway right-of-way widths based on field review and GIS data. The section of the report addresses how land valuations were estimated.

The predominant land use along this study segment is currently residential or irrigated agricultural. We presume the highest and best use of the current agricultural property is that to be developed into a residential subdivision.

To assign fully defendable and accountable costs to right-of-way impacts is outside the scope and budget of this document. To do so would require the preparation of multiple appraisals. By virtue of the amount of parcels adjoining this highway's right-of-way, the appraiser fee to complete this work could amount to several thousand dollars based on industry rates. Instead, to obtain a reasonable estimate of right-of-way acquisition costs, we utilized rates contained in the Lake Helena Drive PER completed in December 2009. These rates were based on the brief research of a local appraiser for recent comparable sales in the Helena Valley for similar size parcels.

In his brief research, the appraiser found that residential tracts of 1- 5 acres sold for $18,000 to $40,000 per acre for similar properties in mixed-use areas with no zoning. Small tracts of less than one acre did sell for about $250,000 in some locations. These high-end comparable sales were not specifically identified as being within this corridor. For this estimate, we are basing all costs on a per-acre basis with no impacts to property improvements such as landscaping, fencing, lawn, sprinkler irrigation, wells, septic drain fields, etc. With that, it is likely that actual acquisition costs could be substantially higher should residential developments be impacted.

Based on the above, we assumed for this estimate that the cost to acquire land for right-of-way from a parcel to be about $32,000 per acre. To acquire the necessary right-of-way, the property must first be appraised. We estimate the appraiser fees for researching comparable sales history, preparing the property valuations, and obtaining title evidence will cost approximately $2,000 per parcel. An assigned land acquisition agent would then use the appraisals to negotiate and procure the necessary right-of-way. We assigned a cost of $1,500 per parcel for the fees that would be charged by a right-of-way acquisition agent. We used web-based information to estimate the number of properties impacted per segment of road. Overall, we project that approximately 40 properties could be impacted during the course of reconstructing 2.3 miles of this road.

4.3. Drainage and Hydraulics

4.3.1. Mainline Cross Drains

The project corridor traverses level terrain and is impacted by drainage following the southwest-to-northeast natural drainage patterns at this location of the valley. Six existing mainline cross drains were identified during the field review. The project corridor appears to require some drainage upgrading, especially considering the recent June 2011 flooding event. Widening the roadside ditch will provide not only an improved clear recovery area for motorists, but will also increase the ditch depth to allow for improved installation of culverts and increased ditch flow capacity. Runoff picked up in this area is conveyed primarily along the roadside, crossing under roads that intersect McHugh Lane by the means of small-diameter approach drains until reaching a cross drain, where runoff is then generally conveyed in a northeasterly direction. The ground on the east side of the road is very flat and a detailed hydraulic analysis would have to be completed to determine how much drainage upgrades on McHugh Lane will to help alleviate flooding in the future. All flood hazard areas discussed below are based on FIRMs attached in **Appendix A**.

The first cross drain is located at MP 0.37 and conveys surface runoff to an existing irrigation channel on the west side of the road. The drain is a corrugated metal pipe and has an existing diameter of 18 inches. The pipe lies in a Zone C floodplain (areas of minimal flood hazard). No evidence of flooding was noted at this drain during the field review. It was assumed that this cross drain would be replaced with a 24-inch diameter pipe.

The second cross drain, located at MP 0.67, serves an existing 500-year Zone B floodplain. Surface runoff and overflow from Tenmile Creek west of the road are conveyed by the cross drain to the roadside ditch on the east side of the road. The cross drain is a concrete pipe 24 inches in diameter. During the recent June 2011 flooding, the cross drain was inundated with overflow from Tenmile Creek and water did not overtop the roadway. However, a large scour hole (**Photo 4.1**) developed on the downstream side of the pipe and it was observed that much of the runoff was bypassing the drain and continuing along the west side of McHugh Lane. A hydraulic analysis should be completed before McHugh Lane is reconstructed to determine if a larger pipe diameter and skew angle would improve drainage. It was assumed for this report that the pipe would be replaced with a 36-inch diameter pipe.

Photo 4.1: Existing cross drain with scour hole located at MP 0.67.

The third cross drain on the McHugh Lane corridor is located at MP 0.78 and is an existing concrete structure (**Photo 4.2**). The structure was full of floodwater during the field review, but is estimated to be approximately 7 feet wide by 3 feet deep. This structure appears to serve an existing overflow channel of Tenmile Creek and is in a 500-year flood hazard area. The structure was inundated with runoff during the recent June 2011 flooding and the road was not overtopped in this location. Runoff was also, however, bypassing the structure and continuing in roadside ditches along the west side of McHugh Lane. A detailed hydraulic analysis should be completed before the road is reconstructed to assess if the current size of drainage structure is adequate. It was assumed for this report that the structure would be upgraded to a double box culvert with a 7-foot span and 3-foot rise.

Photo 4.2: Existing drainage structure at MP 0.78.

The fourth cross drain on the McHugh Lane corridor is located at MP 1.47 and is an existing 24-inch concrete pipe. This pipe serves to convey surface runoff and Tenmile Creek overflow to a shallow drainage channel on the east side of the road. The pipe is in a 500-year flood hazard area. The structure was inundated with runoff during the recent June 2011 flooding and the road was overtopped, and subsequently closed, in this location. Overtopping of McHugh Lane from runoff in the west roadside ditches began near Motsiff Road (MP 1.2). A detailed hydraulic analysis should be completed before the road is reconstructed to determine the size of pipe necessary to minimize flooding impacts at this location. It was assumed for this report that the pipe would be replaced with a 36-inch diameter pipe.

Photo 4.3: Shallow drainage channel downstream of existing cross drain at MP 1.47.

The fifth cross drain, located at MP 1.80, serves an existing 500-year Zone B floodplain. Surface runoff, overflow from Tenmile Creek, and runoff from Forestvale Road are all potentially conveyed under the Forestvale Road intersection to the roadside ditch on the east side of McHugh Lane. The cross drain is a corrugated metal pipe 24 inches in diameter. During the recent June 2011 flooding, the cross drain was inundated with runoff and water did appear to impact the road shoulders. Erosion of the roadside ditches and road shoulders adjacent to the pipe ends was observed during the field review. A hydraulic analysis should be completed before McHugh Lane is reconstructed to determine if a larger pipe diameter and Forestvale Road ditch improvements would improve drainage. It was assumed for this report that the pipe would be replaced with a 36-inch diameter pipe. An upgrade in pipe size was assumed due to the flood damage observed. If a 36-inch pipe is ultimately deemed unachievable at this location due to cover requirements or the depth of the Forestvale Road ditches, other upgrade options such as two 24-inch pipes or a 30-inch equivalent pipe size would be possible.

The last cross drain is located at MP 2.00 and conveys surface runoff and flooding overflow from the east side of McHugh Lane to the roadside ditch on the west side that eventually empties into an existing irrigation ditch. The drain is a corrugated metal pipe and has an existing diameter of 36 inches and serves an existing 500-year Zone B floodplain. During the recent June 2011 flooding, the cross drain was inundated with runoff and sand bags were placed at the upstream end of the pipe to keep water in the ditch from bypassing the pipe. Otherwise, no evidence of erosion or overtopping was noted during the field review. A hydraulic analysis should be completed before McHugh Lane is reconstructed to determine if a larger pipe diameter would improve drainage. It was assumed for this report that the pipe would be replaced with an equivalent 36-inch diameter pipe.

4.3.2. Approach Culverts

As noted previously, the terrain that runs south to north parallel to the highway governs much of this road's drainage characteristic. As such, approach culverts play an important role. Improving the roadside ditches as a part of the reconstruction effort will allow for both an increased ditch capacity, and upsizing small diameter culverts as needed while still providing adequate structural cover. For the purposes of this preliminary study, we estimated the number of new approach pipes needed based on a limited windshield review of quantifying the number of approaches within each road segment. The windshield review was supplemented by review of aerial photography and GIS data. We presume that most culverts will require replacement due to abundance of crushed ends and other defects observed at approaches. The lengths of new approach culverts were estimated by applying a road approach width of 24 feet, with additional inlet and outlet lengths calculated based on ditch elevation and slope.

It was observed during the field review that a large portion of the flood runoff was conveyed in the roadside ditch on the west side of McHugh Lane. The floodwater that overtopped McHugh Lane beginning at Motsiff Road (MP 1.20) was water overflowing from the west side roadside ditch. Cross drain improvements on McHugh Lane and other drainage improvements both west and east of McHugh Lane may help reduce the amount of floodwater carried in this ditch in the future. However, it was assumed for this report that approach pipes along the west side of McHugh Lane would be replaced with pipes that are a minimum of 24 inches in diameter, in case these other drainage improvements are not completed. Several of the approach pipes between Mill Road and Forestvale Road (MP 1.30 to MP 1.80) were observed to have 24-inch approach pipes in place. All approach pipes on the east side of

McHugh Lane would be 15-inch diameter at minimum to meet the County's requirements for a Minor Collector. A detailed hydraulic analysis would determine if larger approach pipe diameters than those assumed would be necessary.

4.3.3. Miscellaneous Drainage

An existing concrete irrigation structure is installed between approximately MP 0.55 and MP 0.67. The structure appears to be an above-ground irrigation channel (**Photo 4.4**). The channel is about 10 feet off the edge of McHugh Lane in the existing right-of-way and originates from private property. It was assumed for this report that the irrigation channel would be removed and replaced with the standard County road ditch for a Minor Collector.

Photo 4.4: Concrete irrigation channel at MP 0.67.

4.3.4. Drainage Summary

Existing culverts that were observed in field reviews are included with the assumption that these will require replacement due to modified construction limits. In addition, a nominal amount of new approach culverts will likely be necessary based on the unusable condition for many pipes observed in the field. The existing bridges for the Helena Valley Canal and Tenmile Creek noted in **Section 3.6** have been inspected by MDT and meet AASHTO minimum width requirements to stay in place during reconstruction.

Table 4.2 below summarizes hydraulic cross drain features within the study area. The cross drain improvements noted are assumptions based on field observations and FIRM maps following the June 2011 flooding along McHugh Lane. A detailed hydraulic analysis of the McHugh Lane corridor would be necessary to identify any drainage improvements required and to verify all assumed pipe replacement sizes.

Table 4.2: Existing Cross Drain Summary

	Existing		Replacement		
Location	**Diameter**	**Length**	**Diameter**	**Length**	**Comments**
MP 0.37	18"	50'	24"	64'	Irrigation ditch, no floodplain
MP 0.67	24"	50'	36"	64'	500-year flood area (Zone B)
MP 0.78	7' x 3'	35'	DBL 7' x 3'	64'	Overflow channel, Tenmile Creek
MP 1.47	24"	35'	36"	64'	500-year flood area (Zone B)
MP 1.80	24"	75'	36"	100'	500-year flood area (Zone B)
MP 2.00	36"	55'	36"	64'	500-year flood area (Zone B)

4.4. Pedestrian and Bicycle Facilities

There are currently no facilities to accommodate pedestrians or bicyclists within this corridor. A previous recommended project in the Greater Helena Area Transportation Plan – 2004 Update, identified as MSN-32, was to widen the shoulders of the road to provide for bicycle travel. This is accommodated by this report’s proposed typical sections.

As such under this study, no costs are being attributed to constructing a shared-use bicycle/pedestrian path as part of the base cost of rebuilding the road. However, an alternative cost of constructing a path on a per-mile basis is included in this report for planning purposes. The estimated cost presented later in this report is for a 10-foot wide asphalt surfaced path.

According to the Greater Helena Area Transportation Plan – 2004 Update, an overriding goal for non-motorized transportation in the greater Helena Area is:

> *To develop a living plan for the Greater Helena Area to create and maintain corridors for cyclists and other non-motorized modes of travel and recreation that are safe and effective for their transportation and enjoyment, and to inform and educate motorists, cyclists, and pedestrians in how to safely and respectfully share our roads and other corridors as citizens transport themselves about the community.*

4.5. Auxiliary Turn Lanes

The scope of this work does not include completing definitive turn lane warrant studies at key intersections. However, when the roadway design is initiated, it can be reasonably ascertained that one or more turn lanes may be warranted. Therefore for the benefit of this study, we have included an estimated cost to construct a left-turn lane serving an approach in a non-signalized intersection. The discussion on traffic control signals follows this section. Turn lanes should be considered at each signalized intersection.

We based the estimated turn lane geometrics for a left-turn lane on the guidelines presented by MDT in their Traffic Engineering Manual. We assume that the shoulder widths in the location of a turn lane will be maintained at 4-feet wide. Using 50 mph design speed criteria, the lane shift bay taper rate will be 50:1 to shift the through lanes outward. An interior bay taper rate of 10:1 is used for vehicles entering the left turn lane. From the left turn bay entry, the recommended deceleration distance is 435 feet. The deceleration is assumed to initiate at the beginning of the left turn bay taper. Since intersection turning movement counts have not been completed as a part of this study, we assume the storage length needed is minimal and left-turning vehicles will complete the maneuver with adequate gaps present in the opposing traffic stream without coming to a stop in most instances. Based on the above, the minimum length left turn lane will require approximately 600 feet of total length for lane shift tapers entering and exiting the left turn area, and 435 feet of auxiliary lane including its bay taper. The total length of road widening for a minimum length left turn lane would then be about 1,035 feet.

4.6. Traffic Signals

A signal warrant analysis was not completed under this study. For purposes of estimating the full potential reconstruction cost of the study area, we presume that signal warrants could eventually be met to consider a signal installation, particularly at the intersection with Mill Road, within the design life of McHugh Lane. Therefore, an estimated cost to install signal hardware has been included.

5. Reconstruction Cost Estimates

This section summarizes the process used to develop cost estimates for the reconstruction of McHugh Lane between Helena city limits and Sierra Road. For cost estimation purposes, the McHugh Lane corridor was broken out into four distinct typical sections as listed below. Each typical section had individually unique characteristics that played a role in developing the cost estimates.

- **Typical Section A** – Helena City Limits (MP 0.00) to MP 0.30
- **Typical Section B** – MP 0.30 to Mill Road (MP 1.30)
- **Typical Section C** – Mill Road (MP 1.30) to Forestvale Road (MP 1.80)
- **Typical Section D** – Forestvale Road (MP 1.80) to Sierra Road (MP 2.30)

Table 5.1 summarizes the estimated cost to reconstruct the McHugh Lane project corridor. **Appendix D** provides a detailed cost estimate consisting of a breakout of major work features, quantities, and unit costs. The following sections briefly discuss how some of the number of units were estimated. The units were then multiplied by average unit costs. Average unit costs were based of values used in the Lake Helena Drive PER completed in January 2010. Those average unit costs were based on a review of the bid history of four highway projects under construction in the Helena Valley at that time. These projects ranged from full highway reconstructions to spot safety improvement projects. It should be noted that the County could similarly improve McHugh Lane by either several smaller spot improvements projects, or larger-length reconstructions.

Table 5.1: Reconstruction Cost Estimate

McHugh Lane	Typical A	Typical B	Typical C	Typical D	Total
Construction Subtotal	$274,276	$835,044	$400,722	$329,238	**$1,839,280**
Total Estimated Cost	$370,272	$1,308,343	$590,715	$444,471	**$2,713,801**
Length (miles)	0.30	1.00	0.50	0.50	**2.30**

5.1. Estimating Procedure

5.1.1. Grading

- Excavation – Unclassified quantity is estimated from **Figure 4.3** by calculating the end section cut areas and multiplying by the applied length to generate a volume. Consideration is given that the figures are likely worst-case scenarios and intermittent locations will likely balance with lesser cuts and fills.
- Topsoil Salvage and Placing is calculated based on **Figure 4.3** assuming 3 inches of topsoil depth.

5.1.2. Surfacing

- The miscellaneous road surfacing quantities such as the crushed top surfacing, select base, subbase, plant mix asphalt paving, prime, and seal coat are estimated based on the recommended pavement design and the proposed surfacing widths as shown in **Figures 4.1** through **4.2**.
- A nominal amount of Traffic Gravel is included to allow for a temporary wearing course for traffic driving on the unfinished subgrade.
- Interim paint quantities are included to delineate the road centerline and shoulder lines prior to the road receiving a chip seal. Final paint quantities would then be applied after the chip seal.

5.1.3. Drainage

- The summarized length of approach pipe lengths is estimated based on the number approaches and their assumed cross-sectional characteristics such as slope rate and depth of cover. Approach top widths are estimated as being an average of 24 feet. The amount of access approaches intersecting the roadway in each applicable segment is based on GIS aerial photographs and limited windshield survey. The approach pipes would be 15-inch diameter at minimum to meet the County's requirements for a Minor Collector on the east side of McHugh Lane and 24-inch diameter minimum on the west side, as discussed previously.
- Cross drain features are listed in **Table 4.2** with the assumed replacement sizes based on field observations. Their new installation lengths are estimated based on the dimensions generated from the proposed road templates. The cross drain at MP 1.80 stretches diagonally under the Forestvale Road intersection. An assumed length of 100 feet was assumed for the reconstructed intersection due to the realignment of this intersection.

5.1.4. Fencing

- It was assumed that new right-of-way fencing would be required along the entire project length, except from Forestvale Road to Sierra Road (MP 1.80 to MP 2.30) where the existing right-of-way is maintained. To re-fence the right-of-way, we assume using a typical 5-strand barbwire fence with metal posts.
- It was assumed that fence panel would be needed for every 330 feet of new fence.

5.1.5. Roadside Revegetation

- Quantifying seeding, fertilizer and seedbed conditioning is based on sectional measurements taken from the finished slopes shown in **Figure 4.3**.

5.1.6. Subgrade Stabilization

- The preliminary pavement designs included with this report identifies subgrade areas having moderate to high risk of failure during construction. However, field conditions could vary from the limited sampling completed under this study. An amount of stabilization gravel was included to be placed over a geotextile fabric based on the recommendations contained in the pavement design. Similarly, we estimated the amount of geotextile needed on a range of digouts based on the subgrade widths derived from **Figures 4.1** through **4.2**.

5.1.7. Right-of-Way

- To estimate appraisal costs for right-of-way acquisition, a $2,000 per parcel fee was applied for an assumed 40 parcels. A similar approach is taken to estimate fees for an agent to prepare closing documents, negotiate the right-of-way, and file documents for record.
- The existing right-of-way widths are listed in **Table 3.1** and were approximately 60, 70, or 100 feet. This is based on field review and Cadastral GIS data. It was assumed that the County will likely require that the minimum standard for Minor Collectors (80 feet of overall right-of-way width) be maintained, where possible. For the section of McHugh Lane between the Helena city limits and Forestvale Road (MP 0.00 to MP 1.80), right-of-way impacts were based on ensuring a minimum of 40 feet of right-of-way on each side of centerline. From Forestvale Road to Sierra Road (MP 1.80 to MP 2.30), it was assumed that the McHugh Lane centerline would be maintained and no new right-of-way would be acquired due to cemetery tracts being on either side of the road.
- $32,000 per acre land valuation is used to estimate the cost to acquire land for right-of-way purposes. This valuation is based on limited coordination with a local appraiser whom completed a brief research of the area to obtain comparable sales history during development of the 2009 PERs. The economic situation and housing industry is assumed to be still very similar. The comparable sales research yielded transactions amounting to $18,000 to $40,000 per acre for residential tracts from 1-5 acres in size. In some cases, highly sought after tracts were much higher in per-acre price. We apply the assumption that agricultural tracts will be negotiated by the owner at residential land values (given the opportunity to subdivide as the highest and best use), and that the cost per acre is based on all similar size parcels.

5.2. Alternate Costs

A number of additional alternative costs were included as part of the project cost estimate. These costs are separate from those developed for the roadway reconstruction. These costs are provided in the event that separate alternative features are needed from those necessary for standard roadway reconstruction. **Table 5.2** provides a summary of the additional alternative cost estimates. The following sections provide information as to how these costs were derived.

Table 5.2: Additional Alternate Cost Estimate

Major Work Feature	Unit	Unit Cost	Number of Units	Total Cost
Traffic Signal	LS	$68,000.00	1	$68,000
Turn Lane	LS	$100,000.00	1	$100,000
Sanitary Sewer Main	MI	$211,200.00	2.30	$485,760
Water Main	MI	$396,000.00	2.30	$910,800
Bicycle/Ped. Path Reconstruction	MI	$77,825.00	2.30	$178,998

5.2.1. Traffic Signal

- The estimated cost to install traffic signal hardware for one intersection is based on the bid history of components currently being installed by MDT around the Helena area.

5.2.2. Left-Turn Lane Widening

- The estimated cost to widen the roadway to install a single turn lane is based on proportion to that cost to construct the roadway with no turn lane.

5.2.3. Miscellaneous

- The estimate includes a per-mile cost to install an 8-inch water main and an 8-inch sanitary sewer main for future services. The estimate is based on an installed cost of $75 per linear foot for the water main, and $40 per linear foot for the sewer main. For planning purposes, the County desires to include an estimate since installing a water main and/or sanitary sewer main would likely be cost-effective to complete at the time the roadway is being reconstructed.
- A per-mile estimate is included to construct an alternate 10-foot wide shared-use bicycle/pedestrian path. The estimate uses 2-inch thick plant mix asphalt surfacing over 4 inches of crushed top surfacing aggregate base. Note that if a pathway is included, land needed for right-of-way could increase beyond the minimum 80 feet assumed by a proportional amount equal to the width of the path plus a desirable offset from the edge of the road’s construction limits.

Appendix A

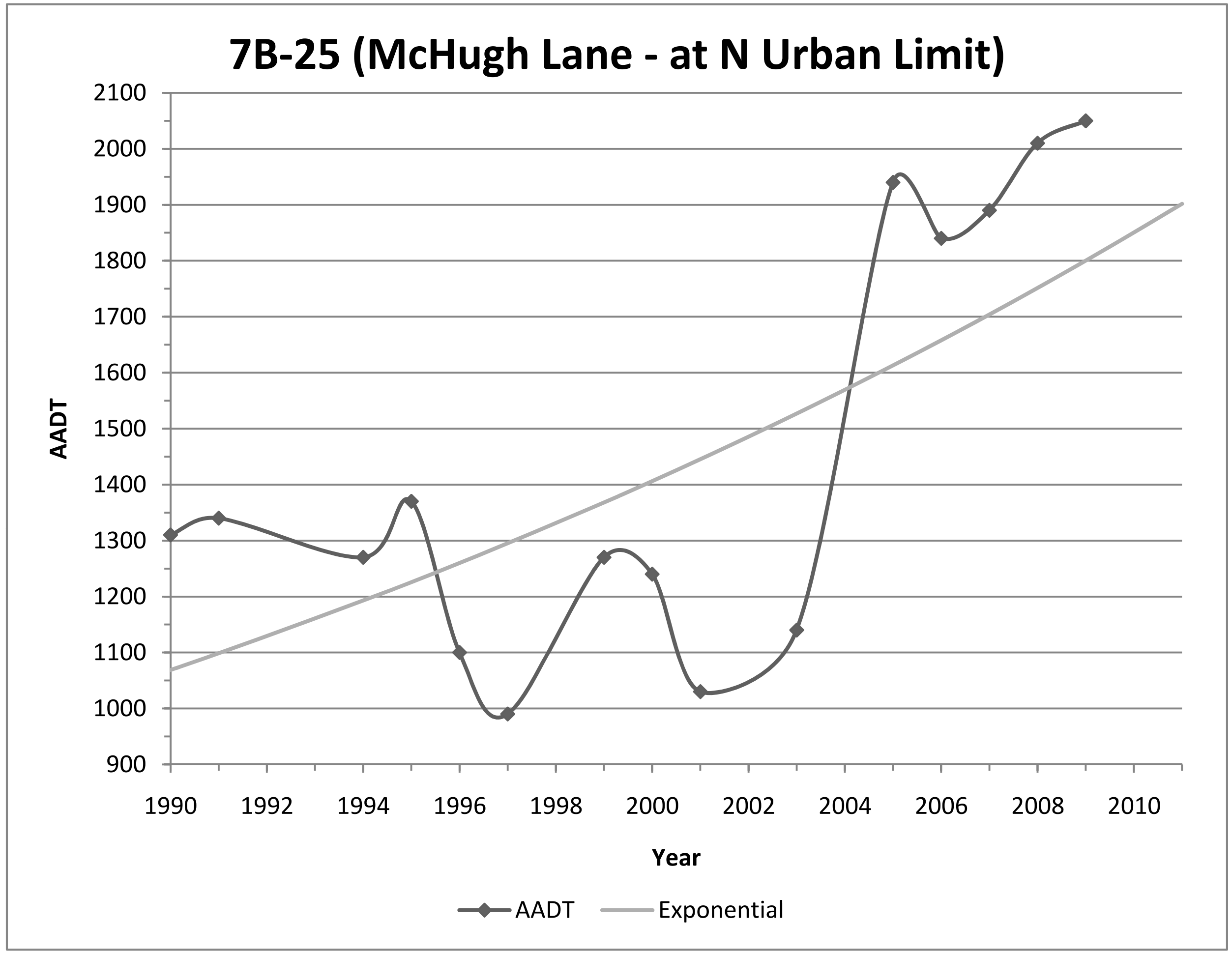
Background Data

#

7B-25 (McHugh Lane - at N Urban Limit)

Year	AADT	Exponential
1990	1310	1069
1991	1340	1099
1994	1270	1193
1995	1370	1226
1996	1100	1260
1997	990	1295
1999	1270	1368
2000	1240	1406
2001	1030	1445
2003	1140	1527
2005	1940	1613
2006	1840	1658
2007	1890	1704
2008	2010	1751
2009	2050	1800
2011	-	1902
2031	-	3292
i	-	**2.78%**

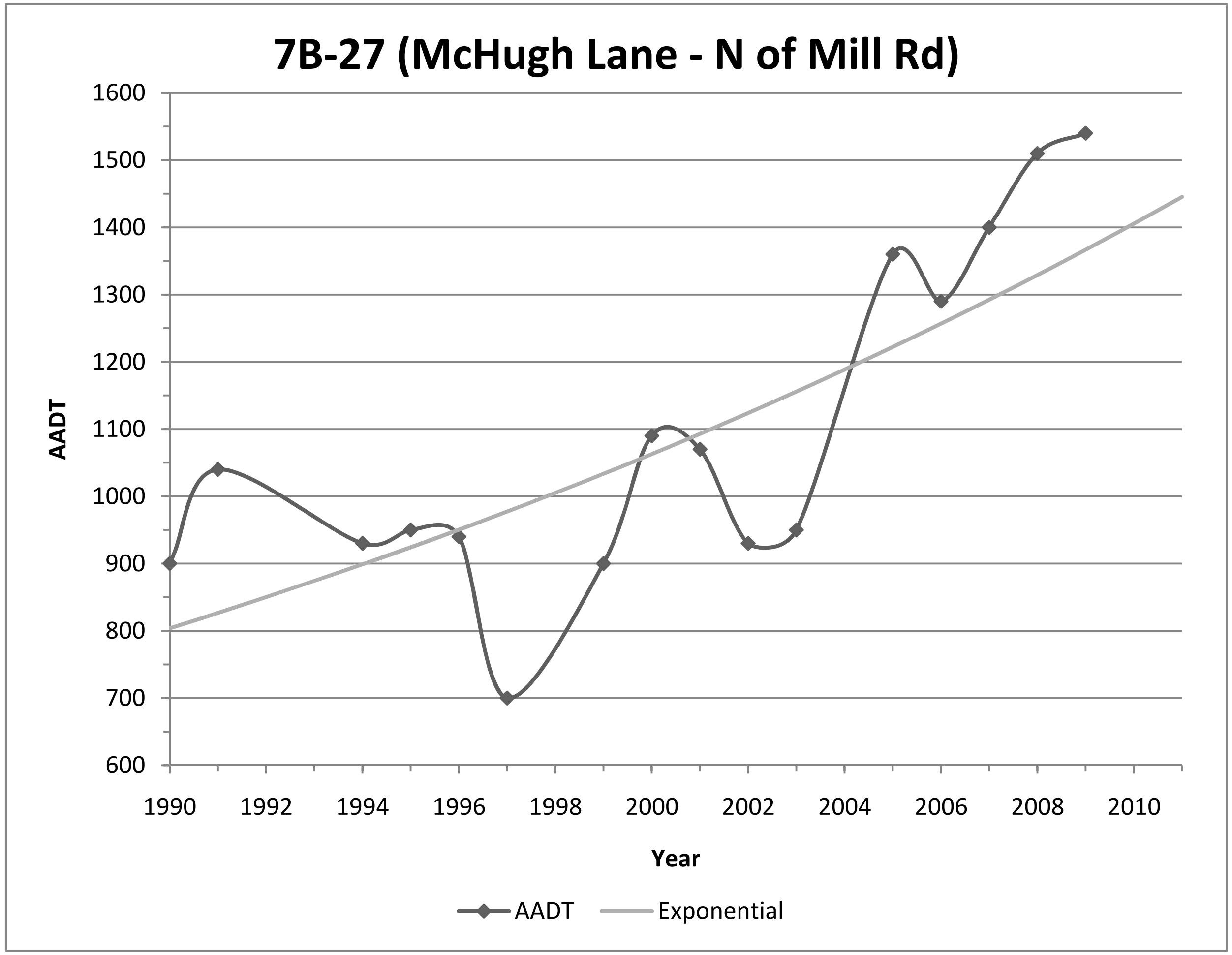
Source: Montana Department of Transportation



7B-27 (McHugh Lane - N of Mill Rd)

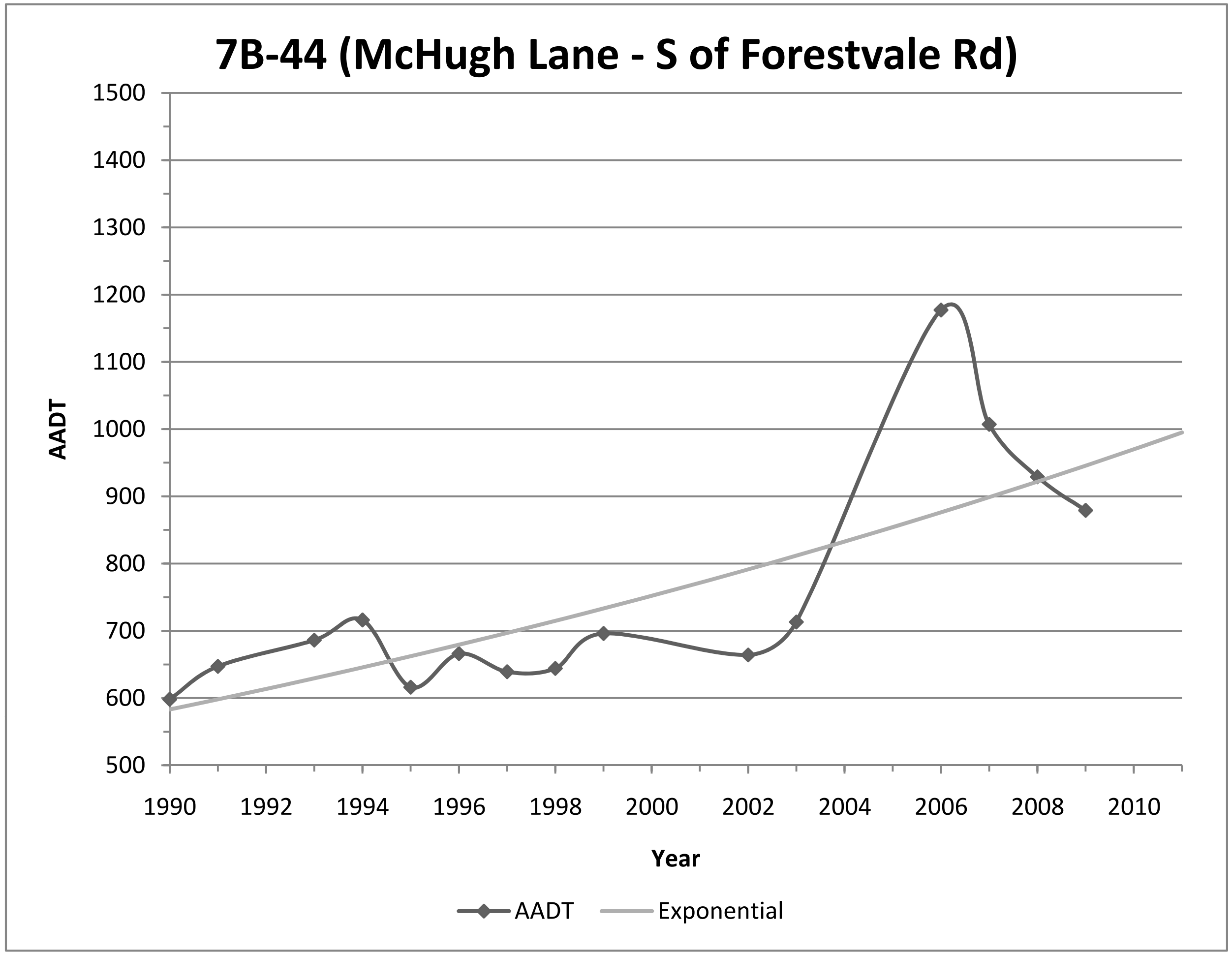
Year	AADT	Exponential
1990	900	804
1991	1040	826
1994	930	899
1995	950	924
1996	940	950
1997	700	977
1999	900	1034
2000	1090	1063
2001	1070	1093
2002	930	1124
2003	950	1156
2005	1360	1222
2006	1290	1257
2007	1400	1292
2008	1510	1329
2009	1540	1367
2011	-	1445
2031	-	2527
i	-	**2.83%**

Source: Montana Department of Transportation



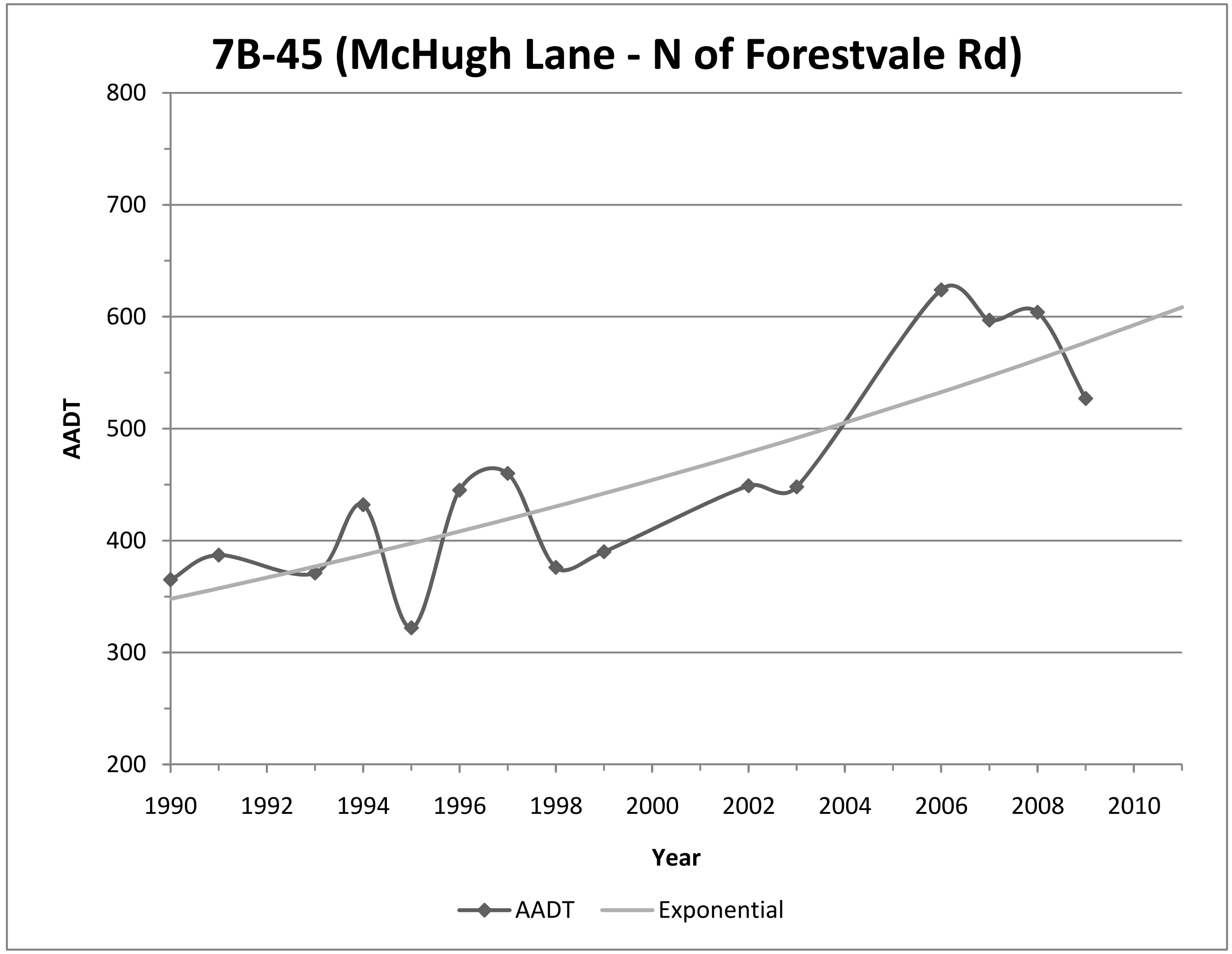
7B-44 (McHugh Lane - S of Forestvale Rd)

Year	AADT	Exponential
1990	598	583
1991	647	598
1993	686	629
1994	716	645
1995	616	662
1996	666	679
1997	639	697
1998	644	715
1999	696	733
2002	664	791
2003	713	812
2006	1177	876
2007	1007	899
2008	929	922
2009	879	946
2011	-	995
2031	-	1656
i	-	**2.58%**



7B-45 (McHugh Lane - N of Forestvale Rd)

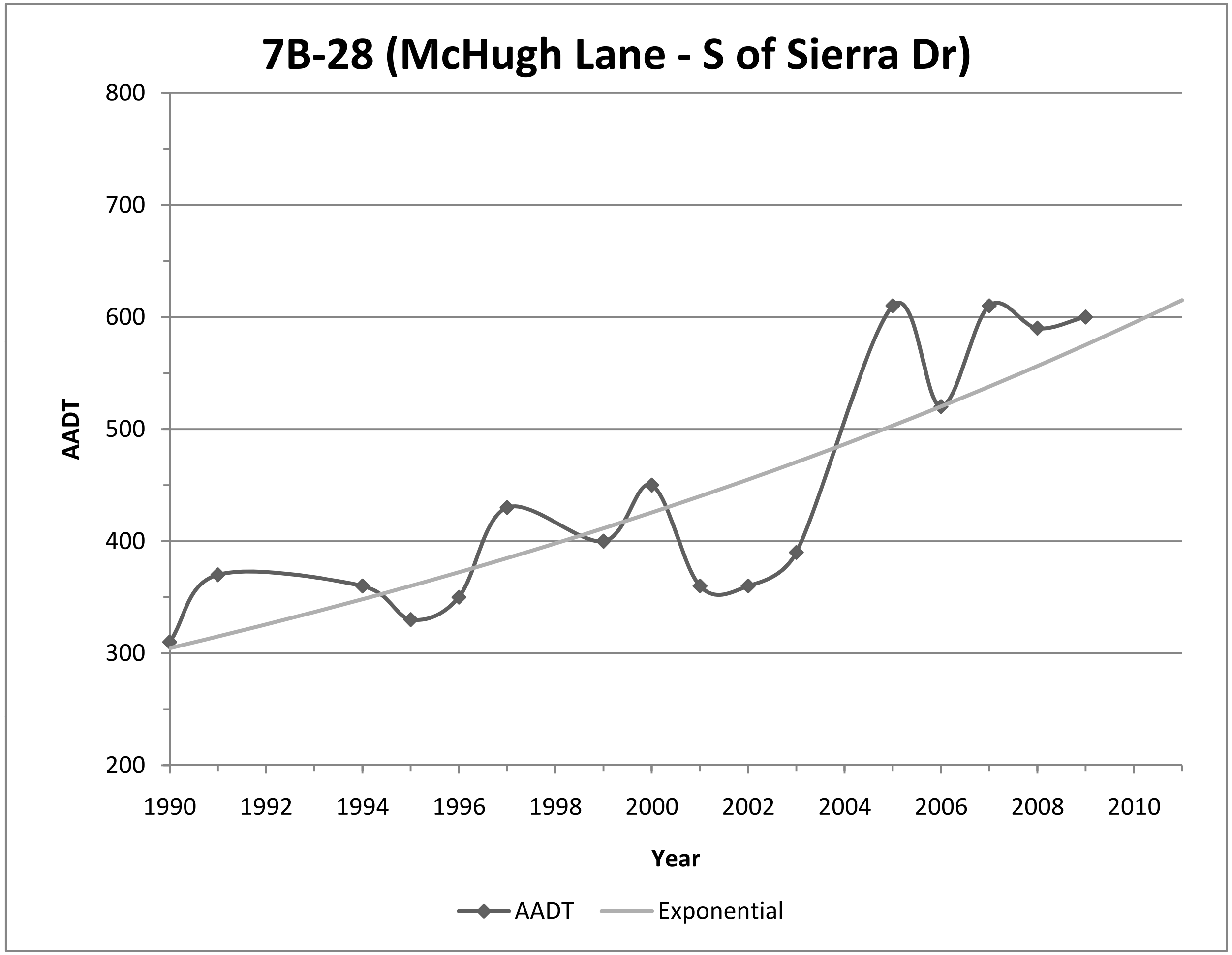
Year	AADT	Exponential
1990	365	348
1991	387	357
1993	371	377
1994	432	387
1995	322	397
1996	445	408
1997	460	419
1998	376	431
1999	390	442
2002	449	479
2003	448	492
2006	624	533
2007	597	547
2008	604	562
2009	527	577
2011	-	608
2031	-	1036
i	-	**2.70%**



7B-28 (McHugh Lane - S of Sierra Dr)

Year	AADT	Exponential
1990	310	304
1991	370	315
1994	360	348
1995	330	360
1996	350	372
1997	430	385
1999	400	412
2000	450	426
2001	360	440
2002	360	455
2003	390	470
2005	610	503
2006	520	520
2007	610	538
2008	590	556
2009	600	575
2011	-	615
2031	-	1202
i	-	**3.41%**

Source: Montana Department of Transportation



McHugh Lane		AADT			
Site ID	**Location**	**2009**	**2011**	**2031**	**Growth**
7B-25	at N Urban Limit	2050	1902	3292	2.78%
7B-27	N of Mill Rd	1540	1445	2527	2.83%
7B-44	S of Forestvale Rd	879	995	1656	2.58%
7B-45	N of Forestvale Rd	527	608	1036	2.70%
7B-28	S of Sierra Dr	600	615	1202	3.41%
Weighted Average:					**2.82%**

, 1 foot west of a fence, approximately level
in the top of a concrete post projecting 0.2

etic Survey bench mark disk 3.5 miles north-
gton Northern Railroad from the crossing of
elena, at the crossing of a county road, 90
f the third pole north-northeast of milepost
outheast of the near rail, 51 feet south-south-
e of the road, 6.8 feet west-northwest of a
west of a fence corner, 1.0 foot west-north-
ost, approximately 1.5 feet lower than the
top of a concrete post projecting 0.1 foot

h flange bolt of hydrant on east side of Mon-
mately 200 feet north of intersection with
lished by U.S. Geological Survey.

of stone base of sign "Last Chance Gulch"
ana Avenue. Established by U.S. Geological

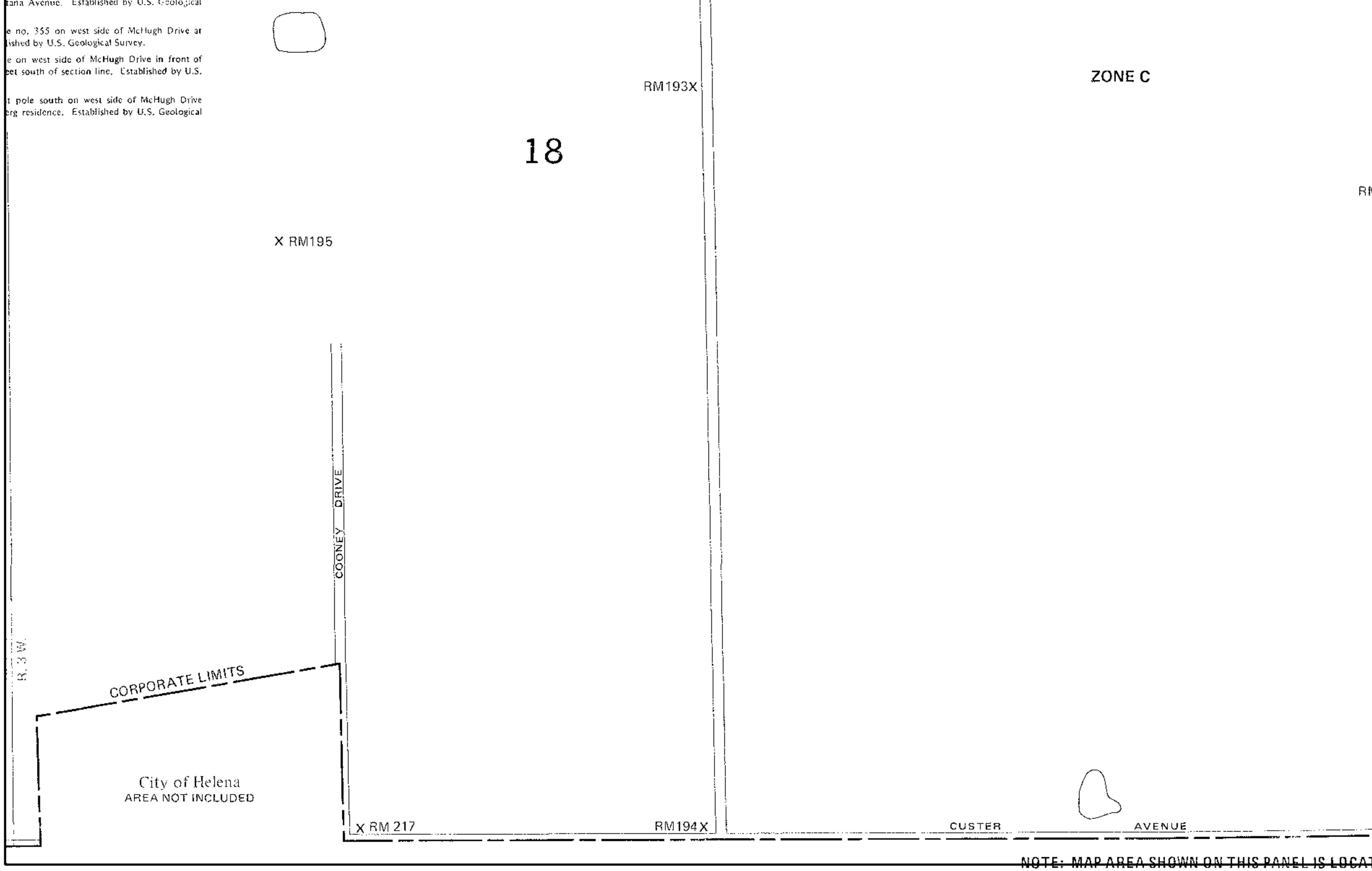
e no. 355 on west side of McHugh Drive at
lished by U.S. Geological Survey.

e on west side of McHugh Drive in front of
eet south of section line. Established by U.S.

t pole south on west side of McHugh Drive
erg residence. Established by U.S. Geological

RM20[illegible]	[illegible]	Chiseled square in top of [illegible] side of Green Meadow Drive on south side of driveway to house no. 4560. Established by U.S. Geological Survey.
RM205	3840.74	Iron pin with stamped cap 1 foot west of fence corner, 1 foot north of telephone box no. 117 on east side of curve in dirt road. Established by U.S. Geological Survey.
RM206	3854.86	Chiseled "X" in northernmost flange bolt of hydrant no. 217 on State Fairgrounds, approximately 100 feet northeast of Administration Building. Established by U.S. Geological Survey.
RM207	3875.99	Chiseled square in top of southeast corner of concrete base for two gas pumps at A. G. C. Training Program for Montana complex, west of third red shed. Established by U.S. Geological Survey.
RM217	3883.04	Right-of-way monument at fence corner located at northeast corner of Custer Avenue and Cooney Drive. Established by U.S. Geological Survey.

*LOCATED IN AREA NOT INCLUDED



APPROXIMATE SCALE IN FEET

400 0 4

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

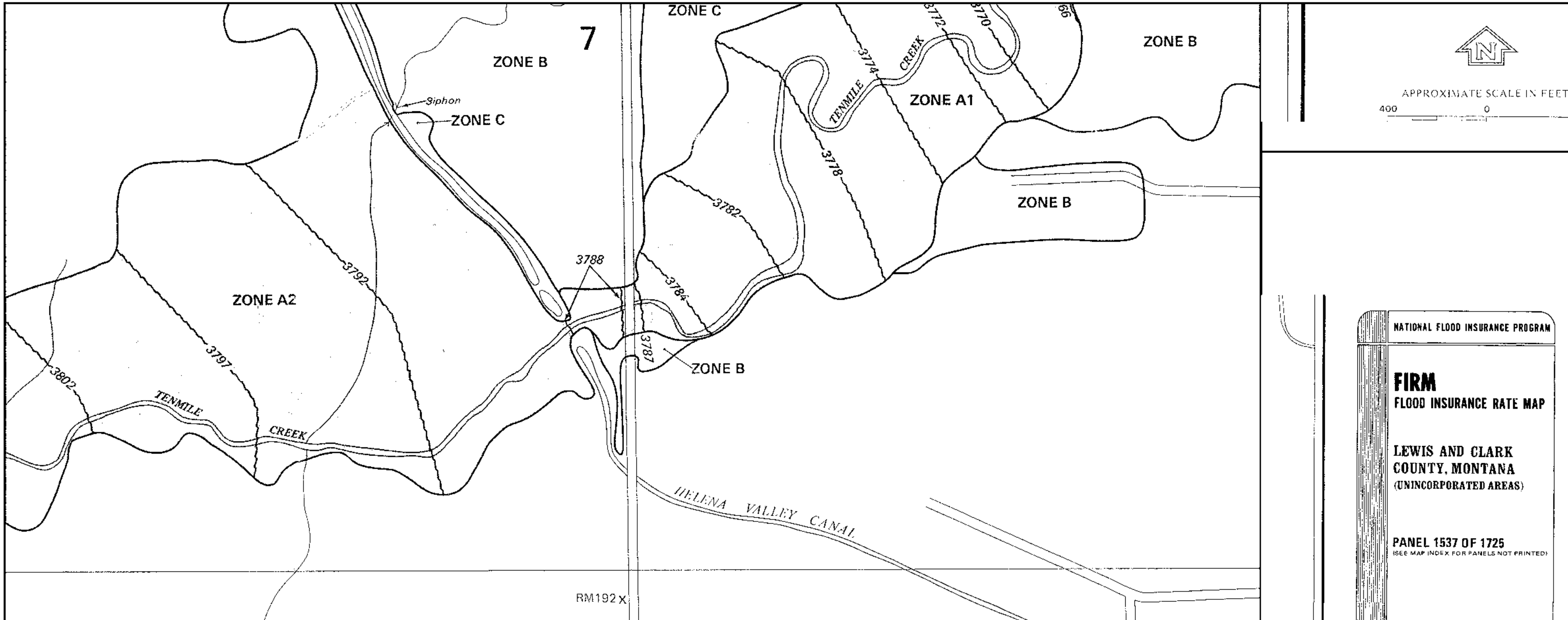
LEWIS AND CLARK COUNTY, MONTANA
(UNINCORPORATED AREAS)

PANEL 1537 OF 1725
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
300038 1537 C

MAP REVISED:
SEPTEMBER 4, 1985

Federal Emergency Management Agency



ELEVATION REFERENCE MARKS

CRIPTION OF LOCATION

tic Survey bench mark disk 2.85 miles north
e from the crossing of the Burlington North-
, 1.75 poles north of a driveway leading east
northeast and across the avenue from the
e L & L Cafe, 181 feet south of the center of
nch pipe culvert, 42 feet east of the centerline
northeast of power pole 134, 1.0 foot west
ately 1.5 feet lower than the avenue, and set
te post projecting 0.1 foot above the ground.

tic Survey bench mark disk 2.65 miles north
e from the crossing of the Burlington North-
, in the top of the north end of the west con-
of concrete bridge over Tenmile Creek, 1.0
rth end of the guardrail, and approximately

etic Survey bench mark disk 2.1 miles north
e from the crossing of the Burlington North-
a, at the junction of a dirt road east, 30 feet
of the avenue, 55 feet south of a power pole
enter of the east end of a 36-inch pipe culvert
0 feet south of the centerline of a driveway
, 1 foot west of a fence, approximately level
in the top of a concrete post projecting 0.2

etic Survey bench mark disk 3.5 miles north-
gton Northern Railroad from the crossing of
elena, at the crossing of a county road, 90

REFERENCE MARK	ELEVATION (FT. NGVD)	DESCRIPTION OF LOCATION
RM194	3864.71	Chiseled square on top north end of 24-inch concrete culvert pipe at northwest corner of junction of McHugh Drive and Custer Avenue. Established by U.S. Geological Survey.
RM195	3828.03	Chiseled "X" on northwest flange bolt of hydrant no. 215, 30 feet northwest of northwest corner of Cooney Convalescent Home. Established by U.S. Geological Survey.
RM196*	3873.21	Punched cross on north rim "Bell System" manhole in center of intersection of Custer and Benton Avenues. Established by U.S. Geological Survey.
RM197*	3866.68	Chiseled square in top of west end of concrete culvert pipe at southwest corner of intersection of Green Meadow Drive and Custer Avenue. Established by U.S. Geological Survey.
RM198	3824.12	Iron pin with stamped cap on west side of road at break in stone fence 15 feet south of dirt drive west and 1 foot south of telephone box no. 3329, 0.5 mile north of intersection of Green Meadow Drive and Custer Avenue. Established by U.S. Geological Survey.
RM199	3815.34	Chiseled square in top of northwest corner concrete bridge deck, 0.5 foot east of 4-inch metal pipe over Tenmile Creek along Green Meadow Drive. Established by U.S. Geological Survey.
RM200	3800.36	Chiseled square in top of 24-inch concrete culvert pipe on west side of Green Meadow Drive on south side of driveway to house no. 4560. Established by U.S. Geological Survey.
RM205	3840.74	Iron pin with stamped cap 1 foot west of fence corner, 1 foot north of telephone box no. 117 on east side of curve in dirt road. Established by U.S. Geological Survey.

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

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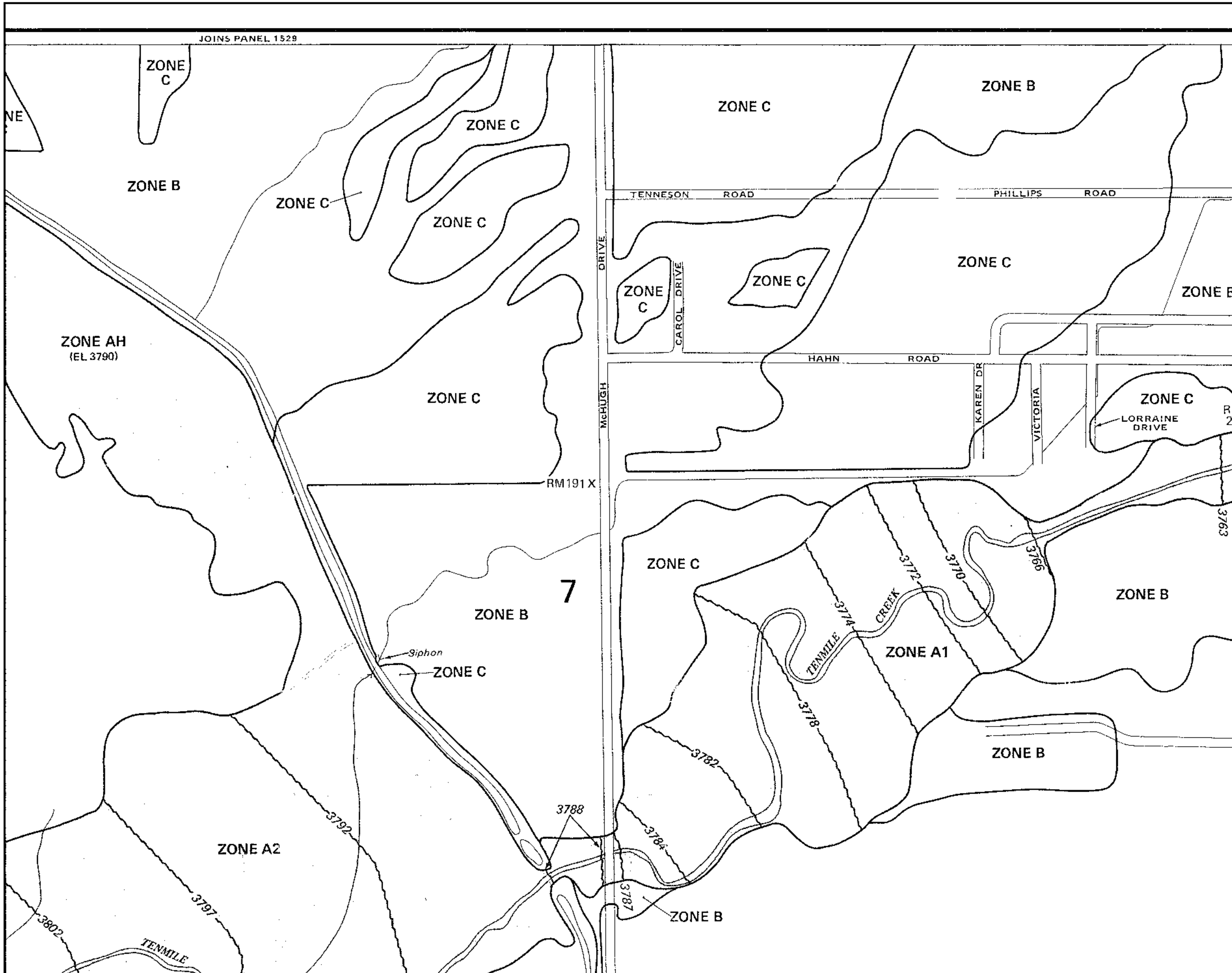

APPROXIMATE SCALE IN FEET

400 0

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

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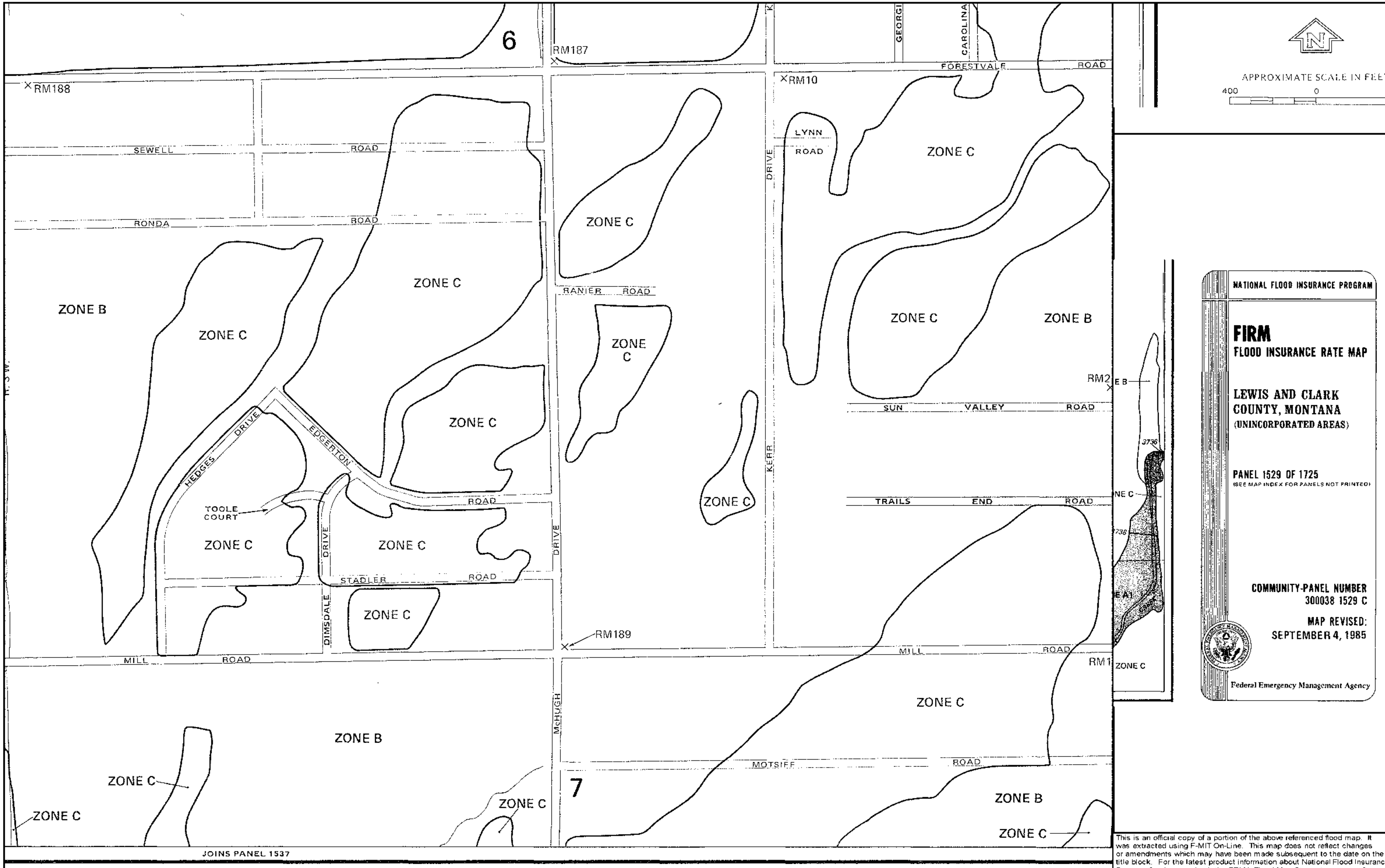

6
7
RM187
RM188
RM10
RM189
RM2
RM1
FORESTVALE ROAD
GEORGI
CAROLINA
SEWELL ROAD
RONDA ROAD
LYNN ROAD
RANIER ROAD
SUN VALLEY ROAD
TRAILS END ROAD
EDGERTON ROAD
HEDGES DRIVE
TOOLE COURT
DRIVE
STADLER ROAD
DIMSDALE
MILL ROAD
McHUGH DRIVE
KERR DRIVE
MOTSIFF ROAD
ZONE B
ZONE C
JOINS PANEL 1537
APPROXIMATE SCALE IN FEET
400
0
NATIONAL FLOOD INSURANCE PROGRAM
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LEWIS AND CLARK COUNTY, MONTANA
(UNINCORPORATED AREAS)
PANEL 1529 OF 1725
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300038 1529 C
MAP REVISED:
SEPTEMBER 4, 1985
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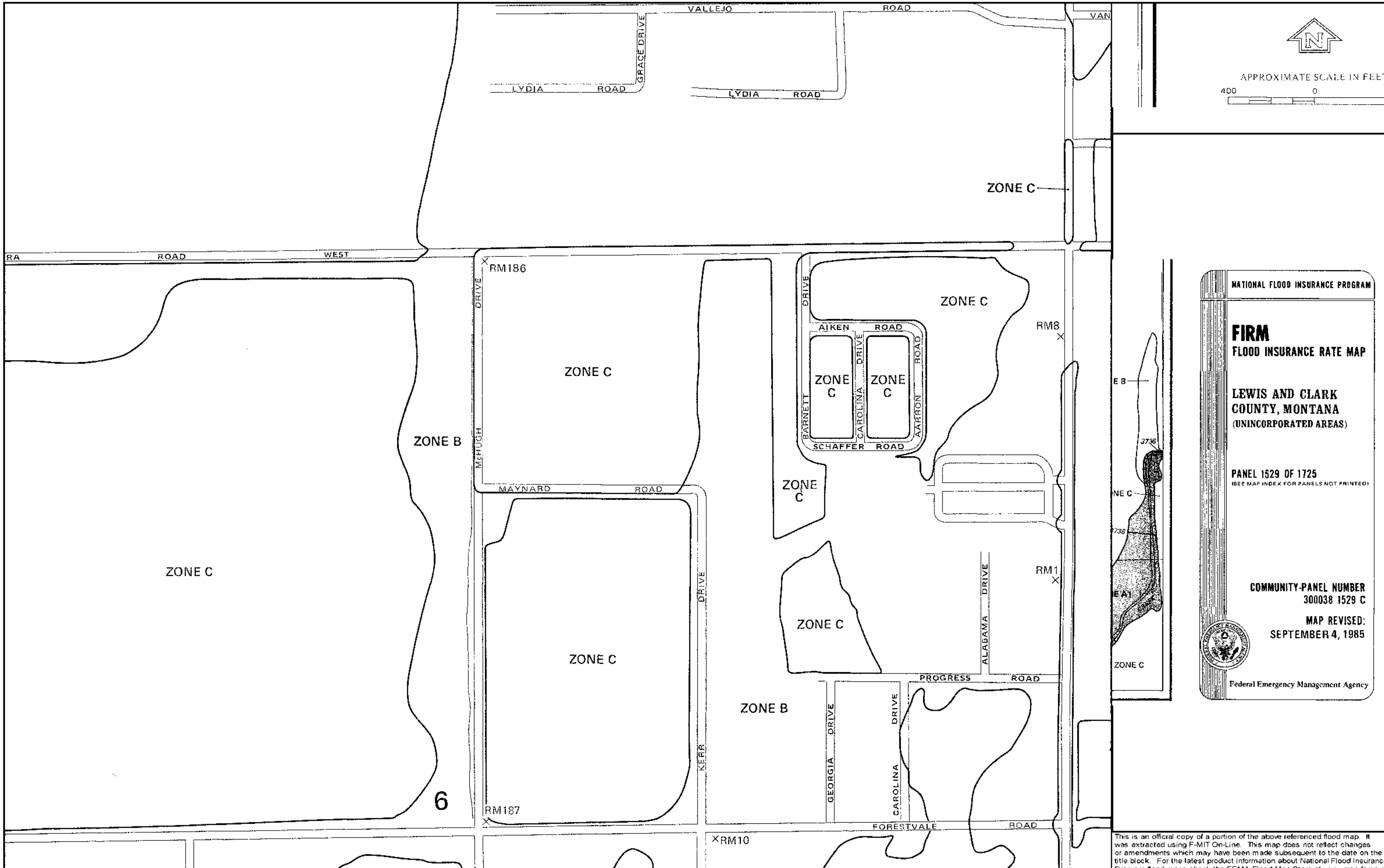
VALLEJO ROAD
VAN
GRACE DRIVE
LYDIA ROAD
LYDIA ROAD
APPROXIMATE SCALE IN FEET
400
0
ZONE C
RA ROAD WEST
RM186
McHUGH DRIVE
ZONE C
ZONE B
ZONE C
MAYNARD ROAD
ZONE C
KERR DRIVE
ZONE B
BARNETT DRIVE
AIKEN ROAD
CAROLINA DRIVE
AARRON ROAD
SCHAFFER ROAD
ZONE C
ZONE C
ZONE C
ZONE C
ZONE C
RM8
RM1
ALABAMA DRIVE
PROGRESS ROAD
GEORGIA DRIVE
CAROLINA DRIVE
FORESTVALE ROAD
RM187
RM10
6
E B
NE C
3738
E A1
ZONE C
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FLOOD INSURANCE RATE MAP
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Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00401

Location : 2M N HELENA Structure Name: Lewis and Clark MD 1

General Location Data

District Code, Number, Location : **03 Dist 3 GREAT FALLS**

Division Code, Location : **31 GREAT FALLS**

County Code, Location : **049 LEWIS & CLARK**

City Code, Location : **35600 HELENA**

Kind fo Hwy Code, Description : **5 5 City Street**

Signed Route Number : **25058**

Str Owner Code, Description : **2 County Highway Agency**

Maintained by Code, Description : **2 County Highway Agenc**

Intersecting Feature : **HELENA VALLEY CANAL 086**

Kilometer Post, Mile Post : **0.06 km 0.04**

Structure on the State Highway System : ☐

Latitude : **46°37'56"**

Structure on the National Highway System : ☐

Longitude : **112°01'55"**

Str Meet or Exceed NBIS Bridge Length : ☒ X

Construction Data

Construction Project Number :

Construction Station Number : **0+00.00**

Construction Drawing Number : **RECORDS**

Construction Year : **2000**

Reconstruction Year :

Traffic Data

Current ADT : **100** ADT Count Year : **2003** Percent Trucks : **3 %**

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 :	**25.4 mton**	**2 AS Allowable Stress**
Posting :		**5 At/Above Legal Loads**

Rating Data :	Operating	Inventory	Posting
Truck 1 Type 3 :	**22**	**16**	
Truck 2 Type 3-S3 :	**24**	**24**	
Truck 3 Type 3-3 :	**43**	**30**	

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **14.41 m**

Deck Area : **132.00 m sq**

Deck Roadway Width : **8.43 m**

Approach Roadway Width : **8.30 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 : **1**

Material Type Code, Description : **5 Prestressed concrete**

Span Design Code, Description : **22 Channel 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 : **1 Monolithic concrete (concurrently placed with struct**

Deck Protection Type : **0 None**

Deck Membrain Type : **0 None**

(52) Out-to-Out Width : **9.13 m**

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

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

Skew Angle : **50°**

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	M25058	Both	99.99 m	8.43 m	N/A		
MCHUGH LANE							

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00401

Continue

Inspection Data

Sufficiency Rating : **79.7**
Health Index : **90.53**
Structure Status :**Not Deficient**

Inspection Due Date : 16 March 2013
(91) Inspection Fequency (months) : **24**

NBI Inspection Data

(90) Date of Last Inspection :	16 March 2011	Last Inspected By :	Charles Pepos - 107
(90) Inspection Date :		Inspected By :	

(58) Deck Rating :	7	(68) Deck Geometry :	6	(36C) Approach Rail Rating :	N	(62) Culvert Rating :	N
(59) Superstructure Rating :	8	(67) Structure Rating :	5	(36A) Bridge Rail Rating :	1	(61) Channel Rating :	7
(60) Substructure Rating :	7	(69) Under Clearance :	N	(36B) Transition Rating :	N	(71) Waterway Adequacy :	8
(72) App Rdwy Align :	8	(41) Posting Status :	A	(36D) End Rail Rating :	0	(113) Scour Critical :	8

Unrepaired Spalls : 0 m sq

Deck Surfacing Depth : 0.00 in

Inspection Hours

Crew Hours for inspection :	2	Snooper Required :	N
Helper Hours :	0	Snooper Hours for inspection :	0
Special Crew Hours :	0	Flagger Hours :	0
Special Equipment Hours :	0		

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

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00401

Continue

Element Inspection Data

********** Span : **Main-0 -** **********

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	2	132	sq.m.	X	0	100	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

03/16/2011 - Generally in Good condition. Some delaminated area in grouted seam between G2 and G3 at Abutment 2. Tight cracks in grouted joints. QGET
03/27/2009 - No change from the previous comments. ZZJZ
04/02/2007 - 9.13 * 14.41 = 131.56 Placed into Condition State 2 as there are a couple of small delaminated patches over the lifting holes. Grout between the girder sections has tight cracks and leak. DZGZ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 109 - P/S Conc Open Girder Tri-beams										
	1	1	72	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

03/16/2011 - Good condition. QGET
03/27/2009 - No problems noted and in Good condition. ZZJZ
04/02/2007 - 14.41 * 5 = 72.05m Underside looks Good. DZGZ

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 and 2										
	1	2	27	m.		95	5	0	0	
						%	%	%	%	%

Previous Inspection Notes :

03/16/2011 - Tight cracks near centerline in both caps. Minor spall on the Left wingwall of Abutment 2. QGET
03/27/2009 - No change from previous report and not a lot of them is visible. ZZJZ
04/02/2007 - Both Abutments have tight cracks under the middle girder sections; not a problem. DZGZ
03/30/2005 - No problems noted. ZZCZ
03/14/2003 - Ok. OSDR
04/23/2001 - Env. State #2 as wet or in mud part of the year. (11.25 * 2) + (4 * 1.15) = 27.10m ODBQ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 334 - Metal Rail Coated T-101										
	1	2	29	m.		100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

03/16/2011 - Good condition. QGET
03/27/2009 - No problems noted and in Good condition. ZZJZ
04/02/2007 - Good condition. DZGZ
03/30/2005 - No problems noted. ZZCZ
03/14/2003 - Good condition. OSDR
04/23/2001 - T-101 rail with metal posts. 14.41 * 2 = 28.82m ODBQ

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00401

Continue

General Inspection Notes

03/16/2011 - Good markers at the corners of the bridge.	QGET
03/27/2009 - NBI 36D, end treatment, is not up to current standards and therefore a "0". NBI 61, channel, rated a "7" as some undercut banks in the area of the bridge. Markers on all (4) corners and in Good condition.	ZZJZ
04/02/2007 - Markers on all (4) corners and in Good condition.	DZGZ
03/30/2005 - Markers at all (4) corners and in Good condition.	ZZCZ
03/14/2003 - No change from the 2001 report.	OSDR
04/23/2001 - Markers at all (4) corners and in Good condition. End anchor sections of the guardrail do not meet current standards; therefore #36D is a "0".	ODBQ

Form: bms001d
Printing Date : Monday, June 13 2011

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00501

Location : 2M N HELENA Structure Name: Lewis and Clark MD 2

General Location Data

District Code, Number, Location : **03 Dist 3 GREAT FALLS**
Division Code, Location : **31 GREAT FALLS**
County Code, Location : **049 LEWIS & CLARK**
City Code, Location : **35600 HELENA**
Kind fo Hwy Code, Description : **5 5 City Street**
Signed Route Number : **25058**
Str Owner Code, Description : **2 County Highway Agency**
Maintained by Code, Description : **2 County Highway Agenc**
Intersecting Feature : **TEN MILE CREEK 087**
Kilometer Post, Mile Post : **0.08 km 0.05**
Structure on the State Highway System : [ ]
Latitude : **46°38'03"**
Structure on the National Highway System : [ ]
Longitude : **112°01'55"**
Str Meet or Exceed NBIS Bridge Length : [X]

Construction Data

Construction Project Number : **BR 9025(6)**
Construction Station Number : **6+65.00**
Construction Drawing Number : **14295**
Construction Year : **1989**
Reconstruction Year :

Traffic Data

Current ADT : **100** ADT Count Year : **2003** Percent Trucks : **3 %**

Structure Loading, Rating and Posting Data

Loading Data :

Design Loading :		**5 MS 18 (HS 20)**
Inventory Load, Design :	**32.4 mton**	**2 AS Allowable Stress**
Operating Load, Design :	**32.4 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 :	**40**		

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **11.89 m**
Deck Area : **153.00 m sq**
Deck Roadway Width : **11.99 m**
Approach Roadway Width : **11.99 m**
Median Code, Description : **0 No median**

Structure Vertical and Horizontal Clearance Data :

Vertical Clearance Over the Structure : **99.99 m**
Reference Feature for Vertical Clearance : **N Feature not hwy or RR**
Vertical Clearance Under the Structure : **0.00 m**
Reference Feature for Lateral Underclearance : **N Feature not hwy or RR**
Minimum Lateral Under Clearance Right : **0.00 m**
Minimum Lateral Under Clearance Left : **0.00 m**

Span Data

Main Span

Number Spans : **3**
Material Type Code, Description : **2 Concrete continuous**
Span Design Code, Description : **1 Slab**

Approach Span

Number of Spans : **0**
Material Type Code, Description :
Span Design Code, Description :

Deck

Deck Structure Type : **1 Concrete Cast-in-Place**
Deck Surfacing Type : **1 Monolithic concrete (concurrently placed with struct**
Deck Protection Type : **1 Epoxy Coated Reinforcing**
Deck Membrain Type : **0 None**

(52) Out-to-Out Width : **12.91 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	M25058	Both	99.99 m	11.99 m	N/A		
MCHUGH LANE							

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00501

Continue

Inspection Data

Sufficiency Rating : **99**
Health Index : **98.46**
Structure Status :**Not Deficient**

Inspection Due Date : 29 March 2013
(91) Inspection Fequency (months) : **24**

NBI Inspection Data

(90) Date of Last Inspection :	29 March 2011	Last Inspected By :	William Lay - 63
(90) Inspection Date :		Inspected By :	

(58) Deck Rating :	6		(68) Deck Geometry :	9		(36C) Approach Rail Rating :	N		(62) Culvert Rating :	N	
(59) Superstructure Rating :	7		(67) Structure Rating :	7		(36A) Bridge Rail Rating :	1		(61) Channel Rating :	7	
(60) Substructure Rating :	7		(69) Under Clearance :	N		(36B) Transition Rating :	0		(71) Waterway Adequacy :	8	
(72) App Rdwy Align :	8		(41) Posting Status :	A		(36D) End Rail Rating :	0		(113) Scour Critical :	8	

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 : **N**

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						

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00501

Continue

Element Inspection Data

********** Span : **Main-0 -** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 52 - Conc Slab/Coatd Bars										
	1	2	153	sq.m.	X	100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

03/29/2011 - No spalls or delaminations noted for Condition State 1. Piece of wood in Span 2's Outside-Left edge of the slab near Pier 3. ZMIZ

04/10/2009 - No change from previous reports and generally in Good condition. Will soon need a DECK CRACKING SMART FLAG due to the density of cracking noted in the previously. KIDZ

04/02/2007 - longitudinal cracks at centerline with minor efflorescence on the underside. Minor mapping cracks in the very short spans; 1 and 3. (11.89 X 12.91 = 153.499) DZGZ

04/01/2005 - No change from previous reports. BZBZ

04/03/2003 - Some tight longitudinal cracks in the slab. A longitudinal crack with efflorescence on the underside of the slab near the roadway's centerline. EZHI

05/18/2001 - 12.90 * 11.89 = 153.38
Some small, tight longitudinal cracks. AFHP

04/07/1999 - R/Conc Cap is considered as part of the slab. It is not coded separately. PGKG

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 202 - Paint Stl Column Pier 2 and 3										
	1	3	10	ea.		85	15	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

03/29/2011 - Some peeling and loss of paint with base/primer coat visible throughout. ZMIZ

04/10/2009 - No change from previous comments and the steel itself is in generally Good condition. KIDZ

04/02/2007 - Peeling paint with some spot rust. Lots of base coat/primer coat visible. DZGZ

04/01/2005 - No change from previous reports except more paint loss and rust. BZBZ

04/03/2003 - Areas where paint has been chipped off and exposing black primer coat. Some rusty spots throughout. EZHI

05/18/2001 - Env. State #3 as always wet. No change fromlast report. AFHP

04/07/1999 - Some loss of paint at the waterline. PGKG

03/31/1997 - None DMFS

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 and 4										
	1	1	30	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

03/29/2011 - No able to see much of them, except for the wingwalls. Nothing noted and in Good condition. ZMIZ

04/10/2009 - No problems noted and in Good condition. KIDZ

04/02/2007 - No problems noted. DZGZ

04/01/2005 - No change from previous reports. BZBZ

04/03/2003 - No problems noted. These may be hanging, cantilevered, Abutments. EZHI

05/18/2001 - (12.90 * 2) + (4 * 1.50) = 30.40m AFHP

04/07/1999 - None PGKG

03/31/1997 - None DMFS

Inspection Notes:

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00501

Continue

* * * * * * * * * * Span : **Main-0 - (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 Pier 2 and 3										
	1	2	26	m.		95	5	0	0	
						%	%	%	%	%

Previous Inspection Notes :

03/29/2011 - Mostly Good condition with some minor surface shrinkage cracking noted. ZMIZ
04/10/2009 - No change and generally in Good condition. KIDZ
04/02/2007 - Mostly in Good condition with a couple of tight surface shrinkage cracks. DZGZ
04/01/2005 - No change from previous reports. BZBZ
04/03/2003 - 2 * 12.90 = 25.80m Minor, tight shrinkage cracks. Env. State 2 as wet part of the year. Cap may have been poured seperate from the slab, so added it in as an element. EZHI

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	24	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

03/29/2011 - Some tight vertical and minor surface shrinkage cracking. ZMIZ
04/10/2009 - No change and in Good condition. KIDZ
04/02/2007 - Some tight vertical cracks and minor surface shrinakge cracks. DZGZ
04/01/2005 - Some small, tight vertical cracks. BZBZ
04/03/2003 - Same as previous report. EZHI
05/18/2001 - 11.89 * 2 = 23.78m Some small, tight vertical cracks. AFHP
04/07/1999 - None PGKG
03/31/1997 - None DMFS

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	2	1	ea.	X	0	100	0	0	
						%	%	%	%	%

Previous Inspection Notes :

03/29/2011 - No change. ZMIZ
04/10/2009 - Due to density. KIDZ

Inspection Notes:

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

M25058000+00501

Continue

General Inspection Notes

03/29/2011 - NBI 36B, transition rail, rated a "0" as no longer up to current standards. End shoes from the concrete rail to the metal guardrail at the NW and SE corners are lapped against traffic.	ZMIZ
04/10/2009 - NBI 36C, approach guardrail, is a "N" as there is no approach rail at this bridge.	KIDZ
04/02/2007 - NBI 58 and 59, deck and superstructure, rated a "7" due to tight surface cracks in the deck and minor efflorescence on the underside. Rail section have wraped ends with cable from the last posts back into the rail section.	DZGZ
04/01/2005 - NBI 60, substructure, dropped to a "7" due to some rust and paint loss to the painted steel piling. No problems noted except some scour at mid-channel.	BZBZ
04/03/2003 - Not much drift under the structure today. Recent high water has cleaned any loose drift from under the structure. Scour still evident at the upstream opening.	EZHI
05/18/2001 - No change from last report except that there is (1) missing guardrail bolt on the NW run also. NBI 36D is now a "0" as it no longer meets current standards. NBI 61 is a "7" due to scour, drift, and vegetation.	AFHP
04/07/1999 - Damage to the NW guard rail is the same as last report. Some drift @ the steel pipe pile. Some minor scour on the upstream side of the bridge @ mid-channel.	PGKG
03/31/1997 - Sufficiency Rating Calculation Accepted by ops$u5963 at 5/29/97 10:53:14 OPS$U5963 inspection comments - Structure M25058000+00501 - Date 3/31/97 - Previous comments > Sufficiency Rating Calculation Accepted by ops$u5963 at 3/11/97 09:33:32 Sufficiency Rating Calculation Accepted by ops$u9004 at 2/19/97 14:21:38	DMFS
07/01/1995 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/11/97 09:33:32 Sufficiency Rating Calculation Accepted by ops$u9004 at 2/19/97 14:21:38	UOTS
10/01/1992 - Updated with tape 1995	NB95
01/01/1991 - Updated with tape 1993	NB93

Appendix B

Design Reference Exhibits

#

TABLE A
COUNTY ROAD DESIGN CRITERIA

	Terrain	Major Collector	Minor Collector	Local Road
Design Speed (MPH)	Level	55	50	30
	Rolling	45	40	25
	Mountainous	45	30	20
Curvature - Minimum at Centerline (feet)	Level	575	575	250
	Rolling	440	440	175
	Mountainous	330	300	110
Minimum Stopping Sight Distance (feet)	Level	per AASHTO	425	200
	Rolling	"	305	150
	Mountainous	"	200	110
Maximum Grade	Level	per AASHTO	6%	6%
	Rolling	"	8%	9%
	Mountainous	"	10%	11%
Length of Maximum Grade (feet)		per AASHTO	per AASHTO	per AASHTO
Minimum Grade		0.5%	0.5%	0.5%
Superelevation		per AASHTO	per AASHTO	N/A
Minimum Intersection Spacing (feet)		500	275	150
Driveway Spacing (feet)		45	45	40
Maximum Length of Cul-de-Sac (feet)		Not Allowed	Not Allowed	See Chapter XI.H.11
Minimum Radius of Cul-de-Sac (feet)		Not Allowed	Not Allowed	48
Sight Distance Triangle (feet)	Level	300	255	120
	Rolling	210	170	95
	Mountainous	210	120	80
Minimum Right of Way Width		100	80	60
Minimum Right of Way Radius for Cul-de-sac (feet)		NA	NA	48
Vertical Clearance (feet)		16.5	16.5	14.5
Intersection Curb Return Radii (feet)		25	25	15
Minimum Sidewalk Width (feet)		5	5	5
Sidewalk Offset From Back of Curb (feet)		5-10	5-10	5
Bike Lane Width (feet)		4-8	4-8	N/A
Minimum Culvert Diameter (inches)		18	15	15
Minimum Culvert Cover		Meet or exceed suppliers recommendations	Meet or exceed suppliers recommendations	Meet or exceed suppliers recommendations
Minimum Culvert Grade		0.5%	0.5%	0.5%
Culvert Material		Support HS-20 Loading	Support HS-20 Loading	Support HS-20 Loading

Type of terrain	Metric: Design speed (km/h) for specified design volume (veh/day)			US Customary: Design speed (mph) for specified design volume (veh/day)		
	0 to 400	400 to 2000	over 2000	0 to 400	400 to 2000	over 2000
Level	60	80	100	40	50	60
Rolling	50	60	80	30	40	50
Mountainous	30	50	60	20	30	40

Note: Where practical, design speeds higher than those shown should be considered.

Exhibit 6-1. Minimum Design Speeds for Rural Collectors

Metric				US Customary			
Design speed	Design stopping sight distance	Rate of vertical curvature, K^a (m/%)		Design speed	Design stopping sight distance	Rate of vertical curvature, K^a (ft/%)	
(km/h)	(m)	Crest	Sag	(mph)	(ft)	Crest	Sag
20	20	1	3	15	80	3	10
30	35	2	6	20	115	7	17
40	50	4	9	25	155	12	26
50	65	7	13	30	200	19	37
60	85	11	18	35	250	29	49
70	105	17	23	40	305	44	64
80	130	26	30	45	360	61	79
90	160	39	38	50	425	84	96
100	185	52	45	55	495	114	115
				60	570	151	136

[a] Rate of vertical curvature, K, is the length of curve per percent algebraic difference in the intersecting grades (i.e., $K = L/A$). (See Chapter 3 for details.)

Exhibit 6-2. Design Controls for Stopping Sight Distance and for Crest and Sag Vertical Curves

Metric			US Customary		
Design speed (km/h)	Design passing sight distance (m)	Rate of vertical curvature, K^a (m/%)	Design speed (mph)	Design passing sight distance (ft)	Rate of vertical curvature, K^a (ft/%)
30	200	46	20	710	180
40	270	84	25	900	289
50	345	138	30	1090	424
60	410	195	35	1280	585
70	485	272	40	1470	772
80	540	338	45	1625	943
90	615	438	50	1835	1203
100	670	520	55	1985	1407
			60	2135	1628

[a] Rate of vertical curvature, K, is the length of curve per percent algebraic difference in the intersecting grades (i.e., $K = L/A$). (See Chapter 3 for details.)

Exhibit 6-3. Design Controls for Crest Vertical Curves Based on Passing Sight Distance

	Metric								US Customary								
	Maximum grade (%) for specified design speed (km/h)								Maximum grade (%) for specified design speed (mph)								
Type of terrain	30	40	50	60	70	80	90	100	20	25	30	35	40	45	50	55	60
Level	7	7	7	7	7	6	6	5	7	7	7	7	7	7	6	6	5
Rolling	10	10	9	8	8	7	7	6	10	10	9	9	8	8	7	7	6
Mountainous	12	11	10	10	10	9	9	8	12	11	10	10	10	10	9	9	8

Note: Short lengths of grade in rural areas, such as grades less than 150 m [500 ft] in length, one-way downgrades, and grades on low-volume rural collectors may be up to 2 percent steeper than the grades shown above.

Exhibit 6-4. Maximum Grades for Rural Collectors

Metric					US Customary				
Design speed (km/h)	Minimum width of traveled way (m) for specified design volume (veh/day)[a]				Design speed (mph)	Minimum width of traveled way (ft) for specified design volume (veh/day)[a]			
	under 400	400 to 1500	1500 to 2000	over 2000		under 400	400 to 1500	1500 to 2000	over 2000
30	6.0[b]	6.0	6.6	7.2	20	20[b]	20	22	24
40	6.0[b]	6.0	6.6	7.2	25	20[b]	20	22	24
50	6.0[b]	6.0	6.6	7.2	30	20[b]	20	22	24
60	6.0[b]	6.6	6.6	7.2	35	20[b]	22	22	24
70	6.0	6.6	6.6	7.2	40	20[b]	22	22	24
80	6.0	6.6	6.6	7.2	45	20	22	22	24
90	6.6	6.6	7.2	7.2	50	20	22	22	24
100	6.6	6.6	7.2	7.2	55	22	22	24	24
					60	22	22	24	24
	Width of shoulder on each side of road (m)					Width of shoulder on each side of road (ft)			
All speeds	0.6	1.5[c]	1.8	2.4	All speeds	2.0	5.0[c]	6.0	8.0

[a] On roadways to be reconstructed, a 6.6-m [22-ft] traveled way may be retained where the alignment and safety records are satisfactory.

[b] A 5.4-m [18-ft] minimum width may be used for roadways with design volumes under 250 veh/day.

[c] Shoulder width may be reduced for design speeds greater than 50 km/h [30 mph] as long as a minimum roadway width of 9 m [30 ft] is maintained.

See text for roadside barrier and offtracking considerations.

Exhibit 6-5. Minimum Width of Traveled Way and Shoulders

Drivers who inadvertently leave the traveled way can often recover control of their vehicles if foreslopes are 1V:4H or flatter and shoulders and ditches are well rounded or otherwise made traversable. Such recoverable slopes should be provided where terrain and right-of-way conditions allow.

Where provision of recoverable slopes is not practical, the combinations of rate and height of slope provided should be such that occupants of an out-of-control vehicle have a good chance of survival. Where high fills, right-of-way restrictions, watercourses, or other problems render such designs impractical, roadside barriers should be considered, in which case the maximum rate of fill slope may be used. Reference should be made to the current edition of the AASHTO *Roadside Design Guide* (3). For further information, see the section on "Traffic Barriers" in Chapter 4.

Cut sections should be designed with adequate ditches. Preferably, the foreslope should not be steeper than 1V:3H and, where practical, should be 1V:4H or flatter. The ditch bottom and slopes should be well rounded, and the backslope should not exceed the maximum needed for stability.

width provided, crash history, traffic volumes, remaining life of the structure, design speed, and other pertinent factors.

Metric			US Customary		
Design volume (veh/day)	Design loading structural capacity	Minimum clear roadway width (m)[a]	Design volume (veh/day)	Design loading structural capacity	Minimum clear roadwaywidth (ft)[a]
under 400	MS 13.5	6.6	under 400	H 15	22
400 to 1500	MS 13.5	6.6	400 to 1500	H 15	22
1500 to 2000	MS 13.5	7.2	1500 to 2000	H 15	24
over 2000	MS 13.5	8.4	over 2000	H 15	28

[a] Clear width between curbs or railings, whichever is less, should be equal to or greater than the approach traveled way width, wherever practical.

Exhibit 6-7. Structural Capacities and Minimum Roadway Widths for Bridges to Remain in Place

Vertical Clearance

Vertical clearance at underpasses should be at least 4.3 m [14 ft] over the entire roadway width, with an additional allowance for future resurfacing.

Horizontal Clearance to Obstructions

For rural collector roads with a design speed of 70 km/h [45 mph] or less, a minimum clear zone of 3 m [10 ft] measured from the edge of the traveled way should be provided. This recovery area should be clear of all unyielding objects such as trees, sign supports, utility poles, light poles, and other fixed objects. The benefits of removing these obstructions should be weighed against any environmental and aesthetic effects.

For rural collector roads with a design speed of 80 km/h [50 mph] or more, the AASHTO *Roadside Design Guide* (3) should be used for guidance in selecting an appropriate clear-zone width.

The approach roadway width (traveled way plus shoulders) should be carried across an overpass or bridge, where practical. Approach roadside barriers, anchored to the bridge rails or parapets, should be provided. Sidewalks should extend across a bridge if the approach roadway has sidewalks or sidewalk areas. To the extent practical, where another highway or railroad passes over the roadway, the overpass structure should be designed so that the pier or abutment supports have lateral clearance as great as the clear zone on the approach roadway. Where a setback beyond the clear zone is not practical, roadside barrier protection should be provided at the piers.

Appendix C

Pavement Evaluation

SK GEOTECHNICAL

November 3, 2009

Project 09-2560C
McHugh Lane

Mr. Tom Cavanaugh
Robert Peccia & Associates
Via Email: *tom@rpa-hln.com*

Dear Tom:

Re: Pavement Evaluation, McHugh Lane, Lewis and Clark County Road Improvement Projects, Helena, Montana

The pavement evaluation for the above-referenced project has been completed. The purpose of the pavement evaluation was to perform soil borings along the alignment and laboratory tests on selected samples to assist Robert Peccia & Associates and Lewis and Clark County to complete initial preliminary engineering analysis for a future reconstruction of a portion of McHugh Lane. The pavement evaluation was performed in general accordance with our Subconsultant Agreement dated June 11, 2009.

Project Information

It is our understanding that approximately 2 1/4 miles of McHugh Lane will be improved. Depending on funding availability, the intent will be for whole or parts of the road to be reconstructed to meet or exceed minimum County standards. The project begins at the northern city limits of Helena, near the intersection with Lander Road and heads north for 2 1/4 miles to Sierra Road West. The limits of the McHugh Lane improvements considered for this pavement evaluation is shown on the attached Boring Location Sketch. At this time, the engineering evaluation along McHugh Lane is based on a total reconstruction need with a new pavement section to bring the road in compliance of meeting or exceeding the minimum road standards in accordance with the Lewis and Clark Subdivision Regulations dated December 18, 2007. Approaching the preliminary engineering as a total reconstruction project will likely present the most conservative cost analysis to assist the County in earmarking funds.

Field Procedures

On July 9, 2009, Borings ST-5 through ST-7 were performed along the alignment being considered for reconstruction. Therefore, the borings were located about 1 mile apart. Boring locations were selected by our personnel and were generally alternated from the northbound and southbound lanes. The locations of Borings ST-5 through ST-7 are shown on the attached sketch. To perform the borings, single lane closure traffic control was performed while drilling.

The borings were performed with a truck-mounted core and auger drill. Sampling of the borings was performed in accordance with American Society for Testing and Materials (ASTM) Method of Test

D 1586, "Penetration Test and Split-Barrel Sampling of Soils." Using this method, we advanced the borehole with hollow-stem auger to the desired test depth. Then a 140-pound hammer falling 30 inches drove a standard, 2-inch OD, split-barrel sampler a total penetration of 1 1/2 to 2 feet below the tip of the hollow-stem auger. The blows for the 1 1/2-foot of penetration are indicated on the boring logs, and are an index of soil strength characteristics. The last 1-foot portion of each penetration test is the N-value, and referred to as blows per foot (BPF) in this report.

While drilling, our engineering assistant measured the thickness of the existing asphalt pavement and underlying gravel base course to the nearest 1/2 inch. We wish to point out, however, that measuring the existing base thickness to the nearest 1/2 inch can be difficult due to previous construction activities along the roadway. Bag samples of the existing base course and subgrade were collected from some of the borings. The borings were then backfilled by our drill crew, and the pavement surface was patched with cold-mix asphalt.

The soils encountered in the borings were visually and manually classified in accordance with ASTM D 2488, "Standard Practice for Description and Identification of Soils (Visual – Manual Procedures)." A summary of the ASTM classification system is attached. All samples were then returned to our laboratory for review of the field classifications by a geotechnical engineer.

Results

General. Log of Boring sheets indicating the depth and identification of the various soil strata, the penetration resistance, laboratory test data, and water level information are attached. It should be noted that the depths shown as boundaries between the strata are only approximate. The actual changes may be transitions and the depths of changes vary between borings.

Geologic origins presented for each stratum on the Log of Boring sheets are based on the soil types, blows per foot, and available common knowledge of the depositional history of the site. Because of the complex glacial and post-glacial depositional environments, geologic origins are frequently difficult to ascertain. A detailed evaluation of the geologic history of the roadway as well as review of contour maps and cross sections was not performed.

The general profile encountered by the three borings was existing pavement underlain by gravel base course over silty sand and clayey gravel subgrades. Table 1 below summarizes the existing pavement and subgrade conditions encountered at the three borings.

Table 1. Summary of Boring Conditions – McHugh Lane

Boring	ST-5	ST-6	ST-7
Existing Asphalt Pavement	3½"	5"	1¼"
Existing Base Thickness	9"	4"	2¾" Base 14" Subbase
Existing Base Quality	Good	Poor	Moderate
Subgrade	Silty Sand (SM)	Clayey Gravel (GC)	Silty Sand (SM)
BPF	12, 6	9, 24	10, 5
Moisture Condition	Near to 10% Over	Over	Near to 5% Over
Risk of Subgrade Failure	High	Moderate	Moderate

General Statistical Summary

Existing Base Course: 1 of 3 borings (33%) encountered POOR quality base course
1 of 3 borings (33%) encountered MODERATE quality base/subbase course
1 of 3 borings (33%) encountered GOOD quality base course

Subgrade Conditions: 1 of 3 borings (33%) have HIGH risk to become unstable during construction
2 of 3 borings (67%) have MODERATE risk to become unstable during construction.

Existing Pavement Section. As indicated in Table 1 above, the three borings encountered existing asphalt pavement to depths ranging from 1 1/4 to 5 inches. Beneath the existing pavement, Boring ST-5 then encountered good quality base course, while Boring ST-6 encountered poor quality base course. Boring ST-7 encountered relatively good quality base course, however, it was thin. Subbase was encountered beneath this base course. Penetration tests were performed in the base/subbase courses directly beneath the asphalt surface while drilling. In general, penetration resistances in the base/subbase courses typically ranged from 14 to 21 blows per foot (BPF), indicating it was medium dense.

Subgrade. Beneath the existing base course, Borings ST-5 and ST-7 encountered silty sand subgrade to a depth of 3 feet underlain by poorly graded gravel. Boring ST-6 encountered clayey gravel subgrade to 2 1/2 feet underlain by poorly graded gravel. Penetration resistances in the silty sand and clayey gravel subgrades typically ranged from 5 to 24 BPF, indicating the silty sands were primarily loose, and the clayey gravel was medium dense. The penetration resistances in the gravel encountered below 3 feet ranged from 33 to 58 BPF, indicating these gravels were medium dense to dense.

Moisture content tests were performed on all of the penetration test samples from the borings. The moisture contents are indicated on the boring logs and were either compared to the optimum moisture content determined by our standard Proctor (described below) or typical optimum moisture contents for these types of soils. Based on these moisture content tests, the subgrade conditions at all three borings are near to well over optimum moisture content.

Groundwater. Groundwater was not encountered in the three borings to their termination depth of 5 1/2 feet at the time of our fieldwork. We wish to point out that clayey gravel subgrade was encountered by one boring. Several days may be required for groundwater levels to develop and stabilize in these types of clay soils. Surface water can also become trapped on top of these clayey soils (perched groundwater), and then be encountered during construction.

Laboratory Tests

Two base course and three subgrade samples were selected for laboratory tests. The results are summarized in Table 2 below and are attached to this report.

Table 2. Summary of Laboratory Tests

Sample	Atterberg Limits			P200	Standard Proctor		CBR Value
	LL	PL	PI		MDD	OMC	
Base Course, ST-6	24	13	11	17.9%	---	---	---
Base/Subbase, ST-7	Nonplastic			10.6%	---	---	---
Composite Subgrade, ST-5 and ST-7	Nonplastic			19.7%	134.7	8.0%	14.3
Subgrade, ST-6	33	16	17	27.2%	---	---	---

MDD = Maximum Dry Density (ASTM D 698), pounds per cubic foot (pcf)
OMC = Optimum Moisture Content

As can be seen above, the base course sample tested from Boring ST-6 was plastic, having a plasticity index of 11. The percent-finer-than-a-200-sieve (P200) of this sample was 17.9 percent. These results indicate the base course classifies as low plasticity clayey sand, which would be considered a poor quality base course. The base/subbase sample from Boring ST-7 was nonplastic and had a P200 of 10.6 percent. This would be considered a moderate quality material. A Laboratory Test of Aggregate sheet compares these base samples to the Lewis and Clark crushed top surfacing and select base course gradation requirements. The base samples tested generally did not meet the specifications.

Standard Proctors (ASTM D 698) and California bearing ratio (CBR) tests were performed on one composite subgrade sample indicated above. A CBR value for this sample was 14.3.

Pavement Analysis and Recommendations

Available Information. Robert Peccia & Associates provided us with the traffic information indicated on the attached graph for Roadway 7B-02, which represents McHugh Lane in the study segment. As can be seen, the 2009 AADT count is 1,024 and the projected 2029 AADT is 1,538 based on the trend line. A linear relationship was used to estimate the increase in AADT over this 20-year period. Based on the AADT trend line, the yearly growth rate within the 20-year performance period is approximately 2.05 percent. Abelin Traffic Services (ATS) performed the recent traffic counts on this and numerous other Lewis and Clark County roads as part of the County's annual traffic count program. The 2009 traffic count summary for Roadway 7B-02 by ATS is attached and includes traffic classification counts. This summary shows the relative percentages and daily traffic of the 13 standard classes of vehicles using the road. We wish to point out that classes 4 through 13 represent the heavier bus and truck traffic on the roadway, and all are reported as 0 percent.

Method. Pavement sections for the roadway were evaluated using DARWin™, a computer program based on the *1993 AASHTO Guide for Design of Pavement Structures*. The AASHTO Pavement Design Method is based on numerous input parameters, each affecting the required total pavement thickness for a given road. Based on the traffic information provided by Robert Peccia & Associates and ATS, we were able to perform a rigorous traffic analysis to determine the design Equivalent Single 18-kip Axle Load (ESAL). The rigorous traffic analysis is included in the DARWin output. The input parameters and traffic information are summarized in Table 3 below.

Table 3. Summary of Pavement Design Assumptions and Analysis

Parameter:	
Road Classification	Minor Collector
2009 AADT	1,024
2029 AADT	1,538
Estimated Annual Growth	2.05%
Performance Period	20 Years
Initial Serviceability	4.2
Terminal Serviceability	2.5
Reliability	85
Number of Lanes in Design Direction	1
Percent All Trucks in Design Lane	50
Percent Trucks in Design Direction	100
18-kip ESALs	22,150

As can be seen above, we calculated a design ESAL of only 22,150 for McHugh Lane, which is considered a minor collector. This is a very low ESAL value, more typical of residential streets. Having 0 percent truck traffic directly affected the low ESAL value used for design. For our calculations, vehicle/truck factors were used for the 13 classes of vehicle counted in the ATS traffic classification count. These vehicle/truck factors were obtained from the *washington.edu* website, and the table is attached.

The DARWin pavement design uses roadbed soil resilient modulus (M_R) to identify subgrade strength. CBR is another method of representing subgrade strength. Correlations of these subgrade strength parameters are contained in the *1993 AASHTO Design of Pavement Structures* manual. For soils having CBR values less than 10, the manual indicates the following equation can be used.

$$M_R \text{ (psi)} = 1{,}500 \times CBR$$

As previously indicated in Table 2, a CBR value 14.3 was determined for the silty sand subgrade along this roadway. When considering that the silty sand was primarily loose, it is our opinion a design CBR of 9 should be used. This results in an M_r equal to 13,500.

Pavement Sections. Pavement sections were analyzed in general accordance with the Lewis and Clark Subdivision Regulations dated December 18, 2007. Based on this approach and the above input parameters and design information, the minimum pavement section from Lewis and Clark County "Paved Road" Standards can be used.

Table 4. Recommended Pavement Section

Asphalt Pavement	3"
Crushed Top Surfacing	3"
Select Base Course*	6"
Subbase Course	0"
Total	**12"**

*Per Table B-4 of Lewis and Clark Subdivision Regulations dated 12/18/2007, 3-inch minus sandy gravel should be used as Select Base Course. Because the Crushed Top Surfacing is only 3 inches thick, it is undesirable to have a subbase aggregate larger than the thickness of leveling course.

Constructability.

General. A common problem in roadway construction is encountering unstable subgrades. Unstable subgrades are those subgrade soils that are excessively wet and soft, and cannot support heavy rubber-tired construction equipment as well as cannot be compacted to specification. They commonly occur beneath existing roads where surface water has seeped through cracks and become trapped in the underlying base course and subgrade. This water saturates the clays, reducing their shear strength, and the clay subgrade becomes too soft and wet to support the heavy rubber-tired construction equipment. When this occurs during fast-tracked construction projects, it can cause delays, which then results in change orders.

As previously indicated, the borings primarily encountered wet, loose silty sand subgrades. We considered one boring to have a "high" risk of subgrade failure during construction and the other two borings to have "moderate" risk of subgrade failure during construction.

Identification of Unstable Areas. When considering total reconstruction, the best method of determining unstable subgrades is to perform proof rolling observations directly on the exposed subgrade. Proof rolling should be performed with a loaded tandem axle dump truck or equivalent. Unstable areas are those subgrade soils where proof rolling indicates 1/2 inch or more of deflection is occurring. Another method of determining unstable subgrades is whether or not they can be recompacted to specification, typically 95 percent of their standard Proctor maximum dry density. Where unstable subgrades are identified, we recommend installing a stabilized pavement section as described below.

Stabilized Pavement Section. Two alternatives for stabilized pavement sections are indicated in Table 5 below. Alternatives 1 and 2 are stabilized pavement sections using geosynthetics, which are available in Montana.

Table 5. Stabilized Pavement Section for Excessively Soft (Unstable) Subgrade Areas

Item	Alternative 1	Alternative 2
Asphalt Pavement	3"	3"
Crushed Top Surfacing	3"	3"
Select Base and/or Subbase	20"	23"
Geosynthetic	Tensar BX 1300 over Class 2 Non-woven Fabric	Mirafi HP 570

Other Alternatives. We suggest also contacting Lewis and Clark County personnel and/or discussing these types of stabilized pavement sections with the contractor, who may have other alternatives for constructing pavements on unstable subgrades. Another alternative is to allow unstable subgrades to possibly dry out during construction. For this approach, several weeks of warm, windy weather will likely be needed to allow the exposed conditions to dry out and become more stable. We have found, however, that the construction schedule of most contractors does not allow them to wait for these areas to dry out and become stable.

Some consideration can also be given to specifying that all construction activities are performed with low-pressured ground equipment. In Montana, however, this equipment is generally not readily available by most earthwork and paving contractors.

Specifications

When the McHugh Lane reconstruction project(s) are undertaken, we recommend all earthwork, subgrade preparation, gravel base and subbase, and asphalt pavement be specified and constructed in accordance with Montana Public Works Standard Specifications (MPWSS). The Montana Department of Transportation (MDT) Specifications for Road and Bridge Design can also be used, however, they are slightly more stringent. If geosynthetics are utilized, we recommend they be placed and constructed in accordance with the manufacturer's recommendations.

Observation and Testing

We recommend the pavement subgrades be observed by a geotechnical engineer or an engineering assistant working under the direction of a geotechnical engineer to see if the materials are similar to those encountered by the borings. During construction, we recommend density tests be taken on the recompacted subgrade and compacted crushed top surfacing, select base, and subbase courses. The thicknesses of crushed top surfacing, select base, and subbase should also be checked to confirm they meet specifications.

We also recommend density testing of the asphaltic concrete surface and Marshall tests on asphaltic concrete mix to evaluate strength and air voids. Cores of asphalt concrete should be taken at intervals to evaluate pavement thickness and compaction. Paving observations should also be performed to confirm the specified thickness of asphalt is provided throughout the roadway.

General Recommendations

Basis of Recommendations. The analyses and recommendations submitted in this report are based upon the data obtained from the borings performed at the locations indicated on the attached sketch. Often, variations occur between these borings, the nature and extent of which do not become evident until additional exploration or construction is conducted. A reevaluation of the recommendations in this report should be made after performing on-site observations during construction to note the characteristics of any variations. The variations may result in additional earthwork and construction costs, and it is suggested that a contingency be provided for this purpose.

It is recommended that when the road is reconstructed, we or another qualified geotechnical engineering firm be retained to perform the observations and testing program for the site preparation. This will allow correlation of the soil conditions encountered during construction to the soil borings.

Groundwater Fluctuations. We made water level observations in the borings at the times and under the conditions stated on the boring logs. These data were interpreted in the text of this report. The period of observation was relatively short, and fluctuation in the groundwater level may occur due to rainfall, flooding, irrigation, spring thaw, drainage, and other seasonal and annual factors not evident at the time the observations were made. Design drawings and specifications and construction planning should recognize the possibility of fluctuations.

Use of Report. This report is for the exclusive use of Robert Peccia & Associates to use in conjunction with the preliminary road reconstruction analysis being completed by them for the County. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analyses and recommendations may not be appropriate for other structures or purposes. We recommend parties contemplating other alignments or purposes contact us.

Level of Care. Services performed by SK Geotechnical Corporation personnel for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is made.

We appreciate the opportunity to provide these services for you. If we can be of further assistance, please contact us at your convenience.

Sincerely,

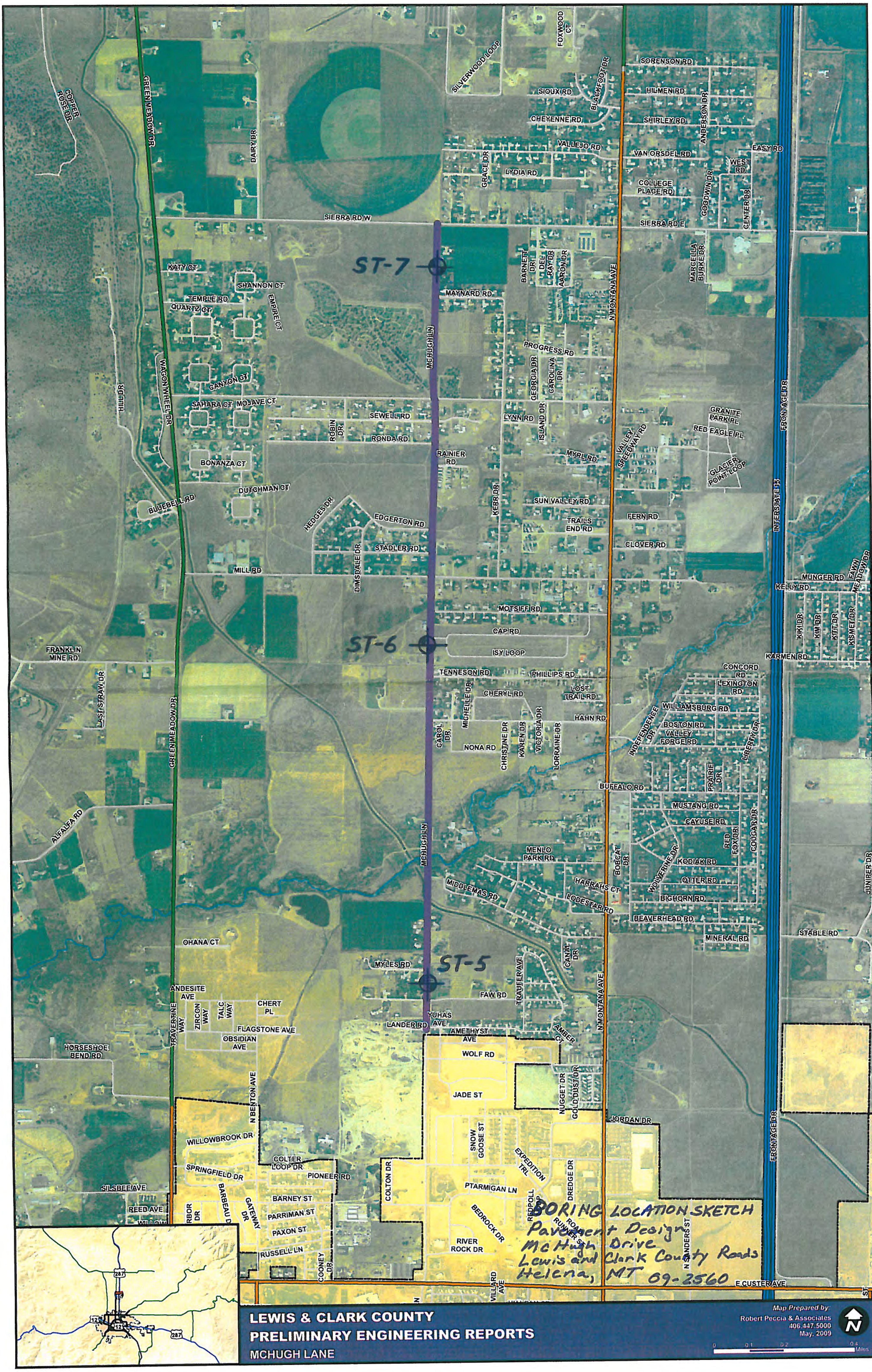
Professional Certification
I hereby certify that this report was prepared by me and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.

GREGORY T. STAFFILENO No. 10798 PE REGISTERED PROFESSIONAL ENGINEER

Gregory T. Staffileno, PE
Principal Geotechnical Engineer
License Number 10798PE

Cory G. Rice, PE
Reviewing Engineer

Attachments:
Boring Location Sketch
Descriptive Terminology
Log of Boring Sheets ST-5 through ST-7
Laboratory Tests
Laboratory Test of Aggregate
Abelin Traffic Data
RPA Traffic Curve
Washington DOT Vehicle/Truck Factors
DARWin Pavement Analysis


ST-7
ST-6
ST-5
MCHUGH LN
SIERRA RD W
SIERRA RD E
MAYNARD RD
PROGRESS RD
SEWELL RD
RONDA RD
RAINIER RD
EDGERTON RD
STADLER RD
MILL RD
MOTSIFF RD
CAP RD
ISY LOOP
TENNESON RD
PHILLIPS RD
CHERYL RD
NONA RD
BUFFALO RD
MIDDLEMAS RD
LODESTAR RD
MYLES RD
FAW RD
LANDER RD
YUHAS AVE
AMETHYST AVE
WOLF RD
JADE ST
PTARMIGAN LN
N MONTANA AVE
GREENMEADOW DR
WAGONWHEEL DR
INTERSTATE 15
FRONTAGE DR
E CUSTER AVE
JORDAN DR
N BENTON AVE
FLAGSTONE AVE
HORSESHOE BEND RD
ALFALFA RD
FRANKLIN MINE RD
OHANA CT
BORING LOCATION SKETCH
Pavement Design
McHugh Drive
Lewis and Clark County Roads
Helena, MT 09-2560
LEWIS & CLARK COUNTY
PRELIMINARY ENGINEERING REPORTS
MCHUGH LANE
Map Prepared by:
Robert Peccia & Associates
406.447.5000
May, 2009
Miles

Descriptive Terminology

Standard D 2487
Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines [C]	$C_U \geq 4$ and $1 \leq C_C \leq 3$ [E]	GW	Well graded gravel [F]
			$C_U < 4$ and/or $1 > C_C > 3$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines [D]	$C_U \geq 6$ and $1 \leq C_C \leq 3$ [E]	SW	Well graded sand [I]
			$C_U < 6$ and/or $1 > C_C > 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid Limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic	Liquid limit – oven dried / Liquid limit – not dried < 0.75	OL	Organic clay [K, L, M, N] Organic silt [K, L, M, O]
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic	Liquid limit – oven dried / Liquid limit – not dried < 0.75	OH	Organic clay [K, L, M, P] Organic silt [K, L, M, Q]
Highly Organic Soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

[A] Based on the material passing the 3" (75 mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[D] Sands with 5 to 12% fines require dual symbols.
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[E] $C_U = D_{50} / D_{10}$
$C_C = (D_{30})^2 / (D_{10} \times D_{50})$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

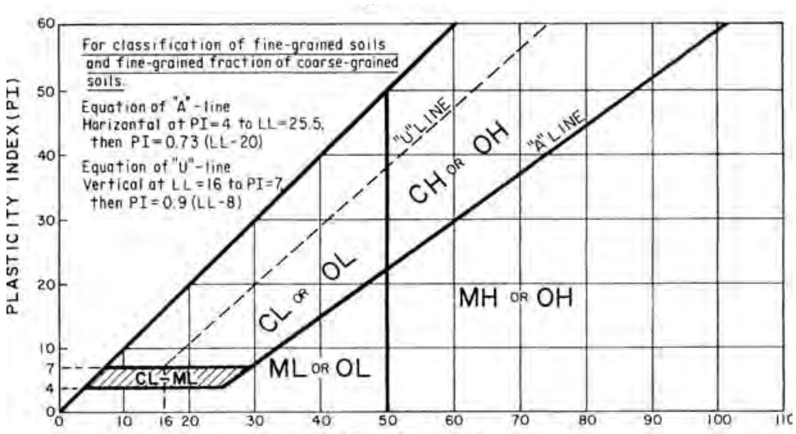


FIG. 4 Plasticity Chart

Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	P_{200}	% passing 200 sieve
LL	Liquid limit	PL	Plastic limit
PI	Plasticity index	MC	Natural moisture content, %
qu	Unconfined compressive strength, psf		
qp	Pocket penetrometer strength, tsf		

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
coarse .... 3/4" to 3"
fine .... No. 4 to 3/4"
Sand
coarse .... No. 4 to No. 10
medium .... No. 10 to No. 40
fine .... No. 40 to No. 200
Silt .... No. 200 to .005 mm
Clay .... less than .005 mm

Relative Density of Cohesionless Soils

very loose .... 0 to 4 BPF
loose .... 5 to 10 BPF
medium dense .... 11 to 30 BPF
dense .... 31 to 50 BPF
very dense .... over 50 BPF

Consistency of Cohesive Soils

very soft .... 0 to 1 BPF
soft .... 2 to 3 BPF
rather soft .... 4 to 5 BPF
medium .... 6 to 8 BPF
rather stiff .... 9 to 12 BPF
stiff .... 13 to 16 BPF
very stiff .... 17 to 30 BPF
hard .... over 30 BPF

Moisture Content (MC) Description

rather dry	MC less than 5%, absence of moisture, dusty
moist	MC below optimum, but no visible water
wet	MC over optimum, visible free water, typically below water table
saturated	Clay soils were MC over optimum

Drilling Notes

Standard penetration test borings were advanced by 3¼" or 4¼" ID hollow-stem augers, unless noted otherwise. Standard penetration test borings are designated by the prefix "ST" (split tube). Hand auger borings were advanced manually with a 2 to 3" diameter auger to the depths indicated. Hand auger borings are indicated by the prefix "HA."

Sampling. All samples were taken with the standard 2" OD split-tube sampler, except where noted. TW indicates thin-walled tube sample. CS indicates California tube sample.

BPF. Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they were separated by backslash (/). In very dense/hard strata, the depth driven in 50 blows is indicated.

WH. WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

Note. All tests were run in general accordance with applicable ASTM standards.

SK GEOTECHNICAL
2611 Gabel Road
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

LOG OF BORING

PROJECT: 09-2560
PAVEMENT DESIGN
Lewis and Clark County Roads
Helena, Montana

BORING: **ST-5**

LOCATION:
McHugh Lane, see attached sketch.

DRILLED BY: C. Larsen | METHOD: 3 1/4" HSA, Automatic | DATE: 7/9/09 | SCALE: 1" = 1'

Elev.	Depth 0.0	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.3		FILL: 3 1/2" of Asphalt Pavement.				
	1.0		FILL: 9" of Gravel Base.				
		SM	SILTY SAND with GRAVEL, fine- to coarse-grained, nonplastic, brown, moist, loose to medium dense. (Alluvium)	7/6/6		10.0	
				4/3/3		22.3	
	3.0						
		GP	POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, gray, moist, loose to dense. (Alluvium)	9/19/21		1.7	
	5.5		END OF BORING				

Water not observed with 4' of hollow-stem auger in the ground.

Water not observed to dry cave-in depth of 2 1/2' immediately after withdrawal of auger.

BORING BPF WL MC 2560.GPJ LAGNNN06.GDT 10/9/09

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LOG OF BORING

PROJECT: 09-2560 **PAVEMENT DESIGN** Lewis and Clark County Roads Helena, Montana	BORING: **ST-6** LOCATION: McHugh Lane, see attached sketch.
DRILLED BY: C. Larsen / METHOD: 3 1/4" HSA, Automatic	DATE: 7/9/09 / SCALE: 1" = 1'

Elev.	Depth	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.0–0.4		FILL: 5" of Asphalt Pavement.				Base course bag sample: LL=24, PL=13, PI=11 P_{200}=17.9%
	0.4–0.8		FILL: 4" of Clayey Sand with Gravel Base.				
	0.8–2.5	GC	CLAYEY GRAVEL with SAND, fine-grained, low plasticity, trace Gravel, brown, moist, loose. (Alluvium)	8/4/5		14.7	Subgrade bag ample: LL=33, PL=16, PI=17 P_{200}=27.2%
				8/16/20		7.4	
	2.5–5.5	GP	POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, gray, moist, dense. (Alluvium)	10/13/20		2.6	
	5.5		END OF BORING				

Water not observed with 4' of hollow-stem auger in the ground.

Water not observed to dry cave-in depth of 1 1/2' immediately after withdrawal of auger.

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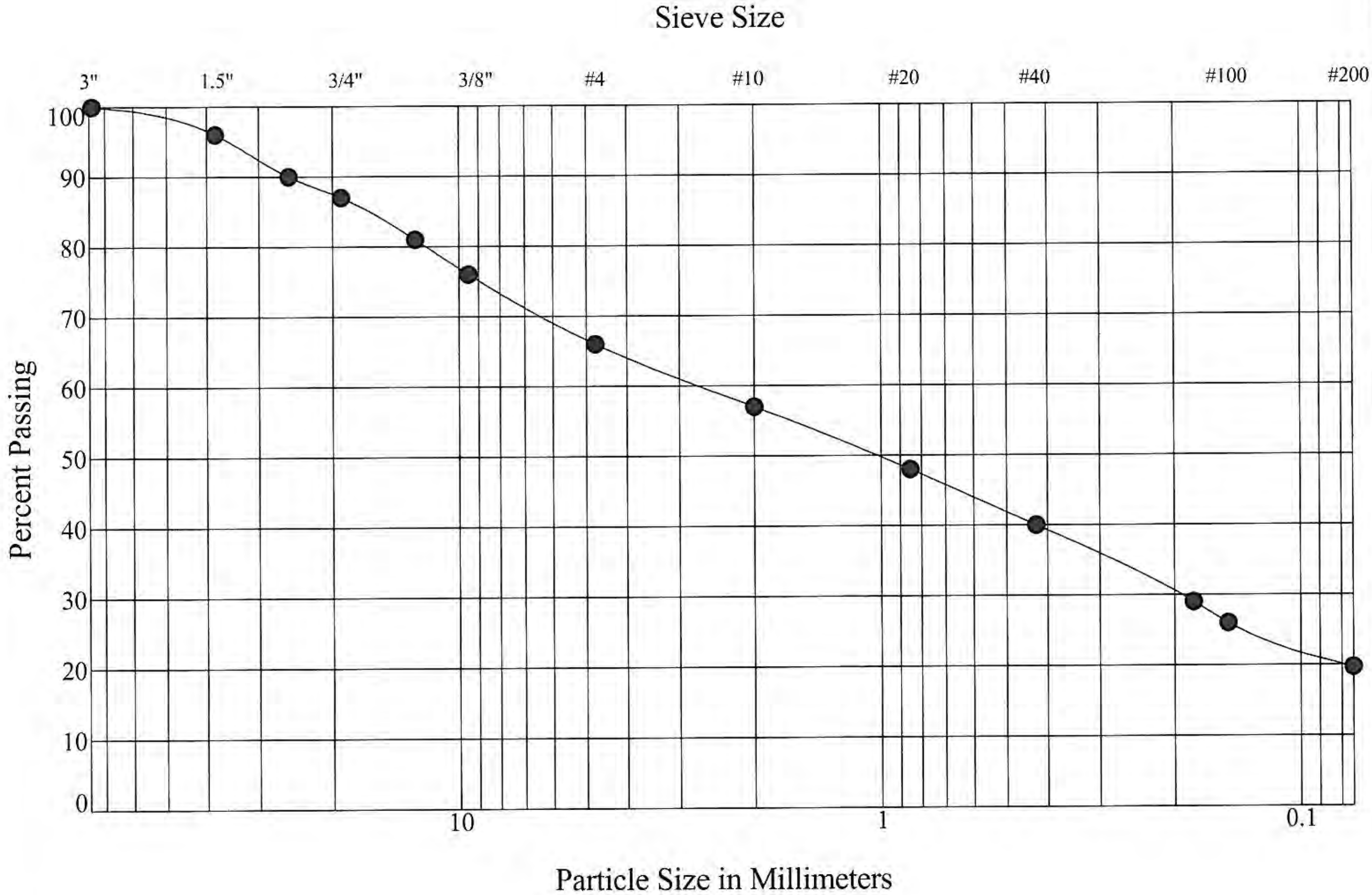
Fax: 406.652.3944

LOG OF BORING

PROJECT: 09-2560 **PAVEMENT DESIGN** Lewis and Clark County Roads Helena, Montana	BORING: **ST-7** LOCATION: McHugh Lane, see attached sketch.
DRILLED BY: C. Larsen — METHOD: 3 1/4" HSA, Automatic	DATE: 7/10/09 — SCALE: 1" = 1'

Elev.	Depth 0.0	Symbol	Description of Materials	BPF	WL	MC (%)	Remarks
	0.3		FILL: 1 1/4" of Asphalt Pavement over 2 3/4" of Well Graded Sand with Silt and Gravel Base.				Base course bag sample: LL=NP,PL=NP,PI=NP P_{200}=10.6% MC=3.9%
	1.5		FILL: 14" of Gravel Subbase.	11/10/5		9.2	
	3.0	SM	SILTY SAND, fine-grained, nonplastic, brown, moist, loose. (Alluvium)	2/3/2		14.6	Composite subgrade bag sample ST-5 and ST-7: LL=NP,PL=NP,PI=NP P_{200}=19.7%
	5.5	GP	POORLY GRADED GRAVEL with SAND, fine- to coarse-grained, gray, moist, very dense. (Alluvium)	11/31/27		1.6	
			END OF BORING Water not observed with 4' of hollow-stem auger in the ground. Water not observed to dry cave-in depth of 1 1/2' immediately after withdrawal of auger.				

BORING BPF WL MC 2560.GPJ LAGNNN06.GDT 10/9/09



Gravel		Sand		
coarse	fine	coarse	medium	fine

Percent Passing U.S. Standard Sieve Size

3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#80	#100	#200
100	96	87	76	66	57	48	40	29	26	19.7

Boring No.: ST-5 and ST-7   Date Received: 07/15/2009
Sample No.: P-3
Depth: Subgrade

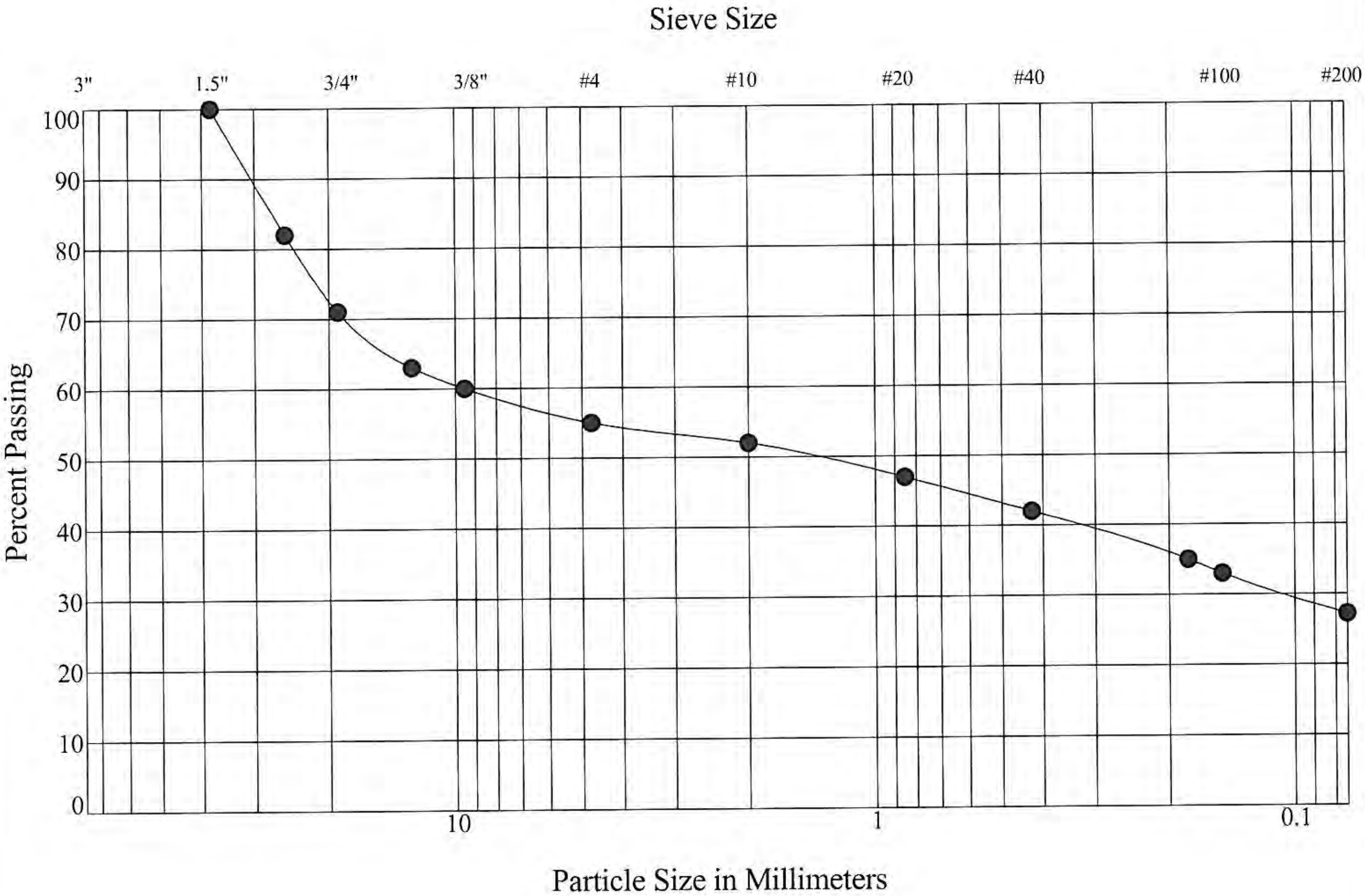
Percent Gravel: 34.0
Percent Sand: 46.3
Percent Silt + Clay: 19.7
ASTM Group Name: SILTY SAND with GRAVEL

Liquid Limit:	NP
Plastic Limit:	NP
Plasticity Index:	NP
Classification:	SM
Moisture Content:	

SK GEOTECHNICAL
2611 Gabel Road
P. O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

Sieve Analysis
Project Number: 09-2560
Lewis and Clark County Roads
Helena, Montana

10/9/09



Gravel		Sand		
coarse	fine	coarse	medium	fine

Percent Passing U.S. Standard Sieve Size

3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#80	#100	#200
	100	71	60	55	52	47	42	35	33	27.2

Boring No.: ST-6
Sample No.: Subgrade
Depth: Subgrade

Date Received: 07/15/2009

Liquid Limit:	33
Plastic Limit:	16
Plasticity Index:	17
Classification:	GC
Moisture Content:	

Percent Gravel: 45.0
Percent Sand: 27.8
Percent Silt + Clay: 27.2
ASTM Group Name: CLAYEY GRAVEL with SAND

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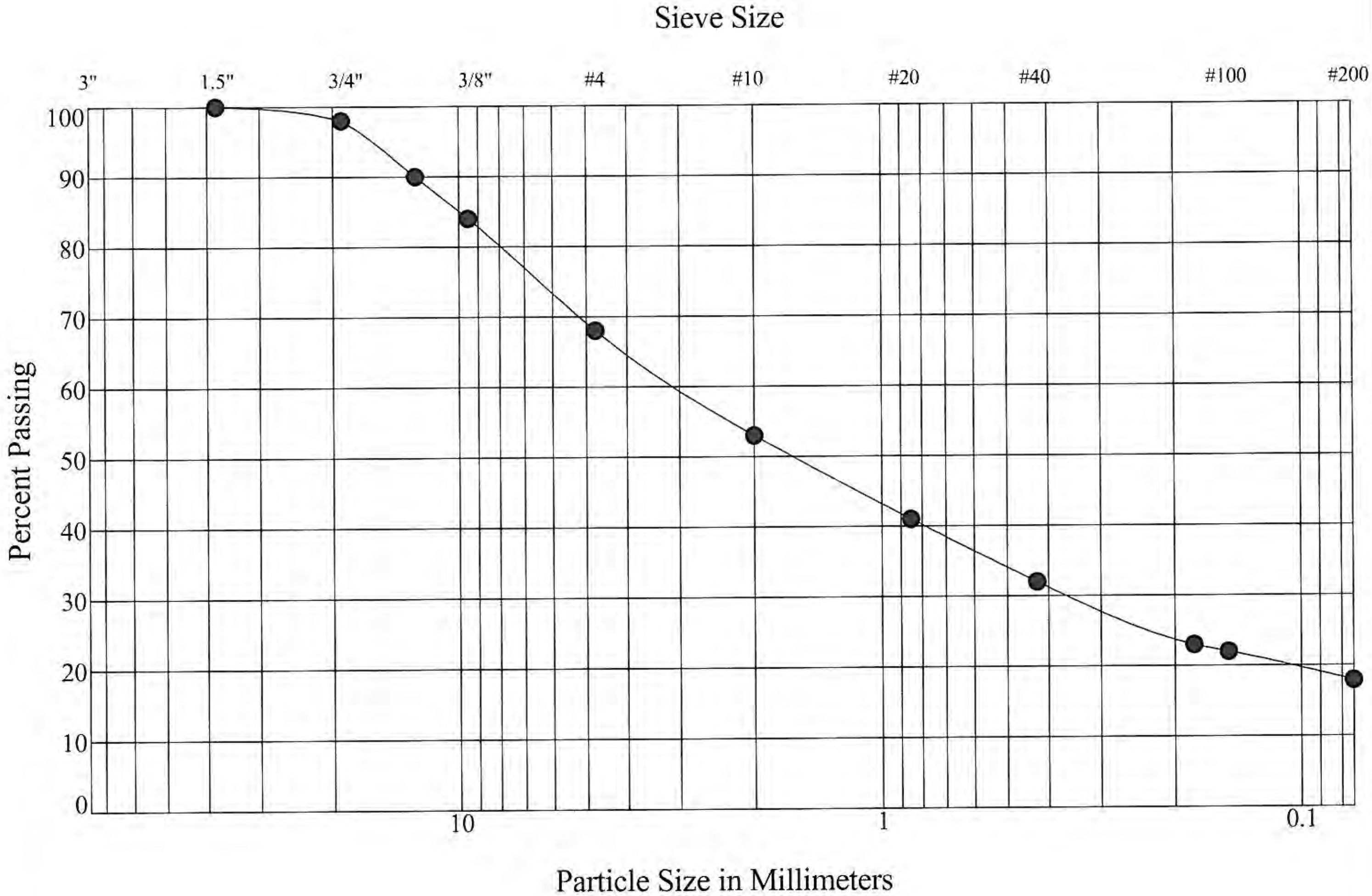
Sieve Analysis

Project Number: 09-2560
Lewis and Clark County Roads
Helena, Montana

10/9/09



Gravel		Sand		
coarse	fine	coarse	medium	fine

Percent Passing U.S. Standard Sieve Size

3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#80	#100	#200
	100	98	84	68	53	41	32	23	22	17.9

Boring No.: ST-6
Sample No.: Base Course
Depth: Base Course

Date Received: 07/15/2009

Liquid Limit:	24
Plastic Limit:	13
Plasticity Index:	11
Classification:	SC
Moisture Content:	5.0%

Percent Gravel: 32.0
Percent Sand: 50.1
Percent Silt + Clay: 17.9
ASTM Group Name: CLAYEY SAND with GRAVEL

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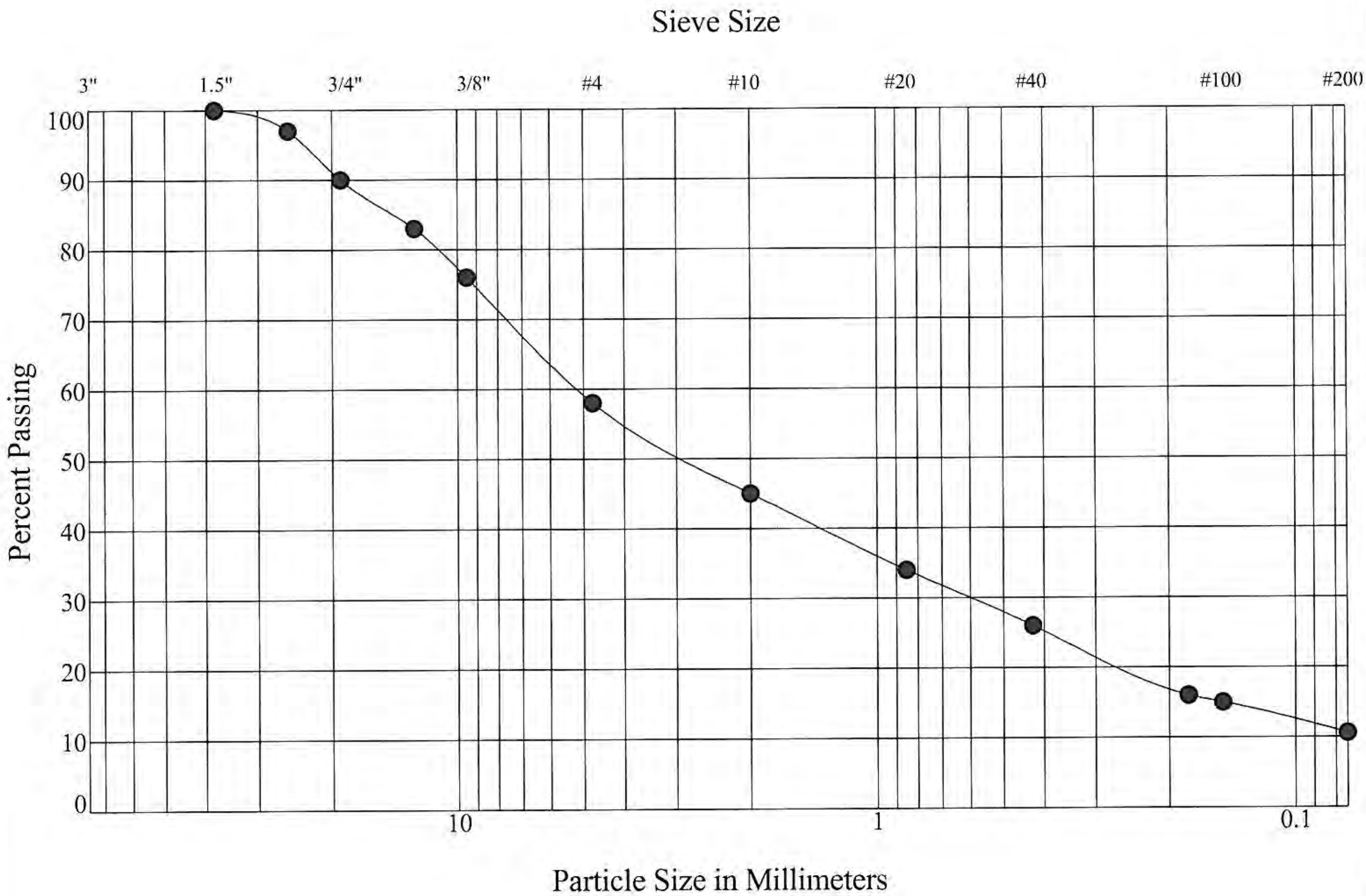

Gravel		Sand		
coarse	fine	coarse	medium	fine

Percent Passing U.S. Standard Sieve Size

3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#80	#100	#200
	100	90	76	58	45	34	26	16	15	10.6

Boring No.: ST-7 Date Received: 07/15/2009
Sample No.: Base Course
Depth: Base Course

Percent Gravel: 42.0
Percent Sand: 47.4
Percent Silt + Clay: 10.6
ASTM Group Name: WELL-GRADED SAND with SILT and GRAVEL

Liquid Limit:	NP
Plastic Limit:	NP
Plasticity Index:	NP
Classification:	SW-SM
Moisture Content:	3.9%

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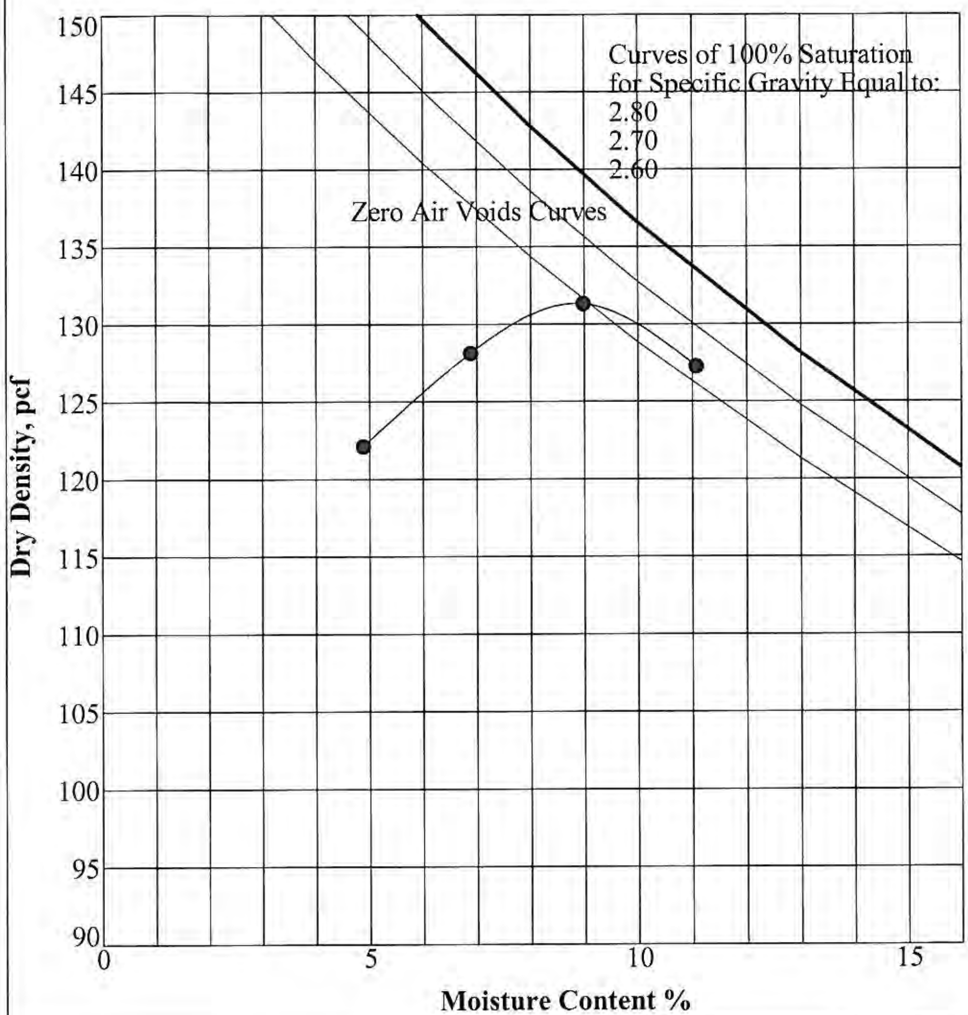
Sieve Analysis
Project Number: 09-2560
Lewis and Clark County Roads
Helena, Montana

10/9/09



ASTM D 4718 Oversize Correction

Maximum Dry Density, pcf	***Optimum Moisture Content %***
134.7	*8*

ASTM C 127

Coarse Specific Gravity = 2.61
Absorption = 1.0%

Fine Portion

ASTM D 698 Method C with Correction

Maximum Dry Density, pcf	Optimum Moisture Content %
131.3	9.0

Rammer Type: Mechanical
Preparation Method: Moist

Soil Description (Visual-Manual)

SILTY SAND with GRAVEL, fine- to coarse-grained, brown, moist.

Sieve Size	% Retained
1 1/2"	0
3/4"	12.9
3/8"	24
#4	34

Sample No:	---
Lab Sample No:	P-3
Date Sampled:	07/09/2009 and 07/10/2009
Sampled By:	Drill Crew
Date Received:	07/15/2009
Sampled From:	ST-5 and ST-7 McHugh Lane
Depth:	Subgrade
Performed by:	MBK/SKG
Date Performed:	07/29/2009

Comments

Additional Remarks

SK GEOTECHNICAL
2611 Gabel Road
P.O. Box 80190
Billings, MT 59108-0190
Phone: 406.652.3930
Fax: 406.652.3944

Laboratory Compaction Characteristics of Soil (Proctor)

Project No.: 09-2560
Lewis and Clark County Roads
Helena, Montana

PROCTOR

P-3

10/9/09

California Bearing Ratio Test

(ASTM D 1883 /AASHTO T 193)

Project: 09-2560 Lewis and Clark County Roads
McHugh Lane

Date: 10/09/09

Boring: ST-5 and ST-7 **Sample:** P-3 **Depth:** Subgrade

Sample Description: Silty Sand with Gravel, fine- to coarse-grained, brown, moist.
(Remolded to 95% relative compaction.)
(Sample was submersed in water and allowed to saturate for 96.8 hours.)

Maximum Dry Density: 131.3 pcf Procedure: ASTM D 698 Method C

Initial			**Final**		
Wt. Specimen + Tare Wet	575.7	gms	Wt. Specimen + Tare Wet	1951.0	gms
Wt. Specimen + Tare Dry	536.6	gms	Wt. Specimen + Tare Dry	1791.0	gms
Wt. Tare	139.7	gms	Wt. Tare	349.4	gms
Moisture Content	9.9%		Moisture Content	11.1%	

Initial Wt. 4625.4 gms Diameter 6.00 in Initial Ht. 4.58 in

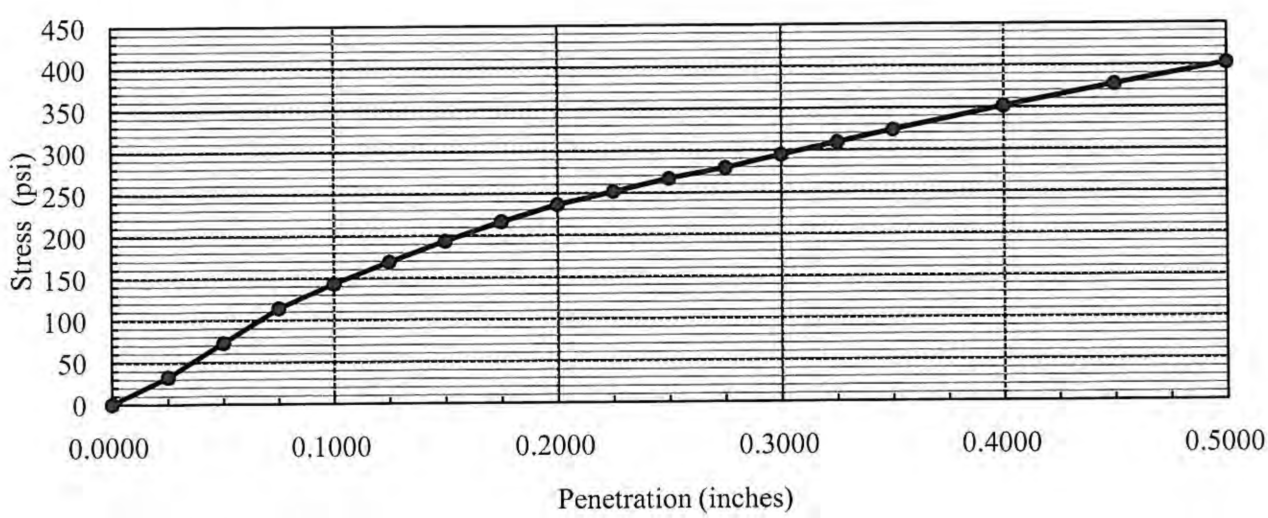
Initial Dry Unit Wt. 123.9 pcf Initial Relative Compaction 94.3%
Final Dry Unit Wt. 123.8 pcf Final Relative Compaction 94.3%

Swell Test

Surcharge Weight 22.5 lbs Surcharge Pressure 133.4 psf
Initial Dial Rdg. 0.5000 Final Dial Rdg. 0.5019 Swell 0.0%

CBR Test

Surcharge Weight 22.5 lbs Surcharge Pressure 128.1 psf
CBR @ 0.1 in. **14.3** CBR @ 0.2 in **15.8**



2611 Gabel Road, P. O. Box 80190, Billings, Montana 59108-0190
Phone (406) 652-3930; Fax (406) 652-3944

Laboratory Test of Aggregate

Date: October 13, 2009

Project: **09-2560 Pavement Evaluation**
McHugh Lane
Lewis and Clark County Road
Improvement Projects
Helena, Montana

To: Mr. Tom Cavanaugh
Robert Peccia & Associates
P. O. Box 5653
Helena, Montana 59604-5653

Copies:

Gradation (ASTM C 136)

Sieve Size	ST-6 Base Course	ST-7 Base/ Subbase Courses	12/18/2007 Lewis and Clark Subdivision: Crushed Top Surfacing	12/18/2007 Lewis and Clark Subdivision: Select Base Course
1 1/2"	100	100*	---	100
3/4"	98*	90	100	---
1/2"	90	83	---	---
No. 4	68*	58	40 – 70	25 – 60
No. 10	53	45	25 – 55	---
No. 40	32	26	---	---
No. 100	22	15	---	---
No. 200	17.9*	10.6*	2 – 10	2 – 12

Remarks: *Do not meet specifications.

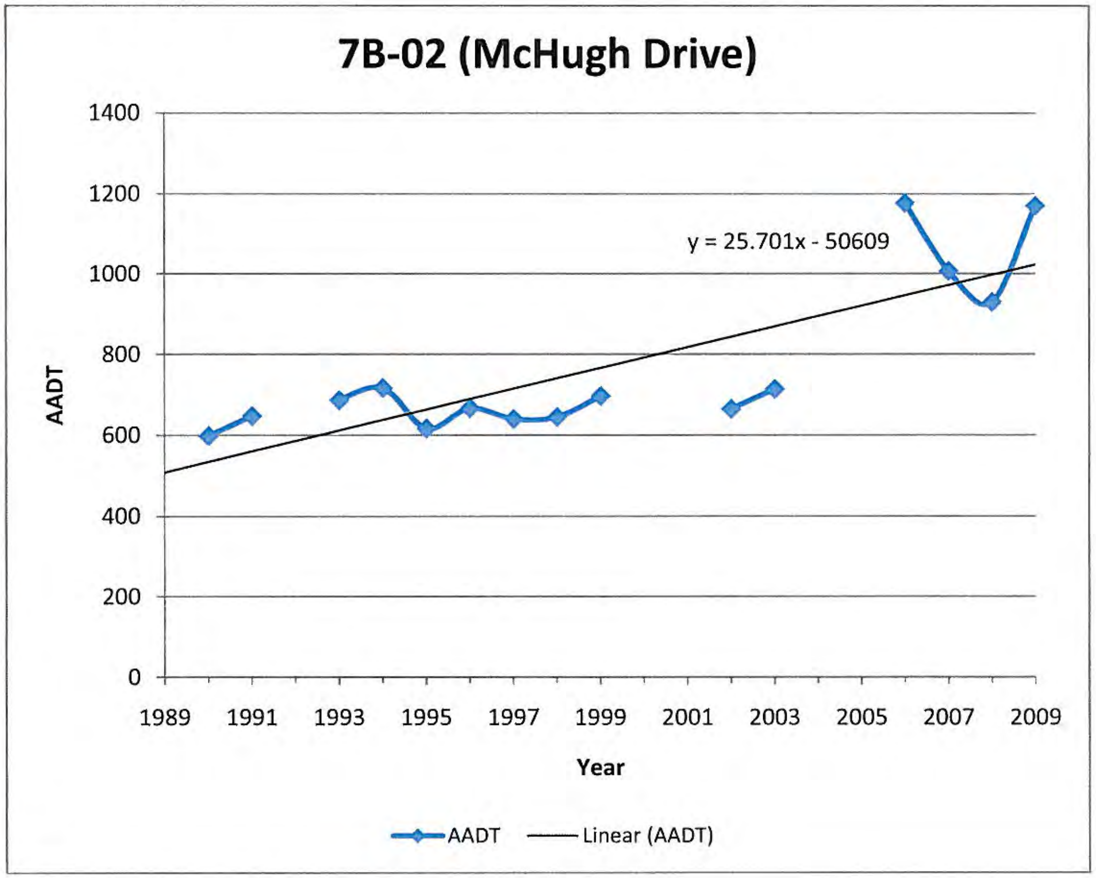
Basic Axle Class Summary: 7B-02

(DEFAULTB) Description	Lane	#1 Cycle	#2 Cars	#3 2A-4T	#4 Buses	#5 2A-SU	#6 3A-SU	#7 4A-SU	#8 4A-ST	#9 5A-ST	#10 6A-ST	#11 5A-MT	#12 6A-MT	#13 Other	Error	Total
TOTAL COUNT :	#1.	24	846	501	2	1	3	0	2	0	0	0	0	0	14	1395
	#2.	16	753	420	4	1	4	0	2	0	0	0	0	0	15	1216
		40	1599	921	6	2	7	0	4	0	0	0	0	0	29	2611
Percents :	#1.	2%	61%	36%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	53%
	#2.	1%	62%	35%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	47%
		2%	61%	35%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	
Average :	#1.	1	18	11	0	0	0	0	0	0	0	0	0	0	0	30
	#2.	0	16	9	0	0	0	0	0	0	0	0	0	0	0	25
		1	34	20	0	0	0	0	0	0	0	0	0	0	0	55
Days & ADT :	#1.	1.9	727													
	#2.	1.9	634													
		1.9	1362													

7B-02 (McHugh Drive - South of Forestvale Road)

Year	AADT
1989	
1990	598
1991	647
1992	
1993	686
1994	716
1995	616
1996	666
1997	639
1998	644
1999	696
2000	
2001	
2002	664
2003	713
2004	
2005	
2006	1177
2007	1007
2008	929
2009	1170
2029	**1538**

2009	1024
2029	1538
Yearly Growth Rate	**2.05%**



Class	Type	Description	Typical ESALs per Vehicle[2]
1	Motorcycles	All two- or three-wheeled motorized vehicles. Typical vehicles in this category have saddle type seats and are steered by handle bars rather than wheels. This category includes motorcycles, motor scooters, mopeds, motor-powered bicycles, and three-wheel motorcycles. This vehicle type may be reported at the option of the State.	0.0 negligible
2	Passenger Cars	All sedans, coupes, and station wagons manufactured primarily for the purpose of carrying passengers and including those passenger cars pulling recreational or other light trailers.	0.0003 negligible Table 0.4
3	Other Two-Axle, Four-Tire Single Unit Vehicles	All two-axle, four tire, vehicles, other than passenger cars. Included in this classification are pickups, panels, vans, and other vehicles such as campers, motor homes, ambulances, hearses, and carryalls. Other two-axle, four-tire single unit vehicles pulling recreational or other light trailers are included in this classification.	0.004 negligible Table 0.4
4	Buses	All vehicles manufactured as traditional passenger-carrying buses with two axles and six tires or three or more axles. This category includes only traditional buses (including school buses) functioning as passenger-carrying vehicles. All two-axle, four-tire single unit vehicles. Modified buses should be considered to be a truck and be appropriately classified.	0.57
5	Two-Axle, Six-Tire, Single Unit Trucks	All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having two axles and dual rear wheels.	0.26
6	Three-Axle Single Unit Trucks	All vehicles on a single frame including trucks, camping and recreational vehicles, motor homes, etc., having three axles.	0.42
7	Four or More Axle Single Unit Trucks	All trucks on a single frame with four or more axles.	0.42
8	Four or Less Axle Single Trailer Trucks	All vehicles with four or less axles consisting of two units, one of which is a tractor or straight truck power unit.	0.30
9	Five-Axle Single Trailer Trucks	All five-axle vehicles consisting of two units, one of which is a tractor or straight truck power unit.	1.20
10	Six or More Axle Single Trailer Trucks	All vehicles with six or more axles consisting of two units, one of which is a tractor or straight truck power unit.	0.93
11	Five or Less Axle Multi-Trailer Trucks	All vehicles with five or less axles consisting of three or more units, one of which is a tractor or straight truck power unit.	0.82
12	Six-Axle Multi-Trailer Trucks	All six-axle vehicles consisting of three or more units, one of which is a tractor or straight truck power unit.	1.06

13	Seven or More Axle Multi-Trailer Trucks	All vehicles with seven or more axles consisting of three or more units, one of which is a tractor or straight truck power unit.	1.39

Note 1: In reporting information on trucks the following criteria should used:

1. Truck tractor units traveling without a trailer will be considered single unit trucks.
2. A truck tractor unit pulling other such units in a "saddle mount" configuration will be considered as one single unit truck and will be defined only by the axles on the pulling unit.
3. Vehicles shall be defined by the number of axles in contact with the roadway. Therefore, "floating" axles are counted only when in the down position.
4. The term "trailer" includes both semi- and full trailers.

Note 2: Based on the overall ESAL per vehicle class for 10 weigh-in-motion (WIM) sites averaged over a one-year period. The averaging method treats all pavements the same (i.e., no separate LEFs for flexible and rigid pavements) and all axles as singles. This approach produces LEFs similar to the 1993 AASHTO Guide's LEFs for single axles assuming SN = 5 and p_t = 2.5.

Figure 4: FHWA Class 5

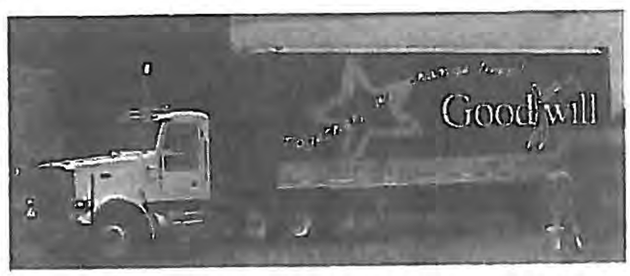


Figure 5: FHWA Class 8

Figure 6: FHWA Class 11

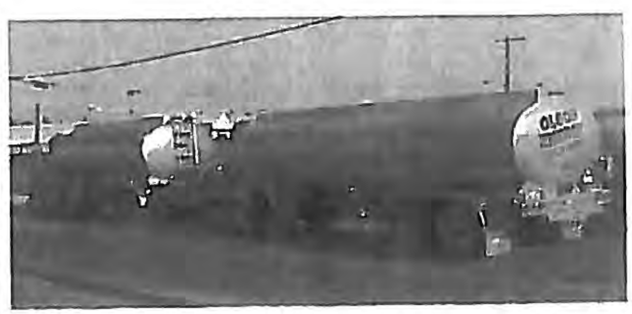


Figure 7: FHWA Class 10

==

DARWin(tm) - Pavement Design

A Proprietary AASHTOWARE(tm)
Computer Software Product

Flexible Structural Design Module

Project Description
McHugh Drive, Lewis and Clark County, Helena, Montana

Flexible Structural Design Module Data
18-kip ESALs Over Initial Performance Period: 22,150
Initial Serviceability: 4.2
Terminal Serviceability: 2.5
Reliability Level (%): 85
Overall Standard Deviation: .45
Roadbed Soil Resilient Modulus (PSI): 13,500
Stage Construction: 1

Calculated Structural Number: 1.37

Specified Layer Design
Layer: 1
Material Description: Asphalt Pavement
Structural Coefficient (Ai): .41
Drainage Coefficient (Mi): 1
Layer Thickness (Di) (in): 3.00
Calculated Layer SN: 1.23

Layer: 2
Material Description: Crushed Top Surfacing
Structural Coefficient (Ai): .14
Drainage Coefficient (Mi): 1
Layer Thickness (Di) (in): 3.00
Calculated Layer SN: .42

Layer: 3
Material Description: Select Base Course
Structural Coefficient (Ai): .07
Drainage Coefficient (Mi): .9
Layer Thickness (Di) (in): 6.00
Calculated Layer SN: .38

Layer: 4
Material Description: Subbase Course
Structural Coefficient (Ai): .07
Drainage Coefficient (Mi): .9
Layer Thickness (Di) (in): .00
Calculated Layer SN: .00

Total Thickness (in): 12.00
Total Calculated SN: 2.03

Rigorous ESAL Calculation
Initial Performance Period (years): 20
Initial Two-Way Daily Traffic (ADT): 1,024
Number of Lanes In Design Direction: 1
Percent of All Trucks In Design Lane (%): 50
Percent Trucks In Design Direction (%): 100
Growth: Simple

Class: 1

% of ADT: 1.53
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .0001
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 7

Class: 2
% of ADT: 62
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .0003
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 831

Class: 3
% of ADT: 35.66
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .004
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 6,374

Class: 4
% of ADT: .23
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .57
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 5,858

Class: 5
% of ADT: .08
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .26
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 929

Class: 6
% of ADT: .27
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .42
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 5,067

Class: 7
% of ADT: 0
Annual % Growth: 0
Average Initial Truck Factor (ESALs/truck): .42
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 0

Class: 8
% of ADT: .23
Annual % Growth: 2.05
Average Initial Truck Factor (ESALs/truck): .3
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 3,083

Class: 9
% of ADT: 0
Annual % Growth: 0
Average Initial Truck Factor (ESALs/truck): 1.2
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 0

Class: 10
% of ADT: 0
Annual % Growth: 0
Average Initial Truck Factor (ESALs/truck): .93
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 0

Class: 11
% of ADT: 0
Annual % Growth: 0
Average Initial Truck Factor (ESALs/truck): .82
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 0

Class: 12
% of ADT: 0
Annual % Growth: 0
Average Initial Truck Factor (ESALs/truck): 1.06
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 0

Class: 13
% of ADT: 0
Annual % Growth: 0
Average Initial Truck Factor (ESALs/truck): 1.39
Annual % Growth in Truck Factor: 0
Accumulated 18K ESALs over Performance Period: 0

Total % of ADT (should be 100): 100.00
Cumulative Esals for all Classes: 22,150

Appendix D

Cost Estimates

McHugh Lane Reconstruction Cost Estimate

Major Work Feature	Unit	Unit Cost	Number of Units: Typical A	Typical B	Typical C	Typical D	Total	Total Cost
Survey - Staking and Grade Control	MI	$15,000.00	0.30	1.00	0.50	0.50	2.30	$34,500
Topsoil - Salvage and Place	CY	$4.05	645	2,200	1,124	733	4,703	$19,048
Excavation - Unclassified	CY	$5.50	4,694	13,922	8,202	3,265	30,082	$165,451
MPDES Permit Fees	LS	$900.00	1	1	1	1	4	$3,600
Temporary Erosion Control - LS	LS	$4,000.00	1	1	1	1	4	$16,000
Select Base Course	CY	$12.00	1,129	3,764	1,882	1,882	8,658	$103,899
Crushed Top Course	CY	$25.41	815	2,121	1,149	1,015	5,100	$129,585
Aggregate Treatment (Prime)	SY	$0.41	6,016	20,052	10,026	10,026	46,120	$18,909
Asphalt Tack Coat	SY	$0.10	5,824	19,413	9,706	9,706	44,649	$4,465
Chip Seal & Cover	SY	$2.00	5,632	18,773	9,387	9,387	43,179	$86,357
Plant Mix Asphalt Paving	Ton	$81.38	1,222	3,499	1,845	1,711	8,277	$673,602
Reset Mailbox	Each	$200.83	8	10	8	4	29	$5,824
Traffic Gravel	CY	$19.03	430	1,434	717	717	3,298	$62,765
Remove/Reset Signs	Each	$184.30	1	3	4	6	14	$2,580
Interim Striping - Yellow Paint	Gal	$34.18	13	42	21	21	97	$3,321
Final Striping - Yellow Paint	Gal	$34.18	13	42	21	21	97	$3,321
Interim Striping - White Paint	Gal	$34.30	13	42	21	21	97	$3,332
Final Striping - White Paint	Gal	$34.30	13	42	21	21	97	$3,332
Remove Existing Culverts	LF	$6.00	840	1,184	840	448	3,312	$19,872
Approach/Relief Drain Pipe - 18/24 In.Dia.	LF	$50.17	840	1,120	840	448	3,248	$162,952
Drainage Pipe 24 Inch Dia.	LF	$50.00	0	64	0	0	64	$3,200
Drainage Pipe 36 Inch Dia.	LF	$96.79	0	64	64	164	292	$28,263
Dbl. Concrete Box Culvert 7' x 3'	LF	$1,500.00	0	64	0	0	64	$96,000
Farm Fence - Type Type 5M	LF	$2.25	0	9,874	2,640	0	12,514	$28,156
Fence Panel	Each	$145.92	0	30	8	0	38	$5,533
Seeding	Acre	$294.16	1.82	6.06	3.03	1.82	12.73	$3,744
Fertilize Seed	Acre	$120.84	1.82	6.06	3.03	1.82	12.73	$1,538
Condition Seedbed Surface	Acre	$221.51	1.82	6.06	3.03	1.82	12.73	$2,819
Geotextile - Subgrade Stabilization	SY	$1.50	4,224	9,387	4,693	3,520	21,824	$32,736
Subgrade Stabilization Gravel (14 - inch Depth)	CY	$8.00	1,643	3,650	1,825	1,369	8,487	$67,897
Subexcavation	CY	$5.50	1,643	3,650	1,825	1,369	8,487	$46,679
Subtotal - Construction	**$/Segment**		**$274,276**	**$835,044**	**$400,722**	**$329,238**		**$1,839,280**
Final Engineering, Geotec. & Survey	LS	8.00%	$21,942	$66,804	$32,058	$26,339		$147,142
Construction QA/QC	LS	4.00%	$10,971	$33,402	$16,029	$13,170		$73,571
Contractor Mobilization	LS	5.00%	$13,714	$41,752	$20,036	$16,462		$91,964
Contingency	LS	10.00%	$27,428	$83,504	$40,072	$32,924		$183,928
Traffic Control During Construction	LS	8.00%	$21,942	$66,804	$32,058	$26,339		$147,142
Right-of-Way Appraisals by Agent	Each	$2,000.00	0	31	9	0	40	$80,000
Right-of-Way Acquisition by Agent	Each	$1,500.00	0	31	9	0	40	$60,000
Purchase Right-of-Way	Acre	$32,000.00	0.00	2.27	0.57	0.00	2.84	$90,773
Total Estimated Cost (2011)	**$/Segment**		**$ 370,272**	**$ 1,308,343**	**$ 590,715**	**$ 444,471**		**$2,713,801**

Unit Costs are 2010 Estimates. The County may periodically update unit prices.

Additional Alternate Costs

Major Work Feature	Unit	Unit Cost	Number of Units: Typical A	Typical B	Typical C	Typical D	Total	Total Cost
Traffic Signal	LS	$68,000.00					1	$68,000
Turn Lane	LS	$100,000.00					1	$100,000
Sanitary Sewer Main	MI	$211,200.00	0.30	1.00	0.50	0.50	2.30	$485,760
Water Main	MI	$396,000.00	0.30	1.00	0.50	0.50	2.30	$910,800
Bicycle/Ped. Path Reconstruction	MI	$77,825.00	0.30	1.00	0.50	0.50	2.30	$178,998