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Teck Tailings Main Dam Team
Teck Alaska Incorporated
Red Dog Operations
3105 Lakeshore Drive
Building A, Suite 101
Anchorage, AK 99517

2018 ANNUAL PERFORMANCE REPORT FOR TAILINGS MAIN DAM, RED DOG MINE, ALASKA

Golder Associates Inc. (Golder) is pleased to submit to Teck Alaska Incorporated (Teck) the 2018 Annual Performance Report (APR) for the Tailings Main Dam (TMD) at Red Dog Mine in Northwest Alaska. The Red Dog Mine, a lead-zinc production mine, is located approximately 90 miles north of Kotzebue, Alaska in the Northwest Arctic Borough. Figure 1 presents the project location and site overview. This work was performed in general accordance with our proposal dated February 13, 2018.

1.0 INTRODUCTION AND BACKGROUND

The TMD is composed of the Embankment and Wing Wall. The TMD Embankment forms the northern barrier of the Tailings Impoundment (tailings pond) across the South Fork of the Red Dog Creek, while the Wing Wall makes up the northeastern barrier, as seen in Figures 2 and 3. A Seepage Collection Pond (SCP) and associated rock drain and pumping chambers located along the downstream toe of the TMD Embankment works in conjunction with a tailings beach to minimize potential seepage out of the tailings pond. The SCP is located on the upstream side of the Seepage Collection Dam and at the outlet of an underdrain constructed along the historic creek alignment within the TMD Embankment (see Figure 2). Sections through the TMD Embankment and Wing Wall are shown in Figures 4 and 5.

The dam raise history including year(s) of construction, crest elevation, crest width, crest length, and type of liner-bedrock tie-in is summarized in Table 1. The TMD is mainly a zoned gravel and rockfill embankment with an upstream 100-mil high density polyethylene (HDPE) geomembrane liner that lies over or is tied into bedrock. The dam embankment generally has 2.5 horizontal to 1 vertical (2.5H:1V) upstream and downstream slopes. The majority of fill materials (Types 1 through 7) are composed of processed better-quality shales borrowed from the DD2 Quarry and Type 9 fill that was sourced from mine waste. The TMD Embankment also includes poorer quality Kivalina Waste Fill (Type 8) and Select Shale fill materials that were not used at the Wing Wall. A summary of these construction materials and the construction stages they were used is presented in Table 2. Soil Type 9, which was used as a protective buttress upstream of the geomembrane liner, was discontinued after Stage VIII because it is understood to act as a conduit that allows direct access for impounded water into and under the Stage I cutoff trench, which was the only stage not keyed into bedrock.

Table 1: Dam Raise History [2016a APR by AECOM]

Dam Stage	Year(s) Constructed	Crest El. (feet)	Crest Width (feet)	Crest Length (feet)	HDPE Liner-Bedrock Tie-in
Stage I	1988	865	42	1,088	Cutoff trench
Stage II	1989	890		1,352	Cutoff wall
Stage III	1990	910		1,776	Cutoff wall
Stage IV	1991	925		1,917	Cutoff wall
Stage V	1993	940		2,175	Cutoff wall
Stage VI	1993	950	52	2,427	Cutoff wall
Stage VII-A	2003 to 2005	955		2,550	Cutoff wall
Stage VII-B	2005 to 2007	960		3,457	Cutoff wall and Curtain Wall (Membrane)
Stage VIII	2008 to 2011	970		4,076	Cutoff wall and Curtain Wall (Slurry)
Stage IX	2012 to 2013	976	52 / 32 *	4,983	Cutoff wall and Curtain Wall (Slurry)
Stage X	2015 to 2016	986	34 / 20 *	5,594	Cutoff wall and Curtain Wall (Slurry)

* These values represent the Embankment / Wing Wall crest widths respectively

The TMD Embankment Stage I Starter Dam is generally founded on slightly to moderately weathered shale bedrock. However, most of the future stages (Stages II to VIII) are founded on native alluvial and colluvial soils after most of the organic materials were stripped. Some organic soils remain under the Kivalina Waste Fill downstream of the Stage I Starter Dam, which was not removed during the later stages. Subgrade preparation for the Stage IX and X raises included removal of all native materials below the expanded fill footprint (URS 2013, AECOM 2016b). The Stage X raise construction also included a shear key and a buttress with a 2H:1V downstream slope to improve stability. Permafrost below the TMD Embankment is typically below the native soils and within the bedrock near the embankment abutments, but permafrost has thawed completely below the underdrain and the historic creek channel.

The Wing Wall embankment is founded on mine development fill materials as well as the native soils (including the organic layer) that overly bedrock. These native soils were partially excavated for the Stage IX widening (URS 2013) and fully excavated for the Stage X extension (AECOM 2016b). Permafrost is understood to be typically thawed below the native soils on the upstream side of the embankment, but still lies within the native soils on the downstream side.

Table - 2: Construction Materials Used

Material ID	Description	Stages
Type 1	Random Rockfill: 24-inch minus	Stages II to X
Type 2	Rockfill: 24-inch minus	Stage I (Starter Dam)
Type 3	Processed Select: 3-inch minus	Stages I to VII
	Processed Select: 1.5-inch minus	Stages VIII to X
Type 4	Processed Select: 1-inch minus	Stages I to VII
	Processed Select: 3/8-inch minus	Stages VIII to X
Type 5	Rock Drain and Riprap	Stage II
Type 6	Random Rockfill: 12-inch minus	Stage II
Type 7	Transition Rockfill: 12-inch minus	Stages I to X
Type 8	Kivalina Waste Fill	Stages I to IV
Type 9	Random Mine Waste Fill: 24-inch minus	Stages I to VIII
Select Shale	Type 1 Rockfill composed of Okpikruak Shale and Kivalina Shale	Stages VI and VII
Geomembrane	100-mil HDPE Liner	Stages I to X
Geotextile	16 oz/yd^2 Non-Woven, placed between Soil Types 3 and 4	Stages I to VII and X
	10 oz/yd^2 Non-Woven, placed between Soil Types 3 and 7	Stages I to VII
Cutoff Trench	About 15 feet deep and backfilled with Type 9	Stage I (Starter Dam)
Cutoff Wall	At least 4 feet deep and backfilled with Concrete or Plastic Concrete	Stage II to X
Curtain Wall	Vertical HDPE Geomembrane (GSE Panels) backfilled with Controlled Density Fill	Stage VIIB
	Slurry Wall composed of Soil-Clay Slurry with Soil-Slag-Cement-Clay Cap	Stages VIII to X

The performance of the TMD is monitored through a system of instruments, surveys, and visual inspections. The instruments used at the TMD are:

- ShapeAccelArray Inclinometers (SAAs) inclinometers on the downstream embankment that measure and record displacements. – 3 SAAs
- Vibrating wire piezometers (VWPs) that measure and record total pressure head and provide water elevations. – 38 formally monitored and 28 other VWPs
- Flowmeters that record the volume of water pumped into the TSF from the Seepage Collection System.
- Thermistor string arrays (thermistors) that measure subsurface ground temperatures and provide information on changes to the permafrost regime. – 5 thermistor strings
- Accelerographs that record seismic data. – 2 accelerographs
- Turbidity sensors that estimate the Total Suspended Solids (TSS) contained within the seepage water. – 2 turbidity sensors

The locations of the SAA's, VWPs, and thermistors are shown in Figures 2 and 3. The monitoring systems are discussed further in Section 3.0.

2.0 FIELD INSPECTION

The field inspection for the TMD was conducted on June 22, 2018, by Golder employees Steven L. Anderson, PE, the designated Engineer of Record (EoR) for the TMD, and Matt Ryans, PE. Golder was accompanied by Teck employees Aaron Sangha and Tanna DeRuyter. During the field inspection the weather was partly to mostly cloudy with no precipitation, and the temperature was about 60˚F. Similar weather preceded the field inspection. During the inspection, the Alaska Department of Natural Resources (ADNR) Visual Inspection Checklist was filled out and is included in Appendix A. Selected photographs taken during the site visit are included in Appendix B and Figure 6.

Highlights from the field inspection are summarized below:

- The tailings pond elevation during the site visit was approximately 974 feet, and the tailings beach was visually estimated to be approximately 500 feet wide from the upstream face of the TMD.
- The upstream and downstream slopes of the TMD Embankment and Wing Wall appeared to be stable with no signs of slumping, seeps, or lateral movements. Lateral cracking was observed along the Wing Wall crest near Station 35+30, as shown in Figure 6 and Photo 10, Appendix B. The crack was about a maximum of ¾ inches wide and less than 6 inches deep based on visual inspection. No signs of distress or instability were noted in the upstream liner or on the downstream slope near the crack. Similar lateral cracking has historically been observed in this area as shown in Figure 6, and they were typically marked with paint and had been surveyed. One such paint-marked lateral crack was observed near Station 51+30 (Figure 6 and Photo 15) that had not been surveyed. These historical lateral cracks were typically very small and seemed to have healed since initially observed based on discussion with Teck. A borehole was drilled at one of these crack locations near Station 35+70, where we observed some subsidence of the annulus backfill materials (Figure 6 and Photo 12). This lateral cracking is thought to be related to thaw consolidation of ice-rich native soils. The lateral nature of the cracks may be related to the orientation and variable ice content of ice-rich

zones that are not uniform within the foundation and induce differential settlements when thawed. Longitudinal cracking was observed at the Wing Wall crest near Station 55+50, but it was along the geomembrane anchor trench and attributed to movements of the liner; therefore, it was not related to instability or movements of the embankment fill.

- The exposed upstream liner generally appeared to be in good condition, except for some liner damage observed near Station 11+80 (see Figure 6 and Photos 5 and 6). Teck was aware of this damage and informed us that it occurred last winter from an excavator during manipulation of the tailings discharge pipeline. Teck had already scheduled the repairs and we understand they have been completed before publication of this report. Teck is working to improve procedures during tailings pipeline manipulation to limit or prevent future damage to the upstream geomembrane liner.
- Longitudinal cracking was observed along the upstream toe of the Stage X Wing Wall extension, from about Station 53+20 to 58+50, as shown in Figure 6 and Photos 16 and 17. The cracking appears to be where the geomembrane liner was connected into the slurry trench. Based on discussions with Teck, we understand that the soil-slag cement-clay (SSC) cap that was used at the top of the slurry trench did not meet the specified strength requirements. This cracking could be related to movement of the liner following backfill if the liner was not in intimate contact with the subgrade, or possibly consolidation of the SSC cap. We recommend carefully exposing the liner and examining the SSC cap in several locations before placing additional fill materials in this area.
- The downstream abutments of the TMD Embankment were observed and we did not see any signs of instability or seepage (see Photos 19 to 22, Appendix B). We also did not observe any signs of instability for the TMD Embankment buttress, such as cracking, slumps, or indications of lateral movement.
- The SCP was at an elevation of about 789 feet and two of the three pumps were operating during our inspection. These pumps were operating at a combined pumping rate of about 600 gallons per minute (gpm). Some iron staining was observed near the toe of the buttress and around the SCP (see Photos 25 to 27). We understand this iron staining near the buttress toe is related to the rock drain repairs that occurred in 2013 to mitigate formation of ferricrete within the underdrain. We also noted a seep entering the SCP that appeared to be near where the underdrain connects into it (Photo 27).
- The Seepage Collection Dam appeared to be in satisfactory condition with no indications of instability (see Photos 26 and 28). The Seepage Seepage Pumpback located downstream of the Seepage Collection Dam was also observed and did not appear to be actively pumping at that time.

3.0 REVIEW OF MONITORING DATA AND INSPECTIONS

The monitoring data that was reviewed as part of this APR included weekly and quarterly inspection reports, horizontal displacements from SAA inclinometers, air temperature and precipitation data, seepage pumpback flowmeter data, groundwater monitoring data from VWPs, and ground temperature from thermistors. Turbidity monitoring is under development and no accelerograph data was provided for this APR. Instrumentation data reviewed for this APR generally included data collected between January 2015 and May 2018, including the data in the 2017 Annual Instrumentation Report (Teck 2018). An extended time period was reviewed for the ground temperature readings. This monitoring data was collected as described in the latest Operations and Maintenance (O&M) Manual for the TMD (AECOM 2016c).

3.1 Inspections and Periodic Performance Assessments

As required in the O&M Manual, Teck completes daily, weekly, and quarterly inspections of the TMD. Golder generally reviewed only the weekly and quarterly inspections performed by Teck between the dates of January 2017 and May 2018.

3.1.1 Weekly and Quarterly Inspection Reports

The visual inspection reports provide a means to monitor and record the air temperature, weather conditions, snow cover, wave action, ponded water condition, and stability condition of the TMD, including signs of cracks, slumps, and seepage. The inspection reports provided for review included 69 Visual Tailings (Main) Dam and Seepage Dam Inspection reports from January 7, 2017 to May 21, 2018. Quarterly reports for 2017 and the first quarter of 2018 were also reviewed. On five occasions, weekly inspection reports were missing.

Based on our review, the weekly and quarterly visual inspections have been performed as described in the O&M Manual. The dam slopes, crest, and buttresses could not be observed over the winter when they were obscured by snow. Highlights identified over the review period include:

- March 09 and April 13, 2017: SCP was noted as being open and having high water. This may be related to the unusual occurrence in January 2017 involving an unseasonal increase in seepage pumpback rates possibly related to flows from the mine water diversion discharge coming into contact with the Type 9 fill overlying the upstream geomembrane liner. The event is described in Section 4.0 and is from now on referred to as the January 2017 unusual occurrence.

- June 04, 2017: Lateral crack was observed on the Wing Wall near the Powerhouse along with some additional cracking not identified. This crack, along with other historical cracks, was observed during the 2018 Golder field inspection (see Section 2.0).

- August to October 2017: A slump on the downstream slope of the Seepage Collection Dam was initially noted on the weekly inspection report dated August 24, 2017 and later described on August 30, 2017. On October 11, 2017, the weekly inspection identified and described a slump on the upstream slope of the Seepage Collection Dam. The same slump was also noted on October 18, 2017. These slumps were not noted during the 2018 Golder field inspection.

- September 25, 2017: Flow from the underdrain was noted flowing into the SCP. This flow was observed during the 2018 Golder field inspection.

- May 02 and 09, 2018: Tear was observed on exposed geomembrane liner on the upstream side of the TMD. This was observed during the 2018 Golder field inspection and was documented by Teck.

- May 21, 2018: Ponding on the west side of the tailings pond was observed as a result of a tailings deposition pipe that failed in January 2018.

3.2 Horizontal Movement Monitoring –SAA Inclinometers

The three SAA inclinometers installed on the downstream slope of TMD Embankment record horizontal displacements that are measured with respect to baseline readings taken in September 2014 for INC-01-13 and INC-02-13 and in August 2014 for INC-03-14. A data logger connected to the SAA inclinometer collects a daily reading at midnight. The SAA inclinometer data is periodically uploaded to the Red Dog intranet and is accessible from the computers in the mine offices. The raw SAA inclinometer readings data are processed and presented according to the procedure described in the O&M Manual.

SAA inclinometer data is presented in Figures C-1 through C-3 (Appendix C) for INC-01-13, INC-02-13, and INC-03-14, respectively. These figures present the cumulative magnitude of displacement with depth, the cumulative magnitude of displacement over time presented at the elevation in which the greatest displacement has occurred, and direction of movement with respect to grid-north. A review of the SAA inclinometer data is summarized below with maximum cumulative displacements also depicted in Figure 2.

- **INC-01-13:** As shown in Figure C-1, INC-01-13 has recorded a cumulative maximum horizontal displacement of approximately 1.0 inches at an elevation of about 809 feet (since the September 2014 baseline). The cumulative displacement has exceeded the 1.0-inch threshold as given in the O&M Manual; however, the majority of this movement (about 0.9 inches) coincides with the Stage X Raise and shear key/buttress construction, and displacements have stabilized after that construction. Due to the movement pivot point occurring near the interface of the native soil and highly weathered shale and the relative lack of displacement since the Stage X Raise construction was completed, this movement is understood to be related to deflections of the instrument casing from the construction activity rather than development of strains occurring within the native soil. The cumulative displacement is in the downstream direction (approximately north-northwest), and the average annual rate of cumulative displacement is about 0.27 inches per year. Discarding the movements related to the Stage X Raise construction, cumulative displacement is within the accuracy of the instrument. The SAA inclinometer monitoring data indicates the cumulative displacements and movement rates and are within the acceptable limits prescribed in the O&M Manual.
- **INC-02-13**: As shown in Figure C-2, INC-02-13 has recorded a cumulative maximum horizontal displacement of approximately 0.26 inches at an elevation of about 822 feet (since the September 2014 baseline). The cumulative displacement direction is primarily to the west, parallel to the dam crest. This displacement direction appears unusual as movement would be expected to be in the downstream direction. This unusual movement may be related to twisting of the instrument during the Stage X Raise construction. Given that the instrument tolerance is about 0.08 inches and the potential disturbance related to construction, this unusual movement direction is not a concern. The average annual rate of cumulative displacement is about 0.07 inches per year. The SAA inclinometer monitoring data indicates the cumulative displacements and movement rates and are within the acceptable limits prescribed in the O&M Manual.
- **INC-03-14:** As shown in Figure C-3, INC-03-14 has recorded a cumulative maximum horizontal displacement of approximately 0.15 inches at an elevation of about 734 feet (since the August 2014 baseline). The cumulative direction of movement is approximately to the east-southeast, in the upstream direction. This displacement direction appears unusual as movement in the downstream direction would be expected, and it may be related to misalignment of the instrument during installation. Movements in the east-west direction appear to have occurred during the 2016 buttress construction. Since the size of the movement is similar to the accuracy of the instrument, this unusual movement direction is not a concern. The average annual rate of cumulative displacement is about 0.05 inches per year. The SAA inclinometer monitoring data indicates the cumulative displacements and movement rates and are within the acceptable limits prescribed in the O&M Manual.

3.3 Vibrating Wire Piezometers

There are 66 VWPs identified in the data files and documents provided to Golder from Teck for this APR. This includes 38 VWPs that are required to be monitored under the O&M Manual and an additional 28 VWPs that provide supplementary data but are not formally monitored. Raw data from the VWPs are collected with dataloggers, most of which are on a wireless data collection system (GeoExplorer by NavStar) that can be monitored in real time by Teck in the mine offices. Teck is currently in the process of upgrading all piezometers to the GeoExplorer system. VWPs not on the GeoExplorer system will remain on manually read dataloggers until they are upgraded.

The O&M Manual catalogs 38 piezometers that are classified as either "critical" or "non-critical." Generally, "critical" piezometers have an associated trigger elevation, whereas all others do not. As per the O&M Manual, the 38 piezometers are subdivided into six groups:

1) Critical Underdrain Piezometers (5 VWPs)
2) Critical Near Underdrain Piezometer (10 VWPs)
3) Critical Downstream Shell Piezometers (6 VWPs)
4) Noncritical Piezometers Beneath Tailings Main Dam (5 VWPs)
5) Noncritical piezometers near Wing Wall (10 VWPs)
6) Seepage Collection Dam Piezometers (2 VWPs)

The O&M Manual and the 2017 Annual Instrumentation Report contain further details of each VWP, such as the embedment elevation, target embedment material, trigger elevation (if applicable), historical minimums and maximums, and the name of the borehole drilled for the installation.

The following sections summarize the significant findings of Golder's review of VWP data, generally collected between January 2015 and May 2018. Overall none of the critical piezometers exceeded their trigger elevation. Significant gaps in data were noted but are typically the result of system upgrades or construction activities and are not of concern. Plots of water elevations, precipitation, and seepage pumpback rates are shown in Figures D-1 through D-6 (Appendix D).

3.3.1 Critical Underdrain Piezometer Analysis

Five VWPs are identified in the O&M Manual as being located in the underdrain. A plot of VWP data is shown in Figure D-1, and a summary of significant findings of the analysis is below:

- Generally, the VWPs showed a decreasing piezometric level from upstream to downstream with typically increased levels during the spring freshet, heavy precipitation events, and when the tailings beach width (distance from the lined dam face) was smaller. As anticipated, higher piezometric levels correspond to the higher flow rates. Piezometers P-8A and P-16-151A were near the same elevation during the 2018 freshet, and it is speculated this is due to the influence of abutment flows from the downstream side of the liner following the Stage X construction, which likely impacted groundwater flows.
- P-05-62 showed an increase in water elevation of about 8.5 feet between June 9 and 10, 2016. This change was later attributed to the instrument being improperly replaced after removal for environmental water

sampling. A similar event occurred on September 23, 2015 and is also attributed to improper replacement of the instrument. In August 2018 Teck rectified this issue by determining the location of the phreatic surface with a water tape and adjusting the tip elevation accordingly. Figure D-1 shows the rectified water elevation for this piezometer.

- P-06-74, P-08A, and P-16-151A have exceeded the rapid rise trigger level (rise of 4 vertical feet per week) for the review period. Typically, the exceedance was related to the freshet, intense precipitation, or the January 2017 unusual occurrence. Rapid rises have also occurred in the fall when the tailings pond level begins to rise; however, this variability appears to be reduced over the last year and is likely related to improved tailings beach production.
- The O&M Manual prescribes monitoring the hydraulic gradients between four of the critical underdrain VWPs to evaluate the likelihood of soil particle migration (erosion). Horizontal distances between instruments are provided in the O&M Manual and the calculated hydraulic gradients are compared to the assigned critical (trigger) hydraulic gradient of 0.17. All of the gradients remained under the trigger level for the review period.

3.3.2 Critical Near Underdrain Piezometer Analysis

There are 10 VWPs located in the general vicinity of the underdrain. A plot of this VWP data is shown in Figure D-2 and a summary of significant findings from the data review are listed below.

- P-16-145B (identified in the O&M Manual as “P-16-145C”) exceeded the rapid rise trigger first in December 2016 after a period of no response that could be the result of instrument not being fully saturated. An exceedance was observed again in February 2017 in response to the January 2017 unusual occurrence and again during the freshets. Exceedances from October 2017 through January 2018 are attributed to rises in the impoundment level. The rapid decline in water elevation immediately after installation is likely from the pressure being influenced by grouting or an unsaturated pore stone.
- P-16-146B is improperly identified in the O&M Manual as “P-16-146D.” Piezometer P-16-146B is non-operational and does not respond to the changes in water elevation as observed by the other VWPs in the same borehole. This instrument is likely damaged.
- P-08B, P-14-131, and P-14-134 exceeded the rapid rise trigger during January 2017 unusual occurrence.
- P-97-20 has only exceeded the rapid rise trigger during intense precipitation events in the summer of 2016 and 2017.
- P-16-151B only exceeded the rapid rise trigger during the January 2017 unusual occurrence and during the freshet in 2018.
- P-97-28 exceeded the rapid rise trigger during the freshet in 2017 and 2018.

3.3.3 Critical Downstream Shell Piezometers Analysis

Six VWPs are located in the downstream shell area below the dam crest. A plot of this VWP data is shown in Figure D-3 and significant findings from our data review are summarized below.

- P-14-129A and P-05-69 appear to be essentially dry with piezometric levels measured near their tip elevation.

- P-97-29 and P-97-30 have only recently exceeded the rapid rise trigger during the most recent freshet. It is noted that although the maximum water elevations remain the same as in previous years, the water elevations before the freshet were lower this year.

3.3.4 Noncritical Crest Piezometers beneath Tailings Main Dam Analysis

There are five VWPs at four locations beneath the crest of the TMD. A plot of their VWP data is shown in Figure D-4 and a summary of significant findings from our review are listed below.

- P-11 did not have much response to changes in seepage pumpback rates until after the January 2017 unusual occurrence. It was also noted as exceeding the rapid rise trigger during the freshet in 2017 and 2018.
- P-12A shows little response with a range of about 2 feet between the minimum and maximum water elevations, but it is not dry as the measured elevation is higher than the instrument tip elevation.
- P-12B was the only VWP to indicate a response to the January 2017 unusual occurrence and exceeded the rapid rise trigger at the start of the event and then at the beginning of the freshet.
- P-13 shows small responses to changes in seepage pumpback rates.
- P-14A is improperly identified in O&M Manual as “P-14,” and shows little response with a range of about 2 feet between the minimum and maximum water elevations. This piezometer does not appear to be dry as the measured elevation is higher than the instrument tip elevation.

3.3.5 Noncritical Piezometers near Wing Wall Analysis

There are 10 VWPs located in the Wing Wall area. VWPs P-05-65, CPT-16-13A, and CPT-19-13A are located within the impoundment and the others are located downstream of the Wing Wall. A plot of VWP data is shown in Figure D-5 and the significant findings from our review are summarized below.

- CPT-16-13A stopped working in October 2016. It was temporarily disconnected to permit construction, but an attempt to reconnect it was unsuccessful.
- CPT-19-13A generally exceeded the rapid rise trigger during the freshet, precipitation events, and the January 2017 unusual occurrence. It was considered a suitable replacement for CPT-16-13A until it became non-operation in November 2017.
- P-05-65 became non-operational in January of 2018 when the communication cable was severed at the collar.
- P-05-63 generally exceeded the rapid rise trigger during the freshet, precipitation events, and the January 2017 unusual occurrence. The VWP is located downstream of the Wing Wall but occasionally has similar changes in elevations as P-05-65, which is located in the impoundment.
- P-16-148A&B, P-16-149A&B, and P-16-150 appear to be installed within permafrost.

3.3.6 Seepage Collection Dam Piezometers

Two VWPs are located within or downstream of the Seepage Collection Dam. A plot of VWP data is shown in Figure D-6 and there were no significant findings from the analysis. The two VWPs do not show any deviation from historical records.

3.3.7 Additional Piezometers

Five additional VWPs were installed at P-16-145 and P-16-146 that provide supplementary data but are not formally monitored. Twenty-three cone penetration test (CPT) VWPs, at eight locations, are located within the TSF. The VWPs were installed in 2013 during a CPT program performed by URS. Data from these additional piezometers are shown in Figure D-7.

3.4 Air Temperature, Precipitation, Tailings Pond Elevation, and Seepage Pumpback Data

Through flowmeters in the SCP pumping chambers, Teck monitors the daily flow volumes of seepage pumpback into the tailings pond. The flowmeters are connected to Teck's PI Server system that uploads data to the intranet making it accessible in real time from the mine offices. The daily pumpback volume returned to the tailings pond includes seepage through the TMD, precipitation and surface flows from the associated downstream catchment area, and secondary seepage pumpback that comes from water collected in a sump below the SCP. Therefore, the pumpback volume is not a direct indicator of seepage from the tailings pond, but seepage pumpback rates do vary seasonally and with changes within the tailings pond, such as the beach width. Golder understands that the three pumps in the pumping chambers are activated automatically at prescribed water elevations that are detailed in the O&M Manual. Figures D-8 through D-10 (Appendix D) compares the daily seepage pumpback rates, tailings pond elevation, precipitation, and air temperature. A summary of observations from these three figures is provided below:

- Figure D-8 shows the daily precipitation, seepage pumpback rate, and air temperature with respect to time beginning in January 2015. The greatest pumpback rate occurs during the spring freshet, which is typically coincident with the air temperature rising to above freezing. However, the January 2017 unusual occurrence caused an unseasonal increase in the pumpback rate that decreased to more normal levels in June 2017. Seepage pumpback rate is also generally coincident with increases in precipitation.

- Figure D-9 shows the daily precipitation, seepage pumpback rate, and tailings pond elevation with respect to time beginning in January 2015. The tailings pond elevation generally rises throughout winter until after the freshet. After the freshet, the tailings pond elevation decreases as a result of water treatment discharge and generally remains stable throughout the summer. The tailings pond elevation has increased between 1 and 5 feet each year since 2015, with an increase of 5 feet occurring between January 2015 and January 2016.

- Figure D-10 shows daily seepage pumpback rate and tailings pond elevations over the Julian year since January 2015. The tailings pond elevation generally follows a similar trend each year, rising over the winter until the freshet and then declining until the onset of winter. The greatest average daily seepage pumpback rate occurred in early April 2017 at just over 1,700 gallons per minute, likely as a result of the January 2017 unusual occurrence.

3.5 Ground Temperature Monitoring

Five thermistors are used to monitor subsurface thermal conditions and monitor changes in the active layer below the TMD Embankment and downstream of the Wing Wall. Two thermistors are located on the west abutment, and the remaining three are located downstream of the Wing Wall near the Mill Site (Figures 2 and 3). Currently, the thermistors are not connected to a data logger and temperatures are collected manually, generally three to four times per year. Data is collected as raw data then converted into temperatures. Temperature profiles and select dates are shown in Figures E-1 through E-5 (Appendix E). The profiles include an initial reading, the warmest and coldest readings, select intermediate readings, and the most current reading(s). Significant findings from the data analysis are as follows:

- T-05-61 is located on the west abutment and indicates permafrost about 28 feet below the bedrock surface. Ground temperatures indicate a slight warming trend since installation, and as a result the permafrost table has degraded from approximate elevation 968 feet to 950 feet between 2005 and 2016.
- T-95-004 is located on the west abutment, is about 400 feet long, and measures the upper and lower bounds of the permafrost zone. The data shows that permafrost is within the bedrock in this area and the upper permafrost table has degraded from about elevation 930 feet to 880 feet between 2005 and 2015. After 2015, the upper permafrost elevation appears to have stabilized. The bottom of the permafrost has seen a slight increase in elevation between 2005 and 2015.
- T-05-64 is located downstream of the Wing Wall next to the Concentrate Storage Building (CSB). The data suggests a slight warming trend since installation. The permafrost level remains near the native ground surface at this location and is likely maintained by the active convection cooling system used to stabilize the building foundation.
- T-05-66 is located downstream of the Wing Wall between the CSB and Fuel Tanks. The permafrost table appears to have remained relatively consistent with time at an elevation of about 960 feet, which is within apparent fill materials.
- T-05-67 is located downstream of the Wing Wall near where the haul road splits to either the Mill Site or the Crusher Pad. The data suggests the permafrost within the bedrock has degraded from about elevation 952 feet to 940 feet between 2005 and 2015.

3.6 Accelerographs

If an earthquake is significant enough to be felt by staff at the mine, earthquake parameters and accelerograph data is to be sent to the EoR for analysis. Earthquake parameters can be obtained from the Alaska Earthquake Information Center, and accelerograph data can be obtained from the two stations located at Red Dog Mine:

- UAF Station: Located on the ridgeline west of DD-2 Quarry located about 0.6 miles southwest of the tailings pond. This station was installed by the University of Alaska Fairbanks (UAF) as part of the Alaska Earthquake Information Center.
- Teck TMD Station: Located downstream of the right abutment of the TMD. This station that was installed by Teck should be set to record and save a record of any event with a peak ground acceleration greater than 0.04g.

Data from the UAF station can be retrieved by contacting UAF, and data from the Teck TMD station is saved on a computer onsite. There was no accelerograph data reviewed as part of this inspection.

3.7 Turbidity Sensors

As per the O&M Manual, two Campbell Scientific turbidity sensors are to be installed in the TMD to estimate and monitor the total suspended solids (TSS) within the seepage water passing through the underdrain. These two sensors are to be located:

- In a turbidity well located at Piezometer P-16-152, and
- In one of the pumpback chambers at the SCP.

As per Teck, the turbidity sensor at P-16-152 was installed in December 2017 and data is recorded hourly and downloaded by mine staff monthly. To evaluate TSS from a turbidity sensor, an instrument-specific correlation between the two parameters is being developed through a laboratory testing program. This monitoring program is still under development and no turbidity data was reviewed as part of this inspection.

4.0 UNUSUAL OCCURRENCES

In the last week of January 2017, mine staff noticed an increase in seepage pumpback flow from the SCP that was unusual for that time of year. Relevant VWP data was collected and indicated a sharp rise in water elevations that was also unusual. The EoR at the time (Mr. Todd Parkington AECOM) was notified, conducted a site visit, and concluded that there was no imminent danger or safety concern.

In March 2017, AECOM summarized the findings of the investigation in a technical memorandum and provided the following conclusion:

> *“AECOM believes the flow path of the mine water diversion discharge into the TSF found its way into the low area between the wing wall and causeway, in the area south of the pipe corridor crossing. From the time that the mine water diversion discharge cut a path over the causeway (December 2016), the TSF pool level continued to rise to a point where the pool level is now higher than the low area between the causeway and the wing wall. Therefore, the pond water has a channel (surface or subsurface) to flow into this area.*
>
> *Water likely reached the top of the Soil Type 9 protective cover, (waste rock fill more permeable than tailings). This additional volume of water resulted in high piezometer readings. This water followed the path of least resistance to the underdrain and the SCP, from where increased pumpback rates were recorded.”*

Concurrent to increased seepage pumpback, ponded water was observed in the area between the pipe bench and zinc thickener. AECOM provided an assessment of the situation and concluded that the ponded water was unlikely related to water from the tailings pond and could be a result of subsurface flows from the Main Waste Stockpile (MWS.) Additionally, AECOM noted that Piezometer P-05-63 showed an increase in water elevation beginning around February 3, 2017 and that no other downstream piezometers showed a similar response.

Golder’s review of the monitoring data associated with the unusual occurrence found that AECOM’s proposed scenario and sequence of events that resulted in the increased seepage pumpback is plausible. However, Golder’s review of the available data from CPT-19-13A and P-05-63 suggests that the two instruments showed a similar response to the event and may have become hydraulically connected (see Figure D-5). The data suggest that P-05-63 began to show an increase in water elevation on January 22, 2017, about 2 days after the increase in CPT-19-13A that was also observed in other nearby operating piezometers within the impoundment. This increase does not appear to be related to precipitation as the level of rise is not seen during previous higher storm events or in other piezometers outside the impoundment, such as P-05-67. Piezometer P-05-63 also seems to have similar behavior to the seepage pumpback, but that could be influenced by downstream groundwater flows. This also suggests that if tailings water is leaking under or through the liner, it appears to be reporting to the SCP. The data indicates that as the beach was further developed, and the pond water moved away from the dam face, the seepage pumpback flows decreased along with the water level at P-05-63. This event exemplifies the importance of maintaining a beach in this area. We recommend consideration of water quality testing or perhaps tracer testing to further evaluate potential leakage in this area.

5.0 CONCLUSIONS

Based on Golder's observations during the site visit and a review of the monitoring data, the following conclusions can be made concerning the safety of the dam and its performance:

- During the field inspection, the TMD and its appurtenant components appeared to be in satisfactory condition. Other than the lateral cracking observed in the Wing Wall crest, no other signs of instability were observed. Teck should continue monitoring dam performance data in accordance with the O&M Manual.
- The lateral (perpendicular to the centerline) cracking observed at the Wing Wall is thought to be related to thaw consolidation of ice-rich native soils. This cracking does not appear to impact stability or freeboard but should continue to be monitored.
- Longitudinal (parallel to the centerline) cracking was observed at the Wing Wall crest near Station 55+50, but it was along the geomembrane anchor trench and attributed to movements of the liner; therefore, it was not related to instability or movements of the embankment fill.
- The exposed upstream liner generally appeared to be in good condition, except for some liner damage observed near Station 11+80. Teck had already scheduled the repairs, and we understand they have been completed before publication of this report. Teck is working to improve procedures during tailings pipeline manipulation to limit or prevent future damage to the upstream geomembrane liner.
- At the time of the field investigation, the downstream abutments of the TMD Embankment did not have signs of instability or seepage. Additionally, there were no signs of instability for the TMD Embankment buttress, such as cracking, slumps, or indications of lateral movement
- The Seepage Collection Dam appeared to be in satisfactory condition with no observed signs of instability. The Seepage Seepage Pumpback located downstream of the Seepage Collection Dam was also observed and did not appear to be actively pumping at that time.
- Based on a review of the weekly, quarterly inspection reports, and monthly monitoring data assessments, Teck is performing inspections in accordance with the O&M Manual. The new system of collecting piezometer data is a vast improvement, and the system is working well. Upgrading of instruments, the infrastructure, and data presentation is ongoing.

- The SAA inclinometer data indicates there were no significant deformations or changes in deformation rate. SAA INC-01-13 exceeded the 1-inch cumulative deformation threshold, but this is attributed to the buttress construction and is not a concern.
- Generally, the greatest seepage pumpback rate occurs during the spring freshet, which is typically coincident with the air temperature rising to above freezing. However, in January of 2017 the pumpback rate began to increase due to the January 2017 unusual occurrence described in Section 4.0. The greatest average daily sump pumping rate occurred in early April 2017 at just over 1,700 gallons per minute. Improved tailings beach production in 2017 has decreased seepage pumpback rates and those beaching practices should continue.
- The tailings pond elevation generally rises throughout winter until spring. After the freshet, the tailings pond elevation decreases as a result of discharging and generally remains stable throughout the summer. The tailings pond elevation has increased between 1 and 5 feet each year since 2015, with an increase of 5 feet occurring between January 2015 and January 2016.
- Piezometric levels have generally behaved as anticipated in response to tailings pond levels and the beach width. None of the critical piezometers exceeded their trigger elevations or hydraulic gradients. Several piezometers exceeded their rapid rise triggers, but they generally were related to anticipated conditions, such as during the spring freshet, beach production, and storm events.
- Piezometer levels within and outside the tailings pond during the January 2017 unusual occurrence suggest that there could be leakage below or through the geomembrane or cutoff near the Wing Wall if pond water comes into contact with the Type 9 materials over the liner in that area. The data also suggests that if leakage is occurring near the Wing Wall, it appears to be reporting to the SCP. This event exemplifies the importance of maintaining a beach in this area.

6.0 RECOMMENDATIONS

The following sections summarize Golder’s recommendations from this APR and recommendations provided by Klohn Crippen Berger Ltd. (KCB) after their periodic safety inspection (PSI) in 2017.

6.1 2018 Golder APR Recommendations

The following recommendations were developed by Golder during the preparation of this 2018 APR including the field inspection and our review of the monitoring data and inspections.

- Continue monitoring the TMD in accordance to the O&M Manual until it is revised.
- Continue monitoring the lateral cracks on the crest of the Wing Wall, looking for changes in length, width, or depth. Survey, photograph, and document in writing any increase observed.
- Backfill the void space within the annulus of the 2017 AECOM borehole located on the Wing Wall. Install a cap over the open PVC pipe, and place a safety cone over it as well to highlight it for any traffic along the crest. Golder understands this has already been accomplished by Teck.
- Carefully expose the liner and examine the condition of the SCC cap and geomembrane liner tie-in at the location of the longitudinal cracking observed along the upstream toe of the Stage X Wing Wall extension.

The purpose of this examination is to determine that additional fill materials will not settle into the slurry trench and/or reduce the geomembrane liner tie-in depth.

6.2 2017 KCB PSI Recommendations

Recommendations provided by KCB 2017 are summarized below in Table 3 along with Golder's target completion date, and current status.

Table 3: KCB PSI RECOMMENDATIONS

No.	Recommendation Description	Target Date	Status
PSI-R-01	As part of any dam raise above existing crest, El. 986 ft., Teck and EoR should review the Hazard Potential Classification, specifically related to the three seasonally occupied cabins that are in the downstream inundation zone and whether they should be considered as "temporarily" populated.	12/31/2018	Partially complete and classified as a Class I structure. Inundation analysis currently being completed will help assess how cabins will be impacted
PSI-R-02	Standalone reports are recommended that summarize key project information applicable to the TMD, specifically for (refer to description in text): • Design Basis / Criteria; and • Dam Site Characterization. These documents should be reviewed annually (minimum), then, if appropriate, updated and reissued (with revision control) by the EoR, similar to O&M and emergency planning documents.	4/30/2019	In progress as part of Stage XI design
PSI-R-03	Review and action, as appropriate, recommendations and opportunities (refer to Table 3.2 of report text)[1] to improve implementation of the Observational Method at the TMD.	12/31/2020	Once Stage XI construction has been completed
PSI-R-04	The basis for selection of undrained shear strength ratio (0.26) and minimum undrained shear strength for the colluvium / alluvium (static and seismic loading) is not well supported in the Stage X design documents (TMD28, TMD30)[1] and should be clarified.	Complete	Have reverted to the shear strength ratio of 0.22, which is deemed appropriate for NC materials
PSI-R-05	The strain weakening behavior observed in the laboratory tests of the colluvium / alluvium should be compared to predicted strain levels within the unit by the deformation models for all loading conditions (Method 1, 2 and 3). Where appropriate, run additional sensitivity analyses to assess the potential impact of strain weakening on design.	4/30/2019	Will be completed as part of the Stage XI design. Analyses related to the Stage XI design will be presented
PSI-R-06	The reported factor of safety (FOS) for the Stage X raise along the highest section of the dam, 1.42, is less than the minimum design criteria (1.5). AECOM should complete the three-dimensional (3D) stability analysis they state as the basis for design compliance. Akhtar (2011)[1] is a useful reference when reviewing analyses methods and applicability of 3D stability analyses.	4/30/2019	Stabilities are being reassessed as part of the Stage XI design. The analyses related to the Stage XI design will be presented
PSI-R-07	The EoR is recommended to document all model and material property assumptions relevant to the Stage X Shear Key Buttress deformation model, with appropriate technical justification and complete a review of the model as described in Section 3.2.2.[1]	NA	Completing an independent deformation analysis as part of the Stage XI design
PSI-R-08	Record document should be prepared or approved by the EoR that summarizes actions taken to address recommendations from Stage IX review (TMD37)[1] to bring the Stage IX Raise into design compliance.	completed	

No.	Recommendation Description	Target Date	Status
PSI-R-09	The risk reduction measures identified by AECOM during the filter workshop (TMD11)[1], or similar, should be incorporated into the TMD monitoring program and documented in the O&M Manual in manner consistent with the Observational Method framework.	12/31/2020	Once Stage XI construction has been completed
PSI-R-10	Teck and AECOM are recommended to develop a 3D seepage model for the TMD. The effort associated with this activity is believed justified because of increasing importance of understanding of seepage and prediction capability as the tailings level rises and the project approaches closure.	TBD	This will be a complicated model, with much of the input information still being developed. This task may be completed at a future date once the input data has been properly defined and calibrated
PSI-R-11	Recommended inclusions that should be incorporated into the next revision of the O&M Manual to improve the document further include: • Update the discussion of the Observational Method based on the discussion herein and recommended activities, specifically the threshold values, refer to Section 6.2.2.[1] • Identify the Responsible Position for the TMD, who currently holds that position and their designated alternates. • Clearing of vegetation growth from the Seepage Collection Dam spillway should be defined as part of routine maintenance.	12/31/2020	Once Stage XI construction has been completed
PSI-R-12	To limit risks associated with omission of key information and staff turnover, Teck is recommended to prepare a document that summarizes design basis information for the TSF and key components as an integrated system, such as: TMD; Tailings Back Dam; water balance; deposition planning and beach management; seepage management; regulatory; closure and other relevant information. This document would consolidate information similar to that recommended in PSI-R-02 for all components of the TSF.	12/31/2020	Will be done after PSI-R-02, O&M Manual update and in coordination with the closure plan update (2021).
PSI-R-13	Installation of inclinometers and additional piezometers to monitor displacement and pore pressure generation within the colluvium / alluvium unit is recommended. Number of instruments, type and locations should be recommended by the EoR.	12/31/2020	Date provided is to make recommendations; date for installation to be coordinated with Teck after construction of Stage XI is complete
PSI-R-14	Teck's plan to establish additional threshold levels that improve the implementation of the Observational Method is supported and should be completed. Additional recommendations related to thresholds include: • EoR to review whether horizontal gradient thresholds should be defined between piezometers referenced in Section 6.2.2[1] of main text. • Establish thresholds for seepage pumpback based on pumping rate, in addition to the existing thresholds that are based on Seepage Collection Dam pond level. • Establish thresholds for tailings beach width based on design assumptions and observations of impact of beach width on seepage rates. • Develop incremental and cumulative inclinometer thresholds for each foundation and dam fill unit, as appropriate, based on deformation model predictions of "most probable conditions" and "most unfavorable conditions."	12/31/2020	Partially complete - to be fully incorporated when the O&M manual is updated following Stage XI construction
PSI-R-15	Given the importance of the tailings beach on seepage management and structural stability in the short and long-term, Teck has refined their tailings planning to maintain a wide beach at the TMD. The same criteria should be defined in TMD design basis and O&M Manual, including an appropriate monitoring program.	12/31/2020	Once Stage XI construction has been completed
PSI-R-16	Teck is recommended to plot tailings beach widths, include historic where available, and pumpback rates to identify whether a correlation can be identified.	Complete	

No.	Recommendation Description	Target Date	Status
PSI-R-17	Recommendations have been made for the EoR to review specific components of the design analyses. If these reviews indicate that minimum required criteria are not met, the condition assessment should be lowered to FAIR, based on ADNR definitions, until the appropriate remedial activities are completed to bring the TMD back into compliance for all loading conditions.	4/30/2019	Will be completed as part of the Stage XI design

Note: 1 – Refer to Table 10.1 KCB 2017

7.0 CLOSING

The work program followed the standard of care expected of professionals undertaking similar work in the State of Alaska under similar conditions. No warranty expressed or implied is made.

Please contact us if you have any questions or comments regarding this report.

Sincerely,

Golder Associates Inc.

STATE OF ALASKA
49TH
11/5/18
STEVEN L. ANDERSON
CE - 9120
REGISTERED PROFESSIONAL ENGINEER

Matthew W. Ryans, PE
Project Engineer

Steven L. Anderson, PE
Associate and Senior Geotechnical Engineering Consultant

MWR/GEC/SLA/sla

Attachments: Figure 1 – Project Location
Figure 2 – Plan View of Tailings Main Dam Embankment
Figure 3 – Plan View of Wing Wall
Figure 4 – Section View Along TMD Embankment Underdrain
Figure 5 – Section Views Along Wing Wall
Figure 6 – Selected Site Observations of TMD Embankment and Wing Wall

Appendix A – ADNR Visual Inspection Checklist
Appendix B – 2018 Site Inspection Photographs
Appendix C – SAA Inclinometer Data
Appendix D – Piezometer, Air Temperature, Precipitation, Tailings Pond Elevation, and Seepage Pumpback Data
Appendix E – Thermistor Data

https://golderassociates.sharepoint.com/sites/18959822/6_deliverables/004_tailingsmaindam/rev 0 - final/18959822-004-l-rev0-2018tmdannualinspection-20181105.docx

8.0 REFERENCES

AECOM. 2016a. 2016 Annual Dam Safety Inspection Report, Tailings Main Dam, Red Dog Mine, Alaska, submitted to Teck Alaska Incorporated, dated October 19. (Project Number 60515442) Seattle, WA: AECOM.

AECOM. 2016b. Construction Completion Report, Stage X Widening and Raise, Tailings Main Dam, Red Dog Mine, Alaska, submitted to Teck Alaska Incorporated, dated November 4. (Project Number 60494023) Seattle, WA: AECOM.

AECOM. 2016c. Operations and Maintenance Manual, Revision 12, Tailings Main Dam, Red Dog Mine, Alaska, submitted to Teck Alaska Incorporated, dated November 4. (Project Number 60494023) Seattle, WA: AECOM.

AECOM. 2017. Analysis of Abnormal Pumpback and Piezometric Data, Tailings Main Dam, Red Dog Mine, Alaska, submitted to Teck Alaska Incorporated, dated March 21. (Project Number 60535779) Seattle, WA: AECOM.

Klohn Crippen Berger Ltd. (KCB). 2017. Red Dog 2017 Inspections, Tailings Main Dam Facility Periodic Safety Inspection Report, prepared for Teck Alaska Incorporated, dated December 1. (Project Number M09811A05.730) Vancouver, BC, CA: Klohn Crippen Berger.

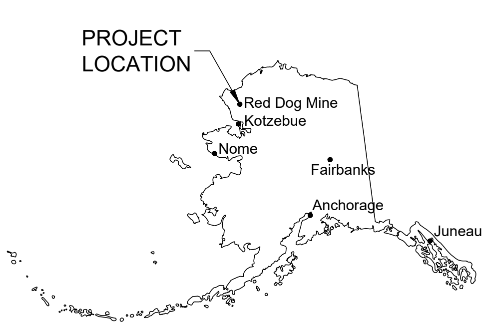
Teck Alaska Incorporated (Teck). 2018. Teck Alaska Red Dog Mine, 2017 Annual Instrumentation Report, Red Dog Mine Tailings Storage Facility, prepared by Teck Alaska Incorporated, Red Dog Operations, dated March 12.

URS Corporation (URS). 2013. Construction Completion Report, Stage IX Raise, Tailings Main Dam, (NID ID# AK 0201, Red Dog Mine, Alaska., prepared for Teck Alaska Incorporated, dated December 31.

Golder Associates Inc.
2121 Abbott Road, Suite 100 Anchorage, Alaska, USA 99507

T: +1 907 344-6001 +1 907 344-6011

Figures



NOT TO SCALE

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CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

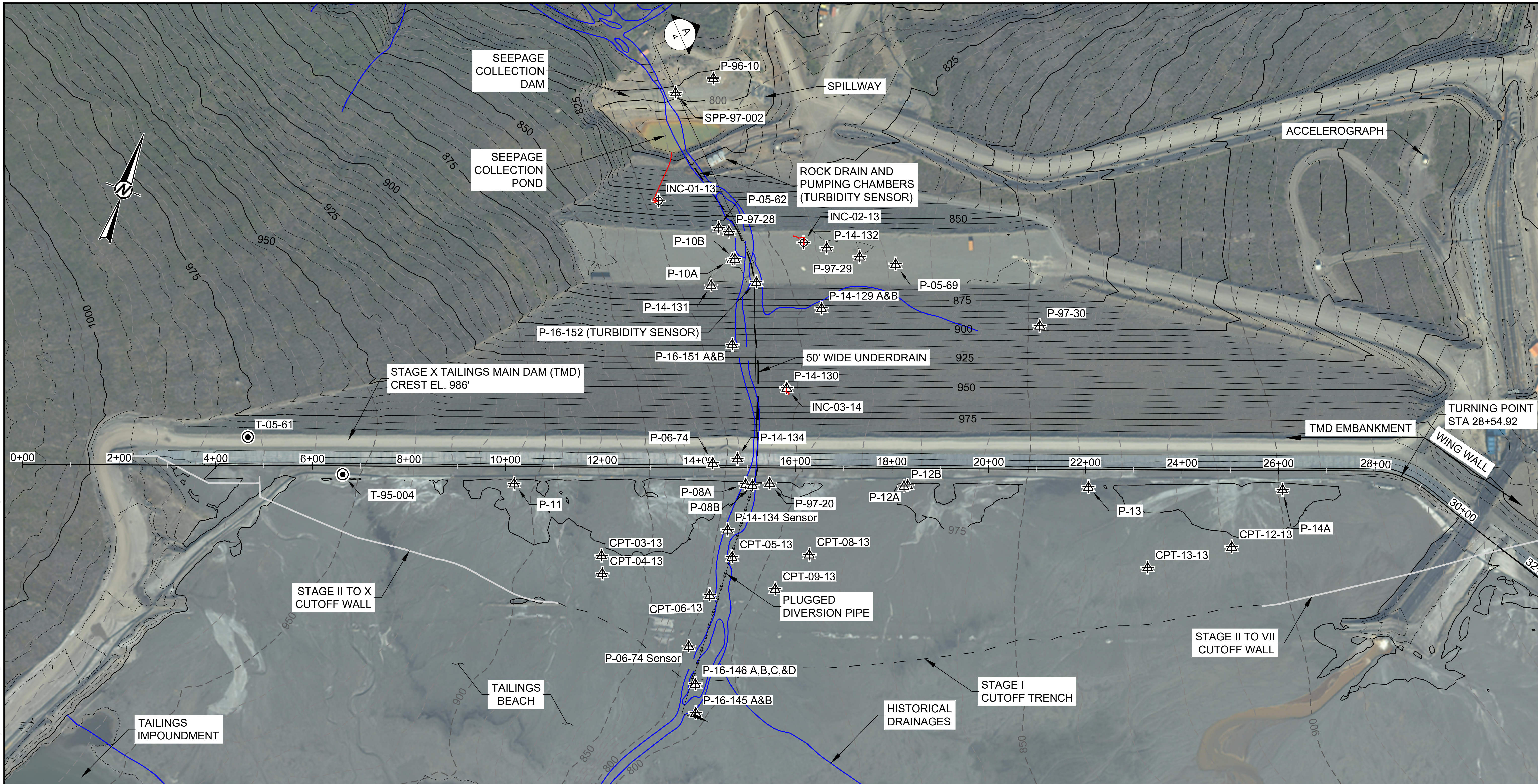
CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	MWR
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
PROJECT LOCATION

PROJECT No.	Rev.	FIGURE
1895982	0	1



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P-06-74	VIBRATING WIRE PIEZOMETER (P, CPT)
INC-01-13	SAA INCLINOMETER (INC) WITH APPROXIMATE DIRECTION AND RESULTANT HORIZONTAL MOVEMENT (SEE NOTE 5)

REFERENCES

1. SITE TOPOGRAPHY DEVELOPED FROM CONTOUR MAP COMPILED BY WHPACIFIC ON 11-07-2017.
2. ORIGINAL TOPOGRAPHY AND HISTORIC DRAINAGES SHOWN FROM 1984 TOPOGRAPHIC CONTOURS PROVIDED BY TAK.
3. AERIAL IMAGERY PROVIDED BY WHPACIFIC ON 03-08-18; FILENAME *REDDOG.MINE2FTLOCAL.TIF*
4. DAM FEATURES INCLUDING STATIONING, CUTOFF WALL AND TRENCH, UNDERDRAIN, AND DIVERSION PIPE FROM STAGE X AS-BUILT DRAWINGS IN "CONSTRUCTION COMPLETION REPORT, STAGE X WIDENING AND RAISE, TAILINGS MAIN DAM, RED DOG MINE, ALASKA," BY AECOM, DATED NOVEMBER 4, 2016.
5. REFER TO APPENDIX C FOR DETAILS REGARDING RESULTANT HORIZONTAL MOVEMENT SHOWN (DRAWING SCALE 1" = 2" MOVEMENT) .

0 100 200 300
SCALE FEET

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
PLAN VIEW OF TAILINGS MAIN DAM EMBANKMENT

PROJECT NO.	REV.	FIGURE
1895982	0	2

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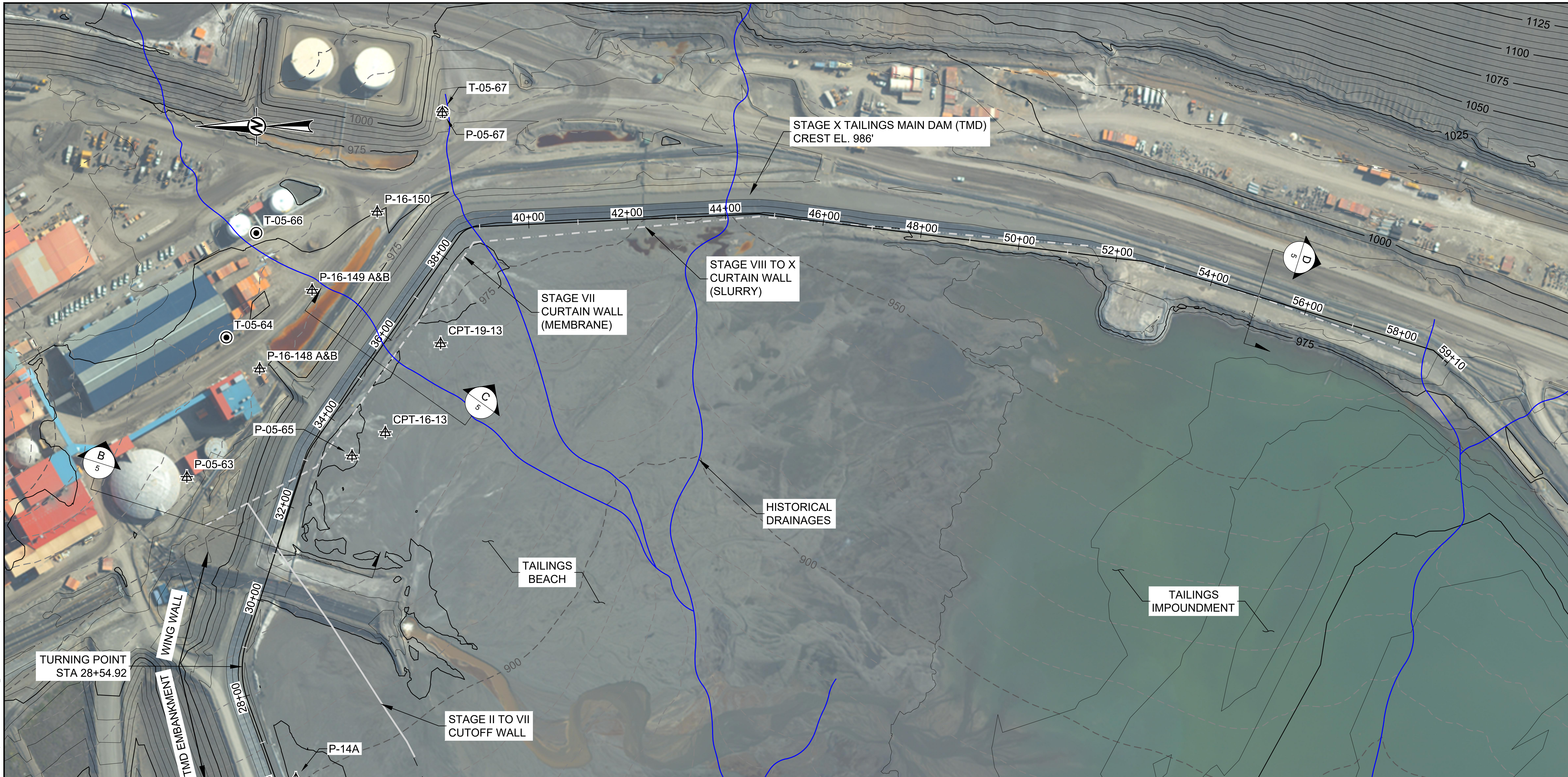

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⊙ T-05-64	THERMISTOR STRING (T)
P-05-65	VIBRATING WIRE PIEZOMETER (P, CPT)

REFERENCES

1. SITE TOPOGRAPHY DEVELOPED FROM CONTOUR MAP COMPILED BY WHPACIFIC ON 11-07-2017.
2. ORIGINAL TOPOGRAPHY AND HISTORIC DRAINAGES SHOWN FROM 1984 TOPOGRAPHIC CONTOURS PROVIDED BY TAK.
3. AERIAL IMAGERY PROVIDED BY WHPACIFIC ON 03-08-18; FILENAME *REDDOG.MINE2FTLOCAL.TIF*
4. DAM FEATURES INCLUDING STATIONING, CUTOFF WALL, AND CURTAIN WALL FROM STAGE X AS-BUILT DRAWINGS IN "CONSTRUCTION COMPLETION REPORT, STAGE X WIDENING AND RAISE, TAILINGS MAIN DAM, RED DOG MINE, ALASKA," BY AECOM, DATED NOVEMBER 4, 2016.

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SCALE FEET

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

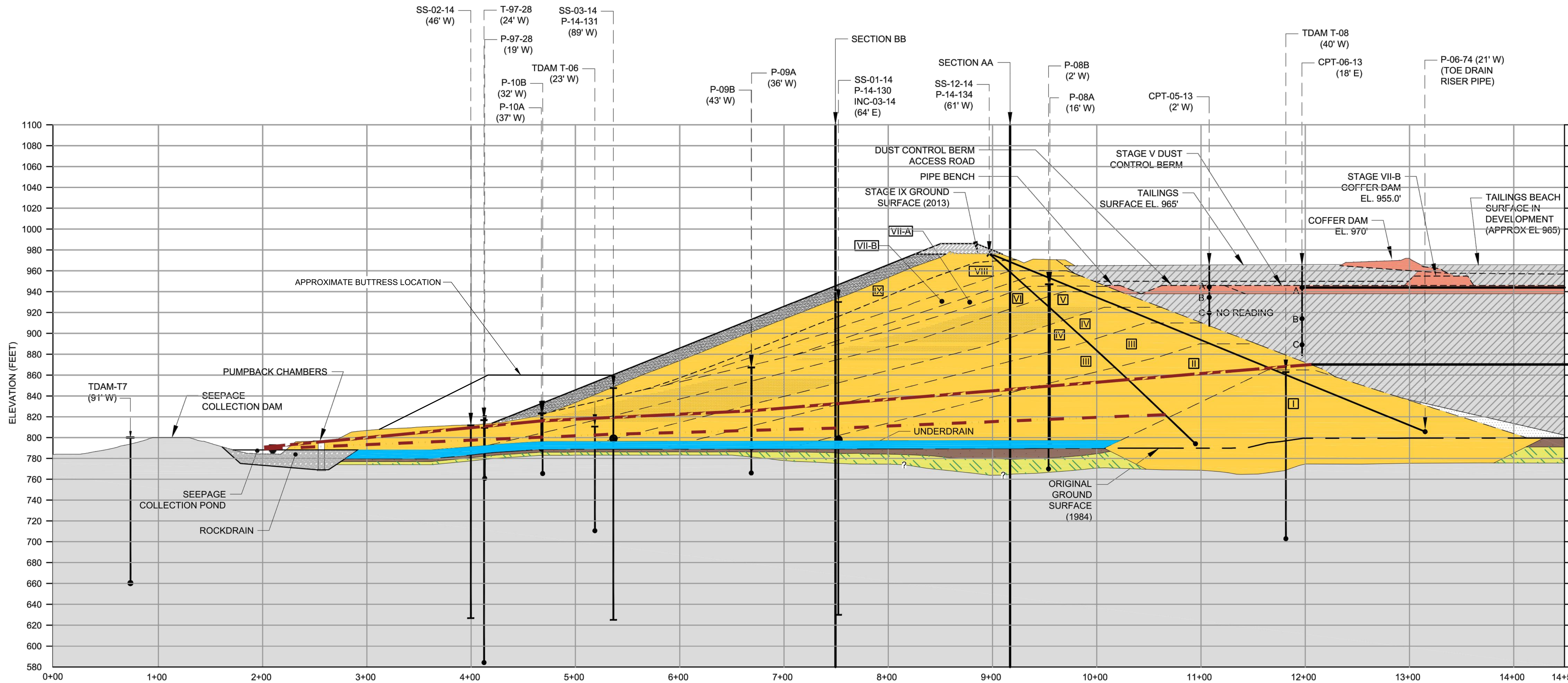
CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
PLAN VIEW OF WING WALL

PROJECT NO.	REV.	FIGURE
1895982	0	3



SCALE 1:100 | VERT. SCALE 1:100 — A / 2 — EMBANKMENT SECTION ALONG UNDERDRAIN

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1" = 100' FEET
APPROXIMATE SCALE

LEGEND

- HIGHLY WEATHERED SHALE
- SLIGHTLY TO MODERATELY WEATHERED SHALE
- ALLUVIUM/COLLUVIUM
- EXISTING EMBANKMENT
- TUNDRA
- COFFER DAM/DUST CONTROL BERM
- TAILINGS
- KIVALINA WASTE FILL
- SELECT SHALE
- SANDSTONE
- STAGE NUMBER
- MAXIMUM DESIGN PHREATIC SURFACE
- MAXIMUM OPERATING PHREATIC SURFACE (OCT 2014-FEB 2015)
- STAGE X WIDENING FILL
- STAGE X RAISE FILL

BORING/PIEZOMETER/THERMISTOR

SURFACE ELEVATION

TIP ELEVATION/ SENSOR

REFERENCE(S)

CROSS SECTION DRAWING FROM FIGURE 6.2 IN "DESIGN REPORT, REVISION 1, STAGE X RAISE, RED DOG MINE TAILINGS MAIN DAM," BY AECOM, PREPARED FOR TECK ALASKA INCORPORATED, DATED APRIL 5, 2016. APPROXIMATE BUTTRESS LOCATION PROVIDED BY GOLDER.

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

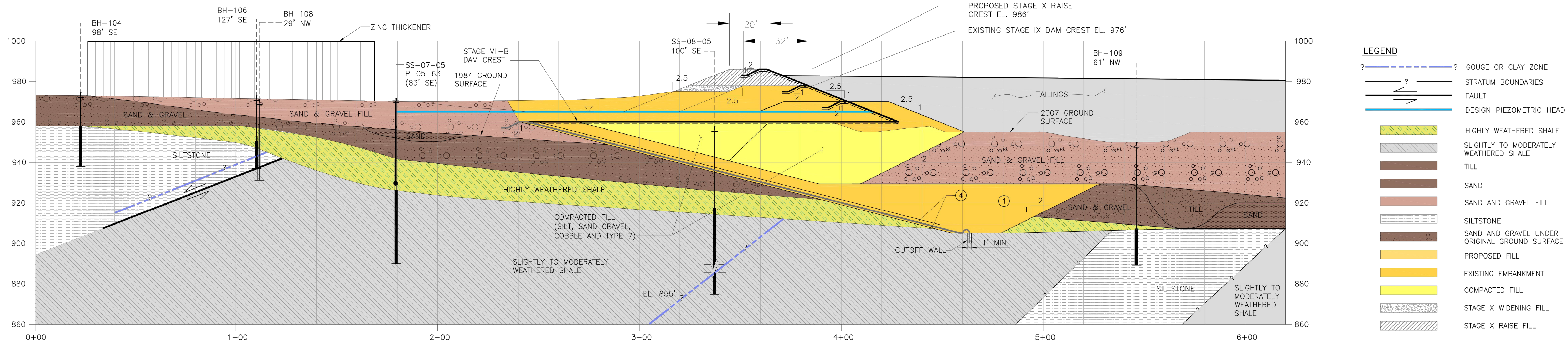
CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
SECTION VIEW ALONG TMD EMBANKMENT UNDERDRAIN

PROJECT NO.	REV.	FIGURE
1895982	0	4



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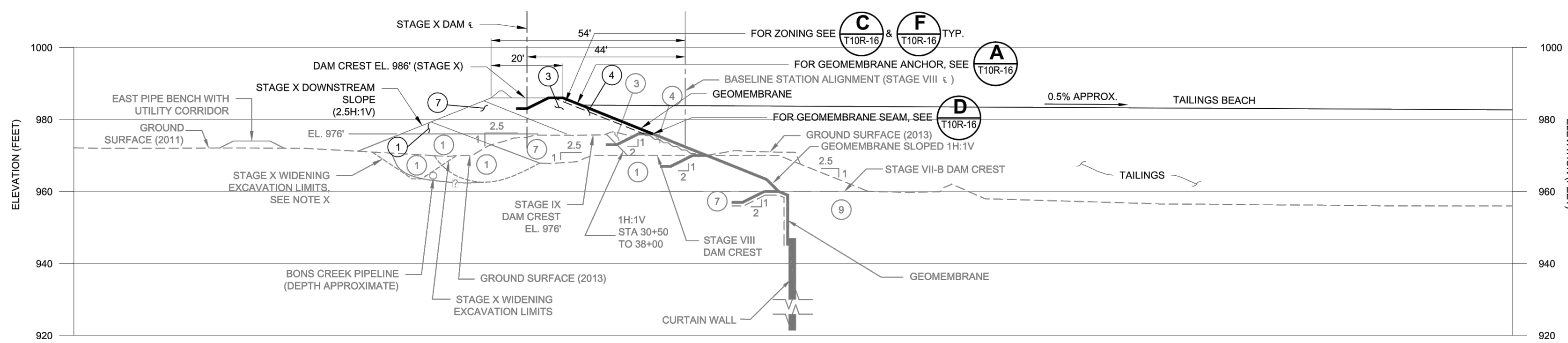
1" = 50' FEET



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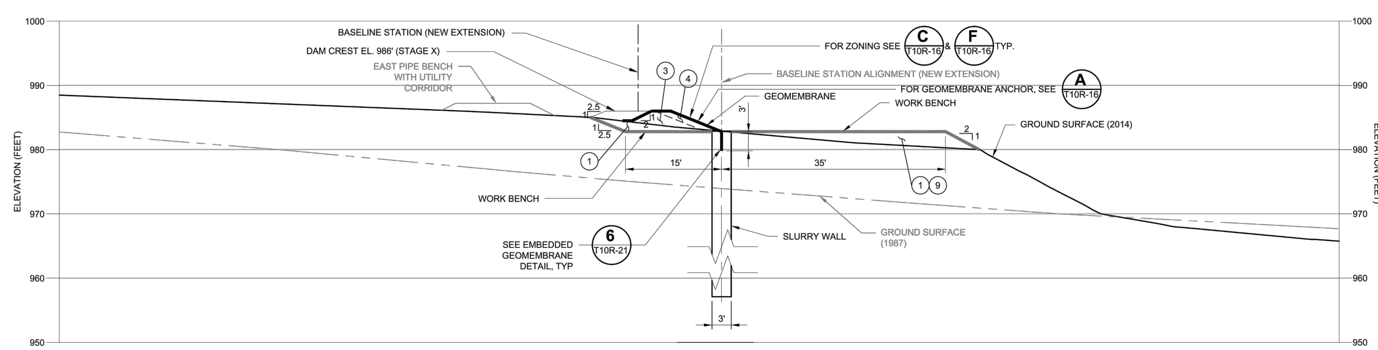

SCALE 1:50 D SECTION AT STATION 55+00
VERT. SCALE 1:50 3

REFERENCE(S)

1. SECTION AT STATION 31+12 FROM FIGURE 6.4 IN "DESIGN REPORT, REVISION 1, STAGE X RAISE, RED DOG MINE TAILINGS MAIN DAM," BY AECOM, PREPARED FOR TECK ALASKA INCORPORATED, DATED APRIL 5, 2016. REFER TO THAT REPORT FOR REFERENCED ZONE TYPES.
2. SECTION AT STATION 35+48 FROM DRAWING NO. T10R-13 IN "DESIGN REPORT, REVISION 1, STAGE X RAISE, RED DOG MINE TAILINGS MAIN DAM," BY AECOM, PREPARED FOR TECK ALASKA INCORPORATED, DATED APRIL 5, 2016. REFER TO THAT REPORT FOR REFERENCED DETAILS AND ZONE TYPES.
3. SECTION AT STATION 55+00 FROM DRAWING NO. T10R-14 IN "DESIGN REPORT, REVISION 1, STAGE X RAISE, RED DOG MINE TAILINGS MAIN DAM," BY AECOM, PREPARED FOR TECK ALASKA INCORPORATED, DATED APRIL 5, 2016. REFER TO THAT REPORT FOR REFERENCED DETAILS AND ZONE TYPES.

CLIENT
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ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
SECTION VIEWS ALONG WING WALL

PROJECT NO. 1895982 REV. 0 FIGURE 5

LEGEND

- SURVEYED CRACKS IN 2018
- SURVEYED CRACKS IN 2017

REFERENCES

1. AERIAL IMAGERY PROVIDED BY WHPACIFIC ON 03-08-18; FILENAME *REDDOG.MINE2FTLOCAL.TIF*
2. DAM FEATURES INCLUDING STATIONING, CUTOFF WALL AND TRENCH, UNDERDRAIN, AND DIVERSION PIPE FROM STAGE X AS-BUILT DRAWINGS IN "CONSTRUCTION COMPLETION REPORT, STAGE X WIDENING AND RAISE, TAILINGS MAIN DAM, RED DOG MINE, ALASKA," BY AECOM, DATED NOVEMBER 4, 2016.
3. FIELD PHOTOGRAPHS TAKEN ON JUNE 22, 2018.

0 200 400 600
SCALE FEET

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
SELECTED SITE OBSERVATIONS OF TMD EMBANKMENT AND WING WALL

PROJECT NO.	REV.	FIGURE
1895982	0	6

APPENDIX A

ADNR Visual Inspection Checklist

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

GENERAL INFORMATION

NAME OF DAM: Tailings Main Dam	POOL ELEVATION: ~975 feet
NATIONAL INVENTORY OF DAMS ID#: AK00201	TAILWATER ELEVATION: ~789 feet (SCP)
OWNER: Teck Alaska Incorporated	CURRENT WEATHER: Partly Cloudy
HAZARD CLASSIFICATION: II	PREVIOUS WEATHER: Partly Cloudy
SIZE CLASSIFICATION: N/A	INSPECTED BY: Steven L. Anderson, PE and Matthew W. Ryans, PE
PURPOSE OF DAM: Tailings Storage Facility	
O & M MANUAL REVIEWED: Yes	INSPECTION FIRM: Golder Associates Inc.
EMERGENCY ACTION PLAN REVIEWED: Yes	DATE OF INSPECTION: June 22, 2018

ITEM	YES	NO	REMARKS
RESERVOIR			
1. Any upstream development?	X		Tailings Back Dam Rockfill Widening
2. Any upstream impoundments?	X		Cofferdam and Tailings Beach
3. Shoreline slide potential?		X	
4. Significant sedimentation?	X		Stored Tailings
5. Any trash boom?		X	
6. Any ice boom?		X	
7. Operating procedure changes?	X		Stage XI Raise DS Toe Work Planned

ITEM	YES	NO	REMARKS
DOWNSTREAM CHANNEL			
1. Channel			Seepage Collection Pond to Fish Weir
a. Eroding or Backcutting		X	
b. Sloughing?		X	
c. Obstructions?	X		Seepage Collection Dam and Fish Weir
2. Downstream Floodplain			
a. Occupied housing?		X	
b. Roads or bridges?	X		Fish Weir Road, Future Exploration Road
c. Businesses, mining, utilities?		X	
d. Recreation Area?	X		Staff Recreational Area
e. Rural land?	X		
f. New development?		X	

ITEM	YES	NO	REMARKS
EMERGENCY ACTION PLAN			
1. Class I or Class II Dam?	X		Class II Dam
2. Emergency Action Plan Available?	X		In Operations and Maintenance Manual
3. Emergency Action Plan current?	X		
4. Has EAP been tested in last year?	X		August 1, 2017 as per Teck

ITEM	YES	NO	REMARKS
INSTRUMENTATION			
1. Are there			
a. Piezometers?	X		
b. Weirs?		X	
c. Observation wells?	X		
d. Settlement Monuments?		X	
e. Horizontal Alignment Monuments?	X		
f. Thermistors?	X		
2. Are readings			
a. Available?	X		
b. Plotted?	X		
c. Taken periodically?	X		In accordance with O&M Manual

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

SAFETY

ITEM	YES	NO	REMARKS
SAFETY			
1. ACCESS			
a. Road access?	X		
b. Trail access?		X	
c. Boat access?	X		Boat Ramp available for Teck use
d. Air access?	X		Air access restricted by Teck
e. Access safe?	X		
f. Security gates and fences?		X	Remote secured site
g. Restricted access signs?	X		
2. PERSONNEL SAFETY			
a. Safe access to maintenance and operation areas?	X		
b. Necessary handrails and ladders available?	N/A		
c. All ladders and handrails in safe condition?	N/A		
d. Life rings or poles available?	X		Available at Mine offices
e. Limited access and warning signs in place?	X		
f. Safe walking surfaces?	X		
3. DAM EMERGENCY WARNING DEVICES			
a. Emergency Action Plan required?	X		
b. Emergency warning devices required by EAP?	X		Types: Monitored Instruments
c. Emergency warning devices available?	X		
d. Emergency warning devices operable?	X		
e. Emergency warning devices tested?	X		
f. Emergency warning devices tested by owner?	X		When: monthly during instrumentation review
g. Emergency procedures available at dam?	X		Mine offices
h. Dam operating staff familiar with EAP?	X		
4. OPERATION AND MAINTENANCE MANUAL			
a. O & M Manual reviewed?	X		
b. O & M Manual current?	X		Rev 12, November 4, 2016
c. Contains routine inspection schedule?	X		
c. Contains routine inspection checklist?	X		

ALASKA DAM SAFETY PROGRAM
VISUAL INSPECTION CHECKLIST

EMBANKMENT DAMS

ITEM	YES	NO	REMARKS
EMBANKMENT DAMS			
1. CREST			
a. Any settlement?		X	
b. Any misalignment?		X	
c. Any cracking?	X		Crest of Wing Wall (Lateral, Shallow)
d. Adequate freeboard?	X		
2. UPSTREAM SLOPE			
a. Adequate slope protection?	X		
b. Any erosion or beaching?	X	X	Beaching approved to El. 983
c. Trees or brush growing on slope?		X	
d. Deteriorating slope protection?		X	
e. Visual settlement?		X	
f. Any sinkholes?		X	
3. DOWNSTREAM SLOPE			
a. Adequate slope protection?	X		
b. Any erosion?		X	
c. Trees or brush growing on slope?		X	
d. Animal burrows?		X	
e. Sinkholes?		X	
f. Visual settlement?		X	
g. Surface seepage?		X	
h. Toe drains dry?		X	Clear seep into Seepage Collection Pond
i. Relief wells flowing?		N/A	Relief Wells not presents
j. Slides or slumps?		X	
4. ABUTMENT CONTACTS			
a. Any erosion?		X	
b. Seepage present?		X	
c. Boils or springs downstream?		X	
5. FOUNDATION			
a. If dam is founded on permafrost			
(1) Is fill frozen?		X	Extent of instrumentation indicates thawed
(2) Are internal temperatures monitored?	X		
b. If dam is founded on bedrock			Stage 1 - Starter Dam
(1) Is bedrock adversely bedded?		X	
(2) Does rock contain gypsum?		X	
(3) Weak strength beds?	X		Clay Gouge
c. If dam founded on overburden			Subsequent Stages
(1) Pipeable?	X		Addressed in design
(2) Compressive?	X		Addressed in design
(3) Low shear strength?	X		Addressed in design

SPILLWAYS

ITEM	YES	NO	REMARKS
SPILLWAYS			
1. CREST			
a. Any settlement?		N/A	
b. Any misalignment?		N/A	
c. Any cracking?		N/A	
d. Any deterioration?		N/A	
e: Exposed reinforcement?		N/A	
f. Erosion?		N/A	
g. Silt deposits upstream?		N/A	
2. CONTROL STRUCTURES			
a. Mechanical equipment operable?	N/A		
b. All gates maintained?	N/A		
c. Will flashboards trip automatically?	N/A		
d. Are stanchions trippable?	N/A		
e. Are gates remotely controlled?	N/A		
3. CHUTE			
a. Any cracking?		N/A	
b. Any deterioration?		N/A	
c. Erosion?		N/A	
d. Seepage at lines or joints?		N/A	
4. ENERGY DISSIPATERS			
a. Any deterioration?		N/A	
b. Erosion?		N/A	
c. Exposed reinforcement?		N/A	
5. METAL APPURTENANCES			
a. Corrosion?		N/A	
b. Breakage?		N/A	
c. Secure anchorages?	N/A		
6. EMERGENCY SPILLWAY			
a. Adequate grass cover?	N/A		
b. Clear approach channel?	N/A		
c. Erodible downstream channel?		N/A	
d. Erodible fuse plug?	N/A		
e. Stable side slopes?	N/A		
f. Beaver dams present?		N/A	

INTAKES

ITEM	YES	NO	REMARKS
INTAKES			
1. EQUIPMENT			
a. Trash racks		X	
b. Trash rake?		X	
c. Mechanical equipment operable?	X		
d. Intake gates?		X	
e. Are racks and gates operable?	N/A		
f. Are gate operators operable?	N/A		
2. CONCRETE SURFACES			
a. Any cracking?		N/A	
b. Any deterioration?		N/A	
c. Erosion?		N/A	
d. Exposed reinforcement?		N/A	
e. Are joints displaced?		N/A	
f. Are joints leaking?		N/A	
3. CONCRETE CONDUITS			
a. Any cracking?		N/A	
b. Any deterioration?		N/A	
c. Erosion?		N/A	
d. Exposed reinforcement?		N/A	
e. Are joints displaced?		N/A	
f. Are joints leaking?		N/A	
4. METAL CONDUITS			
a. Is metal corroded?		N/A	
b. Is conduit damaged?		N/A	
c. Are joints displaced?		N/A	
d. Are joints leaking?		N/A	
5. METAL APPURTENANCES			
a. Corrosion?		N/A	
b. Breakage?		N/A	
c. Secure anchorages?	N/A		
6. PENSTOCKS			
a. Material deterioration?		N/A	
b. Joints leaking?		N/A	
c. Supports adequate?	N/A		
d. Anchor blocks stable?	N/A		

APPENDIX B

2018 Site Inspection Photographs

Appendix B: Photographs	
PHOTO 1 TAILINGS BEACH, LOOKING NE June 22, 2018	
PHOTO 2 UPSTREAM LINER AT TMD EMBANKMENT, LOOKING SW FROM PIPELINE CORRIDOR June 22, 2018	

Appendix B: Photographs	
PHOTO 3 LINER CUTOFF AT TMD EMBANKMENT WEST ABUTMENT June 22, 2018	
PHOTO 4 TMD EMBANKMENT WEST ABUTMENT, LOOKING E-NE June 22, 2018	

Appendix B: Photographs

PHOTO 5

LINER DAMAGE AT TMD EMBANKMENT, LOOKING E

June 22, 2018

PHOTO 6

CLOSEUP OF LINER DAMAGE

June 22, 2018

Appendix B: Photographs

PHOTO 7 TAILINGS DISCHARGE AREA, LOOKING SE June 22, 2018	
PHOTO 8 WING WALL CREST AND UPSTREAM FACE, LOOKING SE June 22, 2018	

Appendix B: Photographs	
PHOTO 9 WING WALL DOWNSTREAM SLOPE NEAR POWER HOUSE, LOOKING NE June 22, 2018	
PHOTO 10 NEW TRANSVERSE CRACK AT WING WALL CREST, LOOKING NE June 22, 2018	

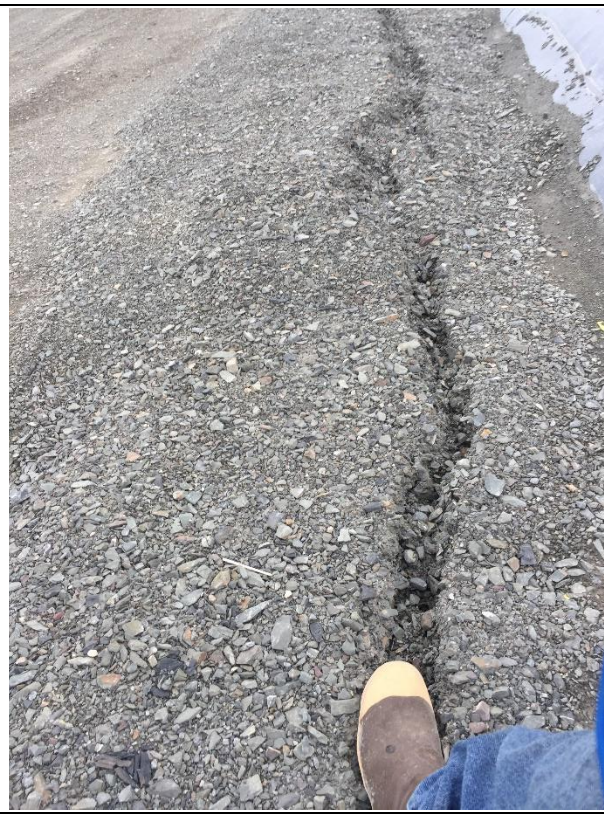
Appendix B: Photographs

PHOTO 11 WING WALL DOWNSTREAM SLOPE NEAR TRANSVERSE CRACK, LOOKING E-NE June 22, 2018	
PHOTO 12 ANNULUS SUBSIDENCE AT 2017 BOREHOLE IN WINGWALL CREST June 22, 2018	

Appendix B: Photographs

PHOTO 13 UPSTREAM WING WALL LINER, LOOKING NW June 22, 2018	
PHOTO 14 UPSTREAM WING WALL LINER, LOOKING S June 22, 2018	

Appendix B: Photographs	
PHOTO 15 HISTORIC TRANSVERSE CRACK AT WING WALL CREST, LOOKING E June 22, 2018	
PHOTO 16 CRACK ALONG STAGE X WING WALL UPSTREAM TOE, LOOKING S June 22, 2018	

Appendix B: Photographs	
PHOTO 17 CLOSEUP OF CRACK ALONG STAGE X WING WALL UPSTREAM TOE, LOOKING N June 22, 2018	
PHOTO 18 WING WALL DOWNSTREAM SLOPE, LOOKING S June 22, 2018	

<table>
<tr><td colspan="2">Appendix B: Photographs</td></tr>
<tr><td>PHOTO 19
TMD EMBANKMENT WEST ABUTMENT, LOOKING DOWN SLOPE FROM CREST

June 22, 2018</td><td></td></tr>
<tr><td>PHOTO 20
TMD EMBANKMENT WEST ABUTMENT, LOOKING UP SLOPE FROM BUTTRESS

June 22, 2018</td><td></td></tr>
</table>

Appendix B: Photographs

PHOTO 21 TMD EMBANKMENT EAST ABUTMENT, LOOKING NW DOWN SLOPE June 22, 2018	
PHOTO 22 TMD EMBANKMENT DOWNSTEAM SLOPE FACE, LOOKING W June 22, 2018	

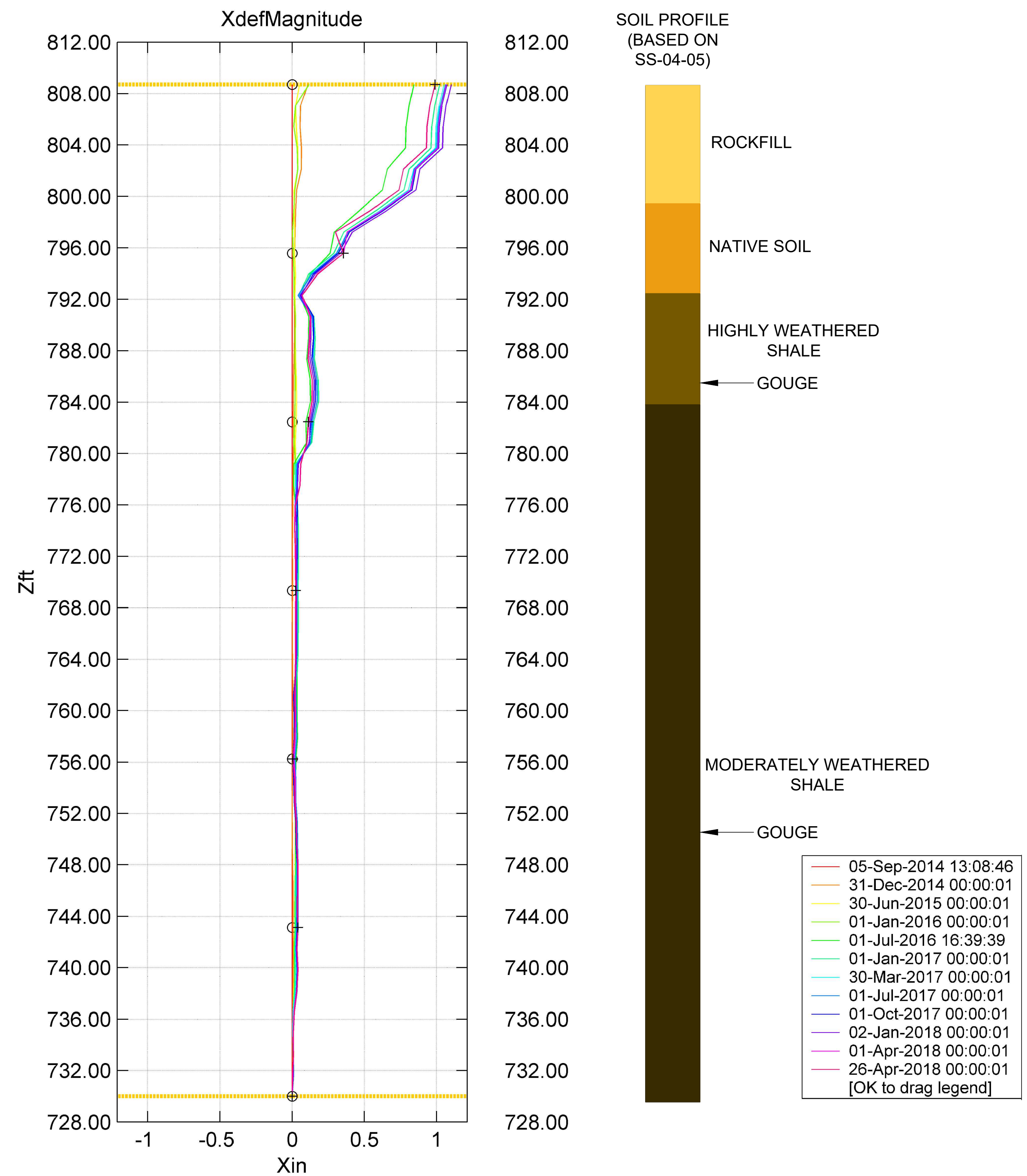
Appendix B: Photographs	
PHOTO 23 TMD EMBANKMENT DOWNSTREAM SLOPE AND EAST ABUTMENT, LOOKING S FROM BUTRESS June 22, 2018	
PHOTO 24 TMD EMBANKMENT DOWNSTREAM SLOPE AND WEST ABUTMENT, LOOKING S FROM BUTTRESS June 22, 2018	

Appendix B: Photographs	
PHOTO 25 TMD EMBANKMENT DOWNSTREAM BUTTRESS SLOPE, LOOKING S June 22, 2018	
PHOTO 26 TMD SEEPAGE COLLECTION POND AND DAM, LOOKING W June 22, 2018	

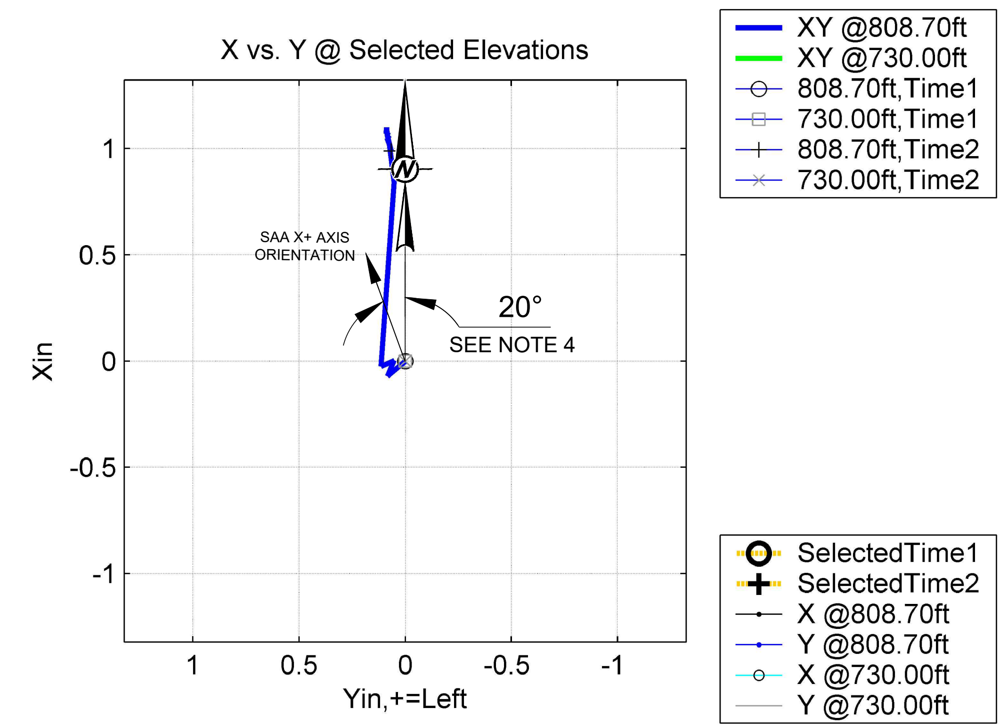
Appendix B: Photographs	
PHOTO 27 SEEPAGE FLOW INTO SEEPAGE COLLECTION POND, LOOKING NW June 22, 2018	
PHOTO 28 DOWNSTREAM SLOPE OF SEEPAGE COLLECTION DAM AND SEEPAGE SEEPAGE PUMPBACK, LOOKING W June 22, 2018	

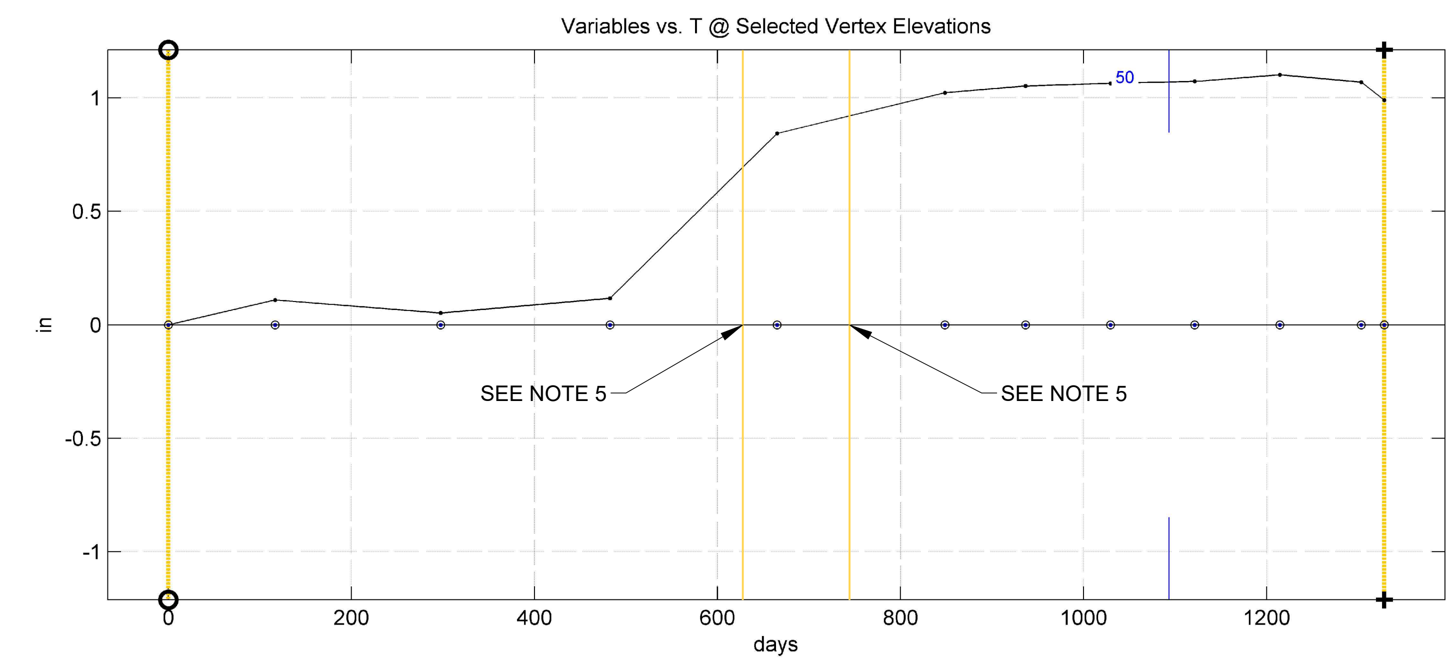
APPENDIX C

SAA Inclinometer Data



CUMULATIVE SAA INCLINOMETER DATA COLLECTED FROM SEPTEMBER 2014 BASELINE





NOTES

1. DISPLACEMENT PLOTTED VERSUS TIME AT LOCATION OF MAXIMUM DISPLACEMENT WITHIN VERTICAL ARRAY.
2. INC-01-13 LIES BURIED UNDERNEATH APPROXIMATELY 25 FEET OF FILL.
3. SENSORIZED INSTRUMENTATION TOLERANCE ERROR AS PER MEASURAND SPECIFICATIONS IS +/- 0.08 INCHES.
4. AZIMUTH ADJUSTMENT OF 20 DEGREES (COUNTER CLOCKWISE) IS ESTIMATED FROM THE URS PHASE II GEOTECHNICAL REPORT THAT STATES THE POSITIVE X-DISPLACEMENT DIRECTION IS NORTH-NORTHWEST
5. APPROXIMATE DATES OF STAGE X BUTTRESS CONSTRUCTION (MAY 15, 2016 TO SEPTEMBER 15, 2016.)

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

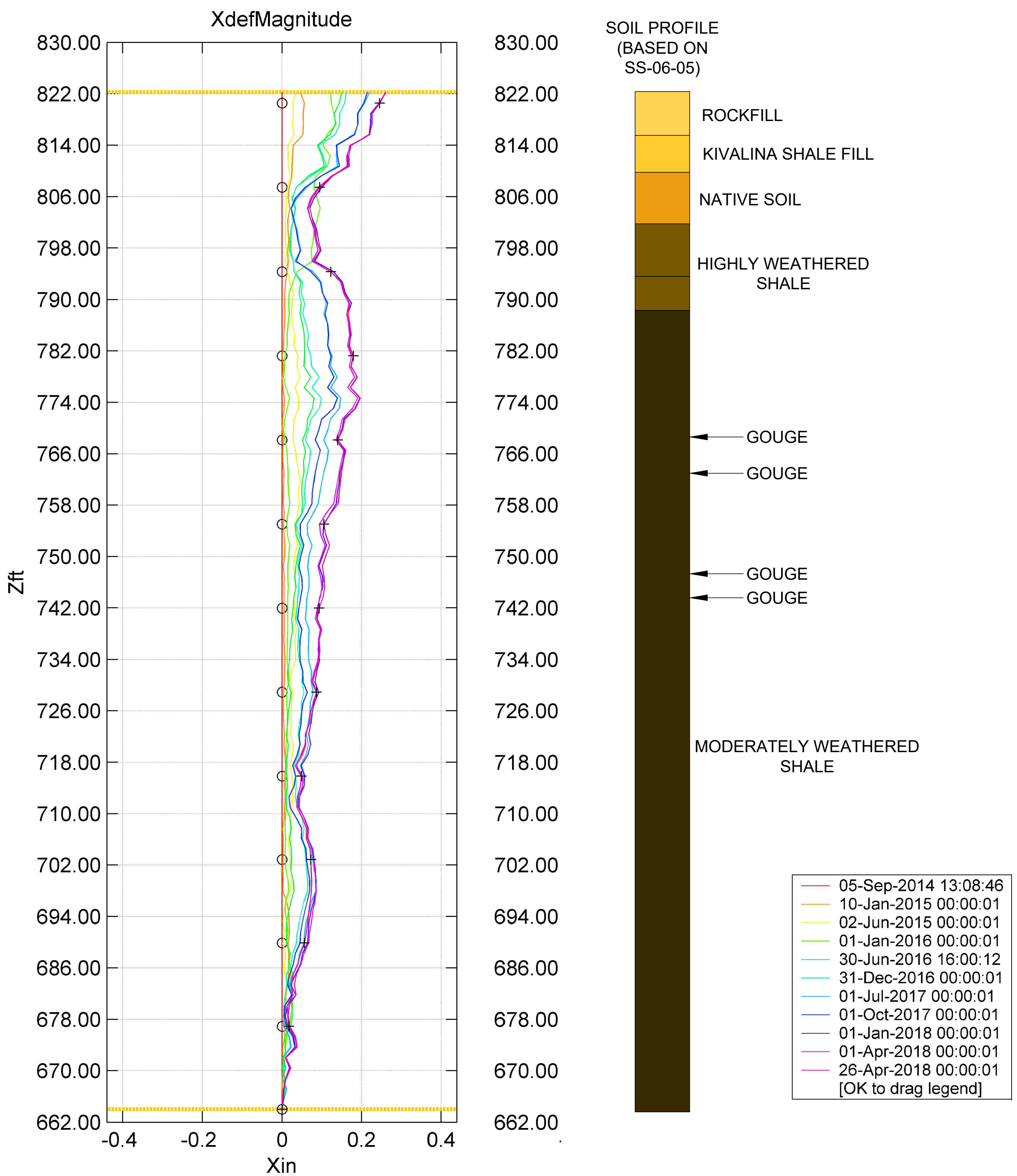
CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
HORIZONTAL MOVEMENT MONITORING AT INC-01-13

PROJECT No.	Rev.	FIGURE
1895982	0	C-1



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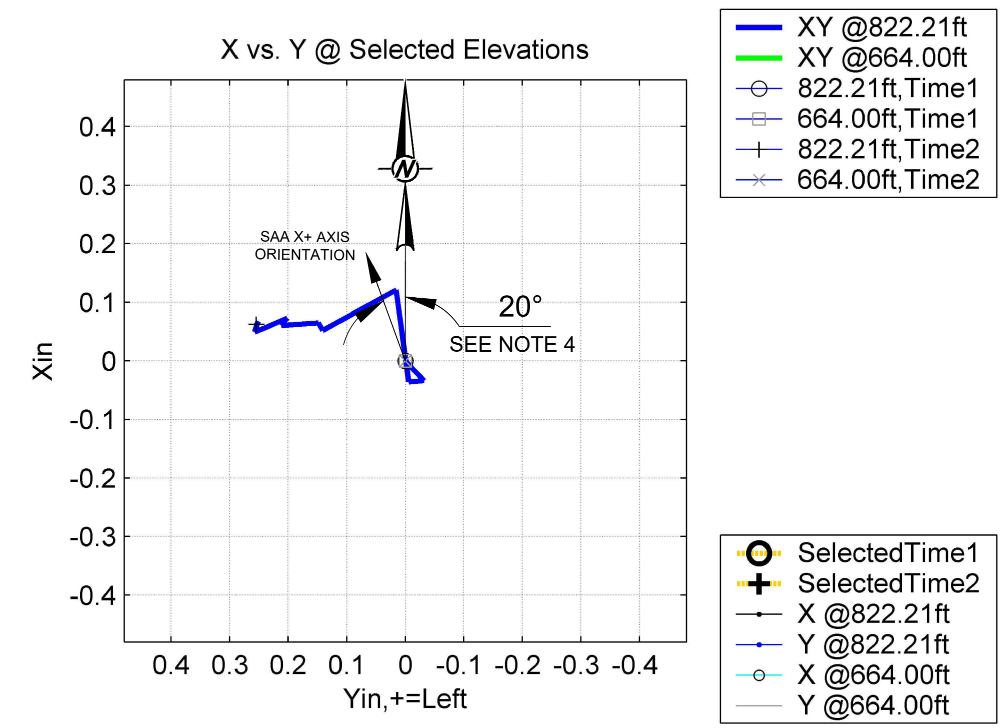
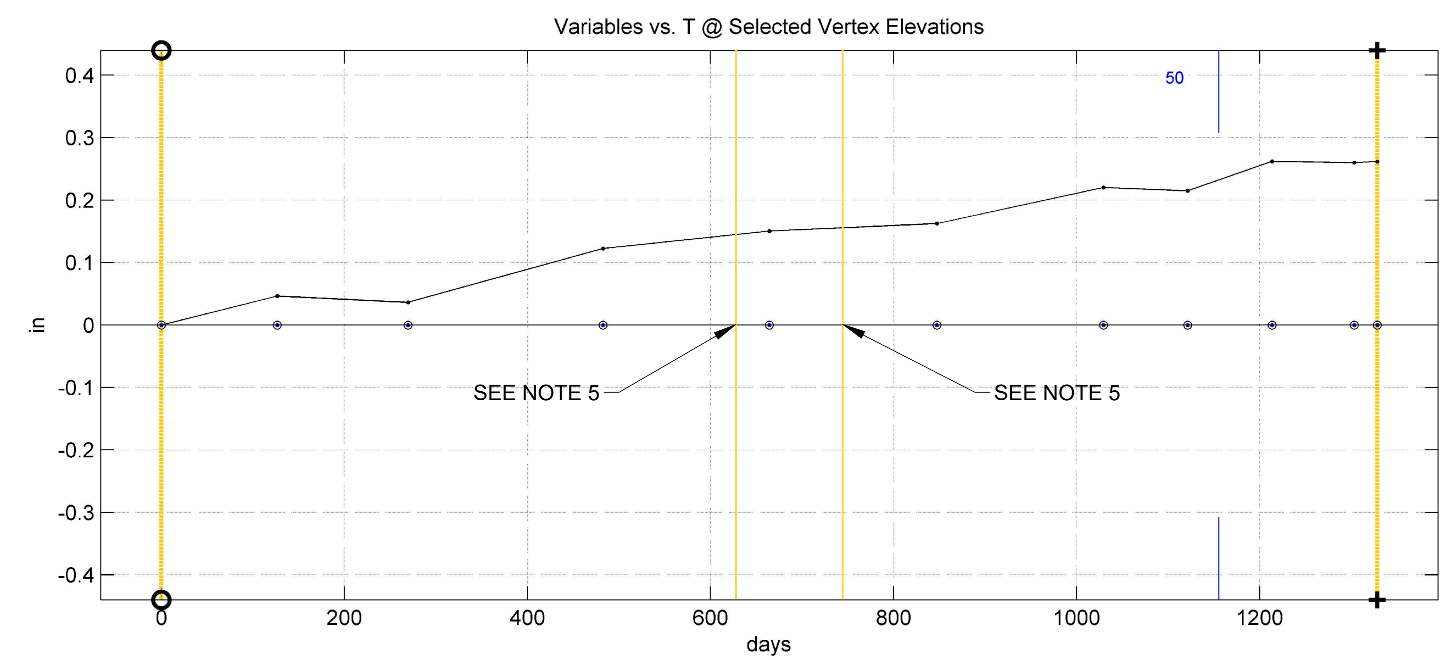
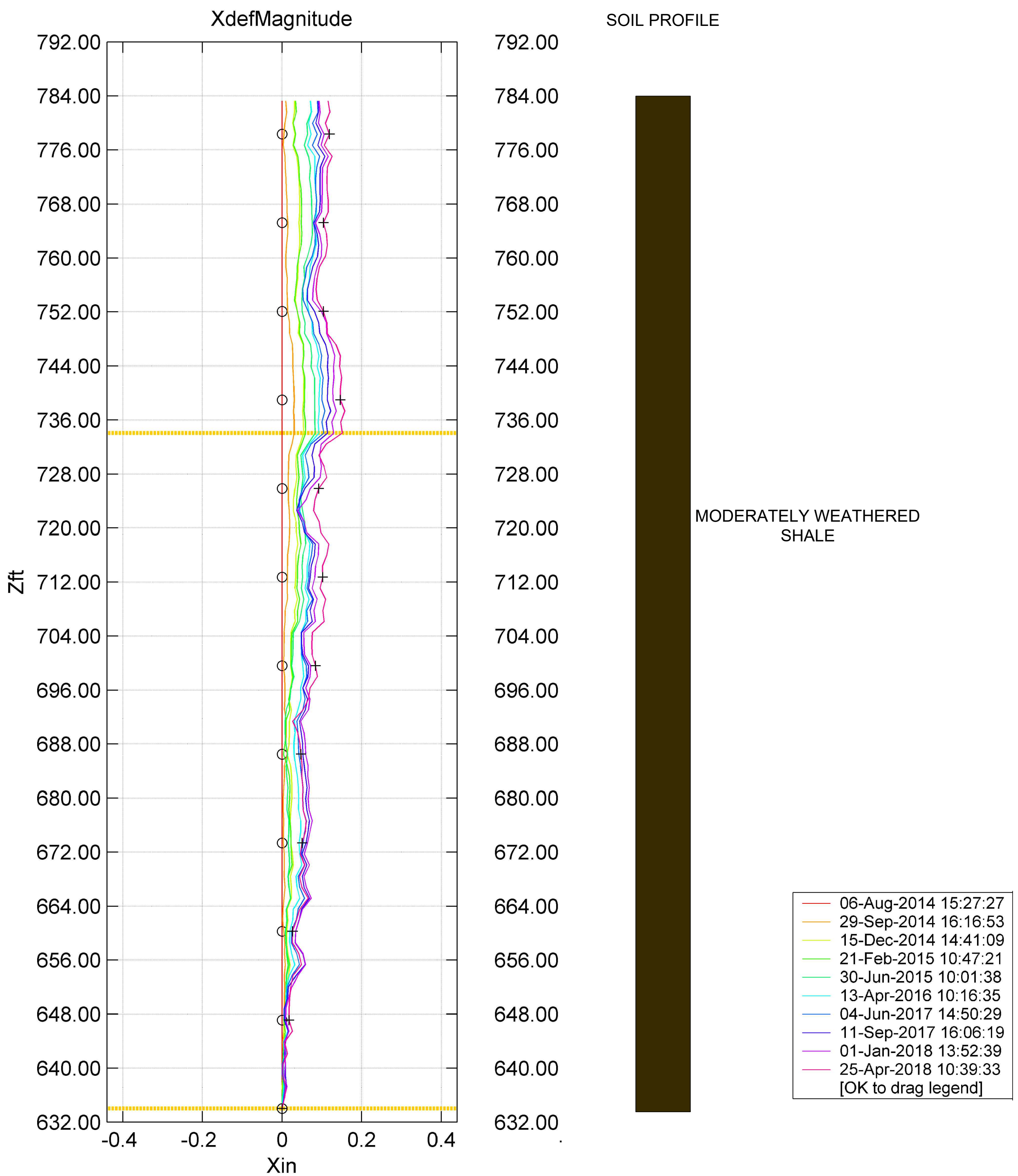




NOTES

1. DISPLACEMENT PLOTTED VERSUS TIME AT LOCATION OF MAXIMUM DISPLACEMENT WITHIN VERTICAL ARRAY.
2. INC-02-13 LIES BURIED UNDERNEATH APPROXIMATELY 35+ FEET OF FILL.
3. SENSORIZED INSTRUMENTATION TOLERANCE ERROR AS PER MEASURAND SPECIFICATIONS IS +/- 0.08 INCHES.
4. AZIMUTH ADJUSTMENT OF 20 DEGREES (COUNTER CLOCKWISE) IS ESTIMATED FROM THE URS PHASE II GEOTECHNICAL REPORT THAT STATES THE POSITIVE X-DISPLACEMENT DIRECTION IS NORTH-NORTHWEST
5. APPROXIMATE DATES OF STAGE X BUTTRESS CONSTRUCTION (MAY 15, 2016 TO SEPTEMBER 15, 2016.)

CLIENT TECK ALASKA INCORPORATED 3105 LAKESHORE DRIVE, BUILDING A, SUITE 101 ANCHORAGE, ALASKA 99517	PROJECT 2018 TAILINGS MAIN DAM ANNUAL INSPECTION RED DOG MINE, ALASKA
CONSULTANT GOLDER YYYY-MM-DD 2018-11-05 PREPARED MWR DESIGN N/A REVIEW SLA APPROVED SLA	TITLE **HORIZONTAL MOVEMENT MONITORING AT INC-02-13** PROJECT No. 1895982 — Rev. 0 — FIGURE C-2



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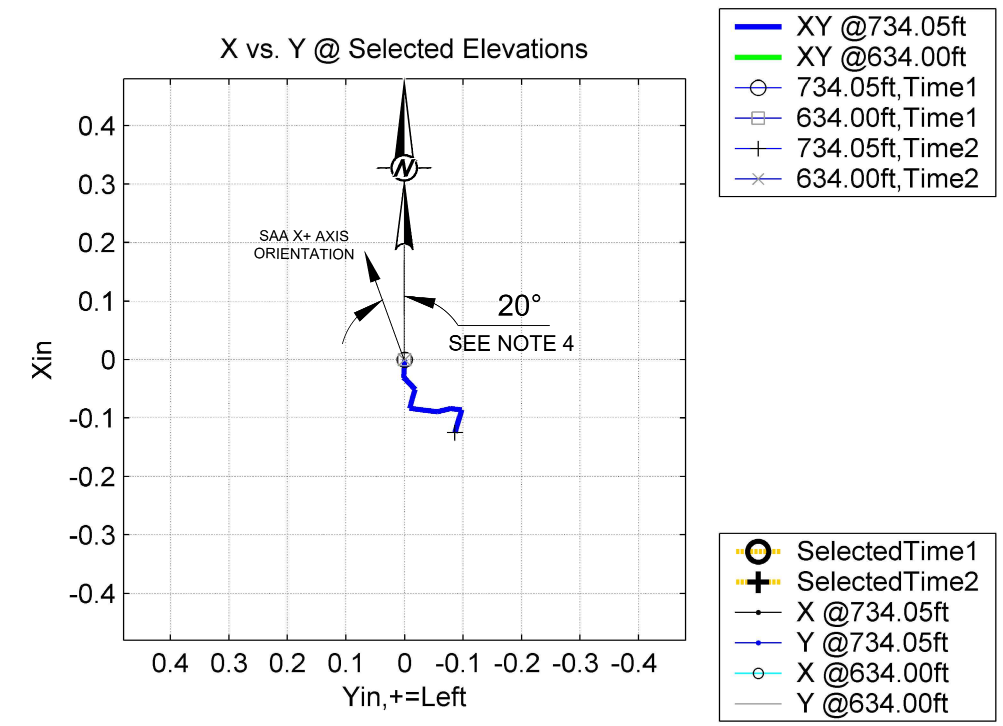
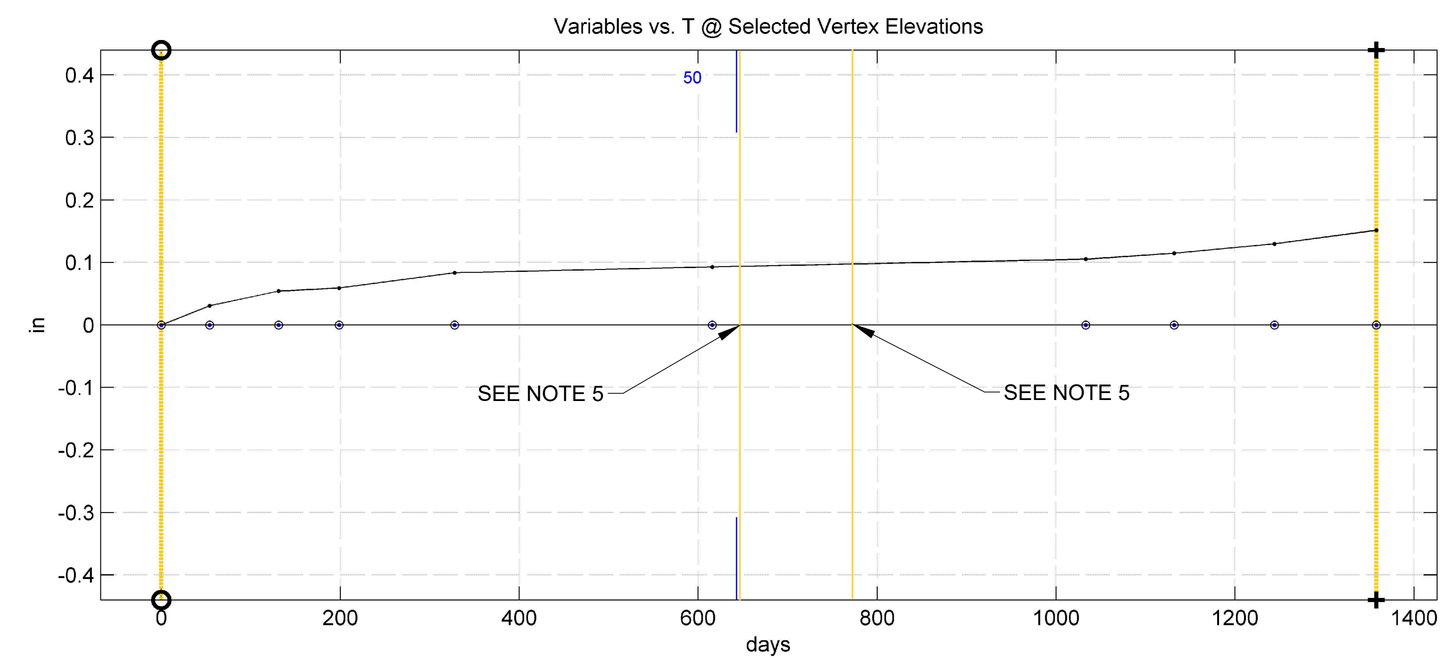




NOTES

1. DISPLACEMENT PLOTTED VERSUS TIME AT LOCATION OF MAXIMUM DISPLACEMENT WITHIN VERTICAL ARRAY.
2. INC-03-14 LIES BURIED UNDERNEATH APPROXIMATELY 17 FEET OF FILL.
3. SENSORIZED INSTRUMENTATION TOLERANCE ERROR AS PER MEASURAND SPECIFICATIONS IS +/- 0.08 INCHES.
4. AZIMUTH ADJUSTMENT OF 20 DEGREES (COUNTER CLOCKWISE) IS ESTIMATED FROM THE URS PHASE II GEOTECHNICAL REPORT THAT STATES THE POSITIVE X-DISPLACEMENT DIRECTION IS NORTH-NORTHWEST
5. APPROXIMATE DATES OF STAGE X BUTTRESS CONSTRUCTION (MAY 15, 2016 TO SEPTEMBER 15, 2016.)

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
HORIZONTAL MOVEMENT MONITORING AT INC-03-14

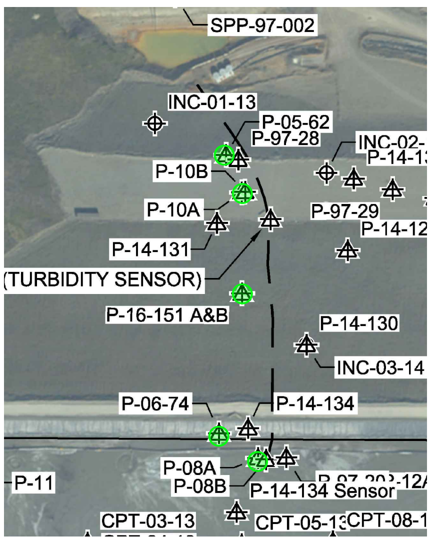
PROJECT No. 1895982
Rev. 0
FIGURE C-3

APPENDIX D

Piezometer, Air Temperature, Precipitation, Tailings Pond Elevation, and Seepage Pumpback Data

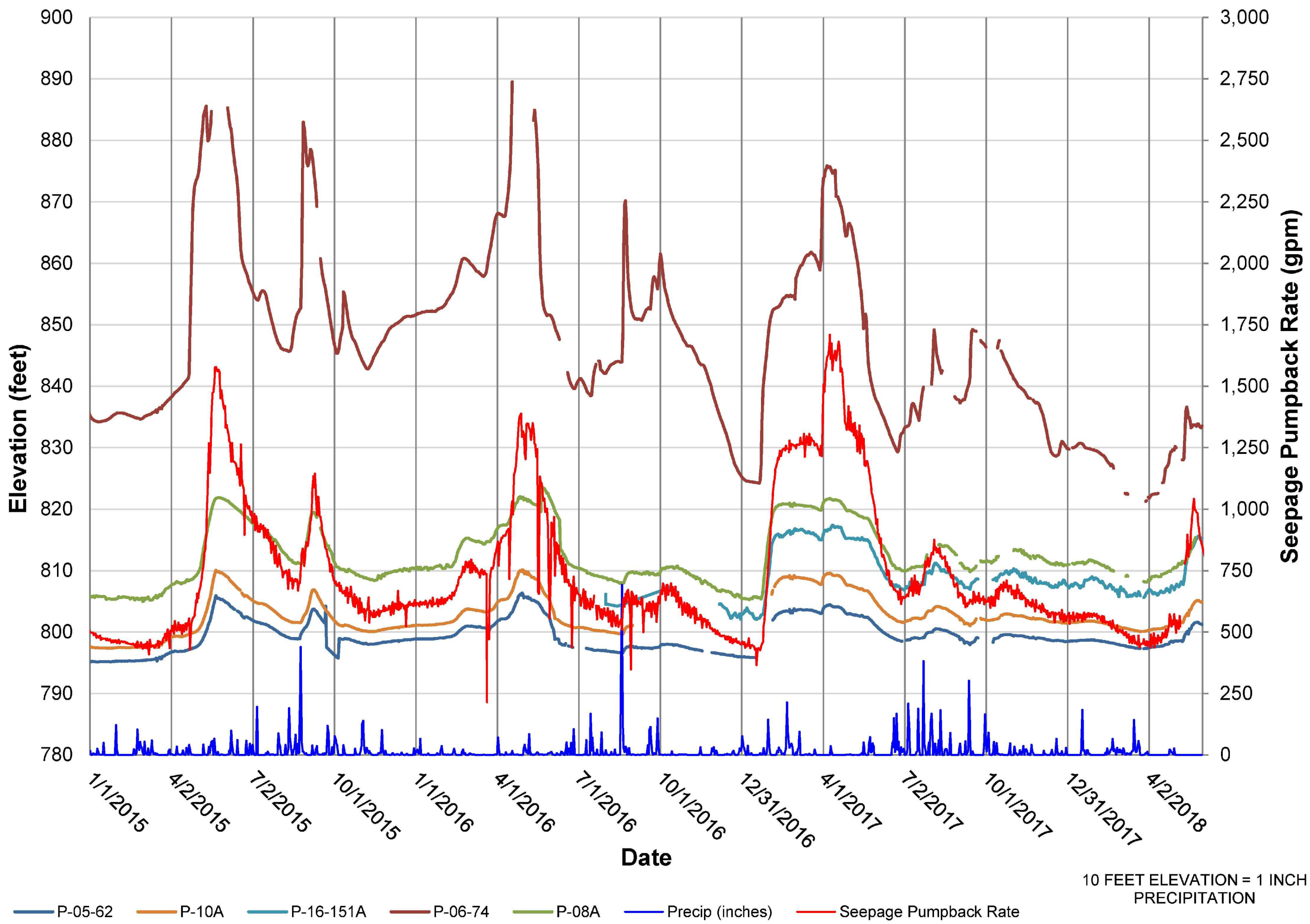
Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg

GENERAL VICINITY MAP



NOT TO SCALE

REFERENCE: SEE FIGURES 2 AND 3



LEGEND

APPLICABLE VIBRATING WIRE PIEZOMETER

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

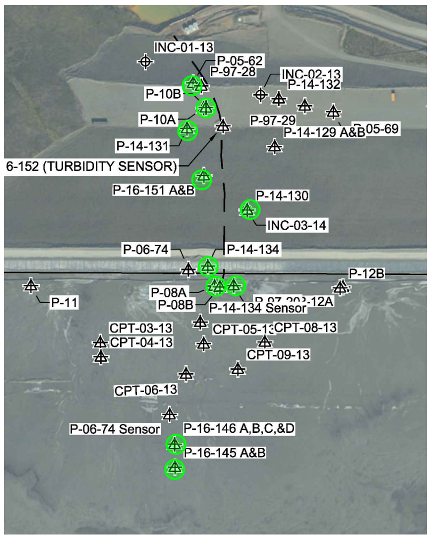
PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
CRITICAL UNDERDRAIN PIEZOMETERS
WATER ELEVATION, PRECIP, AND PUMPBACK

PROJECT No.	Rev.	FIGURE
1895982	0	D-1

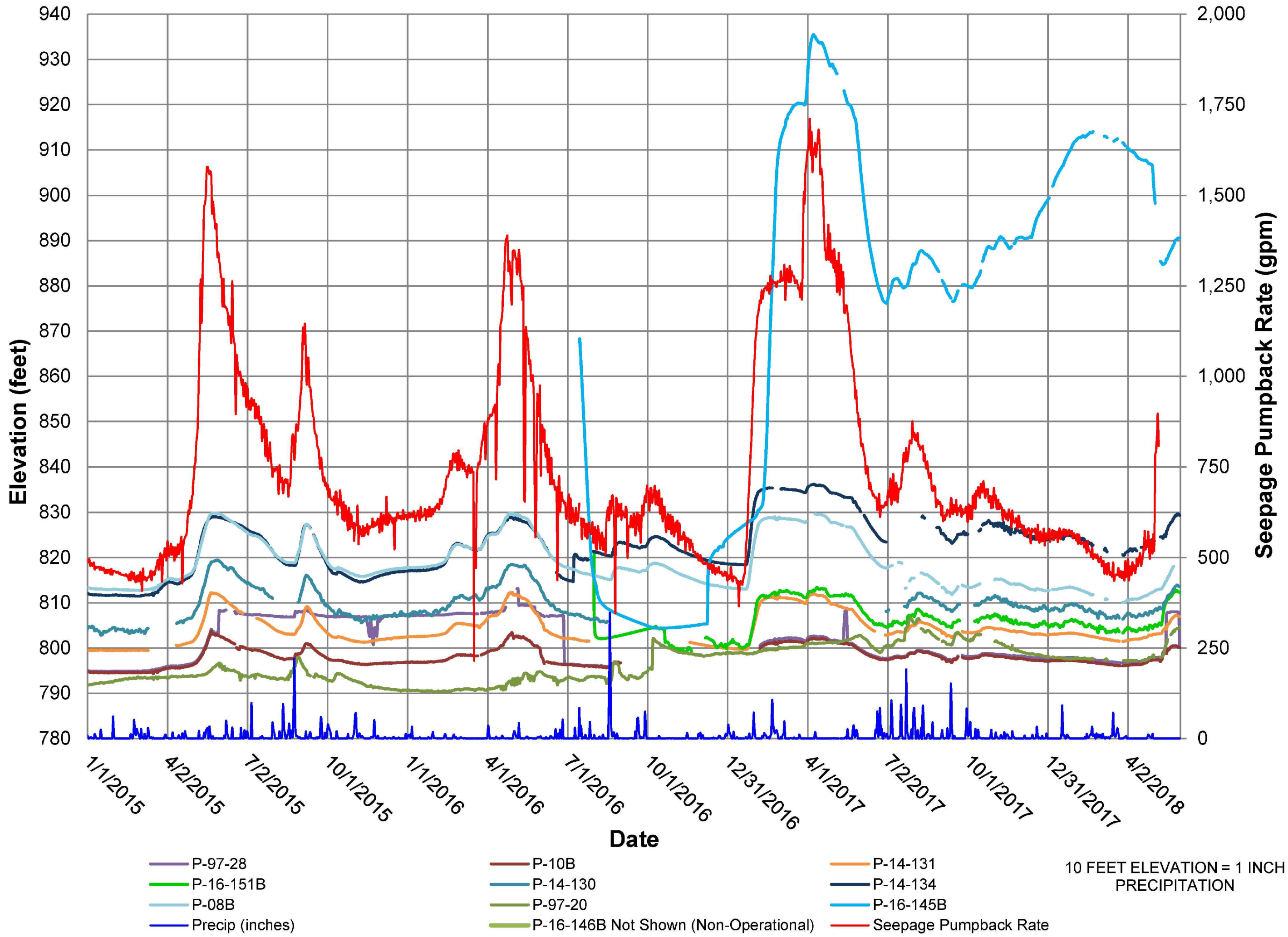
Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg

GENERAL VICINITY MAP



NOT TO SCALE

REFERENCE: SEE FIGURES 2 AND 3



LEGEND

APPLICABLE VIBRATING WIRE PIEZOMETER

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT
GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

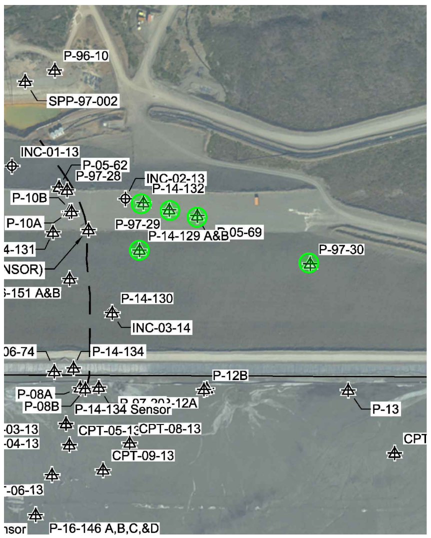
PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
CRITICAL NEAR UNDERDRAIN PIEZOMETERS
WATER ELEVATION, PRECIP, AND PUMPBACK

PROJECT No. 1895982 | Rev. 0 | FIGURE D-2

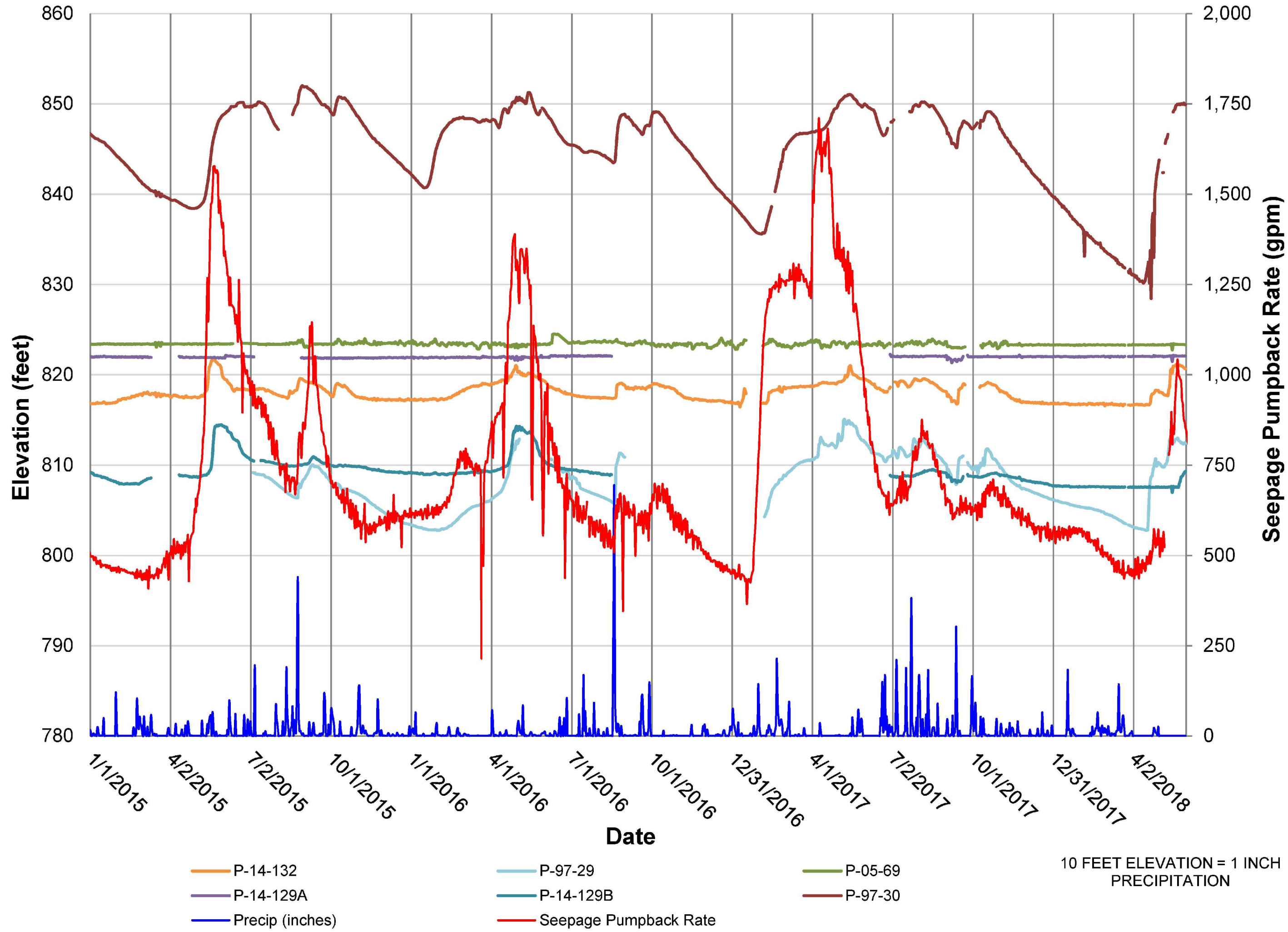
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

GENERAL VICINITY MAP



NOT TO SCALE

REFERENCE: SEE FIGURES 2 AND 3



LEGEND

APPLICABLE VIBRATING WIRE PIEZOMETER

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

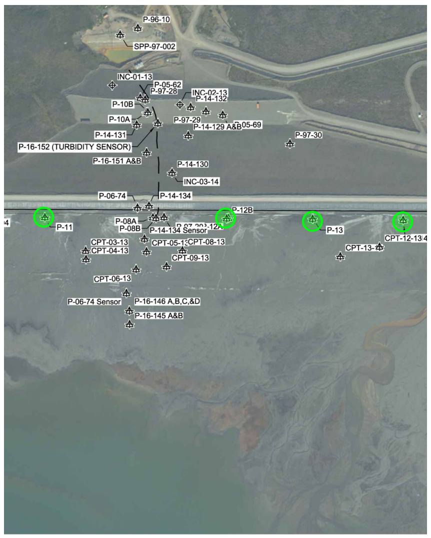
PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
CRITICAL DOWNSTREAM SHELL PIEZOMETERS
WATER ELEVATION, PRECIP, AND PUMPBACK

PROJECT No.	Rev.	FIGURE
1895982	0	D-3

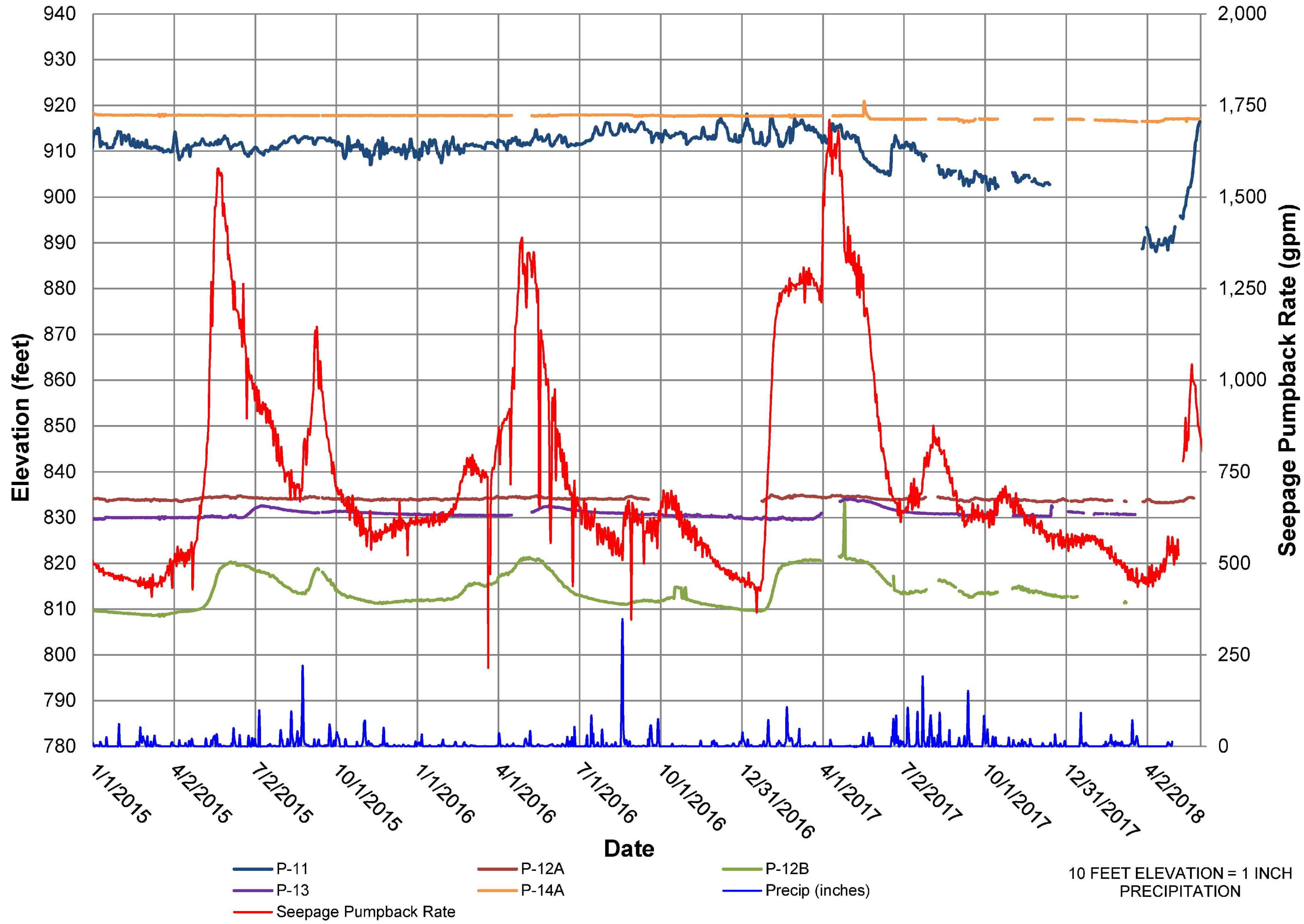
Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg

GENERAL VICINITY MAP



NOT TO SCALE

REFERENCE: SEE FIGURES 2 AND 3



LEGEND

APPLICABLE VIBRATING WIRE PIEZOMETER

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
NONCRITICAL PIEZOMETERS BENEATH TMD
WATER ELEVATION, PRECIP, AND PUMPBACK

PROJECT No.	Rev.	FIGURE
1895982	0	D-4

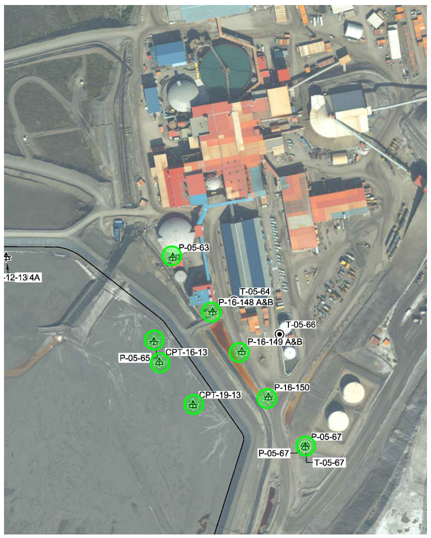
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in

0

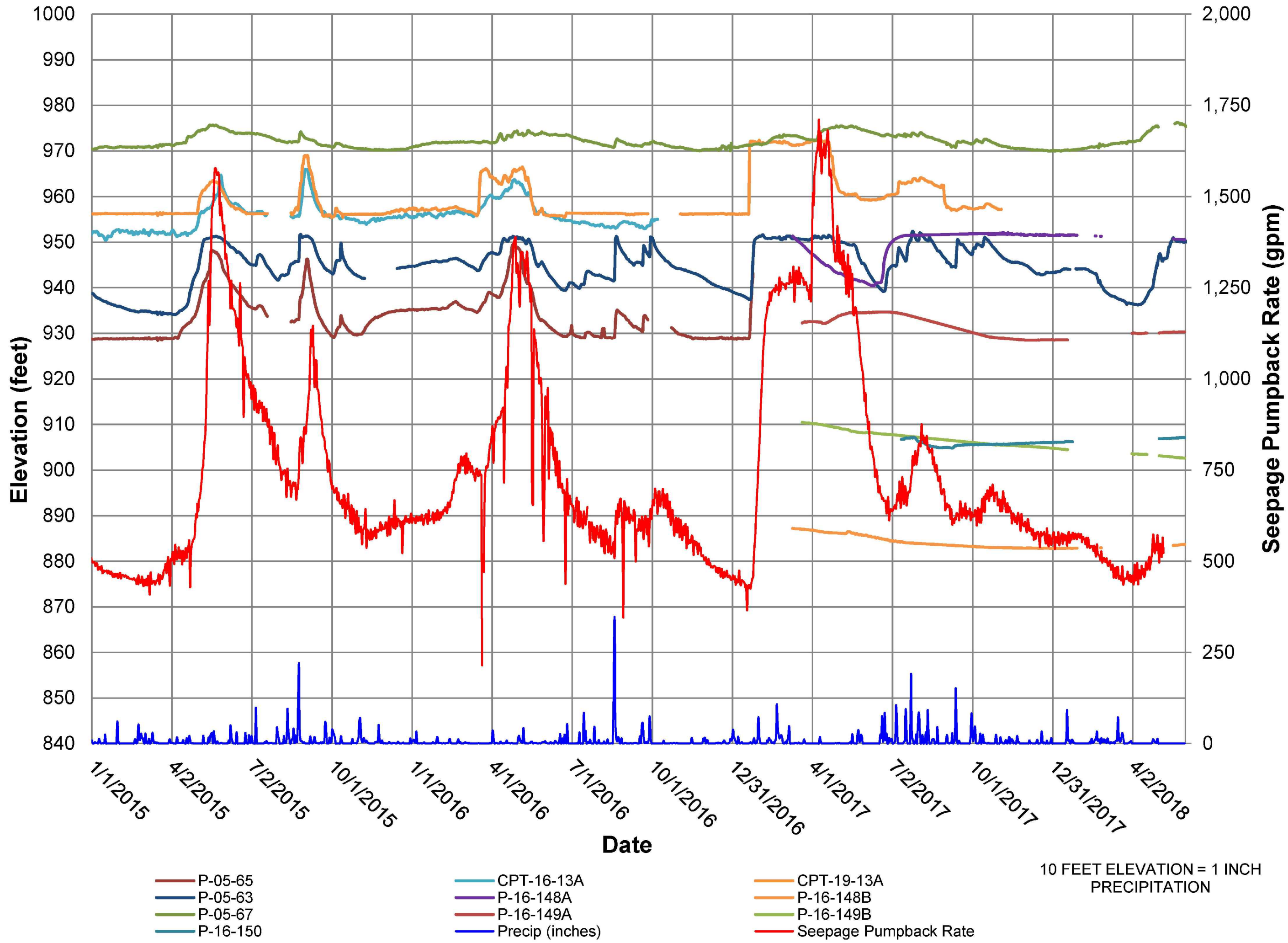
Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg

GENERAL VICINITY MAP



NOT TO SCALE

REFERENCE: SEE FIGURES 2 AND 3



LEGEND

APPLICABLE VIBRATING WIRE PIEZOMETER

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

CONSULTANT

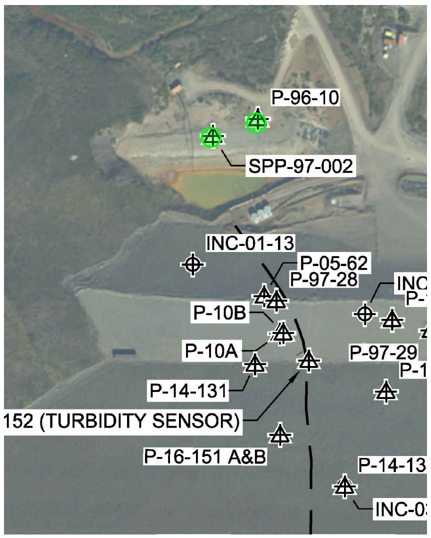
GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

TITLE
NONCRITICAL PIEZOMETERS NEAR WING WALL
WATER ELEVATION, PRECIP, AND PUMPBACK

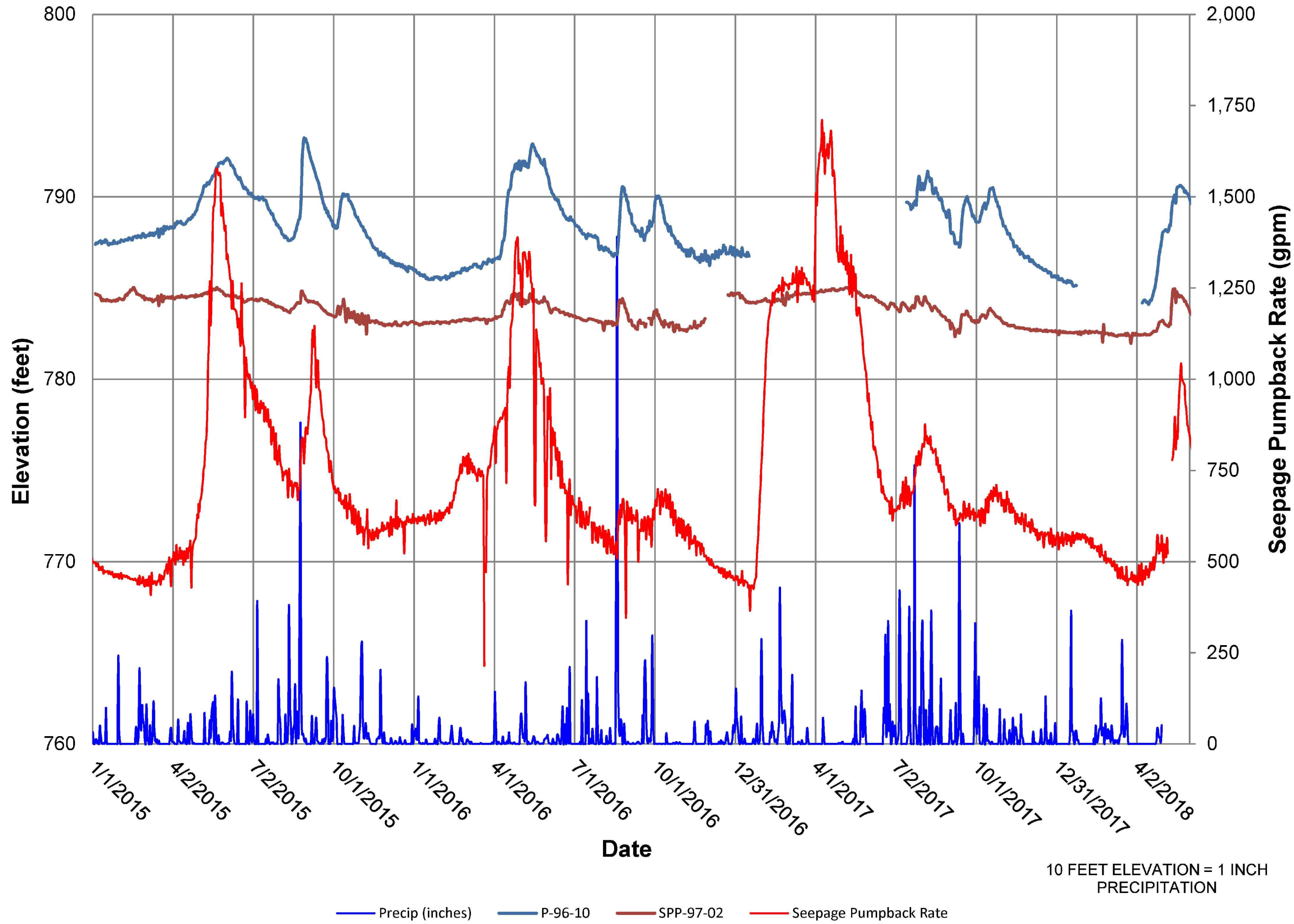
PROJECT No. 1895982
Rev. 0
FIGURE D-5

GENERAL VICINITY MAP



NOT TO SCALE

REFERENCE: SEE FIGURES 2 AND 3



10 FEET ELEVATION = 1 INCH PRECIPITATION

LEGEND

APPLICABLE VIBRATING WIRE PIEZOMETER

CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

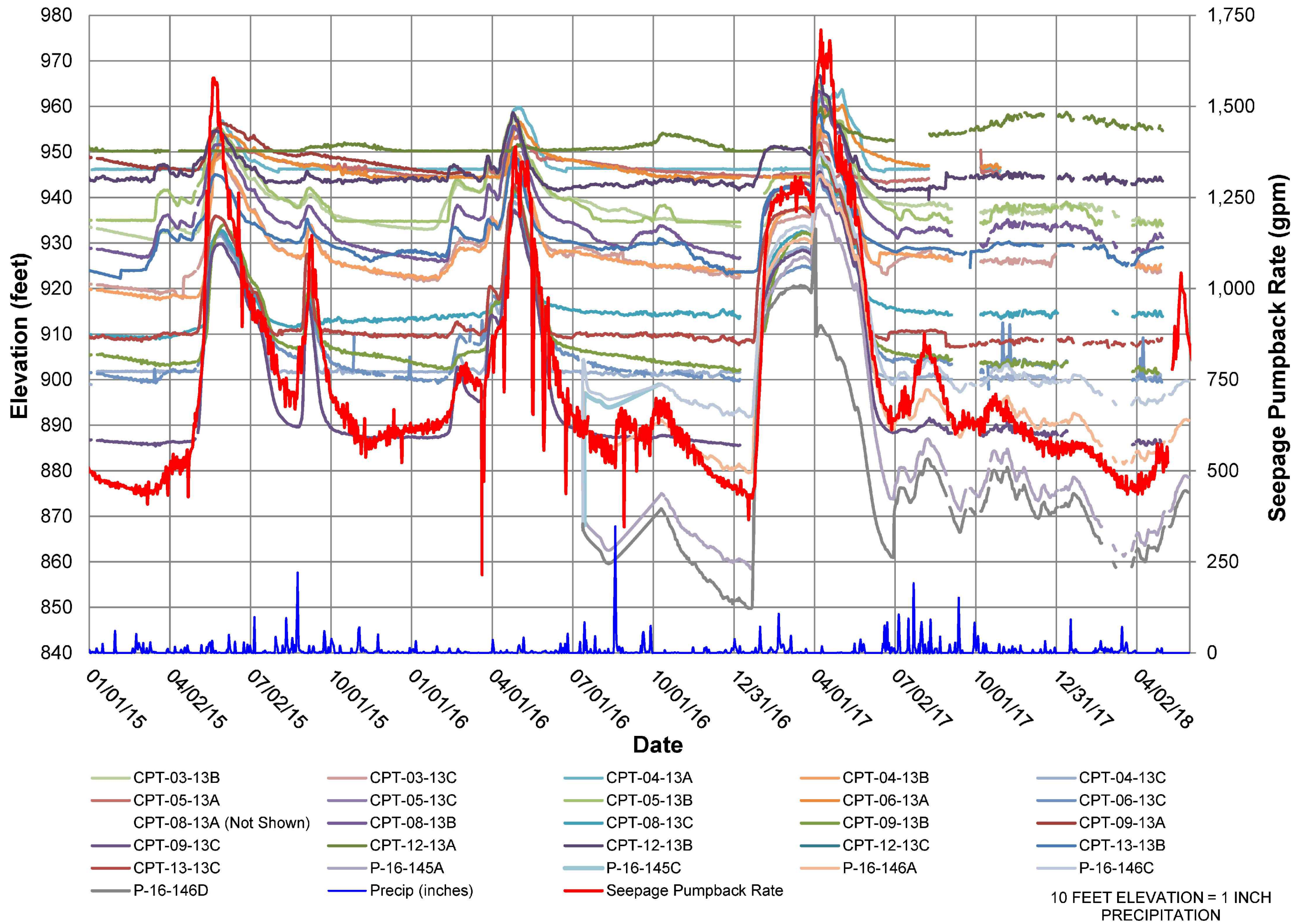
GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
SEEPAGE COLLECTION DAM PIEZOMETERS
WATER ELEVATION, PRECIP, AND PUMPBACK

PROJECT No.	Rev.	FIGURE
1895982	0	D-6



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

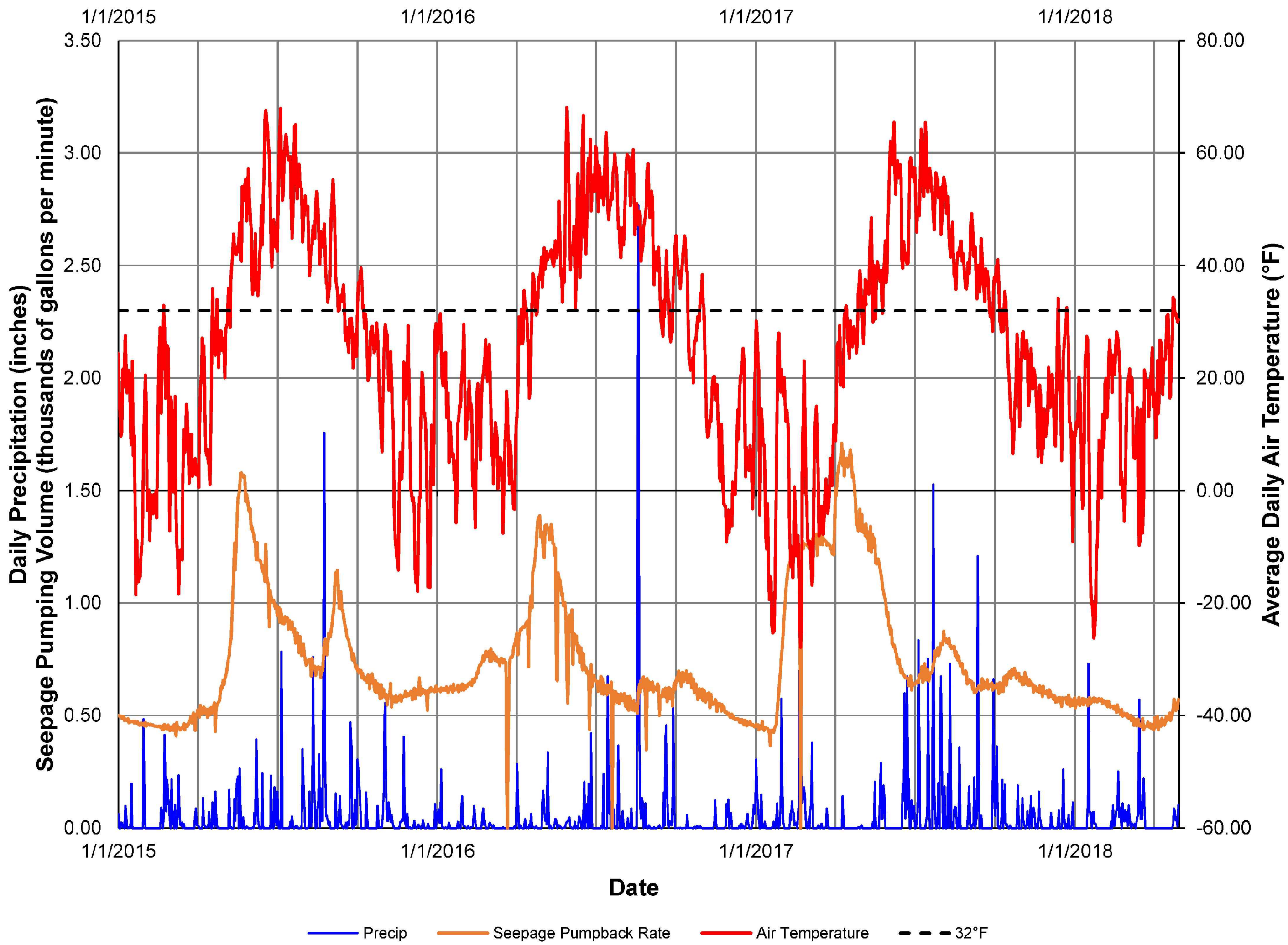
YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
ADDITIONAL VWPS
WATER ELEVATION, PRECIP, AND PUMPBACK

PROJECT No. 1895982
Rev. 0
FIGURE D-7

Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg

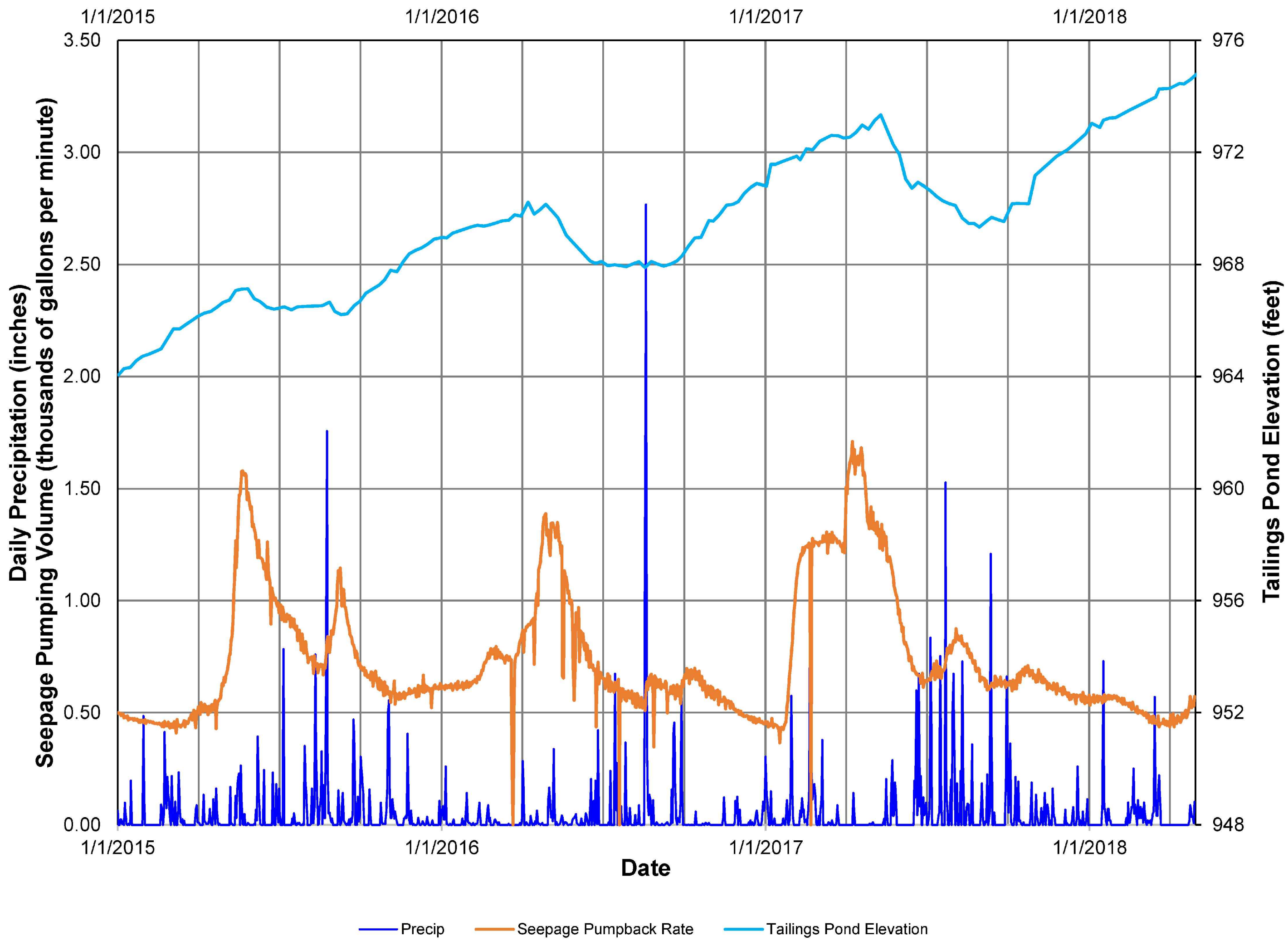


CLIENT TECK ALASKA INCORPORATED 3105 LAKESHORE DRIVE, BUILDING A, SUITE 101 ANCHORAGE, ALASKA 99517	PROJECT 2018 TAILINGS MAIN DAM ANNUAL INSPECTION RED DOG MINE, ALASKA
CONSULTANT GOLDER	TITLE **PRECIPITATION, SEEPAGE PUMP, AND AIR TEMPERATURE DATA**

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT No.	Rev.	FIGURE
1895982	0	D-8

Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
PRECIPITATION, SEEPAGE PUMP, AND TAILINGS POND ELEVATION DATA

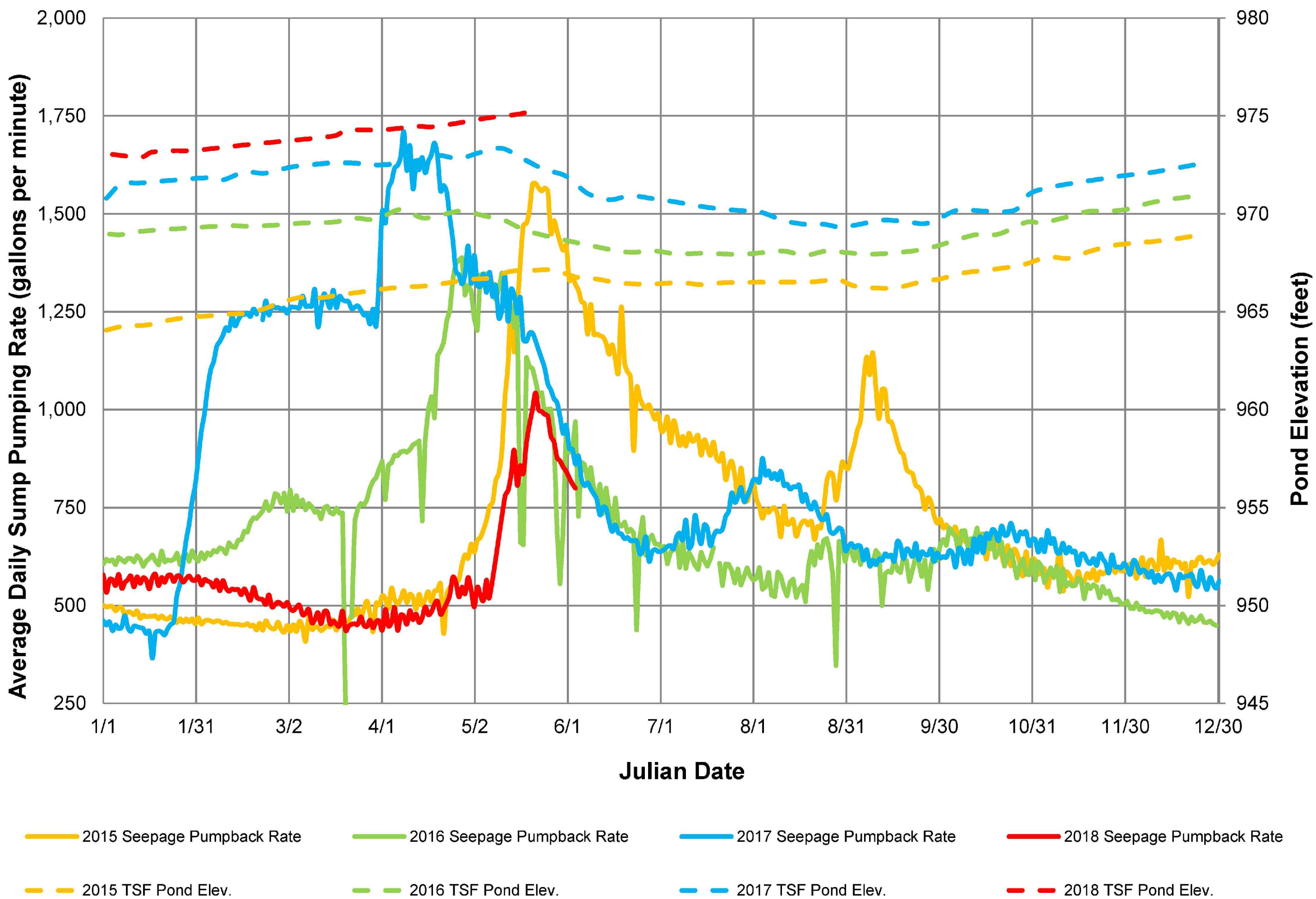
PROJECT No.	Rev.	FIGURE
1895982	0	D-9

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

1 in

0

Path: \\Anchorage\Public\geomatics\Teck\Red Dog\99_projects\1895982 tak 2018 rd main dam annual inspection\task 2000 tmd\02_production\DWG\ | File Name: RD MD 2018 Piezos.dwg



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
PREPARED	MWR
DESIGN	N/A
REVIEW	SLA
APPROVED	SLA

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

TITLE
SEEPAGE PUMP AND POND ELEVATION DATA
JULIAN CALENDAR

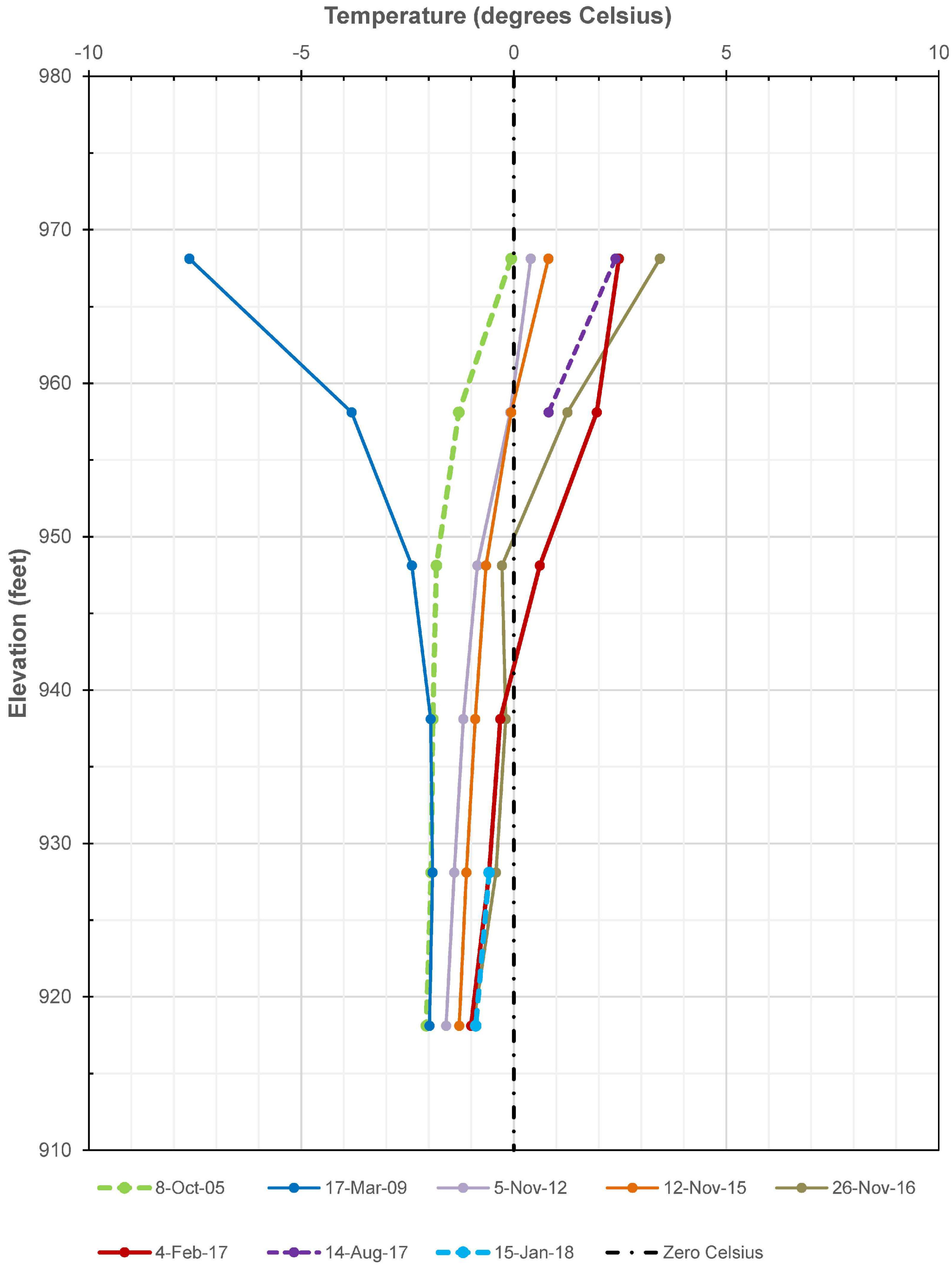
PROJECT No.	Rev.	FIGURE
1895982	0	D-10

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

0 1 in

APPENDIX E

Thermistor Data



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

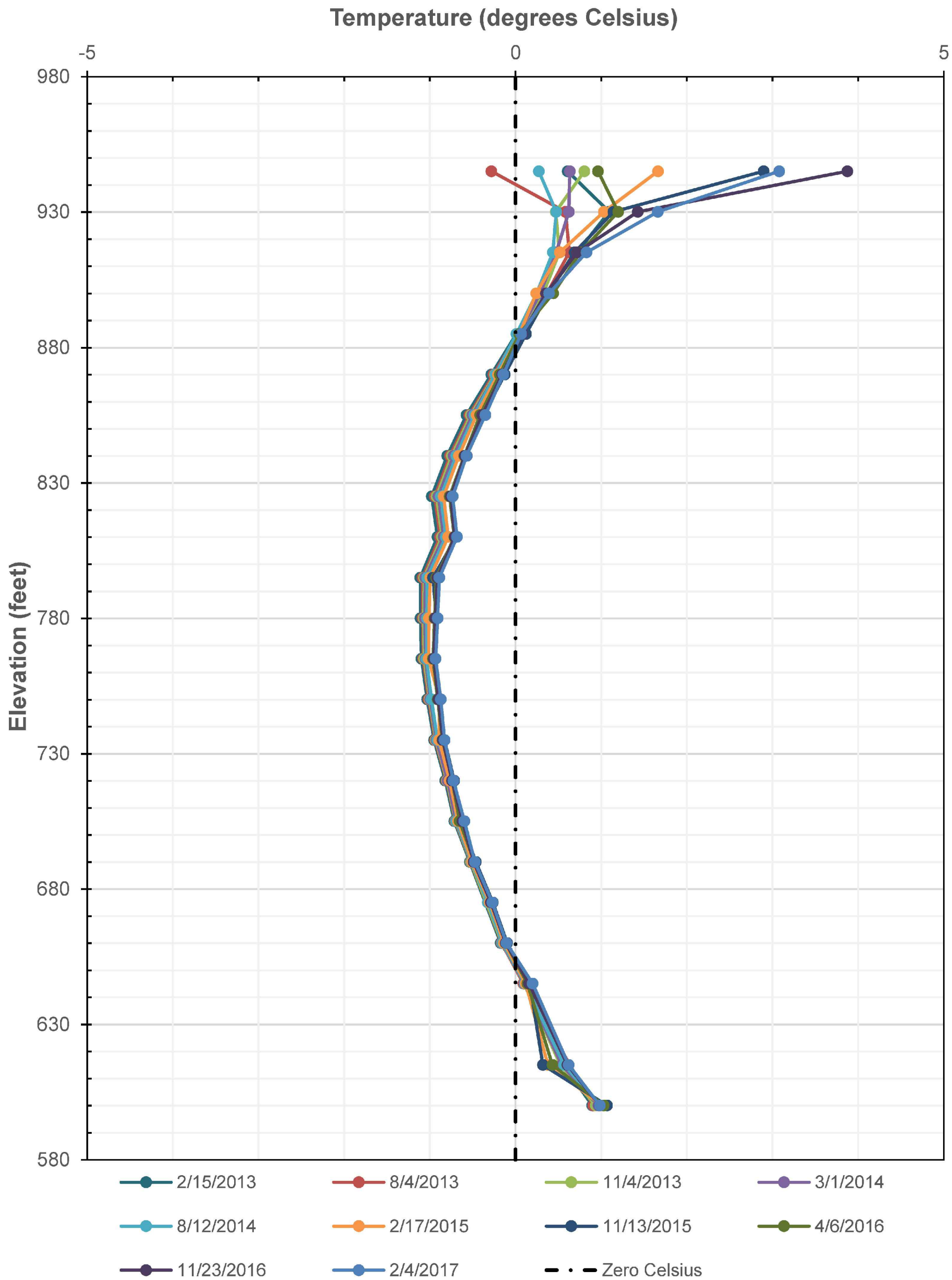
CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
GROUND TEMPERATURE DATA
T-05-61

PROJECT NO.	REV.	FIGURE
1895982	0	E-1



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

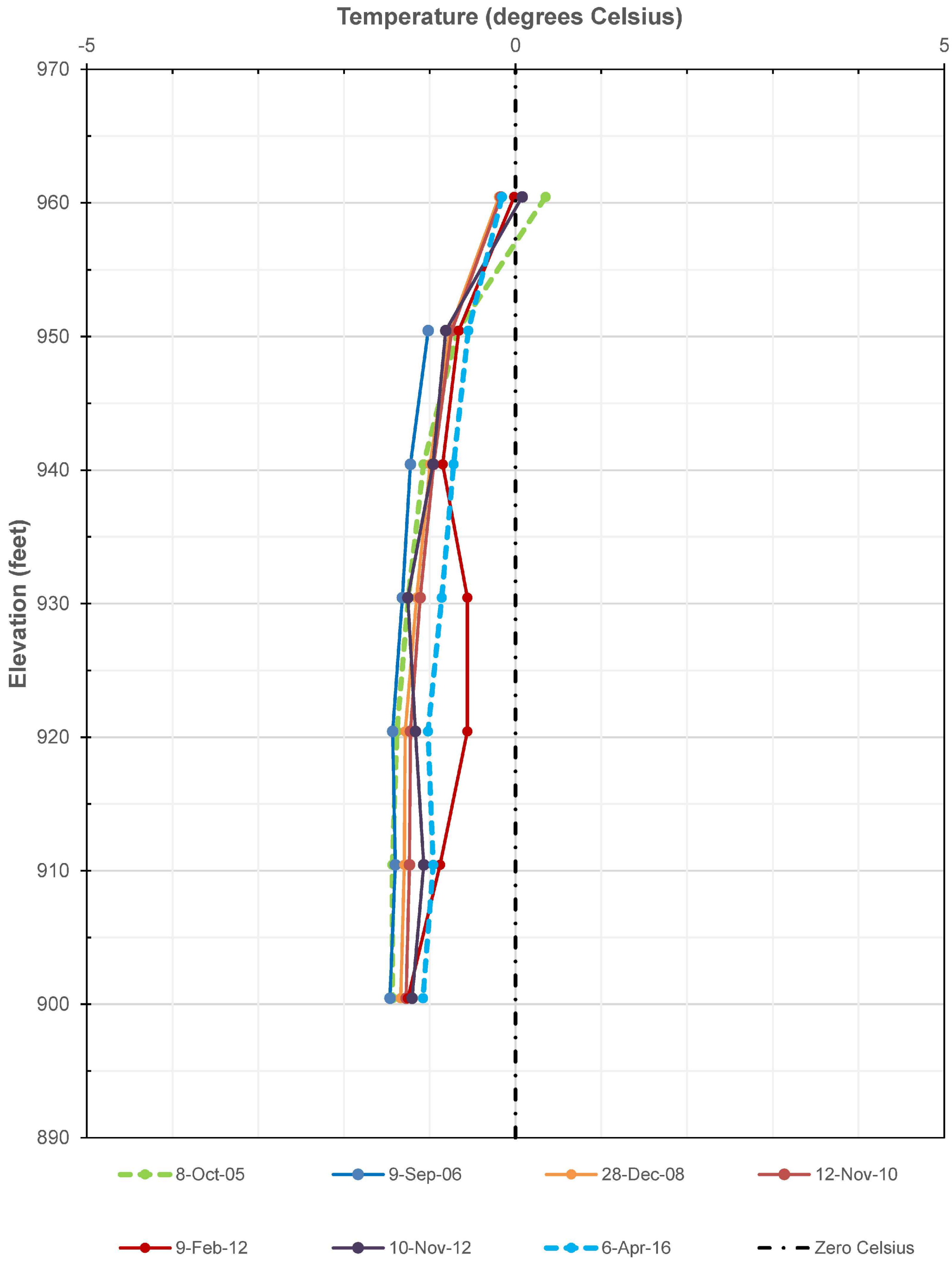
CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
GROUND TEMPERATURE DATA
T−95−004

PROJECT NO.	REV.	FIGURE
1895982	0	E-2



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

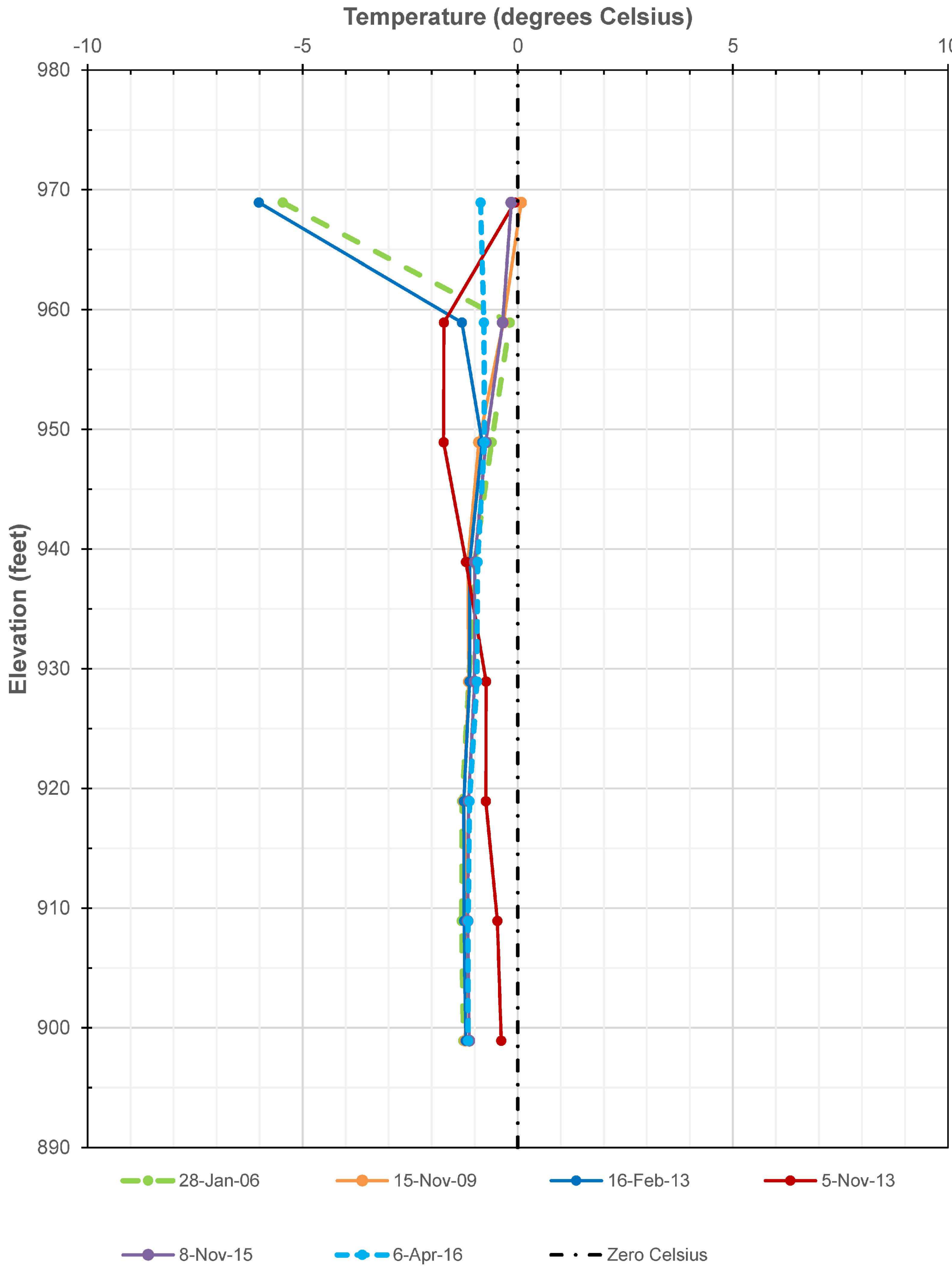
CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
GROUND TEMPERATURE DATA
T-05-64

PROJECT NO. 1895982
REV. 0
FIGURE E-3



CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

CONSULTANT

GOLDER

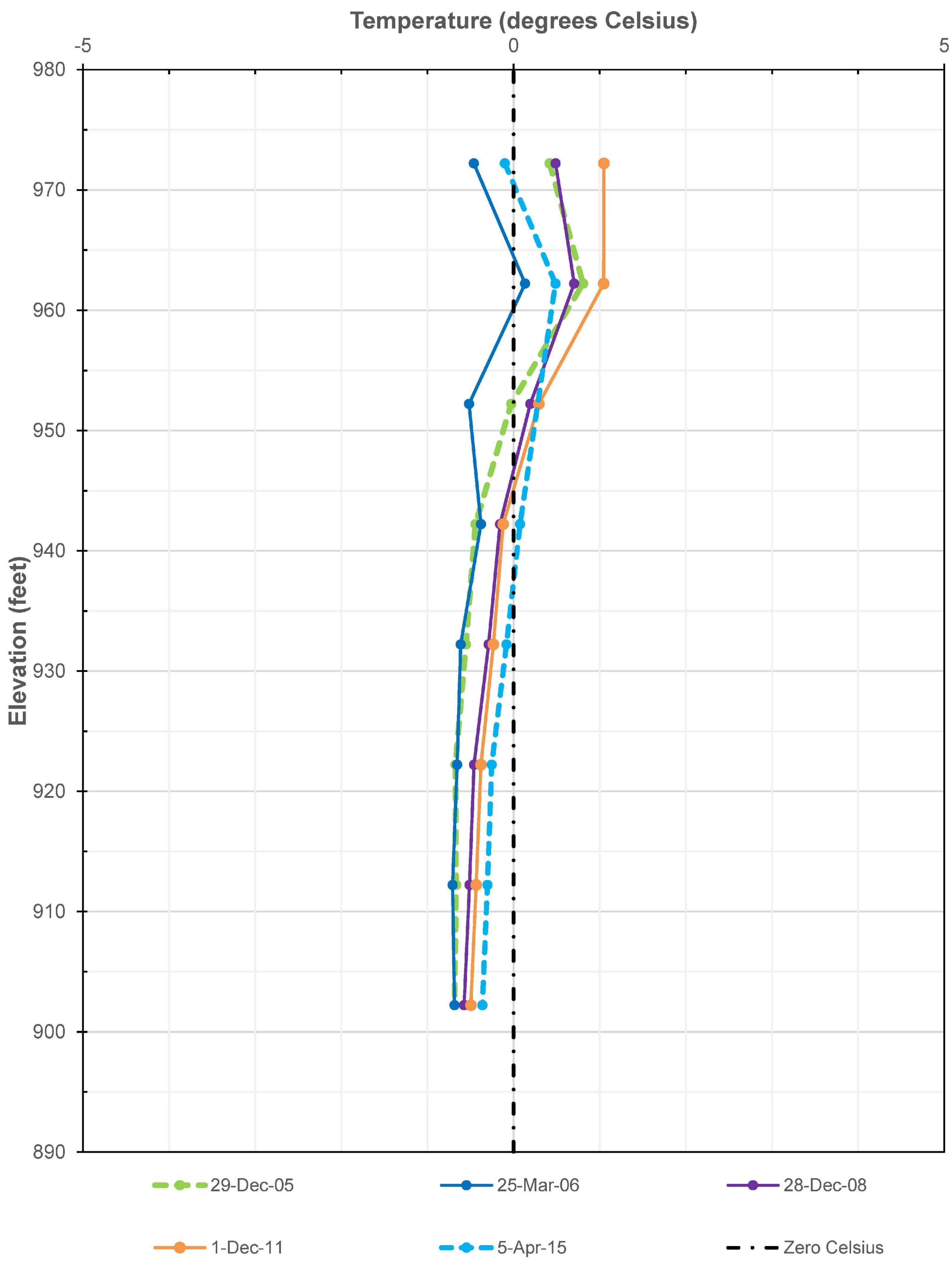
YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
GROUND TEMPERATURE DATA
T-05-66

PROJECT NO.	REV.	FIGURE
1895982	0	E-4

Last Edited By: bhiles Date: 2018-10-24 Time:4:02:07 PM | Printed By: SANDERSON Date: 2018-11-05 Time:12:53:06 PM | File Name: Appendix C Raw Thermistor Data.dwg
Path: \\Anchorage\Public\Geomatics\Teck\Red Dog\99_PROJECTS\1895982 TAK 2018 RD Main Dam Annual Inspection\Task 2000 TMD\02_PRODUCTION\DWG\

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
1 in
0



Last Edited By: bhiles Date: 2018-10-24 Time:4:02:07 PM | Printed By: SANDERSON Date: 2018-11-05 Time:12:53:11 PM
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CLIENT
TECK ALASKA INCORPORATED
3105 LAKESHORE DRIVE, BUILDING A, SUITE 101
ANCHORAGE, ALASKA 99517

PROJECT
2018 TAILINGS MAIN DAM ANNUAL INSPECTION
RED DOG MINE, ALASKA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-05
DESIGNED	N/A
PREPARED	MWR
REVIEWED	SLA
APPROVED	SLA

TITLE
GROUND TEMPERATURE DATA
T-05-67

PROJECT NO.	REV.	FIGURE
1895982	0	E-5