OT PHASE ACTIVITY 106 PRELIMINARY GEOTECHNICAL AND MATERIALS REPORT

Lockwood Interchange – Billings
STPX 90-8(91)450, MDT UPN 9588000
Billings, Montana
Project 19-3792S

Submitted by

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Prepared for

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July 27, 2020

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July 27, 2020 Project 19-3792S

Mr. Timothy Erickson, PE
HDR Engineering, Inc.
970 South 29th Street W
Billings, Montana 59102
Via Email: timothy.erickson@hdrinc.com

Dear Mr. Erickson:

Re: OT Phase Activity 106 Preliminary Geotechnical and Materials Report, Lockwood Interchange – Billings, Yellowstone County, Montana, STPX 90-8(191)450, MDT UPN 9588000

The geotechnical and materials work for the OT Phase Activity 106 for the above-referenced project has been completed. Our report was completed in general accordance with Montana Department of Transportation (MDT) Procedure MT-207, MDT's Consultant Design Guidelines for Activity 106, MDT's Geotechnical Manual, and MDT's Pavement Design Manual. This work has also been conducted and prepared in accordance with our internal Geotechnical Engineering Quality Plan.

The attached report contains the following information.

- Results of soil borings performed along the existing I-90 present travelled way, median, and existing on- and off-ramps.
- Results of soil borings performed on US Highway 87.
- Results of laboratory tests performed on recovered representative samples.
- Culvert inspection, corrosion tests, and topsoil survey results.
- Recommendations for constructing new roadway widened embankments and median infilling.
- Recommendations for pavement design for both total reconstruction and minor rehabilitation.
- Recommendations for future fill slopes as well as shrinkage.

Project stationing was very preliminary during the development of this report and is not final. Therefore, station and offset information was not included on the boring logs. After final alignment is set and project stationing becomes available, project stationing will be incorporated into our future work.

Thank you for using SK Geotechnical. If you have any questions regarding this report, or require additional services, please contact Dustin Hutzenbiler or Cory Rice at (406) 652-3930.

Sincerely,

Dustin P. Hutzenbiler, PE
Geotechnical Engineer

Cory G. Rice, PE
Senior Engineer

Attachment:
Draft OT Phase Activity 106 Geotechnical and Materials Report

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A. Introduction

A.1. Project

The project is located in east Billings, Yellowstone County, Montana, and extends from just west of the Lockwood Interchange at about reference point (RP) 452.75 to the Johnson Lane Interchange at approximately RP 455.1. The project also includes major improvements to US Highway 87 with the preliminary preferred major improvement to include a new diverging diamond interchange. The improvements to US Highway 87 generally extend from the intersection of US Highway 87 and Lockview Lane to about 500 feet west of the intersection of US Highway 87 and Interstate 90 Frontage Road. The improvements also include major upgrades to Ramps A and C. The relative extent of the project improvements are shown on the attached Alternative Design Sheets in Appendix 1.

The project is currently being evaluated under the Other (OT) Phase to evaluate improvement options to the Lockwood Interchange and prepare preliminary construction estimates. It is desired to widen I-90 to three lanes in both the eastbound (EB) and westbound (WB) directions as a continuation of the I-90 Yellowstone R - Billings project to the west. The alignment is generally planned to follow the existing Present Traveled Way (PTW) with added capacity in all directions.

A.2. Scope of Services and Background

SK Geotechnical is providing the geotechnical and soil survey services for the OT Phase of the Lockwood Interchange – Billings project in accordance with our revised proposal to HDR Engineering, Inc., dated July 15, 2019. Our scope of services for the OT Phase Activity 106 work consists of the following.

- Performing an engineering reconnaissance of the proposed alignments, as well as reviewing available project information, and topographic and geologic maps of the area.
- Performing topsoil survey, culvert inspection, and obtaining soil samples for corrosion tests at existing culverts.
- Conducting the following borings along the project (The boring number sequence was started at ST-42, since the adjacent I-90 Yellowstone R – Billings project used ST-1 through ST-41):
  - Borings ST-42 through ST-50 along the eastbound PTW.
  - Borings ST-55 through ST-62 along the westbound PTW.
  - Borings ST-67 through ST-70 along the existing median between the eastbound and westbound lanes.
  - Boring ST-71 along the eastbound on-ramp and ST-72 along the westbound off-ramp.
  - Borings ST-73 through ST-76 along US Highway 87.
- Conducting laboratory tests consisting of moisture content, sieve analysis, Atterberg limits, specific gravity, moisture-density curves, corrosion, and California bearing ratio.

- Provide pavement sections for the following areas:
  - US Highway 87
  - Lockwood Interchange on- and off-ramps
  - I-90 eastbound and westbound main line and widening
  - 30-year bridge ends
- Preparing this OT Phase Activity 106 Preliminary Geotechnical and Material Report containing the following:
  - Summary of our engineering reconnaissance,
  - Log of Boring sheets,
  - Summary of laboratory test results, and
  - Preliminary pavement typical section alternatives, and
  - Preliminary geotechnical recommendations for cut and fill slopes, shrinkage, and asphalt cement content.

A.3. Available Information

HDR provided us with the following documents as this project proceeded. The documents are summarized below.

- Preliminary Geotechnical and Materials Report Consultant Activity 106 report for the Billings Bypass, prepared by DOWL, dated March 2017.
- Alternative I-1: I-90 Widening Inside Conceptual Plan, dated June 2, 2020.
- Alternative 2: Lockwood Diverging Diamond Interchange Concept Plan, dated June 1, 2020.
- Traffic information data for Lockwood Interchange given to HDR by the Montana Department of Transportation (MDT), dated February 18, 2020.
- Preliminary Typical Sections for I-90 widening.

Additionally, SK Geotechnical provided geotechnical services for the adjacent I-90 Yellowstone R - Billings project, and several documents were reviewed for this project. Some of the data is included in Appendix 1, particularly pertinent boring logs performed at the Lockwood Interchange.

B. Reconnaissance and Review of Available Information

B.1. General

Mr. Cory G. Rice, PE, a senior engineer with our firm, and Mr. Dustin P. Hutzenbiler, PE, a geotechnical engineer with our firm, reviewed the topographic and geologic maps of the area and reviewed the project

area during the initial project scoping. An engineering reconnaissance of the alignment was then performed by our personnel. Boring locations and depths were selected at that time. Topsoil survey, culvert inspection, and current pavement conditions were later performed and observed by Mr. Hutzenbiler and Mr. Brandon R. Western, EI, an engineering intern with our firm.

B.2. General Site Conditions and Geology

B.2.a. Geology. A portion of the *Geologic Map of the Billings 30' x 60' Quadrangle, Montana*, by David A. Lopez, prepared by the United States Geological Survey (USGS), 2000, is included in Appendix 1. The geologic map suggests the entire project is situated within the Second Terrace alluvial deposits of the Yellowstone River. Also, the map indicates some colluvium may be present near the eastbound off-ramp at the Lockwood Interchange.

The Second Terrace alluvial deposits are described as having "Gravel underlying terraces about 20 to 40 feet above present elevation of Yellowstone River. Mostly cobbles and pebbles with minor amounts of sand and silt. Clasts are mainly granitic igneous rocks, granitic gneiss, schist, and quartzite, with much less limestone and sandstone. 40 to 60 feet thick."

B.2.b. Topography. The topographic map prepared by USGS indicates the existing PTW generally travels through relatively flat to gently sloping terrain.

B.3. Boring Locations

Table 1 below summarizes the alignment boring locations and gives a brief description of each surrounding area. Photographs of each boring were taken and are included in Appendix 1 of this report. The boring locations are shown on the preliminary plan drawings also included in Appendix 1.

Table 1. Alignment Soil Borings

Boring	Reference Point	Description
I-90 and Ramp Alignments		
ST-42	453.2, EB, Left	PTW Boring
ST-43	453.4, EB, Shoulder	Pavement Shoulder Boring
ST-44	453.6, EB, Right	PTW Boring
ST-46	454.0, EB, Shoulder	Pavement Shoulder Boring
ST-47	454.3, EB, Right	PTW Boring
ST-48	454.7, EB, Left	PTW Boring
ST-49	454.8, EB, Shoulder	Pavement Shoulder Boring
Borings Designated ST-51, 52, 53, 54 are being reserved for the eastbound lanes to be performed during Activity 130		
ST-55	453.1, WB, Shoulder	Pavement Shoulder Boring
ST-56	453.4, WB, Left	PTW Boring
ST-57	453.7, WB Shoulder	Pavement Shoulder Boring
ST-58	453.8, WB, Right	PTW Boring
ST-59	454.1, WB, Left	PTW Boring
ST-60	454.4, WB, Shoulder	Pavement Shoulder Boring
ST-61	454.5, WB, Right	PTW Boring
ST-62	454.9, WB, Left	PTW Boring
Borings Designated ST-63, 64, 65, 66 are being reserved for the westbound lanes to be performed during Activity 130		
ST-67	453.5, Median	Off-Road Boring
ST-68	453.8, Median	Off-Road Boring
ST-69	454.3, Median	Off-Road Boring
ST-70	454.8, Median	Off-Road Boring
ST-71	452.9, EB On-Ramp, Ramp B	Lockwood Interchange PTW Boring
ST-72	452.9 WB Off-Ramp, Ramp A	Lockwood Interchange PTW Boring
Old US Highway 87 Alignment		
ST-73	Old US Highway 87 North Approach	PTW Boring
ST-74	Old US Highway 87 North Approach	PTW Boring
ST-75	Old US Highway 87 South Approach	PTW Boring
ST-76	Old US Highway 87 South Approach	PTW Boring

Boring locations were selected in the office by our personnel during scoping and later staked in the field by Mr. Western and Mr. Eddie K. Coldwell, EI, an engineering intern with our firm. Sanderson Stewart then surveyed the drilled locations and provided us with the locations and elevations of each boring and these locations are shown on the Log of Boring sheets in Appendix 1. We wish to point out that at the time of this report, project stationing has not been finalized. Therefore, project stationing and offset at each boring location will be added as the project progresses.

In addition to these Borings, pertinent borings from the adjacent I-90 Yellowstone R - Billings and Billings Bypass projects were also reviewed. For the I-90 Yellowstone R - Billings project, Borings ST-16 and ST-17 were performed in the eastbound I-90 PTW and Borings ST-32 and ST-33 were performed in the existing westbound PTW. At the Lockwood Interchange, Borings ST-40, ST-138, and ST-140 through ST-142 were performed for Ramp C and Boring ST-41 was performed for Ramp D. Borings ST-206 and ST-207 were performed along US Highway 87 in the eastbound lane southeast of the overpass.

For the Billings Bypass project, DOWL performed several borings near the Johnson Lane Interchange. Borings BH-20, BH-22, BH-29, and BH-30 were performed for the Billings Bypass project in the existing I-90 eastbound and westbound PTW and are included in this report.

B.4. Existing Fill Slopes/Embankments

Along I-90, the existing embankments and side slopes are generally limited to less than about 5 to 10 feet with the exception of the Lockwood Interchange where embankment heights are much taller. Two larger existing embankments were observed along the interchanges, one along the westbound off-ramp, Ramp A, and one along the eastbound on-ramp, Ramp B. The existing sideslopes along Ramp A are currently standing at approximately 2H:1V (Horizontal:Vertical) with some areas appearing to be slightly steeper. During our field reconnaissance, vegetation was relatively thick, which made observations of the existing slopes for any instability difficult to observe. However, signs of slope stability were not readily observed in the fill slopes or on available aerial image. On the south side of Ramp A, two larger erosion channels were observed. One of these channels was created by heavy rains in late June 2020 and extend vertically from the pavement edge just behind the guardrail.

At Ramp B, current sideslopes were generally noted to be 3H:1V, or flatter and appeared stable. Additionally, the vegetation was mowed and the surface more readily observed. Based on the anticipated construction of the new diverging diamond interchange, significant widening of Ramp A will be required to construct the westbound off-ramp approach to US Highway 87. This will likely require the use of retaining walls and/or steeper sideslopes in order to limit the need for additional right-of-way (ROW).

Along Ramps B and D, total reconstruction of the pavement surface is anticipated, to accommodate new lane configurations and improve vertical and horizontal grades.

B.5. Pavement and Soils

Log of Boring sheets indicating the depth and identification of various pavement, soil strata, penetration resistances, laboratory test data, and water level information are included in Appendix 1 and summarized on Form 111. Photographs of borings and features are also included in Appendix 1. It should be noted, 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.

B.5.a. Existing Pavement. Along the I-90 eastbound and westbound alignments, the existing plant mix surfacing (PMS) ranged in thickness from about 8 1/4 to 11 1/4 inches. The PMS was generally underlain by existing crushed top surfacing and base/subbase coarse ranging from about 34 1/2 to 60 inches below current grades. Along Ramps A and B, the existing PMS ranged in thickness from 11 to 11 1/2 inches and was underlain by existing base/subbase extending to depths ranging from about 19 to 21 1/2 inches. Along Ramp C and D, the existing PMS ranged in thickness from 10 1/2 to 11 1/4 inches and was underlain by crushed top surfacing and base course to depths of about 3 1/2 feet. Along Old Highway 87 the existing PMS ranged in thickness from 5 1/2 to 7 1/2 inches and was underlain by existing base/subbase extending to depths ranging from about 23 1/4 to 36 inches. Portland cement concrete pavement (PCCP) was also encountered along US Highway 87 near the western limits of the project and consisted of 9 1/2 inches of PCCP over 3 1/2 inches of sand leveling course followed by existing base course to about 4 feet. We wish to point out differentiating between existing base and subbase materials could not be clearly identified in all of the borings as the materials are fairly similar.

B.5.b. Existing Pavement Condition. We observed the existing pavement condition along the eastbound and westbound lanes of I-90, Ramps A and B at the Lockwood Interchange and US Highway 87. Along the eastbound lane of I-90, we judged the existing pavement to generally be in good condition with rutting generally noted to be less than 1/4-inch, and transverse cracking generally noted to be on about 75- to 150-foot centers. However, in some isolated areas the transverse cracking was observed at a closer spacing of about 25- to 50-foot centers. The majority of the transverse cracks were also noted to only extend partially into the eastbound lanes from the shoulder. It appears that a recent chip seal may have covered the original cracks and/or reflection cracking from the underlying PMS is beginning to reflect through.

Along the I-90 westbound lanes, rut depths were generally noted to be less than 1/4-inch. Transverse cracking was generally more frequent than the eastbound lanes and was observed on about 50- to 100-foot centers with some isolated areas noted to be 25- to 50-foot centers. Minor longitudinal cracking was also observed and was primarily isolated to the transitions from the interstate to the ramps at Johnson Lane Interchange. It appears that the longitudinal cracks are predominantly associated with past overlay projects at the longitudinal joints from the overlay ribbons. We judged the westbound lanes to generally be in good condition with some areas of fair condition.

We also observed the pavement conditions at Ramp A and B for the project. Along Ramp A, transverse cracks were observed on 25- to 50-foot centers and rut depths were generally noted to be less than 1/4-inch. Crack widths were generally observed to be between 1/4- and 1 inch and some were crack sealed. We judged Ramp A to be in generally fair to good condition. Along Ramp B, transverse cracks were observed on 30- to 60-foot centers and rut depths were generally observed to be less than 1/4-inch. Crack widths were generally less than about 3/4-inch. We judged the pavement condition at Ramp B to also be in primarily fair to good condition.

We also observed the pavement condition along US Highway 87. The surface of US Highway 87 within the project limits was recently improved northwest of the bridge with a 0.20-foot mill and fill and southwest of the bridge with a seal and cover as part of the West Billings Interchange – Pine Hills Interchange project completed in 2018/2019. We judged the existing pavement along US Highway 87 to be in generally good condition at the surface, but frequent transverse and longitudinal cracks were beginning to reflect through to the surface southwest of the bridge. Also, a few minor patches and potholes were observed. Based on the observed pavement distress, the condition of the recovered core samples and stripping analysis, we judged the deeper pavement to generally be in poor to fair condition with extensive cracking likely present between the east bridge end and Coburn Road. Between the north bridge end and the intersection of the I-90 Frontage Road, the pavement was judged to be in good condition. Additionally, PCCP is present from the intersection of I-90 Frontage Road to the end of the project. The PCCP is judged to be in good condition, however surface wearing of the traction grooves was readily observed in wheel paths.

B.5.c. Soils Beneath Existing Pavement. Beneath the existing pavement section at the 26 borings performed for this project along the main lines, center median, shoulders, and ramps, and the relevant borings from the I-90 Yellowstone – R and Billings Bypass projects, the general soil profile encountered was primarily fine-grained sandy lean clay, lean clay with sand, and clayey sand. Of the 26 borings performed, 20 of the borings had subgrade soils classifying as A-6 or A-7 soils. The remaining borings classified as A-2 or A-1 over A-2 soils. These soils were encountered at isolated locations along the alignment, however. Additionally, of the most relevant borings from nearby projects, the subgrade soils were all classified as A-6 or A-7 soils. The subgrade soils beneath the pavement section along I-90 were generally found to be moist to wet and ranged from about 3 percent below optimum to 11 percent over optimum moisture content, but were primarily found to be wet and 3 to 7 percent over optimum. Additionally, liquidity indexes ranged from -1.2 to 0.38, indicating there is a higher risk of subgrade failure during total reconstruction. Table 2 contains a more detailed summary of the subgrade conditions encountered at the PTW boring locations. This table has assisted us in evaluating subgrade conditions anticipated along the alignment for total reconstruction and whether or not subgrade stabilization is recommended.

Table 2. Existing PTW Pavement and Anticipated Subgrade Conditions – I-90 PTW

Boring	ST-42	ST-43	ST-44	ST-45	ST-46	ST-47	ST-48	ST-49
Location	I-90E, Passing Lane	I-90E, Shoulder	I-90E, Driving Lane	I-90E, Passing Lane	I-90E, Shoulder	I-90E, Driving Lane	I-90E, Passing Lane	I-90E, Shoulder
Date Drilled	5/5/20	5/4/20	5/4/20	5/6/20	5/5/20	5/5/20	5/6/20	5/5/20
Station, Offset	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
Existing PMS	0.9' (10½")	0.6' (7½")	0.7' (8¾")	0.9' (10½")	0.8' (9")	0.9' (10½")	0.7' (8½")	0.7' (8¼")
Existing Top Surfacing	0.1' (1¾")	0.2' (1½")	---	0.1' (1½")	---	0.1' (1")	0.2' (2")	0.1' (1½")
Existing Base/Subbase	4.2'	2.7'	3.1'	3.0'	3.0'	3.5'	3.2'	3.2'
Total Thickness	**5.2'**	**3.5'**	**3.8'**	**4.0'**	**3.8'**	**4.5'**	**4.1'**	**4.0'**
Subgrade[(1)]								
Description	Sandy Lean Clay/Clayey Sand	Sandy Lean Clay/Clayey Sand	Fill: Clayey Sand with Gravel/Fill: Lean Clay with Sand	Fill: Sandy Lean Clay/Lean Clay	Fill: Sandy Lean Clay/Lean Clay with Sand	Fill: Lean Clay with Sand/Lean Clay	Fill: Lean Clay with Sand/Sandy Lean Clay	Sandy Lean Clay/Clayey Sand
ASTM Class	CL/SC	CL/SC	SC/CL	CL	CL	CL	CL	CL/SC
AASHTO Class	A-6	A-6	A-2/A-6	A-6	A-6	A-6	A-6	A-6/A-2
N-Values	26/5,4	30, 14/4	12/10	11/10	13/7	14, 10	8, 13	10/4
Consistency	Very Stiff/Loose	Very Stiff to Stiff/Loose	Medium Dense/Stiff	Stiff	Stiff/Medium Stiff	Stiff	Medium Stiff/Stiff	Stiff/Loose
Moisture Content	11%, 12%	16%, 11%	13%, 16%	16%, 15%	19%, 22%	20%, 21%	20%, 16%	19%, 14%
Optimum Moisture Content (Approximate)	13%	13%	11%	15%	11%	14%	18%	14%
Liquidity Index	---	0.06	0.21	0.04	0.38	0.35	-0.01	0.11
Risk of Subgrade Failure During Total Reconstruction	Low	Low	Moderate	Low	High	High	Low	Moderate

[(1)]Anticipated subgrade at a depth of about 2 to 3 feet below existing pavement surface/topsoil.

Table 2. Existing PTW Pavement and Anticipated Subgrade Conditions – I-90 PTW Continued.

Boring	ST-55	ST-56	ST-57	ST-58	ST-59	ST-60	ST-61	ST-62
Location	I-90W, Shoulder	I-90W, Passing Lane	I-90W, Shoulder	I-90W, Driving Lane	I-90W, Passing Lane	I-90W, Shoulder	I-90W, Driving Lane	I-90W, Passing Lane
Date Drilled	5/8/20	5/11/20	5/8/20	5/8/20	5/11/20	5/8/20	5/8/20	5/11/20
Station, Offset	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
Existing PMS	0.9' (11¼")	0.7' (8½")	0.7' (8¼")	0.7' (8½")	0.7' (8½")	0.7' (9¼")	0.8' (10")	0.7' (8½")
Existing Top Surfacing	---	0.1' (1½")	0.2' (1¾")	0.2' (1¾")	0.1' (1")	0.14' (1")	0.2' (1½")	0.1' (1½")
Existing Base/Subbase	3.1'	3.3'	3.2'	3.3'	3.7'	3.2'	3.3'	3.2'
Total Thickness	**4.0'**	**4.1'**	**4.0'**	**4.2'**	**4.5'**	**4.0'**	**4.3'**	**4.0'**
Subgrade[(1)]								
Description	Fill: Poorly Graded Gravel with Silt and Clay	Clayey Sand	Fill: Sandy Lean Clay	Fill: Sandy Lean Clay/Sandy Lean Clay	Fill: Sandy Lean Clay/Fill: Clayey Sand	Fill: Sandy Lean Clay/Clayey Sand	Fill: Sandy Lean Clay	Fill: Lean Clay with Sand /Clayey Sand
ASTM Class	GP-GC	SC	CL	CL	CL/SC	CL/SC	CL	CL/SC
AASHTO Class	A-1	A-6	A-6	A-6	A-6/A-2	A-6/A-2	A-6	A-6/A-2
N-Values	26, 6	14, 5	13, 10	9/17	23/18	7/15	10	8/6
Consistency	Medium Dense to Loose	Medium Dense to Loose	Stiff	Stiff/Very Stiff	Very Stiff/Medium Dense	Medium Stiff/Medium Dense	Stiff	Medium Stiff/Loose
Moisture Content	6%, 13%	15%, 18%	17%, 20%	21%, 17%	17%, 11%	3%, 21%	15%, 20%	23%, 19%
Optimum Moisture Content (Approximate)	6%	13%	15%	14%	13%	16%	13%	19%
Liquidity Index	---	0.30	0.16	0.34	0.21	0.12	0.12	0.22
Risk of Subgrade Failure During Total Reconstruction	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate

Table 2. Existing PTW Pavement and Anticipated Subgrade Conditions – I-90 PTW Continued.

Boring	ST-16[2]	ST-17[2]	ST-32[2]	ST-33[2]	BH-20[3]	BH-22[3]	BH-29[3]	BH-30[3]
Location	I-90 EB	I-90 EB	I-90 WB	I-90 WB	I-90E, Driving Lane	I-90E, Diving Lane	I-90E, Passing Lane	I-90W, Diving Lane
Date Drilled	4/7/16	4/8/16	4/11/16	4/11/16	6/28/16	6/20/16	5/17/16	5/20/16
Station, Offset	N/A	N/A	N/A	N/A	Not Available	Not Available	Not Available	Not Available
Existing PMS	0.8' (9½")	0.9' (10¼")	0.8' (9¼")	0.8' (9¼")	0.8' (10")	0.9' (11")	0.9' (10½")	0.9' (10½")
Existing Base/Subbase	3.2'	1.6'	3.2'	3.2'	4.2'	3.6'	3.1'	3.1'
Total Thickness	**4.0'**	**2.5'**	**4.0'**	**4.0'**	**5.0'**	**4.5'**	**4.0'**	**4.0'**
Description	Sandy Lean Clay, Weathered Sandstone	Fill: Clayey Sand with Gravel	Clayey Sand, Weathered Sandstone	Fill: Clayey Sand with Gravel	Sandy Lean Clay	Lean Clay	Sandy Lean Clay	Sandy Lean Clay
ASTM Class	CL/Sandstone	SC	SC/Sandstone	SC	CL	CL	CL	CL
AASHTO Class	A-6	A-2	A-2	A-4	A-6	A-6	A-6	A-6
N-Values	50+	52, 27	32, 50+	9, 6	31, 18	8, 11	9, 18	19
Consistency	Hard	Medium Dense to Very Dense	Dense to Very Dense	Loose	Hard to Very Stiff	Medium Stiff to Stiff	Stiff to Very Stiff	Very Stiff
Moisture Content	9%, 7%	9%, 7%	9%	11%, 7%	4%, 18%	22%, 19%	17%, 20%	12%, 16%
Optimum Moisture Content (Approximate)	11%	6%	7%	9%	14%	15%	14%	14%
Liquidity Index	-0.50	-0.44	-0.36	-0.25	---	0.21	-0.04	-0.07
Risk of Subgrade Failure During Total Reconstruction	Low	Low	Low	Low	Low	Low	Low	Low

[1]Anticipated subgrade at a depth of about 2 to 3 feet below existing pavement surface/topsoil.
[2]Borings performed by SK Geotechnical for I-90 Yellowstone R - Billings project.
[3]Borings performed by Dowl for Billings Bypass project.

B.5.d. Soils Outside PTW – Median. Borings ST-67 through ST-70 were performed in the existing median between the eastbound and westbound lanes. The anticipated subgrade conditions are summarized in Table 3 below.

Table 3. Anticipated Subgrade Conditions – I-90 Median

Boring	ST-67	ST-68	ST-69	ST-70
Date Drilled	5/6/2020	5/6/2020	5/11/2020	5/11/2020
Existing PMS	N/A	N/A	N/A	N/A
Existing Base/Subbase	N/A	N/A	N/A	N/A
Total Thickness	**N/A**	**N/A**	**N/A**	**N/A**
Subgrade(1)				
Description	Fill: Poorly Graded Gravel with Silt and Sand/Sandy Lean Clay	Fill: Poorly Graded Gravel with Silt and Sand/Fill: Sandy Lean Clay	Fill: Clayey Gravel with Sand	Fill: Sandy Lean Clay
ASTM Class	GP-GM/CL	GP-GM/CL	GC	CL
AASHTO Class	A-1/A-6	A-1/A-6	A-2	A-6
N-Values	10, 12	18, 10	18, 12	8, 9
Consistency	Loose/Stiff	Medium Dense/Stiff	Medium Dense	Medium Stiff to Stiff
Moisture Content	6%, 20%	9%, 22%	5%, 23%	9%, 21%
Optimum Moisture Content	15%	16%	16%	15%
Liquidity Index	0.14	0.34	0.09	0.11
Risk of Subgrade Failure During Total Reconstruction	Moderate	High	Moderate	Moderate

B.5.e. Soils Outside Main Line PTW – Lockwood Interchange Ramps. Boring ST-40 was performed along Ramp C. The boring encountered 11 1/4 inches of existing PMS underlain by crushed top surfacing and base course to a depth of about 3 1/2 feet. Sandy lean clay was then encountered to a depth of 8 1/2 feet followed by shale bedrock to the boring termination depth of 9.8 feet. The clays were considered hard and 3 to 6 points below optimum moisture content.

Boring ST-41 was performed along Ramp D. The boring encountered 10 1/2 inches of existing PMS underlain by crushed top surfacing and base course to a depth of about 3 1/2 feet. Clayey sand with gravel was then encountered to a depth of 6 feet followed by weathered sandstone bedrock to the boring termination depth of 9.3 feet. The clayey sand with gravel was judged to be medium dense and was 2 to 6 points above optimum moisture content.

Boring ST-71 was performed along Ramp B. The boring encountered 11 inches of existing PMS underlain by base/subbase coarse to a depth of about 2 1/2 feet. Mixed layers of existing fill consisting of clayey gravel with sand and clayey sand was then encountered to the boring termination depth of 10 1/2 feet. The clayey gravel with sand and clayey sand fill was judged to be medium dense and was about 5 points under to 7 points over optimum moisture content.

Boring ST-72 was performed along Ramp A. The boring encountered 11 1/2 inches of existing PMS underlain by existing base/subbase coarse to a depth of 3 feet. Sandy lean clay and clayey sand with gravel fill was then encountered to the boring termination depth of 10 1/2 feet. The existing sandy lean clay fill was judged to be stiff and the clayey sand with gravel fill was judged to be medium dense. These soils were estimated to be about 2 points under to 5 points over optimum moisture content.

The results of the borings performed for the Lockwood Interchange are summarized in Table 4 below.

Table 4. Existing Pavement and Anticipated Subgrade Conditions –Lockwood Interchange Ramps

Boring	ST-40[(1)]	ST-41[(1)]	ST-71	ST-72
Date Drilled	4/21/16	4/21/16	5/4/2020	5/12/2020
Ramp	Ramp C	Ramp D	Ramp B	Ramp A
Existing PMS	0.9' (11¾")	0.9' (10½")	0.9' (11")	1.0' (11½")
Existing Base/Subbase	2.6'	2.4'	1.6'	1.8'
Total Thickness	**3.5'**	**3.3'**	**2.5'**	**2.8'**
Subgrade[(1)]				
Description	Sandy Lean Clay	Clayey Sand with Gravel	Fill: Clayey Gravel with Sand/Fill: Clayey Sand	Fill: Sandy Lean Clay/Clayey Sand with Gravel
ASTM Class	CL	SC	GC/SC	CL/SC
AASHTO Class	A-6	A-6	A-6/A-2	A-1/A-6
N-Values	67, 47	18	25, 30, 20	12, 18
Consistency	Hard	Medium Dense	Medium Dense	Stiff/Medium Dense
Moisture Content	13%, 10%	15%, 11%	3%, 15%	18%, 11%
Approximate Optimum Moisture Content	16%	9%	8%	13%
Liquidity Index	0.05	0.17	-1.19	-0.23
Risk of Subgrade Failure During Total Reconstruction	Low	Moderate	Low	Low

Note: Risk of subgrade failure in clay soils is highly dependent on weather and construction practices. Risk evaluated based on assumption of best construction practices during inclement weather.
[(1)]Borings performed by SK Geotechnical for I-90 Yellowstone R - Billings Project.

B.5.f. US Highway 87. Borings ST-73 through ST-76 and ST-206 and ST-207 were performed along US Highway 87. Borings ST-75, ST-76, ST-206, and ST-207 were performed east of the existing bridge and Borings ST-73 and ST-74 were performed west of the existing bridge. The borings east of the bridge encountered 5 1/2 to 7 inches of existing PMS underlain by base/subbase course to depths ranging from about 2 1/2 to 3 feet. Beneath the pavement sections, primarily existing fill classifying as A-6 soils consisting of sandy lean clay and clayey sand was encountered. The clayey soils were generally found to be loose to medium dense and medium stiff to very stiff. The soils were considered moist and ranged from about 1 to 3 points above optimum.

West of the bridge to the intersection of the I-90 Frontage Road, Boring ST-74 encountered 7 1/2 inches of existing PMS underlain by base/subbase course to a depth of about 3 feet. Beneath the base/subbase, the boring encountered an existing clayey sand fill subgrade. The clayey sand was found to be medium dense, moist, and about 1 to 3 points above optimum. Boring ST-73 was performed west of the I-90 Frontage Road intersection. The boring encountered 9 1/2 inches of PCCP underlain by base/subbase course to a depth of about 4 feet. Beneath the base/subbase, sandy lean clay and clayey gravel fill was encountered in the subgrade. The subgrade was found to be stiff and medium dense, moist, and 2 to 5 points above optimum. The anticipated subgrade conditions for US Highway 87 are summarized in Table 5 below.

Table 5. Existing Pavement and Anticipated Subgrade Conditions – US Highway 87

Boring	ST-73	ST-74	ST-75	ST-76	ST-206[(1)]	ST-207[(1)]
Date Drilled	5/12/20	5/12/20	5/13/20	5/12/2020	9/9/19	9//19
	Hwy 87W, Driving Lane	Hwy 87W, Passing Lane	Hwy 87W, Driving Lane	Ramp A	Hwy 87E, Driving Lane	Hwy 87E, Driving Lane
Existing PMS	0.8' (9½") PCCP	0.6' (7½")	0.6' (6¾")	0.6' (6¾")	0.6' (7")	0.5' (5½")
Existing Base/Subbase	3.2'	2.4'	3.4'	4.4'	2.3'	2.5'
Total Thickness	**4.0'**	**3.0'**	**4.0'**	**5.0'**	**2.9'**	**3.0'**
Subgrade[(1)]						
Description	Fill: Sandy Lean Clay over Clayey Gravel	Fill: Clayey Sand	Fill: Sandy Lean Clay	Fill: Sandy Lean Clay/Clayey Sand with Gravel	Fill: Sandy Lean Clay	Fill: Clayey Sand
ASTM Class	GP-GM/CL	SC	CL	CL/SC	CL	SC
AASHTO Class	A-1/A-6	A-6	A-6	A-1/A-6	A-6	A-6
N-Values	8, 12	22, 28	6, 16	12, 18	9, 14	26, 7
Consistency	Loose/Stiff	Medium Dense	Medium Stiff to Very Stiff	Stiff/Medium Dense	Medium Stiff to Stiff	Medium Dense to Loose
Moisture Content	11%	14%, 18%	11%, 15%	18%, 11%	4%, 11%	13%, 10%
Approximate Optimum Moisture Content	13%	15%	14%	13%	15%	13%
Liquidity Index	0.0	-0.07	-0.29	-0.29	-0.57	0.0
Risk of Subgrade Failure During Total Reconstruction	Low	Low	Low	Low	Low	Low

Note: Risk of subgrade failure in clay soils is highly dependent on weather and construction practices. Risk evaluated based on assumption of best construction practices during inclement weather.
[(1)]Borings performed for I-90 Yellowstone R - Billings Project

B.6. Drainage

Surface water drainage off the existing PTW appears to be moderate to good. The surface water is generally accommodated by ditches on the outside of the existing PTW. In the median, surface water is generally carried down the median to drop inlets along the alignment, then discharged outside the existing PTW.

B.7. Groundwater Observations

Groundwater was not encountered in any of the borings at the time of our evaluation. It appears groundwater levels are beyond the termination depths of our borings.

C. Laboratory Soil Survey Property Tests

C.1. Results

The results of the laboratory tests for the project are shown on Form 111 and Summary of Soil Index Test Results in Appendix 2. As can be seen in Form 111, 24 representative subgrade samples were classified for the project. Below is a brief summary of these classifications.

- Twenty-one soil samples classified as A-6 clay soils,
- One soil sample classified as A-7-6 clay soils,
- One soil sample classified as A-2-4 silty sand,
- One soil sample classified as A-1-b poorly graded gravel with silt and sand.

In addition to the classification tests, Proctor (standard and modified), moisture content, and specific gravity tests were performed on 24 of these samples. The results of these tests are also shown on the attached Form 111 and Summary of Soil Index Test Results in Appendix 2. The moisture content tests, classification tests, and Proctor results are also indicated on the Log of Boring sheets included in Appendix 1.

C.2. Procedures

Laboratory tests were conducted in accordance with the MDT procedures outlined in the *Montana Materials Manual of Test Procedures* and AASHTO procedures. The test methods are outlined in Table 6 below.

Table 6. Summary of Test Procedures

Test	Procedure
Moisture Contents	MDT MT-218*
Atterberg Limits	MDT MT-208*
Sieve Analysis	MDT MT-202*
Specific Gravity	MDT MT-205*
Proctors	MDT MT-210 and MT-230*
Corrosion	MT 232–16 and MT 532-16
California Bearing Ratio	ASTM D 1883*
Asphalt Core Stripping Analysis	MDT MT-331-14

* SK Geotechnical has AASHTO or equivalent ASTM accreditation for these tests.

D. Culverts and Corrosion Samples

D.1. Culvert Inspection

Twenty-four culverts were inspected along the existing PTW between the Lockwood and Johnson Lane interchanges. The results of our culvert inspection are summarized on the Culvert Inspection Report in Appendix 3. Thirteen of the culverts were judged to be in good condition, three were judged to be in fair to good condition, four were judged to be in fair condition, three were judged to be in fair to poor condition, and one was judged to be in good to poor condition. We wish to point out that the inlet at culvert C18 at mile post 454.29 could not be located during our reconnaissance.

D.2. Corrosion Tests

D.2.a. Sampling. Twenty-four soil samples and six water sample were obtained during our field reconnaissance for corrosion testing. The results of the corrosion tests are summarized in the tables below and included in Appendix 3.

Table 7. Corrosion Test Results from Culvert Water Sample

Culvert	Reference Point	Resistivity (Ω•cm)	Conductivity (m.mhos/cm) MT 232-16 Probe	pH	Marble pH	Sulfate (wt/%)
C6	453.54	575	1.74	7.94	8.02	0.0131
C11	455.25	1,000	1.00	6.55	6.63	0.0012
C12	455.27	983	1.017	6.92	7.36	0.0013
C13	455.25	578	1.73	7.37	7.45	0.0026
C14	455.23	1,064	0.940	6.90	6.97	0.0011
C16	455.25	592	1.690	6.25	6.41	0.0024

Table 8. Corrosion Test Results from Culvert Soil Samples

Culvert	Reference Point	Calculated Resistivity (Ω•cm)	Conductivity (m.mhos/cm) MT 232-16 Probe	pH	Marble pH	Sulfate (%)
C1	452.84	1,047	0.955	8.01	8.25	0.0035
C2	452.91	4,878	0.205	8.30	8.63	0.0020
C3	453.36	4,348	0.230	8.30	8.69	0.0027
C4	453.53	4,034	0.248	8.02	8.61	0.0026
C5	453.55	2,740	0.365	8.59	8.59	0.0028
C6	453.55	4,405	0.227	8.29	8.66	0.0076
C7	453.77	3,597	0.278	8.20	8.33	0.0052
C8	454.15	2,667	0.375	8.23	8.43	0.0038
C9	454.75	7,519	0.133	8.33	8.81	0.0031
C10	454.75	4,132	0.242	8.05	8.63	0.0032
C11	455.27	2,304	0.434	8.48	8.58	0.0050
C12	455.27	1,241	0.806	7.94	8.52	0.0585
C13	455.26	2,315	0.432	7.97	8.86	0.0068
C14	455.23	3,356	0.298	7.98	8.85	0.0016
C15	455.29	5,236	0.191	7.89	8.55	0.0012
C16	455.29	3,953	0.253	7.86	8.78	0.0014
C17	454.73	4,695	0.213	8.19	8.56	0.0074
C18	454.29	3,704	0.270	8.07	8.42	0.0038
C19	453.55	3,086	0.324	8.12	8.26	0.0039
C20	453.21	5,319	0.188	8.32	8.42	0.0022
C21	452.92	8,264	0.121	8.15	8.65	0.0015
C22	452.83	9,009	0.111	8.08	8.70	0.0022
C24	454.39	14,493	0.069	8.24	8.66	0.0019
C25	455.94	9,901	0.101	8.61	9.00	0.0018

Note: Culvert C23 skipped due to renumbering.

D.2.b. Test Procedures. The corrosion tests performed on the soil samples were performed in accordance with MDT 232-16 Soil Corrosion Test Procedures. The sulfate tests were performed in accordance with MDT 532-16 procedures. The corrosion tests consist of pH, marble pH, conductivity, and sulfate. The resistivity is calculated based on the results of the conductivity tests. The sulfate tests were performed by Energy Laboratories of Billings.

D.3. Culvert Recommendations

We reviewed Appendix E – Culvert Service Life Guidelines of Chapter 9 of the AASHTO Model Drainage Manual adopted by MDT's hydraulics section. We reviewed the culvert corrosion test results from the soil and water samples recovered from the culvert inspections. In general, the results of the corrosion tests performed on the soil samples indicate the soils are moderately corrosive to steel pipe and are generally not corrosive to Type II Aluminized steel, aluminum, or reinforced concrete pipes.

The results of the corrosion tests performed on the recovered water samples indicate the water is corrosive to steel, Type II aluminized steel, and aluminum but were not corrosive to concrete. Even so, the two culverts within the project limits found to have water were culverts C6 and C13. Both of these culverts were 90-inch diameter corrugated metal pipe. Assuming both pipes are galvanized steel with an original wall thickness of 0.079 inches (minimum for that pipe size), we estimate the original service life to be about 52 years, if subjected to this corrosive water for its entire life. During our observations we only observed minor amounts of surface corrosion on the inside of the culvert. Since the water observed was stormwater, the culvert is only periodically exposed to the water and appears to only have had a small effect on the pipe. We wish to point out that we were not able to observe the entire culvert and more extensive corrosion could be present within the culvert.

Additionally, the tests suggest the corrosivity of the soils increased around the Johnson Lane Interchange. Therefore, for new culverts, it is our opinion the following can be used:

- Steel with approved bituminous or polymeric coating
- Type II aluminized steel or aluminum,
- Or Class B wall reinforced concrete pipe (RCP).

E. Topsoil Survey

E.1. Field Procedures

The topsoil survey was performed by Mr. Western and Mr. Cody C. Hopkins, EI, an engineer intern with our firm, during the engineering reconnaissance. The topsoil survey consisted of performing shallow test holes at intervals of about 500 to 1,000 feet along the proposed alignments to measure the topsoil thickness. After completion of the field measurements, the measurements were plotted on a topsoil survey map included in Appendix 3.

E.2. Results

The thickness of the topsoil along the alignment ranged from about 4 1/2 to 10 inches but primarily ranged from about 5 to 7 inches. It is currently planned to perform the I-90 widening completely within

the existing median between the eastbound and westbound lanes and only minimal, if any, work will be done on the outside shoulders and slopes. In the median between the eastbound and westbound lanes, the average topsoil thickness was about 6 1/4 inches. Based on Alternative I-1, approximately 12,100 feet of the median will be reconstructed to accommodate the future widening. Additionally, Google Earth indicates that the median is approximately 39 feet in width. Therefore, assuming a total width of 39 feet, a length of 12,100 feet and an average topsoil thickness of 6 1/4 inches, we estimate about 9,100 cubic yards of topsoil will need to be stripped along the alignment. However, similar to the adjacent I-90 Yellowstone – R project, this topsoil is likely not good topsoil and contains excessive refuse and other unsuitable materials. Therefore, we recommend all topsoil be wasted for the project. If topsoil is needed along the project, we recommend a clean source of topsoil be imported for all areas of the project. During the Activity 130 work when the alignment and construction limits are defined, we will reevaluate our topsoil survey estimates.

F. Geotechnical Recommendations

F.1. General

Design of the project is still in the OT phase and is still very preliminary. However, based on the anticipated construction, we anticipate the majority of the earthwork will consist of stripping the topsoil and root zone from the median and some sideslopes, down to native subgrade or existing embankment fill, importing and placing embankment material in widened areas, and importing Special Borrow for roadway sections. At this time, it is planned the new interchange improvements will utilize the existing bridge, with some minor modifications to the bridge anticipated. Evaluation of the suitability of the existing bride to support the proposed project is still being conducted.

F.2. Cut Slopes

Based on the Diverging Diamond Interchange Alternative, we anticipate the proposed Ramp C widening will require cutting into the existing cut slopes south of Ramp C. For cut slopes within the ramps, we generally recommend following the Montana Department of Transportation Geometric Design Standards of the Montana Road Design Manual, Figure 12-2 for National Highway System - Interstate. The standard cut slopes for freeways and level/rolling terrain should be used for the project. Our recommended cut slopes are in Table 9 below.

Table 9. Recommended Cut Slopes for Interstates – Level/Rolling Terrain

Cut Depth (feet)	Slope (Horizontal:Vertical)
0'-5'	5:1
5'-10'	4:1
10'-15'	3:1
>15'	2:1

As part of the I-90 Yellowstone R - Billings Project, we evaluated cut slopes for global stability for Ramp C. Based on our analysis, it is our opinion cut slopes up to 2H:1V can be constructed along Ramp C to limit ROW. Our analysis indicates a 2H:1V cut slope will provide a minimum factor of safety of 1.3 for long term and short term performance. We also evaluated several retaining wall alternatives. Based on our and Sanderson Stewart's analysis, a gravity block wall system was determined to be the preferred retaining wall system at this location, if a wall was needed.

The planned improvements to Ramp C have not been fully defined to date due to the planned improvements of Ramp C for the adjacent I-90 Yellowstone – R project. The improvements to Ramp C will generally be developed depending on the needs of either the I-90 Yellowstone River project or the Lockwood Interchange project, whichever has the greater need. This will be evaluated further as design progresses.

F.3. Fill Slopes.

Fill slopes of the largest heights will generally be constructed around the Lockwood Interchange approaches and ramp embankments. Outside of the interchange areas, embankment heights will generally be less than about 5 to 10 feet. Fill slopes should meet the requirements of Figure 12-2 of Chapter 12 of the Road Design Manual for Urban Freeways. We anticipate retaining walls or steeper slopes will be needed to limit ROW acquisition and/or stay within current ROW limits at the larger fill areas around the interchange.

We anticipate widened embankments constructed of A-1-a Special Borrow can likely be constructed as steep as 2H:1V. After the project is better defined and cross sections become available, specific global stability analysis will need to be performed to determine if 2H:1V side slopes will be stable and will provide adequate factors of safety. We recommend fill slopes not exceed 2H:1V for maintenance, erosion, stability, and safety considerations. If slope steeper than 2H:1V are desired to limit ROW, geosynthetic reinforced soil slopes or retaining walls will be required. The type and extent of reinforcement will be determined in our Activity 130 when the project is better defined and cross sections become available.

F.4. Embankment Settlement and Stabilization.

Widened embankments with the largest heights will generally be constructed along Ramp A with the largest heights being near the intersection of Ramp A and US Highway 87. We estimate widened embankment heights in this area will be up to 25 feet. Soils encountered along the alignment were primarily clayey and sandy soils and were generally found to be loose to medium dense. The soil borings shown in the as-built information for the existing bridge indicate that from the base of the embankment, primarily loose clayey sands exist to about 20 feet, underlain by medium dense sands and gravels to about 30 feet. Beneath the gravels, sandstone bedrock is indicated.

We estimate settlements under the planned widened embankment for Ramp A will be approximately 4 to 6 inches. Since the clayey sands are generally not saturated, we anticipate the soils will drain relatively rapidly, and it is our opinion the majority of the settlement will occur during construction of the widened embankments and surcharging will likely not be required.

Since the subgrade in the median will be primarily clays and clayey sands, it is our opinion the subgrade can quickly become unstable if subjected to heavy rubber-tired construction equipment. Therefore, we recommend placing a stabilization geotextile beneath the Special Borrow layer. This will also reduce future fines contamination of the Special Borrow from long term traffic and the clayey subgrade. A Special Provision for moisture sensitive subgrades should also be included.

F.5. Shrinkage.

Fill areas along the project are relatively limited and are primarily anticipated at the ramp improvements at the intersections of the ramps and US Highway 87. We recommend all embankments be constructed using Special Borrow as we anticipate steeper slopes to limit ROW acquisition and encroachment will be desired. We anticipate shrinkage of imported Special Borrow will be near 10 to 20 percent. We therefore recommend assuming 15 percent shrinkage for the project from the "bank condition" to the "compacted embankment condition" for Special Borrow.

G. Pavement Thickness Design

G.1. Traffic Data

A Traffic Memorandum was provided to HDR from MDT for the project and is included in Appendix 4. Table 10 summarizes the design traffic data provided in the memorandum from MDT dated February 18, 2020.

Table 10. Summary of MDT Design Traffic Memorandum

Segment	Equivalent Single Axle Load (ESAL's) (per day)
I-90 EB and WB	1,305
Ramp A	154
Ramp B	153
Ramp C	265
Ramp D	270
Old US Highway 87 East of Frontage Road	292
Old US Highway 87 West of Frontage Road	269
Frontage Road	219
Old US Highway 87 Between Ramps	277
Old US Highway 87 Between I-90 and Coburn Road	182
Coburn Road South of Old US Highway 87	52

Due to the similar traffic volumes for Ramps A and B, Ramps C and D, US Highway 87, and I-90, one ESAL value for each of these segments was used to simplify design. Table 11 summarizes the design traffic data used to develop typical sections for each segment for the project.

Table 11. Summary of Design ESAL's

Segment	Design ESAL's
I-90	1,305
Ramps A and B	154
Ramps C and D	270
US Highway 87	292

Also, we request these values be reviewed as they are substantially lower than the design values provided for the I-90 Yellowstone – R Project.

G.2. Method

The pavement design was analyzed using the software DARWin® and an Excel spreadsheet created by MDT based on the AASHTO 1993 *Pavement Design Manual* and the results of our analyses are attached. We also incorporated MDT's Pavement Design Manual, dated 2018, for material thicknesses, bridge end pavements, and surfacing coefficients. We also submitted a preliminary pavement design memo dated

June 2, 2020, for review and comment by MDT Surfacing Design. The results of our analyses are included in Appendix 4 and are discussed in further detail below.

G.3. Design R-Value

Twenty-six soil borings were performed along the project as previously discussed. Each of the borings encountered similar subgrade material consisting primarily of lean clay, sandy lean clay, and clayey sand. Of the 26 borings performed, only two subgrades classified as something other than A-6 or A-7 soils. Therefore, we have assumed the entire project to haveA-6 or A-7 subgrade soils. MDT's Pavement Design Manual indicates an R-value of 5 can be assumed for soils classifying as A-6 or A-7. The Pavement Design Manual also indicates a resilient modulus (M_R) of 3,250 pounds per square inch (psi) can be assumed for design. For sections incorporating 2 feet, or more, of Special Borrow below the crushed aggregate course (CAC), and M_R of 12,000 psi was used for the subgrade strength. We have assumed existing and future Special Borrow will have a minimum R-value of 30.

G.4. Pavement Design Alternatives

G.4.a. Main Line. It is currently anticipated that the widening of the I-90 eastbound and westbound lanes will be entirely accommodated by widening into the existing center median. To provide a better pavement section, simplify construction, and to better match existing pavement sections along the main line, we recommend the 2.00-foot Special Borrow section in the median be used for the project. It is our opinion the 2.00-foot Special Borrow section will better bridge over the clay subgrade and provide a better performing pavement section over the long term. A thinner CAC section was also analyzed for comparison. Table 12 below summarizes the pavement section alternatives for the median widening as well as total reconstruction areas for the project.

Table 12. Summary of Pavement Sections – I-90 Eastbound and Westbound Widened and Reconstructed Areas

Pavement Layer	Alternative	
	Special Borrow Section	**Crushed Aggregate Course Section**
PMS	0.60'	0.60'
CAC	0.90'	2.25'
Special Borrow	2.00', minimum	---
Non-woven Stabilization Geotextile	Yes	Yes
Total	**3.50'**	**2.85'**

Depending on final grades through the total reconstruction area planned for the future stepped median barrier, consideration may be given to reusing the existing base/subbase as future special borrow to reduce import requirements. This will be further evaluated as design progresses and cross sections become available, if feasible.

Based on the results of our pavement evaluation and stripping analysis, it appears mill and overlay will be acceptable for the existing eastbound and westbound lanes where total reconstruction is not planned. The results of our stripping analysis indicate the pavement beneath the top layer has an average stripping rating of 2.2 and the average total pavement section is about 4.1 feet thick. The results of our stripping analysis are attached in Appendix 4. Based on the results of the stripping analysis, the observed existing pavement condition, and the required structural resistance, we recommend performing a 0.25-foot mill and overlay for the eastbound and westbound lanes where changes in grade are not planned. The 0.25-foot mill, will, on average, extend through the top layers of the existing plant mix as measured by the asphalt cores. It should be noted, reflection cracking will eventually redevelop in the new overlay. MDT has used mastic products with some success to fill cracks before overlaying, and some quantity of this material should be warranted to reduce/delay reflection cracking.

As mentioned, the 0.25-foot mill would generally, on average, extend through the top pavement layer and would remove joint cracks that are present only in the top lift. However, it is our opinion, a 0.20-foot mill and overlay can also be considered to reduce costs. A 0.20-foot mill and overlay would still provide a 20-year pavement design life, however, the reflection cracking would develop somewhat sooner. Regardless, for both options, some amounts of reflection cracking will occur, and future maintenance will be required. We recommend cost estimates for each alternative be determined and the benefits/disadvantages be discussed at AGR to determine if additional costs for the 0.25-foot mill is warranted. The use of mastic material should also be discussed.

G.4.b. Lockwood Interchange Ramps. We also performed a pavement design for the Lockwood Interchange ramps for total reconstruction. Based on the traffic volumes, anticipated construction, and to provide a better performing pavement section over the long term, we recommend the 2.00-foot Special Borrow section for total reconstruction areas. An alternative crushed aggregate course section was also evaluated for comparison. Table 13 and 14 below summarize our recommended pavement sections for the Lockwood interchange ramps.

Table 13. Summary of Pavement Sections – Lockwood Interchange Ramps A and B

Pavement Layer	Special Borrow Section	Crushed Aggregate Course
PMS	0.40'	0.40'
CAC	0.75'	1.85'
Special Borrow	2.00', minimum	---
Non-woven Stabilization Geotextile	Yes	Yes
Total	**3.15'**	**2.25'**

Table 14. Summary of Pavement Sections – Lockwood Interchange Ramps C and D

Pavement Layer	Special Borrow Section	Crushed Aggregate Course
PMS	0.40'	0.40'
CAC	0.90'	2.10'
Special Borrow	2.00', minimum	---
Non-woven Stabilization Geotextile	Yes	Yes
Total	**3.30'**	**2.50'**

We judged the existing surfacing on-ramps A and B to be in good condition. These ramps were also recently improved with a 0.20-foot mill and overlay as part of the West Billings Interchange – Pine Hills Interchange project. For areas where the PTW follows the existing alignment, it is our opinion minor rehabilitation consisting of mill and overlay can be considered. Our analysis indicates a 0.25-foot mill and overlay will provide a sufficient structural capacity to support the anticipated traffic and provide a 20-year design life. The 0.25-foot depth corresponds to the average top lift thickness of the existing PMS, which is typically desired to be removed on minor rehabilitation projects. However, in our opinion, a 0.20-foot mill and overlay can also be considered.

Along Ramps C and D, total reconstruction is anticipated. However, depending on the improvements at these ramps planned for the adjacent I-90 Yellowstone – R Project, a mill and overlay may be acceptable where the future PTW will follow the future alignment. This will be further evaluated as both projects develop.

G.4.c. US Highway 87. Pavement sections for widening and reconstruction areas along US Highway 87 were also developed and are indicated in Table 15 below.

Table 15. Summary of Pavement Sections – US Highway 87

Pavement Layer	Special Borrow Section	Crushed Aggregate Course
PMS	0.40'	0.40'
CAC	0.80'	1.95'
Special Borrow	2.00', minimum	---
Non-woven Stabilization Geotextile	Yes	Yes
Total	**3.20'**	**2.35'**

To provide better long term performance, we recommend the 2.00-foot Special Borrow section be used for reconstruction areas along US Highway 87.

We also developed a Portland cement concrete pavement (PCCP) section for total reconstruction west of the I-90 Frontage Road and the recommended section is shown in Table 16 below.

Table 16. Summary of Pavement Sections – US Highway 87

Pavement Layer	40-Year Design
PCCP	0.65'*
CAC	0.50'*
Special Borrow	2.00', minimum
Non-woven Stabilization Geotextile	Yes
Total	**3.15'**

*Minimum thicknesses per MDT Pavement Design Manual, 2018

For US Highway 87, it is our opinion a 0.20-foot mill and overlay can also be considered to reduce costs. Our analysis indicates a 0.20-foot mill and overlay will provide adequate structural capacity to support the anticipated traffic and provide a 20-year design life. However, we wish to point out during our pavement reconnaissance we observed reflection cracking beginning to occur along US Highway 87, particularly east of the bridge. These cracks were most likely present prior to the seal and cover project performed in 2018/2019 southwest of the bridge. Northwest of the bridge, the recent 0.20-foot mill and overlay improvement appears to be in good condition. We would like to note that this is only a year or two old and long term performance of this mill and overlay will be observed as the project progresses.

G.4.d. Additional Considerations. Mill and overlays are useful to improve performance and appearance and generally considered to provide an expected life of about 7 to 10 years. For this project, we have evaluated the mill and overlay for a calculated life of about 20 years. However, mill and

overlays do not, and will not, prevent the existing cracks from reflecting though the new surfacing. In other words, all the existing cracks will reflect through the new surfacing within a few years following the improvement. While the analysis indicates the pavement will have a surface life of 20 years, due to the assumed underlying pavement condition and our review of the asphalt cores, it is likely another mill and overlay will be necessary in about 10 years to address cracking and improve performance. If reflection cracking is not acceptable then total reconstruction or major rehabilitation using pulverization will be necessary.

G.4.e. 30-Year Bridge Ends. We also developed preliminary pavement sections for the 30-year bridge ends and our recommendations are indicated in Table 17 below.

Table 17. Summary of Pavement Sections – 30-Year Bridge Ends

Pavement Layer	Special Borrow Section
PMS	0.60'
CAC	0.65'*
Special Borrow	2.00', minimum
Non-woven Stabilization Geotextile	Yes
Total	**3.25'**

*Minimum CAC thickness in MDT's Pavement Design Manual, 2018.

H. Asphalt Content

To determine project specific asphalt content, we reviewed the "MDT Percent Asphalt Content Map" available on the MDT website. Three nearby projects utilizing 3/4-inch aggregate were considered representative as summarized in Table 18 below.

Table 18. Summary of Historic Asphalt Contents

Year	Project	PG Mix	Asphalt Content (%)
2018	IM 94-1(83)0	70-28, Grade S	4.69
2011	IM 90-8(159)457	70-28, Grade S	5.77
2010	ARRA 90-9(98)466	70-28, Grade S	5.56
		Average	**5.34**

Based on the average of the three similar projects, we recommend using an asphalt content of 5.3 percent for anticipated design costs. The actual asphalt content will depend on the specific gravel source and mix design strength parameters during construction.

I. Additional Geotechnical Work

Once the alignment has been defined and the preferred alternatives selected, additional borings will be performed. The additional borings will include additional pavement borings as well as specific borings related to future embankments, possible cut slopes, culverts, retaining walls, and potential bridge improvements. The results of the additional work will be presented in our Activity 130 report.

J. Special Provisions

We anticipate two standard Special Provisions will be needed addressing geotechnical concerns along the project at this time. These Special Provisions are outlined below.

- Special Borrow (4-inch minus A-1-a or better sandy gravels)
- Moisture Sensitive Clay Subgrades

K. Activity 440 Review

An Activity 440 form was completed by our firm and is also included in Appendix 5.

L. General Recommendations

L.1. Basis of Recommendations

The preliminary analyses and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the attached plan and profile sheets. Often, variations occur between the borings, the nature and extent of which will 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 we be retained to perform the observation and testing program for the project. This will allow correlation of the soil conditions encountered during construction to the soil borings, and will provide continuity of professional responsibility.

L.2. Review of Design

This report is based on the preliminary design of the proposed roadway and structures as related to us for preparation of this report. It is recommended that we be retained to review the geotechnical aspects of the

designs and specifications. With the review, we will evaluate whether any changes in design have affected the validity of the recommendations, and whether our recommendations have been correctly interpreted and implemented in the design and specifications.

L.3. 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 groundwater levels 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.

L.4. Use of Report

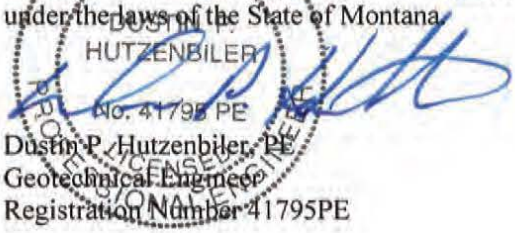
This report is for the exclusive use of HDR Engineering, Inc., Sanderson Stewart, and the Montana Department of Transportation to use to design the proposed roadway and prepare construction documents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analyses and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us.

L.5. Level of Care

Services performed by SK Geotechnical 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.

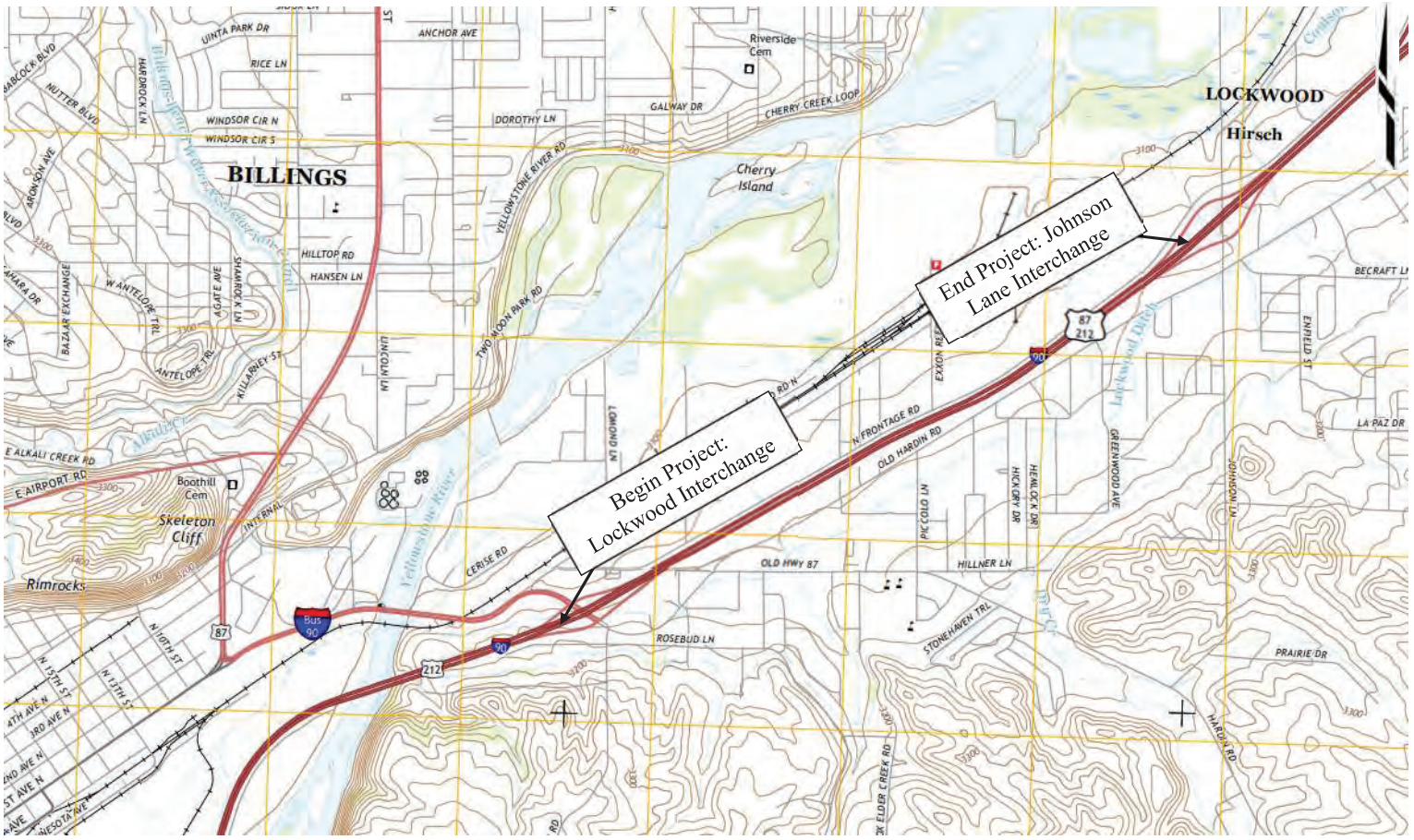
Professional Certification

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.

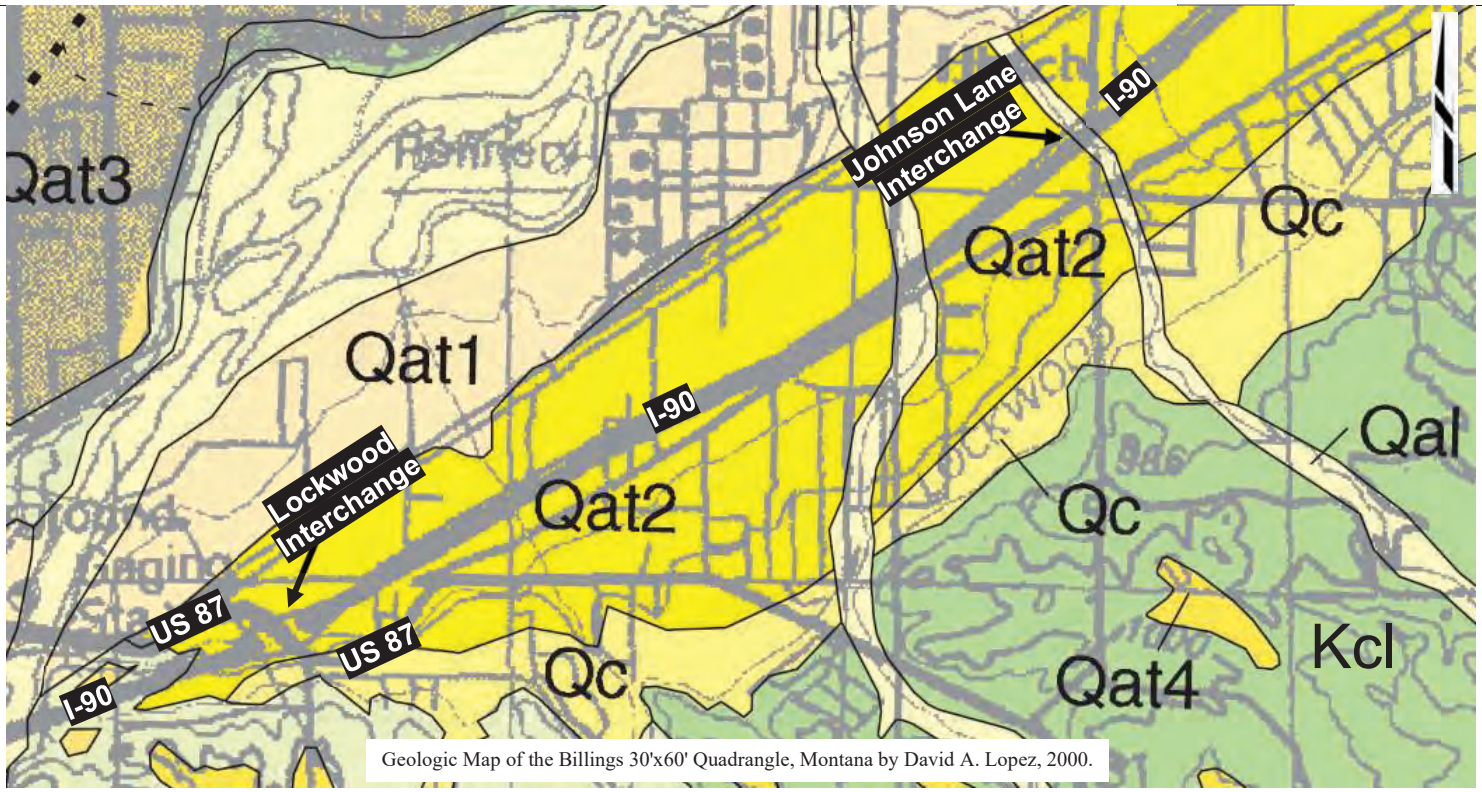


Dustin P. Hutzenbiler, PE
Geotechnical Engineer
Registration Number 41795PE

Appendix 1



SITE LOCATION SKETCH **Lockwood Interchange - Billings** **STPX 90-8(191)450, UPN 9588000** **Yellowstone County, Montana**	Drawn by: USGS/SKGeo	Date 7/2/2020	
	Project: 19-3792S		
	Scale: NTS		FIGURE
	Sheet 1 of 1		1



Qal — Alluvium

Kcl — Claggett Shale

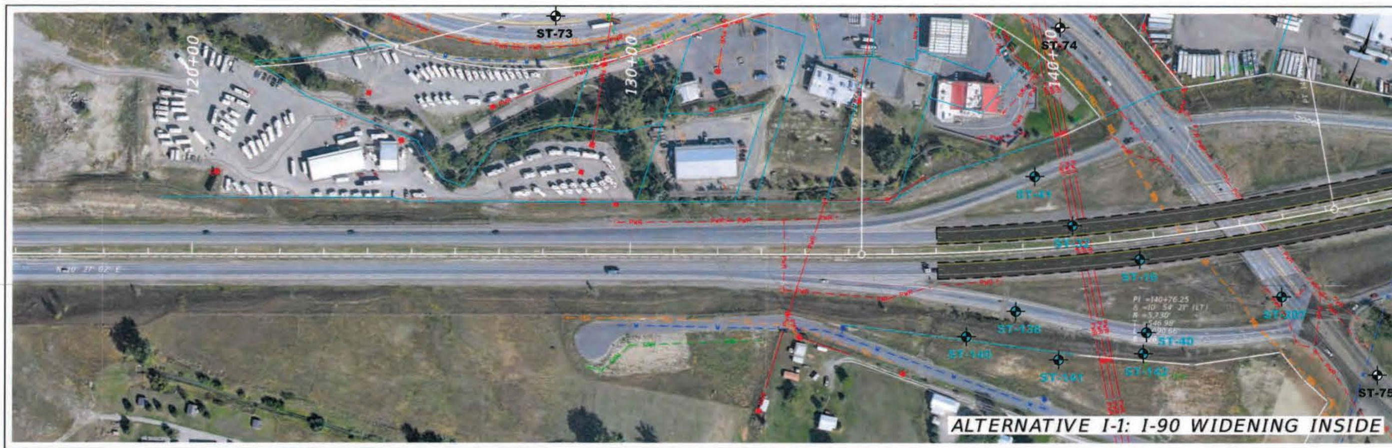
Qc — Colluvium

Qat1 | Qat2 | Qat3 | Qat4 — Alluvial Gravel, Terrace Levels 1, 2, 3, & 4

SK GEOTECHNICAL

GEOLOGIC SKETCH
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

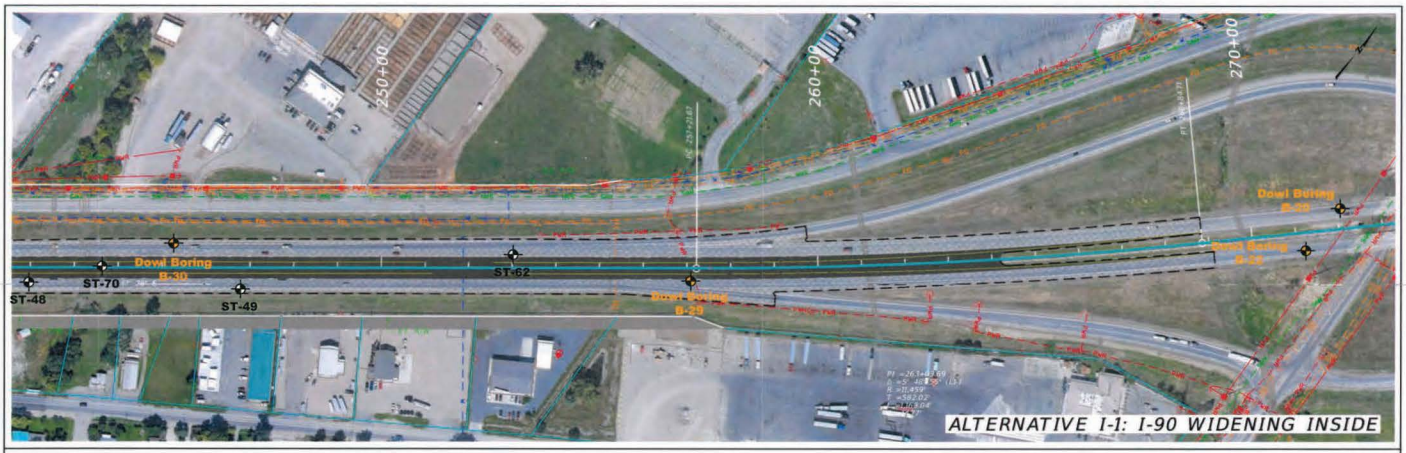
Drawn by:	MBMG/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	1 of 1		2



MDT	ROAD PLANS	PRELIMINARY	LOCKWOOD INTERCHANGE - BILLINGS	
	YELLOWSTONE COUNTY		UPN 9588000	

MDT

ROAD PLANS	PRELIMINARY	LOCKWOOD INTERCHANGE - BILLINGS	
YELLOWSTONE COUNTY		UPN 9548000	4



BORING LEGEND

- Boring, Typ. - Lockwood Interchange Boring
- Boring, Typ. - I-90 Yellowstone-R Boring
- Boring, Typ. - Billings Bypass Dowl Boring

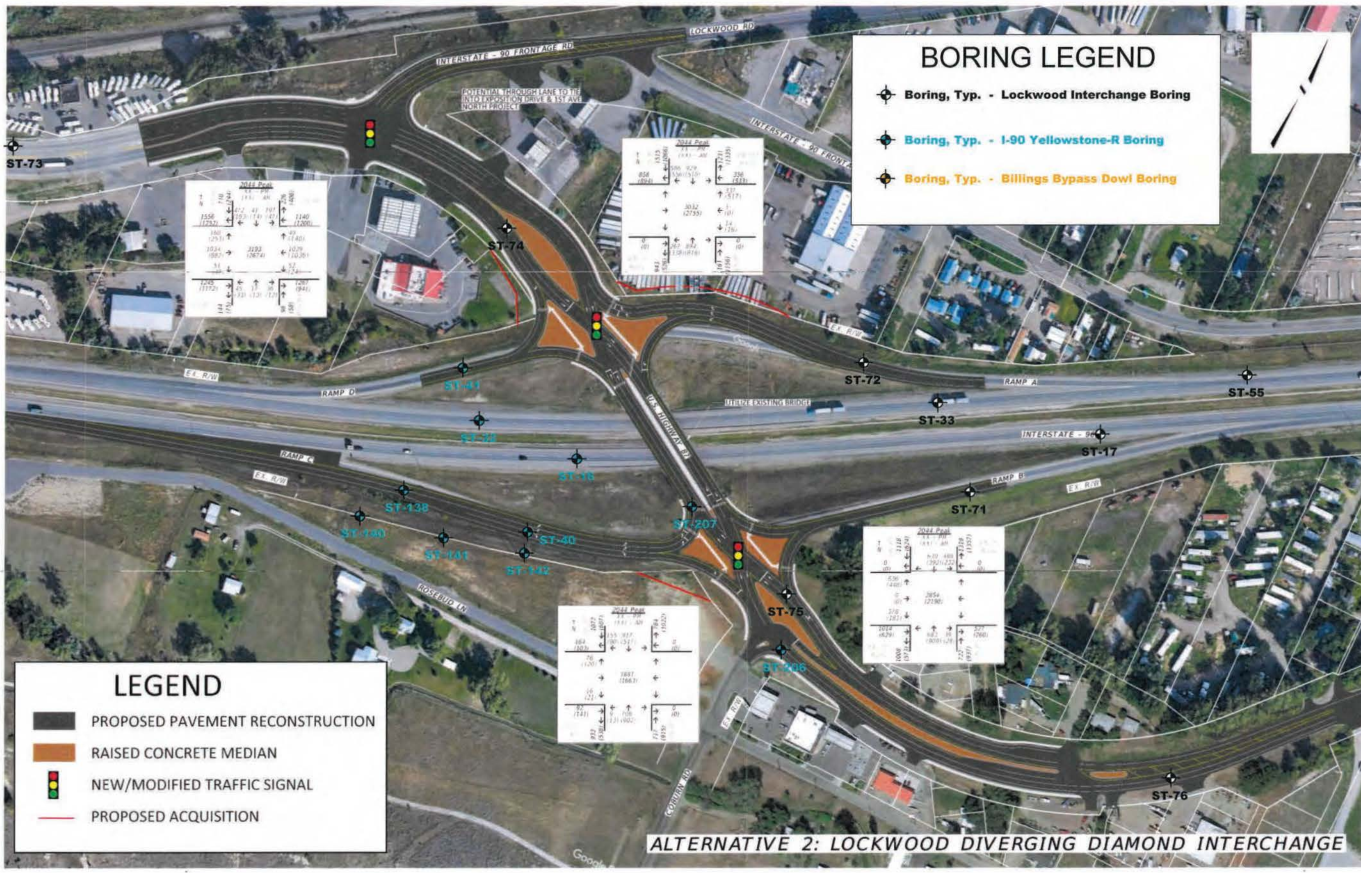
HDR

LEGEND

- PROPOSED FULL DEPTH PAVEMENT RECONSTRUCTION/WIDENING
- PROPOSED MILL/FILL
- PROPOSED ACQUISITION

MDT

				ROAD PLANS	PRELIMINARY	LOCKWOOD INTERCHANGE - BILLINGS	STPX 90-8(191)450
				YELLOWSTONE COUNTY		UPN 9588000	5



MDT — MONTANA DEPARTMENT OF TRANSPORTATION

DESIGNED BY / REVIEWED BY / CHECKED BY	ROAD PLANS	PRELIMINARY	LOCKWOOD INTERCHANGE - BILLINGS	STPX 90-8(191)450
	YELLOWSTONE COUNTY		UPN 9588000	4

SK Geotechnical Boring Log Descriptive Terminology
Key to Soil Symbols and Terms

12/06/12

SK GEOTECHNICAL

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	Well-graded gravels, gravel sand mixtures, little or no fines.
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clayey gravels, gravel-sand-clay mixtures.
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	Well-graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands, gravelly sands, little or no fines.
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	Silty sands, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixures.
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
				OL	Organic silts and organic silty clays of low plasticity.
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				PT	Peat and other highly organic soils.

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Order of Descriptors

- Group Name
- Consistency or Relative Density
- Moisture Condition
- Color
- Particle size descriptor(s) (coarse grained soils only)
- Angularity of coarse grained soils
- Other relevant notes

Criteria For Descriptors

Consistency of Fine Grained Soils

Consistency	N-Value (uncorrected)
Very Soft	< 2
Soft	2 - 4
Medium Stiff	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	> 30

Apparent Density of Coarse Grained Soils

Relative Density	N-Value (uncorrected)
Very Loose	< 4
Loose	4 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

Moisture Condition

Dry -Absence of moisture, dusty, dry to the touch.
Moist -Damp, but no visible water.
Wet -Visible free water.

Definition of Particle Size Ranges

Soil Component	Size Range
Boulder	> 12 in (300 mm)
Cobble	3 in (75 mm) - 12 in (300 mm)
Gravel	No. 4 Sieve (4.75 mm) to 3 in (75 mm)
Sand	No. 200 (0.075 mm) to No. 4 Sieves (4.75 mm)
Silt	< No. 200 Sieve (0.075 mm)*
Clay	< No. 200 Sieve (0.075 mm)*

*Atterberg limits and chart below to differentiate between silt and clay.

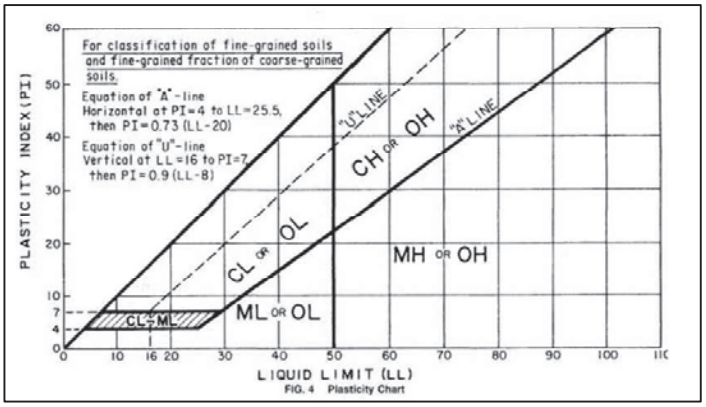


FIG. 4 Plasticity Chart

Notes

See Soil Boring Information Special Provision.

SPT (Standard Penetration Test-ASTM D1586):
The number of blows of a 140 lb (63.6 kg) hammer falling 2.5 ft (750 mm) used to drive a 2 in (50 mm) O.D. Split Spoon sampler for a total of 1.5 ft (0.45 m) of penetration.
Written as follows:
first 0.5 ft (0.15 m) - second 0.5 ft (0.15 m) - third 0.5 ft (0.15 m) (ex: 1-3-9)
Note: if the number of blows exceeds 50 before 0.5 ft (0.15 m) of penetration is achieved, the actual penetration rounded to the nearest 0.1 ft (0.03 m) follows the number of blows in parentheses (ex: 12-24-50 (0.09 m), 34-50 (0.4 ft), or 100 (0.3 ft)).WR denotes a zero blow count with the weight of the rods only.
WH denotes a zero blow count with the weight of the rods plus the weight of the hammer.

MC=Moisture Content, LL=Liquid limit, PL=Plastic Limit
-200%=percent soil passing 200 sieve, DD=Dry Density

Soil Classifications are Based on the Unified Soil Classification System, ASTM D2487 and D2488. Also included are the AASHTO group classifications (M145). Descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Angularity of Coarse-Grained Particles

Angular -Particles have sharp edges and relative plane sides with unpolished surfaces.
Subangular -Particles are similar to angular description, but have rounded edges.
Subrounded-Particles have nearly plane sides, but have no edges.
Rounded -Particles have smoothly curved sides and well-rounded corners and edges.

Example soil description: Sandy FAT CLAY (CH), soft, wet, brown. (A-7)

12/06/12

SK Geotechnical Boring Log Descriptive Terminology
Key to Rock Symbols and Terms

Rock Type	Symbol	Rock Type	Symbol	Rock Type	Symbol
Argillite		Dolomite		Quartzite	
Basalt		Gneiss		Rhyolite	
Bedrock (other)		Granitic		Sandstone	
Breccia		Limestone		Schist	
Claystone		Siltstone		Shale	
		Conglomerate			

Order of Descriptors

- Rock Type
- Color
- Grain size (if applicable)
- Stratification/Foliation (as applicable)
- Field Hardness
- Other relevant notes

Criteria For Descriptors

Grain Size

Description	Characteristic
Coarse Grained	-Individual grains can be easily distinguished by eye
Fine Grained	-Individual grains can be distinguished with difficulty

Stratum Thickness

Thickly Bedded	3-10 ft (1-3 m)
Medium Bedded	1-3 ft (300 mm - 1 m)
Thinly Bedded	2-12 in (50-300 mm)
Very Thinly Bedded	< 2 in (50 mm)

Rock Field Hardness

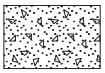
Very Soft	-Can be carved with knife. Can be excavated readily with point of rock hammer. Can be scratched readily by fingernail.
Soft	-Can be grooved or gouged readily by knife or point of rock hammer. Can be excavated in fragments from chips to several inches in size by moderate blows of the point of a rock hammer.
Medium	-Can be grooved or gouged 0.05 in (2 mm) deep by firm pressure of knife or rock hammer point. Can be excavated in small chips to pieces about 1 in (25 mm) maximum size by hard blows of the point of a rock hammer.
Moderately hard	-Can be scratched with knife or pick. Gouges or grooves to 0.25 in (6 mm) can be excavated by hard blow of rock hammer. Hand specimen can be detached by moderate blows.
Hard	-Can be scratched with knife or pick only with difficulty. Hard hammer blows required to detach hand specimen.
Very Hard	-Cannot be scratched with knife or sharp rock hammer point. Breaking of hand specimens requires several hard blows of a rock hammer.

Notes:

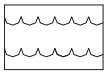
UCS = Unconfined Compressive Strength obtained from laboratory testing at the given depth.

See Soil Boring Information Special Provision.

Miscellaneous Soil/Rock Symbols and Terms

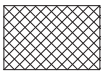

Concrete

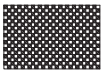

Asphalt

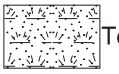

Water


Boulders and Cobbles


Coal


Fill


Millings


Topsoil

Explanation of Text Fields in Boring Logs:

Material Description: Lithologic Description of soil or rock encountered.

Remarks: Comments on drilling, including method, bit type, and problems encountered.

Unless stated on logs as being surveyed by district survey, all locations are considered approximate.

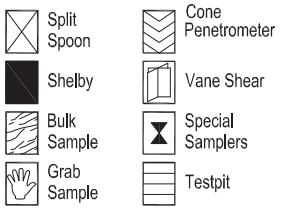
General Notes

- Descriptions on these boring logs apply only at the specific boring, and at the time the time the borings were made. These logs are not warranted to be representative of subsurface conditions at other locations or times.
- Water level observations apply only at the specific boring, and at the time the borings were made. Due to the variability of groundwater measurements given the type of drilling used, and the stratification of the soil in the boring, these logs are not warranted to be representative of groundwater conditions at other locations or times.
- Other terms may be used as descriptors, as defined by the profession.

-Soil and Rock descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Operation Types:

Sample Types:



Example Rock Log

SANDSTONE, gray, fine grained, thickly bedded, hard field hardness.

LOG OF BORING

Boring 9588000-ST-42

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 566453.3 ft **Coordinates** E: 2235947.0 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3137.1 ft
Date Started: 5/5/20	**Date Finished:** 5/5/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 26 - DCD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							10½" Existing PMS.	0.9 *3136.2*	2		NP	7		Crushed Top Surfacing Bag 10½"-12¼"
			89		16 - 32 - 35		BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), brown, moist, fine to coarse grained, subangular to subrounded, [A-1]. 10½"-12¼" Crushed Top Surfacing.	1.0 *3136.1*	2					
			72		12 - 27 - 25		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to medium dense, brown to gray, moist, fine to coarse grained, subangular to subrounded, [A-1].		1					
5 *3132.1*			72		6 - 15 - 13		Sandy Lean CLAY (CL), very stiff, brown, moist, [A-6]. (Alluvium).	5.2 *3131.9*						
			72		3 - 2 - 3		Clayey SAND (SC), loose, brown, moist, fine grained, subangular, [A-6]. (Alluvium).	6.0 *3131.1*	11					
									12					
10 *3127.1*			56		3 - 2 - 2									
								10.5 *3126.6*						

Boring Depth: 10.5 ft, *Elevation: 3126.6 ft*

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 6½' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-43

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 566993.3 ft **Coordinates** E: 2236915.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3139.2 ft
Date Started: 5/4/20	**Date Finished:** 5/4/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 26 - DDD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							7½" Existing PMS.	0.6	2		NP	11		
							BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), brown, moist, fine to coarse grained, subangular to subrounded, [A-1]. 7½"-9" Crushed Top Surfacing.	*3138.6* 0.8 *3138.4*	2 4					Crushed Top Surfacing Bag 7½"-9"
			83		9 - 28 - 24									
			28		16 - 15 - 15		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to medium dense, brown, moist, fine to coarse grained, subrounded, [A-1].	3.5 *3135.7*	12					Bulk Bag 3½'-10' MDD=120.8 pcf OMC=13%
5 *3134.2*			89		3 - 7 - 7		Sandy Lean CLAY (CL), very stiff to soft, brown, moist, [A-6]. (Alluvium).		16 11	28	15	62		
			89		1 - 2 - 2		Clayey SAND (SC), loose, brown, moist, fine grained, rounded, [A-6]. (Alluvium).	7.0 *3132.2*						
10 *3129.2*			44		1 - 2 - 2				15					
							Boring Depth: 10.5 ft, *Elevation: 3128.7 ft*	10.5 *3128.7*						

Water Level Observations		
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**	Remarks: Water not encountered to dry cave-in depth of 5½' immediately after withdrawal of auger.
	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-44

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 567512.5 ft **Coordinates** E: 2237782.2 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3141.6 ft
Date Started: 5/4/20	**Date Finished:** 5/4/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - CBC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8¾" Existing PMS.							
			56		16 - 21 - 18		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to medium dense, brown, moist, fine to coarse grained, subrounded, [A-1].	0.7 *3140.9*	3					
			44		11 - 17 - 8				5					
5 *3136.6*			11		3 - 5 - 7		FILL, Clayey SAND with gravel (SC), medium dense, brown, moist, fine to coarse grained, subangular, [A-6].	3.8 *3137.8*	13 16	29	13	47		Bulk Bag 3.8'-5½' MDD=124.6 pcf OMC=11%
			67		2 - 4 - 6		FILL, Lean CLAY with sand (CL), stiff, gray to brown, moist, [A-6].	6.0 *3135.6*	16					Pen: 3½ tsf
10 *3131.6*			56		1 - 2 - 2		Sandy Lean CLAY (CL), soft, brown, moist, [A-6]. (Alluvium).	8.5 *3133.1*	16					
							Boring Depth: 10.5 ft, *Elevation: 3131.1 ft*	10.5 *3131.1*						

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 5½' immediately after withdrawal of auger.
▽ During Drilling: **Not Encountered**	▽ After Drilling: **Not Encountered, Augers Out**	
▼ After Drilling: **Not Encountered, Augers In**		

LOG OF BORING

Boring 9588000-ST-45

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 568513.7 ft **Coordinates** E: 2239451.1 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3141.6 ft
Date Started: 5/6/20	**Date Finished:** 5/6/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - CAB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							10½" Existing PMS.							
			72		8 - 32 - 37		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subrounded, [A-1]. 10½"-12" Crushed Top Surfacing.	0.9 *3140.7* 1.0 *3140.6*	2 3					
			56		16 - 27 - 25		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense, brown, moist, fine to coarse grained, subangular, [A-1].	4.0 *3137.6*	16					Pen: 3½ tsf
5 *3136.6*			100		1 - 5 - 6		FILL, Sandy Lean CLAY (CL), stiff, brown to gray, moist, [A-6].	6.0 *3135.6*	17	40	16	64		Bulk Bag 4'-6' MDD=114.3 pcf OMC=15%
			56		2 - 6 - 4		Lean CLAY with sand (CL), stiff, brown, moist, [A-6]. (Alluvium).		15					
							Clayey SAND (SC), loose, light brown, moist, fine grained, subangular, [A-2]. (Alluvium).	8.5 *3133.1*	12					
10 *3131.6*			28		1 - 2 - 2									
							Boring Depth: 10.5 ft, *Elevation: 3131.1 ft*	10.5 *3131.1*						

Water Level Observations		Remarks
▽ After Drilling: Not Encountered, Augers In	▽ During Drilling: Not Encountered ▼ After Drilling: Not Encountered, Augers Out	Remarks: Water not encountered to dry cave-in depth of 3½' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-46

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 568730.3 ft **Coordinates** E: 2239909.5 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3138.7 ft
Date Started: 5/5/20	**Date Finished:** 5/5/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - CAA	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							9" Existing PMS.	0.8 / 3137.9	2					
			72		21 - 30 - 34		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to medium dense, brown to gray, moist, fine to coarse grained, subangular to subrounded, [A-1].		6					
			72		11 - 17 - 8			3.8 / 3134.9	19					Pen: 2 tsf
5 / 3133.7			72		4 - 7 - 6		FILL, Sandy Lean CLAY (CL), stiff, brown, moist, [A-6].		22	35	14	59		Bulk Bag 3.8'-6½' MDD=125.2 pcf OMC=11%
			56		2 - 3 - 4		Lean CLAY with sand (CL), medium stiff, brown, moist, [A-6]. (Alluvium).	6.0 / 3132.7	22					Pen: ¾ tsf
							Clayey SAND (SC), loose, brown, moist, fine grained, subangular, [A-2]. (Alluvium).	8.5 / 3130.2	14					
10 / 3128.7			50		2 - 2 - 3			10.5 / 3128.2						

Boring Depth: 10.5 ft, *Elevation: 3128.2 ft*

Water Level Observations

- ▽ During Drilling: **Not Encountered**
- ▼ After Drilling: **Not Encountered, Augers In**
- ▼ After Drilling: **Not Encountered, Augers Out**

Remarks: Water not encountered to dry cave-in depth of 4' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-47

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 569356.8 ft **Coordinates** E: 2241216.8 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3137.2 ft
Date Started: 5/5/20	**Date Finished:** 5/5/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - ACD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							10½" Existing PMS.	0.9 *3136.3*	2					
			89		18 - 36 - 37		BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), brown, moist, fine to coarse grained, subangular to subrounded, [A-1].		4		NP	8		Crushed Top Surfacing Bag 10½"-11½"
			33		10 - 31 - 50/0.3ft		10½"-11½" Crushed Top Surfacing.	1.0 *3136.2*	4					
							BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense, brown to gray, moist, fine to coarse grained, subangular to subrounded, [A-1].		16					
5 *3132.2*			39		24 - 8 - 6			4.5 *3132.7*	20	34	13	64		Bulk Bag 4½'-6½' MDD=117.9 pcf OMC=14% Pen: 3½ tsf
							FILL, Sandy Lean CLAY (CL), stiff, brown, moist, [A-6].	6.0 *3131.2*	21					
			89		2 - 4 - 6		Lean CLAY (CL), stiff to soft, dark gray to brown, moist, [A-6]. (Alluvium).							
									20					Pen: 2 tsf
10 *3127.2*			33		2 - 2 - 1									
								10.5 *3126.7*						

Boring Depth: 10.5 ft, *Elevation: 3126.7 ft*

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 4½' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-48

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 570552.4 ft **Coordinates** E: 2242892.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3135.7 ft
Date Started: 5/6/20	**Date Finished:** 5/6/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 27E 30 - BBC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8½" Existing PMS.	0.7	4		NP	7		
			44		18 - 22 - 21		BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), brown, moist, fine to coarse grained, subrounded, [A-1]. 8½"-10½" Crushed Top Surfacing.	3135.0 0.9 3134.8	4 6					Crushed Top Surfacing Bag 8½"-10½"
			50		11 - 20 - 7		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to medium dense, brown, moist, fine to coarse grained, subrounded to subangular, [A-1].	4.1 3131.6	21 20	45	20	83		Bulk Bag 4.1'-6' MDD=108.0 pcf OMC=18%
5 3130.7			39		1 - 4 - 4		FILL, Lean CLAY with sand (CL), medium stiff, brown, moist, [A-7].	6.0 3129.7	16					Pen: 1½ tsf
			89		2 - 5 - 8		Sandy Lean CLAY (CL), stiff, brown, moist, [A-6]. (Alluvium).	8.5 3127.2	16					
10 3125.7			78		3 - 4 - 3		Clayey SAND (SC), loose, light brown, moist, fine grained, subangular, [A-2]. (Alluvium).	10.5 3125.2						

Boring Depth: 10.5 ft, *Elevation: 3125.2 ft*

Water Level Observations		
▽ During Drilling: **Not Encountered**		Remarks: Water not encountered to dry cave-in depth of 4½' immediately after withdrawal of auger.
▼ After Drilling: **Not Encountered, Augers In**	▼ After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-49

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 570820.6 ft **Coordinates** E: 2243288.5 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3136.5 ft
Date Started: 5/5/20	**Date Finished:** 5/5/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 27E 30 - BBC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8¼" Existing PMS.	0.7 *3135.8*	4					
			67		11 - 18 - 19		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subangular to subrounded, [A-1]. 8¼"-9¾" Crushed Top Surfacing.	0.8 *3135.7*	5					
			28		9 - 13 - 5		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to medium dense, brown to gray, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.0 *3132.5*	19 16	28	14	54		Bulk Bag 4'-6' MDD=116.0 pcf OMC=14%
5 *3131.5*			72		2 - 4 - 6		Sandy Lean CLAY (CL), stiff, brown, moist, [A-6]. (Alluvium).	6.0 *3130.5*	14					
			50		2 - 3 - 1		Clayey SAND (SC), loose, brown, moist, fine grained, subangular, [A-6]. (Alluvium).		13					
10 *3126.5*			56		2 - 2 - 2			10.5 *3126.0*						

Boring Depth: 10.5 ft, *Elevation: 3126.0 ft*

Water Level Observations	
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**
	After Drilling: **Not Encountered, Augers Out**

Remarks: Water not encountered to dry cave-in depth of 5½' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-55

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 566356.0 ft **Coordinates** E: 2235622.1 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3135.7 ft
Date Started: 5/8/20	**Date Finished:** 5/8/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 26 - DCD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							11¼" Existing PMS.	0.9 *3134.8*	3					
			72		18 - 27 - 33		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].		4					
			39		15 - 20 - 9				6					
5 *3130.7*			83		5 - 11 - 15		FILL, Poorly-Graded GRAVEL with clay and sand (GP-GC), medium dense to loose, dark gray, moist, fine to coarse grained, subangular to subrounded, [A-1]. Hydrocarbon odor.	4.0 *3131.7*	13					
			56		2 - 3 - 3			8.0 *3127.7*						Boring terminated due to potentially contaminated soils.

Boring Depth: 8.0 ft, *Elevation: 3127.7 ft*

Water Level Observations		
▽ After Drilling: **Not Encountered, Augers In**	▽ During Drilling: **Not Encountered**	Remarks: Water not encountered to dry cave-in depth of 3½' immediately after withdrawal of auger.
	▼ After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-56

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 567039.3 ft **Coordinates** E: 2236832.5 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3139.4 ft
Date Started: 5/11/20	**Date Finished:** 5/11/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 26 - DDB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8½" Existing PMS.	0.7 *3138.7*	3 5					
			83		15 - 29 - 29		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subrounded, [A-1]. 8½" to 10" Crushed Top Surfacing.	0.8 *3138.6*						
			33		11 - 16 - 11		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.1 *3135.3*	15 18	26	14	49		Pen: 1½ tsf Bulk Bag 4.1'-6½ MDD=118.8 pcf OMC=13%
5 *3134.4*			56		2 - 6 - 8									
			67		2 - 2 - 3		Clayey SAND (SC), medium dense to very loose, light brown, moist, fine grained, subangular, [A-6]. (Alluvium).		15 14					
10 *3129.4*			73		1 - 2 - 1									
							Boring Depth: 10.5 ft, *Elevation: 3128.9 ft*	10.5 *3128.9*						

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 3' immediately after withdrawal of auger.
▽ During Drilling: Not Encountered	▼ After Drilling: Not Encountered, Augers Out	
▼ After Drilling: Not Encountered, Augers In		

LOG OF BORING

Boring 9588000-ST-57

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 567820.4 ft **Coordinates** E: 2238110.3 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3142.3 ft
Date Started: 5/8/20	**Date Finished:** 5/8/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - CBC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8¼" Existing PMS.	0.7 *3141.6*	2					
			83		13 - 26 - 24		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subrounded, [A-1]. 8¼" to 10" Crushed Top Surfacing.	0.8 *3141.5*	9					
			61		12 - 25 - 13		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.0 *3138.3*	17					Pen: 3½ tsf
5 *3137.3*			94		3 - 6 - 7		FILL, Sandy Lean CLAY (CL), stiff, light brown, moist, [A-6].		19 20	34	16	62		Bulk Bag 4'-8' MDD=118.3 pcf OMC=15%
			100		1 - 4 - 6			8.0 *3134.3*						
							Sandy Lean CLAY (CL), medium stiff, gray, moist, [A-6]. (Alluvium).		24					Pen: 1½ tsf
10 *3132.3*			56		2 - 3 - 5									
							Boring Depth: 10.5 ft, *Elevation: 3131.8 ft*	10.5 *3131.8*						

Water Level Observations		Remarks
▽ After Drilling: Not Encountered, Augers In	▽ During Drilling: Not Encountered ▼ After Drilling: Not Encountered, Augers Out	Remarks: Water not encountered to dry cave-in depth of 4' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-58

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 568019.6 ft **Coordinates** E: 2238463.9 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3143.2 ft
Date Started: 5/8/20	**Date Finished:** 5/8/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - CBD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8½" Existing PMS.	0.7	2		NP	6		
			83		21 - 32 - 36		BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), brown, moist, fine to coarse grained, subrounded, [A-1]. 8½"-10¼" Crushed Top Surfacing.	3142.5 0.9 3142.3	3 5					Crushed Top Surfacing Bag 8½"-10¼"
			89		14 - 22 - 20		BASE COURSE, Poorly-Graded with silt and sand (GP-GM), very dense to dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.2	21					Pen: 2 tsf
5 3138.2			78		7 - 5 - 4		FILL, Sandy Lean CLAY (CL), stiff, brown to gray, moist, [A-6].	3139.0	21	33	14	64		Bulk Bag 4.2'-6½' MDD=117.8 pcf OMC=14%
			100		2 - 6 - 11		Sandy Lean CLAY (CL), very stiff to stiff, gray to brown, moist, [A-6]. (Alluvium).	6.5 3136.7	17					Pen: 2 tsf
									17					Pen: 1 tsf
10 3133.2			100		2 - 5 - 8									
								10.5 3132.7						

Boring Depth: 10.5 ft, *Elevation: 3132.7 ft*

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 5' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-59

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 568979.4 ft **Coordinates** E: 2240249.0 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3138.4 ft
Date Started: 5/11/20	**Date Finished:** 5/11/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - DBB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8½" Existing PMS.	0.7						
			78		14 - 28 - 26		BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), brown, moist, fine to coarse grained, subrounded, [A-1]. 8½"-9½" Crushed Top Surfacing.	*3137.7* 0.8 *3137.6*	3 4		NP	12		Crushed Top Surfacing Bag 8½"-9½"
			6		13 - 20 - 23		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].		5					
5 *3133.4*			3		9 - 12 - 9			4.5 *3133.9*	17	30	14	58		Bulk Bag 4½'-6' MDD=120.0 pcf OMC=13%
			83		3 - 7 - 11		FILL, Sandy Lean CLAY (CL), stiff, brown, moist, [A-6].	6.0 *3132.4*	11					
							FILL, Clayey SAND (SC), medium dense, light brown, moist, fine grained, subangular, [A-2].		15					
							Lean CLAY with sand (CL), stiff, light brown to dark gray, moist, [A-6]. (Alluvium).	8.5 *3129.9*	19					Pen: 3½ tsf
10 *3128.4*			56		2 - 5 - 5			10.5 *3127.9*						

Boring Depth: 10.5 ft, *Elevation: 3127.9 ft*

Water Level Observations	
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**
	After Drilling: **Not Encountered, Augers Out**

Remarks: Water not encountered to dry cave-in depth of 3½' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-60

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 569713.9 ft **Coordinates** E: 22419627.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3136.3 ft
Date Started: 5/8/20	**Date Finished:** 5/8/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - ADC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8½" Existing PMS.	0.7 / 3135.6						
			56		13 - 28 - 28		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subrounded, [A-1]. 8½"-9½" Crushed Top Surfacing.	0.8 / 3135.5	3					
			28		20 - 27 - 8		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.0 / 3132.3	6					
5 / 3131.3			6		5 - 3 - 4		FILL, Sandy Lean CLAY (CL), medium stiff, brown, moist, [A-6].	6.0 / 3130.3	3 19	40	16	67		Bulk Bag 4.1'-6' MDD=114.7 pcf OMC=16%
			89		1 - 6 - 9		Clayey SAND (SC), medium dense, light brown, moist, fine grained, subangular, [A-6]. (Alluvium).	7.5 / 3128.8	21					
							Lean CLAY with sand (CL), very stiff to stiff, brown to dark gray, moist, [A-6]. (Alluvium).		24					
10 / 3126.3			56		1 - 4 - 5									
							Boring Depth: 10.5 ft, *Elevation: 3125.8 ft*	10.5 / 3125.8						

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 4' immediately after withdrawal of auger.
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**	
	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-61

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 570020.2 ft **Coordinates** E: 2242070.8 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3138.0 ft
Date Started: 5/8/20	**Date Finished:** 5/8/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - ADA	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							10" Existing PMS.	0.8	3		NP	11		
			93		21 - 42 - 43		BASE COURSE, Poorly-Graded SAND with silt and gravel (SP-SM), brown, moist, fine to coarse grained, subrounded, [A-1]. 10"-11½" Crushed Top Surfacing.	3137.2 1.0 3137.0	3					Crushed Top Surfacing Bag 10"-11½"
			72		16 - 20 - 16		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.3	20					
5 3133.0			50		6 - 5 - 5		FILL, Sandy Lean CLAY (CL), stiff, brown, moist, [A-6].	3133.7	16	30	14	63		Bulk Bag 4.3'-8' MDD=117.8 pcf OMC=13% Pen: 1½ tsf
			94		1 - 5 - 5				15					
							Clayey SAND (SC), loose, light brown, moist, fine grained, subangular, [A-2]. (Alluvium).	8.0 3130.0	13					
10 3128.0			22		1 - 3 - 2									
							Boring Depth: 10.5 ft, *Elevation: 3127.5 ft*	10.5 3127.5						

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 4' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-62

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 571246.8 ft **Coordinates** E: 2243716.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3140.4 ft
Date Started: 5/11/20	**Date Finished:** 5/11/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 27E 30 - BBA	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							8½" Existing PMS.	0.7 *3139.7*	3					
			83		22 - 39 - 3		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subrounded, [A-1]. 8½"-10" Crushed Top Surfacing.	0.8 *3139.6*	9					
			50		10 - 13 - 7		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense to medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.0 *3136.4*	23					Pen: 1 tsf
5 *3135.4*			78		1 - 3 - 5		FILL, Lean CLAY with sand (CL), medium stiff, brown, moist, [A-6].	6.0 *3134.4*	20	34	16	77		Bulk Bag 4'-6' MDD=110.0 pcf OMC=19%
			56		2 - 3 - 3		Clayey SAND (SC), loose, brown to light brown, moist, fine grained, subangular, [A-2]. (Alluvium).		19					
									16					
10 *3130.4*			56		2 - 3 - 2			10.5 *3129.9*						

Boring Depth: 10.5 ft, *Elevation: 3129.9 ft*

Water Level Observations	
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**
	After Drilling: **Not Encountered, Augers Out**

Remarks: Water not encountered to dry cave-in depth of 3' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-67

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 567247.8 ft **Coordinates** E: 2237251.8 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3137.9 ft
Date Started: 5/6/20	**Date Finished:** 5/6/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 26 - DDA	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
			28		2 - 5 - 5		2" Topsoil and Root Zone.	0.2 *3137.7*	6					
			67		2 - 6 - 6		FILL, Poorly-Graded GRAVEL with silt and sand (GP-GM), loose, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	1.0 *3136.9*	18	34	15	64		
5 *3132.9*			83		3 - 4 - 6		FILL, Sandy Lean CLAY (CL), stiff, brown to gray, moist, [A-6].		17 20					Bulk Bag 2'-5' MDD=113.0 pcf OMC=15% Pen: 4+ tsf
			72		1 - 2 - 1		Clayey SAND (SC), very loose, brown, moist, fine grained, subangular, [A-2]. (Alluvium).	6.0 *3131.9*	16					
10 *3127.9*			61		WH - 1 - 2		Lean CLAY with sand (CL), soft, brown, moist, [A-6]. (Alluvium).	9.0 *3128.9*	20					Pen: ½ tsf
							Boring Depth: 10.5 ft, *Elevation: 3127.4 ft*	10.5 *3127.4*						

Water Level Observations	
After Drilling: Not Encountered, Augers In	During Drilling: Not Encountered
	After Drilling: Not Encountered, Augers Out

Remarks: Water not encountered to dry cave-in depth of 5' immediately after withdrawal of auger.

LOG OF BORING

Boring 9588000-ST-68

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 568254.7 ft **Coordinates** E: 2238962.9 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3141.0 ft
Date Started: 5/6/20	**Date Finished:** 5/6/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - CAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							4" Topsoil and Root Zone.	0.3 *3140.7*	9					
			28		3 - 6 - 12		FILL, Poorly-Graded GRAVEL with silt and sand (GP-GM), medium dense, brown, moist, fine to coarse grained, subangular, [A-1].	1.8 *3139.2*	22	35	16	70		Pen: 2½ tsf Bulk Bag 1.8'-3½' MDD=113.7 pcf OMC=16%
			83		5 - 5 - 5		FILL, Lean CLAY with sand (CL), stiff, brown to light brown, moist, [A-6].	3.5 *3137.5*	17 27					
5 *3136.0*			100		1 - 2 - 2		Sandy Lean CLAY (CL), stiff to soft, gray to light brown, moist to wet, [A-6]. (Alluvium).	6.0 *3135.0*	26					Pen: ¾ tsf
			78		1 - 2 - 3		Lean CLAY with sand (CL), medium stiff, brown, moist, [A-6]. (Alluvium).	8.5 *3132.5*	17					
10 *3131.0*			50		1 - 1 - 2		Clayey SAND (SC), very loose, brown, moist, fine grained, subangular, [A-6]. (Alluvium).	10.5 *3130.5*						

Boring Depth: 10.5 ft, *Elevation: 3130.5 ft*

Water Level Observations	
▽ During Drilling: **Not Encountered**	Remarks: Water not encountered to dry cave-in depth of 1½' immediately after withdrawal of auger.
▼ After Drilling: **Not Encountered, Augers In**	▼ After Drilling: **Not Encountered, Augers Out**

LOG OF BORING

Boring 9588000-ST-69

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 569276.5 ft **Coordinates** E: 2240946.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3135.2 ft
Date Started: 5/11/20	**Date Finished:** 5/11/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 25 - ACC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							4" Topsoil and Root Zone.	0.3						
							FILL, Clayey GRAVEL with sand (GC), medium dense, brown, moist, fine to coarse grained, subrounded, [A-2].	3134.9	5					
			22		WH - 3 - 15				15					
			33		4 - 4 - 8				23					
								4.0						
5			94		4 - 4 - 5		FILL, Lean CLAY with sand (CL), stiff, brown, moist, [A-6].	3131.2	17	37	15	64		Bulk Bag 4'-6' MDD=113.5 pcf OMC=16%
3130.2								6.0						
							Sandy Lean CLAY (CL), medium stiff, brown to light brown, moist, [A-6]. (Alluvium).	3129.2	19					
			50		1 - 3 - 2									
									11					
10			39		1 - 3 - 2									
3125.2								10.5						
							Boring Depth: 10.5 ft, *Elevation: 3124.7 ft*	3124.7						

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 1' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-70

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 570673.1 ft **Coordinates** E: 2243005.2 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3133.5 ft
Date Started: 5/11/20	**Date Finished:** 5/11/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 27E 30 - BBC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							2" Topsoil and Root Zone.	0.2 3133.3						
			78		2 - 4 - 4		FILL, Lean CLAY with sand (CL), medium stiff to stiff, brown to dark gray, moist, [A-6].		9					Pen: 2½ tsf
			89		2 - 3 - 6				21 16	34	14	71		Bulk Bag ½'-6' MDD=112.5 pcf OMC=15%
5 3128.5			83		3 - 4 - 7				20					Pen: 3½ tsf
								6.0 3127.5	20					
			78		3 - 5 - 5		Clayey SAND (SC), loose, gray to dark gray, moist, fine grained, rounded, [A-2]. (Alluvium).							
									12					
10 3123.5			39		1 - 2 - 2									
								10.5 3123.0						

Boring Depth: 10.5 ft, *Elevation: 3123.0 ft*

Water Level Observations		
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**	Remarks: Water not encountered to dry cave-in depth of 3' immediately after withdrawal of auger.
	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 9588000-ST-71

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 565833.2 ft **Coordinates** E: 2235152.2 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3145.8 ft
Date Started: 5/4/20	**Date Finished:** 5/4/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - ABB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							11" Existing PMS.	0.9 *3144.9*	2					
			72		15 - 24 - 16		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense, brown, moist, fine to coarse grained, subrounded, [A-1].	2.5 *3143.3*	3					
			39		9 - 9 - 16		FILL, Clayey GRAVEL with sand (GC), medium dense, brown, moist, fine to coarse grained, subangular, [A-2].		5 15	23	15	20		Bulk Bag 2½'-5' MDD=134.7 pcf OMC=8%
5 *3140.8*			100		10 - 15 - 10		FILL, Clayey SAND (SC), medium dense, light brown, moist, medium grained, subangular, [A-2].	5.0 *3140.8*						
			100		4 - 7 - 5		Clayey SAND (SC), loose, light brown, moist, medium grained, subangular, [A-2]. (Alluvium).	7.5 *3138.3*	15					
							Lean CLAY with sand (CL), stiff, light brown, moist, [A-6]. (Alluvium).	8.5 *3137.3*						Pen: 2¼ tsf
10 *3135.8*			56		2 - 5 - 5				15					
							Boring Depth: 10.5 ft, *Elevation: 3135.3 ft*	10.5 *3135.3*						

Water Level Observations	
▽ During Drilling: **Not Encountered**	Remarks: Water not encountered to dry cave-in depth of 5½' immediately after withdrawal of auger.
▼ After Drilling: **Not Encountered, Augers In**	▼ After Drilling: **Not Encountered, Augers Out**

LOG OF BORING

Boring 9588000-ST-72

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 565966.2 ft **Coordinates** E: 2234780.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3138.5 ft
Date Started: 5/12/20	**Date Finished:** 5/12/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - ABB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							11½" Existing PMS.							
			83		12 - 23 - 16		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	1.0 *3137.5*	4					
			100		10 - 4 - 8		FILL, Sandy Lean CLAY (CL), stiff, gray to brown, moist, [A-6].	2.8 *3135.7*	13 18	28	16	65		Bulk Bag 2.8'-4' MDD=123.5 pcf OMC=13%
5 *3133.5*			73		2 - 6 - 12		FILL, Clayey SAND with gravel (SC), medium dense, gray to brown, moist, fine to coarse grained, subangular to subrounded, [A-2].	4.0 *3134.5*	11					
			100		4 - 8 - 10		FILL, Clayey GRAVEL with sand (GC), medium dense, gray to brown, moist, fine to coarse grained, subangular to subrounded, [A-2].	6.0 *3132.5*	12					
10 *3128.5*			56		5 - 6 - 6		FILL, Clayey SAND (SC), medium dense, gray to light brown, moist, fine grained, subangular to subrounded, [A-2].	8.5 *3130.0*	20					
							Boring Depth: 10.5 ft, *Elevation: 3128.0 ft*	10.5 *3128.0*						

Water Level Observations	
During Drilling: **Not Encountered**	Remarks: Water not encountered to dry cave-in depth of 2' immediately after withdrawal of auger.
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**

LOG OF BORING

Boring 9588000-ST-73

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 565540.3 ft **Coordinates** E: 2232818.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3130.3 ft
Date Started: 5/12/20	**Date Finished:** 5/12/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BBC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							9½" Existing PCCP.	0.8 *3129.5*	4					
			94		10 - 22 - 13		BASE COURSE, Poorly-Graded SAND with gravel (SP), brown, moist, fine to coarse grained, subrounded, [A-1]. 9½"-13" Leveling Course.	1.1 *3129.2*	8					Bulk Bag 2'-5' MDD=138.1 pcf OMC=6%
			83		7 - 6 - 4		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to loose, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	4.0 *3126.3*	7 11		NP	7		
5 *3125.3*			73		4 - 7 - 5		FILL, Sandy Lean CLAY (CL), stiff, dark gray, moist, [A-6].	4.5 *3125.8*	11					
			39		4 - 11 - 12		FILL, Clayey GRAVEL with sand (GC), medium dense, brown to dark gray, moist, fine to coarse grained, subangular to subrounded, [A-2].	8.0 *3122.3*						

Boring Depth: 8.0 ft, *Elevation: 3122.3 ft*

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 2½' immediately after withdrawal of auger.
▽ During Drilling: **Not Encountered**	▼ After Drilling: **Not Encountered, Augers In**	
▼ After Drilling: **Not Encountered, Augers Out**		

LOG OF BORING

Boring 9588000-ST-74

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 565891.2 ft **Coordinates** E: 2233923.0 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3140.5 ft
Date Started: 5/12/20	**Date Finished:** 5/12/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							7½" Existing PMS.	0.6						
			67		18 - 27 - 13		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense, brown, moist, fine to coarse grained, subangular, [A-1].	*3139.9*	3 14					
			73		3 - 9 - 13		FILL, Clayey SAND (SC), medium dense, light brown to gray, moist, fine to coarse grained, subrounded to subangular, [A-6].	3.0 *3137.5*	18 14	33	15	43		Bulk Bag 3'-5' MDD=117.0 pcf OMC=15%
5 *3135.5*			100		9 - 15 - 13									
			78		13 - 20 - 15		FILL, Poorly-Graded SAND with clay and gravel (SP-SC), medium dense, light brown to gray, moist, fine to coarse grained, subrounded to subangular, [A-2].	6.0 *3134.5*	15 16					
10 *3130.5*			83		8 - 13 - 15			10.5 *3130.0*						

Boring Depth: 10.5 ft, *Elevation: 3130.0 ft*

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 2' immediately after withdrawal of auger.
▽ During Drilling: **Not Encountered**	▽ After Drilling: **Not Encountered, Augers In**	
▼ After Drilling: **Not Encountered, Augers Out**		

LOG OF BORING

Boring 9588000-ST-75

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 565410.5 ft **Coordinates** E: 2234834.6 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3170.9 ft
Date Started: 5/13/20	**Date Finished:** 5/13/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - ABC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							6¾" Existing PMS.	0.6 / 3170.3	2					
			83		21 - 30 - 30		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].		19					
			56		8 - 7 - 5		BASE COURSE, Silty GRAVEL with sand (GM), medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1]. Subbase Course.	3.0 / 3167.9 4.0 / 3166.9	7		NP	23		Subbase Bag 3'-4'
5 / 3165.9			61		1 - 3 - 3		FILL, Sandy Lean CLAY (CL), medium stiff to very stiff, brown, moist, [A-6].		14					Bulk Bag 4'-7½' MDD=118.5 pcf OMC=14%
									11 15	33	16	51		
			73		1 - 8 - 9		FILL, Clayey GRAVEL with sand (GC), medium dense to loose, brown, moist, fine to coarse grained, subangular to subrounded, [A-2].	7.5 / 3163.4	15					
10 / 3160.9			78		4 - 3 - 3									
							Boring Depth: 10.5 ft, *Elevation: 3160.4 ft*	10.5 / 3160.4						

Water Level Observations		
After Drilling: Not Encountered, Augers In	During Drilling: Not Encountered	Remarks: Water not encountered to dry cave-in depth of 2½' immediately after withdrawal of auger.
	After Drilling: Not Encountered, Augers Out	

LOG OF BORING

Boring 9588000-ST-76

Project: Lockwood Interchange - Billings STPX 90-8(191)450		**Rig:** CME75 **Hammer:** Auto	**Boring Location** N: 565430.9 ft **Coordinates** E: 2235824.0 ft	**Station:** **Offset:**
Project Number: 19-3792S	**UPN:** 9588000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3167.5 ft
Date Started: 5/13/20	**Date Finished:** 5/13/20	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart	**Elevation Source:** Sanderson Stewart
Driller: E. Hollibaugh **Logger:** C. Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - ABD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD	Remarks and Other Tests
							6¾" Existing PMS.	0.6 *3166.9*	2					
			83		18 - 28 - 22		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	2.5 *3165.0*	12					
			72		4 - 6 - 17		BASE COURSE, Silty GRAVEL with sand and clay (GC-GM), medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-2].		5 4	21	14	28		Bulk Bag 3'-5' MDD=135.2 pcf OMC=8%
5 *3162.5*			6		9 - 13 - 10		Subbase Course.	5.0 *3162.5*						
							FILL, Sandy Lean CLAY (CL), very stiff, brown, moist, [A-6].		14 6	34	13	68		Bulk Bag 5'-7' MDD=120.7 pcf OMC=13%
			61		6 - 19 - 8		FILL, Poorly-Graded GRAVEL with sand (GP), medium dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	7.0 *3160.5*						
			100		22 - 50/0.4ft		Silty SAND with gravel (SM), very dense, light brown, moist, fine to coarse grained, subangular to subrounded, [A-2]. (Decomposed Sandstone).	9.0 *3158.5*	7					
								9.9 *3157.6*						

Boring Depth: 9.9 ft, *Elevation: 3157.6 ft*

Water Level Observations		Remarks: Water not encountered to dry cave-in depth of 2' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

I-90 Yellowstone R – Billings

Log of Boring Sheets

LOG OF BORING

Boring 7972000-ST-16

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565488.2 ft **Coordinates** E: 2234312.6 ft	**Station:** 252 + 78 **Offset:** 45 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3138.2 ft
Date Started: 4/7/16	**Date Finished:** 4/7/16	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: M. Luce **Logger:** B. Western		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							9½" PMS.	0.8	2					
			78		20 - 32 - 31		CRUSHED TOP SURFACING, Silty GRAVEL with sand (GM), dense, dark brown, moist, fine to coarse grained, subrounded, [A-1].	*3136.2* 1.1	2	27	14	14		Base Bag 1.1'-1.3'
								3136.1	3					
			100		18 - 36 - 50		BASE COURSE, Clayey SAND with gravel (SC), very dense, brown, moist, fine to coarse grained, subangular, [A-2].	4.0	9					
5			56		37 - 50/0.2ft			*3132.9*	7	27	15	56		Bulk Bag 4'-4½' MDD=125.7 pcf OMC=11%
3133.9							FILL, Sandy Lean CLAY with gravel (CL), hard, olive, moist, [A-6].	4.5 *3133.6*						
			17		50/0.3ft		Weathered SANDSTONE, brown to gray, coarse grained, medium to hard field hardness.		4					
									1					
			9		50/0.5ft			8.5 *3197.6*						Auger Refusal 8½'

Boring Depth: 8.5 ft, *Elevation: 3129.7 ft*

Water Level Observations	
During Drilling: **Not Encountered**	
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**

Remarks: Water not observed to dry cave-in depth of 5.3' immediately after withdrawal of auger.

LOG OF BORING

Boring 7972000-ST-17

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565954.8 ft **Coordinates** E: 2235133.0 ft	**Station:** 262 + 19 **Offset:** 45 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3135.1 ft
Date Started: 4/8/16	**Date Finished:** 4/8/16	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: M. Luce **Logger:** B. Western		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - ABB	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							10¼" PMS.							
			89		23 - 24 - 29		CRUSHED TOP SURFACING, Silty GRAVEL with sand (GM), dense, dark brown, moist, fine to coarse grained, subrounded, [A-1].	0.9 *3132.9*	2					
								1.1 *3132.8*	2					
			72		17 - 28 - 24		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP), very dense, brown, moist, fine to coarse grained, subrounded to subangular, [A-1].	2.5 *3139.4*	4	22	13	27		Bulk Bag 2½'-3½' MDD=133.9 pcf OMC=6% CBR=9.7
5 *3138.1*			78		7 - 9 - 18		FILL, Clayey SAND with gravel (SC), medium dense to very dense, olive, moist, fine to coarse grained, subrounded to subangular, [A-2].		9					
			89		4 - 3 - 3		FILL, Silty SAND (SM), loose, olive, moist, [A-2].	6.5 *3195.4*	7					
10 *3190.1*			94		6 - 4 - 2				8					
							Boring Depth: 10.5 ft, *Elevation: 3124.6 ft*	10.5 *3192.4*						

Water Level Observations	
During Drilling: **Not Encountered**	Remarks: Water not observed to dry cave-in depth of 5.6' immediately after withdrawal of auger.
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**

LOG OF BORING

Boring 7972000-ST-32

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565465.6 ft **Coordinates** E: 2234057.3 ft	**Station:** 250 + 37 **Offset:** 44 ft L
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3141.4 ft
Date Started: 4/11/16	**Date Finished:** 4/11/16	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: M. Luce **Logger:** B. Western		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							9¼" PMS.	0.8 *3128.4*	2					
			100		35 - 42 - 48		CRUSHED TOP SURFACING, Silty GRAVEL with sand (GM), very dense, dark brown, moist, fine to coarse grained, subrounded to subangular, [A-1].	1.1 *3128.3*	2					
			100		25 - 38 - 50		BASE COURSE, Poorly-Graded GRAVEL with clay, sand, and cobbles (GP-GC), very dense, gray to brown, moist, fine to coarse grained, subangular, [A-1].	4.0 *3136.2*	9					
5 *3134.2*			100		16 - 50/0.3ft		FILL, Clayey SAND with gravel (SC), very dense, brown, moist, fine to coarse grained, [A-2].	4.5 *3134.7*	3	28	14	25		Bulk Bag 4'-4½' MDD=133.7 pcf OMC=7% CBR=8.1
			100		50/0.2ft		Weathered SANDSTONE, olive, fine grained, soft to medium field hardness.	6.7 *3132.6*	4					

Boring Depth: 6.7 ft, *Elevation: 3134.7 ft*

Water Level Observations		Remarks: Water not observed to dry cave-in depth of 3.4' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 7972000-ST-33

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565869.2 ft **Coordinates** E: 2234811.2 ft	**Station:** 258 + 98 **Offset:** 44 ft L
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3134.2 ft
Date Started: 4/11/16	**Date Finished:** 4/11/16	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: M. Luce **Logger:** B. Western		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAA	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							9¼" PMS.							
			100		28 - 34 - 34		CRUSHED TOP SURFACING, Silty GRAVEL with sand (GM), very dense, dark brown, moist, fine to coarse grained, subrounded, [A-1].	0.8 *3133.2* 1.1 *3133.1*	2 3					
			72		16 - 23 - 14		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to very dense, gray, moist, fine to coarse grained, subrounded to subangular, [A-1].	4.0 *3138.9*	11					Pen: 2¾ tsf
5 *3197.9*			50		5 - 5 - 4		Clayey SAND with gravel (SC), loose, brown, moist, fine to coarse grained, [A-4]. some seams lean clay. (Alluvium).		7	21	13	38		Bulk Bag 4'-10' MDD=128.3 pcf OMC=9% CBR=7.6
			89		4 - 3 - 3				16					
									15					
10 *3192.9*			56		5 - 5 - 3									
								10.5 *3193.6*						

Boring Depth: 10.5 ft, *Elevation: 3123.7 ft*

Water Level Observations		Remarks: Water not observed to dry cave-in depth of 7.5' immediately after withdrawal of auger.
During Drilling: **Not Encountered**		
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 7972000-ST-40

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565293.2 ft **Coordinates** E: 2234312.8 ft	**Station:** 251 + 94 **Offset:** 220 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3159.5 ft
Date Started: 4/21/16	**Date Finished:** 4/21/16	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: M. Luce **Logger:** B. Western		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							11¼" PMS.	0.9 *3105.4*	2					
			83		12 - 34 - 31		CRUSHED TOP SURFACING, Silty GRAVEL with sand (GM), very dense, dark brown, moist, fine to coarse grained, angular, [A-1].	1.2 *3105.3*	15					
			100		10 - 12 - 28		BASE COURSE, Poorly-Graded GRAVEL with silt, sand, and cobbles (GP-GM), dense to very dense, gray to brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	3.5 *3104.8*	13 10	32	12	69		Bulk Bag 3½'-4½' MDD=113.3 pcf OMC=16%
5 *3102.0*			100		19 - 37 - 30		FILL, Sandy Lean CLAY (CL), very stiff, olive, moist, [A-6].		17					
			100		7 - 17 - 30									
			100		37 - 50/0.3ft		SHALE, olive, fine grained, very thinly bedded, medium to hard field hardness.	8.5 *3101.8*	8					
							Boring Depth: 9.8 ft, *Elevation: 3149.7 ft*	9.8 *3127.6*						

Water Level Observations		Remarks: Water not observed to dry cave-in depth of 1.8' immediately after withdrawal of auger.
▽ During Drilling: **Not Encountered**	▼ After Drilling: **Not Encountered, Augers In**	
▽ After Drilling: **Not Encountered, Augers Out**		

LOG OF BORING

Boring 7972000-ST-41

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565567.4 ft **Coordinates** E: 2233997.3 ft	**Station:** 250 + 24 **Offset:** 161 ft L
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3145.7 ft
Date Started: 4/21/16	**Date Finished:** 4/21/16	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: M. Luce **Logger:** B. Western		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							10½" PMS.							
			100		21 - 37 - 30		CRUSHED TOP SURFACING, Silty GRAVEL with sand (GM), dense, dark gray, moist, fine to coarse grained, rounded to subrounded, [A-1].	0.9 *3122.5* 1.1 *3122.4*	2 11					
			83		17 - 16 - 13		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), medium dense to very dense, brown, moist, fine to coarse grained, subangular, [A-1].	3.3 *3129.2*	15					
5 *3128.6*			67		8 - 7 - 11		FILL, Clayey SAND with gravel (SC), medium dense, olive, moist, fine to coarse grained, subrounded, [A-6].	6.0 *3137.6*	11 9	25	13	37		Bulk Bag 4'-5' MDD=127.8 pcf OMC=9.0%
			100		48 - 50/0.5ft		Weathered SANDSTONE, olive, fine grained, thinly bedded, medium to hard field hardness.							
			100		50/0.3ft			9.3 *3134.2*	8					

Boring Depth: 9.3 ft, *Elevation: 3136.4 ft*

Water Level Observations	
During Drilling: **Not Encountered**	
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**

Remarks: Water not observed to dry cave-in depth of 2.2' immediately after withdrawal of auger.

LOG OF BORING

Boring 7972000-ST-138

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** CME 75HT **Hammer:** Auto	**Boring Location** N: 565246.9 ft **Coordinates** E: 2234020.0 ft	**Station:** 249 + 17 **Offset:** 142 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3150.8 ft
Date Started: 3/26/18	**Date Finished:** 3/26/18	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: C. Larsen **Logger:** S. Kuhn		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							4½" PMS.	0.4 *3150.4*	5					
			72		11 - 16 - 22		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense, light brown to gray, moist, fine to coarse grained, angular to subangular, [A-1].		3					
			67		17 - 21 - 23									
5 *3145.8*			72		9 - 12 - 14		FILL, Clayey SAND with gravel (SC), medium dense, light brown to gray, moist, fine to coarse grained, subrounded to subangular, [A-2]. trace sandstone chunks.	4.0 *3146.8*	11					
			25		50/0.3ft		Weathered SANDSTONE, brown to light brown, coarse grained, medium bedded, soft to medium field hardness.	6.5 *3144.3*	10					
			8		50/0.2ft		SANDSTONE, light brown, fine grained, medium bedded, medium field hardness.	8.0 *3142.8* 9.2 *3141.6*	8					

Boring Depth: 9.2 ft, *Elevation: 3141.6 ft*

Water Level Observations		
After Drilling: **Not Encountered, Augers In**	During Drilling: **Not Encountered**	Remarks: Water not observed to dry cave-in depth of 2.5' immediately after withdrawal of auger.
	After Drilling: **Not Encountered, Augers Out**	

LOG OF BORING

Boring 7972000-ST-206

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565304.4 ft **Coordinates** E: 2234933.4 ft	**Station:** 257 + 17 **Offset:** 504 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 8"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3176.2 ft
Date Started: 9/9/19	**Date Finished:** 9/9/19	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: S. Robertson **Logger:** D. Hutzenbiler		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - ABC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							7" PMS.	0.6	4					
			100		50/0.5ft		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), very dense, brown, moist, fine to coarse grained, subrounded, [A-1].	*3175.6*	2	0	0	8		
			8		20 - 32 - 17			1.5 *3174.7*	12					
							BASE COURSE, Poorly-Graded GRAVEL with sand (GP), dense, brown, moist, fine to coarse grained, subangular to subrounded, [A-1].	2.9 *3173.3*	14					
5 *3171.2*			18		5 - 5 - 4		FILL, Sandy Lean CLAY (CL), stiff, brown, moist, [A-6].		4	26	12	58		
			18		2 - 7 - 34				11					
							FILL, Lean CLAY with gravel (CL), very stiff, brown, moist, [A-6].	7.5 *3168.7*						
							FILL, Sandy Lean CLAY with gravel (CL), very stiff, brown, moist, [A-6].	8.5 *3167.7*						
10 *3166.2*			18		8 - 11 - 9				11					
								10.5 *3165.7*						

Boring Depth: 10.5 ft, *Elevation: 3165.7 ft*

Water Level Observations	
After Drilling: Not Encountered, Augers In	During Drilling: Not Encountered
	After Drilling: Not Encountered, Augers Out

Remarks: Water not observed to dry cave-in depth of 3' immediately after withdrawal of auger

LOG OF BORING

Boring 7972000-ST-207

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** Diedrich D-120 **Hammer:** Auto	**Boring Location** N: 565497.1 ft **Coordinates** E: 2234576.3 ft	**Station:** 255 + 12 **Offset:** 160 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 8"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3163.2 ft
Date Started: 9/13/19	**Date Finished:** 9/13/19	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: S. Robertson **Logger:** C.Hopkins		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** N 26E 35 - BAD	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
			33		31 - 28 - 17		5½" PMS. BASE COURSE, Poorly-Graded GRAVEL with sand (GP), medium dense to dense, brown, moist, fine to coarse grained, subangular, [A-1].	0.5 *3162.7*	6 1 4	0	0	5		
			50		7 - 17 - 13									
							FILL, Clayey SAND (SC), loose, brown, moist, fine to coarse grained, subrounded to subangular, [A-6].	3.0 *3160.2*	13	27	13	42	
5 *3158.2*			56		3 - 3 - 4			5.0 *3158.2*	10					MDD=120.6pcf OMC=12.2%
							FILL, Silty SAND with sandstone gravel (SM), loose to dense, light brown, moist, fine to coarse grained, subangular to angular, [A-2].		8					
			100		18 - 33 - 19									
10 *3153.2*			67		17 - 21 - 23			10.5 *3152.7*	8					

Boring Depth: 10.5 ft, *Elevation: 3152.7 ft*

Water Level Observations	
During Drilling: **Not Encountered**	
After Drilling: **Not Encountered, Augers In**	After Drilling: **Not Encountered, Augers Out**

Remarks: Water not observed to dry cave-in depth of 4½' immediately after withdrawal of auger

LOG OF BORING

Boring 7972000-ST-140

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** CME 75HT **Hammer:** Auto	**Boring Location** N: 565149.1 ft **Coordinates** E: 2233975.1 ft	**Station:** 248 + 41 **Offset:** 215 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3170.1 ft
Date Started: 3/29/18	**Date Finished:** 3/30/18	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: C. Larsen **Logger:** S. Kuhn		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
			69		WH - 2 - 2		Topsoil and root zone.	0.5 *3169.6*	18					
							Lean CLAY with sand (CL), soft, brown, moist, [A-6]. (Alluvium).	1.0 *3169.1*	13					
			53		1 - 2 - 2		Clayey SAND (SC), very loose, light brown, moist, fine to coarse grained, subangular, [A-2]. (Alluvium).	3.5 *3166.6*						
5 *3165.1*			56		11 - 22 - 29		Poorly-Graded GRAVEL with silt, sand, and cobbles (GP), dense to very dense, brown to gray, moist, fine to coarse grained, subangular, [A-1]. (Alluvium).		1					
			78		16 - 40 - 50/0.4ft				3					
10 *3160.1*			75		27 - 50/0.5ft				2					
			39		50/0.5ft				3					
							Weathered SANDSTONE, light gray-brown to orange, fine grained, thinly bedded, medium to moderately hard field hardness.	13.0 *3157.1*	10					
15 *3155.1*			72		27 - 50/0.4ft									
			17		50/0.3ft				8					
20 *3150.1*														
			17		50/0.3ft			24.3 *3145.8*	12					

Boring Depth: 24.3 ft, *Elevation: 3145.8 ft*

Added 35 gallons of water to free auger, let sit overnight.

Water Level Observations		Remarks:
▽ During Drilling: Not Encountered	▽ After Drilling: Not Encountered, Augers In	
▼ After Drilling: Not Encountered, Augers Out		

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 7/7/20 13:26 - Z:\GINT\GINT\PROJECTS\3201-3300\3269S.GPJ

LOG OF BORING

Boring 7972000-ST-141

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** CME 75HT **Hammer:** Auto	**Boring Location** N: 565183.4 ft **Coordinates** E: 2234138.4 ft	**Station:** 249 + 98 **Offset:** 247 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"/3¼"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3171.5 ft
Date Started: 3/30/18	**Date Finished:** 3/30/18	**Drilling Fluid:** None/Water	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: C. Larsen **Logger:** S. Kuhn		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							Topsoil and root zone.	0.6	18					
			75		1 - 2 - 2		Silty SAND (SM), loose to medium dense, light brown, moist, fine grained, subangular to angular, [A-2]. (Alluvium).	3170.9	10					
			69		2 - 2 - 3									
			25				Lean CLAY with sand (CL), medium stiff to stiff, brown, moist, [A-6]. Seams of sand. (Alluvium).	3.5	6	22	12	53		
5			61		5 - 6 - 7			3168.0						
3166.5								6.5	2					
			50		11 - 21 - 30		Poorly-Graded GRAVEL with silt, sand, and cobbles (GP-GM), dense to very dense, light brown to gray-brown, moist, fine to coarse grained, subangular to subrounded, [A-1]. (Alluvium).	3165.0						
			50		31 - 50/0.4ft				1					
10														
3161.5			67		29 - 50/0.5ft				2					
								14.0	5					
15			89		25 - 31 - 40		Poorly-Graded GRAVEL with sand and cobbles (GP), dense to very dense, light brown, moist to wet, fine to coarse grained, subrounded, [A-1]. (Alluvium).	3157.5						
3156.5								15.5						
							Weathered SANDSTONE, light brown, fine grained, thinly bedded, medium to moderately hard field hardness.	3156.0						
									11					
			78		40 - 50/0.3ft									
20			96	46					8				137	UCS: 1040 psi
3151.5														
									17				125	UCS: 2289 psi
			100	41										
25														
3146.5														
							SANDSTONE, light brown to gray, fine grained, medium bedded, hard field hardness.	26.5						
			100	89				3145.0						
30														
3141.5														

Water Level Observations

- During Drilling: **Not Encountered**
- After Drilling: **Not Encountered, Augers In**
- After Drilling: **Not Encountered, Augers Out**

Remarks: Water not observed to wet cave-in depth of 14.5' immediately after withdrawal of auger.

(2) MDT LOG OF BORING - MDT_REVISED_2009+(CPT_IMPORT).GDT - 7/7/20 13:26 - Z:\GINT\GINT\PROJECTS\3201-3300\3269S.GPJ

LOG OF BORING

Boring 7972000-ST-141

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** CME 75HT **Hammer:** Auto	**Boring Location** N: 565183.4 ft **Coordinates** E: 2234138.4 ft	**Station:** 249 + 98 **Offset:** 247 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"/3¼"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3171.5 ft
Date Started: 3/30/18	**Date Finished:** 3/30/18	**Drilling Fluid:** None/Water	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: C. Larsen **Logger:** S. Kuhn		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) *Elev. (ft)*	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) *Elev. (ft)*	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
							Sandstone Continued.	31.0 *3140.5*						
							Boring Depth: 31.0 ft, *Elevation: 3140.5 ft*							

Water Level Observations		
▽ During Drilling: **Not Encountered**	▼ After Drilling: **Not Encountered, Augers In**	▼ After Drilling: **Not Encountered, Augers Out**

Remarks: Water not observed to wet cave-in depth of 14.5' immediately after withdrawal of auger.

LOG OF BORING

Boring 7972000-ST-142

Project: I-90 Yellowstone R - Billings, NHPB 90-8(176)450		**Rig:** CME 75HT **Hammer:** Auto	**Boring Location** N: 565234.6 ft **Coordinates** E: 2234341.5 ft	**Station:** 251 + 95 **Offset:** 285 ft R
Project Number: 14-3269S	**UPN:** 7972000	**Boring Diameter:** 9"	**System:** MT S.P. (E) **Datum:** NAD83	**Top of Boring Elevation:** 3168.4 ft
Date Started: 3/28/18	**Date Finished:** 3/28/18	**Drilling Fluid:** None	**Location Source:** Sanderson Stewart Survey	**Elevation Source:** Sanderson Stewart
Driller: C. Larsen **Logger:** S. Kuhn		**Abandonment Method:** Backfilled with Cuttings	**Township, Range, and Section:** 1N 26E 35 - BAC	

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	DD (pcf)	Remarks and Other Tests
			61		WH - 1 - 2		Topsoil and root zone.	0.5	18					Pen: ½ tsf
							Lean CLAY with sand (CL), medium stiff, brown to dark brown, moist, [A-6]. (Alluvium).	3167.9	17					
			39		1 - 2 - 6			2.5						
							Poorly-Graded GRAVEL with clay and sand (GW-GC), very dense, brown, moist, fine to coarse grained, subangular, [A-1]. trace FeOx at 3'. (Alluvium).	3165.9						
5			83		16 - 31 - 38			3.0	1					
3163.4							Poorly-Graded GRAVEL with sand and cobbles (GP), very dense, light brown to gray, moist, fine to coarse grained, subangular to angular, [A-1]. (Alluvium).	3165.4						
			89		22 - 44 - 50/0.5ft				3					
									4					
10			94		16 - 42 - 47									
3158.4									13					
			67		41 - 50/0.3ft									
							SANDSTONE, light orange to brown, fine grained, thinly bedded, soft field hardness.	12.0						
								3156.4						
							-FeOx staining on bedding planes.		22					
15			83		11 - 15 - 22									
3153.4							SHALE, dark brown, fine grained, very thinly bedded, very soft field hardness.	15.0						
								3153.4						
							-FeOx staining on bedding planes.							
							SHALE, light gray to dark gray, fine grained, very thinly bedded, medium field hardness.	18.0						
								3150.4	8					
			83		50/0.3ft			19.3						
							Boring Depth: 19.3 ft, *Elevation: 3149.1 ft*	3149.1						

Water Level Observations	
▽ During Drilling: **Not Encountered**	Remarks: Water not observed to dry cave-in depth of 7.5' immediately after withdrawal of auger.
▼ After Drilling: **Not Encountered, Augers In**	▼ After Drilling: **Not Encountered, Augers Out**

DOWL – Billings Bypass

Log of Boring Sheets

LOG OF BORING

Boring 4199000-BH-20

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 572463.126 ft **Coordinates** E: 2245146.915 ft	**Station:** 23 + 67 **Offset:** 173 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3149.412 ft
Date Started: 6/27/16	**Date Finished:** 6/28/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 19 - CD **Abandonment:** Cuttings

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
			66.6		14 - 24 - 27		Asphalt (10").	0.8	3						
			55.5		13 - 11 - 18		BASE COURSE, Well-Graded GRAVEL with silt and sand (GW-GM), medium dense, moist, brown, fine to coarse grained, subrounded to subangular, [A-1].	*3148.6*	4						
5 *3144.4*			48.0				Sandy Lean CLAY (CL), soft to very stiff, moist to wet, brown, fine grained, [A-6].	5.0 *3144.4*	14						
			22.2		25 - 15 - 16				4						
10 *3139.4*			88.8		3 - 4 - 14				18						
15 *3134.4*			77.7		5 - 11 - 14				15						
20 *3129.4*			76.0						18						
			44.4		3 - 3 - 5										
25 *3124.4*			33.3		4 - 4 - 4										
30 *3119.4*			66.6		5 - 6 - 5				11						
35 *3114.4*			77.7		5 - 4 - 5										
40 *3109.4*			66.6		5 - 4 - 5				19						
45															
3104.4															

Water Level Observations

During Drilling: **55.0 ft** *(3094.4 ft)*

After Drilling:

After Drilling:

Remarks:

LOG OF BORING

Boring 4199000-BH-20

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 572463.126 ft **Coordinates** E: 2245146.915 ft	**Station:** 23 + 67 **Offset:** 173 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3149.412 ft
Date Started: 6/27/16	**Date Finished:** 6/28/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 19 - CD **Abandonment:** Cuttings

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
			66.6		6 - 6 - 7										
50 3099.4			100		3 - 3 - 3				29						
55 3094.4			100		1 - 1 - 2										
60 3089.4			100		1 - 3 - 4										
65 3084.4			100		1 - 5 - 6										
70 3079.4			88.8		9 - 10 - 39		Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to very dense, wet, brown, fine to coarse grained, subrounded to subangular, [A-1].	70.0 3079.4							
75 3074.4			33.3		1 - 16 - 23										
80 3069.4			22.2		35 - 45 - 31										
85 3064.4			0		50										
90															
3059.4															

Water Level Observations

During Drilling: **55.0 ft** *(3094.4 ft)*

After Drilling:

After Drilling:

Remarks:

LOG OF BORING

Boring 4199000-BH-20

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 572463.126 ft **Coordinates** E: 2245146.915 ft	**Station:** 23 + 67 **Offset:** 173 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3149.412 ft
Date Started: 6/27/16	**Date Finished:** 6/28/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 19 - CD **Abandonment:** Cuttings

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
								91.5 *3057.9*							
95 *3054.4*			70	9			SANDSTONE, gray, fine grained, thickly bedded, soft to moderately hard field hardness.								
100 *3049.4*			98	20											
105 *3044.4*			100	80					5				2032	147	
110 *3039.4*			98	48											
115 *3034.4*			96	74											
120 *3029.4*			98	86					6				1258	138	
125 *3024.4*								125.0 *3024.4*							

Boring Depth: 125.0 ft, *Elevation: 3024.4 ft*

Water Level Observations		Remarks:
During Drilling: **55.0 ft** *(3094.4 ft)*		
After Drilling:	After Drilling:	

LOG OF BORING

Boring 4199000-BH-22

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 572343.491 ft **Coordinates** E: 2245157.206 ft	**Station:** 22 + 47 **Offset:** 164 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3149.814 ft
Date Started: 6/20/16	**Date Finished:** 6/21/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 19 - CD **Abandonment:** Cuttings

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
			77.7		18 - 26 - 37		Asphalt (11").	0.9	4	15	0	8			
			66.6		17 - 25 - 17		BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), dense, moist, brown, fine to coarse grained, subrounded to subangular, [A-1].	3148.9	3						
5								4.5	22						
3144.8			77.7		3 - 4 - 4		Lean CLAY (CL), soft to very stiff, moist, brown, [A-6].	3145.3	22	44	16	88			
			68						22						
10									19						
3139.8			66.6		5 - 5 - 6										
15									21						
3134.8			88.8		4 - 7 - 9										
20								20.0	17						
3129.8			77.7		5 - 13 - 12		Sandy Lean CLAY (CL), medium stiff to very stiff, moist to wet, brown, fine grained, [A-4].	3129.8							
25															
3124.8			33.3		11 - 11 - 9										
30															
3119.8			84						14	27	19	60	7	94	
			66.6		5 - 6 - 9										
35															
3114.8			66.6		4 - 6 - 8										
40									21						
3109.8			77.7		3 - 4 - 6										
45															
3104.8															

Water Level Observations

During Drilling: **62.0 ft** *(3087.8 ft)*

After Drilling:

After Drilling:

Remarks:

LOG OF BORING

Boring 4199000-BH-22

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 572343.491 ft **Coordinates** E: 2245157.206 ft	**Station:** 22 + 47 **Offset:** 164 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3149.814 ft
Date Started: 6/20/16	**Date Finished:** 6/21/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 19 - CD **Abandonment:** Cuttings

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
			77.7		6 - 6 - 8										
50 3099.8			100		3 - 4 - 5				25						
55 3094.8			100		5 - 7 - 10										
60 3089.8			100		2 - 2 - 4										
65 3084.8			100		1 - 3 - 4										
70 3079.8			66.6		1 - 1 - 3		Poorly-Graded GRAVEL with silt and sand (GP-GM), dense to very dense, wet, brown, fine to coarse grained, subrounded to subangular, [A-1].	70.0 3079.8							
75 3074.8			22.2		17 - 19 - 21										
80 3069.8			33.3		43 - 35 - 36										
85 3064.8			22.2		50										
90															
3059.8															

Water Level Observations		Remarks:
▽ During Drilling: 62.0 ft (3087.8 ft)	▽ After Drilling:	

(2) MDT LOG OF BORING - CONSULTANT_V2_2016+ 2.GDT - 3/17/17 09:22 - \\BIL-FS\BIL-PROJECTS\24\20946-01\31GEOSCIENCE\0106\REPORT\APPENDIX B- LOGS\BILLINGS BYPASS LOGS_DRAFT.GPJ

LOG OF BORING

Boring 4199000-BH-22

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 572343.491 ft **Coordinates** E: 2245157.206 ft	**Station:** 22 + 47 **Offset:** 164 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3149.814 ft
Date Started: 6/20/16	**Date Finished:** 6/21/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 19 - CD **Abandonment:** Cuttings

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
95 *3054.8*			66.6		23 - 37 - 31		SANDSTONE, gray, fine grained, thickly bedded, soft to hard field hardness.	92.5 *3057.3*							
100 *3049.8*			64	18											
105 *3044.8*			60	60					5				936	137	
110 *3039.8*			84	84											
115 *3034.8*			88	88											
120 *3029.8*			97	97											
125 *3024.8*			96	86				125.0 *3024.8*							

Boring Depth: 125.0 ft, *Elevation: 3024.8 ft*

Water Level Observations		Remarks:
After Drilling:	During Drilling: **62.0 ft** *(3087.8 ft)*	
	After Drilling:	

LOG OF BORING

Boring 4199000-BH-29

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 571698.072 ft **Coordinates** E: 2244424.761 ft	**Station:** 16 + 10 **Offset:** 903 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3145.909 ft
Date Started: 5/17/16	**Date Finished:** 5/17/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 30 - BA **Abandonment:** Cuttings

Depth (ft) Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
			77.7		16 - 22 - 33		Asphalt (10.5").	0.9	3						
							BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), medium dense to very dense, dry to moist, brown, fine to coarse grained, subrounded to subangular, [A-1].	3145.0	4						
			44.4		14 - 14 - 7			4.0	19						
5								3141.9	17	44	18	68			
3140.9			66.6		2 - 4 - 5		Sandy Lean CLAY (CL), medium stiff to very stiff, moist, brown, fine grained, [A-7].		20						
			66.6		3 - 6 - 12										
10									20						
3135.9			66.6		3 - 6 - 7										
15									18						
3130.9			55.5		4 - 4 - 4										
20									21						
3125.9			66.6		3 - 4 - 5			21.5							
							Boring Depth: 21.5 ft, *Elevation: 3124.4 ft*	3124.4							

Water Level Observations		
After Drilling:	During Drilling: Not Encountered	Remarks:
	After Drilling:	

LOG OF BORING

Boring 4199000-BH-30

Project: NCDP 56(55) Billings Bypass		**Rig:** BK-81 **Hammer:** Auto	**Boring Location** N: 570794.622 ft **Coordinates** E: 2243090.513 ft	**Station:** 220 + 92 **Offset:** 2258 ft L
Project Number: 4024.20946.01	**UPN:** 4199000	**Boring Diameter:** 8.25"	**System:** MT S.P. (E) **Datum:** NAD83	**Ground Elevation:** 3135.922 ft
Date Started: 5/20/16	**Date Finished:** 5/20/16	**Drilling Fluid:** None	**Location Source:** Surveyed	**Elevation Source:** Surveyed
Driller: Haz-Tech **Logger:** A. Zwemke	**Notes:**			**PLS TRS-QQ:** 1N 27E 30 - BB **Abandonment:** Cuttings

Depth (ft) / Elev. (ft)	Operation	Sample Type	Recovery (%)	RQD (%)	Blow Count	Lithology	Material Description	Depth (ft) / Elev. (ft)	MC (%)	LL	PL	-200 (%)	Qu (psi)	DD (pcf)	Remarks and Other Tests
			77.7		23 - 32 - 29		Asphalt (10.5").	0.9	3						
							BASE COURSE, Poorly-Graded GRAVEL with silt and sand (GP-GM), medium dense to very dense, dry to moist, brown, fine to coarse grained, subrounded to subangular, [A-1].	3135.0	2 4	0	0	7			
			22.2		12 - 10 - 4			4.0							
5								3131.9	16 14	44	16	59			
3130.9			88.8		4 - 8 - 11		Sandy Lean CLAY (CL), soft to very stiff, moist, brown, fine grained, [A-7].								
			80						12 13	28	18	50			
10															
3125.9			66.6		2 - 2 - 2			11.0							
							Boring Depth: 11.0 ft, *Elevation: 3124.9 ft*	3124.9							

Water Level Observations		
▽ After Drilling:	▽ During Drilling: Not Encountered	Remarks:
	▼ After Drilling:	

Boring ST-42, eastbound lane, looking east.

Boring ST-42, eastbound lane, looking west.

Boring ST-43, eastbound lane, looking east.

Boring ST-43, eastbound lane, looking west.

Boring ST-44, eastbound lane, looking east.

Boring ST-44, eastbound lane, looking west.

Boring ST-45, eastbound lane, looking east.

Boring ST-45, eastbound lane, looking west.

Boring ST-46, eastbound lane, looking east.

Boring ST-46, eastbound lane, looking west.

Boring ST-47, eastbound lane, looking east.

Boring ST-47, eastbound lane, looking west.

Boring ST-48, eastbound lane, looking east.

Boring ST-48, eastbound lane, looking west.

Boring ST-49, eastbound lane, looking east.

Boring ST-49, eastbound lane, looking west.

Boring ST-55, westbound lane, looking east.

Boring ST-55, westbound lane, looking west.

Boring ST-56, westbound lane, looking east.

Boring ST-56, westbound lane, looking west.

Boring ST-57, westbound lane, looking east.

Boring ST-57, westbound lane, looking west.

Boring ST-58, westbound lane, looking east.

Boring ST-58, westbound lane, looking west.

Boring ST-59, westbound lane, looking east.

Boring ST-59, westbound lane, looking west.

Boring ST-60, westbound lane, looking east.

Boring ST-60, westbound lane, looking west.

Boring ST-61, westbound lane, looking east.

Boring ST-61, westbound lane, looking west.

Boring ST-62, westbound lane, looking east.

Boring ST-62, westbound lane, looking west.

Boring ST-67, I-90 center median, looking east.

Boring ST-67, I-90 center median, looking west.

Boring ST-68, I-90 center median, looking east.

Boring ST-68, I-90 center median, looking west.

Boring ST-69, I-90 center median, looking east.

Boring ST-69, I-90 center median, looking west.

Boring ST-70, I-90 center median, looking east.

Boring ST-70, I-90 center median, looking west.

Boring ST-71, Ramp B, eastbound on-ramp, looking east.

Boring ST-71, Ramp B, eastbound on-ramp, looking west.

Boring ST-72, Ramp A, westbound off-ramp, looking east.

Boring ST-72, Ramp A westbound off-ramp, looking west.

Boring ST-73, US 87 westbound lane, looking east.

Boring ST-73, US 87 westbound lane, looking west.

Boring ST-74, US 87 eastbound lane, looking east.

Boring ST-74, US 87 eastbound lane, looking west.

Boring ST-75, US 87 westbound lane, looking east.

Boring ST-75, US 87 westbound lane, looking west.

Boring ST-76, US 87 eastbound lane, looking east.

Boring ST-76, US 87 eastbound lane, looking west.

Appendix 2

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-42	1.0	-	2.5	31	2.0											
	2.5	-	4.0	32	1.9											
	4.0	-	5.5	33	1.3											
	6.5	-	8.0	34	10.6											
	9.0	-	10.5	35	12.4											
	0.9	-	1.0	CTS	2.4	NP	NP	100	96	63	48	28	12	7	A-1-a	(0)
ST-43	1.0	-	2.5	6	1.6											
	2.5	-	4.0	7	3.8											
	4.0	-	5.5	8	12.2											
	6.5	-	8.0	9	10.9											
	9.0	-	10.5	10	14.8											
	0.7	-	0.8	CTS	2.3	NP	NP	100	84	52	42	28	15	10	A-1-a	(0)
	3.5	-	10.0	Bulk	15.8	28	15	100	100	97	94	91	84	62	A-6	(5)
ST-44	1.0	-	2.5	11	3.2											
	2.5	-	4.0	12	4.5											
	4.0	-	5.5	13	12.6											
	6.5	-	8.0	14	15.6											
	9.0	-	10.5	15	15.7											
	3.8	-	5.5	Bulk	16.4	29	13	100	96	80	75	70	61	47	A-6	(4)
ST-45	1.0	-	2.5	46	1.6											
	2.5	-	4.0	47	2.9											
	4.0	-	5.5	48	15.9											
	6.5	-	8.0	49	15.2											
	9.0	-	10.5	50	11.7											
	4.1	-	6.0	Bulk	16.9	40	16	100	100	97	94	88	78	64	A-6	(13)

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-46	1.0	-	2.5	16	1.9											
	2.5	-	4.0	17	5.7											
	4.0	-	5.5	18	18.9											
	6.5	-	8.0	19	21.6											
	9.0	-	10.5	20	13.5											
	3.8	-	6.5	Bulk	21.9	35	14	100	100	93	89	84	76	59	A-6	(9)
ST-47	1.0	-	2.5	21	3.6											
	2.5	-	4.0	22	3.9											
	4.0	-	5.5	23	15.8											
	6.5	-	8.0	24	20.5											
	9.0	-	10.5	25	20.4											
	0.9	-	1.0	CTS	2.2	NP	NP	100	99	67	50	28	13	8	A-1-a	(0)
	4.5	-	6.5	Bulk	20.3	34	13	100	100	100	98	95	87	64	A-6	(10)
ST-48	1.0	-	2.5	51	3.7											
	2.5	-	4.0	52	6.3											
	4.0	-	5.5	53	21.1											
	6.5	-	8.0	54	15.9											
	9.0	-	10.5	55	15.5											
	0.7	-	0.9	CTS	3.5	NP	NP	100	100	76	59	32	14	7	A-1-b	(0)
	4.1	-	6.0	Bulk	19.8	45	20	100	100	98	97	93	87	83	A-7-6	(21)
ST-49	1.0	-	2.5	26	3.7											
	2.5	-	4.0	27	4.5											
	4.0	-	5.5	28	18.6											
	6.5	-	8.0	29	13.5											
	9.0	-	10.5	30	13.3											
	4.0	-	6.0	Bulk	15.5	28	14	100	100	95	93	88	71	54	A-6	(4)

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-55	1.0	-	2.5	76	2.8											
	2.5	-	4.0	77	3.5											
	4.0	-	5.5	78	5.8											
	6.5	-	8.0	79	12.6											
ST-56	1.0	-	2.5	100	2.6											
	2.5	-	4.0	101	4.8											
	4.0	-	5.5	102	14.8											
	6.5	-	8.0	103	15.0											
	9.0	-	10.5	104	13.7											
	4.1	-	6.5	Bulk	17.6	26	14	100	100	91	78	75	68	49	A-6	(3)
ST-57	1.0	-	2.5	71	2.1											
	2.5	-	4.0	72	9.3											
	4.0	-	5.5	73	17.0											
	6.5	-	8.0	74	19.5											
	9.0	-	10.5	75	24.3											
	4.0	-	8.0	Bulk	18.8	34	16	100	100	95	94	91	83	62	A-6	(8)
ST-58	1.0	-	2.5	66	2.7											
	2.5	-	4.0	67	4.8											
	4.0	-	5.5	68	21.3											
	6.5	-	8.0	69	17.0											
	9.0	-	10.5	70	17.0											
	0.7	-	0.9	CTS	2.1	NP	NP	100	95	61	45	23	11	6	A-1-a	(0)
	4.2	-	6.5	Bulk	20.5	33	14	100	100	97	94	89	79	64	A-6	(7)

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-59	1.0	-	2.5	95	3.9											
	2.5	-	4.0	96	4.6											
	4.0	-	5.5	97	11.1											
	6.5	-	8.0	98	14.8											
	9.0	-	10.5	99	19.4											
	0.7	-	0.8	CTS	2.9	NP	NP	100	93	59	47	31	17	12	A-1-b	(0)
	4.5	-	6.0	Bulk	17.4	30	14	100	100	92	89	86	79	58	A-6	(5)
ST-60	1.0	-	2.5	61	3.2											
	2.5	-	4.0	62	5.9											
	4.0	-	5.5	63	3.0											
	6.5	-	8.0	64	21.1											
	9.0	-	10.5	65	23.9											
	4.1	-	6.0	Bulk	18.9	40	16	100	100	93	90	85	77	67	A-6	(10)
ST-61	1.0	-	2.5	56	3.2											
	2.5	-	4.0	57	3.1											
	4.0	-	5.5	58	19.6											
	6.5	-	8.0	59	14.8											
	9.0	-	10.5	60	12.7											
	0.8	-	1.0	CTS	2.9	NP	NP	100	99	72	57	35	17	11	A-1-b	(0)
	4.3	-	8.0	Bulk	15.9	30	14	100	100	97	94	89	79	63	A-6	(6)
ST-62	1.0	-	2.5	80	3.2											
	2.5	-	4.0	81	7.8											
	4.0	-	5.5	82	22.9											
	6.5	-	8.0	83	18.6											
	9.0	-	10.5	84	16.4											
	4.0	-	6.0	Bulk	20.0	34	16	100	100	95	92	87	81	77	A-6	(11)

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-67	1.0	-	2.5	36	6.3											
	2.5	-	4.0	37	16.7											
	4.0	-	5.5	38	20.4											
	6.5	-	8.0	39	16.0											
	9.0	-	10.5	40	19.8											
	2.0	-	5.0	Bulk	17.6	34	15	100	99	96	95	93	84	64	A-6	(7)
ST-68	1.0	-	2.5	41	9.3											
	2.5	-	4.0	42	17.3											
	4.0	-	5.5	43	26.6											
	6.5	-	8.0	44	26.1											
	9.0	-	10.5	45	17.1											
	1.8	-	3.5	Bulk	22.4	35	16	100	99	98	97	96	89	70	A-6	(9)
ST-69	1.0	-	2.5	90	4.5											
	2.5	-	4.0	91	14.9											
	4.0	-	5.5	92	23.2											
	6.5	-	8.0	93	19.1											
	9.0	-	10.5	94	11.1											
	4.0	-	6.0	Bulk	16.9	37	15	100	96	92	91	88	80	64	A-6	(8)
ST-70	1.0	-	2.5	85	8.5											
	2.5	-	4.0	86	21.0											
	4.0	-	5.5	87	19.5											
	6.5	-	8.0	88	20.0											
	9.0	-	10.5	89	11.6											
	0.5	-	6.0	Bulk	16.1	34	14	100	98	95	94	93	85	71	A-6	(8)

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-71	1.0	-	2.5	1	2.0											
	2.5	-	4.0	2	2.9											
	4.0	-	5.5	3	14.8											
	6.5	-	8.0	4	15.4											
	9.0	-	10.5	5	14.9											
	2.5	-	5.0	Bulk	5.5	23	15	100	94	50	44	37	28	20	A-2-4	(0)
ST-72	1.0	-	2.5	114	3.7											
	2.5	-	4.0	115	18.1											
	4.0	-	5.5	116	11.2											
	6.5	-	8.0	117	12.4											
	9.0	-	10.5	118	19.9											
	2.8	-	4.0	Bulk	13.3	28	16	100	99	97	94	90	81	65	A-6	(7)
ST-73	1.0	-	2.5	105	3.7											
	2.5	-	4.0	106	8.0											
	4.0	-	5.5	107	11.0											
	6.5	-	8.0	108	10.7											
	2.0	-	5.0	Bulk	7.3	NP	NP	100	92	52	37	31	19	7	A-1-b	(0)
ST-74	1.0	-	2.5	109	2.7											
	2.5	-	4.0	110	13.6											
	4.0	-	5.5	111	17.5											
	6.5	-	8.0	112	15.3											
	9.0	-	10.5	113	15.7											
	3.0	-	5.0	Bulk	13.7	33	15	99	99	91	77	65	52	43	A-6	(3)

SK GEOTECHNICAL CORPORATION
SUMMARY OF SOIL INDEX TEST RESULTS

Name: Lockwood Interchange - Billings **Project Number:** STPX 90-8(191)450, UPN 9588000

Boring No.	Depth (feet)			Jar ID	MC (%)	LL	PL	GRAIN SIZE DISTRIBUTION							AASHTO Class	GI
								1½"	¾"	No. 4	No. 10	No. 40	No. 100	No. 200		
ST-75	1.0	-	2.5	124	1.7											
	2.5	-	4.0	125	19.0											
	4.0	-	5.5	126	14.4											
	6.5	-	8.0	127	14.8											
	9.0	-	10.5	128	14.5											
	3.0	-	4.0	Subbase	6.6	NP	NP	100	95	53	44	39	31	23	A-1-b	(0)
	4.0	-	7.6	Bulk	11.1	33	16	100	100	94	86	77	63	51	A-6	(5)
ST-76	1.0	-	2.5	119	2.1											
	2.5	-	4.0	120	11.7											
	4.0	-	5.5	121	4.0											
	6.5	-	8.0	122	4.5											
	9.0	-	10.5	123	7.0											
	3.0	-	5.0	Subbase	5.1	21	14	100	93	56	46	40	34	28	A-2-4	(0)
	5.0	-	7.0	Bulk	14.2	34	13	100	100	94	89	83	78	68	A-6	(7)
ST-42 through ST-49	Composite (Varies)			Base	2.0	NP	NP	99	73	33	26	18	11	7	A-1-a	(0)
ST-55 through ST-62	Composite (Varies)			Base	2.2	NP	NP	99	70	32	25	17	9	5	A-1-a	(0)
ST-73 through ST-76	Composite (Varies)			Base	2.6	NP	NP	98	77	41	34	23	14	10	A-1-a	(0)

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-42	Not Available	0 - 0.9	PMS															
		0.9 - 1.0	CTS	A-1-a (0)	NP	NP	100	96	63	48	28	7.2			2.4			
		1.0 -5.2	Base	A-1-a	See Composite Base ST-42 through ST-49													
		5.2 - 6.0	Subgrade	A-6														
		6.0 - 10.5	Subgrade	A-6													N/E	
ST-43	Not Available	0 - 0.6	PMS															
		0.6 - 0.8	CTS	A-1-a	NP	NP	100	84	52	42	28	11			2.3			
		0.8 - 3.5	Base	A-1-a	See Composite Base ST-42 through ST-49													
		3.5 - 7.0	Subgrade	A-6 (5)	28	13	100	100	97	94	91	62	2.72	120.8	15.8	13.3		5
		7.0 - 10.5	Subgrade	A-6													N/E	
ST-44	Not Available	0 - 0.7	PMS															
		0.7 - 3.8	Base	A-1-a	See Composite Base ST-42 through ST-49													
		3.8 - 6.0	Subgrade	A-6 (4)	29	16	100	96	80	75	70	47	2.73	124.6	16.4	11.3		5
		6.0 - 8.5	Subgrade	A-6														
		8.5 - 10.5	Subgrade	A-6													N/E	
ST-45	Not Available	0 - 0.8	PMS															
		0.8 - 1.0	CTS	A-1-a														
		1.0 - 4.1	Base	A-1-a	See Composite Base ST-42 through ST-49													
		4.1 - 6.0	Subgrade	A-6 (13)	40	24	100	100	97	94	88	64	2.73	114.3	16.9	15.2		5
		6.0 - 8.5	Subgrade	A-6														
		8.5 - 10.5	Subgrade	A-2-4													N/E	

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-46	Not Available	0 - 0.8	PMS															
		0.8 - 3.8	Base	A-1-a	See Composite Base ST-42 through ST-49													
		3.8 - 6.0	Subgrade	A-6 (9)	35	21	100	100	93	89	84	59	2.70	125.2	21.9	11.1		5
		6.0 - 8.5	Subgrade	A-6														
		8.5 - 10.5	Subgrade	A-2-4													N/E	
ST-47	Not Available	0 - 0.8	PMS															
		0.8 - 0.9	CTS	A-1-a (0)	NP	NP	100	99	67	50	28	8.4			2.2			
		0.9 - 4.5	Base	A-1-a	See Composite Base ST-42 through ST-49													
		4.5 - 6.0	Subgrade	A-6 (10)	34	21	100	100	100	98	95	64	2.73	117.9	20.3	13.7		5
		6.0 - 10.5	Subgrade	A-6													N/E	
ST-48	Not Available	0 - 0.7	PMS															
		0.7 - 0.9	CTS	A-1-b (0)	NP	NP	100	100	76	59	32	6.7			3.5			
		0.9 - 4.1	Base	A-1-a	See Composite Base ST-42 through ST-49													
		4.1 - 6.0	Subgrade	A-7-6 (21)	45	25	100	100	98	97	93	83	2.76	108.0	19.8	18.0		5
		6.0 - 8.5	Subgrade	A-6														
		8.5 - 10.5	Subgrade	A-2-4													N/E	
ST-49	Not Available	0 - 0.7	PMS															
		0.7 - 0.8	CTS	A-1-b														
		0.8 - 4.0	Base	A-1-a	See Composite Base ST-42 through ST-49													
		4.0 - 6.0	Subgrade	A-6 (4)	28	14	100	100	95	93	88	54	2.68	116	15.5	13.8		5
		6.0 - 10.5	Subgrade	A-6													N/E	
ST-55	Not Available	0 - 0.9	PMS															
		0.9 - 4.0	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.0 - 8.0	Subgrade	A-1-b													N/E	

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-56	Not Available	0 - 0.7	PMS															
		0.7 - 0.8	CTS	A-1-b														
		0.8 - 4.1	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.1 - 10.5	Subgrade	A-6 (2)	26	12	100	100	91	78	75	49	2.75	118.8	17.6	13.4	N/E	5
ST-57	Not Available	0 - 0.7	PMS															
		0.7 - 0.8	CTS	A-1-b														
		0.8 - 4.0	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.0 - 8.0	Subgrade	A-6 (8)	34	18	100	100	95	94	91	62	2.70	118.3	18.8	14.6		5
		8.0 - 10.5	Subgrade	A-6													N/E	
ST-58	Not Available	0 - 0.7	PMS															
		0.7 - 0.9	CTS	A-1-a (0)	NP	NP	100	95	61	45	23	5.8			2.1			
		0.9 - 4.2	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.2 - 6.5	Subgrade	A-6 (9)	33	19	100	100	97	94	89	64	2.70	117.8	20.5	14.0		5
		6.5 - 10.5	Subgrade	A-6													N/E	
ST-59	Not Available	0 - 0.7	PMS															
		0.7 - 0.8	CTS	A-1-b (0)	NP	NP	100	93	59	47	31	12			2.9			
		0.8 - 4.5	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.5 - 6.0	Subgrade	A-6 (0)	30	16	100	100	92	89	86	58	2.75	120.0	17.4	13.0		5
		6.0 - 8.5	Subgrade	A-2-4														
		8.5 - 10.5	Subgrade	A-6													N/E	

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-60	Not Available	0 - 0.7	PMS															
		0.7 - 0.8	CTS	A-1-b														
		0.8 - 4.0	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.0 - 6.0	Subgrade	A-6 (14)	40	24	100	100	93	90	85	67	2.73	114.7	18.9	16.3		5
		6.0 - 7.5	Subgrade	A-6														
		7.5 - 10.5	Subgrade	A-6													N/E	
ST-61	Not Available	0 - 0.8	PMS															
		0.8 - 1.0	CTS	A-1-b (0)	NP	NP	100	99	72	57	35	11			2.9			
		1.0 - 4.3	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.3 - 8.0	Subgrade	A-6 (7)	30	16	100	100	97	94	89	63	2.71	117.8	15.9	13.4		5
		8.0 - 10.5	Subgrade	A-2-4													N/E	
ST-62	Not Available	0 - 0.7	PMS															
		0.7 - 0.8	CTS	A-1-b														
		0.8 - 4.0	Base	A-1-a	See Composite Base ST-55 through ST-62													
		4.0 - 6.0	Subgrade	A-6 (12)	34	18	100	100	95	92	87	77	2.75	110.0	20.0	18.5		5
		6.0 - 10.5	Subgrade	A-2-4													N/E	
ST-67	Not Available	0 - 0.2	Topsoil															
		0.2 - 1.0	Subgrade	A-1-b														
		1.0 - 6.0	Subgrade	A-6 (9)	34	19	100	99	96	95	93	64	2.66	113.0	17.6	15.0		5
		6.0 - 9.1	Subgrade	A-2-4														
		9.1 - 10.5	Subgrade	A-6													N/E	

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-68	Not Available	0 - 0.3	Topsoil															
		0.3 - 1.8	Subgrade	A-1-b														
		1.8 - 3.5	Subgrade	A-6 (11)	35	19	100	99	98	97	96	70	2.67	113.7	22.4	15.5		5
		3.5 - 6.0	Subgrade	A-6														
		6.0 - 8.5	Subgrade	A-6														
		8.5 - 10.5	Subgrade	A-7-6													N/E	
ST-69	Not Available	0 - 0.3	Topsoil															
		0.3 - 4.0	Subgrade	A-2-4														
		4.0 - 6.0	Subgrade	A-6 (11)	37	22	100	96	92	91	88	64	2.66	113.5	16.9	15.5		5
		6.0 - 10.5	Subgrade	A-6													N/E	
ST-70	Not Available	0 - 0.2	Topsoil															
		0.2 - 6.0	Subgrade	A-6 (12)	34	20	100	98	95	94	93	71	2.66	112.5	16.1	15.4		5
		6.0 - 10.5	Subgrade	A-2-4													N/E	
ST-71	Not Available	0 - 0.9	PMS															
		0.9 - 2.5	Base	A-1-b														
		2.5 - 5.0	Subgrade	A-2-4 (0)	23	8	100	94	50	44	37	20	2.72	134.7	5.5	8.0		5.2
		5.0 - 7.5	Subgrade	A-2-4														
		7.5 - 8.5	Subgrade	A-2-4														
		8.5 - 10.5	Subgrade	A-6													N/E	
ST-72	Not Available	0 - 1.0	PMS															
		1.0 - 2.8	Base	A-1-b														
		2.8 - 4.0	Subgrade	A-6 (5)	28	12	100	99	97	94	90	65	2.71	123.5	13.3	12.6		5
		4.0 - 6.0	Subgrade	A-2-4														
		6.0 - 8.5	Subgrade	A-2-4														
		8.5 - 10.5	Subgrade	A-2-4													N/E	

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-73	Not Available	0 - 0.8	PCCP															
		0.8 - 1.1	Leveling Course	A-1-a														
		1.1 - 2.0	Base	A-1-a	See Composite Base ST-73 through ST-76													
		2.0 - 4.0	Subgrade	A-1-b (0)	NP	NP	100	92	52	37	31	7.4	2.71	138.1	7.3	5.5		9.6
		4.0 - 4.5	Subgrade	A-6														
		4.5 - 8.0	Subgrade	A-2-4													N/E	
ST-74	Not Available	0 - 0.6	PMS															
		0.6 - 3.0	Base	A-1-a	See Composite Base ST-73 through ST-76													
		3.0 - 6.0	Subgrade	A-6 (4)	33	18	100	99	91	77	65	43	2.68	117.0	13.7	14.5		5
		6.0 - 10.5	Subgrade	A-2-4													N/E	
ST-75	Not Available	0 - 0.6	PMS															
		0.6 - 3.0	Base	A-1-a	See Composite Base ST-73 through ST-76													
		3.0 - 4.0	Subbase	A-1-b (0)	NP	NP	100	95	53	44	39	23			6.6			
		4.0 - 7.5	Subgrade	A-6 (5)	33	17	100	100	94	86	77	51	2.72	118.5	11.1	13.8		5
		7.5 - 10.5	Subgrade	A-2-4													N/E	
ST-76	Not Available	0 - 0.6	PMS															
		0.6 - 2.5	Base	A-1-a	See Composite Base ST-73 through ST-76													
		2.5 - 5.0	Subbase	A-2-4 (0)	21	7	100	93	56	46	40	28	2.73	135.2	5.1	7.5		12.1
		5.0 - 7.0	Subgrade	A-6 (11)	34	21	100	100	94	89	83	68	2.70	120.7	14.2	12.6		5
		7.0 - 9.0	Subgrade	A-1-b														
		9.0 - 9.9	Subgrade	A-2-4													N/E	

Form 111. Pavement Boring Logs, Preconstruction Soil Survey Data and Special Recommendations Relative to Subgrade and Road Surface Design

Project Number: 19-3792S Designation: STPX 90-8(191)450 Length: ~0.8 miles County: Yellowstone County Date: 07/07/20

Submitted by: Brandon R. Western, EI Title: Engineering Intern

Boring	Station and Offset	Depth (feet)	Material Type	Soil Class	LL	PI	3"	3/4"	#4	#10	#40	#200	Specific Gravity	Max. Dry Density (pcf)	Natural Moisture Content (%)	Optimum Moisture Content (%)	Depth to Water (feet)	Equivalent "R" Value
ST-42 through ST-50	Not Applicable	Base Course	Composite	A-1-a	NP	NP	100	73	33	26	18	6.8			2.0			
ST-55 through ST-62	Not Applicable	Base Course	Composite	A-1-a	NP	NP	100	70	32	25	17	4.9			2.2			
ST-73 through ST-76	Not Applicable	Base Course	Composite	A-1-a	NP	NP	100	77	41	34	23	9.6			2.6			

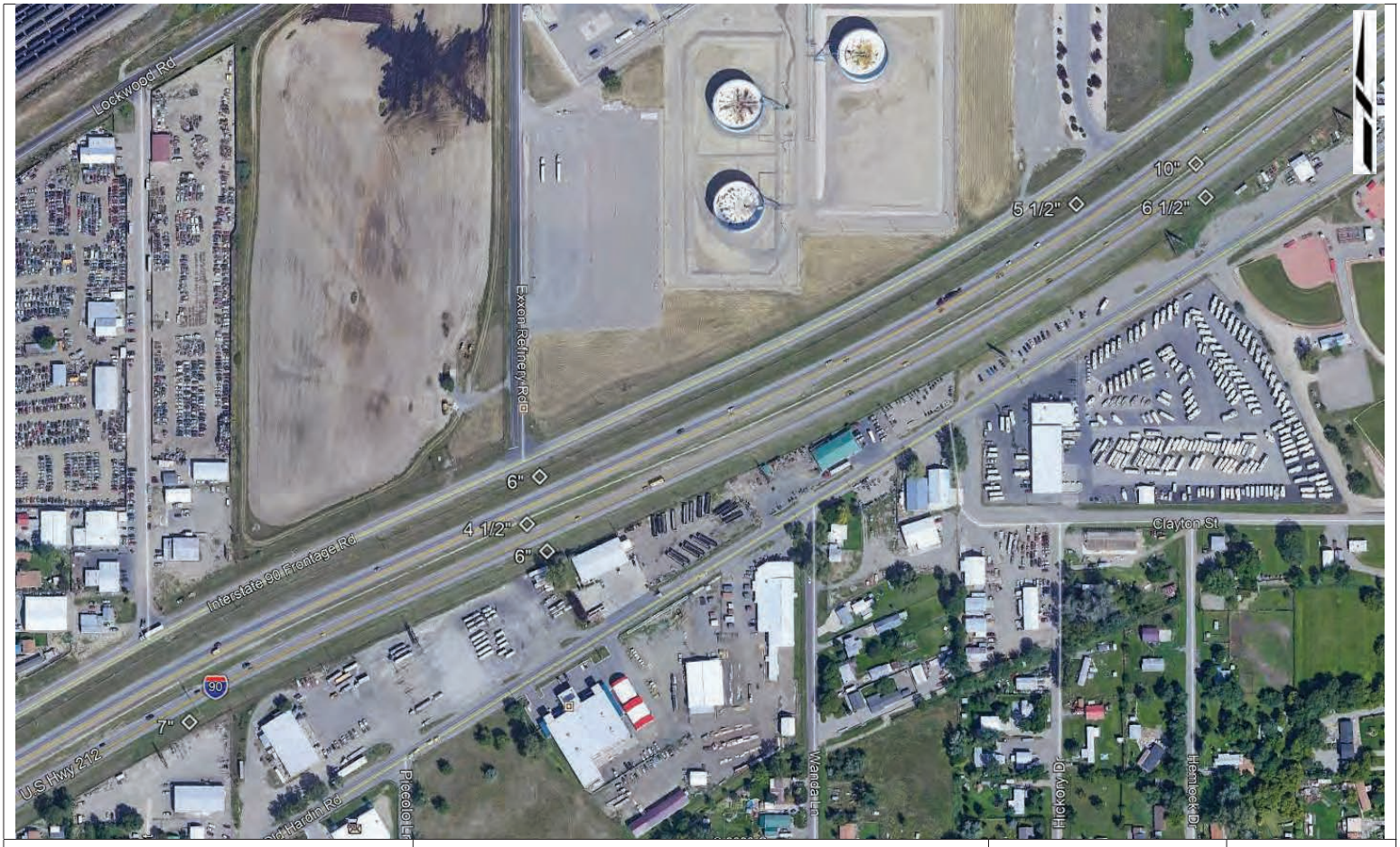
*R-value assumed.

When the group index is shown in parentheses, lab classification tests were performed. When no group index is shown, classification was visual.

Appendix 3

SK GEOTECHNICAL	**TOPSOIL SURVEY MAP** **Lockwood Interchange - Billings** **STPX 90-8(191)450, UPN 9588000** **Yellowstone County, Montana**	Drawn by: Google/SKGeo	Date 7/2/2020
		Project: 19-3792S	
		Scale: NTS	FIGURE
		Sheet 1 of 5	3

TOPSOIL SURVEY MAP **Lockwood Interchange - Billings** **STPX 90-8(191)450, UPN 9588000** **Yellowstone County, Montana**	Drawn by: Google/SKGeo	Date 7/2/2020	
	Project: 19-3792S		
	Scale: NTS		FIGURE
	Sheet 2 of 5		4



SK GEOTECHNICAL	**TOPSOIL SURVEY MAP** **Lockwood Interchange - Billings** **STPX 90-8(191)450, UPN 9588000** **Yellowstone County, Montana**	Drawn by:	Google/SKGeo	Date 7/2/2020
		Project:	19-3792S	
		Scale:	NTS	FIGURE
		Sheet	3 of 5	5

SK GEOTECHNICAL

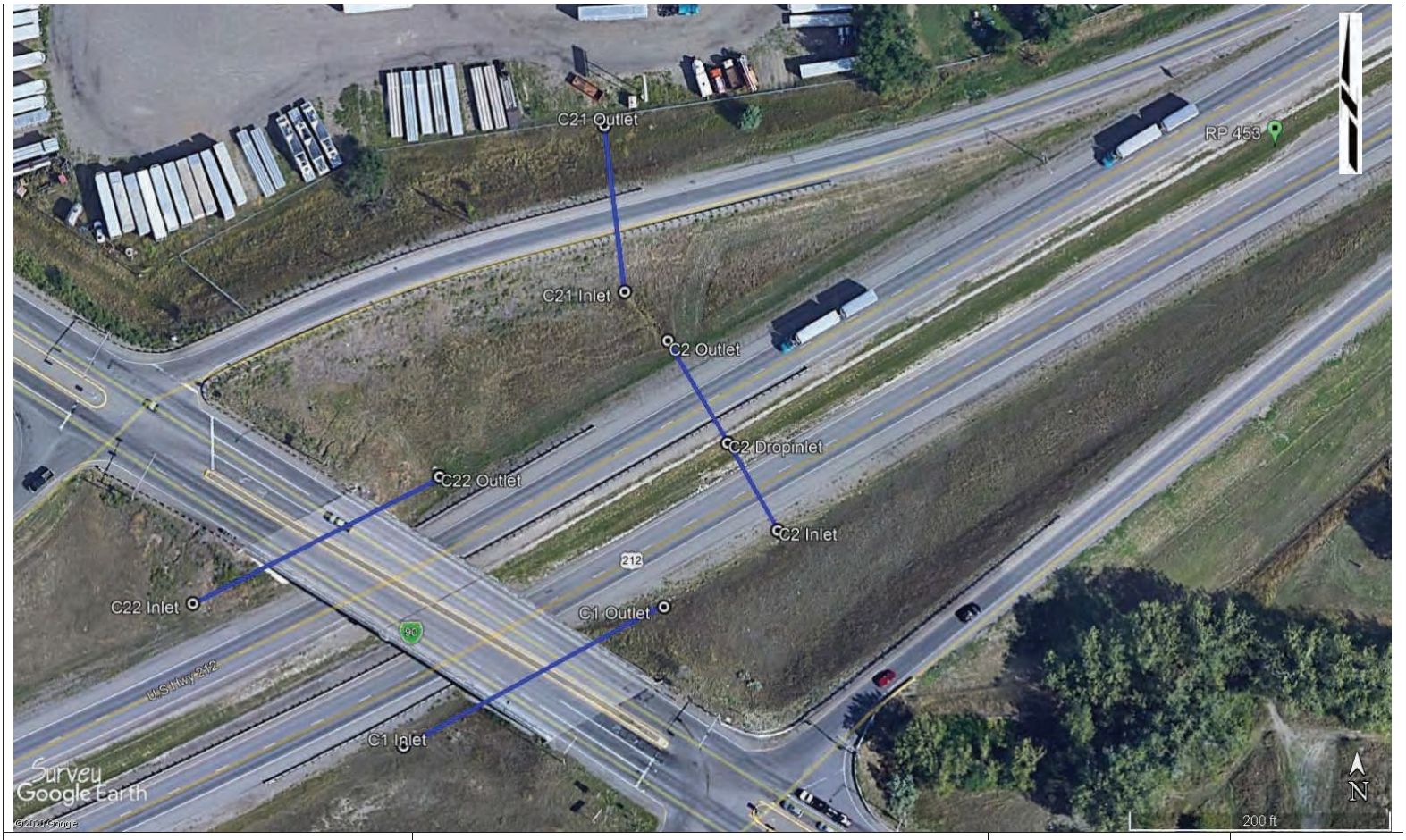
TOPSOIL SURVEY MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	4 of 5		6

SK GEOTECHNICAL

TOPSOIL SURVEY MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	5 of 5		7

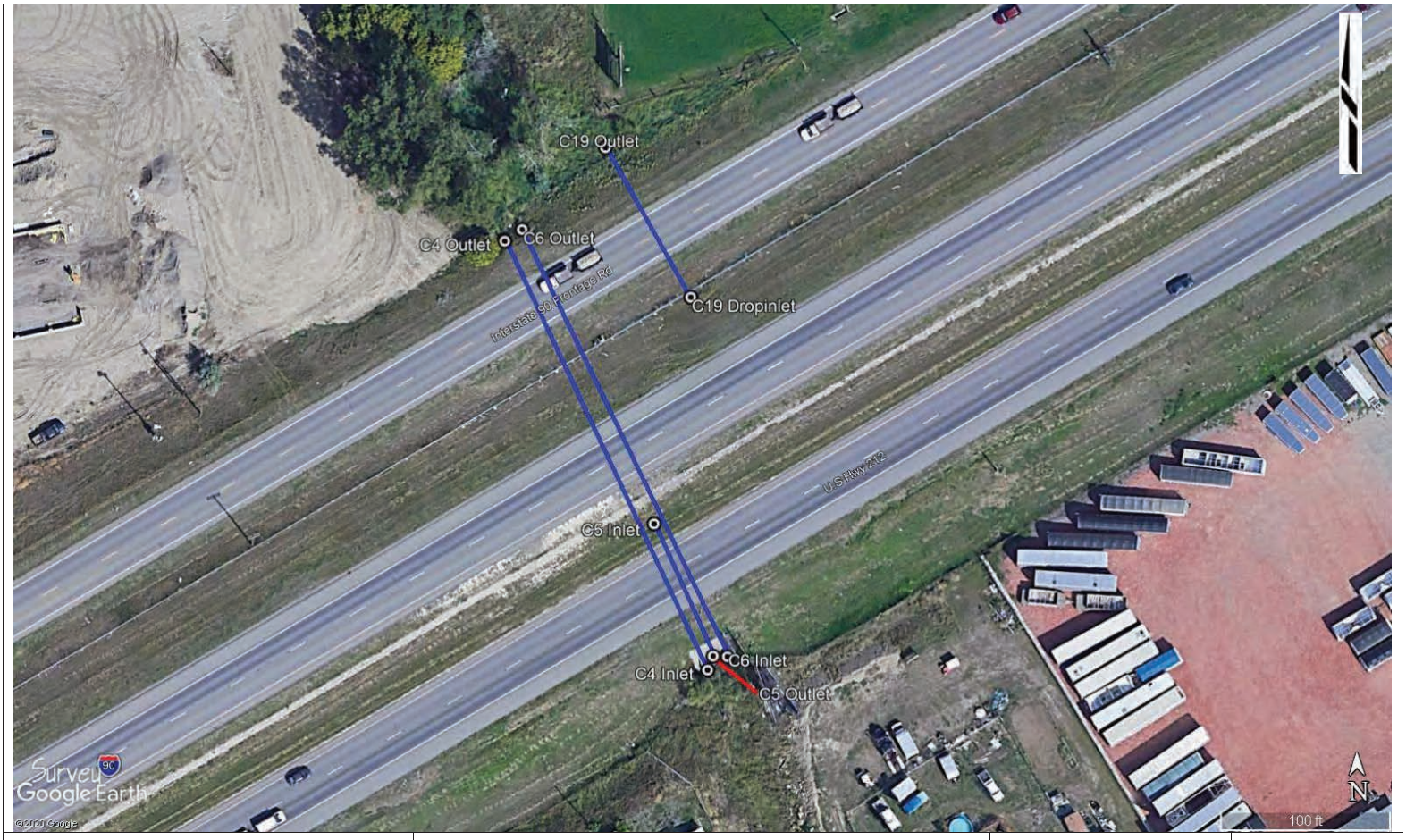


SK GEOTECHNICAL

CULVERT INSPECTION MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	1 of 7		8

CULVERT INSPECTION MAP **Lockwood Interchange - Billings** **STPX 90-8(191)450, UPN 9588000** **Yellowstone County, Montana**	Drawn by:	Google/SKGeo	Date 7/2/2020
	Project:	19-3792S	
	Scale:	NTS	FIGURE
	Sheet	2 of 7	9



CULVERT INSPECTION MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	3 of 7		10

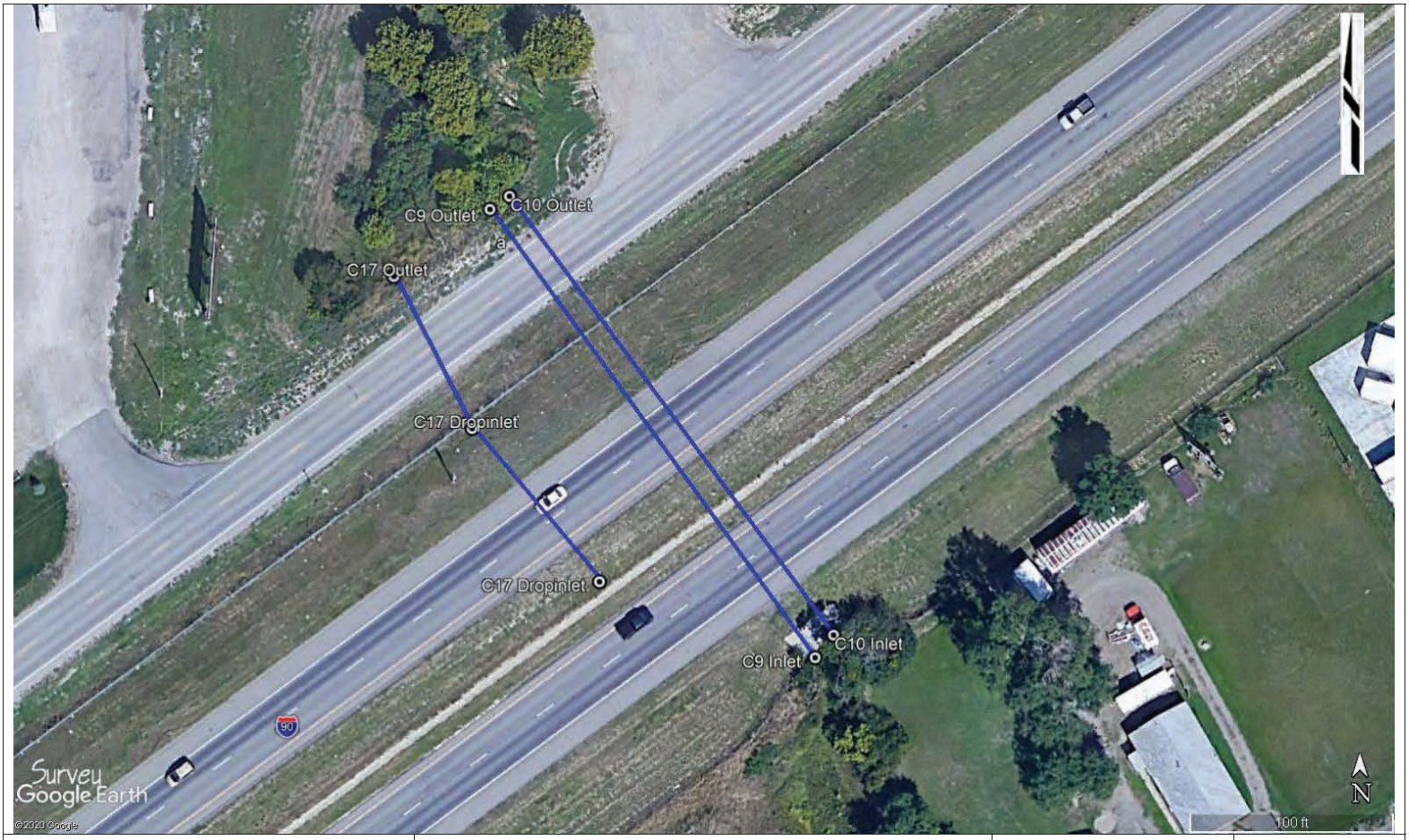
SK GEOTECHNICAL

CULVERT INSPECTION MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	4 of 7		11

CULVERT INSPECTION MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

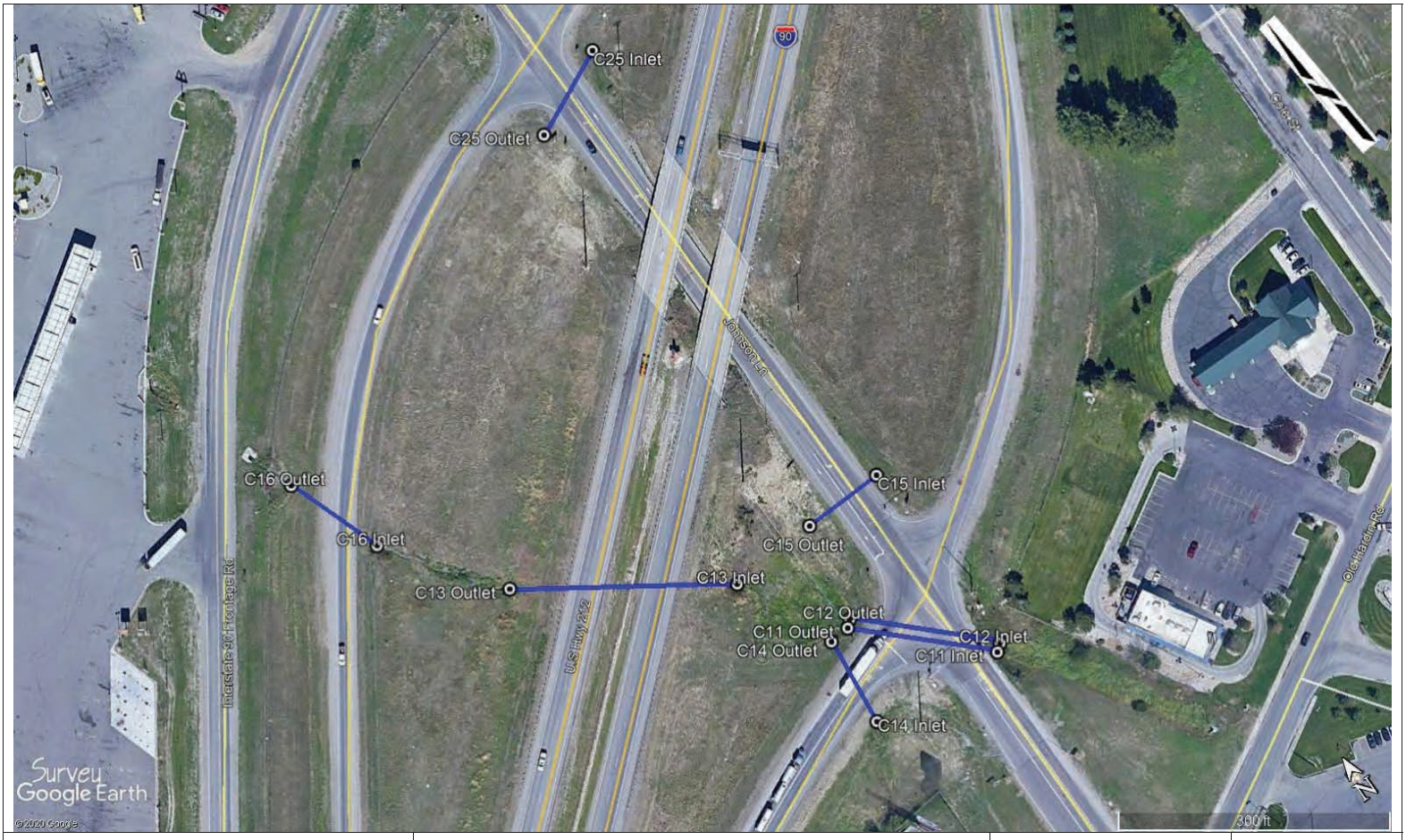
Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	5 of 7		12



SK GEOTECHNICAL

CULVERT INSPECTION MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	6 of 7		13



CULVERT INSPECTION MAP
Lockwood Interchange - Billings
STPX 90-8(191)450, UPN 9588000
Yellowstone County, Montana

Drawn by:	Google/SKGeo	Date	7/2/2020
Project:	19-3792S		
Scale:	NTS		FIGURE
Sheet	7 of 7		14

Culvert Inspection Report

Project No. 19-3792S (STPX 90-8(191)450) **Project Limits:** MP 452.65 **to** MP 455.31

Project Name: Lockwood Interchange - Billings **Inspected by:** Cody Hopkins, EI & Brandon Western, EI **Date(s):** 12/5/19-12/6/19

M.P.	Culvert #	Culvert Description			General Condition			Sample		Photo	Remarks/Comments
		Dia.	FETS In/Out	Type	Good	Fair	Poor	Soil	Water		
M.P. 452.84	C1 Inlet	24"	None	RCP		X				X	Partially blocked with trash, reinforcement steel is exposed. 70% open.
M.P. 452.88	C1 Outlet	24"	None	RCP			X	X		X	Partially blocked with trash and soil, 7-8" open. Some damage to lip of culvert. 30% open.
M.P. 452.91	C2 Inlet	24"	In	RCP		X				X	Minor FETS damage, and some vegetation. 95% open.
M.P. 452.90	C2 Outlet	24"	Out	RCP		X		X		X	Some concrete deterioration. Some FETS damage. 95% open. Drop-inlet present in median.
M.P. 453.36	C3 Inlet	24"	In	RCP	X					X	Some vegetation and garbage blocking inlet. 95% open
M.P. 453.36	C3 Outlet	24"	Out	RCP	X			X		X	Some separation between FETS and pipe joint, 95% open.
M.P. 453.53	C4 Inlet	90"	In	CMP	X					X	Minor damage, some vegetation, 100% open.
M.P. 453.54	C4 Outlet	90"	Out	CMP	X			X		X	Minor damage, some vegetation, 100% open.
M.P. 453.55	C5 Inlet	24"	In	RCP	X			X		X	In center median, metal grate on top of pipe in good condition, some exposed FETS reinforcement. Some blockage. 95% open.
M.P. 453.54	C5 Outlet	24"	Out	RCP	X					X	Some FETS reinforcement exposed. 100% open.

Culvert Inspection Report

Project No. 19-3792S (STPX 90-8(191)450) **Project Limits:** MP 452.65 **to** MP 455.31

Project Name: Lockwood Interchange - Billings **Inspected by:** Cody Hopkins, EI & Brandon Western, EI **Date(s):** 12/5/19-12/6/19

M.P.	Culvert #	Culvert Description			General Condition			Sample		Photo	Remarks/Comments
		Dia.	FETS In/Out	Type	Good	Fair	Poor	Soil	Water		
M.P. 453.55	C6 Inlet	90"	In	CMP	X					X	Minor damage, some vegetation blocking inlet. 95% open.
M.P. 453.54	C6 Outlet	90"	Out	CMP	X			X	X	X	Some standing water in culvert. Minor damage with some vegetation. 95% open.
M.P. 453.77	C7 Inlet	24"	None	RCP	X					X	Two drop inlets, in the westbound ditch and center median. Grates present on both, but some garbage visible at culvert bottom.
M.P. 453.77	C7 Outlet	24"	Out	RCP		X		X		X	Some vegetation present, and minor FETS damage. 75% Open.
M.P. 454.15	C8 Inlet	24"	In	RCP	X					X	FETS in fair condition, some vegetation and soil creating a mound near inlet. 100% open.
M.P. 454.15	C8 Outlet	24"	Out	RCP	X			X		X	Some vegetation and garbage present. Damage to FETS. 95% open.
M.P. 454.75	C9 Inlet	102"	In	CMP	X			X		X	Partially blocked by some vegetation and garbage, minor damage. 90% open.
M.P. 454.74	C9 Outlet	102"	Out	CMP	X					X	Some trash in culvert, minor damage. 100% open.
M.P. 454.75	C10 Inlet	102"	In	CMP	X					X	Minor damage. 100% open.
M.P. 454.74	C10 Outlet	102"	Out	CMP	X			X		X	Some vegetation and garbage present in culvert, minor damage to lip of culvert edge. 90% open.

Culvert Inspection Report

Project No. 19-3792S (STPX 90-8(191)450) **Project Limits:** MP 452.65 **to** MP 455.31

Project Name: Lockwood Interchange - Billings **Inspected by:** Cody Hopkins, EI & Brandon Western, EI **Date(s):** 12/5/19-12/6/19

M.P.	Culvert #	Culvert Description			General Condition			Sample		Photo	Remarks/Comments
		Dia.	FETS In/Out	Type	Good	Fair	Poor	Soil	Water		
M.P. 455.27	C11 Inlet	72"	In	CMP		X				X	Partially blocked by dense vegetation. Flowing water present. 70% open.
M.P. 455.25	C11 Outlet	72"	Out	CMP		X		X	X	X	Minor damage, some garbage and vegetation. Flowing water present. 60% open.
M.P. 455.27	C12 Inlet	72"	In	CMP	X			X	X	X	Thick vegetation around inlet. Minor damage. 95% open.
M.P. 455.25	C12 Outlet	72"	Out	CMP	X					X	Some vegetation present and flowing water. 75% open.
M.P. 455.26	C13 Inlet	90"	In	CMP	X					X	Existing tree branch covering culvert. 75% open.
M.P. 455.25	C13 Outlet	90"	Out	CMP	X			X	X	X	Minor vegetation growing in culvert. Minor damage. 100% open.
M.P. 455.23	C14 Inlet	24"	In	CMP		X		X	X	X	Minor damage, some vegetation. 90% open.
M.P. 455.24	C14 Outlet	24"	Out	CMP			X			X	Soil and vegetation mound near outlet. 50% open.
M.P. 455.29	C15 Inlet	24"	In	CMP		X		X		X	Moderate damage, some vegetation. 80% open.
M.P. 455.27	C15 Outlet	24"	Out	CMP		X				X	Minor damage, some garbage and vegetation present around the outlet. 90% open.

Culvert Inspection Report

Project No. 19-3792S (STPX 90-8(191)450) **Project Limits:** MP 452.65 **to** MP 455.31

Project Name: Lockwood Interchange - Billings **Inspected by:** Cody Hopkins, EI & Brandon Western, EI **Date(s):** 12/5/19-12/6/19

M.P.	Culvert #	Culvert Description			General Condition			Sample		Photo	Remarks/Comments
		Dia.	FETS In/Out	Type	Good	Fair	Poor	Soil	Water		
M.P. 455.25	C16 Inlet	78"	In	CMP	X					X	Scrap concrete creating minor blockage in FETS. Some garbage. 100% open.
M.P. 455.25	C16 Outlet	78"	Out	CMP	X			X	X	X	Minor debris in culvert. 100% open.
M.P. 454.73	C17 Inlet	24"	None	RCP		X				X	Multiple drop inlets, in the westbound ditch and center median. Grates have been damaged allowing some garbage into the pipe.
M.P. 454.73	C17 Outlet	24"	Out	RCP	X			X		X	Some vegetation, garbage, and soil blocking culvert. Minor damage. 70% open.
M.P. 454.29	C18 Inlet	---	---							X	Unable to locate inlet in eastbound ditch, possibly buried. drop inlet present in center median.
M.P. 454.29	C18 Outlet	24"	Out	RCP	X			X		X	FETS in fair condition, with some vegetation. 95% open.
M.P. 453.55	C19 Inlet	24"	None	RCP	X					X	Drop inlet in westbound ditch. Minor damage, with some vegetation present.
M.P. 453.55	C19 Outlet	24"	None	RCP			X	X		X	Partially blocked by substantial vegetation and soil. 30% open.
M.P. 453.21	C20 Inlet	24"	Out	RCP	X			X		X	Drop inlet in westbound ditch. Some vegetation overgrowth and garbage. Grate is severely bent.
M.P. 453.21	C20 Outlet	24"	None	RCP	X					X	Some vegetation overgrowth and garbage. Minor damage. 95% open.

Culvert Inspection Report

Project No. 19-3792S (STPX 90-8(191)450) **Project Limits:** MP 452.65 **to** MP 455.31

Project Name: Lockwood Interchange - Billings **Inspected by:** Cody Hopkins, EI & Brandon Western, EI **Date(s):** 12/5/19-12/6/19

M.P.	Culvert #	Culvert Description			General Condition			Sample		Photo	Remarks/Comments
		Dia.	FETS In/Out	Type	Good	Fair	Poor	Soil	Water		
M.P. 452.92	C21 Inlet	24"	None	RCP		X				X	Inlet partially blocked by vegetation and soil. Minor damage. 60% open.
M.P. 452.91	C21 Outlet	24"	None	RCP		X		X		X	Minor damage, with some vegetation. 95% open.
M.P. 452.83	C22 Inlet	24"	None	RCP		X				X	Some garbage and minor damage. 75% open.
M.P. 452.87	C22 Outlet	24"	None	RCP			X	X		X	Partially blocked by vegetation and garbage. Minor damage. 50% open.
M.P. 454.39	C24 Inlet	24"	None	RCP	X			X		X	Garbage accumulation at mouth of inlet. Inlet along Old Hardin Road. 95% open.
M.P. 454.36	C24 Outlet	24"	None	RCP		X				X	Partially blocked by vegetation and soil. Minor damage. 60% open.
M.P. 455.39	C25 Inlet	24"	In	CMP	X			X		X	Minor cosmetic damage to edge of culvert and vegetation blockage. 95% open.
M.P. 455.34	C25 Outlet	24"	Out	CMP	X					X	Vegetation and garbage present at mought of outlet. 90% open.

*Identification number "C23" skipped due renumbering.

P. O. Box 80190
Billings, Montana 59108-0190
p: 406.652.3930; f: 406.652.3944
www.skgeotechnical.com

Corrosivity of Soil

MDT MT 232-16 and MT 532-16

Date: June 30, 2020

Project: **19-3792S Geotechnical Evaluation**
I-90 Lockwood Interchange
Billings, Montana

Client: Tim Erickson, PE
HDR, Inc.

Date sampled: 12/12/2019
Sampled by: Drill Crew

Date tested: 12/26/2019
Tested by: SM/SK

Culvert	Sample Type	Inlet/Outlet	Resistivity (Ω•cm) Calculated	Conductivity (m.mhos/cm) MT 232-16 Probe	pH	Marble pH	Sulfate (wt %) MT 532-16
C1	Soil	Outlet	1047	0.955	8.01	8.25	0.0035
C2	Soil	Outlet	4878	0.205	8.30	8.63	0.0020
C3	Soil	Outlet	4348	0.230	8.30	8.69	0.0027
C4	Soil	Outlet	4032	0.248	8.02	8.61	0.0026
C5	Soil	Inlet	2740	0.365	8.59	8.59	0.0028
C6	Soil	Outlet	4405	0.227	8.29	8.66	0.0076
C6	Water	Outlet	575	1.740	7.94	8.02	0.0131
C7	Soil	Outlet	3597	0.278	8.20	8.33	0.0052
C8	Soil	Outlet	2667	0.375	8.23	8.43	0.0038
C9	Soil	Inlet	7519	0.133	8.33	8.81	0.0031
C10	Soil	Outlet	4132	0.242	8.05	8.63	0.0032
C11	Soil	Outlet	2304	0.434	8.48	8.58	0.0050
C11	Water	Outlet	1000	1.000	6.55	6.63	0.0012
C12	Soil	Inlet	1241	0.806	7.94	8.52	0.0585
C12	Water	Inlet	983	1.017	6.92	7.36	0.0013
C13	Soil	Outlet	2315	0.432	7.97	8.86	0.0068
C13	Water	Outlet	578	1.730	7.37	7.45	0.0026
C14	Soil	Inlet	3356	0.298	7.98	8.85	0.0016
C14	Water	Inlet	1064	0.940	6.90	6.97	0.0011
C15	Soil	Inlet	5236	0.191	7.89	8.55	0.0012
C16	Soil	Outlet	3953	0.253	7.86	8.78	0.0014
C16	Water	Outlet	592	1.690	6.25	6.41	0.0024
C17	Soil	Outlet	4695	0.213	8.19	8.56	0.0074
C18	Soil	Outlet	3704	0.270	8.07	8.42	0.0038
C19	Soil	Outlet	3086	0.324	8.12	8.26	0.0039
C20	Soil	Inlet	5319	0.188	8.32	8.42	0.0022
C21	Soil	Outlet	8264	0.121	8.15	8.65	0.0015
C22	Soil	Outlet	9009	0.111	8.08	8.70	0.0022

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Corrosivity of Soil

MDT MT 232-16 and MT 532-16

Date: June 30, 2020

Project: **19-3792S Geotechnical Evaluation**
I-90 Lockwood Interchange
Billings, Montana

Client: Tim Erickson, PE
HDR, Inc.

Date sampled: 12/12/2019
Sampled by: Drill Crew

Date tested: 12/26/2019
Tested by: SM/SK

Culvert	Sample Type	Inlet/Outlet	Resistivity (Ω•cm) Calculated	Conductivity (m.mhos/cm) MT 232-16 Probe	pH	Marble pH	Sulfate (wt %) MT 532-16
C24	Soil	Inlet	14493	0.069	8.24	8.66	0.0019
C25	Soil	Outlet	9901	0.101	8.61	9.00	0.0018

Remarks: Sulfate result is MT 532-16 water soluble method from Energy Labs.

Culvert C1. M.P. 452.84, 24-inch RCP, Inlet

Culvert C1. M.P. 452.88, 24-inch RCP, Outlet

Culvert C2. M.P. 452.91, 24-inch RCP, Inlet

Culvert C2. M.P. 452.90, 24-inch RCP, Outlet

Culvert C2. M.P. 452.90, 24-inch RCP, Drop Inlet

Culvert C3. M.P. 453.36, 24-inch RCP, Inlet

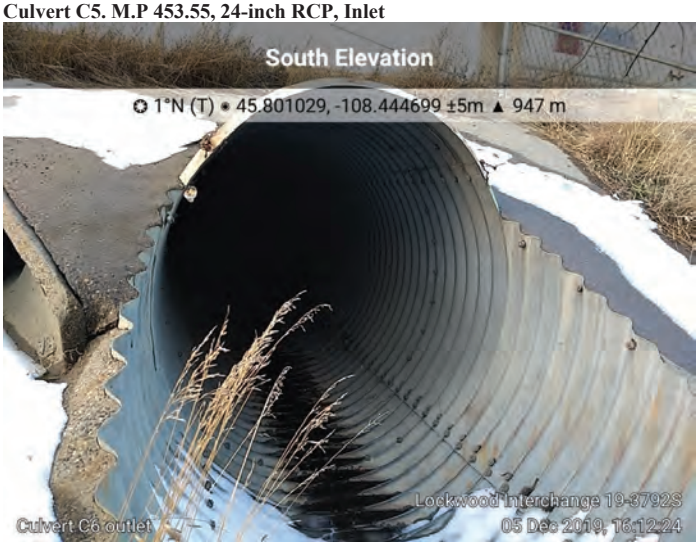
Culvert C3. M.P. 453.36, 24-inch RCP, Outlet

Culvert C4. M.P. 453.53, 90-inch CMP, Inlet

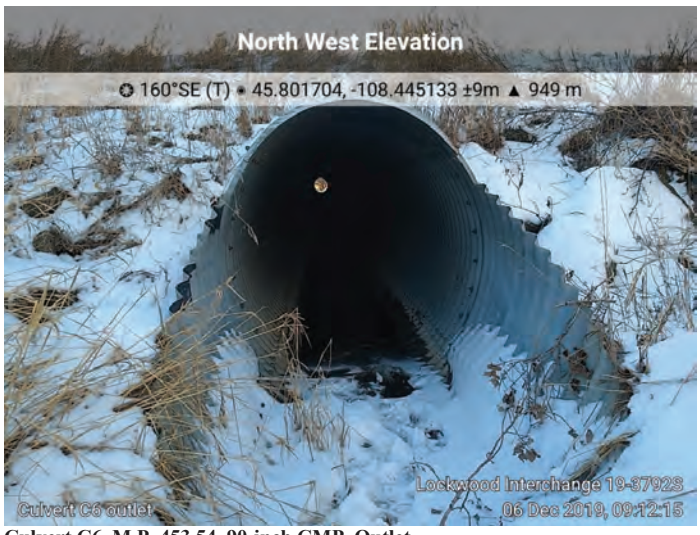
Culvert C4. M.P. 453.54, 90-inch CMP, Outlet

Culvert C5. M.P 453.55, 24-inch RCP, Inlet

Culvert C5. M.P. 453.54, 24-inch RCP, Outlet



Culvert C6. M.P. 453.55, 90-inch CMP, Inlet



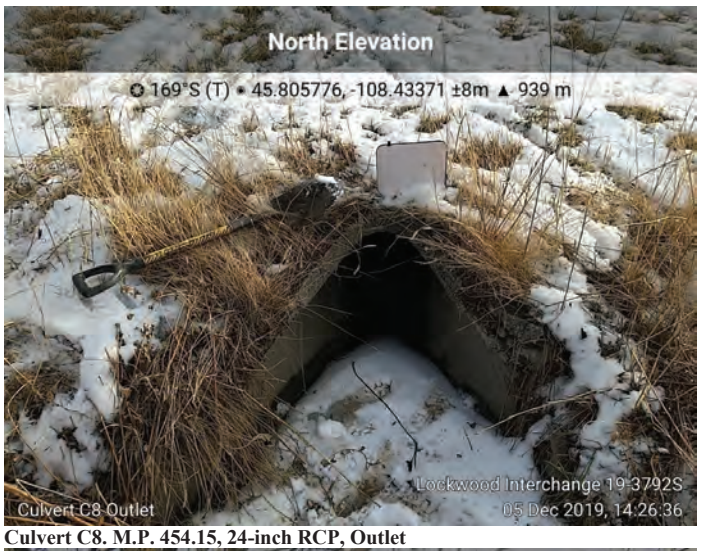
Culvert C6. M.P. 453.54, 90-inch CMP, Outlet

Culvert C7. M.P. 453.77, 24-inch RCP, Drop Inlet

Culvert C7. M.P. 453.77, 24-inch RCP, Drop Inlet

Culvert C7. M.P. 453.77, 24-inch RCP, Outlet

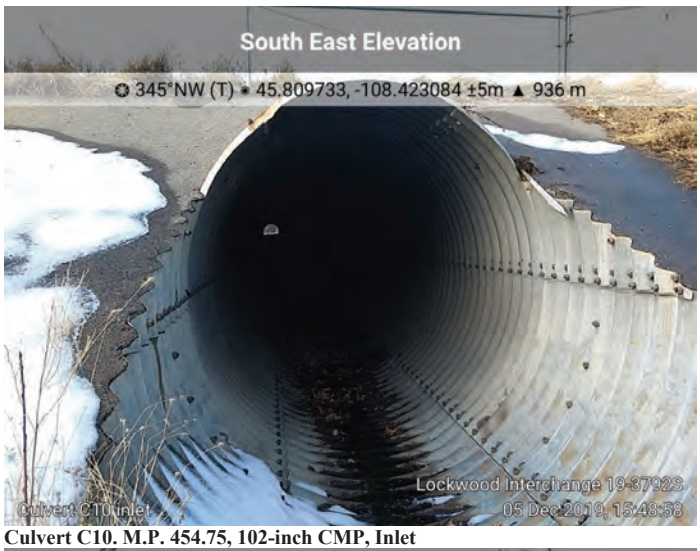
Culvert C8. M.P. 454.15, 24-inch RCP, Inlet



Culvert C8. M.P. 454.15, 24-inch RCP, Outlet

Culvert C9. M.P. 454.75, 102-inch CMP, Inlet

Culvert C9. M.P. 454.74, 102-inch CMP, Outlet



Culvert C10. M.P. 454.75, 102-inch CMP, Inlet

Culvert C10. M.P. 454.74, 102-inch CMP, Outlet

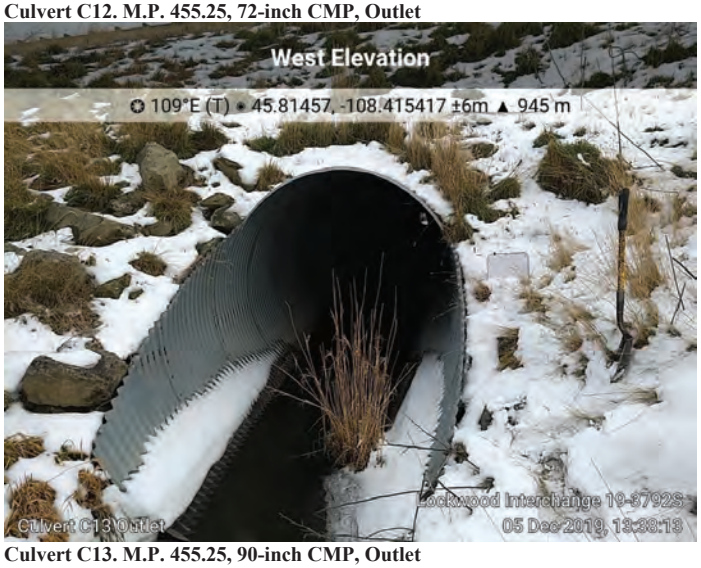
Culvert C11. M.P. 455.27, 72-inch CMP, Inlet

Culvert C11. M.P. 455.25, 72-inch CMP, Outlet

Culvert C12. M.P. 455.27, 72-inch CMP, Inlet

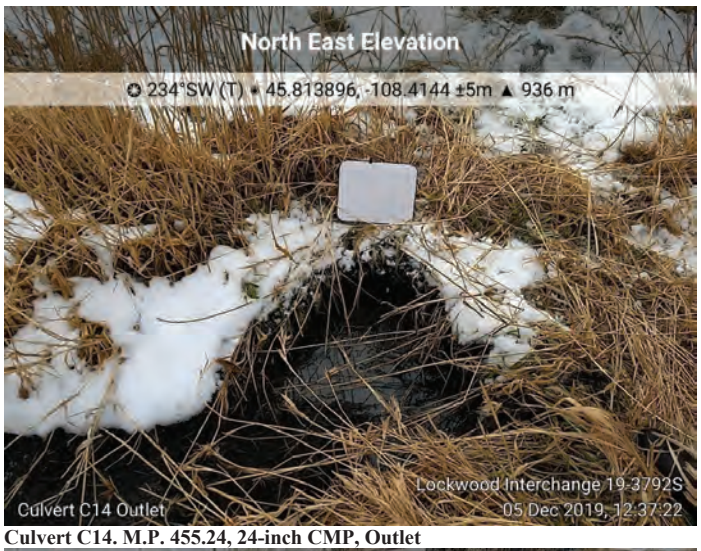
Culvert C12. M.P. 455.25, 72-inch CMP, Outlet

Culvert C13. M.P. 455.26, 90-inch CMP, Inlet



Culvert C13. M.P. 455.25, 90-inch CMP, Outlet

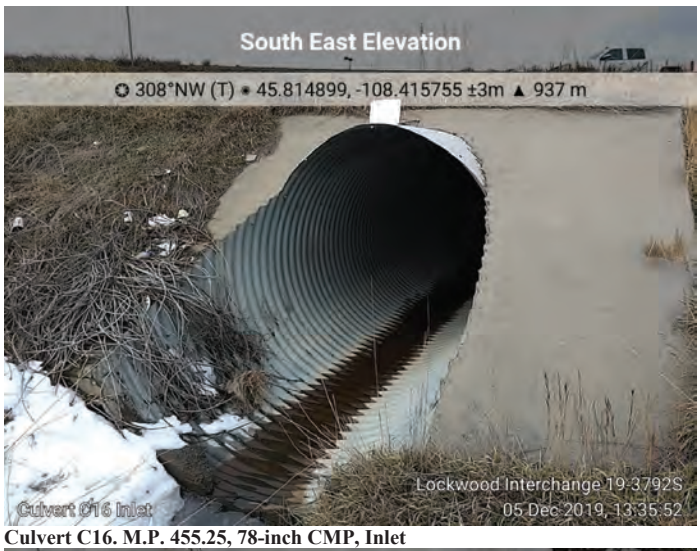
Culvert C14. M.P. 455.23, 24-inch CMP, Inlet



Culvert C14. M.P. 455.24, 24-inch CMP, Outlet

Culvert C15. M.P. 455.29, 24-inch CMP, Inlet

Culvert C15. M.P. 455.27, 24-inch CMP, Outlet



Culvert C16. M.P. 455.25, 78-inch CMP, Inlet

Culvert C16. M.P. 455.25, 78-inch CMP, Outlet

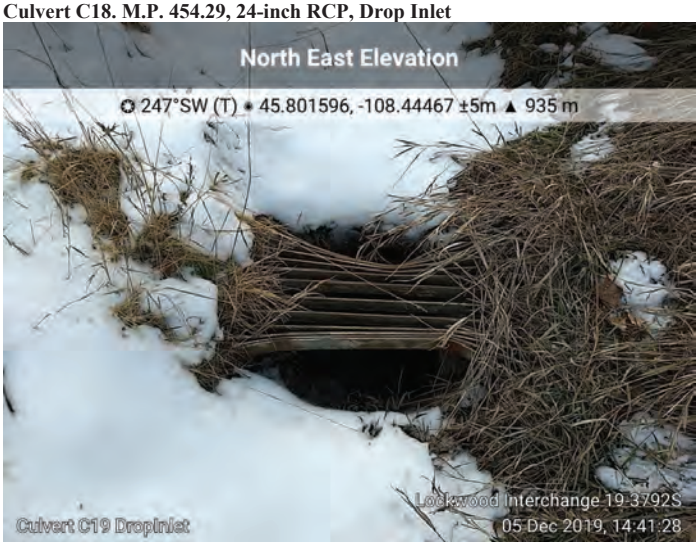
Culvert C17. M.P. 454.73, 24-inch RCP, Drop Inlet

Culvert C17. M.P. 454.73, 24-inch RCP, Drop Inlet

Culvert C17. M.P. 454.73, 24-inch RCP, Outlet

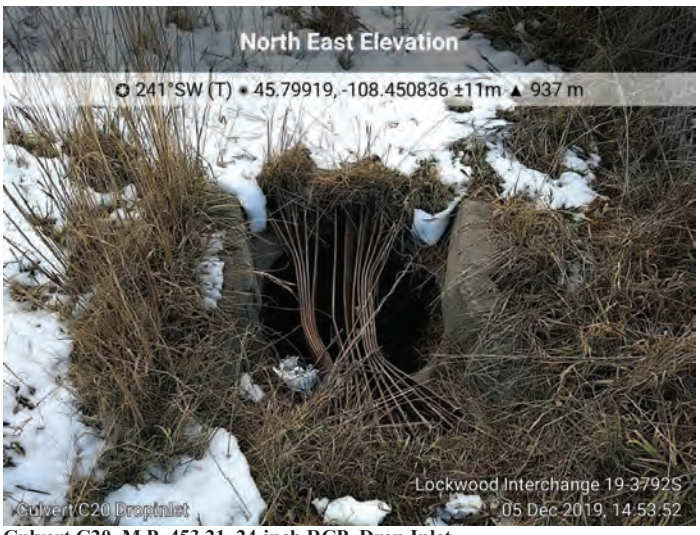
Culvert C18. M.P. 454.29, 24-inch RCP, Drop Inlet

Culvert C18. M.P. 453.29, 24-inch RCP, Outlet



Culvert C19. M.P. 453.55, 24-inch RCP, Drop Inlet

Culvert C19. M.P. 453.55, 24-inch RCP, Outlet



Culvert C20. M.P. 453.21, 24-inch RCP, Drop Inlet

Culvert C20. M.P. 453.21, 24-inch RCP, Outlet

Culvert C21. M.P. 452.92, 24-inch RCP, Inlet

Culvert C21. M.P. 452.91, 24-inch RCP, Outlet

Culvert C22. M.P. 452.83, 24-inch RCP, Inlet

Culvert C22. M.P. 452.87, 24-inch RCP, Outlet

Culvert C24. M.P. 454.39. 24-inch RCP, Inlet

Culvert C24. M.P. 454.36, 24-inch RCP, Outlet

Culvert C25. M.P. 455.39, 24-inch CMP, Inlet

Culvert C25. M.P. 455.39, 24-inch CMP, Outlet

Appendix 4

Montana Department of Transportation
Helena, Montana 59620

Memorandum

To: Mark Studt, P.E.
Consultant Project Engineer
Consultant Design

From: Becky Duke, Supervisor
Traffic Data Collection & Analysis Section

Date: February 18, 2020

Subject: STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000

Attached is the traffic information requested in a memo dated January 21, 2020. There are no major traffic breaks within the project. Please note that the equivalency factors used to calculate ESAL values are determined using information from our weigh-in-motion sites and reflect a five-year average.

If you have any questions or need further assistance, please contact me at 6122.

CC: Pavement Analysis and Research - Helena
Project File

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
I-90 E of Lockwood Interchange

Interstate Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
I-90: E of Lockwood Intch

DATE: 12-Feb-20

2020	AADT= **23,240**	PRESENT	
2024	AADT= **25,260**	LETTING YEAR	
2044	AADT= **38,270**	DESIGN YEAR	
	DHV= **4060**		
	D=		
	T= **16.8%**		
	ESAL= **1305**		
	AGR= **2.1%**		

*Truck Distribution**

5	**23.5 %**	**3.9 %**
6	**2.5 %**	**0.4 %**
7	**0.6 %**	**0.1 %**
8	**2.1 %**	**0.3 %**
9	**53.9 %**	**9.0 %**
10	**5.6 %**	**0.9 %**
11	**0.5 %**	**0.1 %**
12	**1.6 %**	**0.3 %**
13	**9.8 %**	**1.6 %**
	100.0 %	16.8 %

2019

AADT*=	22,760	
BUS=	0.4%	88
COM=	16.8%	3818
AGR=	2.1%	
K Factor=	10.60%	

* Distribution: 2019 Continuous Count VC Count (Site ID: W-203)

* AADTs and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
I-90 W of Lockwood Interchange

Interstate Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
I-90: W of Lockwood Intch

DATE: 12-Feb-20

			*Truck Distribution**	
			5	**23.5 %**	**3.5 %**
2020	AADT= **27,720**	PRESENT	6	**2.5 %**	**0.4 %**
			7	**0.6 %**	**0.1 %**
2024	AADT= **30,120**	LETTING YEAR	8	**2.1 %**	**0.3 %**
2044	AADT= **45,650**	DESIGN YEAR	9	**53.9 %**	**8.1 %**
	DHV= **4840**		10	**5.6 %**	**0.8 %**
	D=		11	**0.5 %**	**0.1 %**
	T= **15.1%**		12	**1.6 %**	**0.2 %**
	ESAL= **1409**		13	**9.8 %**	**1.5 %**
	AGR= **2.1%**				
				100.0 %	15.1 %

2019

AADT*= 27,150

BUS= 0.5% 127

COM= 15.1% 4099

AGR= 2.1%

K Factor= 10.60%

* Distribution: 2019 Continuous Count VC Count (Site ID: W-203)

* AADTs and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
I-90 EB Off Ramp

Interstate Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
I90EB Off Ramp

DATE: 14-Feb-20

				*Truck Distribution**	
			5	18.5 %	1.3 %
2020	AADT= **6,350**	PRESENT	6	24.1 %	1.7 %
			7	1.5 %	0.1 %
2024	AADT= **6,910**	LETTING YEAR	8	2.6 %	0.2 %
2044	AADT= **10,460**	DESIGN YEAR	9	28.9 %	2.0 %
	DHV= **1090**		10	17.8 %	1.2 %
	D=		11	0.7 %	0.1 %
	T= **7.0%**		12	1.1 %	0.1 %
	ESAL= **265**		13	4.8 %	0.3 %
	AGR= **2.1%**				
				100.0 %	7.0 %

2019

AADT*=	6,220	
BUS=	0.5%	32
COM=	7.0%	437
AGR=	2.1%	
K Factor=	10.40%	

* Distribution: 2019 Miovision Video provided by Sanderson Stewart

* AADTs and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
I-90 EB On Ramp

Interstate Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
I90EB On Ramp

DATE: 14-Feb-20

2020	AADT= **3,500**	PRESENT		
2024	AADT= **3,810**	LETTING YEAR		
2044	AADT= **5,770**	DESIGN YEAR		
	DHV= **600**			
	D=			
	T= **7.6%**			
	ESAL= **153**			
	AGR= **2.1%**			

*Truck Distribution**

5	18.5 %	1.4 %
6	24.1 %	1.8 %
7	1.5 %	0.1 %
8	2.6 %	0.2 %
9	28.9 %	2.2 %
10	17.8 %	1.4 %
11	0.7 %	0.1 %
12	1.1 %	0.1 %
13	4.8 %	0.4 %
	100.0 %	7.6 %

2019

AADT*=	3,430	
BUS=	0.3%	9
COM=	7.6%	261
AGR=	2.1%	
K Factor=	10.40%	

* Distribution: 2019 Miovision Video provided by Sanderson Stewart

* AADTs and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
I-90 WB Off Ramp

Interstate Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
I90WB Off Ramp

DATE: 14-Feb-20

2020	AADT= **3,490**	PRESENT	
2024	AADT= **3,790**	LETTING YEAR	
2044	AADT= **5,750**	DESIGN YEAR	
	DHV= **600**		
	D=		
	T= **7.7%**		
	ESAL= **154**		
	AGR= **2.1%**		

*Truck Distribution**

5	**18.5 %**	**1.4 %**
6	**24.1 %**	**1.9 %**
7	**1.5 %**	**0.1 %**
8	**2.6 %**	**0.2 %**
9	**28.9 %**	**2.2 %**
10	**17.8 %**	**1.4 %**
11	**0.7 %**	**0.1 %**
12	**1.1 %**	**0.1 %**
13	**4.8 %**	**0.4 %**
	100.0 %	7.7 %

2019

AADT*= 3,420

BUS= 0.2% 7

COM= 7.7% 263

AGR= 2.1%

K Factor= 10.40%

* Distribution: 2019 Sanderson Stewart Miovision Video

* AADTs and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
I-90 WB On Ramp

Interstate Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
I90WB On Ramp

DATE: 18-Feb-20

2020	AADT= **5,920**	PRESENT	
2024	AADT= **6,440**	LETTING YEAR	
2044	AADT= **9,750**	DESIGN YEAR	
	DHV= **1010**		
	D=		
	T= **7.8%**		
	ESAL= **270**		
	AGR= **2.1%**		

*Truck Distribution**

5	**18.5 %**	**1.4 %**
6	**24.1 %**	**1.9 %**
7	**1.5 %**	**0.1 %**
8	**2.6 %**	**0.2 %**
9	**28.9 %**	**2.3 %**
10	**17.8 %**	**1.4 %**
11	**0.7 %**	**0.1 %**
12	**1.1 %**	**0.1 %**
13	**4.8 %**	**0.4 %**
	100.0 %	7.8 %

2019

AADT*=	5,800	
BUS=	0.4%	26
COM=	7.8%	452
AGR=	2.1%	
K Factor=	10.40%	

* Distribution: 2019 Sanderson Stewart Miovision Video

* AADTs and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
Old US 87 E of Frontage

Principal Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
Old US 87 E of Frontage Rd

Date: 14-Feb-20

2020	AADT= **21,070**	PRESENT		
2024	AADT= **22,100**	LETTING YEAR		
2044	AADT= **28,050**	DESIGN YEAR		
	DHV= **2690**			
	D=			
	T= **6.2%**			
	ESAL= **292**			
	AGR= **1.2%**			

*Truck Distribution**

5	**46.77 %**	**2.9 %**
6	**12.58 %**	**0.8 %**
7	**2.26 %**	**0.1 %**
8	**4.52 %**	**0.3 %**
9	**18.39 %**	**1.1 %**
10	**10.32 %**	**0.6 %**
11	**0.00 %**	**0.0 %**
12	**0.00 %**	**0.0 %**
13	**5.16 %**	**0.3 %**
	100.0 %	6.2 %

2019

AADT*=	20,820	
BUS=	0.2%	43
COM=	6.2%	1294
AGR=	1.2%	
K Factor=	9.60%	

* Distribution: 2019 Video Count (Site ID: 56-4A-011)

* AADT and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
Old US 87 W of Frontage

Principal Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
Old US 87 W of Frontage Rd

Date: 14-Feb-20

2020	AADT= **23,790**	PRESENT		
2024	AADT= **24,750**	LETTING YEAR		
2044	AADT= **30,200**	DESIGN YEAR		
	DHV= **2900**			
	D=			
	T= **5.7%**			
	ESAL= **269**			
	AGR= **1.0%**			

*Truck Distribution**

5	**46.77 %**	**2.7 %**
6	**12.58 %**	**0.7 %**
7	**2.26 %**	**0.1 %**
8	**4.52 %**	**0.3 %**
9	**18.39 %**	**1.0 %**
10	**10.32 %**	**0.6 %**
11	**0.00 %**	**0.0 %**
12	**0.00 %**	**0.0 %**
13	**5.16 %**	**0.3 %**
	100.0 %	5.7 %

2019

AADT*=	23,550	
BUS=	0.2%	37
COM=	5.7%	1343
AGR=	1.0%	
K Factor=	9.60%	

* Distribution: 2019 Video Count (Site ID: 56-4A-011)

* AADT and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
Frontage Rd

Minor Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
Frontage Rd

Date: 18-Feb-20

2020	AADT= **6,670**	PRESENT		
2024	AADT= **6,940**	LETTING YEAR		
2044	AADT= **8,470**	DESIGN YEAR		
	DHV= **970**			
	D=			
	T= **10.0%**			
	ESAL= **219**			
	AGR= **1.0%**			

*Truck Distribution**

5	**46.8 %**	**4.7 %**
6	**12.6 %**	**1.3 %**
7	**2.3 %**	**0.2 %**
8	**4.5 %**	**0.5 %**
9	**18.4 %**	**1.8 %**
10	**10.3 %**	**1.0 %**
11	**0.0 %**	**0.0 %**
12	**0.0 %**	**0.0 %**
13	**5.2 %**	**0.5 %**
	100.0 %	10.0 %

2019

AADT*=	6,610	
BUS=	0.2%	11
COM=	10.0%	659
AGR=	1.0%	
K Factor=	11.50%	

* Distribution: 2019 Video Count (Site ID: (56-4A-011)
* AADT & Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
Old US 87 Btwn Ramps

Principal Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
Old US 87 Btwn Ramps

Date: 18-Feb-20

2020	AADT= **15,210**	PRESENT		
2024	AADT= **16,330**	LETTING YEAR		
2044	AADT= **23,340**	DESIGN YEAR		
	DHV= **2240**			
	D=			
	T= **5.8%**			
	ESAL= **277**			
	AGR= **1.8%**			

*Truck Distribution**

5	**46.77 %**	**2.7 %**
6	**12.58 %**	**0.7 %**
7	**2.26 %**	**0.1 %**
8	**4.52 %**	**0.3 %**
9	**18.39 %**	**1.1 %**
10	**10.32 %**	**0.6 %**
11	**0.00 %**	**0.0 %**
12	**0.00 %**	**0.0 %**
13	**5.16 %**	**0.3 %**
	100.0 %	5.8 %

2019

AADT*=	14,940	
BUS=	0.3%	48
COM=	5.8%	869
AGR=	1.8%	
K Factor=	9.60%	

* Distribution: 2019 Video Count (Site ID: 56-4A-011)

* AADT and Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
Old US 87 Btwn I90/Coburn Rd

Minor Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
Old US 87 Btwn I90/Coburn Rd

Date: 14-Feb-20

2020	AADT= **10,720**	PRESENT		
2024	AADT= **11,720**	LETTING YEAR		
2044	AADT= **18,290**	DESIGN YEAR		
	DHV= **2210**			
	D=			
	T= **4.3%**			
	ESAL= **182**			
	AGR= **2.3%**			

*Truck Distribution**

5	46.8 %	2.0 %
6	12.6 %	0.5 %
7	2.3 %	0.1 %
8	4.5 %	0.2 %
9	18.4 %	0.8 %
10	10.3 %	0.4 %
11	0.0 %	0.0 %
12	0.0 %	0.0 %
13	5.2 %	0.2 %
	100.0 %	4.3 %

2019

AADT*=	10,490	
BUS=	0.6%	62
COM=	4.3%	449
AGR=	2.3%	
K Factor=	12.10%	

* Distribution: 2019 Video Count (Site ID: [redacted]56-4A-011)
* AADT & Growth Rate: Provided by Sanderson Stewart

RAIL TRANSIT AND PLANNING DIVISION
TRAFFIC DATA COLLECTION SECTION
Worksheet for Engineering and Planning Purposes

Project Description:
Coburn Rd

Minor Flexible
STPX 90-8(191) 450
Lockwood Interchange
UPN: 9588000
Coburn Rd S of Old US 87

Date: 18-Feb-20

2020	AADT= **2,440**	PRESENT		
2024	AADT= **2,590**	LETTING YEAR		
2044	AADT= **3,490**	DESIGN YEAR		
	DHV= **400**			
	D=			
	T= **5.7%**			
	ESAL= **52**			
	AGR= **1.5%**			

*Truck Distribution**

5	**46.8 %**	**2.7 %**
6	**12.6 %**	**0.7 %**
7	**2.3 %**	**0.1 %**
8	**4.5 %**	**0.3 %**
9	**18.4 %**	**1.1 %**
10	**10.3 %**	**0.6 %**
11	**0.0 %**	**0.0 %**
12	**0.0 %**	**0.0 %**
13	**5.2 %**	**0.3 %**
	100.0 %	5.7 %

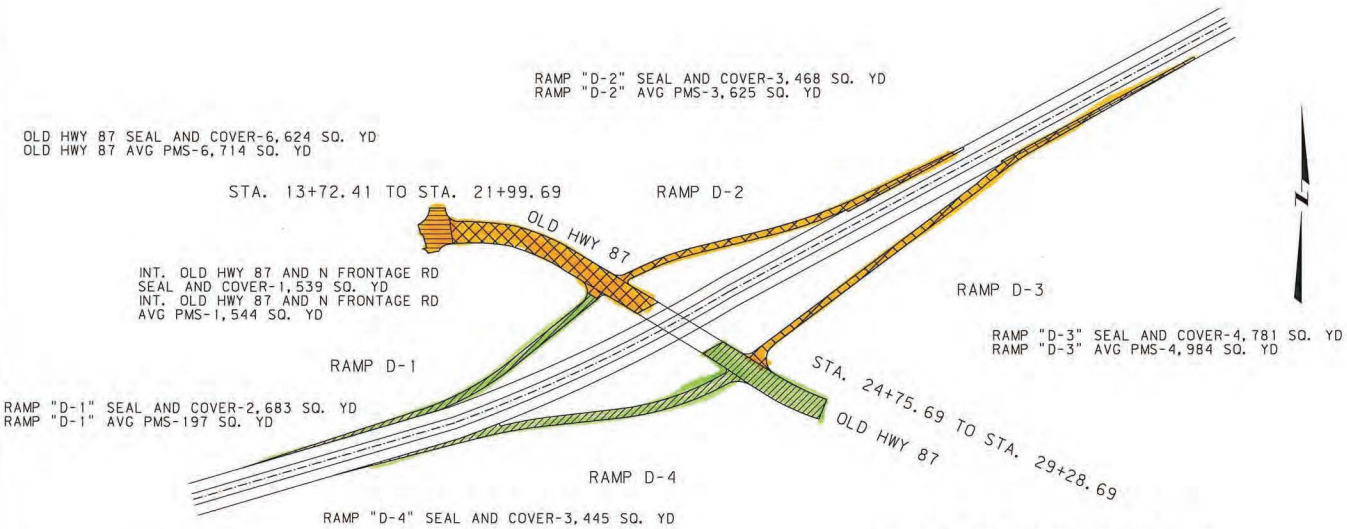
2019

AADT*=	2,410	
BUS=	0.2%	5
COM=	5.7%	138
AGR=	1.5%	
K Factor=	11.50%	

* Distribution: 2019 Video Count (Site ID: 156-4A-011)
* AADT & Growth Rate: Provided by Sanderson Stewart

AWARD COPY

LOCKWOOD INTERCHANGE



SEE ADDITIONAL SURFACING AND COLD MILLING SUMMARY FRAMES FOR QUANTITIES

MILL, FILL, SEAL AND COVER DETAIL

NO SCALE

3	MDT MONTANA DEPARTMENT OF TRANSPORTATION	C:\DGN\9199000rddet002.dgn	DESIGNED BY	S. TWO CROW	2/22/18	ROAD PLANS	W BLGS INTCH-PINEHILLS INTCH	IM-NH 90-8(118)1446
2		9/14/2018	REVIEWED BY	J. BROTZLER	2/22/18			
		1:23:52 PM CPS - U6206	CHECKED BY	J. CORNELL	3/13/18	YELLOWSTONE COUNTY	UPN 9199000	12

Montana Department of Transportation - Core Evaluation Form

Project: Lockwood Interchange - Billings **Lab#:** SK Geotechnical **Date:** 5/14/2020

Limits: MP 452.65 to MP 455.31 **Evaluated By:** Cody C. Hopkins, EI

Sample#	Description Location	Overall	Cumulative Depth (in +/- 1/8")						Rating					Comments
			Chip	Top	2nd	3rd	4th	5th	Top	2nd	3rd	4th	5th	
ST-42	I-90 Eastbound Mainline, See Attached Sketch	10.50	**0.25**	3.25	6.50	10.50			4	3	3			
ST-43		7.38	**0.38**	3.50	7.38				4	2				
ST-44		8.50	**0.38**	3.00	5.50	8.50			4	3	2			
ST-45		10.50	**0.25**	3.00	5.00	10.25			4	2	1			
ST-46		9.00	**0.25**	3.25	5.75	9.00			4	3	2			
ST-47		10.25	**0.25**	3.00	5.00	10.25			4	3	1			
ST-48		8.50	**0.25**	2.75	5.25	8.25			4	1	1			
ST-49		8.13	**0.25**	2.75	4.75	8.13			4	4	3			
ST-55	I-90 Westbound Mainline, See Attached Sketch	11.25	**0.38**	2.88	6.00	11.25			3	3	2			
ST-56		8.38	**0.25**	2.50	4.00	8.38			4	3	2			
ST-57		8.13	**0.25**	2.38	4.63	8.13			4	4	2			
ST-58		8.25	**0.25**	3.00	8.25				3	2				
ST-59		8.25	**0.25**	2.50	4.00	6.25	8.50		4	2	1	1		
ST-60		8.00	**0.38**	2.75	4.50	6.00	8.00		4	3	2	2		
ST-61		9.75	**0.25**	3.50	5.50	9.75			4	3	2			
ST-62		8.50	**0.25**	2.75	5.00	8.50			4	2	1			
ST-71	I-90 Lockwood Ramps, See Attached Sketch	11.13	**0.25**	3.25	6.50	8.50	11.13		3	1	1	1		
ST-72		11.00	**0.25**	3.00	4.38	6.38	8.13	11.00	3	2	2	2	2	
ST-73	US Highway 87, See Attached Sketch	9.50												9 1/2 inch PCCP
ST-74		7.50	**0.25**	2.38	3.25	5.50	7.50		4	2	2	2		
ST-75		6.75	**0.25**	2.00	4.75	6.75			3	2	2			
ST-76		6.75	**0.38**	2.38	4.63	6.75			4	3	3			
	Minimum	6.75	0.25	2.00	3.25	5.50	7.50	11.00	3.00	1.00	1.00	1.00	2.00	
	Maximum	11.25	0.38	3.50	8.25	11.25	11.13	11.00	4.00	4.00	3.00	2.00	2.00	
	Average	**8.90**	**0.28**	**2.85**	**5.26**	**8.26**	**8.65**	**11.00**	**3.8**	**2.5**	**1.8**	**1.6**	**2.0**	

Core Rating:	**Description:**
4) Good:	**- Face shiny, black all aggregate particles are coated.**
3) Moisture Damaged:	**- Loss of sheen, dull appearance some smaller (-10m) aggregate is uncoated.**
2) Stripping:	**- In addition to moisture damage some large aggregate is not coated.**
1) Severely Stripped:	**- Most of the aggregate is so clean the colors of the rock are easily seen.**
0) No Core:	**- Asphalt is mostly gone from all size of aggregate. The core has disintegrated.**

Montana Department of Transportation - Core Evaluation Form

Project: Lockwood Interchange - Billings **Lab#:** SK Geotechnical **Date:** 5/14/2020

Limits: MP 452.65 to MP 455.31 **Evaluated By:** Cody C. Hopkins, EI

Sample#	Description / Location	Overall	Rating Top	Rating 2nd	Rating 3rd	Rating 4th	Rating 5th	Break Load (lbs)	Compressive Strength (psi)	Tensile Strength (psi)	Comments
ST-42	I-90 Eastbound Mainline, See Attached Sketch	10.50	4	3	3			**3308**		**300**	
ST-43		7.38	4	2				**4238**		**384**	
ST-44		8.50	4	3	2			**3192**		**289**	
ST-45		10.50	4	2	1			**1639**		**148**	
ST-46		9.00	4	3	2			**3201**		**290**	
ST-47		10.25	4	3	1			**5273**		**477**	
ST-48		8.50	4	1	1			**3239**		**293**	
ST-49		8.13	4	4	3			**4127**		**374**	
ST-55	I-90 Westbound Mainline, See Attached Sketch	11.25	3	3	2			**5714**		**517**	
ST-56		8.38	4	3	2			**3239**		**293**	
ST-57		8.13	4	4	2			**4127**		**374**	
ST-58		8.25	3	2				**3256**		**295**	
ST-59		8.25	4	2	1	1		**1552**		**141**	
ST-60		8.00	4	3	2	2		**4614**		**418**	
ST-61		9.75	4	3	2			**3216**		**291**	
ST-62		8.50	4	2	1			**2207**		**200**	
ST-71	I-90 Lockwood Ramps, See Attached Sketch	11.13	3	1	1	1		**1895**		**172**	
ST-72		11.00	3	2	2	2	2	**1834**		**166**	
ST-73	US Highway 87, See Attached Sketch	9.50						**57270**	**5420**		9 1/2 inch PCCP
ST-74		7.50	4	2	2	2		**1276**		**116**	
ST-75		6.75	3	2	2			**2376**		**215**	
ST-76		6.75	4	3	3			**3822**		**346**	
	Minimum	6.75	3.00	1.00	1.00	1.00	2.00			**ASTM D6931**	
	Maximum	11.25	4.00	4.00	3.00	2.00	2.00				
	Average	**8.90**	**3.8**	**2.5**	**1.8**	**1.6**	**2.0**				

Core Rating: **Description:**

4) Good: - Face shiny, black all aggregate particles are coated.

3) Moisture Damaged: - Loss of sheen, dull appearance some smaller (-10m) aggregate is uncoated.

2) Stripping: - In addition to moisture damage some large aggregate is not coated.

1) Severely Stripped: - Most of the aggregate is so clean the colors of the rock are easily seen.

0) No Core: - Asphalt is mostly gone from all size of aggregate. The core has disintegrated.

Core ST-42

Core ST-43

Core ST-44

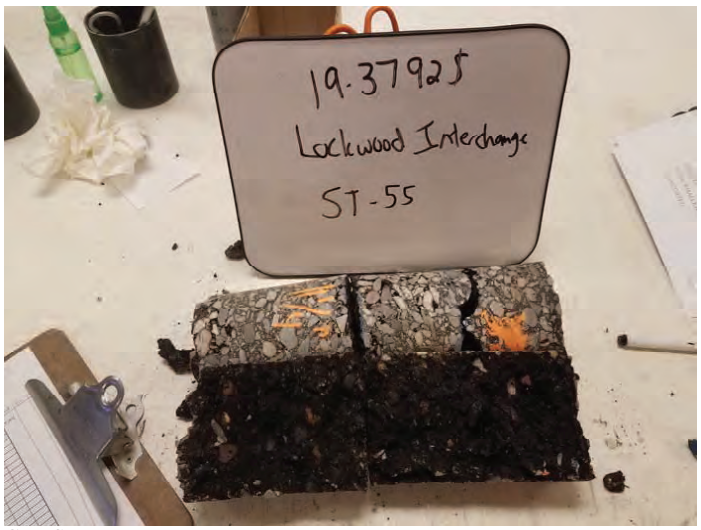
Core ST-45

Core ST-46

Core ST-47

Core ST-48

Core ST-49



Core ST-55

Core ST-56

Core ST-57

Core ST-58

Core ST-59

Core ST-60

Core ST-61

Core ST-62

Core ST-71

Core ST-72

Core ST-74

Core ST-75

Core ST-76

Core ST-73

I-90 eastbound on ramp, Lockwood exit, looking east.

I-90 eastbound on ramp, Lockwood exit, looking west.

I-90 eastbound mainline, looking east.

I-90 eastbound mainline, looking west.

I-90 eastbound mainline, looking east.

I-90 eastbound mainline, looking west.

I-90 eastbound mainline, looking east.

I-90 eastbound mainline, looking west.

I-90 eastbound mainline, looking east.

I-90 eastbound mainline, looking west.

I-90 eastbound mainline, looking east.

I-90 eastbound mainline, looking west.

I-90 eastbound mainline, looking east.

I-90 eastbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound mainline, looking east.

I-90 westbound mainline, looking west.

I-90 westbound off ramp, Lockwood exit, looking east.

I-90 westbound off ramp, Lockwood exit, looking west.

I-90 eastbound and westbound mainline, typical transverse crack.

I-90 eastbound and westbound mainline, typical longitudinal crack.

Highway 87 eastbound, looking east.

Highway 87 eastbound, looking west.

Highway 87 westbound, looking east.

Highway 87 westbound, looking west.

Highway 87 westbound, looking east.

Highway 87 westbound, looking west.

Highway 87 westbound, looking south.

Highway 87 westbound, looking north.

Highway 87 westbound, looking south.

Highway 87 westbound, looking north.

Highway 87 eastbound, looking south.

Highway 87 eastbound, looking north.

Highway 87 eastbound, looking east.

Highway 87 eastbound, looking west.

Highway 87 typical transverse cracks and minor rutting, looking east. Cracks have been sealed.

Highway 87 typical transverse cracks and minor rutting, looking northwest. Cracks have been sealed.

Coburn Road approach to Highway 87, looking southwest. Alligator and block cracking. Many shoulder failures.

Coburn Road approach to Highway 87, looking northeast. Alligator and block cracking. Many shoulder failures.

Highway 87 Lockwood Interchange south bridge end pavement distress, looking west. Rutting, transverse cracks, patches, and block cracking.

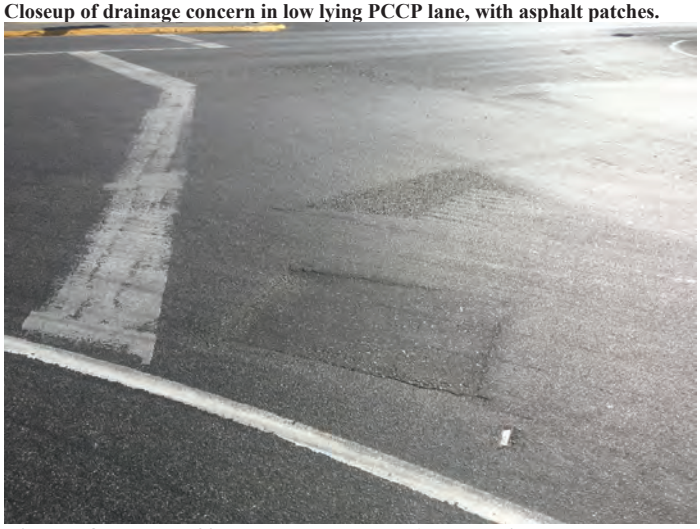
Highway 87 Lockwood Interchange south bridge end pavement distress, looking west. Pothole in intersection, and transverse crack. Intersection in poor shape beneath surface.

Intersection of Highway 87 and North Frontage Road, looking west. Minor patches and reflecting at the joints, but otherwise in good shape.

Intersection of Highway 87 and North Frontage Road, looking southwest. Possible drainage problem observed in westbound lane.

Intersection of Highway 87 and North Frontage Road, looking southwest. Closeup of drainage concern in low lying PCCP lane, with asphalt patches.

Highway 87 typical PCCP worn surface, and some minor infrequent broken edges.



Highway 87 turn to I-90 westbound on ramp. A recent mill and overlay was performed, and bleeding was observed.

Highway 87 turn to I-90 westbound on ramp. Joint cracking observed across lane.

	UPN: 9588000			
Route	STPX 90-8(191)450			
Name	Lockwood Interchange - Billings, Yellowstone County			
Date of Run	6/2/2020			
Typical Section	**1**	**2**	**3**	**4**
Traffic	**I-90 Median - CBC Section**	**I-90 Median - 2.00' Special Borrow Section**	**I-90 EB 0.25 Mill/Overlay**	**I-90 WB 0.25 Mill/Overlay**
Daily ESAL	1305	1305	1305	1305
Yearly ESAL	476325	476325	476325	476325
20 Year ESAL	9526500	9526500	9526500	9526500
Demand				
Note	Subgrade = CL	Subgrade = 2.0' SB	Subgrade = CL	Subgrade = CL
Note	R=5	R=30	R=5	R=5
Reliability	95	95	95	95
So	0.45	0.45	0.45	0.45
DeltaPSI	1.7	1.7	1.7	1.7
Mr	3250	12000	3250	3250
SNDES	**6.73**	**4.43**	**6.73**	**6.73**
W18	*9526500*	*9526500*	*9526500*	*9526500*
Zr	*-1.645*	*-1.645*	*-1.645*	*-1.645*
ESAL	*1305*	*1305*	*1305*	*1305*
Life	*20.0*	*20.0*	*20.0*	*20.0*
Capacity				
a1	0.41	0.41	0.41	0.41
D1 (in)	**7.8**	**7.8**	**3**	**3**
SN1	3.2	3.2	1.2	1.2
a2	**0.14**	**0.14**	**0.27**	**0.27**
m2	1	1	1	1
D2 (in)	**25.8**	**9.0**	**6.3**	**6.0**
SN2	3.6	1.3	1.7	1.6
a3			**0.12**	**0.12**
m3	1	1	1	1
D3 (in)			**40.8**	**40.8**
SN3	0.0	0.0	4.9	4.9
a4				
m4	0	0	0	0
D4 (in)				
SN4	0.0	0.0	0.0	0.0
Sntot = SN1+SN2+SN3+SN4	**6.81**	**4.46**	**7.81**	**7.74**
Traffic Chk W18=20 Yr ESAL	OK	OK	OK	OK
SN Check	OK	OK	OK	OK
Design Check	**DESIGN OK**	**DESIGN OK**	**DESIGN OK**	**DESIGN OK**
Layer 1 (ft)	0.65	0.65	0.25	0.25
Layer 2 (ft)	2.15	0.75	0.52	0.50
Layer 3 (ft)	0.00	0.00	3.40	3.40
Total	2.80	1.40	4.17	4.15

	UPN: 9588000				
Route	STPX 90-8(191)450				
Name	Lockwood Interchange - Billings, Yellowstone County				
Date of Run	7/1/2020				
Typical Section	**1**	**2**	**3**	**4**	**5**
Traffic	**I-90 Lockwood Ramps A&B - CBC Section**	**I-90 Lockwood Ramps A&B - 2.00' Special Borrow Section**	**I-90 Lockwood Ramps A&B - 0.25 Mill and Fill**	**I-90 Lockwood Ramps C&D - CBC Section**	**I-90 Lockwood Ramps C&D 2.00' - Special Borrow Section**
Daily ESAL	154	154	154	270	270
Yearly ESAL	56210	56210	56210	98550	98550
20 Year ESAL	1124200	1124200	1124200	1971000	1971000
Demand					
Note	Subgrade = CL	Subgrade = 2.0' SB	Subgrade = CL	Subgrade = CL	Subgrade = 2.0' SB
Note	R=5	R=30	R=5	R=5	R=30
Reliability	95	95	95	95	95
So	0.45	0.45	0.45	0.45	0.45
DeltaPSI	1.7	1.7	1.7	1.7	1.7
Mr	3250	12000	3250	3250	12000
SNDES	**5.05**	**3.15**	**5.05**	**5.46**	**3.45**
W18	*1124200*	*1124200*	*1124200*	*1971000*	*1971000*
Zr	*-1.645*	*-1.645*	*-1.645*	*-1.645*	*-1.645*
ESAL	*154*	*154*	*154*	*270*	*270*
Life	*20.0*	*20.0*	*20.0*	*20.0*	*20.0*
Capacity					
a1	0.41	0.41	0.41	0.41	0.41
D1 (in)	**4.8**	**4.8**	**3**	**4.8**	**4.8**
SN1	2.0	2.0	1.2	2.0	2.0
a2	**0.14**	**0.14**	**0.27**	**0.14**	**0.14**
m2	1	1	1	1	1
D2 (in)	**22.2**	**9.0**	**8.3**	**25.2**	**10.8**
SN2	3.1	1.3	2.2	3.5	1.5
a3			**0.12**		
m3	1	1	1	1	1
D3 (in)			**20.3**		
SN3	0.0	0.0	2.4	0.0	0.0
Sntot = SN1+SN2+SN3+SN4	**5.08**	**3.23**	**5.89**	**5.50**	**3.48**
Traffic Chk W18=20 Yr ESAL	OK	OK	OK	OK	OK
SN Check	OK	OK	OK	OK	OK
Design Check	**DESIGN OK**	**DESIGN OK**	**DESIGN OK**	**DESIGN OK**	**DESIGN OK**
Layer 1 (ft)	0.40	0.40	0.25	0.40	0.40
Layer 2 (ft)	1.85	0.75	0.69	2.10	0.90
Total	2.25	1.15	2.63	2.50	1.30

	UPN: 9588000		
Route	STPX 90-8(191)450		
Name	Lockwood Interchange - Billings, Yellowstone County		
Date of Run	6/2/2020		
Typical Section	**1**	**2**	**3**
Traffic	**Old US Hwy 87 - CAC Section**	**Old US Hwy 87 2.00' Special Borrow Section**	**Old US Hwy 87 30-Year Bridge Ends**
Daily ESAL	292	292	292
Yearly ESAL	106580	106580	106580
20 Year ESAL	2131600	2131600	
30 Year ESAL			3197400
Demand			
Note	Subgrade = CL	Subgrade = 2.0' SB	Subgrade = 2.0' SB
Note	R=5	R=30	R=30
Reliability	90	90	90
So	0.45	0.45	0.45
DeltaPSI	1.7	1.7	1.7
Mr	3250	12000	12000
SNDES	**5.24**	**3.29**	**3.52**
W18	*2131600*	*2131600*	*3197400*
Zr	*-1.282*	*-1.282*	*-1.282*
ESAL	*292*	*292*	*438*
Life	*20.0*	*20.0*	*20.0*
Capacity			
a1	0.41	0.41	0.41
D1 (in)	**4.8**	**4.8**	**7.2**
SN1	2.0	2.0	3.0
a2	**0.14**	**0.14**	**0.14**
m2	1	1	1
D2 (in)	**23.4**	**9.6**	**7.8**
SN2	3.3	1.3	1.1
a3			
m3	1	1	1
D3 (in)			
SN3	0.0	0.0	0.0
Sntot = SN1+SN2+SN3+SN4	**5.24**	**3.31**	**4.04**
Traffic Chk W18=20 Yr ESAL	OK	OK	OK
SN Check	OK	OK	OK
Design Check	**DESIGN OK**	**DESIGN OK**	**DESIGN OK**
Layer 1 (ft)	0.40	0.40	0.60
Layer 2 (ft)	1.95	0.80	0.65
Total	2.35	1.20	1.25

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DARWin(tm) - Pavement Design

A Proprietary AASHTOWARE(tm)

Computer Software Product

Rigid Structural Design Module

SK Geotechnical Corp.

2511 Holman Ave.

Billings, MT 59102

B. Western

Project Description

STPX 90-8(191)450 - Lockwood Interchange, 40 Year Design

Rigid Structural Design Module Data

Pavement type: JPCP

18-kip ESALs for initial performance period: 4,263,200

Initial Serviceability: 4.5

Terminal Serviceability: 2.5

28-day mean PCC Modulus of Rupture (psi): 650

28-day mean Elastic Modulus of Slab (psi): 4,000,000

Mean Effective k-value (pci): 150

Reliability Level (%): 90

Overall Standard Deviation: .35

Load Transfer Coefficient: 2.6

Overall Drainage Coefficient: 1

Stage Construction: 1

Calculated Design Thickness (in): 7.77

Appendix 5

ACTIVITY 440 Preliminary Geotechnical and Materials Review
(03/27/2008)

DEFINITION:

Initial review of Geotech and Materials plan recommendations from consultant designed project.

TASKS:

Preliminary Soil Survey Investigation (450)

	Task Checklist Description	Yes	No	N/A	Initial
1	Log of each test hole.	X			BDH
2	Location of each test hole noted.	X			
3	Soil Class shown for each sample(AASHTO).	X			
4	Moisture/Density curve for each representative soil sample	X			
5	In place density at each location.		X		
6	Natural moisture shown for each soil sample.	X			
7	R-Value or other acceptable test method for each representative soil sample.	X			
8	Soil survey adequate for entire project.		X		
9	Chemical and corrosion sample taken at each pipe installation.	X			
10	Report submitted describing in-place pipe condition.	X			
11	Test holes plotted on plan and profile sheets.		X - not available		
12	Narrative describing unusual conditions or potential problems soils or drainage.	X			BDH

Borrow and Surface Pit Investigation (452)

	Task Checklist Description	Yes	No	N/A	Initial
1	Review Form 92 (Prospected Area Report)			X	BDH
2	Map showing location of pit submitted.			X	
3	Pit sketch submitted showing location of test holes, legal description and quantity of aggregate available.			X	
4	Completed Field Sample Analysis Report submitted.			X	
5	Log of test holes submitted.			X	
6	Is the pit satisfactory for use as bituminized or non-bituminized surfacing?			X	

Preliminary Surfacing Typical Sections (600)

	Task Checklist Description	Yes	No	N/A	Initial
1	Have 3 alternate typical sections been recommended?	X			BDH

		YES	NO	N/A	INITIAL
2	Is there an economic analysis for each alternate?			X	DPA
3	Is the method of design satisfactory?	X			
4	Are the designs based on subgrade R-Value? Other?	X			
5	Are the design ESAL's current?	X			
6	Are the proposed surfacing layer thicknesses reasonable?	X			
7	Has special borrow or a 2' subgrade cap been considered to reduce surfacing?	X			
8	Is the recommended typical alternate satisfactory?	X			

Deflection Analysis

	Task Checklist Description	Yes	No	N/A	Initial
1	Are back calculated layer modulus values needed for this project? (If not, skip 2, 3 and 4)		X		DPA
2	Was an acceptable back-calculation technique utilized?				
3	Are back calculated moduli values available for all in-place layers?				
4	Are values representative of the area? (Compare to network data)				

Preliminary Geotechnical Evaluation (460)

	Task Checklist Description	Yes	No	N/A	Initial
1	Has a literature and map review been performed?	X			DPA
2	Has a site visit been completed to look at geology, slopes, roadway, drainage, wetlands and other geotechnical issues?	X			
3	Have any potential Geotechnical problems been identified?	X			
4	Has a written report been provided?	X			

START DEPENDENCIES:

Completion of Activity 106.