ConocoPhillips
Alaska

Culvert Monitoring Report

2020 Greater Moose's Tooth 2 (GMT2/MT7)

Spring Breakup

Prepared By:

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ACRONYMS & ABBREVIATIONS

Baro	Barometric
BPMSL	British Petroleum Mean Sea Level
CFDD	cumulative freezing degree days
cfs	cubic feet per second
CPAI	ConocoPhillips Alaska, Inc.
CRD	Colville River Delta
DS	Downstream
ft	Feet
fps	Feet per second
GMT2/MT7	Greater Moose's Tooth 2
GPS	Global positioning systems
HWM	High water mark(s)
Michael Baker	Michael Baker International
NAD83	North American Datum of 1983
NPR-A	National Petroleum Reserve Alaska
PT	Pressure transducer
UMIAQ	UMIAQ, LLC (formerly LCMF)
US	Upstream
USACE	U. S. Army Corps of Engineers
USGS	U.S. Geological Survey
WGS84	World Geodetic System of 1984
WSE	Water surface elevation(s)

1 INTRODUCTION

Greater Moose's Tooth 2 (GMT2/MT7) Spring Breakup Culvert Monitoring supports the ConocoPhillips Alaska, Inc. (CPAI) Environmental group in meeting State of Alaska, federal, and local permit stipulations. GMT2/MT7 facilities include the GMT2 access road and pad. The GMT2 access pad, road, and 80 culverts were installed during the winter of 2018-2019.

The GMT2/MT7 access road spring breakup culvert monitoring field program took place during the 2020 spring breakup monitoring and hydrologic assessment field program. Spring breakup monitoring began on May 4 and concluded on June 8. An additional site visit was performed on June 29 to retrieve field equipment and document summer conditions. Figure 1 shows the GMT2/MT7 access road culvert monitoring locations. Culvert locations and properties are provided in Appendix A and hydrologic staff gage (gage) and associated vertical control locations are provided in Appendix B.

UMIAQ, LLC (UMIAQ), Soloy Helicopters, and CPAI Alpine Field Environmental Coordinators provided support during the field program and contributed to a safe and productive monitoring season. The field methodologies used to collect hydrologic data on the North Slope of Alaska during spring breakup are proven safe, efficient, and accurate for the conditions encountered.

1.1 Study Objective

The objective of the GMT2/MT7 culvert monitoring program is to monitor and document culvert performance and to evaluate areas where additional culverts or modifications to existing culverts are necessary to maintain natural drainage. This meets the hydrology monitoring requirements set forth in the U.S. Army Corps of Engineers (USACE) permit POA-2015-0048. This permit requires annual GMT2/MT7 access road culvert monitoring reports to be submitted for three years post-construction. This is the second year of post-construction reporting.

The following tasks were performed to meet the permit requirements:

- Aerial and ground photo documentation of the GMT2/MT7 access road and pad to demonstrate hydraulic connections during spring breakup and post breakup (summer) conditions
- Identification of areas of differential ponding (ponding on one side of the road), drying, erosion, or stream channel changes adjacent to fill areas
- Demonstration of culvert conveyance of surface water flow based on the maintenance of natural drainage patterns and lack of evidence to the contrary (ponding, drying, erosion, stream channel changes)
- Evaluation of all areas where additional culverts are necessary to maintain natural drainage patterns
- Evaluation of all areas where culvert maintenance, repair, upgrade, setting adjustments, or replacement are necessary to maintain natural drainage patterns

Culvert locations and properties referenced in this report are taken from the As-Built drawings of applicable facilities produced by UMIAQ in August of 2019 and provided in Figure 1.

ConocoPhillips Alaska	0 0.25 0.5 1 mile
Date: 7/7/2020	Scale: 1 inch = 0.5 mile
Drawn: JEM	Project: 178301
Checked: GCY	File: SB2020_GMT2_Culverts.mxd

- gage(s) + PT
- Culvert
- Pipeline
- Access Ice Road
- GMT2 Pipeline Ice Corridor
- Gravel Road
- Gravel Pad

Imagery Source : Conoco Phillips Alaska 2018 Aerial

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2020 SPRING BREAKUP
GMT2/MT7 Access Road

Culvert Monitoring Locations

FIGURE 1

1.2 Data Collection

Data was collected at the locations provided in Table 1.

Table 1: GMT2 / MT7 Access Road Culverts and Associated Gages

Culverts	Associated Gages	Location Description
MT7-01 through MT7-09	S13-A/S13-B	Gage in a depression where flow is conveyed by a network of polygon troughs near the proposed GMT2/MT7 pad location
MT7-10 through MT7-28	-	No defined drainage
MT7-29 through MT7-32	S12-A/S12-B	Gages and culverts in a swale depression between Lake Z06005 and MB0401
MT7-33 through MT7-53	-	No defined drainage
MT7-54 through MT7-58	S11-A/S11-B	Gages and culverts on the southwest corner of a paleolake between Lakes M9923 and M9922
MT7-59 through MT7-66	S10-A/S10-B	Gages and culverts on the east end of a paleolake between Lakes M9923 and M9913
MT7-67 through MT7-69	-	No defined drainage
MT7-70 through MT7-76	S9-A/S9-B	Gages and culverts on the northwest corner of lake M9925 in a shallow depression
MT7-77 through MT7-80	-	No defined drainage; near GMT1 pad location

2 METHODS

2.1 Observations

Gage locations were selected based on topography and hydraulic significance. Field data collection and observations of interactions between floodwaters and infrastructure were recorded in field notebooks and on field sheets. Photographic documentation of spring breakup conditions was collected using digital cameras with integrated global positioning systems (GPS). The latitude, longitude, data, and time are imprinted on each photo. The photo locations are referenced to the World Geodetic System of 1984 (WGS84) horizontal datum.

Sites were accessed via helicopter because road maintenance prevented truck access.

2.2 Water Surface Elevations

Water surface elevation (WSE) data was collected on both sides of the road to document WSE differential for assessing culvert performance. This was completed using hydrologic staff gages with pressure transducers (PTs) attached to each gage. For the purposes of this report, the terms stage and WSE are used interchangeably.

2.2.1 Hydrologic Staff Gages

Gage assemblies (gage and PT) were installed or rehabilitated prior to breakup. The gage stations consist of one gage assembly positioned on both the upstream and downstream sides of the road. Each gage assembly includes a standard U.S. Geological Survey (USGS) metal faceplate mounted on a wooden two-by-four. The two-by-four is attached with U-bolts to a 1.5-inch-wide angle iron gage support post driven into the ground. The faceplate is graduated and indicates water levels every 100th of a foot between 0.00 to 3.33 feet. Gage assemblies were identified with alphabetical designations, with the letter ‘A’ representing the gage assembly located on the north side of the GMT2/MT7 access road and the letter ‘B’ representing gage assemblies located on the south side of the GMT2/MT7 access road.

High water marks (HWMs) on the gages were recorded by applying chalk on the angle iron posts and measuring the wash line. HWMs were recorded to document peak stage.

2.2.2 Pressure Transducers

PTs were attached to all gages to supplement gage readings and to provide a continuous record of WSE when the water column is above the PT sensor. PTs were programmed to collect data at 15-minute intervals beginning mid-May. Each PT was housed in a perforated galvanized steel pipe and secured to the base of the gage assembly with hose clamps. The PTs record the absolute pressure of the atmosphere and water column above the PT. A separate barometric (baro) PT was installed nearby and measured the local atmospheric pressure. The depth of water above the sensor was calculated by subtracting the atmospheric pressure from the absolute pressure measured by the site PT. During data processing, the PT measurements were adjusted to WSE readings. PT setup, testing, and processing methods are detailed in Appendix C.

2.3 Discharge Measurements

Site visits and discharge measurements were performed as near to peak flow conditions as possible. Measurements were collected in all culverts observed conveying flow. Culvert velocity and flow depth were measured using a HACH FH950 electromagnetic velocity meter and a wading rod. Discharge was calculated using measured velocity, flow depth, and the inside culvert diameter. Inside culvert diameter was determined based on the outside culvert diameter and wall thickness data provided by UMIAQ (UMIAQ 2019). Discharge methods are detailed in Appendix D.

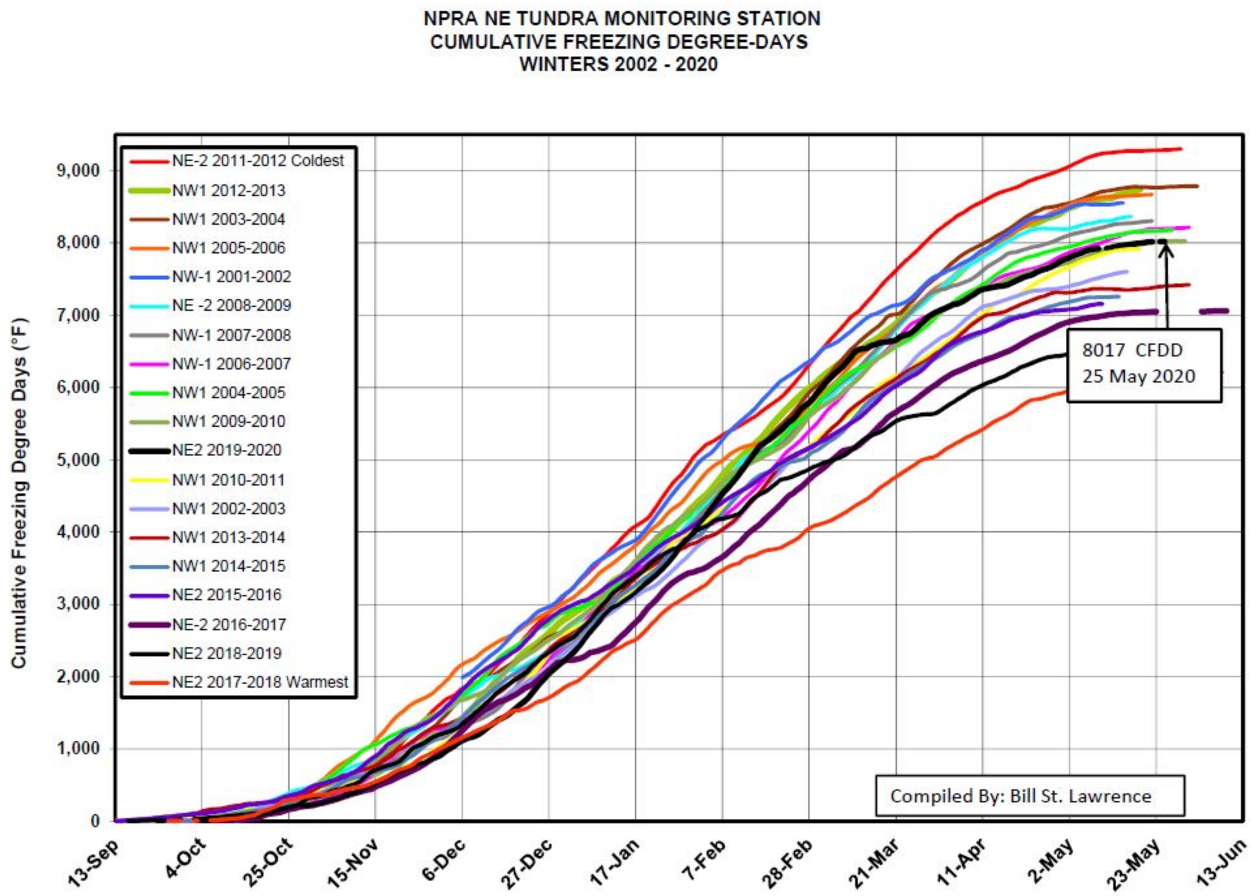
2.4 Culvert Performance Evaluation

Culvert performance was evaluated based on observations, WSE, and discharge measurements with a focus on maintenance, repair, upgrade, setting adjustments, and/or replacement. In addition, the condition of the road fill around the culverts was evaluated to identify areas of erosion or lack thereof.

3 RESULTS

3.1 General Climatic Summary

According to cumulative freezing degree-days (CFDD) measured at the National Petroleum Reserve Alaska (NPR-A) tundra monitoring station, the 2019-2020 (September – May) winter was approximately average compared against the record for the past 19 years (Graph 3.1, ICE 2020).



Graph 3.1: NPRA N. Tundra Monitoring Station CFDD, Winters 2002-2019 (ICE 2019)

There is no NRCS North Slope snowpack data currently available for the 2019-2020 winter season, but general observations indicate snowpack was at or above normal levels in the Colville River drainage basin and the GMT2/MT7 surrounding area.

A warming trend in the upper Colville River watershed (the Brooks Range foothills, as recorded at Umiat, USGS 2020) started on May 9 and lasted until May 12. This was followed by a sub-freezing period for approximately 10 days before temperatures began to rise again on May 22. Daily maximum temperatures began to exceed freezing on May 22; daily minimum temperatures did not begin to exceed freezing until after the breakup monitoring period ended on June 8. A weather station at the Alpine airstrip at CD1 approximately 20-miles northeast of the GMT2/MT7 pad provided the closest temperature data to the GMT2/MT7 study area. At CD1, daily maximum temperatures consistently exceeded freezing on May 24 and continued through the end of the breakup monitoring period on June 8 (Wunderground 2020). Daily minimum temperatures remained below freezing through the end of the breakup monitoring period on June 8 at both CD1 and at Umiat.

3.2 General Observations Summary

Visual inspections performed in mid-May showed that snow had been mechanically cleared from all culvert inlets and outlets prior to spring breakup flooding, although culverts were reburied by drifted snow which accumulated along each embankment prior to breakup (Photo 3.1). On May 24, localized melting was observed along the GMT2/MT7 access road. Snow cover on the surrounding tundra at that time was approximately 90%. On May 26, localized melting was observed at most monitoring stations and PT data indicates rising stage at most upstream monitoring locations. On May 30, a site visit was performed. Discharge was measured through 15 culverts conveying flow along the GMT2/MT7 road. All other culverts were either dry or blocked with ice and snow and impounding meltwater at the inlet and preventing equalization. Aerial observations showed only minor isolated areas of impounded meltwater, except for a large pool behind the inlets of culverts MT7-32 through MT7-30 near the S12 gages, where meltwater extended nearly 1,500 feet along the north embankment.

Equalization continued to improve as culvert blockages melted out through early June. On June 8, aerial observations confirmed the equalization of water across the GMT2/MT7 road, except near S12, where culverts MT7-32 through MT2-30 remained blocked by snow and ice Snow cover on the surrounding tundra was approximately 5% and drifted snow remained along embankments on both sides of the road. By June 29, meltwater was confined to lakes and low-lying areas of drainages, and minimal meltwater remained at the culverts. All culverts where meltwater concentrated properly equalized flow after snow and ice blockages melted out. Meltwater did not reach culverts situated on higher ground during spring breakup.

Photo 3.1: Snow cleared from a culvert on the GMT2/MT7 road, looking south; early May, 2020

3.3 Site Specific Observations & Water Surface Elevations

3.3.1 S9 Culverts (MT7-70 through MT7-76)

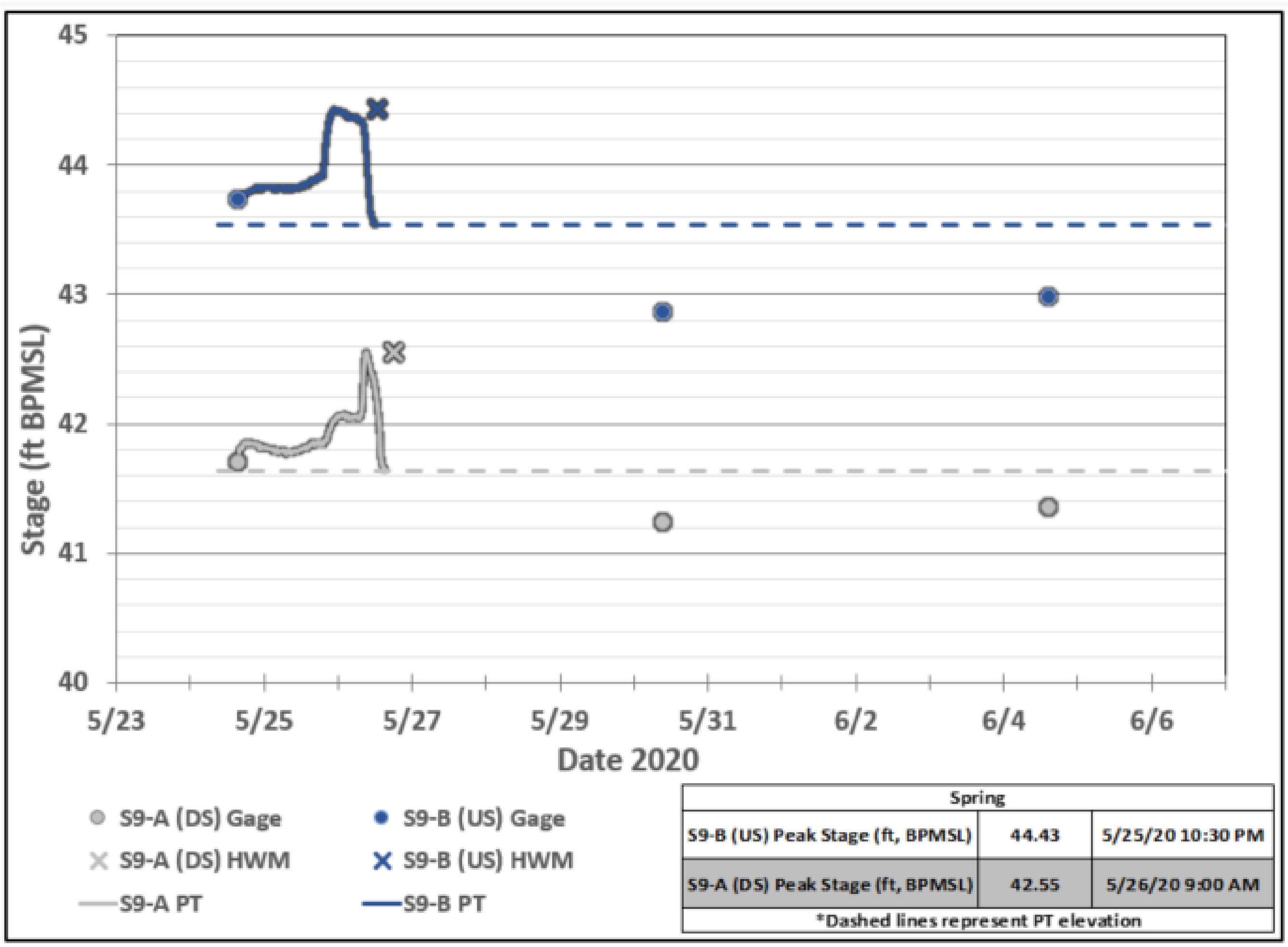
The S9 gages are situated in a low-lying area near the outlet of Lake M9925. Flow, when present, is conveyed north through area culverts via polygon cracks. Culverts MT7-70 through MT7-76 are in this low-lying feature. Both S9-A and S9-B, originally positioned near MT7-72, were moved this year and are now positioned near MT7-71 to better monitor stage where flow tends to concentrate.

Spring breakup melt was initially observed on both sides of the road on May 24 as crews installed monitoring equipment at S9. At this time, ice and snow were present at area culvert inlets and outlets. On May 25, peak stage was recorded at the upstream PT. This peak was likely the result of ponded melt based on the stage hydrograph and that culvert conveyance capacity was limited at this time due to ice and snow blocking the culverts. Equalization occurred on May 26, represented by the decrease in stage at the upstream gage accompanied by the sharp increase in stage at the downstream gage which resulted in peak at the downstream gage. Stage quickly decreased at both locations following this event.

Water levels were equalizing from the north to the south side of the road on May 26. On May 30 flow was measured through culvert MT7-71. All culverts in the associated drainage, except culvert MT7-71, were blocked with snow and ice. Minor ponding was observed along the south embankment between culverts MT7-72 and MT7-70. Stage had further receded by June 8 and minimal meltwater remained in the area. A site visit performed on June 29 confirmed that all culvert blockages from spring breakup had cleared.

An ice road between the GMT2/MT7 pipeline alignment and the GMT2/MT7 road had negligible impacts to drainage in the area. With the exception of temporary blockages from ice and drifted snow accumulation, all culverts were observed to be functioning as designed and natural drainage patterns in the area were maintained.

S9 spring breakup stage data is provided in Graph 3.2. Measured discharge data is presented in section 3.4. Photos are provided in Appendix F.1.



Graph 3.2: S9 Water Surface Elevations

3.3.2 S10 Culverts (MT7-59 through MT7-66)

The S10 gages are in the east end of a paleolake between Lakes M9923 and M9913. Flow, when present, is conveyed north through area culverts via low-lying areas in the paleolake. Culverts MT7-59 through MT7-66 are in the paleolake feature. The S10 gages are positioned to record stage where flow is more concentrated. It is conveyed primarily through culvert MT7-64.

Spring breakup melt was initially observed on the south (upstream) side of the road on May 24 as crews installed monitoring equipment at S10. At this time, ice and snow were present at area culvert inlets and outlets. On May 26 meltwater was increasing on the south side of the road near culvert MT7-64. On May 30 flow was measured through culvert MT7-63. This culvert as equalizing meltwater diverting from the impoundment behind blocked culvert MT7-64 to the esst.

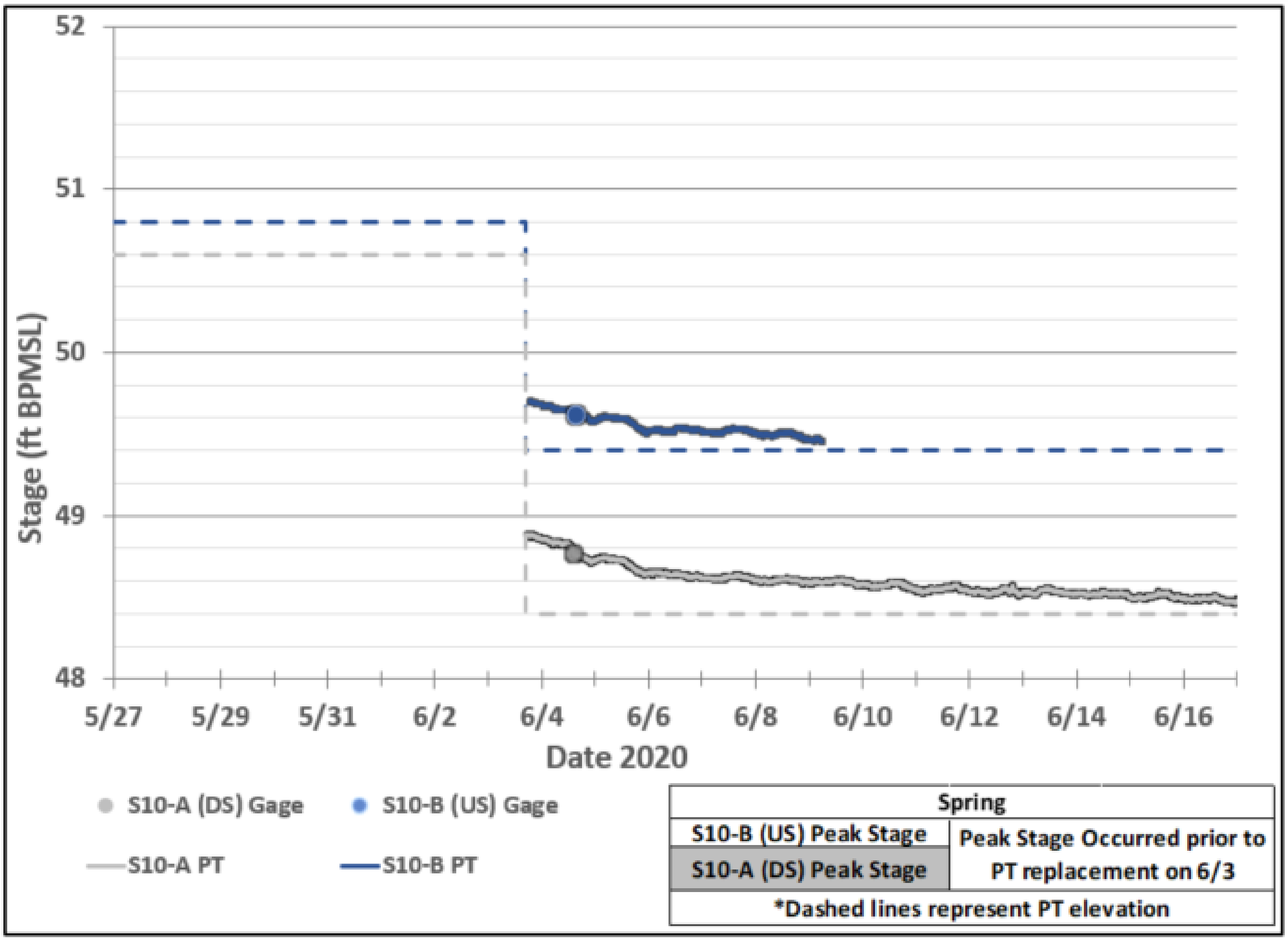
On May 31 meltwater was equalizing exclusively through culvert MT7-63. By June 5, stage had receded and impounded meltwater behind culvert MT7-64 was no longer hydraulically connected to the inlet of culvert MT7-63, leaving meltwater stagnant behind the blocked culvert MT7-64.

The S10 PTs were moved lower into the channel on June 3. By then, peak stage had occurred and stage in the area was receding. Peak stage at the upstream and downstream gages did not exceed the PT elevations of 50.8-

ft and 50.6-ft BPMSL, respectively. By June 29, a site visit confirmed that ice and snow in the culverts had melted out and the pool behind MT7-64 was no longer present. No flow was observed, and meltwater was confined to the low-lying areas of the paleolake.

An ice road between the GMT2/MT7 pipeline alignment and the GMT2/MT7 road had negligible impacts to drainage in the area. With the exception of temporary blockages from ice and drifted snow accumulation, all culverts were observed to be functioning as designed and natural drainage patterns in the area were maintained.

S10 spring breakup stage data is provided in Graph 3.3. Measured discharge data is presented in section 3.4. Photos are provided in Appendix F.2.



Graph 3.3: S10 Water Surface Elevations

3.3.3 S11 Culverts (MT7-54 through MT7-58)

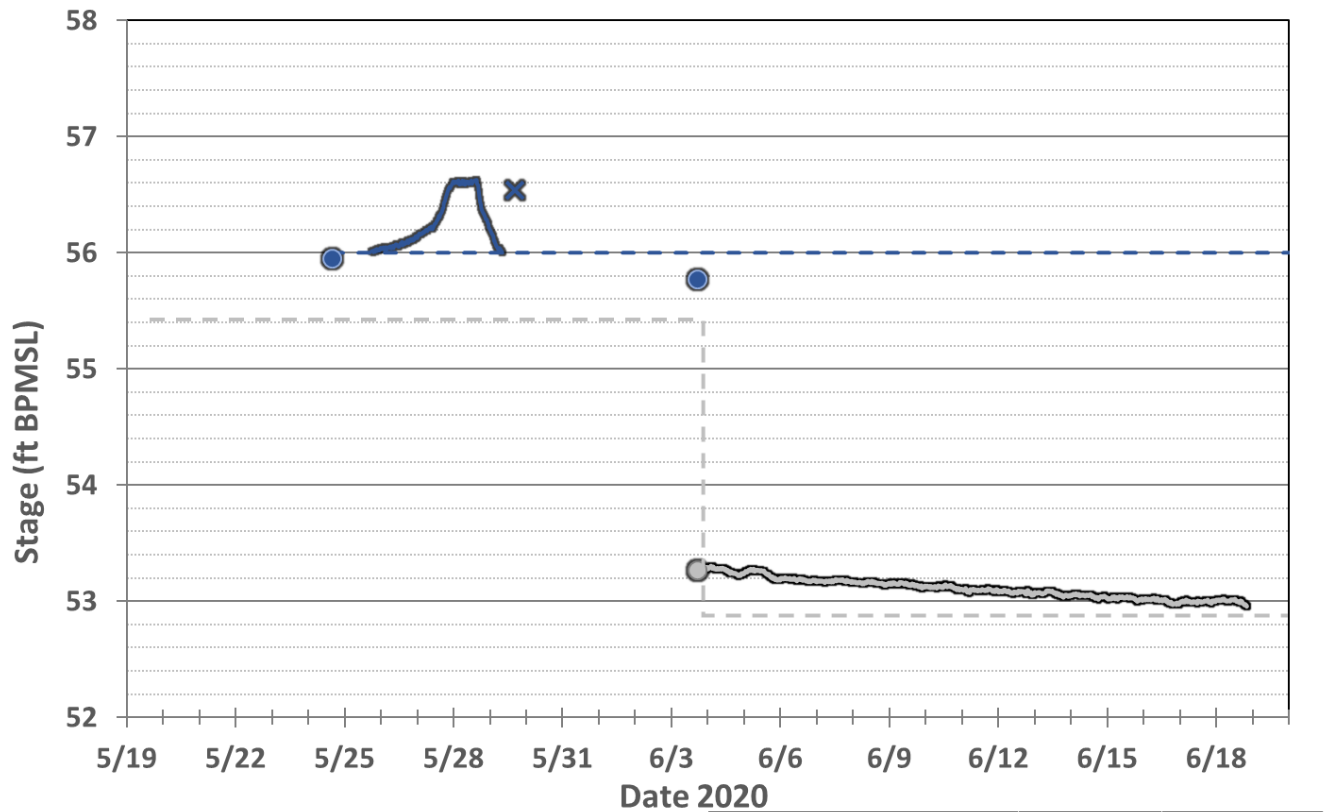
The S11 gages are in a low-lying area between Lakes M9923 and M9922. Flow, when present, is conveyed north through area culverts via polygon cracks. Culverts MT7-54 through MT7-58 are in this low-lying feature. The S11 gages are positioned to record stage where flow is more concentrated. It is conveyed primarily through culvert MT7-56.

Spring breakup melt was initially observed on the south (upstream) side of the road on May 24 as crews installed monitoring equipment at S11. At this time, ice and snow were present at area culvert inlets and outlets. On May 26, the upstream stage hydrograph recorded an initial rise in stage, and ponding was occurring on the south side of the GMT2/MT7 road near culvert MT7-56. Stage at the upstream gage continued to rise until peak stage occurred on May 28. Equalization likely occurred on May 29 when stage at the upstream gage rapidly receded after having peaked the previous day. There was a lack of concurrent stage rise at the downstream gage because culvert MT7-56 remained blocked with ice and snow. It was instead diverted north through culvert MT7-57.

On May 30 a site visit was performed, and flow was measured through culvert MT7-57. Culvert MT7-56 was blocked with ice and snow, and impounded meltwater behind culvert MT7-56 was hydraulically connected to culvert MT7-57. On June 3, stage at the upstream gage had receded and culvert MT7-56 remained blocked. By June 29, all culvert blockages had melted out and minimal meltwater remained in the area. Minimal flow was observed through culvert MT7-56.

An ice road between the GMT2/MT7 pipeline alignment and the GMT2/MT7 road had negligible impacts to drainage in the area. With the exception of temporary blockages from ice and drifted snow accumulation, all culverts were observed to be functioning as designed and natural drainage patterns in the area were maintained.

S11 spring breakup stage data is provided in Graph 3.4. Measured discharge data is presented in section 3.4. Photos are provided in Appendix F.3.



Spring		
S11-B (US) Peak Stage (ft, BPMSL)	56.63	5/28/2020 14:45
S11-A (DS) Peak Stage (ft, BPMSL)	53.30	6/4/2020 14:00
* Dashed lines represent PT elevation. PTs repositioned on 6/3		

Graph 3.4: S11 Water Surface Elevations

3.3.4 S12 Culverts (MT7-29 through MT7-32)

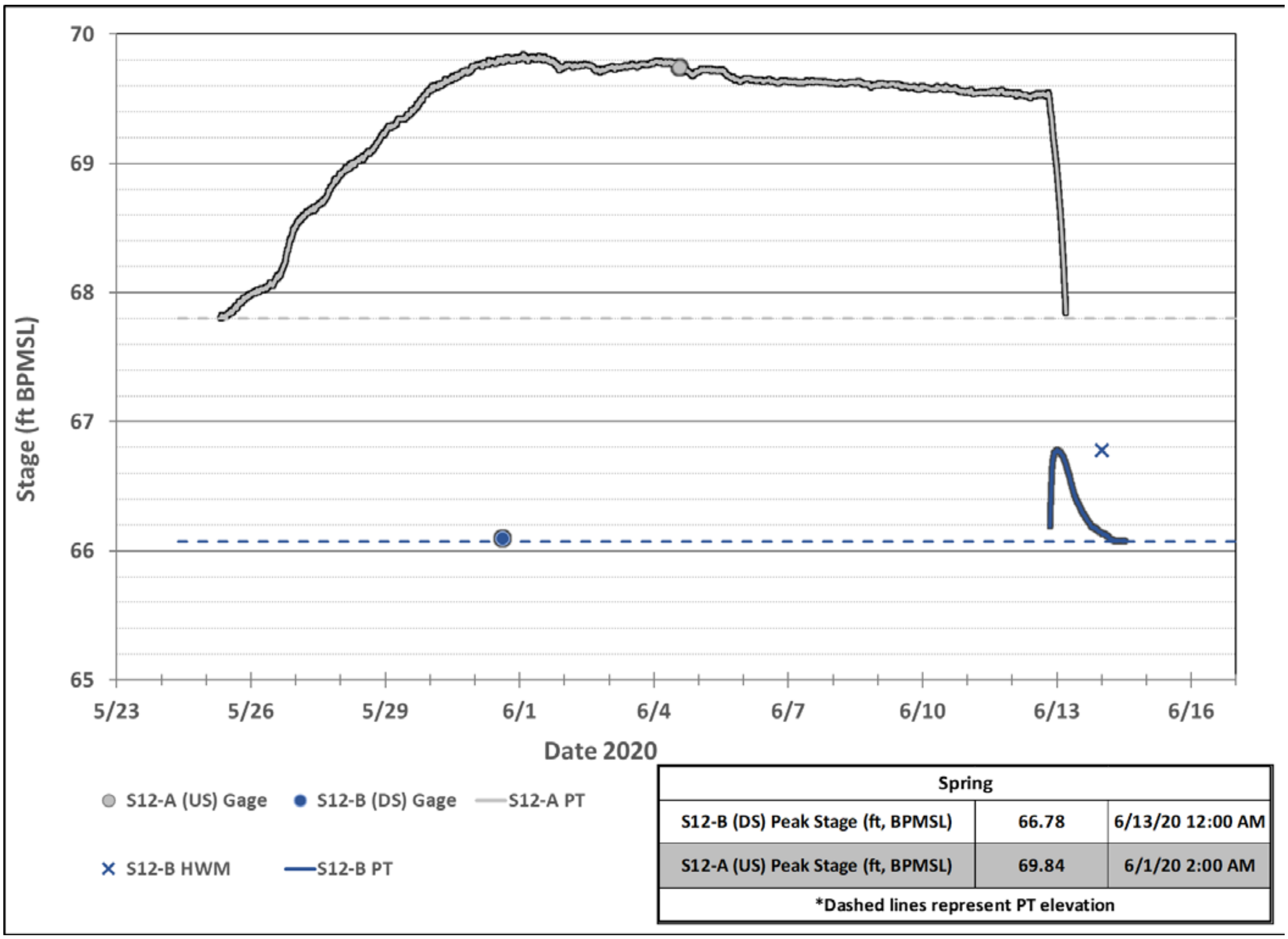
The S12 gages are in a low-lying area between Lake Z06005 and MB0401. Flow, when present, is conveyed south through area culverts via polygon cracks. Culverts MT7-29 through MT7-32 are within the low-lying feature. The S12 gages are positioned to capture flow primarily through culvert MT7-31.

Spring breakup melt was initially observed underneath saturated snow on the upstream (north) side of the road on May 24 as crews installed monitoring equipment at S12. At this time, ice and snow were present at area culvert inlets and outlets. Stage at the upstream gage rose from May 24 until June 1. The downstream gage remained dry as meltwater impounded at the inlet of blocked culverts MT7-32 to MT7-30. Extensive ponding from impounded meltwater was observed along the north embankment at S12 on May 30. The pond length along the north embankment was approximately 1,500 feet and spanned from culvert MT7-32 to MT7-30, ending approximately 200 feet from MT7-29. The ponded water near S12 remained on June 8. Stage at the upstream gage receded slightly but remained elevated and the downstream gage remained dry through June 12.

Equalization occurred on June 12, represented by the rapid decrease in stage at the upstream gage accompanied by the sharp increase in stage at the downstream gage which resulted in peak. CPAI crews facilitated equalization by heating the culverts to thaw ice blockages. The culvert blockages had melted out by June 29 and the S12 monitoring area was dry. Wash marks and isolated pockets of minor sloughing were observed along the north embankment. Displaced gravel from sloughing near MT7-31 was cleared after floodwaters receded.

The ponding near S12 was due to ice and snow accumulation in the culverts. This was likely exaggerated by the propensity of snow to accumulate on the north/east side of roadways, driven by predominately easterly winds and winter storms. The inlets of these culverts, positioned on the north side of the road, were buried deep by snow during winter and were quickly drifted in again after snow was mechanically cleared in April. With the exception of the temporary blockages from ice and drifted snow accumulation, all culverts are presumed to be functioning as designed, and the natural drainage patterns in the area were confirmed to have been maintained. Culvert performance could be improved by the use/development of superior snow and ice clearing or thawing techniques at the culvert inlets.

S12 spring breakup stage data is provided in Graph 3.5. Detailed measured discharge data is presented in section 3.4. Photos are provided in Appendix F.5.



Spring		
S12-B (DS) Peak Stage (ft, BPMSL)	66.78	6/13/20 12:00 AM
S12-A (US) Peak Stage (ft, BPMSL)	69.84	6/1/20 2:00 AM
*Dashed lines represent PT elevation		

Graph 3.5: S12 Water Surface Elevations

3.3.5 S13 Culverts (MT7-01 through MT7-09)

The S13 gages are in a small, poorly defined network of low-lying polygons near the GMT2/MT7 pad location. Flow, when present, is conveyed north through the area culverts via low-lying polygon cracks. Culverts MT7-01 through MT7-09 are within this polygon network. The S13 gages are positioned to capture flow primarily through culvert MT7-02.

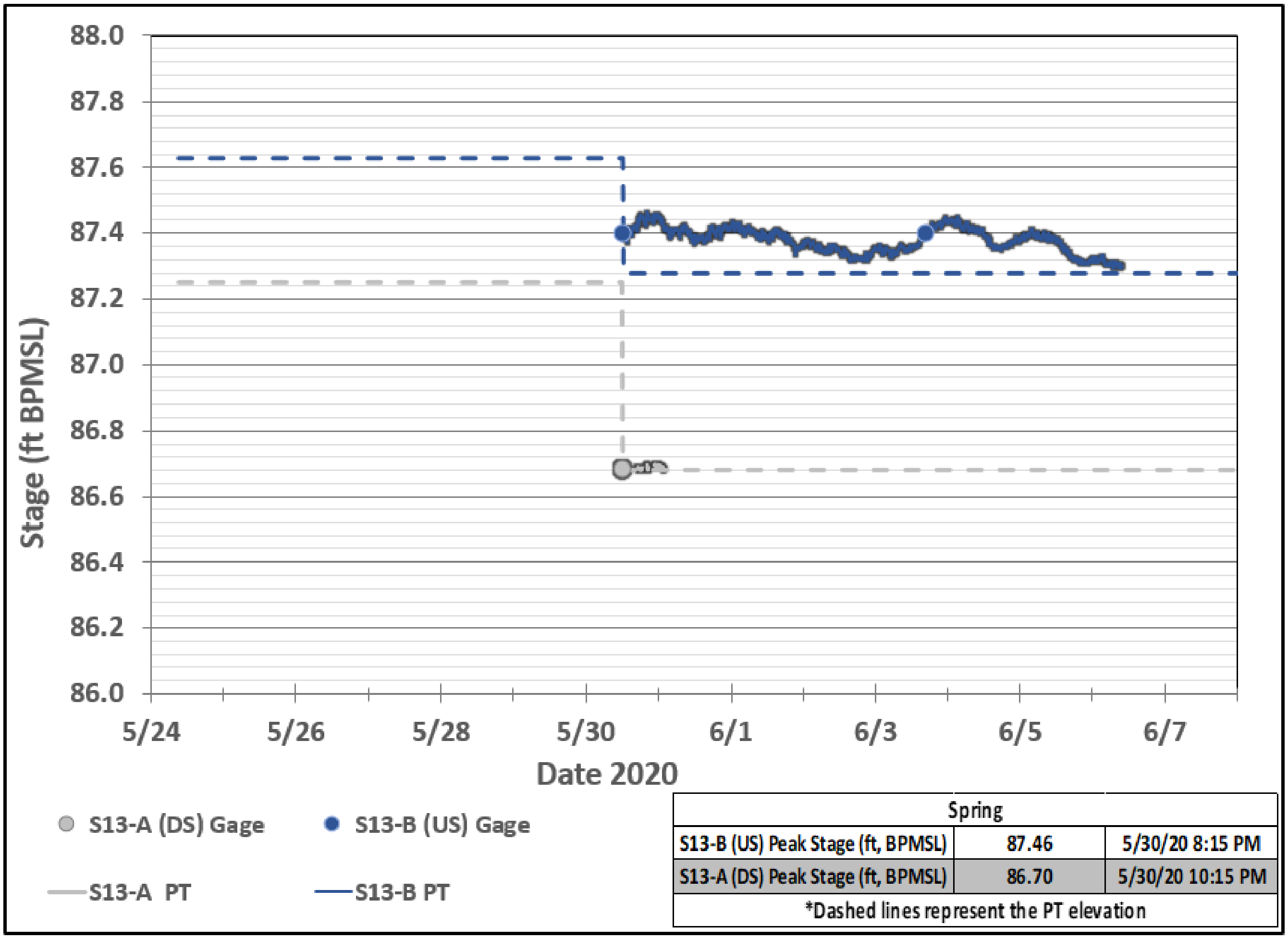
Spring breakup melt was initially observed on the south (upstream) side of the road near S13 on May 24. On May 26, local meltwater was present on both sides of the road near the S13 gages but had not reached either embankment. On May 30, isolated areas of ponded water were observed along the south embankment, particularly at the sharp road bend near MT7-02 and near culverts MT7-04 and MT7-08. Ponded water had not reached the north embankment. Flow was measured through culverts MT7-05 and MT7-12 on May 30.

Stage at the upstream gage fluctuated slightly but remained steady through the monitoring period and was below the PT by June 7. Stage slowly receded through early June. By June 4 minimal meltwater was present near S13.

The S13 PTs were positioned lower in the channel on May 30 to capture the low stage conditions. Stage at the downstream gage remained below the PT elevation after June 3. Stage at the upstream gage likely peaked prior to June 3, however the lack of an HWM on the upstream gage suggests overall stage rise during peak was minimal.

An ice road between the GMT2/MT7 pipeline alignment the GMT2/MT7 road had negligible impacts on drainage in the area. With the exception of temporary blockages from ice and drifted snow accumulation, all culverts were observed to be functioning as designed and natural drainage patterns in the area were maintained.

S13 spring breakup stage data is provided in Graph 3.1. Detailed measured discharge data is presented in section 3.4. Photos are provided in Appendix F.7.



Spring		
S13-B (US) Peak Stage (ft, BPMSL)	87.46	5/30/20 8:15 PM
S13-A (DS) Peak Stage (ft, BPMSL)	86.70	5/30/20 10:15 PM
*Dashed lines represent the PT elevation		

Graph 3.6: S13 Water Surface Elevations

3.5 Discharge Measurements

Discharge was measured on May 30 at all GMT2/MT7 culverts observed conveying flow. A summary of the discharge measurements is presented in Table 2.

Table 2: GMT2 / MT7 Access Road Culvert Discharge

Culvert	Measurement Date & Time	Culvert Inside Diameter (ft)	Flow Area (ft^2)	Total Depth of Flow (ft)	Measured Velocity (fps)	Discharge (cfs)
MT7-05	5/30/2020 11:56	1.9	1.7	1.1	0.6	1.0
MT7-12	5/30/2020 11:34	1.9	1.7	1.1	1.0	1.6
MT7-22	5/30/2020 11:24	1.9	1.5	1.0	1.5	2.3
MT7-27	5/30/2020 11:13	1.9	1.7	1.1	1.4	2.3
MT7-44	5/30/2020 11:01	1.9	1.3	0.9	1.3	1.7
MT7-50	5/30/2020 10:50	2.8	4.5	1.9	0.6	2.9
MT7-51	5/30/2020 10:39	2.8	2.8	1.3	0.1	0.1
MT7-52	5/30/2020 10:43	2.8	4.2	1.8	0.4	1.6
MT7-57	5/30/2020 10:17	1.9	1.0	0.7	0.2	0.2
MT7-61	5/30/2020 10:09	1.9	1.1	0.8	1.8	2.1
MT7-63	5/30/2020 09:59	1.9	1.7	1.1	1.4	2.4
MT7-71	5/30/2020 09:35	1.9	0.8	0.6	0.6	0.4
MT7-75	5/30/2020 09:27	1.9	0.6	0.5	1.3	0.8
MT7-78	5/30/2020 09:18	2.8	3.9	1.7	0.3	1.1

3.6 Culvert Performance Evaluation

No performance issues were identified at any culverts along the GMT2/MT7 access road, besides temporary blockages from ice and drifted snow. Ponded water was present at several locations along the access road but was mainly attributed to snow and ice impeding flow and not culvert placement (Photo 3.2 and Photo 3.3).

Drifted snow and along both embankments buried culvert inlets and outlets and temporarily impeded drainage in some locations (Photo 3.4 and Photo 3.5). Once conveyance paths were established by water melting through snow/ice, the culverts all performed as designed and natural drainage patterns were maintained (Photo 3.6). With the exception of the minimal sloughing observed at culvert MT7-31, no displacement of gravel fill attributed with spring breakup flooding was observed along the road embankment or around culvert inlets and outlets (Photo 3.7). Displaced gravel near MT7-31 was mechanically replaced in July after floodwaters receded (Photo 3.8). There were no signs of undermining at drainage structures. Several culverts were perched on either the north or south sides of the road which may lead to the development of scour holes (Photo 3.9). Besides these perched culverts, no culvert maintenance, repair, upgrade, setting adjustments, and/or replacements are recommended at this time.

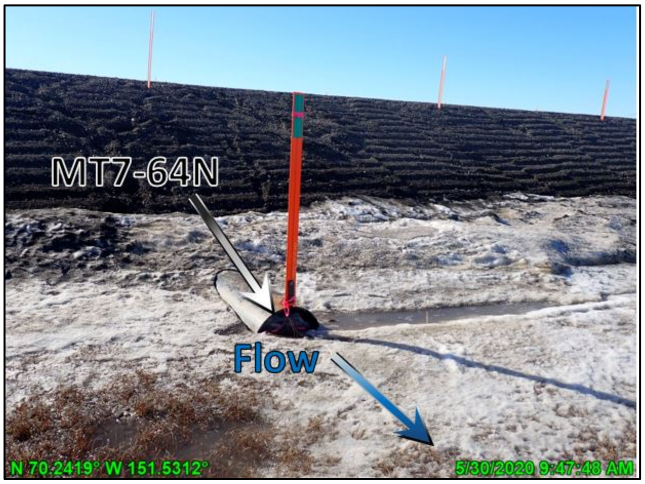


Photo 3.2: Culvert MT7-64 outlet partially buried with snow, looking south; May 30, 2020

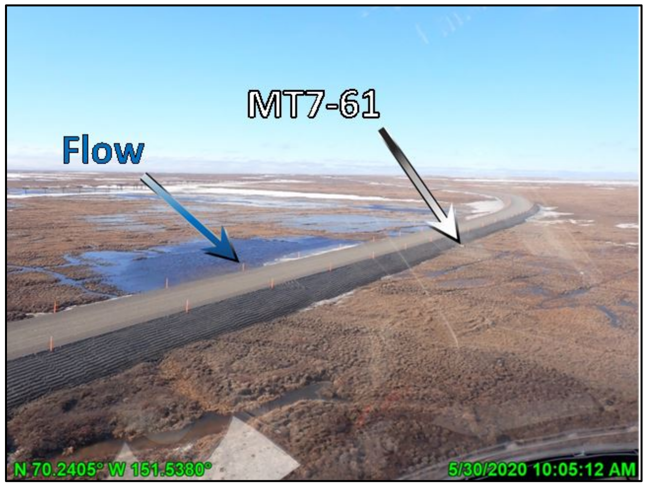


Photo 3.3: Ponding near culvert MT7-61 looking north; May 30, 2020

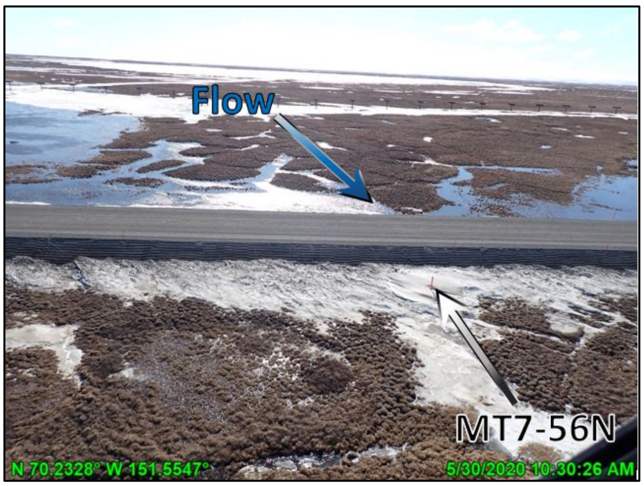


Photo 3.4: Drifted snow blocking flow at MT7-56, looking south; May 30, 2020

Photo 3.5: Drifted snow along GMT2 / MT7 road embankments, looking southwest; May 30, 2020

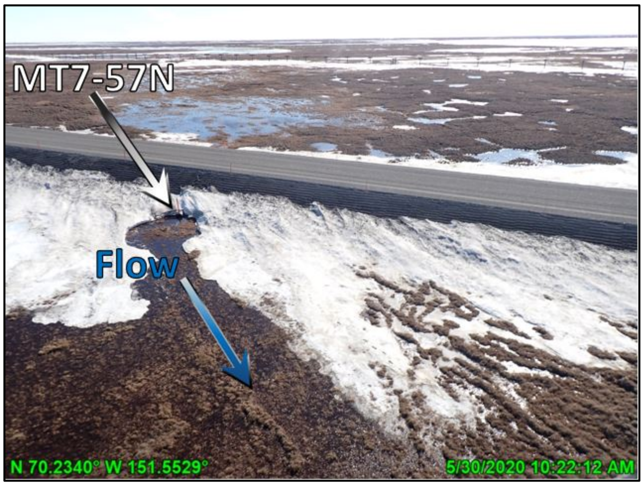


Photo 3.6: Flow through culvert MT7-57, looking south; May 30, 2020

Photo 3.7: Sloughing along the north embankment near MT7-31, looking west; June 29, 2020

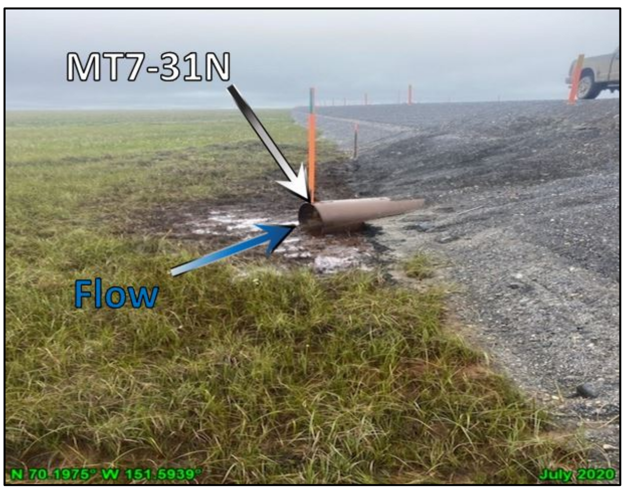


Photo 3.8: Culvert MT7-31 after displaced gravel cleared from site, looking east; July, 2020

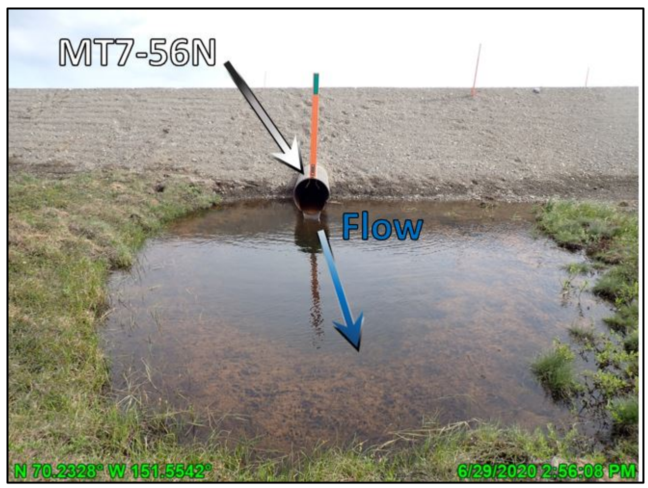


Photo 3.9: Culvert GMT2-56 perched on the north side of the GMT2/MT7 access road, looking south; June 29, 2020

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Appendix A Culvert Locations & Properties

Culvert	Station	Length (ft)	Latitude (NAD83)	Longitude (NAD83)	Invert Elevation (BPMSL)	Outside Diameter (ft)	Wall Thickness (ft)	Inside Diameter (ft)
MT7-01N	03+06	96..2	70.1750	-151.6902	87.089	2	0.052	1.90
MT7-01S			70.1750	-151.6909	86.545			
MT7-02N	06+91	76.1	70.1759	-151.6893	85.688	2	0.052	1.90
MT7-02S			70.1757	-151.6889	85.175			
MT7-03N	11+97	66.0	70.1765	-151.6855	84.459	2	0.052	1.90
MT7-03S			70.1763	-151.6854	85.140			
MT7-04N	15+58	74.0	70.1768	-151.6827	84.480	2	0.052	1.90
MT7-04S			70.1766	-151.6827	84.257			
MT7-05N	22+49	78.1	70.1773	-151.6776	84.507	2	0.052	1.90
MT7-05S			70.1772	-151.6771	85.221			
MT7-06N	26+34	70.1	70.1776	-151.6744	84.970	2	0.052	1.90
MT7-06S			70.1774	-151.6743	86.060			
MT7-07N	31+64	70.2	70.1780	-151.6704	85.874	2	0.052	1.90
MT7-07S			70.1778	-151.6702	84.238			
MT7-08N	40+82	64.5	70.1787	-151.6632	88.027	2	0.052	1.90
MT7-08S			70.1785	-151.6631	88.329			
MT7-09N	48+59	74.1	70.1793	-151.6572	86.088	2	0.052	1.90
MT7-09S			70.1791	-151.6570	86.471			
MT7-10N	66+45	70.0	70.1806	-151.6433	79.695	2	0.052	1.90
MT7-10S			70.1804	-151.6432	78.269			
MT7-11N	69+00	64.2	70.1808	-151.6414	78.479	2	0.052	1.90
MT7-11S			70.1806	-151.6412	78.069			
MT7-12N	72+69	76.0	70.1811	-151.6384	76.755	2	0.052	1.90
MT7-12S			70.1809	-151.6385	76.771			
MT7-13N	76+50	68.3	70.1813	-151.6355	78.047	2	0.052	1.90
MT7-13S			70.1812	-151.6354	77.595			
MT7-14N	78+37	84.1	70.1815	-151.6339	78.300	2	0.052	1.90
MT7-14S			70.1813	-151.6342	77.022			
MT7-15N	84+25	62.1	70.1819	-151.6295	81.057	2	0.052	1.90
MT7-15S			70.1817	-151.6294	80.840			
MT7-16N	89+18	64.0	70.1823	-151.6257	77.959	2	0.052	1.90
MT7-16S			70.1821	-151.6256	78.102			
MT7-17N	96+57	80.1	70.1830	-151.6201	74.828	2	0.052	1.90
MT7-17S			70.1828	-151.6202	75.574			

Culvert	Station	Length (ft)	Latitude (NAD83)	Longitude (NAD83)	Invert Elevation (BPMSL)	Outside Diameter (ft)	Wall Thickness (ft)	Inside Diameter (ft)
MT7-18N	101+98	70.0	70.1839	-151.6169	77.267	2	0.052	1.90
MT7-18S			70.1837	-151.6164	77.382			
MT7-19N	109+35	81.7	70.1853	-151.6124	72.620	2	0.052	1.90
MT7-19S			70.1851	-151.6122	73.296			
MT7-20N	112+35	67.8	70.1858	-151.6107	71.909	2	0.052	1.90
MT7-20S			70.1857	-151.6103	71.811			
MT7-21N	115+83	64.0	70.1864	-151.6086	70.870	2	0.052	1.90
MT7-21S			70.1863	-151.6083	70.585			
MT7-22N	122+38	74.1	70.1877	-151.6048	71.870	2	0.052	1.90
MT7-22S			70.1875	-151.6044	71.446			
MT7-23N	127+12	68.0	70.1886	-151.6022	76.438	2	0.052	1.90
MT7-23S			70.1885	-151.6018	76.122			
MT7-24N	131+04	80.0	70.1895	-151.6006	70.058	3	0.083	2.83
MT7-24S			70.1894	-151.6000	69.134			
MT7-25N	131+10	80.0	70.1895	-151.6006	70.285	3	0.083	2.83
MT7-25S			70.1894	-151.6000	69.157			
MT7-26N	135+74	69.9	70.1907	-151.5991	68.918	2	0.052	1.90
MT7-26S			70.1906	-151.5987	69.228			
MT7-27N	139+70	66.0	70.1917	-151.5984	69.450	2	0.052	1.90
MT7-27S			70.1917	-151.5978	69.360			
MT7-28N	143+52	72.1	70.1927	-151.5976	68.569	2	0.052	1.90
MT7-28S			70.1927	-151.5970	69.566			
MT7-29N	152+40	68.2	70.1951	-151.5957	72.787	2	0.052	1.90
MT7-29S			70.1950	-151.5952	71.859			
MT7-30N	159+87	72.2	70.1971	-151.5942	67.842	2	0.052	1.90
MT7-30S			70.1970	-151.5937	67.781			
MT7-31N	161+36	70.1	70.1974	-151.5939	67.903	2	0.052	1.90
MT7-31S			70.1974	-151.5933	67.241			
MT7-32N	167+24	66.3	70.1990	-151.5927	71.253	2	0.052	1.90
MT7-32S			70.1990	-151.5922	70.751			
MT7-33N	178+69	72.1	70.2021	-151.5903	74.111	2	0.052	1.90
MT7-33S			70.2020	-151.5898	73.917			
MT7-34N	186+75	80.3	70.2042	-151.5887	71.281	2	0.052	1.90
MT7-34S			70.2041	-151.5882	71.114			
MT7-35N	187+88	90.0	70.2045	-151.5884	71.777	2	0.052	1.90
MT7-35S			70.2044	-151.5879	71.043			

Culvert	Station	Length (ft)	Latitude (NAD83)	Longitude (NAD83)	Invert Elevation (BPMSL)	Outside Diameter (ft)	Wall Thickness (ft)	Inside Diameter (ft)
MT7-36N	190+10	116.0	70.2052	-151.5879	73.886	2	0.052	1.90
MT7-36S			70.2049	-151.5876	72.148			
MT7-37N	196+24	86.4	70.2066	-151.5868	71.771	2	0.052	1.90
MT7-37S			70.2067	-151.5861	71.798			
MT7-38N	198+17	70.1	70.2072	-151.5864	71.453	2	0.052	1.90
MT7-38S			70.2072	-151.5858	72.081			
MT7-39N	207+45	66.4	70.2096	-151.5843	76.703	2	0.052	1.90
MT7-39S			70.2096	-151.5838	76.565			
MT7-40N	212+53	66.4	70.2109	-151.5827	76.120	2	0.052	1.90
MT7-40S			70.2108	-151.5822	76.917			
MT7-41N	220+80	84.1	70.2130	-151.5799	70.639	2	0.052	1.90
MT7-41S			70.2128	-151.5795	71.387			
MT7-42N	228+59	66.3	70.2149	-151.5774	70.759	2	0.052	1.90
MT7-42S			70.2148	-151.5769	71.309			
MT7-43N	235+52	70.3	70.2167	-151.5750	68.095	2	0.052	1.90
MT7-43S			70.2166	-151.5746	67.412			
MT7-44N	241+96	74.1	70.2182	-151.5730	63.278	2	0.052	1.90
MT7-44S			70.2182	-151.5724	63.448			
MT7-45N	250+51	74.3	70.2204	-151.5700	60.025	2	0.052	1.90
MT7-45S			70.2203	-151.5697	60.116			
MT7-46N	252+97	66.2	70.2210	-151.5693	60.334	2	0.052	1.90
MT7-46S			70.2209	-151.5688	60.023			
MT7-47N	257+56	82.2	70.2222	-151.5677	58.601	2	0.052	1.90
MT7-47S			70.2220	-151.5674	57.912			
MT7-48N	264+81	74.1	70.2240	-151.5654	55.432	2	0.052	1.90
MT7-48S			70.2238	-151.5649	56.534			
MT7-49N	271+24	78.1	70.2256	-151.5632	52.422	2	0.052	1.90
MT7-49S			70.2254	-151.5628	52.239			
MT7-50N	274+61	68.2	70.2264	-151.5621	52.142	3	0.083	2.83
MT7-50S			70.2263	-151.5616	52.581			
MT7-51N	280+35	70.0	70.2278	-151.5602	52.679	3	0.083	2.83
MT7-51S			70.2277	-151.5598	52.483			
MT7-52N	282+85	68.0	70.2284	-151.5594	52.027	3	0.083	2.83
MT7-52S			70.2284	-151.5589	52.404			
MT7-53N	288+14	122.1	70.2299	-151.5575	53.010	2	0.052	1.90
MT7-53S			70.2296	-151.5574	53.200			

Culvert	Station	Length (ft)	Latitude (NAD83)	Longitude (NAD83)	Invert Elevation (BPMSL)	Outside Diameter (ft)	Wall Thickness (ft)	Inside Diameter (ft)
MT7-54N	294+05	69.7	70.2313	-151.5557	54.433	2	0.052	1.90
MT7-54S			70.2311	-151.5553	54.218			
MT7-55N	296+83	67.9	70.2319	-151.5548	51.649	2	0.052	1.90
MT7-55S			70.2318	-151.5543	53.594			
MT7-56N	300+38	71.7	70.2328	-151.5536	54.435	2	0.052	1.90
MT7-56S			70.2327	-151.5531	52.445			
MT7-57N	305+96	84.1	70.2342	-151.5519	53.157	2	0.052	1.90
MT7-57S			70.2342	-151.5512	55.112			
MT7-58N	314+66	71.8	70.2364	-151.5488	58.247	2	0.052	1.90
MT7-58S			70.2363	-151.5484	58.404			
MT7-59N	320+54	63.9	70.2378	-151.5467	58.841	2	0.052	1.90
MT7-59S			70.2377	-151.5463	58.853			
MT7-60N	325+88	67.9	70.2389	-151.5437	51.297	2	0.052	1.90
MT7-60S			70.2387	-151.5433	51.427			
MT7-61N	328+82	69.9	70.2393	-151.5416	50.239	2	0.052	1.90
MT7-61S			70.2391	-151.5414	50.505			
MT7-62N	334+52	66.0	70.2402	-151.5378	50.876	2	0.052	1.90
MT7-62S			70.2400	-151.5375	53.522			
MT7-63N	341+20	75.8	70.2412	-151.5334	47.832	2	0.052	1.90
MT7-63S			70.2410	-151.5329	49.002			
MT7-64N	344+85	74.0	70.2418	-151.5311	48.322	2	0.052	1.90
MT7-64S			70.2417	-151.5307	48.996			
MT7-65N	349+75	63.9	70.2428	-151.5285	53.046	2	0.052	1.90
MT7-65S			70.2427	-151.5281	53.910			
MT7-66N	357+06	67.7	70.2444	-151.5249	54.281	2	0.052	1.90
MT7-66S			70.2443	-151.5244	54.583			
MT7-67N	362+88	75.7	70.2456	-151.5219	53.199	2	0.052	1.90
MT7-67S			70.2455	-151.5215	53.121			
MT7-68N	377+03	71.8	70.2486	-151.5148	46.917	2	0.052	1.90
MT7-68S			70.2485	-151.5144	48.819			
MT7-69N	381+62	70.0	70.2496	-151.5125	46.426	2	0.052	1.90
MT7-69S			70.2495	-151.5121	45.078			
MT7-70N	386+01	71.7	70.2506	-151.5103	43.019	2	0.052	1.90
MT7-70S			70.2504	-151.5099	42.461			
MT7-71N	389+31	77.8	70.2513	-151.5084	40.556	2	0.052	1.90
MT7-71S			70.2511	-151.5082	41.757			

Culvert	Station	Length (ft)	Latitude (NAD83)	Longitude (NAD83)	Invert Elevation (BPMSL)	Outside Diameter (ft)	Wall Thickness (ft)	Inside Diameter (ft)
MT7-72N	391+87	66.0	70.2517	-151.5069	40.988	2	0.052	1.90
MT7-72S			70.2516	-151.5066	41.995			
MT7-73N	393+93	66..0	70.2521	-151.5056	40.639	2	0.052	1.90
MT7-73S			70.2519	-151.5053	41.093			
MT7-74N	396+47	83.9	70.2526	-151.5040	40.034	2	0.052	1.90
MT7-74S			70.2523	-151.5039	41.350			
MT7-75N	399+96	68.0	70.2531	-151.5021	41.005	2	0.052	1.90
MT7-75S			70.2530	-151.5016	41.731			
MT7-76N	404+42	65.8	70.2540	-151.4993	42.898	2	0.052	1.90
MT7-76S			70.2538	-151.4990	43.357			
MT7-77N	411+47	71.9	70.2552	-151.4951	38.525	2	0.052	1.90
MT7-77S			70.2551	-151.4947	39.279			
MT7-78N	418+30	95.8	70.2565	-151.4906	39.210	3	0.083	2.83
MT7-78S			70.2562	-151.4907	39.129			
MT7-79N	424+62	69.8	70.2573	-151.4864	38.901	2	0.052	1.90
MT7-79S			70.2571	-151.4860	39.644			
MT7-80N	429+09	69.7	70.2578	-151.4830	39.947	2	0.052	1.90
MT7-80S			70.2576	-151.4828	40.794			

Appendix B Gage & Associated Vertical Control Locations

Monitoring Location	Gage ID	Gage Position Relative to Road	Gage Location		Associated Vertical Control	Vertical Control Location	
			Latitude (NAD83)	Longitude (NAD83)		Latitude (NAD83)	Longitude (NAD83)
S9	S9-A	downstream	70.2513	-151.5085	MT7-72N	70.2517	-151.5069
	S9-B	upstream	70.2510	-151.5082		70.2516	-151.5066
S10	S10-A	downstream	70.2419	-151.5313	MT7-64N	70.2418	-151.5310
	S10-B	upstream	70.2415	-151.5301		70.2416	-151.5306
S11	S11-A	downstream	70.2328	-151.5538	MT7-56N	70.2328	-151.5536
	S11-B	upstream	70.2326	-151.5524		70.2326	-151.5530
S12	S12-A	upstream	70.1974	-151.5940	MT7-31N	70.1974	-151.5938
	S12-B	downstream	70.1974	-151.5928		70.1974	-151.5933
S13	S13-A	downstream	70.1759	-151.6893	PBM-16	70.1751	-151.6883
	S13-B	upstream	70.1756	-151.6886			

Appendix C PT Setup, Testing & Processing Methods

PTs measure the absolute pressure of the atmosphere and water, allowing the depth of water above the sensor to be calculated. Resulting data yield a comprehensive record of the fluctuations in water levels. The reported pressure is the sum of the forces imparted by the water column and atmospheric conditions. Variations in local barometric pressure are taken into account, using two independent barometric pressure loggers: In-Situ BaroTROLL® and Solinst Barologger®. A correction of barometric pressure was obtained from the Barologger installed at the Colville River East Channel horizontal directionally drilled pipeline crossing. The PT sensors were surveyed during spring breakup setup to establish a vertical datum using local control.

All PTs were tested before field mobilization and configured using Win-Situ® LT 5.6.21.0 (for the Level TROLL 500s) or Solinst Levelogger® v4.0.3 (for the Solinst Leveloggers) software prior to placement in the field. Absolute pressure was set to zero.

PT-based water level values were determined by adding the calculated water depth and the surveyed sensor elevation. PTs have the potential to drift and can be affected by ice and sediment. Gage WSE readings were used to validate and adjust the data collected by the PTs. A standard conversion using the density of water at 0°C was used to calculate all water depths from adjusted gage pressures. Fluctuations in water temperature during the sampling period did not affect WSE calculations because of the limited range in temperature and observed water depths.

Appendix D Discharge Methods

Standard USGS velocity/area techniques (Bodhaine 1968) were used to measure depth of flow and velocity to determine discharge at each culvert experiencing flow. Depth of flow and velocity were measured on the downstream end of the culvert using a HACH FH950 electromagnetic velocity meter attached to a wading rod. The accuracy of the HACH meter is ± 2% of the reading, ± 0.05 ft/s between 0 ft/s and 10 ft/s, and ± 4% of the reading from between 10 ft/s and 16 ft/s.

Appendix E GMT2 Road Culvert Visual Observation Summary

Observation Date	Time	Culvert ID	Flow Conditions	Flow Direction	Notes
5/30/2020	09:10	MT7-80	Dry	-	-
5/30/2020	09:10	MT7-79	Dry	-	-
5/30/2020	09:20	MT7-78	Flowing	South to North	-
5/30/2020	09:20	MT7-77	Stagnant	-	Blocked by ice and snow in culvert
5/30/2020	09:25	MT7-76	Dry	-	-
5/30/2020	09:30	MT7-75	Flowing	South to North	-
5/30/2020	09:30	MT7-74	Stagnant	-	Blocked by ice and snow in culvert
5/30/2020	09:30	MT7-73	Dry	-	-
5/30/2020	09:35	MT7-72	Dry	-	-
5/30/2020	09:35	MT7-71	Flowing	South to North	S9.
5/30/2020	09:45	MT7-70	Stagnant	-	Blocked by ice road
5/30/2020	09:45	MT7-69	Stagnant	-	Partially blocked by snow
5/30/2020	09:45	MT7-68	Stagnant	-	Partially blocked by snow
5/30/2020	09:45	MT7-67	Stagnant	-	Blocked by ice and snow in culvert
5/30/2020	09:45	MT7-66	Dry	-	-
5/30/2020	09:45	MT7-65	Dry	-	Ponded meltwater between MT7 66-65 on south side
5/30/2020	09:50	MT7-64	Stagnant	-	Blocked by ice and snow in culvert. Large pond upstream. S10.
5/30/2020	10:00	MT7-63	Flowing	South to North	Cap removed
5/30/2020	10:05	MT7-62	Dry	-	-
5/30/2020	10:10	MT7-61	Flowing	South to North	-
5/30/2020	10:15	MT7-60	Stagnant	-	Blocked by ice road
5/30/2020	10:15	MT7-59	Dry	-	-
5/30/2020	10:15	MT7-58	Stagnant	-	Blocked by ice and snow in culvert. Minimal ponding
5/30/2020	10:20	MT7-57	Flowing	-	-
5/30/2020	10:25	MT7-56	Stagnant	-	Blocked by ice and snow in culvert. Large pond upstream. S11.
5/30/2020	10:30	MT7-55	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	10:30	MT7-54	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	10:45	MT7-53	Flowing	South to North	Culvert buried by snow, could not measure discharge.
5/30/2020	10:45	MT7-52	Flowing	South to North	-
5/30/2020	10:45	MT7-51	Flowing	South to North	-
5/30/2020	10:45	MT7-50	Flowing	South to North	-
5/30/2020	10:50	MT7-49	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	10:55	MT7-48	Stagnant	-	Blocked by ice road
5/30/2020	10:55	MT7-47	Stagnant	-	Equalized, some snow burial
5/30/2020	10:55	MT7-46	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	10:55	MT7-45	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	10:55	MT7-44	Flowing	South to North	-
5/30/2020	11:00	MT7-43	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	11:00	MT7-42	Flowing	-	Questionable
5/30/2020	11:05	MT7-41	Stagnant	-	Equalized
5/30/2020	11:05	MT7-40	Dry	-	-
5/30/2020	11:05	MT7-39	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	11:05	MT7-38	Stagnant	-	Equalized
5/30/2020	11:05	MT7-37	Flowing	-	Nearly equalized
5/30/2020	11:05	MT7-36	Stagnant	-	Blocked by snow and ice burying culvert
5/30/2020	11:05	MT7-35	Flowing	Questionable	Nearly equalized
5/30/2020	11:05	MT7-34	Stagnant	-	Nearly equalized through culvert 35.
5/30/2020	11:05	MT7-33	Stagnant	-	Blocked by snow and ice burying culvert
5/30/2020	11:05	MT7-32	Stagnant	-	Blocked by snow and ice burying culvert
5/30/2020	11:05	MT7-31	Stagnant	-	Blocked by ice and snow in culvert. Pond on north side of road

Observation Date	Time	Culvert ID	Flow Conditions	Flow Direction	Notes
5/30/2020	11:05	MT7-30	Stagnant	-	Blocked by ice and snow in culvert. Pond on north side of road
5/30/2020	11:10	MT7-29	Stagnant	-	Blocked by ice and snow burying culvert
5/30/2020	11:10	MT7-28	Stagnant	-	Blocked by ice and snow burying culvert
5/30/2020	11:15	MT7-27	Flowing	North to South	-
5/30/2020	11:15	MT7-26	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	11:20	MT7-25	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	11:20	MT7-24	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	11:20	MT7-23	Dry	-	-
5/30/2020	11:20	MT7-22	Flowing	North to South	-
5/30/2020	11:25	MT7-21	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	11:25	MT7-20	Dry	-	-
5/30/2020	16:30	MT7-19	Dry	-	Minor ponding between culvers 19 and 20 north side
5/30/2020	11:30	MT7-18	Dry	-	-
5/30/2020	11:30	MT7-17	Dry	-	-
5/30/2020	11:30	MT7-16	Dry	-	-
5/30/2020	11:30	MT7-15	Dry	-	-
5/30/2020	11:35	MT7-14	Dry	-	-
5/30/2020	11:35	MT7-13	Dry	-	Equalized
5/30/2020	11:40	MT7-12	Flowing	North to South	-
5/30/2020	11:40	MT7-11	Dry	-	-
5/30/2020	11:40	MT7-09	Dry	-	-
5/30/2020	11:40	MT7-08	Dry	-	-
5/30/2020	11:40	MT7-07	Dry	-	Near ice road intersection
5/30/2020	11:45	MT7-06	Dry	-	-
5/30/2020	12:00	MT7-05	Flowing	South to North	-
5/30/2020	12:00	MT7-04	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	12:10	MT7-03	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	12:15	MT7-02	Stagnant	-	Blocked by ice and snow in culvert.
5/30/2020	12:15	MT7-01	Dry	-	-

Appendix F Monitoring Location Photos

F.1 S9 Monitoring Location

Photo F.1: Meltwater accumulation near S9, looking northeast; May 26, 2020

Photo F.2: Flow through culvert MT7-71, looking north; May 30, 2020

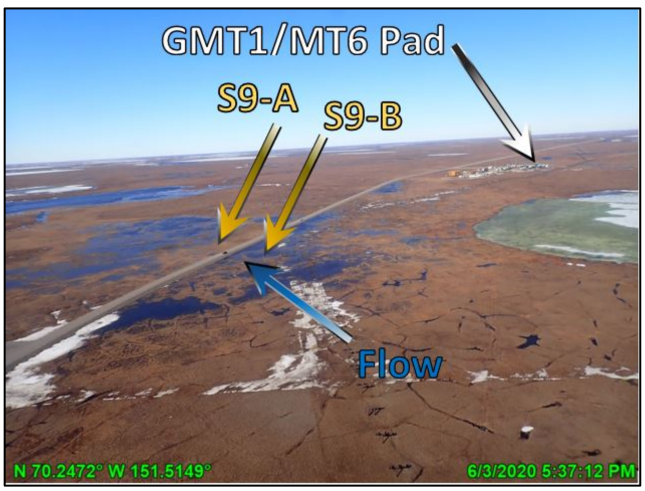

Photo F.3: Meltwater equalizing near S9, looking northeast; June 3, 2020

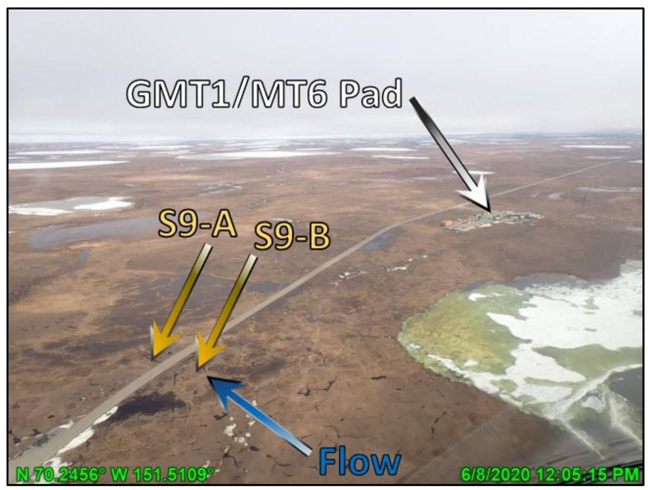

Photo F.4: Hydraulic equalization near S9, looking northeast, June 8, 2020

F.2 S10 Monitoring Location

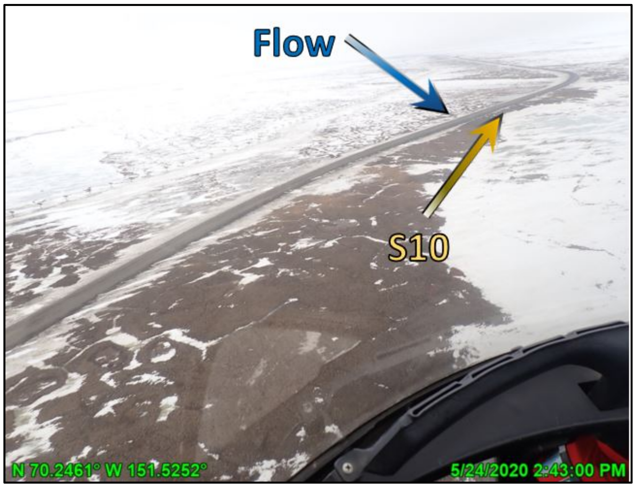

Photo F.5: Local melt near S10, looking southwest; May 24, 2020

Photo F.6: Increasing meltwater on the upstream (south) side of road, looking northeast; May 26, 2020

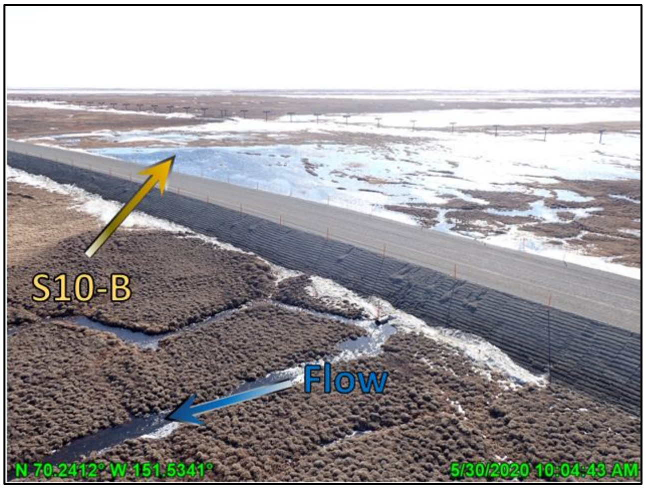

Photo F.7: Flow through culvert MT7-63, looking southeast; May 30, 2020

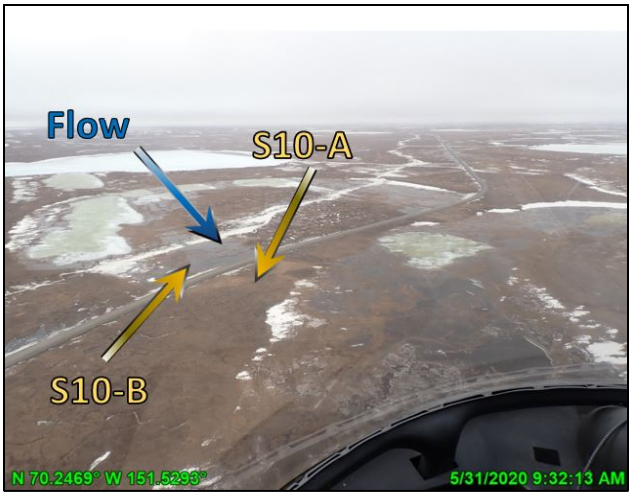

Photo F.8: Receding stage near S10, looking southwest; May 31, 2020

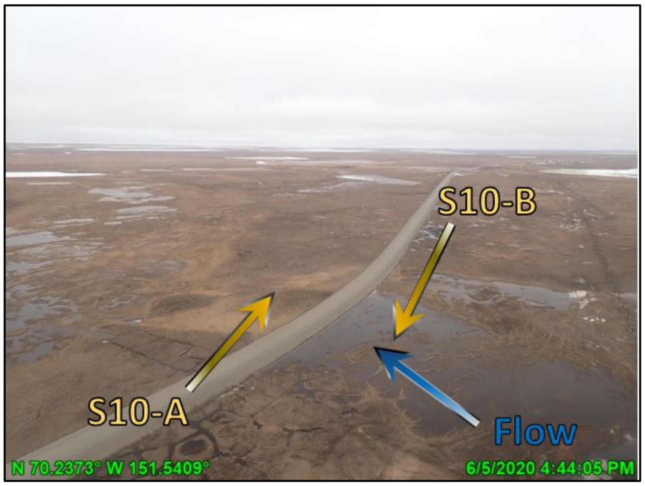

Photo F.9: Impounding behind blocked culvert MT7-64, looking northeast; June 5, 2050

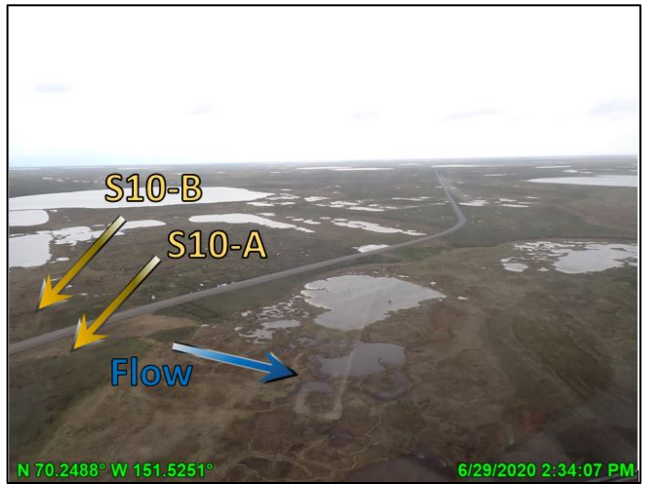

Photo F.10: Equalized conditions near S10, looking south; June 29, 2020

F.3 S11 Monitoring Location

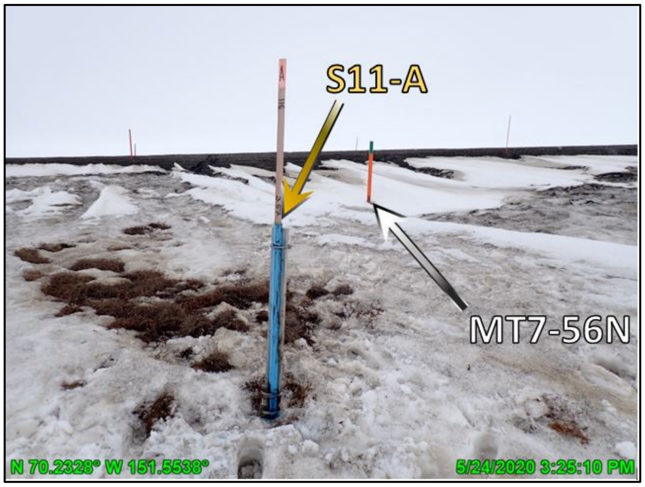

Photo F.11: Local melt and saturated snow at S11-A, looking south; May 24, 2020

Photo F.12: Ponding near S11, looking northeast; May 26, 2020

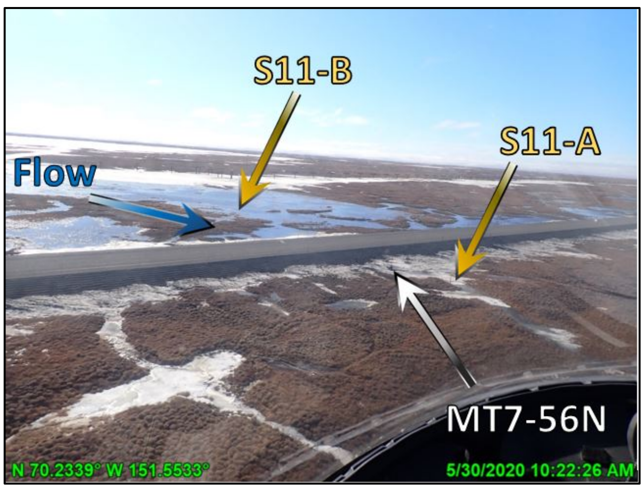

Photo F.13: Meltwater behind blocked culvert MT7-56, looking south; May 30, 2020

Photo F.14: Equalized conditions near S11, looking south; June 3, 2020

F.4 S12 Monitoring Location

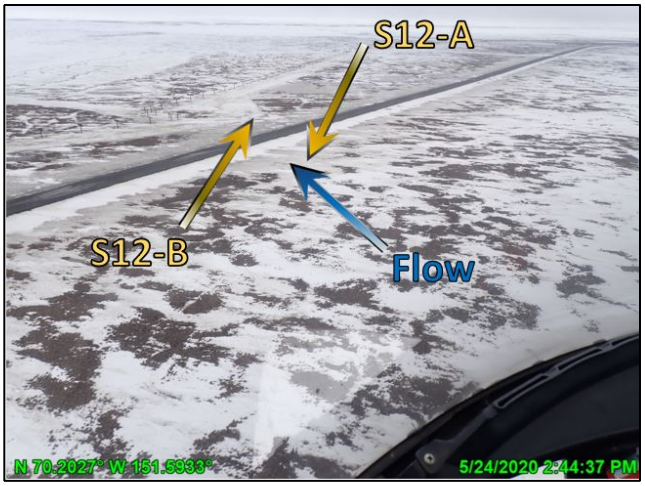

Photo F.15: Local melt near S12, looking southwest; May 24, 2020

Photo F.16: Ponded water on the upstream side of the road near S12, looking southwest; May 30, 2020

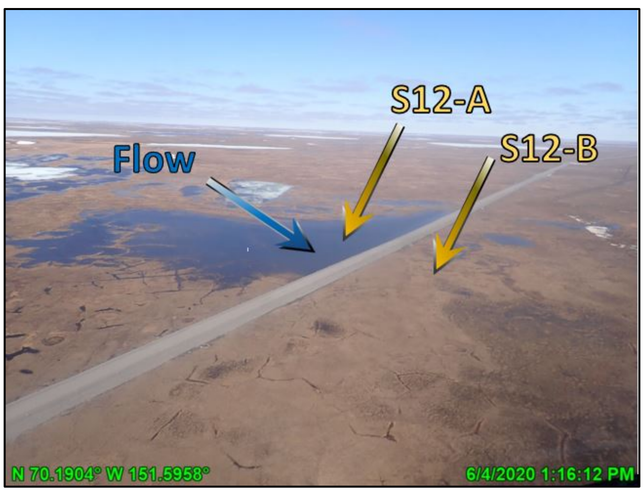

Photo F.17: Ponding near S12 behind blocked culverts, looking east; June 4, 2020

Photo F.18: Sloughed gravel near culvert MT7-31 and S12, looking west; July 2, 2020

Photo F.19: Culvert MT7-31 after sloughed gravel replaced on embankment; July, 2020

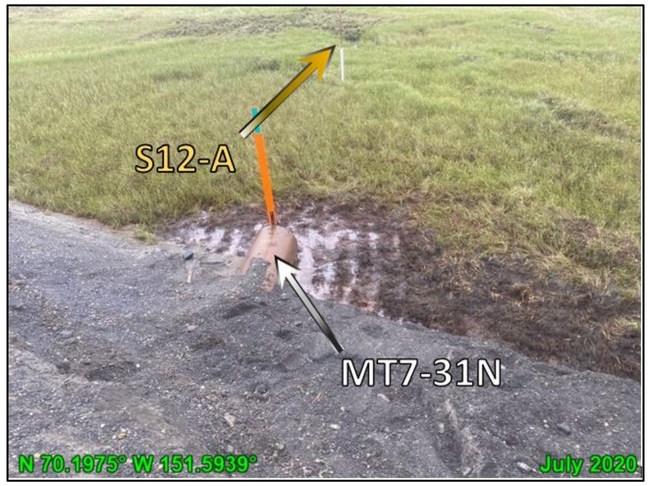

Photo F.20: Culvert MT7-31 after soughed gravel replaced on embankment; July, 2020

F.5 S13 Monitoring Location

Photo F.21: Local meltwater around S13, looking south; May 24, 2020

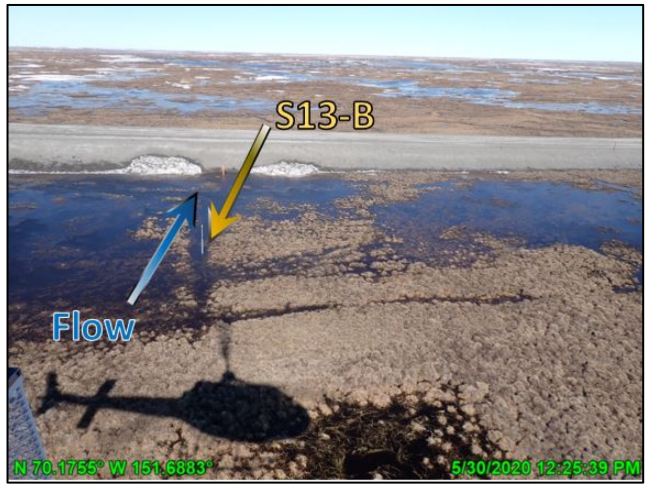

Photo F.22: Ponding near S13 along the south embankment, looking north; May 30, 2020

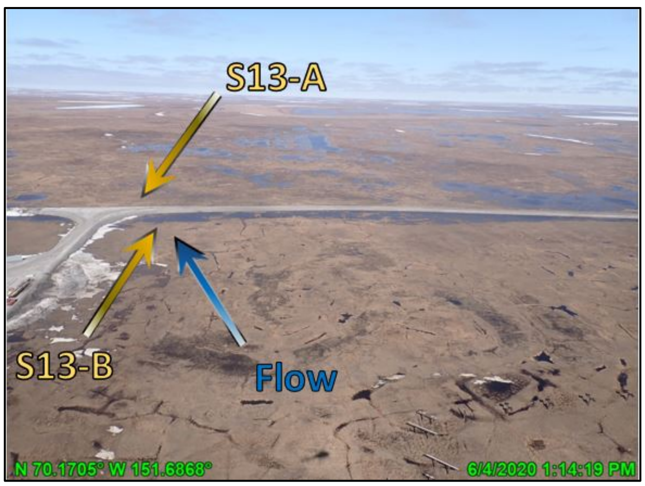

Photo F.23: Receding stage near S13, looking north; June 4, 2020