Klohn Crippen Berger

Teck Metals Ltd.

Sullivan Mine Tailings Facilities

2018 Dam Safety Inspection

A05807A18

March 2019

Klohn Crippen Berger

March 26, 2019

Teck Metals Ltd.
Bag 2000
Kimberley, British Columbia
V1A 3E1

Kathleen Willman
Manager, Engineering and Remediation

Dear Ms. Willman:

Sullivan Mine Tailings Facilities
2018 Dam Safety Inspection

Klohn Crippen Berger is pleased to submit a copy of the “2018 Dam Safety Inspection Report” for Teck Metal’s Sullivan Mine located in Kimberley, British Columbia. This report documents our visual observations of the existing conditions of the Sullivan Mine tailings dikes and our review of the instrumentation data to August 31, 2018. The reporting period for the 2018 DSI is from September 1, 2017 through August 31, 2018.

We appreciate the opportunity to continue to provide our services to Teck Metals. Please call the undersigned at (780) 733-4592 if you have any questions.

Yours truly,
KLOHN CRIPPEN BERGER LTD.

Pamela Fines

Pamela Fines, M.A.Sc., P.Eng.
Project Manager

KM:ro

190326R SUL 2018 TSF DSI.docx
A05807A18

Klohn Crippen Berger Ltd. • 500 - 2618 Hopewell Place NE • Calgary AB T1Y 7J7 • CANADA
403.274.3424 t • 403.274.5349 f • www.klohn.com

Teck Metals Ltd.

Sullivan Mine Tailings Facilities

2018 Dam Safety Inspection

Klohn Crippen Berger

March 2019

EXECUTIVE SUMMARY

This report presents the 2018 Annual Dam Safety Inspection (DSI) of the tailings dikes and dams at Sullivan Mine located in Kimberley, British Columbia. The 2018 DSI is the 27th consecutive annual inspection of the dikes and dams at the facility carried out by Klohn Crippen Berger Ltd. (KCB), formerly Klohn Crippen Consultants Ltd.

The report presents the findings from the site visit by the Engineer of Record (EoR), Mr. Bill Chin, P.Eng., and the approved EoR designate Ms. Pamela Fines, P.Eng. on May 23 and 24, 2018, as well as a review of the instrumentation data collected, and routine work performed at Sullivan Mine between September 1, 2017 and August 31, 2018. The 2018 work included:

- Regular maintenance activities, such as grading of access roads, cleaning of ditches and removal of shrubs.
- Ongoing review of ARD storage and stormwater management capacities, which KCB is assisting Teck with, including a review and update of the surface hydrology. Work is expected to continue into 2019.
- Geotechnical investigation completed August 7th to 17th, 2018. Sonic drilling, standpipe installations, and cone penetrations tests (CPT) were completed in the East Gypsum, West Gypsum, and No. 2 and No. 3 Siliceous Dikes. This was conducted in accordance with recommendations by KCB, which are supported by the Independent Tailings Review Board (ITRB). One of the targeted objectives was to examine whether there is evidence of aging effects in the tailings over nearly two decades since the facility was closed by comparing the results of recent and past CPTs conducted at similar locations. Work is ongoing to complete associated laboratory testing and report.
- Instrument replacements completed during the August 7th to 17th, 2018 geotechnical investigation in accordance with the recommendation in the 2017 Annual Dam Safety Inspections report. Five standpipes were replaced with vibrating wire piezometers. Work is ongoing to complete a report and automating the instruments.

Summary of Facility Description

After almost a century of operations, the Sullivan Mine was closed at the end of 2001. Reclamation work on the tailings areas started in 1990 and was essentially completed by 2008.

There is a total of 15 earthfill dams and dike structures that create seven separate storage facilities for tailings, ARD water, and water treatment sludge. A summary of the maximum height and crest lengths of the main embankments for each facility is shown below. The earthfill structures have a combined length of about 10.4 km, with maximum heights varying from about 4.2 m to 29 m.

While many of these facilities were initially designed and constructed through the 1970s and 1980s or earlier, field investigations and design reviews (stability and performance assessments) have been periodically completed since that time. Over the last 10 years prior to closure, a significant amount of work was conducted to enhance long-term stability; modifications to the structures included flattening of slopes and/or construction of toe berms such that the structures meet or exceed required factors of safety under static and dynamic loading, considering the Maximum Credible Earthquake and assuming all saturated tailings liquefy. In addition, a closure surface water management plan was put in place including construction of surface water diversions and spillways to safely handle inflow design floods.

No modifications have been required for the Sludge Impoundment dikes to date. This is because the original design capacity of the facility far exceeded production requirements and there had been little accumulation of sludge immediately against the dikes. A design review of the Sludge Impoundment dikes is planned in the near future and its design will be updated as necessary based on projected storage requirements.

Most recently, two Dam Safety Reviews of the Sullivan facilities were completed in 2008 and 2013, which included reviews of dam/dike stability against current criteria, and they did not identify any dam safety concerns. The next required Dam Safety Review was initiated in 2018 and is currently in progress with the final reporting coming later in 2019.

Summary of Storage Facilities at Sullivan Mine

Storage Facility	Embankment	Type	Approximate Embankment Length (m)	Approximate Maximum Height (m)	Starter Dike Constructed (Year) [1]	Year of Last Dike Raise (Year)
Iron TSF	Iron Dike	Iron Tailings	1500	29.0	1975	1999
Old Iron TSF	Old Iron Dike	Iron Tailings	520	7.6	prior to 1948	Unknown
	Iron TSF Divider Dike	Iron Tailings	1190	3.6 [3]	post 1948	Unknown
Siliceous TSF	No. 1 Siliceous Dike	Silica Tailings	2000	4.9 [3]	1923	1979
	No. 2 Siliceous Dike	Silica Tailings	730	9.5	1975	1982
	No. 3 Siliceous Dike	Silica Tailings	1540	12.5	1975	1984
Gypsum TSF	East Gypsum Dike	Gypsum	670	16.8	1969	1983
	West Gypsum Dike	Gypsum	640	22.9	1969	1986
	Northeast Dike	Gypsum, Seepage Water	120	10.0	1985	1985
	Recycle Dam	Seepage/ARD Water	90	6.0	1985	1985
Calcine TSF	Calcine Dike	Calcine	520	4.6 [3]	1972	1986
ARD Pond [2]	North Dam	ARD/Seepage Water	460	7.6	2001	2001
	South Dam	ARD/Seepage Water	330	16.8	1976	2001
Sludge Impoundment	North Dike	Sludge	120	4.3	1978	1978
	South Dike	Sludge	200	6.1	1978	1978

Notes:

[1] Starter Dike information based on data from Annual Inspection Report by SRK-Robinson dated June 1991.

[2] The ARD Pond is established at the site of the old cooling pond.

[3] Tailings were placed downstream of both Iron TSF Divider Dike and No. 1 Siliceous Dike. The original height of the Iron TSF Divider Dike and No. 1 Siliceous Dike from original ground is 10.7 m and 16.8 m, respectively. A municipal landfill is downstream from the Calcine Dike. The height of the Calcine Dike from original ground is 15.2 m.

Summary of Key Hazards and Consequences

As a required component of a dam safety inspection, the key potential hazards and failure modes have been identified. The hazards for the storage facilities at Sullivan Mine are overtopping during major flood events for all ponds and TSFs, and piping failures at the ARD Pond and the Iron TSF.

The likelihood of overtopping failures for the inactive facilities is close to non-credible[1] to very rare[2] given the closure measures in place, including drainage channels and spillways for the inactive Old Iron, Siliceous, Gypsum, and Calcine TSFs, which are designed for the PMF. The likelihood of overtopping for the active facilities, the ARD Pond and the Iron TSF (which contains the Emergency Storage Pond), is close to non-credible, as they have spillways designed for the PMF. The likelihood of failure from overtopping of the Sludge Impoundment is currently under review.

The likelihood for piping failures (ARD Pond and Iron TSF) is also close to non-credible to very rare given the filter zones within the ARD Pond Dams and the low pond water levels and associated piezometric surfaces within the Iron TSF. The likelihood of a piping failure for the Sludge Impoundment is rare[3] given the filter zone along the upstream face and lack of permanent pond.

In addition, Teck has a robust surveillance program to monitor pond levels and check for dike surface gullying that might lead to freeboard changes and/or local slope steepening, and to look for any evidence of changes in seepage conditions at the toe of each dike that could be indicative of potential piping (ARD Pond, Iron TSF, and Sludge Impoundment).

The likelihood of failure due to an earthquake is also very rare to close to non-credible for the tailings facilities as the dikes were designed considering the Maximum Credible Earthquake and assuming all saturated liquefiable tailings will liquefy. As the design of the dikes/dams assumed liquefied residual undrained strengths for saturated tailings, the static factors of safety are generally well above the minimum required factor of safety of 1.5. It is expected that the stability of the dikes/dams for the tailings facilities, under both seismic and static loading conditions, would have increased over time as the phreatic surfaces within the various tailings impoundments have decreased since closure.

The likelihood of failure due to seismic and foundation stability for the sludge pond is rare based on the design factors of safety of 1.2 and 1.4, respectively.

It is worth noting that several of the tailings storage facilities are approaching the permanent condition of not meeting the definition of a "dam" any longer. KBC and Teck have initiated engineering activities towards quantifying improvements that have occurred towards reducing the

---

[1] "Close to Non-Credible" Likelihood Rating is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is greater than 1 in 10,000 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) for slope instability of 2.0 or greater.

[2] "Very Rare" is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is between 1 in 1,000 and 1 in 10,000 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) against slope instability of 1.5 to 2.0.

[3] "Rare" Likelihood Rating is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is between 1 in 100 years and 1 in 1000 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) against slope instability of 1.3 to 1.5

incremental consequences of failure to support continuing work towards reclassifying the facilities that no longer meet the dam definition to engineered landforms.

Consequence Classifications (CDA and HSRC)

Consequence classification is not related to the likelihood of a failure, but rather the potential impact resulting from a failure if it did occur. A review of the consequence classification according to 2007 CDA guidelines (CDA, 2013) was undertaken as part of the 2008 Dam Safety Review (KCB, 2009) and the 2013 Dam Safety Review (Golder, 2014), and based on the information available, consequence classifications of the seven storage facilities were determined as summarized below:

Tailings Dikes and Consequence Classification

Storage Facility	Embankment	Consequence Classification
Iron TSF	Iron Dike	H
Old Iron TSF	Old Iron Dike	L
	Iron TSF Divider Dike	L
Siliceous TSF	No. 1 Siliceous Dike	L
	No. 2 Siliceous Dike	L
	No. 3 Siliceous Dike	L
Gypsum TSF	East Gypsum Dike	H
	West Gypsum Dike	H
	Northeast Gypsum Dike	L
	Recycle Dam	L
Calcine TSF	Calcine Dike	L
Sludge Impoundment	North Dike	L
	South Dike	L
ARD Pond	North Dam	VH
	South Dam	VH

Notes:
Consequence Categories based on 2007 Canadian Dam Safety Guidelines (CDA, 2013): E=Extreme, VH= Very High, H=High, S=Significant, L=Low.

The consequence classifications for the embankments are currently being reviewed as part of the 2018 DSR.

It is important to highlight that, while these structures are currently considered "dams" from a regulatory perspective, few of the inactive facilities are retaining fluid tailings and many could be considered equivalent to earthen landfills. This is evident through a review of the instrumentation data, which indicates that piezometric surfaces for most are very low (i.e. near original ground or 1 – 2 m above), especially for the Iron TSF Divider Dike and Old Iron Dike of the Old Iron TSF, the Siliceous TSF, the Calcine TSF and the Gypsum TSF. In addition, aging effects may also be an important factor in reducing the mobility of tailings over time. In such cases, their respective consequence classifications could be significantly lowered, and in the near future, it may be possible to declassify some of these dikes. Teck and KCB are in the process of completing a phased work plan to support lowering the consequence classifications for some of the inactive facilities and towards eventual declassification of the dikes where considered feasible and appropriate.

Summary of Key Observations (Instrumentation and Visual)

Threshold levels have been established for all instruments. The thresholds for piezometers are not intended to be indicative of any dam safety concern and have been set at values that are well below those assumed in the design for limit equilibrium stability calculations. Rather, their main objective is to identify any measured change from historic or expected behaviour that warrants review by Teck and the EoR (or designate) to QA the reliability of the readings and/or to understand the likely cause of that change.

A review of the thresholds is planned for 2019 with the intent of linking them to potential key failure modes and will also incorporate the experience from previous years where the readings were influenced by higher than average precipitation.

Iron Dike

Based on the visual observations and instrumentation review, the stability of the Iron Dike is considered satisfactory. The Emergency spillway is in good condition.

Of the 30 piezometers installed within the Iron Dike, 23 indicated an increase in the measured pore pressures during the 2018 reporting period over the previous year's readings due to higher than average precipitation. However, all readings were below the threshold levels and well below levels assumed for design stability assessments. Two of the piezometers (P92-H and P92-25) are installed within the confined aquifer underlying glacial till below the dike. These piezometers indicated stable piezometric levels during 2018.

There was essentially no measurable settlement recorded by the settlement plates in 2018. There has been total settlement of between 30 to 65 mm since 2007.

At Station 5+00 there is seepage from the Iron Dike that collects in the drainage ditch at the dike toe. This seepage has been observed since the construction of the Iron Dike. The ditch connects to the main collector ditch along the west side of the West Gypsum Cell. The flow rates within the ditches are recorded by two weirs (Weir #3- AIPWU and Weir #4). Weir #3 (AIPWU), which was installed in 2013 and is located 25 m from the dike, recorded a minimum flow rate of 0.1 m^3/day during February, and a peak flow rate of 124.8 m^3/day during the freshet in April. The peak flow rates recorded during this reporting period were the highest since installation of the new weir, in response to above average precipitation and snowpack during the reporting period. Due to the location of the weir, the peak recorded flow will include runoff from the dike and surrounding area. A peak flow of 1084.3 m^3/day was recorded during the same month at Weir #4. As this weir is 300 m from the dike, the flow rate includes runoff from the surrounding terrain as well as seepage. The peak flow recorded for Weir #4 is significantly higher than in previous years and is the maximum recorded flow for the weir. This reading followed several days of rain on the melting snowpack. Seepage also collects in a pond near the dike toe at station 24+00, and observations of this pond should be collected by Teck during routine inspections.

Old Iron TSF

The instrumentation and visual inspection indicate the Iron TSF Divider Dike and Old Iron Dike of the Old Iron TSF are in good physical condition and performing as intended. Three of the four active piezometers installed within the Old Iron Dike recorded maximum pore pressures above the threshold levels, but subsequent readings have indicated a reduction of piezometric levels below threshold levels. Both of the active piezometers located within the Iron TSF Divider Dike are currently below their threshold levels. The increases were due to the higher than average precipitation (snowpack) in 2018.

It was recommended in the 2016 DSI that piezometer P96-11 be replaced as it could not be read in 2008/2009 nor in 2013 and recent readings had been erratic. Additionally, it was recommended that piezometer P96-08 be replaced as the tip elevation was unknown and only relative changes in pore pressures were recorded. The recent readings were also erratic. P96-11 was replaced with vibrating wire piezometers SUL-OID-VWP-18-02 A&B and P96-08 was replaced with vibrating wire piezometers SUL-OID-VWP-18-01 A&B in August 2018.

Siliceous TSF Dikes

The instrumentation data and visual inspections indicate that the No. 1, No. 2, and No. 3 Siliceous Dikes, the surface water diversion channel, and rip-rapped Siliceous Emergency Spillway are in good condition.

Of the 13 piezometers installed within the Siliceous Dikes, one instrument (P105) recorded a reading above its threshold level. However, the reading was below the maximum piezometric level recorded the previous year.

It was recommended that three piezometers, P301, P302 and P303 be replaced in 2018 due to sediment build-up in the standpipes and to more accurately ascertain the piezometric level within the pond. Standpipe P301 was replaced with vibrating wire piezometers SUL-SD3-VWP-18-06 A&B, P302 was replaced with SUL-SD3-VWP-18-07, and standpipe P303 was replaced with SUL-SD3-VWP-18-08 A&B. Another VWP was installed at the toe of Station 7+00 (SUL-SD3-VWP-18-09). Additionally, two more standpipes were installed at the toe of the No. 3 Dike in 2018 (SUL-SD3-P-18-10 and SUL-SD3-P-18-11).

Gypsum TSF Dikes

The instrumentation data and visual inspections indicate that both the East and West Gypsum Dikes are in good physical condition and performing as intended. There were indications of increased rodent activity at the toes of the dikes, which is not considered a dam safety issue. Some of the burrows were filled in, but new burrows were identified. Burrows should be filled in as they are identified. The areas will continue to be monitored during subsequent inspections. Visual observations of seepage indicate similar flows as previous years and no indication of sediments.

Four of six active piezometers in the West Gypsum Dike and two of seven active piezometers in the East Gypsum Dike saw an increase in maximum recorded pore pressures, likely due to higher than average precipitation and snowpack during the reporting period. However, all maximum readings were below their threshold level. One standpipe piezometer was installed in the West Gypsum Dike toe (SUL-WG-P-18-03) and two standpipe piezometers were installed in the East Gypsum Dike toe (SUL-EG-P-18-04 and SUL-EG-P-18-05) in August 2018.

The three settlement plates and Sondex gauge at the West Gypsum Dike are settling between 0 to 25 mm/year, with rates decreasing in 2018. The general mode of deformation shows ongoing settlement with a slight rotation of the crest upstream into the pond. The two active settlement plates and Sondex Gauge in the East Gypsum Dike continue to settle at a uniform rate of approximately 15 mm/year to 30 mm/year. The horizontal displacements are occurring at a rate of approximately 10 mm/year, and are directed upstream, perpendicular to the dike crest. The rates of settlement are below the threshold levels, settlement is expected to continue, and it is not a dam safety concern. The ongoing small creep movements are consistent with and reflect the expected behavior of gypsum tailings.

Northeast Gypsum Dike and Recycle Dam

The visual inspection indicates the structures to be in good physical condition and performing as intended. Following the recommendations of the 2004 DSI report, piezometric readings are no longer required for dam safety purposes. The two settlement plates indicate no measurable settlement since 2007.

North and South Dams of the ARD Pond

Based on a review of the instrumentation data for the North and South Dams of the ARD Pond and the results of the visual inspection, the dams are in good physical condition. A buildup of algae was observed in the ditch south of the South Dam during the 2017 site inspection, potentially impacting flow of seepage in the ditch and affecting the readings from Weir #1 (ARDWU). The algae was cleared in the fall of 2017 following KCB's site visit, but the build-up was again noticed during the 2018 site visit. Many of the standpipe piezometers located along or near the North and South Dams continue to show a response to changes in the reservoir elevation. One the eight piezometers installed within the North Dam (ND-02S) and three of the five piezometers installed within the South Dam (PP01-06, SD-02 and SD-03) recorded readings above the threshold level in early spring, but subsequently decreased to levels below the thresholds following spring runoff. The increased pore pressures were expected as precipitation (rainfall and snowpack) were higher than average. As previously noted, the piezometric levels above the thresholds are not a dam safety concern since they are set well below those assumed for design stability calculations.

Two weirs (Weir #1 – ARDWU and Weir #2) are located at the South Dam to record seepage flows, although runoff from the dikes and surrounding terrain is also captured. The short duration peak measured flows for the reporting period were 145.3 m^3/day and 241.2 m^3/day, respectively. The highest flows were recorded when the pond elevation was above 1040 m coinciding with the spring melt and rainfall in March and April. This is consistent with historical trends. The lowest flows are encountered in July and August when pond levels are low, after the water collected in the pond has been pumped to the water treatment plant and there is lower precipitation.

Calcine TSF

There were no changes observed during the site inspection and the visual observations from the previous inspection.

North and South Dikes of the Sludge Impoundment

The North and South Dikes of the Sludge Impoundment were observed to be in good physical condition. Surveys of the South Dike and North Dike crests conducted in 2016, 2017, and 2018 indicated that the south end of the South Dike crest is lower than required at the access ramp. The 2017 survey indicated that the east end of the North Dike crest was narrower than the design minimum. Grading work was completed in Fall 2017 at the North Dike access ramp such that the crest width is now per design and no further work is required regarding this issue. An assessment of the effect of the lower crest at the South Dike will be completed as part of a design update review that is ongoing and noted below.

As previously discussed, a review of the geotechnical design for the Sludge Impoundment dikes was not completed at the time of mine closure, as there was minimal sludge retained and the risk and consequences of failure were very low. There is still minimal sludge deposited against the South Dike, however, the sludge at the North Dike is approaching the maximum level assumed in the original design. A review of the stability of the dikes was recommended in the 2017 DSI. A review of the Sludge Impoundment capacity was completed in 2015. It was estimated that the Sludge Impoundment could accommodate another 15 to 20 years of operation. However, with the recent changes to the HSRC requirements, the design flood event required for the Sludge Impoundment has increased and a review is ongoing to assess if the current design freeboard is adequate to accommodate the new required design flood event of 1/3 between 1/975 event and PMF (EMPR, 2017). A complete design review of the Sludge Impoundment is recommended for 2019.

Summary of Significant Changes

There are no significant changes to report with regards to observed or monitored information with respect to dam stability for all dikes/dams. As the mine is a closed facility and the ponds and dikes have undergone reclamation, there are no annual operations activities other than ongoing water seepage collection and treatment and care and maintenance.

Summary of Review of OMS & EPRP Manuals

The Operation, Maintenance and Surveillance (OMS) Manual for the Sullivan Mine Tailings Facilities was updated in August 2018, which included changes as recommended in the 2016 DSI and a reorganization to meet Teck internal guidelines.

The Emergency Preparedness and Response Procedures Manual (EPRP) was updated in August 2018 and meets requirements outlined in Teck guidance, provincial regulations and other guidance documents. The EPRP was converted to a Mine Emergency Response Plan (MERP) in January, 2019.

Summary of Deficiencies and Non-conformances

Recommendations arising from the 2018 inspection are summarized below along with completed recommendations from previous DSI summaries. None of the issues, closed/new/outstanding, are related to dam safety concerns. All of the recommendations pertain to the framework of continual improvements in the dam safety management program, including documentation and maintenance/surveillance protocols. The recommendation for the Sludge Pond Impoundment is part of the design review and update that is already being planned by Teck and KCB, and is listed herein for the purpose of completeness.

Closed, Outstanding and New Recommendations

Structure	ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline /Status
Previous Recommendations Closed / Superceded						
ALL	2016-1	OMS Manual requires updates	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Additional information to be added in 2017. EPRP Section to be removed once separate document completed.	4	CLOSED- ongoing revisions being conducted
ALL	2016-2	EPR Plan requires updates	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Update EPR Plan such that it follows Teck's Tailings Guidelines and EMPR's HSRC (2016a). Currently no mention of potential inundation/flood hazard.	4	CLOSED- incorporated into the MERP as per EHSC guidelines
Old Iron TSF	2016-3	Old Iron Dike piezometer P96-11 readings are erratic and unreliable.	OMS Section 4.0	Recommend replacement of P96-11 (improperly labelled P91-11 in 2016 DSI) with a new piezometer near the toe of the 2007 buttress to monitor piezometric levels at the toe.	4	CLOSED- completed August 2018
Old Iron TSF	2017-01	Old Iron Dike piezometer P96-08 only records relative piezometric levels as tip elevation is unknown.	OMS Section 4.0	P96-08 should be replaced as the tip elevation is unknown and the readings only provide relative change in elevation. This instrument will provide additional information regarding piezometric levels near the crest of the dike.	4	CLOSED- completed August 2018
Siliceous TSF	2017-02	No. 3 Siliceous Dike standpipe piezometers P301, 302 and 303 contain significant sediment, which was not removed during flushing in 2014. The bottom depths of these piezometers are now at or just above the phreatic surface assumed for design.	OMS Section 4.0	These piezometers should be replaced such that the tips are near the base of the tailings to monitor the phreatic surface within the cell.	4	CLOSED- completed August 2018
Previous Recommendations Ongoing						
Sludge Impoundment	2017-03	Changes to HSRC design flood requirements indicate a review of the Sludge Impoundment hydrology is needed.	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Review of the current design freeboard and design sludge levels is required for the new design flood event of 1/3 between 1/975 and PMF (HSRC 2016). To facilitate the design update, the Sludge Impoundment surface should be surveyed to obtain average sludge deposition rates. This design review should include recommendations for addressing the low crest location at the South Dike. All of this will be combined into an overall design review of the Sludge Impoundment facility.	3	2019
2018 Recommendations						
None						

The priority ranking for outstanding and new recommendations is defined as follows:

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrence of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

Date of Next DSR

A DSR for all the Sullivan TSFs and dams was initiated in 2018 and in progress at the time of this report with completion of final report to occur in 2019. The DSR completed prior to that was undertaken by Golder Associates in 2013. This is consistent with the revised EMPR Health, Safety and Reclamation Code Regulations that require DSR's to be conducted every five years regardless of consequence classification. This frequency of dam safety reviews is also in compliance with the 2007 CDA Guidelines (CDA, 2013) for Very High consequence structures, which is the current classification for the ARD Pond dams, which contain no tailings. The ARD Pond dams are the highest consequence structures at the Sullivan Mine.

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

TABLE OF CONTENTS
(continued)

List of Tables

List of Figures in text

TABLE OF CONTENTS
(continued)

List of Figures

TABLE OF CONTENTS

(continued)

List of Appendices

1 INTRODUCTION

1.1 Purpose, Scope of Work and Methodology

This report presents the results of the 2018 Annual Dam Safety Inspection (DSI) of the tailings dikes and other dams at the Teck Metals Ltd. (Teck) former Sullivan Mine, located in Kimberley, British Columbia. The work was carried out in general accordance with our proposal letter dated March 27, 2018 and the Teck Guideline for Tailings and Water Retaining Structures (Teck 2014).

The scope of work consists of:

- a visual inspection of the physical conditions of the various containment dikes and water retention dams during the site visit May 23rd and 24th, 2018, which included:
  - reading of select piezometers at the West Gypsum Dike; and
  - reading of select piezometers at the Siliceous Dikes #2 and #3.
- a review of the climate and water balance data for the site;
- a review of annual flow rates recorded from weirs for the ARD Pond and Iron TSF;
- a review of updated piezometer and settlement records provided by Teck in 2018; and
- a review of the OMS and ERP/EPP Manuals for the storage facilities.

As in previous years, this report focuses on the geotechnical performance of the tailings dikes and water balance for the tailings facilities. Teck addresses and reports water discharge and water quality separately. The reporting period for this DSI is from September 1, 2017 through August 31, 2018. Figure 1 shows the project location and general layout of the tailings facilities.

This is the 27th consecutive annual inspection of the Sullivan Mine tailings dikes carried out by Klohn Crippen Berger Ltd. (KCB), formerly Klohn Crippen Consultants Ltd. Annual inspection reports for the periods preceding KCB's involvement were prepared by SRK-Robinson Inc. from 1989 to 1991 and by Robinson Dames and Moore from 1984 to 1988.

1.2 Regulatory Requirements

1.2.1 Mines Act and HSRC

This DSI addresses the performance of the tailings/sludge storage facilities and associated water management infrastructure in accordance with the most recent Health, Safety and Reclamation Code for Mines in British Columbia (EMPR, 2016 & EMPR, 2017), which forms part of the Mines Act (RSBC 1996).

As required by the HSRC, the following persons have been designated:

- Engineer of Record – Mr. Bill Chin, P.Eng. (KCB)
- Tailings Storage Facility Qualified Person – Ms. Kathleen Willman, P.Eng. (Teck)

1.2.2 Water Act and BC Dam Safety Regulation

None of the dikes or dams at Sullivan Mine require a water licence and are therefore not regulated by the BC Dam Safety Regulations. However, the BC Dam Safety Regulation was referenced for guidance related to dam safety where appropriate.

1.2.3 Permits and Licences

Sullivan Mine is regulated by the following permits:

- Reclamation Permit M-74 (September 29, 2017) issued by the Ministry of Mines. This permit is issued under the provision of the Mines Act (RSBC 1996), and addresses reclamation and metal leaching and acid rock drainage requirements at Sullivan Mine. The requirements of the permit are:
  - monitoring programs of vegetation, surface water and groundwater;
  - annual reporting, as required under the HSRC (EMPR 2017); and
  - informing the ministry of changes at the mine that might impact the amount of the reclamation security.
- Effluent Permit PE-00189 (Oct. 24, 2016), issued by the Ministry of Environmental Protection & Sustainability: Waste Management. This permit is issued under the provision of the Environmental Management Act (SBC 2003) and authorizes the discharge of effluent in Kimberley Creek and St. Mary River as well as sludge on land. Requirements under this permit include:
  - general requirements (Section 2 of the permit), which state the conditions under which the DWTP and Sludge Impoundment must be operated (i.e., maintaining the infrastructure in good working order, addressing emergencies, modification to infrastructure and processes, bypasses and suspension); and
  - monitoring and reporting requirements (Sections 3 and 6 of the permit), which describe monitoring work to conduct on the discharges and receiving environment as well as the reporting frequency (i.e., spring and fall).
- Permit PR6742 (January 2, 2018), issued by Ministry of Environmental Protection & Sustainability: Waste Management. This permit is issued under the provision of the Environmental Management Act (SBC 2003) and authorizes the discharge of refuse to a landfill. The landfill is located within the boundaries of the Old Iron TSF (northwest corner) and is denoted as E242184 and E310949 by the Ministry. Requirements under this permit include:
  - reporting of volumes of material placed within landfill; and
  - regular inspections and maintenance of the landfill works.

1.3 Facility Description

There is a total of 15 earthfill dam and dike structures that create seven separate storage facilities (the Northeast Gypsum Dike and Recycle Dam are included in the Gypsum TSF). A summary of the seven facilities is provided in Table 1.1. The earthfill structures have a combined crest length of the main embankments of just over 10.4 km, with maximum heights varying from about 4.2 m to 29 m. A plan of the storage facilities and their retaining structures is provided on Figure 1.

The two water retaining dams[4], designated as the North Dam and South Dam, that form the ARD Pond are shown in Figures 3 and 16. This pond, located at the old Cooling Pond site, annually stores the water requiring treatment. Other than the North and South Dams of the ARD Pond, which are water retaining structures, and the North and South Dikes of the Sludge Impoundment, the dikes listed in Table 1.1 have been used primarily for tailings storage. Typically, these dikes consist of an initial earthfill starter section raised incrementally over the years using the upstream method of construction. The design and construction records for the original Old Iron TSF dikes and the No. 1 Siliceous Dike are not available, so it is unclear how these were originally constructed. In the 1990's, stability assessments for all of the tailings dikes were completed and, where required, slopes were flattened and toe berms were constructed to meet required design criteria. A discussion of the design basis and criteria are provided in Section 5.1.

The Iron Pond, the ARD Pond, the West Gypsum Seepage Collection Pond, and the Northeast Gypsum and Recycle Dam seepage collection ponds are the only storage facilities retaining water at the Sullivan Mine. The Sludge Impoundment is also active but does not retain ponded water. The other tailings facilities have been decommissioned and surface reclamation is complete. The reclamation included draining and covering the TSF surfaces and the construction of surface water runoff conveyance channels and spillways.

Water collected at Sullivan Mine through mine drainage, contaminated groundwater and seepage from TSFs and waste dumps is stored in the ARD Pond and then pumped to the Drainage Water Treatment Plan (DWTP). The ARD Pond serves as a flow equalization basin to facilitate seasonal operating campaigns at the DWTP. The treated water is released to the environment (St. Mary River) and the sludge is deposited in the Sludge Impoundment. The ARD Pond was designed with a spillway, which connects to the Iron Pond in the Iron TSF. The Iron TSF has an emergency spillway to safely convey excess water from the dikes/dams offsite. This spillway connects to Cow Creek, which in turn empties into the St. Mary River.

---

[4] In this report KCB refers to "dams" as water retaining structures engineered to retain or limit seepage and refers to "dikes" as the structures that are constructed as part of the tailings storage facilities.

Table 1.1 Summary of Storage Facilities at Sullivan Mine

Storage Facility	Embankments	Type	Approximate Embankment Length (m)	Approximate Maximum Height (m)	Starter Dike Constructed (Year) [1]	Year of Last Dike Raise (Year)
Iron TSF	Iron Dike	Iron Tailings	1500	29.0	1975	1999
Old Iron TSF	Old Iron Dike	Iron Tailings	520	7.6	prior to 1948	Unknown
	Iron TSF Divider Dike	Iron Tailings	1190	3.6 [3]	post 1948	Unknown
Siliceous TSF	No. 1 Siliceous Dike	Silica Tailings	2000	4.9 [3]	1923	1979
	No. 2 Siliceous Dike	Silica Tailings	730	9.5	1975	1982
	No. 3 Siliceous Dike	Silica Tailings	1540	12.5	1975	1984
Gypsum TSF	East Gypsum Dike	Gypsum	670	16.8	1969	1983
	West Gypsum Dike	Gypsum	640	22.9	1969	1986
	Northeast Dike	Gypsum, Seepage Water	120	10.0	1985	1985
	Recycle Dam	Seepage/ARD Water	90	6.0	1985	1985
Calcine TSF	Calcine Dike	Calcine	520	4.6[3]	1972	1986
ARD Pond (see note 2)	North Dam	ARD/Seepage Water	460	7.6	2001	2001
	South Dam	ARD/Seepage Water	330	16.8	1976	2001
Sludge Impoundment	North Dike	Sludge	120	4.3	1978	1978
	South Dike	Sludge	200	6.1	1978	1978

Notes:

[1] Starter Dike information based on data from Annual Inspection Report by SRK-Robinson dated June 1991.

[2] The ARD Pond is established at the site of the old Cooling Pond.

[3] Tailings were placed downstream of both Iron TSF Divider Dike and No .1 Siliceous Dike. The original height of the Iron TSF Divider and No .1 Siliceous Dike from original ground is 10.7 m and 16.8 m, respectively. A municipal landfill is downstream from the Calcine Dike. The height of the Calcine Dike from original ground is 15.2 m.

Site location plans, and plans and typical sections of the dikes/dams are provided in Figures 1 through 24.

1.4 Background Information and History

After almost a century of operations, the Sullivan Mine was closed at the end of 2001, with approximately 94,000,000 tonnes of tailings and 16,900,000 tonnes of mine waste stored at the former mine. Reclamation work on the tailings areas commenced in 1990 and was essentially complete by 2008.

The mine had been mainly underground and operated on a near-continuous basis from the early 1900s to 2001. In the last decade prior to closure, the mine was processing primarily lead/zinc ore. For most of the mine's operating life, mill tailings were hydraulically transported to an area immediately southeast of the Concentrator for disposal and storage. The historical development of the tailings areas is summarized in Table 1.2. Gypsum and circulation water from operation of the fertilizer plant have also been stored in the tailings area. These by-products from the fertilizer plant were produced and stored from about 1969 to 1987.

A Drainage Water Treatment Plant (DWTP), which began operating in 1979, continues to operate as part of the water management plan for the site. The DWTP treats acid rock drainage and other seepage produced from the underground mine and waste storage facilities. Sludge from the water treatment plant (DWTP) is located in an impoundment about 2 km south of Marysville near the DWTP. Figure 2 illustrates the relative locations of the DWTP, the tailings facilities, and the pipelines from the underground mine, and highlights the primary seepage collection system.

Table 1.2 Historical Development

Date	Process	Storage Area	Comments
Prior to 1941	Milling/Flotation for lead and zinc recovery	One tailings stream to Old Iron TSF	
1941 to 1985	Tin Recovery Circuit	Iron tailings to Old Iron TSF and Iron TSF Siliceous tailings to No. 1, 2, 3 Siliceous Cells	
1953 to 1987	Fertilizer production including roasting of iron concentrate Waste products include Iron Oxide and Gypsum	Iron Oxide (known as calcine tailings) to Calcine TSF Gypsum tailings to East and West Gypsum Cells	Gypsum TSF not developed until 1968; prior to that gypsum tailings were stored and seasonally discharged to the St. Mary River during spring freshet
1975 to 1987	Fertilizer Plant effluent water	Stored and recycled from Cooling Ponds 1 and 2	
1987 to 2001	Fertilizer plant closed; single mill tailings stream	Single stream to Iron TSF	
1979 to present	Drainage Water Treatment Plant (DWTP) Sludge Impoundment	Sludge Impoundment	Located offsite, 1.5 km south of Marysville, 0.5 km south of Drainage Water Treatment Plant DWTP
2001 to present	Water storage for feed to Drainage Water Treatment Plant (DWTP)	Cooling Ponds 1 and 2 converted to Acid Rock Drainage (ARD) Pond	

1.4.1 Reference Reports

Beginning in 1991, Teck retained KCB to review the existing and long-term stability of a number of the tailings dikes. These studies were part of Teck efforts toward decommissioning and eventual closure of the Sullivan Mine tailings facilities. Stability assessments were completed for the Iron Dike, the East and West Gypsum Dikes, the No. 1, No. 2 and No. 3 Siliceous Dikes, and the Old Iron Dike. A design of two new dams for the ARD pond was also completed, including new spillways and a downstream flood impact study. Additional post-closure assessments have been performed as required based on performance. The main conclusions and recommendations from the studies are documented in the following KCB reports:

- Iron Dike Tailings Facility: 1991 Failure Assessment, dated February 20, 1992.
- Iron Dike Tailings Facility: Dike Stabilization, dated March 13, 1992.
- Stability Review of Gypsum Dikes, dated November 26, 1993.
- Stability Review of Southwest Limb of Old Iron Dike, dated June 21, 1994.
- Stability Review of Siliceous Dikes, dated June 24, 1994.
- 1993 – 1994 Annual Inspection of Tailings Dikes (Sections 5.5, 9.4, 10.4, and 11.4, Typical Dike Cross-Section and Factors of Safety) dated October 21, 1994.
- Iron Dike: Geotechnical Design of 1995 Dike Raise, dated May 18, 1995.
- 1999 Annual Inspection of Tailings Dikes (Section 4.4 – Iron Pond Dike, Stability Review) dated September 16, 1999.
- Iron Pond Dike – Construction Recommendations for Float Rock Toe Berm, dated January 24, 2000.
- ARD Pond - Storage Pond No. 1 Design Report, dated February 29, 2000 and addendum letter dated August 21, 2000.
- ARD Pond - Storage Pond No. 1 Construction Record Report dated January 31, 2002.
- Geotechnical Design Basis for Tailings Dikes – Overview Summary Report, dated January 9, 2002.
- ARD Pond - Dam Breach and Inundation Study, Storage Pond No. 1 dated September 6, 2002.
- ARD and Emergency Storage Ponds - Potential Downstream Flood Impacts from Spillway Flows dated November 14, 2002.
- Southwest Limb Stability Review dated July 28, 2006.
- Geotechnical Stability Analysis of Sullivan Mine CPR Ballast Deposition Site, dated February 28, 2007.
- Sullivan Mine Tailings Area, Emergency Storage Pond (ESP) Spillway Design dated September 28, 2007.
- Sullivan Mine Iron Pond Dike Stability dated May 11, 2011.

- Sullivan Mine Emergency Storage Pond, Surface Water Management Plan Update dated December 8, 2011.
- TML Sullivan Mine Tailings Facility: Iron Pond Dike – Artesian Pressures in Confined Aquifer (Piezometers P92-H and P92-25) dated November 18, 2015.

The following report authored by others provided additional information:

- Dam Break Inundation Study for Three Containment Structures Sullivan Mine, BC – Final Report dated November 26, 2014. Prepared by AMEC Environment & Infrastructure, A Division of AMEC Americas Limited.

1.4.2 Reference As-Built Drawings

Teck has updated as-built drawings for the various facilities post reclamation. Table 1.3 provides a summary of these drawings, which were prepared for Teck by TM Tech Services. An updated LiDAR image created in December 2012 and a drone survey completed in August 2018 were provided by Teck and used to update the figures attached to this report. We understand there has been no significant construction/modifications to the as-built conditions since the drawings by TM Tech Services were issued.

Table 1.3 Summary of Drawings Prepared by TM Tech Services

Title	Drawing	Date
Site Plans		
TAILINGS SEEPAGE COLLECTION/DWT PLANT SYSTEM PIPING DETAILS	K100 A 3007	FEB 3/09
DAM SAFETY REVIEW KEY PLAN	K100 A 3010	MAR 23/09
Gypsum TSF		
WEST GYPSUM DIKE PLAN VIEW	K100 A 3230	JAN 29/07
WEST GYPSUM DIKE PROFILE / SECTIONS	K100 A 3231	JAN 29/07
EAST GYPSUM DIKE PLAN /PROFILE /SECTIONS	K100 A 3232	JAN 29/07
Iron TSF & Emergency Spillway (Iron Dike)		
EMERGENCY POND DIKE PLAN VIEW (FORMER IRON POND)	K100 A 3233	FEB 13/09
EMERGENCY POND DIKE PROFILE/SECTIONS (FORMER IRON POND)	K100 A 3234	FEB 13/09
EMERGENCY POND OVERFLOW SPILLWAY AS BUILT	K100 A 3235	FEB 13/09
West Gypsum Cell Ditching		
WEST GYPSUM POND DITCHING PLAN VIEW	K100 A 3236	JAN 14/09
WEST GYPSUM POND DITCH PROFILES	K100 A 3237	JAN 14/09
WEST GYPSUM POND DITCHING SECTIONS 1 TO 7	K100 A 3238	JAN 14/09
Calcine TSF		
CALCINE DIKE PLAN /PROFILE /SECTIONS	K100 A 3239	DEC 4/06
Old Iron Dike		
SW LIMB AS BUILT (OLD IRON POND)	K100 A 3240	JAN 16/09
Iron TSF Divider Dike		
SE LIMB AS BUILT	K100 A 3246	FEB/12/09
Siliceous TSF		
SILICEOUS PONDS 1/2/3 AS BUILT PLAN/PROFILE	K100 A 3241	JAN/26/09
SILICEOUS PONDS 1/2/3 AS BUILT SECTIONS	K100 A 3242	JAN/26/09
ARD Pond		
ARD POND, NORTH & SOUTH DIKE AS BUILT	K100 A 3243	FEB 4/08
ARD POND, NORTH & SOUTH DIKE AS BUILT	K100 A 3244	JAN 29/09
ARD POND OVERFLOW SPILLWAY AS BUILT	K100 A 3245	JAN 31/09
Iron TSF to Cow Creek		
SURFACE WATER CHANNELS D, E, F AND G PLAN VIEW	K100 A 3254	MAR 11/09
SURFACE WATER CHANNELS D, E, F AND G PROFILE AND SECTIONS	K100 A 3255	MAR 11/09
North of Siliceous TSF to Luke Creek		
SURFACE WATER CHANNELS M, P1, O, & P2 PLAN VIEW	K100 A 3310	MAR 4/09
SURFACE WATER CHANNELS M, P1, O, & P2 PROFILE /SECTIONS	K100 A 3311	MAR 4/09
Sludge Impoundment		
SLUDGE POND DIKE CREST AS BUILT	K101 A 2240	DEC 10/08
SLUDGE POND DIKE CREST AS BUILT	K101 A 2249	SEP 11/17
SLUDGE POND SURFACE AS-BUILT	K101 A 2243	SEP 9/15

1.4.3 Units of Measure and Reference Coordinates

To facilitate the long-term monitoring of the site, this report has converted historical values, recorded in Imperial units of measure in the Sullivan Mine Grid coordinate system, to metric units in UTM (NAD 83). Some figures still reference stationing along dikes to the Imperial units.

2 CONSTRUCTION AND OPERATION DURING 2018

2.1 Tailings Deposition – Not Applicable

Sullivan Mine is a closed facility.

2.2 Available Tailings Storage – Not Applicable

Sullivan Mine is a closed facility.

2.3 Construction and Operations Activities (2018)

The mine was closed at the end of 2001, and since this time the facility has not been used for tailings deposition.

The construction activities that take place each year are related to ongoing care and maintenance activities such as road grading, cleaning of ditches, rodent burrow repair, removal of trees and shrubs from dike slopes, and maintenance of the seepage collection system. However, additional reviews and designs may occur to support changes to government regulations and operations. There are also activities that occur each year to support operation of the seepage management and water collection systems. Between October 1, 2017 and August 31, 2018, the following additional activities occurred:

- Ongoing review of ARD storage and stormwater management capacities – KCB is assisting Teck with this work, which includesreview and update of the surface hydrology, including inflow design flood (IDF) and Probable Maximum Flood (PMF). Work is ongoing and expected to continue into 2019.
- A geotechnical investigation was completed August 7th to 17th, 2018. Sonic drilling, standpipe installations, and cone penetrations tests (CPT) were completed in the East Gypsum, West Gypsum, and No. 2 and No. 3 Siliceous Dikes. This was conducted in accordance with recommendations by KCB, which are supported by the Independent Tailings Review Board (ITRB). One of the targeted objectives was to examine whether there is evidence of aging effects in the tailings over nearly two decades since the facility was closed by comparing the results of recent and past CPTs conducted at similar locations. Schmertmann (1993)[5] has reported indications of typical 50% to 100% improvement in the given behavior of both natural and artificial soils due to aging, which may be an important factor in reducing the mobility of tailings over time. In such cases, their respective consequence classifications could be significantly lowered, and in the near future, it may be possible to declassify some of these dikes. Teck and KCB are in the process of completing a phased work plan to support lowering the consequence classifications for some of the inactive facilities and towards eventual declassification of the dikes where considered feasible and appropriate.
- Instrument replacements were also completed during the August 7th to 17th 2018 ground investigation in accordance with the recommendation in the 2017 Annual Dam Safety

---

[5] Schmertmann, J.H. (1993). Update on the Mechanical Aging of Soils. 25th Terzaghi Lecture. Sobre Envejecimiento de Suelos Symposium, Mexico City, August 1993.

Inspections report. Five standpipes were replaced with vibrating wire piezometers. Work is ongoing to complete a report associated with this work and automating the instruments.

2.4 Updated Cross Sections

While there are ongoing activities related to the operation and maintenance of the seepage collection and water treatment system (see Section 3.2), there have been no changes to the dikes/dams during the reporting period. Typical cross-sections for each structure are included with this report (see Section 1.3 for a list).

3 CLIMATE DATA AND WATER BALANCE DURING 2017-2018

This section summarizes the annual water balance review as required by the EMPR HSRC and Guidance document. The tailings facilities at Sullivan Mine have been closed and reclaimed. The only active storage facilities are the ARD Pond, Iron Pond, Sludge Impoundment, and West Gypsum Seepage Collection Pond. In general, the water collected from the site is collected at the ARD Pond to be treated in the DWTP before being released to St. Mary River. The focus for the water balance is the collective storage of the ARD Pond. The reporting period for the water balance review is September 1, 2017 to August 31, 2018.

3.1 Mine Description

Teck has developed a specially designed multi-layer soil cover system of float rock and till for reclamation of the tailings areas. In addition, surface water collection channels and spillways have been designed and constructed. The main channels and spillways have been designed to safely pass the Probable Maximum Flood (PMF) storm events. In addition, storage of the 100-year snowmelt event and controlled release of the 1000-year snowmelt event has also been provided for, if it cannot be stored. The channels are riprap lined and incorporate stilling basins, where required. Several spillways and channels are used to assist in controlled release of excess water.

Groundwater management involves the collection and treatment of mine drainage, contaminated groundwater, and seepage from TSFs and waste dumps. Details of the system are included in the Kimberley Operations Seepage Collection Manual (Teck 2017). The mine water from the underground workings is pumped seasonally from the 3700 ft. portal and from the 3900 ft. mine level to the ARD Pond. The water from the waste dumps and the tailings seepage collection pumps and sumps is pumped as required to the ARD Pond to facilitate seasonal operating campaigns at the Drainage Water Treatment Plant. The ARD Pond can be by-passed with temporary routing of mine water (underground and dumps) and seepage water to the Iron Pond, which can then be pumped to the DWTP if required.

The ARD Pond has a large storage capacity, thereby allowing efficient operation of the DWTP for discrete periods of time. It provides control over the time period when treated effluent is discharged to St. Mary River. Water collected in the Iron Pond is pumped as required to the ARD Pond (or directly to the DWTP if required). The Iron Pond provides storage volume for ARD contaminated water during spring runoff events.

3.2 Review and Summary of Climate Data

3.2.1 Precipitation

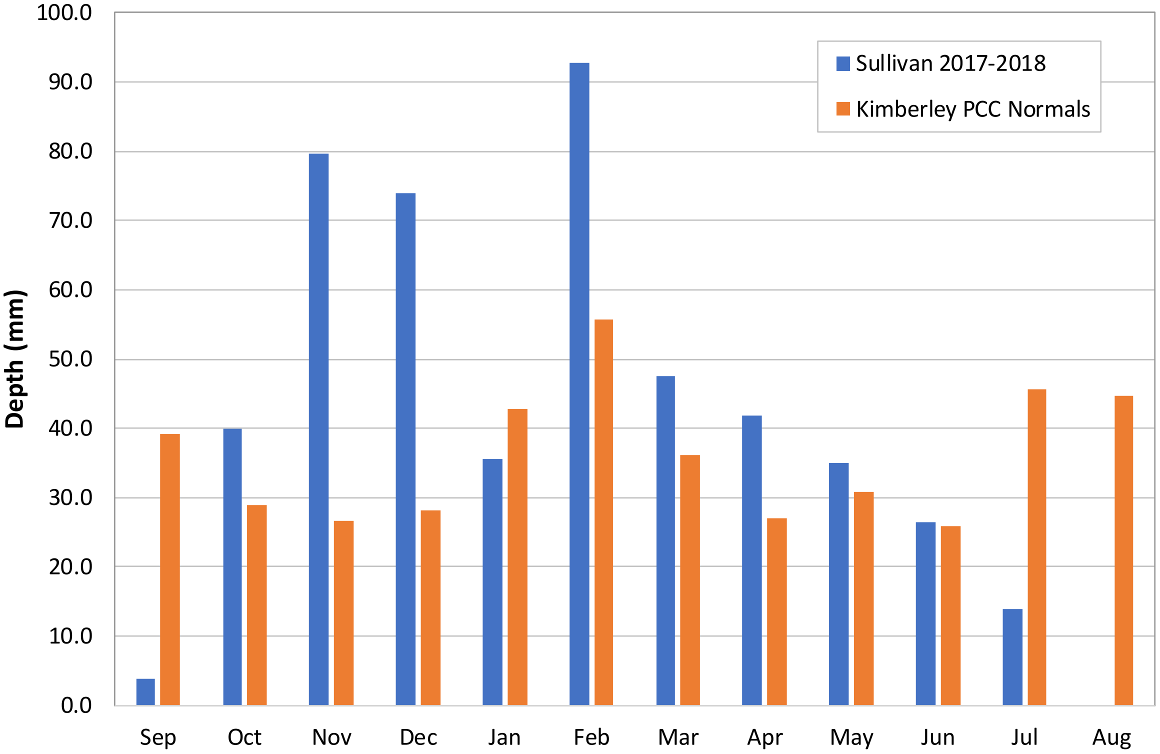
Climate stations in the Environment Canada (EC) database relevant to the Sullivan Mine Tailings Facilities precipitation and active during the time period of this water balance assessment are Kimberley PCC (Station No. 1154203) located approximately 3 km southwest of the mine and Cranbrook A (Station No. 1152105) located about 13 km south east of the mine.

For the purpose of this assessment, site precipitation was estimated as the daily precipitation recorded at Kimberley PCC, with any missing data filled by precipitation recorded at the Cranbrook A station. Total precipitation estimated for the mine from September 1, 2017 to August 31, 2018 is compared to climate normals for Kimberley (EC 2017) in Table 3.1 and on Figure 3.1. Snowpack over the 2017-2018 winter is compared to climate normals in Table 3.1 and on Figure 3.2. There was more snow than usual in winter, but the summer was dryer.

Table 3.1 Monthly Total Precipitation at Sullivan Mine 2017 – 2018 Compared to Normals

Month	2017-18 Total Precipitation (mm)	Normal Total Precipitation (mm)	2017 – 2018 Snow Depth (cm)	Normal Snow Depth (cm)
Sep 2017	3.8	30.9	0	0
Oct 2017	40.0	25.8	0	0
Nov 2017	79.6	45.6	13	6
Dec 2017	74.0	44.7	11	22
Jan 2018	35.6	39.2	35	34
Feb 2018	92.7	28.9	44	39
Mar 2018	47.5	26.6	33	19
Apr 2018	41.9	28.2	0	0
May 2018	35.0	42.7	0	0
Jun 2018	26.4	55.8	0	0
Jul 2018	14.0	36.2	0	0
Aug 2018	0.0	27.0	0	0
Total	**490.5**	**431.6**		

Figure 3.1 Monthly Total Precipitation at Sullivan Mine 2017 – 2018 Compared to Normals



The precipitation data collected for the water balance is for the ARD Pond and its surrounding catchment. All water collected in the mine and tailings areas is pumped to the ARD Pond, and these flows are measured and recorded by Teck.

3.2.2 Evaporation

Monthly lake evaporation data at the tailings area for the reporting period was estimated as the mean lake evaporation reported for Duncan Lake Dam (Station No. 1142574), located about 100 km northwest of the mine (EC 2017). The monthly estimated lake evaporation depths are presented in Table 3.2

Table 3.2 Mean Monthly Lake Evaporation Depths from Duncan Lake Dam (EC 2017)

Month	Mean Evaporation (mm)
Sep 2017	54
Oct 2017	0
Nov 2017	0
Dec 2017	0
Jan 2018	0
Feb 2018	0
Mar 2018	0
Apr 2018	0
May 2018	90
Jun 2018	102
Jul 2018	102
Aug 2018	90
Total	**438**

3.3 Review and Summary of Water Levels

The two key storage ponds at the tailings area are the ARD Pond and Iron Pond. The area-volume curves and measured water elevations for these ponds are provided in the following sections.

3.3.1 Area-Volume Curves

ARD Pond

The retaining dikes of the pond are the South and North Dams built in 2001. The dam crest elevation is at El. 1048.0 m, and the pond's spillway crest elevation is at 1047.4 m with the pond Maximum Operating Level (MOL) set at 1046.5 m (Klohn Crippen Consultants 2000). Figure XII.1 (Appendix XII) shows the pond area-volume curve used for the water balance assessment. Based on that curve, the pond surface area is approximately 10 ha and its storage volume is 710 dam^3 at MOL.

Iron Pond

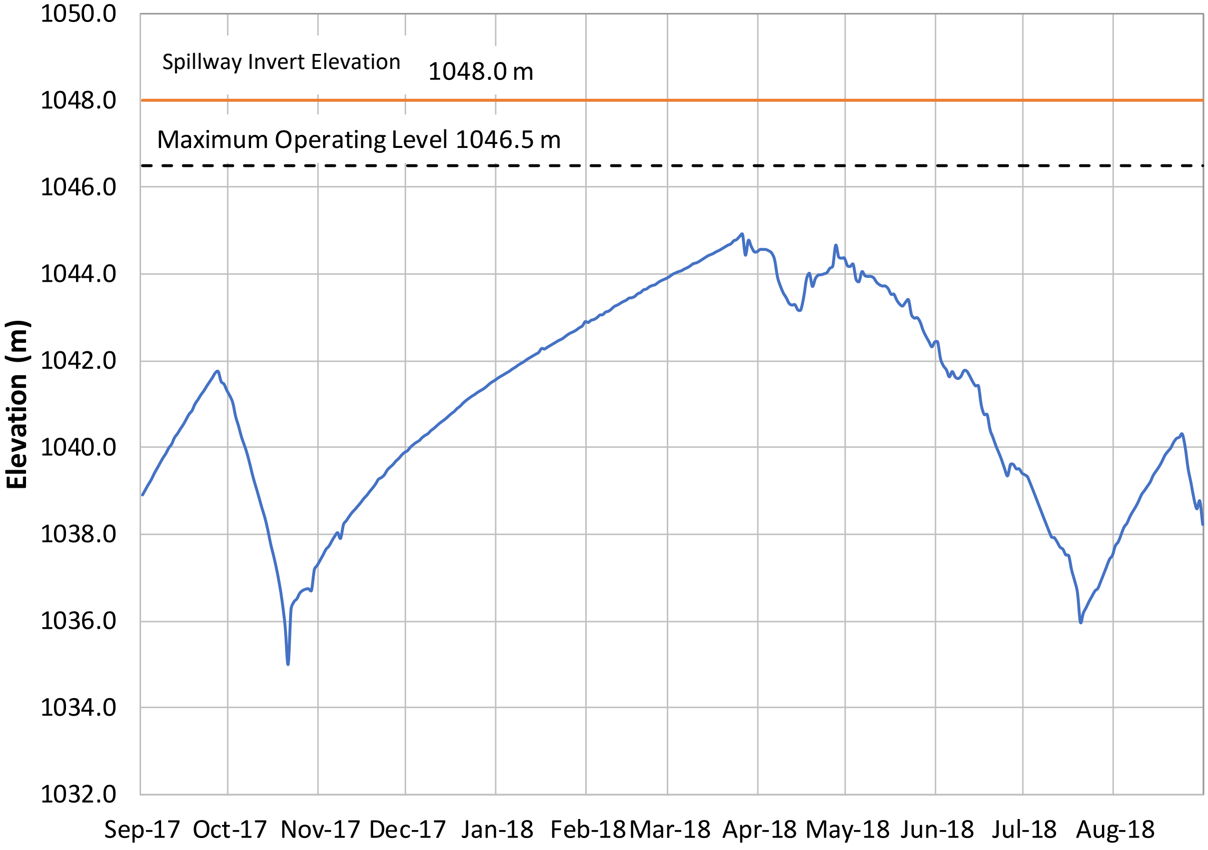
The Iron Pond was intended for emergency storage when the capacity of the ARD Pond is exceeded. During normal operation, surface runoff from the Iron TSF and the upstream area is collected in the Iron Pond before pumping to the ARD Pond or directly to the DWTP. The LiDAR survey from 2012, provided by Teck, shows the elevation of the top of the dike to be at 1042.0 m. The stage–storage curve (KCB 2007) for the pond is shown on Figure XII.2. Based on the curve, the storage capacity of the Iron Pond at the Emergency Spillway crest elevation of 1042.0 m is 380 dam^3.

3.3.2 Water Levels

ARD Pond

Figure 3.2 shows the water levels measured by Teck in the ARD Pond during the time period from September 2017 to August 2018. The pond level was recorded daily.

Figure 3.2 ARD Pond Level 2017 – 2018



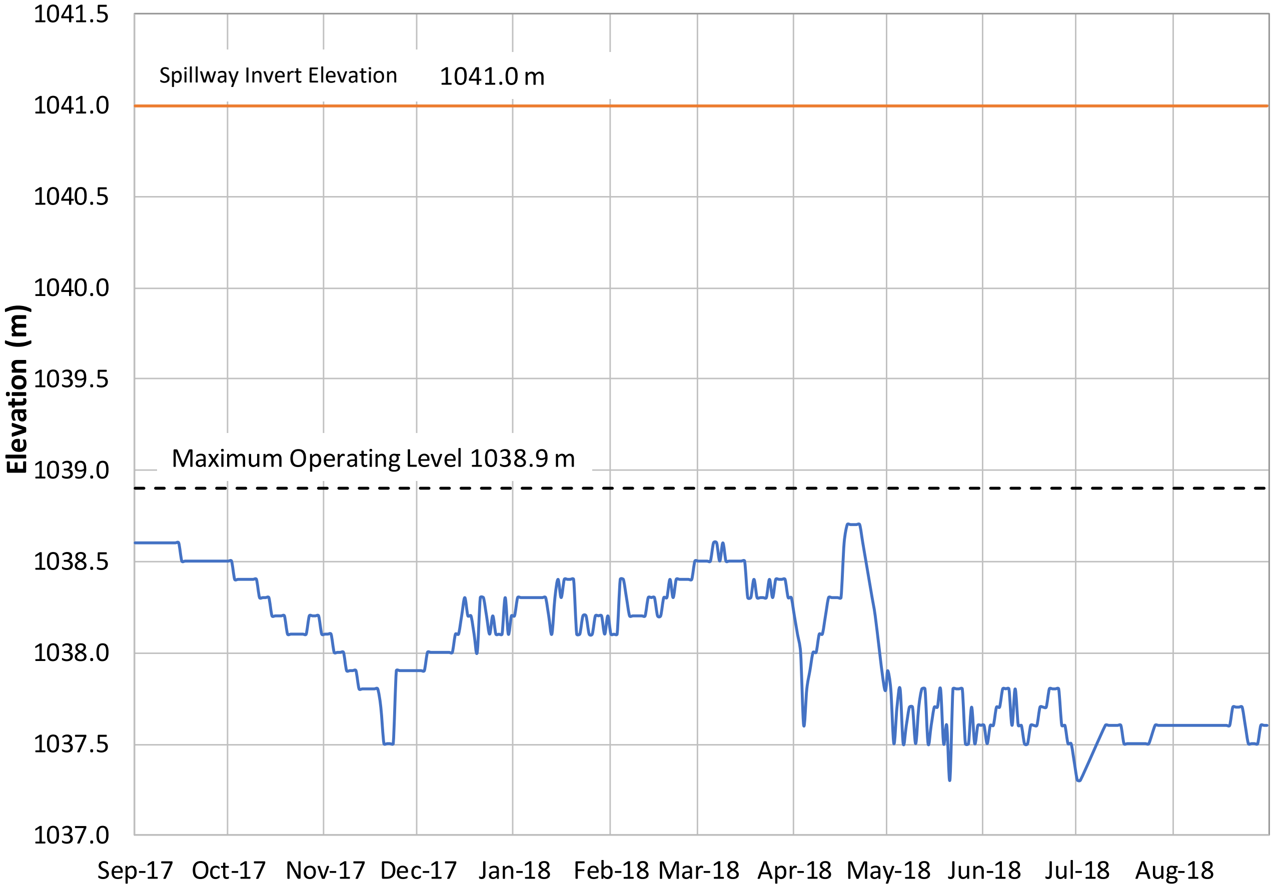
Based on the pond water levels, the maximum level observed during the time period was 1044.9 m, which occurred on March 26, 2018. This is 1.6 m lower than the maximum operating level (MOL) and 2.5 m below the spillway crest elevation (spillway reports to the Iron Pond). There was no water discharged from the spillway to the Iron Pond during the water balance time period, and records show that water has never discharged from the ARD Pond spillway since it was commissioned in 2001.

Iron Pond

Figure XII.5 shows the measured water levels by Teck in the Iron Pond during the time period from September 2017 to August 2018. The pond level was recorded daily.

Based on pond water levels, the maximum level observed during the time period was 1038.7 m from April 18, 2018 to April 22, 2018, which is 2.3 m lower than the spillway crest (spillway discharges to downstream creek). No water was discharged from the Iron Pond to the spillway during the water balance period, and records show that water has never been discharged to the spillway since closure.

Figure 3.3 Iron Pond Level 2017 - 2018

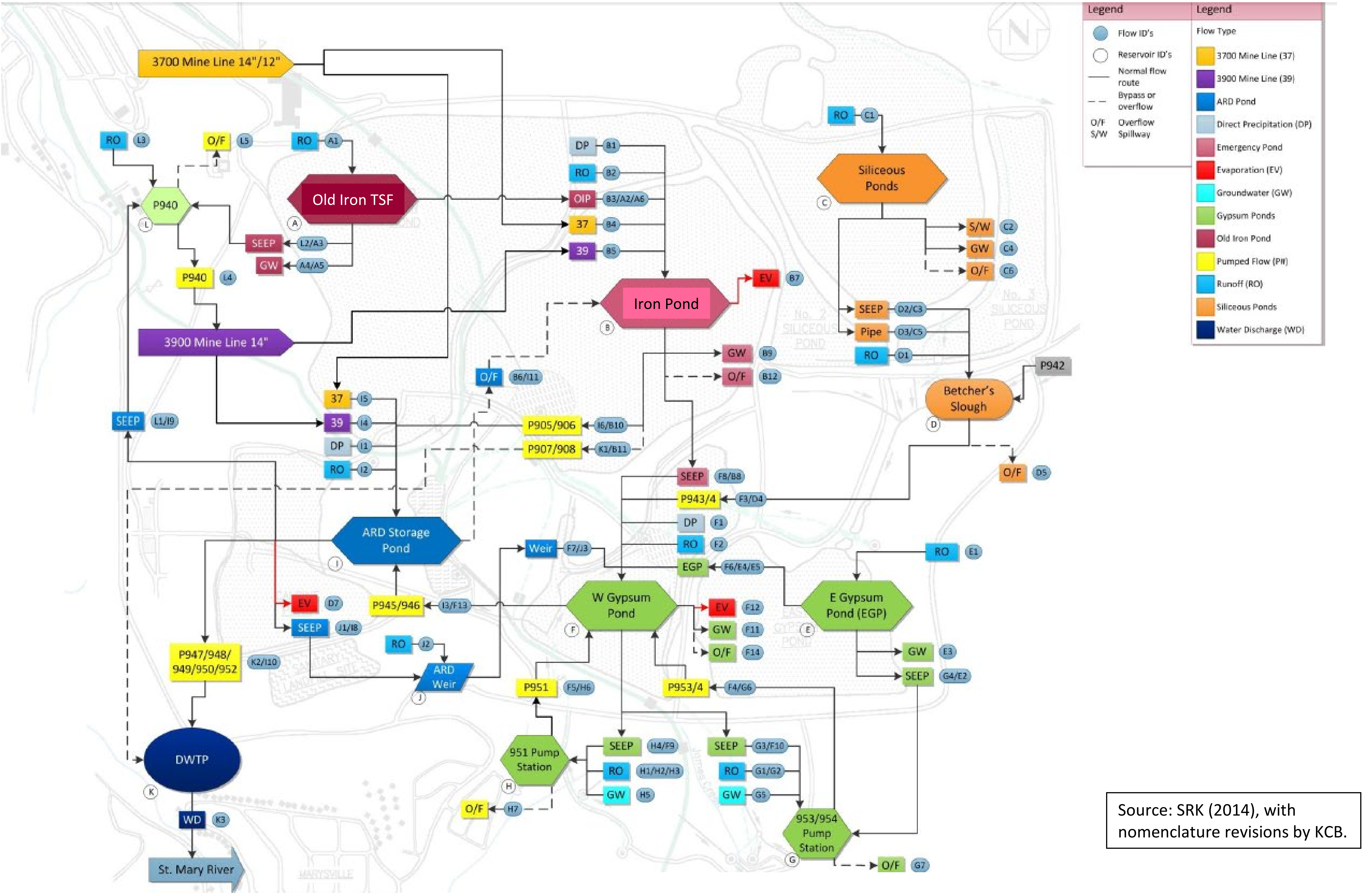


3.4 Tailings Area Water Balance

3.4.1 Water Balance Schematic

A schematic of the tailings area water balance is shown on Figure 3.4.

Figure 3.4 Tailings Area Water Balance Schematic



Source: SRK (2014), with nomenclature revisions by KCB.

3.4.2 Inflows

As shown on Figure 3.4, inflows to the ARD Storage Pond include the following:

- Seepage from the Iron Pond, Gypsum TSF, and Siliceous TSF, which is collected in the West Gypsum Seepage Collection Pond and directed to the ARD Pond through Pumps 945 and 946.
- Discharge from the mine through the 3700 and 3900 Mine Lines. The 3700 line carries water from the underground mine to the ARD Storage Pond. The 3900 line collects water from the waste dumps, aquifer dewatering wells, and Sullivan Creek as well as pump 940, which collects seepage from the Old Iron TSF.
- Direct precipitation on the ARD Storage Pond surface.
- Runoff from the surrounding catchment.

Teck provided the pumping data.

Precipitation and runoff are calculated for the ARD Pond only. All other inflows are captured as measured pump flows to the ARD Pond, which already include precipitation and runoff from all other tailings areas. The ARD Pond catchment area is 0.179 km^2 (SRK 2014), including the pond and its surrounding catchment. Precipitation and runoff inflows were estimated based on the precipitation depths presented in Table 3.1, and estimated pond and catchment areas, which vary by pond level. The following inputs and assumptions were used for the precipitation and runoff estimates:

- monthly yield coefficients ranging from 0.15 to 0.30, as estimated by SRK (2014);
- precipitation accumulated as snow: November through March; and
- snowmelt: 100% of accumulated snow melted in March, based on the snowpack data shown on Figure 3.2.

3.4.3 Outflows

Outflows from the ARD Storage Pond include the following:

- Seepage through the South Dam (Weir #1; identified as “ARD Weir” on Figure 3.4), reporting to the West Gypsum Seepage Collection Pond. The weir also collects runoff from the dam face.
- Water pumped from the ARD Pond to the DWTP.
- Evaporation from the pond surface.

Teck provided measured pump and weir flows. Water is pumped from the ARD Pond to the DWTP through pumps 947/948/949/950/952. The water is treated and then released to the St. Mary River.

Evaporation losses from the ARD Pond were estimated by multiplying the monthly evaporation depth shown in Table 3.2 by the estimated water surface area of the pond based on the measured pond elevation. Evaporation losses from other areas are reflected in the measured pump flows.

3.4.4 Water Balance Summary

A summary of the monthly inflow and outflow volumes for the ARD Pond is provided in Table 3.3. The water storage in the ARD Storage Pond is calculated monthly based on the inflows and outflows and compared to the observed storage (calculated from the measured water elevation and stage-elevation curve). These volumes are based on the original capacity of the pond, so the accumulation of solids in the pond means that the actual water volume is somewhat less than the table indicates.

Agreement between the observed and calculated storage is variable on a monthly basis, but quite good on an annual basis. The difference between the observed and calculated year-end storage volumes amounts to only 6% of the annual inflow to the pond.

Table 3.3 ARD Pond Monthly Water Balance Summary

Description	Units	Sept. 2017	Oct. 2017	Nov. 2017	Dec. 2017	Jan. 2018	Feb. 2018	Mar. 2018	Apr. 2018	May 2018	Jun. 2018	Jul. 2018	Aug. 2018	Sept. 2017 – Aug. 2018
Beginning Water Level	(m)	1038.77	1041.30	1037.28	1039.88	1041.54	1042.89	1043.89	1044.50	1044.35	1042.42	1039.40	1037.51	1038.77
Beginning Storage	(dam^3)	117.0	268.0	51.4	177.7	284.5	386.2	468.9	522.4	509.1	349.4	150.3	59.7	117.0
Inflow:														
Pump 905/906/907/908	(dam^3)	8.5	28.5	15.1	0.0	0.0	0.0	19.5	142.8	38.4	11.9	3.4	1.5	269.5
Pump 945 / 946	(dam^3)	51.7	54.2	60.3	58.6	59.8	53.1	72.4	172.8	108.2	69.8	65.8	62.4	889.0
Mine Line 3700	(dam^3)	103.9	49.5	0.0	0.0	0.0	0.0	0.0	70.9	253.9	231.9	127.9	75.8	913.7
Mine Line 3900	(dam^3)	73.5	72.9	62.7	66.6	57.0	50.6	60.5	142.8	217.6	96.8	73.5	63.1	1037.9
Precipitation and Runoff	(dam^3)	0.3	3.1	3.8	4.8	2.7	7.6	12.8	4.5	3.4	2.2	0.9	0.0	46.1
Total Inflow	(dam^3)	237.8	208.2	141.9	130.0	119.5	111.3	165.2	533.8	621.5	412.6	271.5	202.8	3156.1
Outflow:														
Pump 947/948/949/950/952	(dam^3)	56.5	410.8	0.0	0.0	0.0	0.0	62.9	632.2	740.0	584.4	338.4	141.9	2967.2
ARD Weir[2]	(dam^3)	0.0	0.0	0.0	0.0	0.1	0.6	1.8	2.9	2.1	1.2	0.1	0.0	8.8
Evaporation	(dam^3)	0.0	0.2	1.0	2.1	5.2	7.3	8.1	4.9	1.4	1.1	0.2	0.0	31.5
Total Outflow	(dam^3)	56.5	411.0	1.0	2.1	5.2	7.9	72.8	640.0	743.6	586.8	338.8	141.9	3007.5
Calculated Net Change in Storage	(dam^3)	181.4	-202.8	140.9	127.9	114.3	103.5	92.4	-106.2	-122.1	-174.2	-67.3	60.9	148.6
Calculated Month-End Storage	(m^3)	298.4	65.2	192.3	305.6	398.8	489.6	561.2	416.2	387.0	175.2	83.1	120.6	265.6
Observed Month-End Storage	(m^3)	268.0	51.4	177.7	284.5	386.2	468.9	522.4	509.1	349.4	150.3	59.7	90.3	90.3
Storage Difference (% of Inflow)	(%)	-13%	-7%	-10%	-16%	-11%	-19%	-24%	17%	-6%	-6%	-9%	-15%	-6%

Notes:

[1] ARD Weir = weir at toe of South Dike near abutment, measuring seepage and some runoff from the South Dike.

[2] Inflows to ARD pond from 3700 and 3900 lines include some flows diverted to Iron Pond when ARD Pond line maintenance is completed.

3.5 Freeboard and Storage

ARD Pond

The MOL of the pond is set at 1046.5 m, which is 0.9 m lower than the spillway crest (1047.4 m). It allows for a storage depth of 0.6 m for a 48 hour Probable Maximum Flood (PMF) plus 0.3 m for a 1:100 year significant wave run-up. The elevation of the top of the dam is set at 1048.0 m, providing a vertical distance of 0.6 m above the spillway crest. The distance is intended to allow 0.3 m surcharge above the spillway crest and a freeboard of 0.3 m (KCB 2000) when routing the inflow design flood through the spillway to the Iron Pond.

The stage–storage curve of the pond is shown on Figure XII.1, and its key design and performance characteristics are provided in Table 3.4.

Table 3.4 Relevant ARD Pond Characteristics

Item	Value
Top of Dam Elevation (m)	1048.0
Spillway Crest Elevation (m)	1047.4
Maximum Operating Level (m)	1046.5
Storage Capacity at the MOL (dam^3)	710.7
Designed Storage Capacity for PMF (dam^3)	50.0
Designed Freeboard for PMF (m)	0.3
Minimum Water Level in 2017-2018 (m)	1035.0
Maximum Water Level in 2017-2018 (m)	1044.9
Maximum Storage in 2017-2018 (dam^3)	557.9
Minimum Available Capacity Below MOL 2017-2018 (dam^3)	152.8

Iron Pond

The maximum operating level of the Iron Pond is 1038.9 m. The spillway was designed to safely pass the PMF. The stage – storage curve of the pond is shown on Figure XII.2, and its key design and performance characteristics are provided in Table 3.5.

Table 3.5 Relevant Iron Pond Characteristics

Item	Value
Top of the Dike Elevation (m)	1042.0
Spillway Crest Elevation (m)	1041.0
Maximum Operating Level (m)	1038.9
Storage Capacity at the MOL (dam^3)	76.9
Designed Storage Capacity up to the Spillway (dam^3)	614.2
Minimum Water Level in 2017-2018 (m)	1037.3
Maximum Water Level in 2017-2018 (m)	1038.7
Maximum Storage in 2017-2018 (dam^3)	55.7
Minimum Available Capacity Below MOL 2017-2018 (dam^3)	21.2

3.6 Water Discharge Volumes

There were no discharges over the ARD Pond and Iron Pond spillways during the reporting period. The only discharge to the environment is treated water from the Drainage Water Treatment Plant, which enters the St. Mary River. Table 3.6 provides a summary of the monthly discharge volumes. There was a total discharge volume of 3136 dam^3 between September 2017 and August 2018.

Table 3.6 Summary of Discharge to St. Mary River

Month	Total Volume (dam^3)	Average Discharge per Day (dam^3)
Sep 2017	43.2	1.4
Oct 2017	440.2	14.2
Nov 2017	0.0	0.0
Dec 2017	4.0	0.1
Jan 2018	22.5	0.7
Feb 2018	0.0	0.0
Mar 2018	48.5	1.6
Apr 2018	640.2	21.3
May 2018	775.1	25.0
Jun 2018	625.5	23.2
Jul 2018	379.1	12.2
Aug 2018	158.1	5.1
Total	**3136**	

The discharge volumes are less than the maximum limits of 28 dam^3 per day during the months March to October and 15.84 dam^3 during the month of November, as directed by the permit PE-00189.

3.7 Water Discharge Quality

KCB does not assess water quality. Teck reports groundwater quality and discharge water quality to BC Ministry of Environment as specified in Permit PE-00189.

4 SITE OBSERVATIONS

4.1 Visual Observations

The on-site inspection of the dikes was carried out by Ms. Pamela Fines, P.Eng, Ms. Karen Masterson, P.Eng. and Engineer of Record, Mr. Bill Chin, P.Eng, of KCB from May 23 through May 24, 2018. The weather during the inspection was warm and mostly clear skies. The 2018 Dam Safety Inspection Forms that were completed for each dike are included in Appendix I and selected photographs from the site visit are included in Appendix II. A summary of the visual observations of each dike is provided below.

Iron TSF and Iron Dike

The visual inspection of the Iron Dike indicated that the dike was in good condition with no signs of structural distress. No cracking was noted along the crest or downstream slopes. Dike slopes and crests are grassed, with no areas observed with bare or loose soil.

Seepage has continued similar to previous years on the downstream side of the dike near station 5+00. The seepage is currently being monitored by two weirs (Weir #4 and Weir #3 – AIPWU) installed within the drainage ditch (Appendix II Photos 1.13 through 1.17). The locations of these weirs are shown on Figures 3 and 4, respectively. Seepage is also occurring on the downstream side of the dike near station 24+00 and is being collected in the existing ditch and low-lying area (Appendix II Photo 1.02). This seepage should continue to be monitored.

The visual inspection of the Iron Pond (contained within Iron TSF) indicated that it was in good condition.

The Emergency Spillway Channel at the west side of the West Gypsum Seepage Collection Pond appears to be in good condition. Some vegetation is evident near the low point of the spillway, located near the 951 Pump House (Appendix II Photo B.4).

Old Iron TSF

The Old Iron Dike and Iron TSF Divider Dike of the Old Iron TSF appear to be in good condition with no signs of cracking or distress. Dike slopes of the Old Iron Dike are grassed, with no areas of bare or loose soil. There were no signs of seepage. The Iron TSF Divider Dike is buttressed by the Iron TSF and is currently being used as an access road between the two TSFs. No changes were observed from the previous DSI. The Iron TSF Divider Dike is buttressed on both sides with tailings and has no consequence of failure.

No. 1, 2, and 3 Siliceous Cells

The dike surfaces were found to be in good physical condition, with no visible signs of structural distress at the time of the inspection. Seepage of variable amounts generally occurs from the toes of all the Siliceous Dikes during the spring from runoff due to snowmelt water infiltration through the cover system. The seepage water is collected by drainage ditches. Inspection of seepage locations along the Siliceous Dikes is performed by Teck on a routine basis. Signs of surface seepage were not evident during KCB's site visit which was carried out after freshet in late May.

The surface water runoff channel from No. 1 Siliceous Cell across No. 3 Siliceous Cell, the diversion channel to the north of Cells No. 1 and No. 3 (Appendix II Photos C.1), and the riprapped emergency spillway channel (Appendix II Photo C.4) constructed down the slope of No. 3 Siliceous Cell were in good condition during the time of the site visit.

West Gypsum Cell

The West Gypsum Dike was observed to be in good condition based on a visual assessment with no indication of structural distress. The ditches that convey seepage from the dike toe to the pond at the 951 Pump House were well maintained. Water was observed within the ditches near the dike toe. Rodent burrows were observed near the middle and west of the dike toe (Appendix II Photos F.2 and F.3). These burrows are currently not a dam safety issue but they are a safety hazard to personnel walking along the dam toe and slope.

East Gypsum Cell

The East Gypsum Dike was observed to be in good physical condition during the inspection. Dike slopes are grassed with no areas of bare or loose soil observed. No indicators of erosion or structural distress were found. Large rodent burrows (most likely badger) were observed along the toe of the East Gypsum Dike, but are currently not a dam safety issue (Appendix II Photo F.3) The burrows are a safety hazard to personnel walking along the dam toe and slope.. Seepage was observed within the ditch at the dike toe (Appendix II Photo F.5). There were also seepage flows through James Creek coming from the east abutment where a filter was constructed in 2002 to collect seepage and from the toe ditches. The observed seepage was similar to previous DSI site visits.

Northeast Gypsum Dike and Recycle Dam

Both the Northeast Gypsum Dike and Recycle Dam embankments were observed to be in good condition, with no signs of structural distress observed along the crest. The slopes of both embankments are grassed and in good condition, however there is some evidence of minor surficial erosion (Appendix II Photo F.6) along the slope of the Northeast Gypsum Dike due to run-off.

ARD Pond

The visual inspection of the North and South Dams of the ARD pond did not reveal any evidence of problems with the integrity of the dams. The riprap on both dams was in good condition with no evidence of beaching or damage. It was noted that the debris build up in the ditch located to the north of the North Dam had been removed and continues to appear in good condition.

The downstream slope of the North Dam appears to be in similar conditions to previous years. Localized depressions/steepened slopes along the toe of the north dam have been noted during the annual inspections (Appendix II Photo A.6). These areas were constructed to manage seepage from the dam. Seepage collects in the toe ditch and flows to the seepage pond at the west end of the dam.

The ditch south of the South Dam that feeds into Weir #1 (ARDWU) and Weir #2 had a buildup of algae, which was potentially impeding flow (Appendix II Photo A.11). The locations of the weirs are shown on Figure 16. The downstream slope of the South Dam appeared to be in similar condition to past inspections. Wetlands vegetation was observed in the ditch by the access road (Appendix II Photo A.12). The seepage zone near piezometer SD-02, which is captured with a gravel blanket, feeds the toe ditch (Appendix II Photo A.1). Flows within the toe ditch appear to be similar to previous years and is clear with some algae growth.

Calcine TSF

The Calcine Dike remains in good physical condition and there were no obvious changes relative to previous inspections. The downstream slope of the dike is well vegetated and is buttressed by a municipal landfill. Monitoring of the Calcine Dike should remain as an annual visual inspection.

The old beach surface is at crest level adjacent to the dike, and gently slopes downward towards the north. There was no free water observed during the inspection, and vegetation has become established over the entire upstream and downstream area. Calcine removal from a pit developed at the northwest side of the lower cell ceased in 2011/2012 and this area was reclaimed. The pit is well drained and no standing water was observed (Appendix II Photos E.1 and E.2).

Sludge Impoundment

The visual inspection indicated that the structures remain in good condition, with moderate vegetation on the dam slopes at the time of the inspection. The sludge level is low within the impoundment. A slight depression was observed near the east end of the north dike as well as the south end of the south dike. These depressions in the crest align with the locations of the access ramps.

4.2 Photographs

Selected photographs of the various embankments taken during the site visit are presented in Appendix II and are referenced throughout this report. Photographs have been grouped as follows:

▪ ARD Pond/ARD Spillway	A.1 – A.12
▪ Iron Pond Emergency Spillway	B.1 – B.6
▪ Siliceous TSF	C.1 – C.4
▪ Sludge Impoundment and Treatment Plant	D.1 – D.5
▪ Calcine TSF	E.1 – E.5
▪ Gypsum TSF/Recycle Dam	F.1 – F.7
▪ Iron TSF	G.1 – G.8
▪ Old Iron Dike and Iron TSF Divider Dike	H.1 – H.3
▪ Iron Pond	I.1 – I.3

Aiming positions/locations for the photographs are shown separately on Figures 3, 4, 6, 8, 10, 12, 14, 16, 21, and 23 for each mine tailings area.

4.3 Instrumentation Review

Quantifiable Performance Objectives (QPOs) have been established for the instrumentation installed within the dikes/dams, including pond water levels for the ARD Pond and Iron Pond. The QPOs for the instrumentation and water levels are provided in Appendix III as well as tables (AIII-1 through 3), summarizing the piezometer, settlement and seepage data along with threshold levels for the instruments.

Threshold levels have been established for all instruments. Piezometric levels above the thresholds are not a dam safety concern as the maximum 2018 piezometric levels are below those assumed for design and the design factors of safety are well above minimum requirements. The intent of the threshold levels had not been to indicate a dam safety concern but to highlight a condition that is a change from historical norms and require a closer review.

A review of the thresholds is planned for 2019 with the intent of linking them to potential key failure modes and will also consider incorporating the experience from previous years where the readings have been influenced by higher than average precipitation.

The precipitation data for Kimberley/Cranbrook indicated higher than normal rainfall (fall 2017) as well as snowfall (winter 2018) for the reporting period as compared to 2009 through 2011 and 2014 through 2016. As occurred during the wetter years in 2012, 2013, and 2017 piezometric levels generally increased. This response is expected and piezometric levels tend to decrease during the drier summer months. Attached in Appendix III (Figure AIII-1) is a summary plot of precipitation data for reference.

4.3.1 Iron Dike

The locations of the existing instruments at the Iron Dike are shown on Figure 4. Typical sections showing geometry and pore pressure response are shown on Figure 5.

Water Levels

Time plots of the piezometric readings received from Vast[6] are presented on Figures IV-1 through IV-9 in Appendix IV. Peak values are reported in Table AIII.3 and shown on Figure 4.

Most of the Iron Dike piezometers (23 of 30) indicated an increase in in the measured pore pressures during the 2018 reporting period over the previous year's readings. However, all of the readings were below the threshold levels and well below levels assumed for stability assessments. In general, the instruments in the area have all shown expected responses based on higher than average precipitation observed in the fall/winter of 2016, 2017, and 2018.

There are two piezometers that were installed within a confined aquifer underlying glacial till below the dike (P92-H and P92-25). Previous DSI's discuss the history of these two instruments as P92-H was

---

[6] Vast is a company contracted by Teck to collect monitoring data and provide the data to Teck and KCB.

experiencing erratic readings and high pore pressure readings near trigger levels. The threshold levels were adjusted, and P92-H was replaced by a vibrating wire piezometer within the existing standpipe. Since then, the readings collected have indicated that pore pressures have stabilized which confirmed that the previous method of reading 92-H (i.e. by using a pressure gauge on the standpipe riser pipe) did not provide reliable data.

Deformation/Settlement

Of the five settlement plates being monitored, four plates on the south side (upstream of the dike crest, between stations 2+00 and 9+00) indicate settlements have stabilized with between 45 mm and 65 mm of total settlement since 2007. The SP92-07 plate on the 1033.0 m bench, downstream side, has indicated settlement of approximately 31 mm since 2007, with no change since 2014. As the incremental settlement is essentially zero, it is well within threshold limits.

In addition to the settlement plates, a survey of the dam crest is performed in the area surrounding the Iron Pond spillway annually. While the settlement plates indicate minimal settlement, portions of the dike crest are used as access roads and maintenance activities may alter the elevation of the dike crest. Surveys performed in 2017 and 2018 indicated the dike crest is at or above the design elevation of 1042 m.

Seepage Flows

Two weirs (Weir #3 – AIPWU and Weir #4) exist to monitor seepage from the toe of the west portion of the Iron Dike. Weir #3 is located near the toe of the Dike, and Weir #4 is located 300 m downstream.

Weir #3 - AIPWU (Figure IV-10) measured peak flows of 124.8 m^3/day in April during freshet. The flow data indicate minimum flows through Weir #3 (AIPWU) are 0.1 m^3/day and 2.3 m^3/day. The peak flows were higher in 2018 than in previous reporting periods; however, this is expected due to the greater than average snowpack and rain on the melting snowpack. As this weir was installed in 2013 at the start of a drier period, there is no long term historical trends for comparison. It should be noted that while the weir is installed close to the dike toe, there will still be some influence of run-off from the dike slope in the measured seepage flows.

Data for Weir #4 has been collected since 2008 and the trend is presented on Figure IV-11. The flow data generally indicates maximum flows of about 200 m^3/day to 250 m^3/day every year, with higher flows during wet years. In 2018 a peak flow of 1084.3 m^3/day was recorded in April during freshet. This reading is substantially higher than the peak of 2017 due to increased precipitation/snow. A similar peak was observed in 2012 during a year of high precipitation. It should be noted that this weir is 300 m from the dike toe at station 5+00 and flow measurements will also include surface run-off from the surrounding terrain as well as any seepage collected.

The weirs are read at a minimum monthly, with daily or weekly readings performed during spring freshet and additional readings following heavy rainfall events.

4.3.2 Old Iron TSF Dikes

The locations of the existing instruments at the Old Iron TSF (Old Iron Dike and Iron TSF Divider Dike) are shown on Figure 6. A typical section showing geometry is shown on Figure 7.

Water Levels

Plots of the piezometer readings for the Old Iron TSF are included as Appendix V. Old Iron Dike piezometers are shown on Figures V-1 and V-2, and the Iron TSF Divider Dike piezometers are shown on Figure V-3. Peak values are reported in Table AIII.3 and shown on Figure 6.

Five piezometers were monitored during the reporting period. All five saw increases in maximum pore pressure readings when compared to the previous reporting period. Two of these piezometers (P93-17 and P93-18) indicated maximum measured pore pressures above current threshold levels; however, the most recent readings have shown decreased water level, with P93-17 and P93-18 below trigger levels. The increase is most likely due to the higher than average rainfall and snowpack observed in the fall of 2017 and winter and spring of 2018. These piezometers will continue to be monitored to confirm that pore pressures continue to dissipate. The measured pore pressures are all below the assumed piezometric surface used for design.

As per 2016 DSI recommendations, piezometer P96-11 was replaced due to erratic data with vibrating wire piezometers (VWP) SUL-OID-VWP-18-02 A&B. Piezometer P96-08 was also replaced with VWPs, SUL-OID-VWP-18-01 A&B, because the tip elevation was unknown and produced erratic readings. Readings of the new instruments began in the 2018-2019 reporting period.

4.3.3 No. 1, 2, and 3 Siliceous Cell Dikes

The locations of the existing instruments at the Siliceous Cells are shown on Figure 8. Typical sections showing geometry and pore pressure responses are shown on Figure 9.

Water Levels

No. 1 Dike

Time-history plots of piezometer readings for the No. 1 Dike are presented on Figures VI-1 to VI-2 in Appendix VI. Peak values are reported in Table AIII.3 and shown on Figure 8.

There are currently five piezometers for No. 1 Siliceous Cell Dike that are providing data. Several instruments are no longer read as they had been dry for many years. No instruments saw an increase in the maximum recorded pore pressures in comparison to the previous reporting period. The current reading for P105 is above the threshold level; however, this is still well below the piezometric surface assumed for design. As previously indicated, a review of the piezometer thresholds is planned for 2019.

No. 2 Dike

A time-history plot of the piezometer data for the No. 2 Dike is included as Figure VI-3 in Appendix VI. The only active piezometers in the area are P231, P257, and P91-13. P231 and P257 have both shown an increase in comparison to 2017 readings, and is likely a reflection of the higher precipitation. While the piezometer readings have increased, they are below the threshold levels.

No. 3 Dike

A time-history plot of the piezometer data for the No. 3 Dike is included as Figure VI-4 in Appendix VI. Five functioning standpipe piezometers along the No. 3 Siliceous Dike alignment were monitored during this reporting period, which are read annually.

Of the five piezometers read in 2018, three of them, P301, P302, and P303, were dry, while both P232 and P233 reported no change from last year.

Three standpipes were replaced in 2018 due to their bottom depths being at or above the phreatic surface for design, as per 2017 DSI recommendations. Standpipe P301 was replaced with SUL-SD3-VWP-18-06 A&B, P302 was replaced with SUL-SD3-VWP-18-07, and standpipe P303 was replaced with SUL-SD3-VWP-18-08 A&B. Another VWP was installed at the toe of Station 7+00 (SUL-SD3-VWP-18-09). Additionally, two more standpipes were installed at the toe of the No. 3 dike in 2018 (SUL-SD3-P-18-10 and SUL-SD3-P-18-11). Readings for the six new instruments started during the 2018-2019 reporting period.

4.3.4 West Gypsum Cell Dike

The locations of the existing instruments at the West Gypsum Cell are shown on Figure 10. A typical section showing geometry and pore pressure responses is shown on Figure 11.

Water Levels

Plots of piezometer data are included as Figure VII-2 and Figure VII-3 in Appendix VII. Currently there are six active piezometers along the West Gypsum Dike. Of these, four are showing an increase in maximum recorded pore pressure in comparison to last year, most likely due to higher than average precipitation and snowpack during the reporting period. All readings show pore pressures greater than 2.5 m below the specified threshold levels and the phreatic surface assumed for design. All active piezometers should continue to be read three times per year at the West Gypsum Dike. A standpipe was installed at the toe of the dike in 2018 (SUL-WG-P-18-03). Readings from the new instruments started in the 2018-2019 reporting period.

Settlement

The three settlement plates remaining at the West Gypsum Dike are surveyed in three directions. The plots of their displacements are provided on Figures VII-4 to VII-6 in Appendix VII.

Settlement plates SP97-01 and SP97-05 are located at Station 10+00. SP97-01 on the downstream side of the dike has settled about 275 mm and displaced horizontally, in the upstream direction, about 320 mm since installation in 1997. The data indicates the settlement started to stabilize in 2004, with a settlement of approximately 0 mm recorded since last year. SP97-05 on the upstream side of the dike has settled about 970 mm and moved upstream about 185 mm since installation. It has continued to settle at a relatively constant rate of about 30 mm/year to 50 mm/year since 2004, with a settlement of 23 mm recorded since last year.

Settlement plate SP97-06 is located at Station 20+00 on the upstream side of the dike. It has recorded about 595 mm of settlement and about 105 mm of horizontal upstream displacement since installation in 1998. It has been settling at an approximate rate of about 20 mm/year to 30 mm/year since 2004, with a settlement of 22 mm recorded since last year.

Continued settlement of the dike crest is expected as continued creep is common in gypsum, and the dike was constructed using the upstream method, i.e., dike raises are founded on gypsum. The measured settlement is below the threshold limits and is expected to continue. It is not a dam safety concern.

Consolidation of the West Gypsum Cell tailings is monitored with Sondex multiple settlement gauge S94-01, installed about 50 m upstream of the crest at Station 10+00 (Figure VII-1 in Appendix VII). A reading of the Sondex gauge was taken during the 2016 site visit. The reading schedule for this gauge was changed to every three years and the next reading is scheduled for 2019. The Sondex gauge readings have indicated a settlement rate of approximately 30 mm/year (top ring) since 2008 with a total settlement of about 1.6 m since 1994. The settlement rate has not leveled off to date. As indicated in KCB's report Stability Review of Gypsum Dikes dated November 26, 1993, long term creep is a common characteristic of gypsum.

A survey of the dike crest was completed in 2017. A comparison of the results with the 2012 LiDAR indicates approximately 0.2 m of settlement, which is to be expected for an upstream dike constructed over gypsum and is not a dam safety concern. A review of the hydrology design is ongoing to assess the effects of the settlement with respect to hydrologic performance of the dike. The results will be reported separately from this report.

Lateral Movement

Inclinometer BI94-01 at Station 10+00 has not been read since 2004 as it is blocked 4.7 m below the ground surface. This is likely due to cumulative and continuing upstream movement occurring at this depth combined with the ongoing settlement. It is not necessary to replace this instrument, based on the movement trends observed and there is sufficient instrumentation to adequately monitor potential slope deformations in this area. It may only be necessary to replace BI94-01 if visual observations and/or the other instruments indicate adverse deformation patterns.

Figure VII-1 in Appendix VII shows the cumulative deflection up to 2004 as well as readings of the upper 4.7 m taken in 2007 through 2009. The 2007 through 2009 data were merged with the 2004 data below 4.7 m to observe any potential movement at the top of the casing. No additional movement at the top of the casing was observed and this inclinometer is no longer read.

4.3.5 East Gypsum Cell Dike

The locations of the existing instruments at the East Gypsum Cell are shown on Figure 12. A typical section showing geometry and pore pressure responses is shown on Figure 13.

Water Levels

Plots of piezometer readings are provided in Appendix VIII (Figures VIII-2 and VIII-3). Currently there are seven active piezometers installed along the East Gypsum Dike. Of these, two showed an increase in maximum recorded pore pressure in comparison to last year, most likely due to higher than average precipitation and snowpack during the reporting period. Instrument P93-14 was reported as dry and blocked at 13.3 m. All readings show pore pressures below the specified threshold levels and below the level assumed in the stability analyses.

Two standpipes were installed at the toe of the dike in 2018 (SUL-EG-P-18-04 and SUL-EG-P-18-05). Readings from these instruments will be part of the next reporting period. All active piezometers should continue to be read annually at the East Gypsum Dike.

The groundwater levels in the East Gypsum Cell are generally higher than in the West Gypsum Cell.

Settlement

Two active settlement plates at the East Gypsum Dike are surveyed in three directions. The plots of their displacements are provided on Figures VIII-4 and VIII-5 in Appendix VIII.

Settlement plate SP97-03 is located at Station 33+00 on the downstream side. It has settled about 615 mm and displaced horizontally, in the upstream direction, about 100 mm since installation in 1998. Settlement plate SP97-04 is located at Station 48+00 on the downstream side. It has recorded about 535 mm of settlement and about 125 mm of horizontal upstream displacement since installation. Both plates continue to settle at a uniform rate of about 20 mm/year to 30 mm/year, with recent readings of 17 mm (SP97-03) and 28 mm (SP97-04) in comparison to last year’s readings. The horizontal displacements are occurring at a rate of approximately 10 mm/year, and are directed upstream, perpendicular to the dike crest. The settlement is below threshold values and is expected as gypsum continues to settle for many years following deposition.

Consolidation of the East Gypsum Cell tailings is monitored with the Sondex settlement gauge S94-02, installed about 25 m upstream of the crest at Station 33+00 (Figure VIII-1 in Appendix VIII). The reading schedule for this gauge was changed to every three years and the next reading is scheduled for 2019. The Sondex gauge readings have indicated a settlement rate of approximately 40 mm/year (top ring) since 2008 with a total settlement of about 940 mm since 1994. The settlement rate has not leveled off to date. As indicated in KCB’s report Stability Review of Gypsum Dikes dated November 26, 1993, long term creep is a common characteristic of gypsum and is not a dam safety concern.

A survey of the dike crest was completed in 2017. A comparison of the results with the 2012 LiDAR indicates approximately 0.5 m of settlement, which is to be expected for an upstream dike constructed over gypsum and is not a dam safety concern. As noted above, a review of the hydrology design is ongoing to assess the effects of the settlement with respect to hydrologic performance of the dike.

Lateral Movement

There is one inclinometer (BI94-02) installed within the East Gypsum Dike at Station 33+00. There has been very little horizontal movement (<10 mm) indicated since 2010. The BI94-02 readings are presented on Figure VIII-1. This inclinometer was not read in 2018 as the next reading is scheduled for 2019.

4.3.6 Northeast Gypsum Dike and Recycle Dam

A plan view of the Northeast Gypsum Dike and Recycle Dam are shown on Figure 14. A typical section showing geometry is shown on Figure 15.

Water Levels

There are four standpipe piezometers installed at the Northeast Gypsum Dike, and two standpipe piezometers installed at the Recycle Dam. Following the recommendations in the 2004 DSI, the piezometers are no longer being read as they essentially recorded the pond elevations and were not providing information to assess Dike/Dam performance. Monitoring of the piezometrc levels in these embankments is not considered necessary given their long history of good performance, relatively low heights and any impacts in the unlikely event of a failure would be wholly contained within the impoundment area.

Settlement

Settlement of the Northeast Gypsum Dike is measured by plates W (S1) and E (S2) that indicate essentially no settlement since 2007 (See Appendix IX).

Lateral Movement

Lateral movement is monitored from the survey of the settlement plates. There has been less than 20 mm of lateral movement observed since 2007.

4.3.7 ARD Pond South Dam

The locations of the existing instruments at the ARD Pond are shown on Figure 16. Typical sections showing geometry and pore pressure response are shown on Figures 17 through Figure 20.

Water Levels

There are currently five active piezometers installed within the ARD South Dam, three of which are standpipes, and two are pneumatic. Time history plots of the piezometer readings are shown on Figures X-1 and X-2 in Appendix X. Key trends are highlighted below:

- All of the piezometer readings fluctuate with the pond water level to some extent. The greater response is exhibited by standpipes SD-01 and SD-02, while a more muted response is evident in SD-03, PP01-05 and PP01-06.
- The pneumatic piezometers in the middle section of the South Dam, PP01-05 and PP01-06, have recorded relatively stable groundwater elevation, generally fluctuating between about

1030 m and 1031 m since installation in 2002. PP01-06 recorded 2018 values that temporarily exceeded the threshold level, but subsequently dropped below the threshold level.

- Both standpipes SD-02 and SD-03 also recorded readings in 2018 that were at or above their threshold levels, but subsequently dropped below the threshold levels. The threshold level exceedance typically occur in the spring when they are read daily and when piezometric elevations are expected at their peak.
- Standpipe SD-01 readings show a strong response to pond water level, showing fluctuations of up to 5 m, but have continued to remain below the threshold level.

As previously noted, exceedance of threshold levels is not indicative of a dam safety concern, as the threshold levels are set well below those assumed for design in the stability calculations. A review of the threshold levels is planned in 2019.

Settlement

Settlement plates SP4, SP5 and SP6 at the South Dam have recorded no measurable settlement since 2001 (Figure X-7 in Appendix X), indicating the dam is performing as intended.

Lateral Movement

Lateral movements are monitored through survey of the settlement plates. There has been less than 25 mm of lateral movement recorded by the survey since the end of construction.

Seepage Flows

There are currently two weirs installed to measure seepage at the South Dam toe, although runoff from the dikes and surrounding terrain is also captured. These include Weir #1 (ARDWU) installed in 2013, and Weir #2 approximately 50 m downstream installed in 2003. The locations of Weir #1 (ARDWU) & Weir #2 are shown on Figure 16. In 2018 readings obtained for Weir #1 - ARDWU (Figure X-5 in Appendix X) indicate similar trends to Weir #2 (Figure X-6 in Appendix X). The short-term peak flows measured for the reporting period were 145.3 m^3/day and 241.2 m^3/day, respectively.

Both Weir #1 and Weir #2 flows fluctuate in response to the water levels in the reservoir, with almost no flow recorded until the pond elevation exceeds about elevation 1036 m. Higher than typical flows were recorded in 2013/2014, 2017 and 2018, which are attributed to the melting of a larger snowpack, and increased rainfall during the spring.

4.3.8 ARD Pond North Dam

The locations of the existing instruments at the ARD Pond are shown on Figure 16. Typical sections showing geometry and pore pressure response are shown on Figures 17 through Figure 20.

Water Levels

There are currently eight active piezometers installed within the ARD North Dam, four of which are standpipes, and four are pneumatic. Time history plots of the piezometer readings are shown on Figures X-3 and X-4 in Appendix X. Key trends are highlighted below:

- All of the piezometer readings fluctuate with the pond water level to some extent. The greater response is exhibited by piezometers ND-01, ND-02S, ND-2D, ND-03 and PP01-04, while a more muted response is evident in PP01-01, PP01-02 and PP01-03.
- The 2018 maximum groundwater levels measured in ND-01, ND-02S, ND-02D and ND-03, which are located along the dam toe, are between elevation 1041.0 m on the east side and elevation 1038.9 m on the west side. These piezometric elevations correspond to about 2 m to 3 m below ground surface, and refects a general gradient toward the seepage collection pond located about Station 0+350 m (Figure X-3 in Appendix X).

Only one standpipe (ND-02S) recorded a value close to the threshold level, but subsequently decreased to below the threshold.

Settlement

Similar to the South Dam, settlement plates SP1, SP2 and SP3 at the North Dam have recorded a total settlement of less than 20 mm since installation in 2001 (Figure X-8), indicating the dam is performing as intended.

Lateral Movement

Lateral movements are monitored through survey of the settlement plates. There has been less than 25 mm of lateral movement recorded by the survey since the end of construction.

4.3.9 Calcine TSF Dike

A plan view of the Calcine Dike is shown on Figure 21. A typical section showing geometry is shown on Figure 22.

Water Levels

Three standpipe piezometers are located on the dike crest as shown on Figure 21 (C1, C2 and C3). The piezometers were last inspected in June 2004 and have been dry since 1986. As per KCB’s recommendation, piezometer monitoring at the Calcine Dike ceased in 2007.

4.3.10 Sludge Impoundment Dikes

A plan view of the Sludge Impoundment Dikes is shown on Figure 23. A typical section showing geometry is shown on Figure 24.

Water Levels

There is no instrumentation installed to monitor water levels as there is no water stored within the impoundment. Water deposited during sludge deposition or due to precipitation drains through the embankment (which contains a filter zone) and into the foundation.

Settlement

A survey of the Sludge Impoundment Dike crests (North and South Dikes) was taken in 2018 to monitor any settlement that is occurring and to compare the crest elevations to the design elevation of 894.6 m. The survey of the dike crests is completed annually.

The most recent survey from September 2018 can be found on Figure XI-1. The surveys from 2016, 2017 and 2018 indicates that the most southern portion of the South Dike crest is currently below the design elevation by approximately 0.5 m as a result of the access ramp cutting into the crest. There was a similar issue at the east end of the North Dike where a section of the crest did not meet the design width. The access ramp at the North Dike was adjusted in Fall 2017, such that the required crest width is now per design. An assessment of the effect of the lower crest at the South Dike will be completed as part of a design update review in 2019.

The surveys indicate that there has been no settlement. A survey of the dike crest is only required once per year unless visual inspections indicate some observed settlement.

4.3.11 Overview Summary

Based on the review of the instrumentation data, there are no dam safety concerns. The current monitoring schedule for the all instruments will be maintained for the 2019 DSI reporting period. The monitoring frequencies are reported below in Table 4.1 below. Additional readings may be requested as required depending on trends observed during the 2019 reporting period.

Table 4.1 Monitoring Frequencies for 2019

Dike/Pond		Monitoring Frequency (3x = Three times per year, 3y = Every 3 years, A = Annual, AV = Annual Visual, M = Monthly, W = Weekly)				
		Piezometers	Settlements	Inclinometers	Seepage	Water Levels
Iron Dike		3x (1,9)	3y)+ A(11)	-	W + special regime (8)	Daily
Old Iron TSF	**Old Iron Dike**	3x(1)	-	-	-	-
	Iron TSF Divider Dike	A (2)	-	-	-	-
No. 1, 2, and 3 Siliceous Cell Dikes		A(6)	-	-	-	-
Gypsum Cell Dikes	**West**	3x	A + 3y(7)	-	AV (4)	-
	East	A	A + 3y(7)	3y(7)	AV (4)	-
Northeast Gypsum Dike and Recycle Dam		-	3y	-	-	-
ARD Pond	**North Dam**	M + special regime (3,10)	3y	-	-	Daily
	South Dam	M + special regime (3,10)	3y	-	W + special regime(3)	
Sludge Impoundment	**North Dike**	-	A	-	-	-
	South Dike	-	A	-	-	-

Notes:

[1] Three times a year (spring, summer and fall).

[2] Annually in the spring if possible as this will be peak level.

[3] Special regime: Weirs weekly with daily readings between March 1 and May 30. Daily readings when the pond level is > 1045 m. Read for 3 days following rainfall event >10 mm. Standpipe piezometers monthly with weekly readings when ARD Pond levels are above 1040 m and daily when ARD Pond levels are above 1045 m. Record pond water levels when weirs read. When reading weirs, provide visual observations of ditch flows, i.e., ice build-up upstream of weir, flows under or around weir, etc.

[4] Annually, visual inspection.

[5] Only read standpipe piezometers.

[6] At a minimum only required to read piezometers P5 and P105 in No. 1 Siliceous Dike; P231 and P257 in No. 2 Siliceous Dike; and, P232, P301 and P303 in No. 3 Siliceous Dike.

[7] Settlement plates to be read annually. Inclinometer and Sondex gauges to be read every three years

[8] Special regime: Weir weekly with daily readings between March 1 and May 30. Read for 3 days following rainfall event >10 mm. Record pond water levels when weirs read. When reading weirs, provide visual observations of ditch flows, i.e., ice build-up upstream of weir, flows under or around weir, etc.

[9] Three times a year (spring, summer and fall) except P92-H which is recorded weekly by a data logger and P92-02 and P92-25 are read monthly.

[10] Read pneumatic piezometers monthly per year and weekly when pond is above 1045 m.

[11] Survey of Iron Dike from Station 0+00 to 12+00 to be completed annually.

5 DAM SAFETY ASSESSMENT

5.1 Design Basis Review

5.1.1 Geotechnical

From 1992 through 1994, KCB (EoR firm) completed stability assessments for all of the tailings dikes, except for ARD Pond dams (constructed in 2001), Calcine Dike, Sludge Impoundment Dikes, and Northeast Gypsum and Recycle dams. The stability assessment work included field investigation programs, laboratory testing and material parameter reviews. The assessment resulted in the construction of stabilization measures, either by slope flattening and/or toe berms, to enhance long term stability under closure. The KCB report “Geotechnical Design Basis for Tailings Dikes – Overview Summary Report” dated January 9, 2002 provides an overview of this work as well as the construction history and geotechnical design basis adopted for long term stability of the tailings dikes.

The stability assessment recognized that loose and contractive, saturated tailings, such as those present in the tailings storage facilities at the Sullivan Mine, are known to be susceptible to liquefaction. This was demonstrated by a static liquefaction failure of the Old Iron Dike in 1948 and a static liquefaction failure of the (then) active Iron Dike in 1991 (Davies et al, 1998)[7]. The 1991 failure raised a potential concern regarding the seismic vulnerability of the other tailings storage dikes at the Sullivan Mine, which led to the stability assessment program carried out from 1992 to 1994.

The stabilization measures for the tailings storage dikes been designed for ground motions generated by the Maximum Credible Earthquake (MCE), and were based on stability design criteria that were applicable at the time. In particular, the minimum target static factor of safety was 1.5 and the minimum target post-earthquake factor of safety was 1.1. It is noted that the target post-earthquake factor of safety of 1.1 adopted at the time is lower than 1.2 to 1.3 that is currently specified in the 2007 CDA Guidelines (CDA 2013). However, it should be emphasized that, irrespective of the earthquake ground motion, it was assumed that all saturated tailings would liquefy. Therefore, all saturated tailings were assigned the liquefied residual undrained strength for stability calculations. Since mine closure in 2001, it is expected that the respective post-earthquake factors of safety of the various tailings storage dikes will have improved as the phreatic surface in the impoundments (and, therefore, the proportion of liquefiable tailings) continued to decrease over time. Teck and KCB are planning to review the stability of the dikes and update the factors of safety as appropriate to better reflect existing conditions.

With regards to the ARD Pond Dams (which are water retention dams), they were also designed based on ground motions generated by the MCE (KCC 2000). For long-term stability, the minimum factor of safety was calculated to be 2.0 for static conditions and 1.8 for rapid reservoir drawdown. For pseudo-static stability, the minimum design factor of safety is 1.1. These factors of safety are in compliance with the applicable design criteria (EMPR 2017).

---

[7] Davies, M.P., Dawson, B.B. and Chin, B.G. (1998). Static Liquefaction Slump of Mine Tailings – A Case History”. Proceedings, 51st Canadian Geotechnical Conference, Edmonton, Alberta, Canada

With regards to the Sludge Impoundment Dikes, and as previously discussed, there was minimal sludge retained at that time of the stability assessment work but it was recommended that a review be performed in the future once sludge began to accumulate. The original design report completed in 1978 by others reported a static factor of safety of 1.4 and a pseudo-static factor of safety of 1.2. As discussed in previous sections of the report, review of the stability of the dikes will be carried out as part of the design update for the Sludge Impoundment scheduled in 2019.

The Northeast Gypsum Dike and Recycle Dam were also not reviewed prior to closure as the likelihood of failure was very low and any release is contained within Teck's property. These dikes were designed by Robinson Dames& Moore (1984) assuming a minimum static factor of safety of 1.5 and minimum pseudo-static factor of safety of 1.3.

The stability of the Calcine Dike was also not reviewed prior to closure, since there is a municipal landfill downstream of the dam which provides a significant stabilizing buttress for the dike. In addition, the calcine tailings are known to be free-draining such that the piezometric levels are now close to original ground. Therefore, there is no concern with respect to long-term stability.

5.1.2 Hydrology

The hydrologic design basis for the tailings facilities (except for the Sludge Impoundment) is described in the KCB report "Tailings Area Post-Closure Water Management Study – Final Report" dated January 3, 2001. The tailings facilities at the site were modified for closure and these closure designs used the Probable Maximum Flood (PMF) events for water management assessments. The 2007 CDA (2013 Revision) and HSRC (EMPR, 2016 & EMPR, 2017) criteria stipulates that dams of very high consequence classification such as the ARD Pond dams (highest consequence classification dams on site) must be able to pass a flood 2/3 between the 1 in 1,000 year and the PMF during active closure. CDA recommends increasing the flood management criteria up one consequence level for passive closure. The other facilities have lower regulatory requirements. All of the dikes/dams at Sullivan Mine (except for the Sludge Impoundment) meet or exceed the guideline/regulatory requirements.

The Sludge Impoundment design assumed a design flood event of 1:200 year. The design also assumed a much faster sludge deposition than has actually occurred. It was assumed that the dikes would need to be raised and expanded well before closure. According to Teck, about 121,000 tonnes of sludge were deposited in the impoundment from October 1997 to December 2001. After the mine closure, from 2002 to 2018, 55,841 tonnes of sludge were deposited in the impoundment, with an average annual deposition rate since closure of 3,285 tonnes/year.

A review of the Sludge Impoundment capacity was completed in 2015. It was estimated that the Sludge Impoundment could accommodate another 15 to 20 years of operation. However, with the recent changes to the HSRC requirements, the design flood event required for the Sludge Impoundment has increased and a review is ongoing to assess if the current design freeboard is adequate to accommodate the new required design flood event of 1/3 between the 1/975 and the PMF (EMPR, 2017). To facilitate the review, the Sludge Impoundment surface has been surveyed to obtain average sludge deposition rates. A comprehensive review of the Sludge Impoundment is needed to assess flood routing, sludge filling rates and embankment stability, and this work is ongoing.

5.2 Hazards and Failure Modes Review

As a required component of a dam safety inspection, the key potential hazards and failure modes must be identified. Failure at the tailings facilities can be defined as an uncontrolled release of tailings or ARD water to the environment. As the tailings and waste facilities are closed and have been reclaimed (except for the Sludge Impoundment, ARD Pond and Iron Pond), the key hazards and failure modes of concern are potential overtopping during major flood events for all ponds and piping failures (ARD Pond and Iron Pond). Additional hazards include earthquake, slope instability and foundation stability.

The likelihood of overtopping failures is close to non-credible[8] to very rare[9] given the closure measures in place (e.g. drainage channels, spillways, etc. designed for PMF/PMP) for the Old Iron TSF, Siliceous, Gypsum and Calcine TSFs. Spillways designed for the PMF/PMP are also in place for the ARD Pond and Iron Pond such that the likelihood of overtopping is non-credible and close to non-credible, respectively. The likelihood of failure for overtopping of the Sludge Impoundment is unlikely[10] based on the review of the storage capacity completed in 2015. The design criteria has changed and a review was started in 2018, with work expected to be completed in 2019 (see Section 5.1.2).

The likelihood for piping failures (ARD Pond and Iron Pond) is also close to non-credible to very rare given the filter zones within the ARD Pond Dams and the low pond water levels and associated piezometric surfaces within the Iron Pond. The likelihood of a piping failure for the Sludge Impoundment is rare[11] given the filter zone along the upstream face and lack of permanent pond.

In addition, Teck has a robust surveillance program to monitor pond levels and check for dike surface gullying that might lead to freeboard changes, and to look for any evidence of changes in seepage conditions at the toe of each dike that could indicate potential piping (ARD Pond, Iron Pond and Sludge Impoundment).

The likelihood of failure due to seismic and static instability (foundation and slope) is very rare to close to non-credible for the tailings facilities. As discussed in Section 5.1.1, stability assessments completed in the 1990s for the Iron Dike, Old Iron Dike, Iron TSF Divider Dike, Siliceous Dikes, and Gypsum Dikes reviewed material parameter assumptions and used ground motions generated by the Maximum Credible Earthquake, assuming all saturated tailings liquefying. To enhance stability, slopes were flattened and/or toe berms constructed. Since this work was completed, the piezometric levels

---

[8] “Close to Non-Credible” Likelihood Rating is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is greater than 1 in 10,000 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) for slope instability of 2.0 or greater.

[9] “Very Rare” is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is between 1 in 1,000 and 1 in 10,000 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) against slope instability of 1.5 to 2.0.

[10] “Unlikely” is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is between 1 in 10 and 1 in 100 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) against slope instability of 1.2 to 1.3.

[11] “Rare” Likelihood Rating is defined as: for a natural hazard (earthquake, flood, windstorm, etc.), the predicted return period for an event of this strength/magnitude is between 1 in 100 years and 1 in 1000 years; this rating is also applicable for failure modes such as instability and internal erosion. Factor of safety (FoS) against slope instability of 1.3 to 1.5

within the dikes have decreased, further enhancing both static and seismic stability. Static factors of safety are well above 1.5. This would also be the case for the Calcine and Northeast Gypsum Dikes as piezometric levels have also decreased.

Failures due to earthquake, slope instability and foundation instability are not considered credible failure modes for the ARD dams due to the assumption of MCE ground motions for seismic design and the resulting factors of safety, which are much greater than recommended in the 2007 CDA guidelines.

The likelihood of failure due to seismic and foundation stability for the Sludge Impoundment is rare based on the design factors of safety of 1.2 and 1.4, respectively. As discussed in Section 5.1.1, a review of the stability is ongoing in 2018 and to be completed in 2019.

5.3 Review of Downstream and Upstream Conditions

There have been no changes to the downstream of the tailings facilities at Sullivan Mine. The town of Kimberley, B.C. (Marysville) located downstream of the facility has not experienced any major development or population changes since last year's reporting period.

The conditions upstream of the tailings facilities have also not experienced any changes since last year that would require a reassessment of the failure consequence classification. There have been no changes to surface water run-off, watershed, or hydrology upstream.

5.4 Dam Classification Review

A review of the CDA guidelines was undertaken as part of the 2008 Dam Safety Review (KCB, 2009) and the 2013 Dam Safety Review (Golder, 2014), and based on the information available, the consequence of failure classification for the facilities at the Sullivan Mine is shown in Table 5.2. There have been no changes to the consequences of failure to warrant a change to the current dam classifications.

However, it is important to highlight that, while all of these structures are currently considered "dams" from a regulatory perspective, few of the inactive facilities are retaining fluid tailings and could be considered equivalent to earthen landfills. This is evident through a review of the instrumentation data, which indicates piezometric surfaces for most which are very low (i.e. near original ground or 1 – 2 m above), especially for the Old Iron Dike and Iron TSF Divider Dike, the Siliceous TSF, the Calcine TSF, and the Gypsum TSF. In addition, as previously discussed, aging effects may also be an important factor in reducing the mobility of the tailings over time. In such cases, their respective consequence classifications could be significantly lowered, and in the near future, it may be possible to declassify some of these dikes. Teck and KCB are continuing to develop a phased work plan to support lowering the consequence classifications for some of the inactive facilities and towards eventual declassification of the dikes where considered feasible and appropriate. The 2018 Geotechnical Investigation included work completed on the Siliceous TSF's and Gypsum TSF's tailings and foundation units. Work determining if consequence classifications can be lowered or if some dams may be declassified is ongoing.

Table 5.1 Consequence Classification

Storage Facility	Embankment	Consequence Classification[1]
Iron TSF	Iron Dike	H
Old Iron TSF	Old Iron Dike	L
	Iron TSF Divider Dike	L
Siliceous TSF	No. 1 Siliceous Dike	L
	No. 2 Siliceous Dike	L
	No. 3 Siliceous Dike	L
Gypsum TSF	East Gypsum Dike	H
	West Gypsum Dike	H
	North East Gypsum Dike	L
	Recycle Dam	L
Calcine TSF	Calcine Dike	L
Sludge Impoundment	North Dike	L
	South Dike	L
ARD Pond	North Dam	VH
	South Dam	VH

Notes:
Consequence Categories based on 2007 Canadian Dam Safety Guidelines (CDA, 2013):
E=Extreme, VH= Very High, H=High, S=Significant, L=Low.

5.5 Physical Performance

5.5.1 Geotechnical

Iron TSF

Based on the visual observations and instrumentation review, the stability of the Iron Dike is considered satisfactory. With the completion of the reclamation cover and a relatively constant phreatic surface, it is expected that the piezometric elevation within the Iron Dike will continue to stabilize.

Old Iron TSF

The monitoring data for the Old Iron Dike found in Appendix V indicate the dike is in good condition. Although the maximum measured phreatic conditions (recorded in Spring 2017) for some instruments were above threshold levels, subsequent readings in the summer and fall indicated a reduction in the piezometric levels to levels below the thresholds. The stability of the Old Iron Dike is considered satisfactory.

Stability of the Iron TSF Divider Dike is not a concern since it is buttressed by the Iron TSF immediately downstream.

No. 1, 2, and 3 Siliceous Cells

Based on the available monitoring data and observations made during the site inspection, the dikes are in good condition.

East and West Gypsum Cells

Based on the visual inspection and available monitoring data, the East and West Gypsum dikes are in satisfactory condition.

The rodent burrows observed at the dike toe are not a dam safety concern as there is no pond to generate a piping failure, even after some infilling in 2017, the burrows were more extensive in 2018. The area should continue to be monitored for continued burrow activity. These burrows do pose a safety hazard to personnel walking along the toe of the dikes.

Northeast Gypsum Dike and Recycle Dam

Both structures appear to be in good condition based on the site inspection.

ARD Pond

Based on the review of all most recent instrumentation data and observations made during the annual inspection, the North and South dams are in good condition.

Calcine TSF

Based on visual observations, the dike is in good condition.

Sludge Impoundment

Based on the visual observations and the dike crest survey, the dikes are in satisfactory condition. The South Dike crest was lower than the design elevation near the access ramp. The effect of this low spot and potential repair recommendations, if required, are being reviewed in 2019 as part of the recommended design review and storage capacity assessment (See Sections 5.1.1 and 5.1.2) and a broader design review of the Sludge Impoundment.

5.5.2 Hydrotechnical

The hydrotechnical performance of the tailings facilities are dictated by surface water flows and frequency of water discharge through existing spillways. During the current reporting period, there was no evidence of any issues related to surface water overtopping any of the existing dams or discharging into the emergency spillways for the ARD Pond and Iron Pond. The current condition of these spillways can be seen on photos A.8 to A.9 and B.1 to B.6. It was noted during the site inspection that there is some growth of vegetation at the base of the Iron Pond spillway channel to the west of the West Gypsum Dike.

The Sludge Impoundment has performed as expected. As noted in Section 5.1.2, the design criteria based on HSRC (EMPR 2017) requirements has changed, and a review of the available storage capacity is required and ongoing.

5.5.3 Hydrogeological – Not Applicable

KCB does not review or monitor groundwater data. Groundwater monitoring data is reviewed by others and reported separately.

5.5.4 Geochemical – Not Applicable

KCB does not review geochemical data for Sullivan Mine. This information is reported separately by Teck.

5.5.5 Mechanical and Structural – Not Applicable

There are no mechanical or structural components to the dikes/dams at Sullivan Mine.

5.6 OMS Manual

The Operation, Maintenance and Surveillance (OMS) Manual for the Sullivan Mine Tailings facilities was updated in 2014 by Golder Associates. KCB annually updates the recommended instrument reading frequencies and trigger levels for the instruments as recommended in the DSI reports. An update of the OMS Manual was completed in Q3 2018 (V5 August 17, 2018) by Teck to address the following concerns from the 2016 DSI:

- The OMS Manual provides tables of required design criteria (CDA Guidelines, 2013), however the manual does not provide the design criteria used for each of the tailings structures.
- Some of the facility names used in the OMS Manual do not reflect the current naming conventions.
- This update also included a restructure to follow Teck’s recommended Table of Contents for OMS Manuals.

Teck will review the manual annually and continue to make revisions as necessary.

5.7 Emergency Preparedness & Response Review

The current version of the Emergency Preparedness and Response Plan (EPRP) was updated in 2018. (Version 6, September 2018). The plan meets the regulatory requirements and guidance documents from CDA and the Mining Association of Canada. The plan includes identification of communities of interest, failure modes and responses to various emergencies.

As required by HSRC (EMPR 2017), the EPRP is tested annually. The most recent test was completed in December 2018. The EPRP converted to a Mine Emergency Response Plan (MERP) in January, 2019.

6 SUMMARY AND RECOMMENDATIONS

6.1 Summary of Construction and Operation Activities

The construction activities that take place each year are on-going care and maintenance activities such as road grading, cleaning of ditches to remove algae and debris build-up, rodent burrow repair, removal of trees and shrubs from dike slopes, and maintenance of the seepage collection systems around the site. Ongoing activities include seepage and groundwater collection and treatment.

Operational activities and reporting conducted during the 2017/2018 DSI period include the following:

- Design work associated with ARD storage and storm water management capacities. This work is ongoing, and KCB is working with Teck to review potential options for optimizing storage of ARD water. The work is expected to continue in 2019 and includes reviews of storm water management for the East/West Gypsum Dikes and Sludge Impoundment.
- A geotechnical investigation was completed August 7th to 17th, 2018. Sonic drilling, standpipe installations, and cone penetrations tests (CPT) were completed in the East Gypsum, West Gypsum, and No. 2 and No. 3 Siliceous Dikes. This was conducted in accordance with recommendations by KCB, which is supported by the Independent Tailings Review Board (ITRB). One of the targeted objectives was to examine whether there is evidence of aging effects in the tailings over nearly two decades since the facility was closed, by comparing the results of recent and past CPTs conducted at similar locations. Work is ongoing to complete lab testing and to complete a report associated with the work.
- Instrument replacements were also completed during the August 7th to 17th, 2018 ground investigation in accordance to the recommendation in the 2017 Annual Dam Safety Inspections reports. Five standpipes were replaced with vibrating wire piezometers. Work is ongoing to complete a report associated with this work and automating the instruments.

6.2 Summary of Climate and Water Balance

September 2017 – August 2018 precipitation was 490.5 mm, compared to the long-term average of 431.6 mm. Precipitation depths were above normal during the winter, and below normal during the summer. The winter snowpack was above normal, with a monthly mean depth in February of 44 cm, compared to the long-term value of 39 cm.

The ARD Storage Pond and the Iron Pond did not spill. The highest water level on the ARD Storage Pond was 2.5 m below the spillway crest elevation, and the highest water level on the Iron Pond was 2.3 m below the spillway crest.

Agreement between the observed storage in the ARD Storage Pond and the calculated storage based on pump records and hydrologic estimates is variable on a monthly basis, but quite good on an annual basis. The difference between the observed and calculated year-end storage volumes amounts to only 6% of the annual inflow to the pond.

The total discharge to the St. Mary River from the DWTP was 3136 dam^3.

6.3 Summary of Performance

Based on the dam safety inspection and review of instrumentation, KCB concludes that the tailings storage facilities, Sludge Impoundment dikes and the ARD Pond dams at Sullivan Mine remain in good condition and there was no evidence of any dam safety related issues or concerns.

In terms of water levels within the ponds, TSFs, and foundation units, several piezometers experienced an increase in the recorded pore pressure in comparison to last year, however, most are below threshold values, and measured pore pressures began to decrease following spring thaw and early summer rainfall. There was higher than average rainfall and snowpack during the 2018 reporting period (see Figure III-1), which accounts for the increase in pore pressures. The review did highlight that a number of piezometers were near (within reasonable fluctuation range) or above the threshold levels in 2018. None of these threshold exceedances are a dam safety concern, since they are well below the piezometric levels assumed in design for stability analyses. A review of the threshold levels will be carried out in 2019, with the intent of linking them to potential key failure modes and incorporating experience from past years of higher than average precipitation.

The measured settlements for the Gypsum Dikes were as expected. There was no measurable settlement at the Iron Dike and ARD Pond Dams. The only settlement plates which recorded measurable (>15 mm/year) settlement were those installed upstream of the East and West Gypsum Dikes within the tailings. This is as expected as the tailings are continuing to settle and are the only ones required to be surveyed annually.

Surveys of the Sludge Impoundment dike crests began in 2016 and continued into 2018 to monitor potential settlement. A comparison of the data (2016, 2017, 2018 data and as-built information) indicate little to no settlement of the dikes, which is expected as they were founded on sands and gravels. The survey data also indicated that the most southern portion of the South Dike crest is currently below the design elevation by approximately 0.5 m as a result of the access ramp cutting into the crest. There was a similar issue at the east end of the North Dike where the design crest width was not met. The access ramp at the North Dike was adjusted in Fall 2017, such that the required crest width is now per design. As discussed in Section 5.1.2, the capacity of the Sludge Impoundment and the effect of the low spot at the South Dike is currently being reviewed as part of a broader design review.

The observed seepage from the dams was similar to previous years and was clear and free of sediment.

6.4 Summary of Changes to Facility

There have been no changes to the tailings storage facilities during the 2018 DSI reporting period other than regular maintenance.

6.5 Consequence Classification

There are no recommended changes to the consequence classification. There is a potential to lower the classification of the East and West Gypsum Dikes and work related to this following the 2018 Geotechnical Investigation is ongoing.

6.6 Recommended Improvements to Surveillance Monitoring

Ponding of water has been noted at the Iron Dike near station 24+00 in past DSI inspections. The size of the pond, any notes on clarity of the water should also be recorded by Teck during routine inspections and these observations should be added to the inspection checklist.

6.7 Table of Deficiencies and Non-conformances

Recommendations arising from the 2018 inspection are summarized in Table 6.1 along with completed recommendations from previous DSI summaries. None of the issues, closed/new/outstanding, are related to dam safety concerns. All of the recommendations pertain to the framework of continual improvements in the dam safety management program, such as documentation and maintenance/surveillance protocols. The recommendation for the Sludge Pond Impoundment is part of the design review and update that is already being planned by Teck and KCB, and is listed herein for the purpose of completeness.

Table 6.1 Summary of Closed, Outstanding and New Recommendations

Structure	ID No.	Deficiency or Non-Conformance	Applicable Regulation or OMS Reference	Recommended Action	Priority	Recommended Deadline /Status
Previous Recommendations Closed / Superceded						
ALL	2016-1	OMS Manual requires updates	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Additional information to be added in 2017. EPRP Section to be removed once separate document completed.	4	CLOSED- ongoing revisions being conducted
ALL	2016-2	EPR Plan requires updates	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Update EPR Plan such that it follows Teck's Tailings Guidelines and EMPR's HSRC (2016a). Currently no mention of potential inundation/flood hazard.	4	CLOSED- Incorporated into the MERP as per EHSC guidelines
Old Iron TSF	2016-3	Old Iron Dike piezometer P96-11 readings are erratic and unreliable.	OMS Section 4.0	Recommend replacement of P96-11 (improperly labelled P91-11 in 2016 DSI) with a new piezometer near the toe of the 2007 buttress to monitor piezometric levels at the toe.	4	CLOSED- completed August 2018
Old Iron TSF	2017-01	Old Iron Dike piezometer P96-08 only records relative piezometric levels as tip elevation is unknown.	OMS Section 4.0	P96-08 should be replaced as the tip elevation is unknown and the readings only provide relative change in elevation. This instrument will provide additional information regarding piezometric levels near the crest of the dike.	4	CLOSED- completed August 2018
Siliceous TSF	2017-02	No. 3 Siliceous Dike standpipe piezometers P301, 302 and 303 contain significant sediment, which was not removed during flushing in 2014. The bottom depths of these piezometers are now at or just above the phreatic surface assumed for design.	OMS Section 4.0	These piezometers should be replaced such that the tips are near the base of the tailings to monitor the phreatic surface within the pond.	4	CLOSED- completed August 2018
Previous Recommendations Ongoing						
Sludge Impoundment	2017-03	Changes to HSRC design flood requirements indicate a review of the Sludge Impoundment hydrology is needed.	EMPR HSRC (2017) & CDA Guidelines: Application to Mining Dams (2014)	Review of the current design freeboard and design sludge levels is required for the new design flood event of 1/3 between 1/975 and PMF (HSRC 2017). To facilitate the design update, the Sludge Impoundment surface should be surveyed to obtain average sludge deposition rates. This design review should include recommendations for addressing the low crest location at the South Dike.	3	2019
2018 Recommendations						
None						

The priority ranking for outstanding recommendations is defined as follows:

Priority	Description
1	A high probability or actual dam safety issue considered immediately dangerous to life, health or the environment, or a significant risk of regulatory enforcement.
2	If not corrected could likely result in dam safety issues leading to injury, environmental impact or significant regulatory enforcement; or, a repetitive deficiency that demonstrates a systematic breakdown of procedures.
3	Single occurrence of deficiencies or non-conformances that alone would not be expected to result in dam safety issues.
4	Best Management Practice – Further improvements are necessary to meet industry best practices or reduce potential risks.

7 CLOSURE

This report is an instrument of service of Klohn Crippen Berger Ltd. The report has been prepared for the exclusive use of Teck Metals Ltd. (Client) for the specific application to the 2018 Dam Safety Inspection. The report's contents may not be relied upon by any other party without the express written permission of Klohn Crippen Berger. In this report, Klohn Crippen Berger has endeavoured to comply with generally-accepted professional practice common to the local area. Klohn Crippen Berger makes no warranty, express or implied.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

P.E. FINES
31106

26-MAR-2019

B.G. CHIN

25-Mar-2019

Pamela Fines, M.A.Sc., P.Eng.
Project Manager

Bill Chin, P.Eng.
Engineer of Record

REFERENCES

Ministry of Energy, Mines and Petroleum Resources, 2016. Guidance Document: Health, Safety and Reclamation Code for Mines in British Columbia. Version 1, July 2016.

Ministry of Energy, Mines and Petroleum Resources, 2017. Health, Safety and Reclamation Code for Mines in British Columbia Updated February 28, 2017.

Canadian Dam Association, 2013. Dam Safety Guidelines 2007 (Revised 2013).

Golder Associates, 2014. 2013 Dam Safety Review. Submitted to Teck Metals Ltd. September 11, 2014. Reference Number 1314270027-002-R-Rev 0-1000.

Klohn Crippen Consultants, 2000. Sullivan Mine – Storage Pond No. 1 Design Report. Submitted March 20, 2000 to Cominco Ltd. Project No. PM5807.34.

Klohn Crippen Consultants, 2001. Cominco Sullivan Mine – Tailings Area Post-Closure Water Management Study Final Report. Submitted January 3, 2001 to Cominco Ltd. Project No. PM5807.80.

Klohn Crippen Consultants, 2002. Geotechnical Design Basis for Tailings Dikes – Overview Summary Report. Submitted January 9, 2002 to TeckCominco Metals Ltd. Project No. PM5807.85.

Klohn Crippen Consultants, 2002. Storage Pond No. 1 Construction Record Report. Submitted January 31, 2002 to TeckCominco Metals Ltd. Project No. PM5807.83.

Klohn Crippen Berger, 2007. Sullivan Mine Tailings Area, Emergency Storage Pond (ESP) Spillway Design (ESP). Submitted September 28, 2007 to TeckCominco Metals Ltd. Project No. A05807A04.

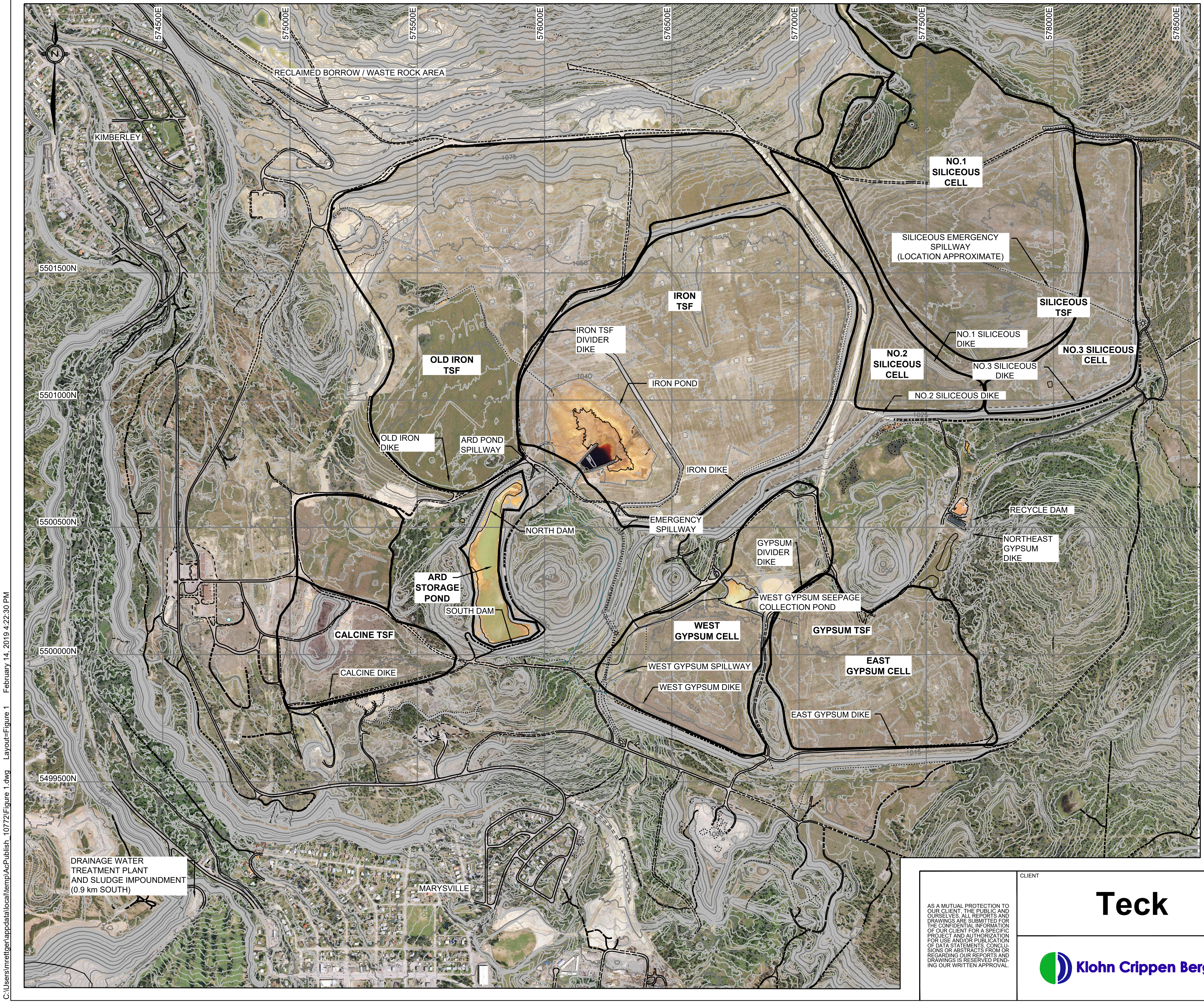
Klohn Crippen Berger, 2009. Sullivan Mine Tailings Facility 2008 Dam Safety Review Report. Submitted April 30, 2009 to Teck Metals, Ltd. Project No. A05807A02.

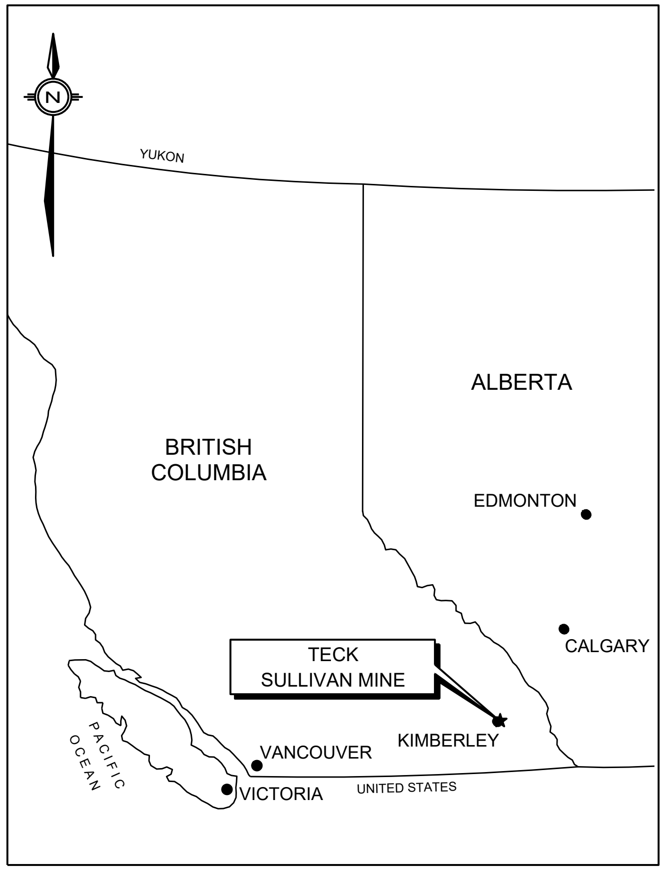
Klohn Crippen Berger, 2011. Sullivan Mine Iron Pond Dike Stability. Submitted May 11, 2011 to Teck Metals Ltd. Project No. A05807B10.

Robinson Dames & Moore, 1984. Investigation and Design Norteast Retention Embankment Gypsum Ponds to Cominco Limited on December 18, 1984. Project Number CM-42.

Teck Metals Ltd., 2017. Sullivan – Seepage Collection Manual. Version 005. September 25, 2017.

FIGURES





PROJECT LOCATION PLAN

N.T.S

NOTES:

1. GENERAL TOPOGRAPHY FROM TM Tech DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83). CONTOUR INTERVAL IS ONE METRE.
4. AERIAL PHOTO PROVIDED BY TECK. DATE: 2008.

SCALE 1:15 000 0 150 300 m

CLIENT

Teck

Klohn Crippen Berger

PROJECT

SULLIVAN MINE
2016 DAM SAFETY INSPECTION

TITLE

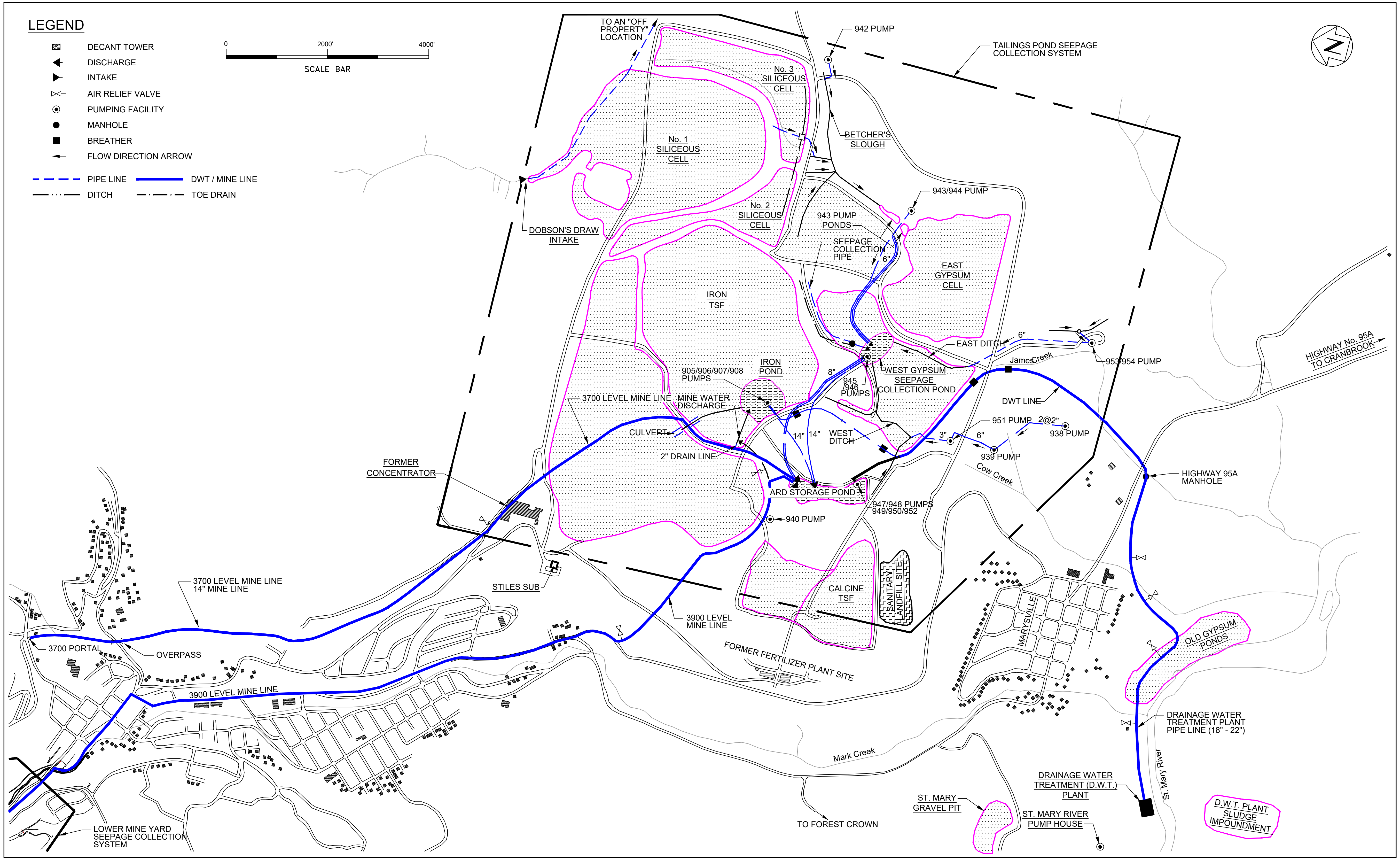
LOCATION AND SITE PLAN

PROJECT No.
A05807A18

FIG No.
FIGURE 1

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_10772\Figure 1.dwg Layout=Figure 1 February 14, 2019 4:22:30 PM



NOTES:

1. FROM TM Tech SERVICES DRAWING K100E3007 DATED FEB. 3, 2009, REV. 1.

SCALE 1:12 500 0 125 250 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2016 DAM SAFETY INSPECTION

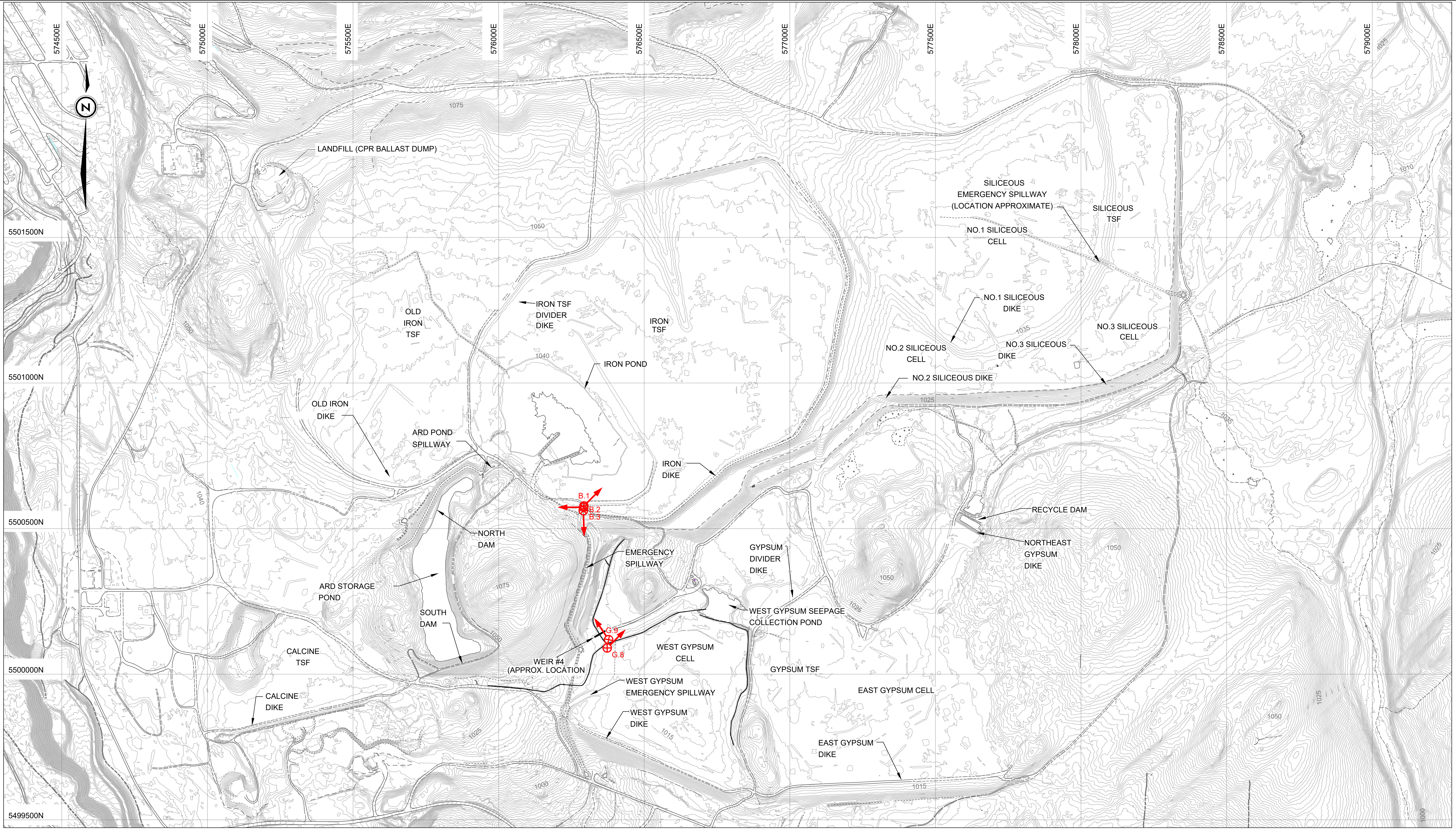
TITLE
TAILINGS SEEPAGE COLLECTION
AND DWT PLANT LOCATION

PROJECT No.
A05807A16

FIG No.
FIGURE 2

KCC-D-B

Z:\A\CGY\Alberto\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 2.dwg Layout=Figure 2 February 14, 2019 2:04:41 PM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83). CONTOUR INTERVAL IS ONE METRE.

LEGEND

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

1.04 PHOTO NUMBER

⊗ LOCATION WHERE PHOTO WAS TAKEN

← DIRECTION OF VIEW

⊕ PANORAMA

SCALE 1:12 500 0 125 250 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

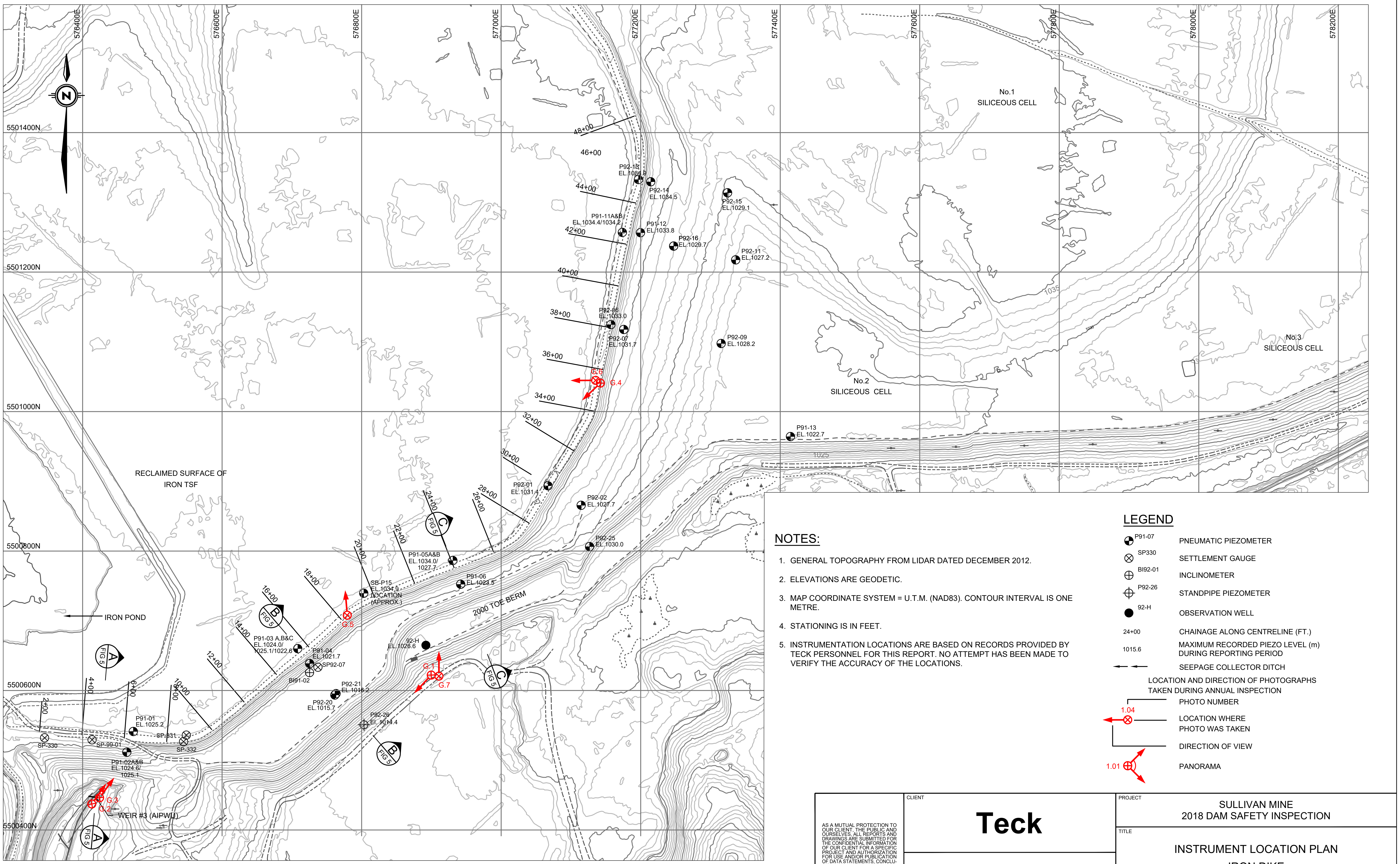
TITLE
GENERAL ARRANGEMENT
OF TAILINGS FACILITIES

PROJECT No.
A05807A18

FIG No.
FIGURE 3

KCC-D-B

C:\Users\rgazley\appdata\local\temp\AcPublish_11864\Figure 3_GenArg.dwg Layout=Figure 3 February 15, 2019 10:16:50 AM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. STATIONING IS IN FEET.
5. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND

◕ P91-07	PNEUMATIC PIEZOMETER
⊗ SP330	SETTLEMENT GAUGE
⊕ BI92-01	INCLINOMETER
⌖ P92-26	STANDPIPE PIEZOMETER
● 92-H	OBSERVATION WELL
24+00	CHAINAGE ALONG CENTRELINE (FT.)
1015.6	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
← ←	SEEPAGE COLLECTOR DITCH

LOCATION AND DIRECTION OF PHOTOGRAPHS
TAKEN DURING ANNUAL INSPECTION

1.04 ← ⊗
PHOTO NUMBER
LOCATION WHERE PHOTO WAS TAKEN
DIRECTION OF VIEW

1.01 ⊕ PANORAMA

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

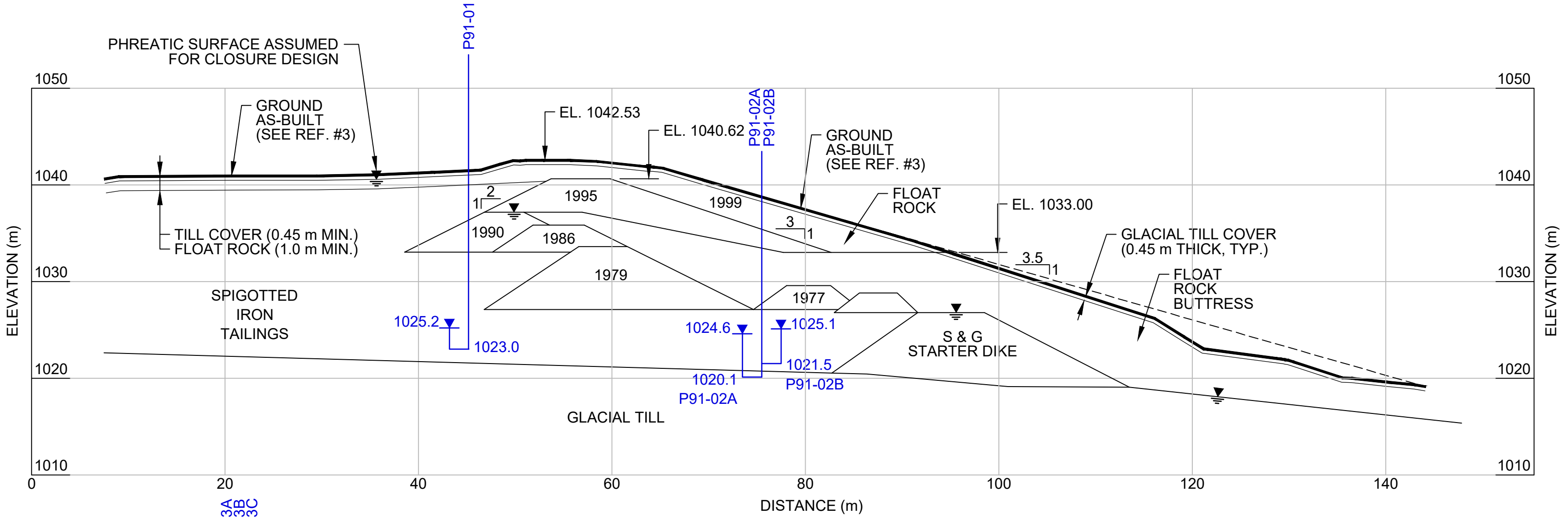
TITLE
INSTRUMENT LOCATION PLAN
IRON DIKE

PROJECT No.
A05807A18

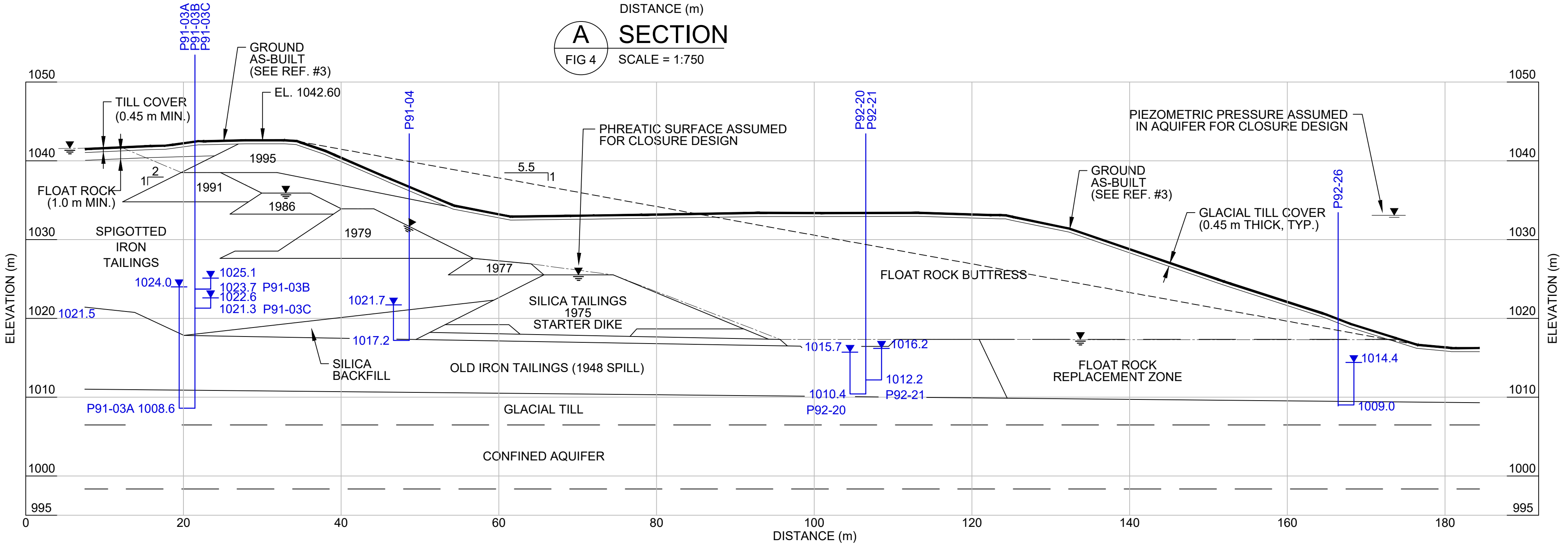
FIG No.
FIGURE 4

KCC-D-B

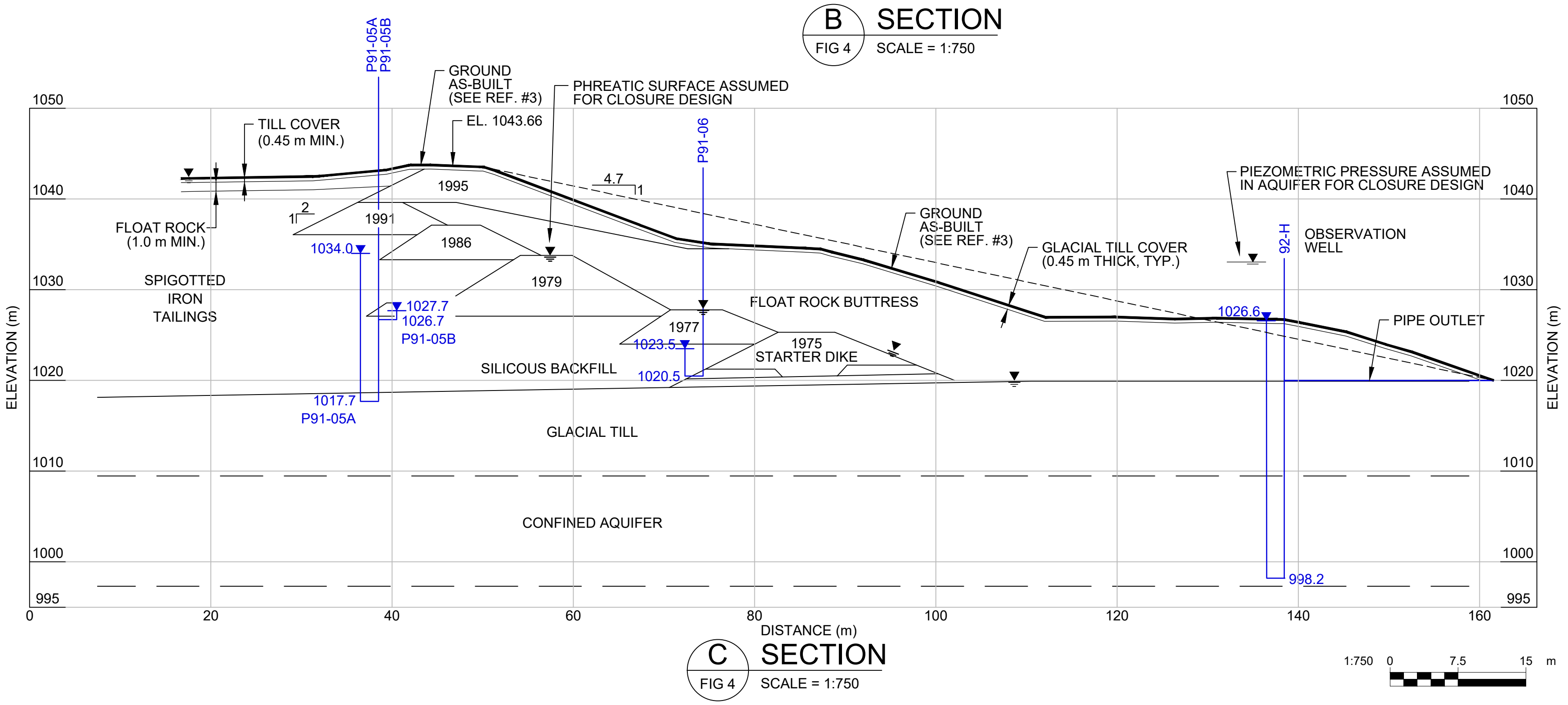
C:\Users\rgazley\appdata\local\temp\AcPublish_41684\Figure 4_IronPond.dwg Layout=Figure 4 February 15, 2019 10:25:22 AM



A SECTION
FIG 4
SCALE = 1:750



B SECTION
FIG 4
SCALE = 1:750



C SECTION
FIG 4
SCALE = 1:750

REFERENCES:

1. KLOHN-CRIPPEN REPORT "ACTIVE IRON DIKE - GEOTECHNICAL DESIGN OF 1995 DIKE RAISE", MAY 18, 1995.
2. KLOHN-CRIPPEN SUMMARY REPORT "SULLIVAN MINE - GEOTECHNICAL DESIGN BASIS FOR TAILINGS DIKES", JANUARY 9, 2002.
3. TM TECH SERVICES DRAWINGS K100 A 3233, K100 A 3234 (FEBRUARY 13, 2009).

LEGEND:

P91-01	PIEZOMETER
▼ 1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

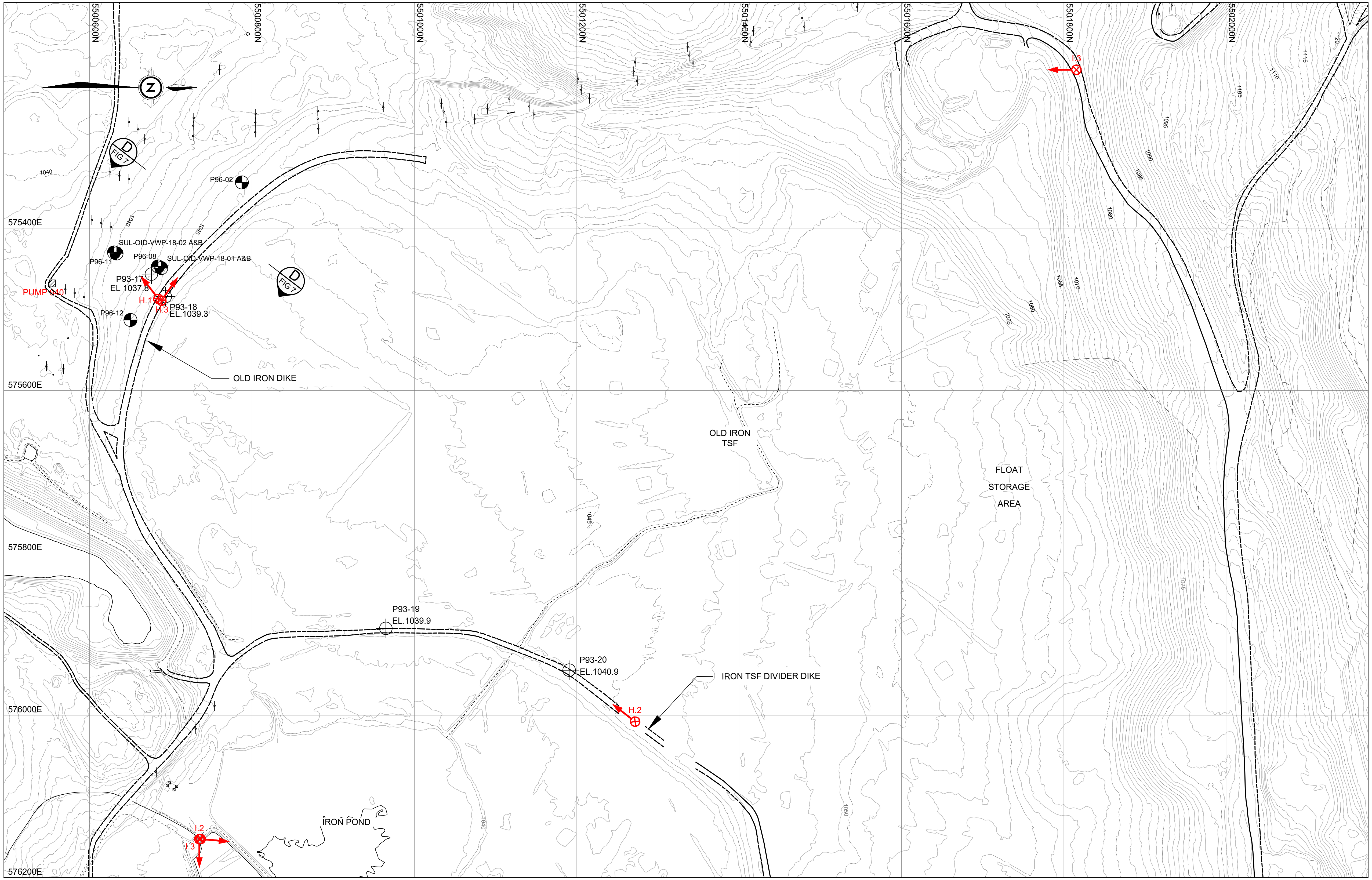
TITLE
IRON DIKE
TYPICAL SECTIONS

PROJECT No.
A05807A18

FIG No.
FIGURE 5

KCC-D-B

Z:\ACGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 5_IronPond Sections.dwg Layout=Figure 5 February 14, 2019 2:19:11 PM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83).
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

1:5 000 0 50 100 m

LEGEND:

SUL-OID-VWP-18-01A&B ●	VIBRATING WIRE PIEZOMETER
P205 ⊕	STANDPIPE PIEZOMETER
P91-07 ●	PNEUMATIC PIEZOMETER
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

3.01 ⊗ PHOTO NUMBER / LOCATION WHERE PHOTO WAS TAKEN / DIRECTION OF VIEW

3.01 ⊕ PANORAMA

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
Teck
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

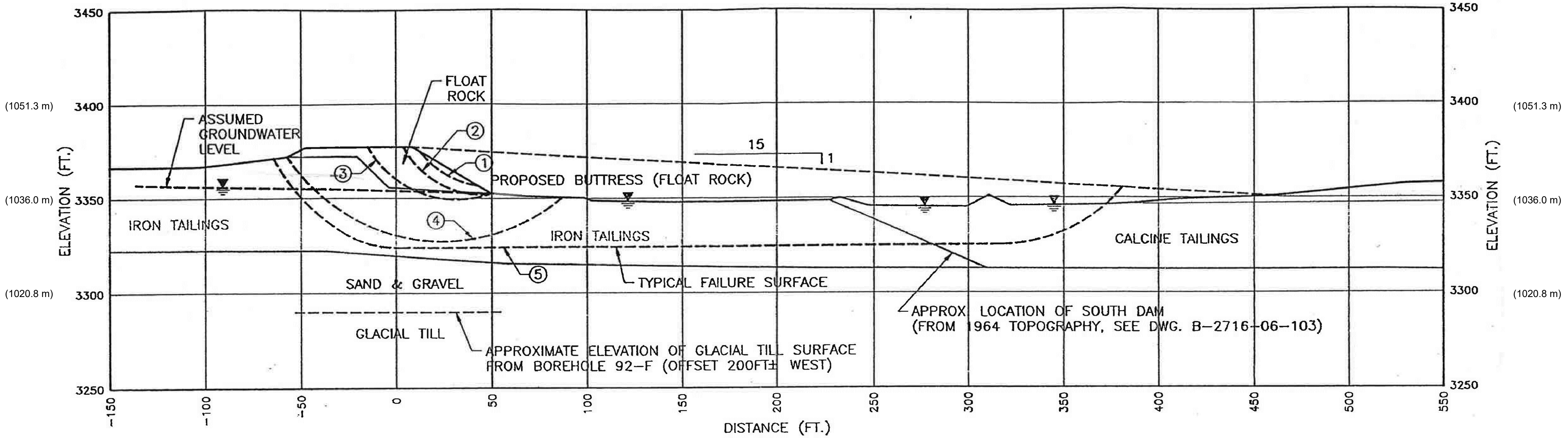
TITLE
INSTRUMENT LOCATION PLAN
OLD IRON & IRON TSF DIVIDER DIKES

PROJECT No.
A05807A18

FIG No.
FIGURE 6

KCC-D-B

C:\Users\mrettger\appdata\local\temp\AcPublish_8468\Figure 6_OldIronPond.dwg Layout=Figure 6 February 20, 2019 10:06:11 AM



D SECTION
FIG 6
SCALE = N.T.S.

CLIENT
Teck
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

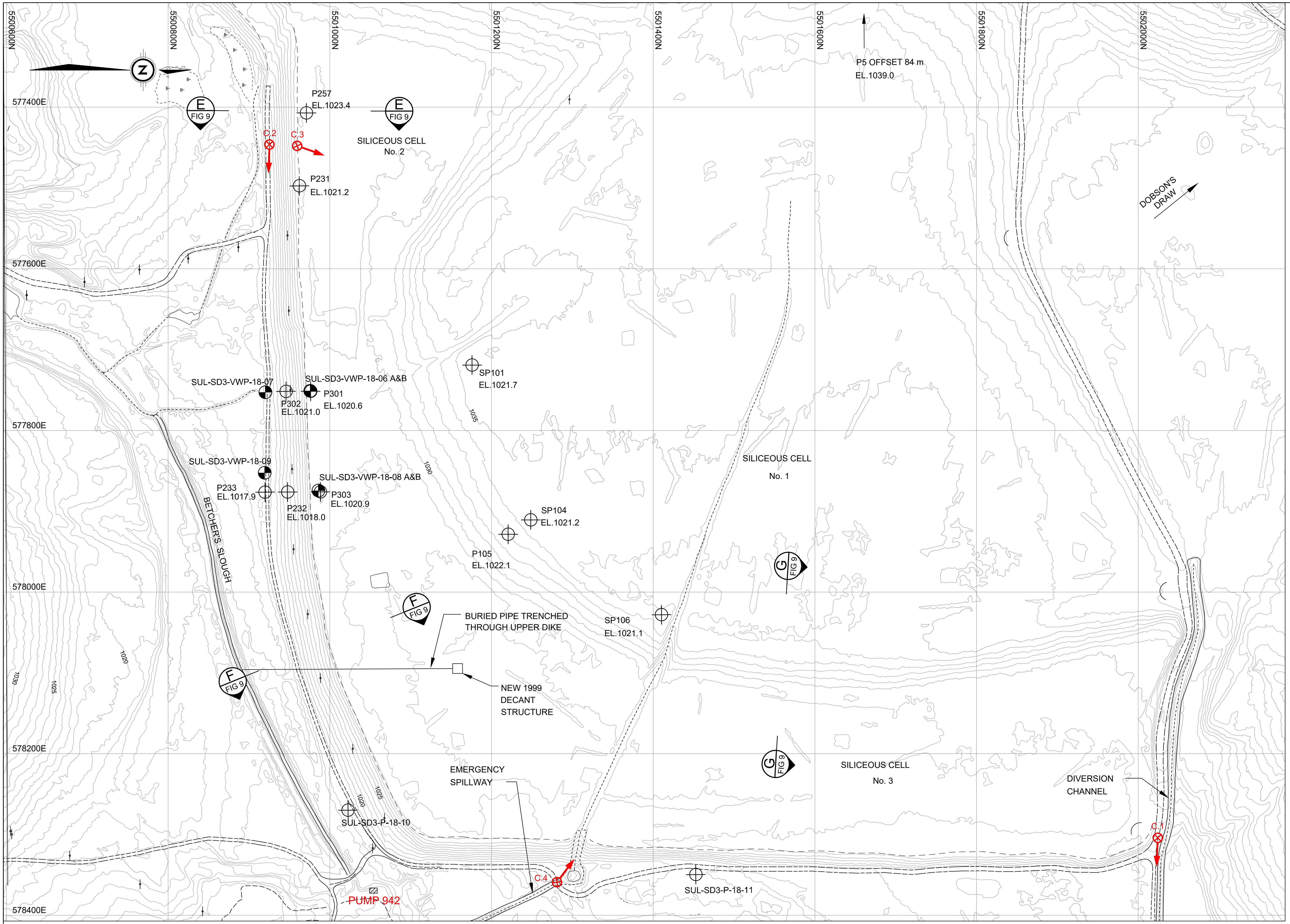
TITLE
OLD IRON & IRON TSF DIVIDER DIKES
TYPICAL SECTION

PROJECT No.
A05807A18

FIG No.
FIGURE 7

KCC-D-B

\\int.klohn.com\ProjData\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 7_OldIronPond Section.dwg Layout=Figure 7 February 20, 2019 10:05:44 AM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83).
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.
5. SPILLWAY LOCATIONS ARE APPROXIMATE.

LEGEND:

SUL-SD3-VWP-18-06A&B ◐ VIBRATING WIRE PIEZOMETER

P91-07 ◐ PNEUMATIC PIEZOMETER

P205 ⊕ STANDPIPE PIEZOMETER

SP206 ⊕ STANDPIPE PIEZOMETER AND SETTLEMENT PLATE

EL.1032.1 MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOS TAKEN DURING ANNUAL INSPECTION

4.01 ⊗ ←

PHOTO NUMBER

LOCATION WHERE PHOTO WAS TAKEN

DIRECTION OF VIEW

4.01 ⊕ PANORAMA

1:5 000 0 50 100 m

CLIENT

Teck

Klohn Crippen Berger

PROJECT

SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE

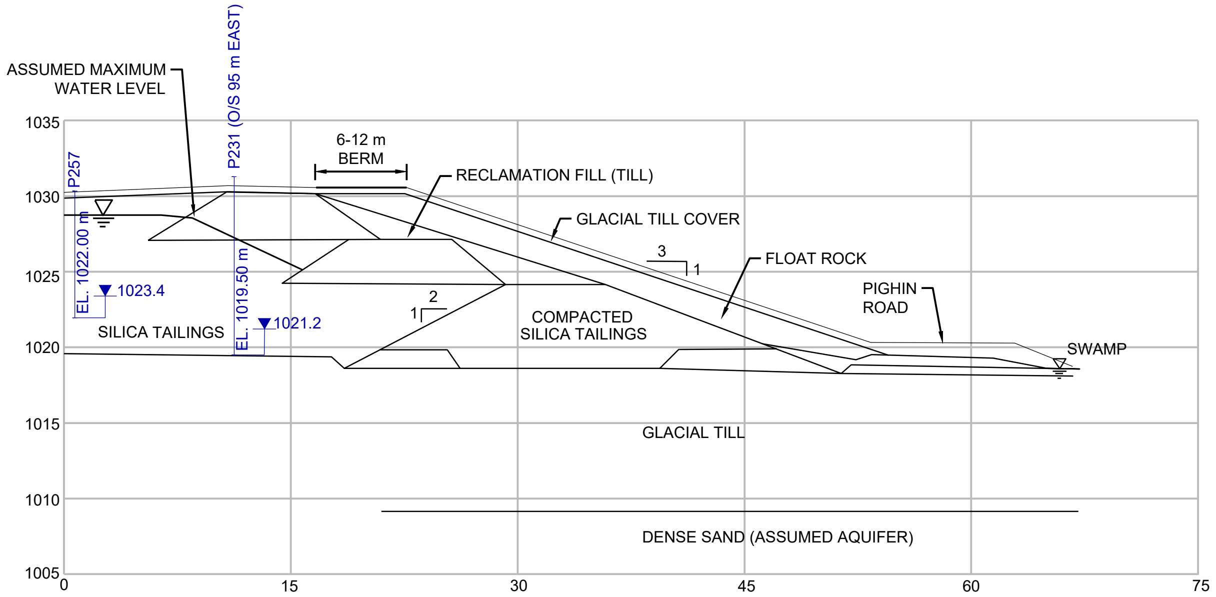
INSTRUMENT LOCATION PLAN
NO. 1, 2 & 3
SILICEOUS DIKES

PROJECT No.
A05807A18

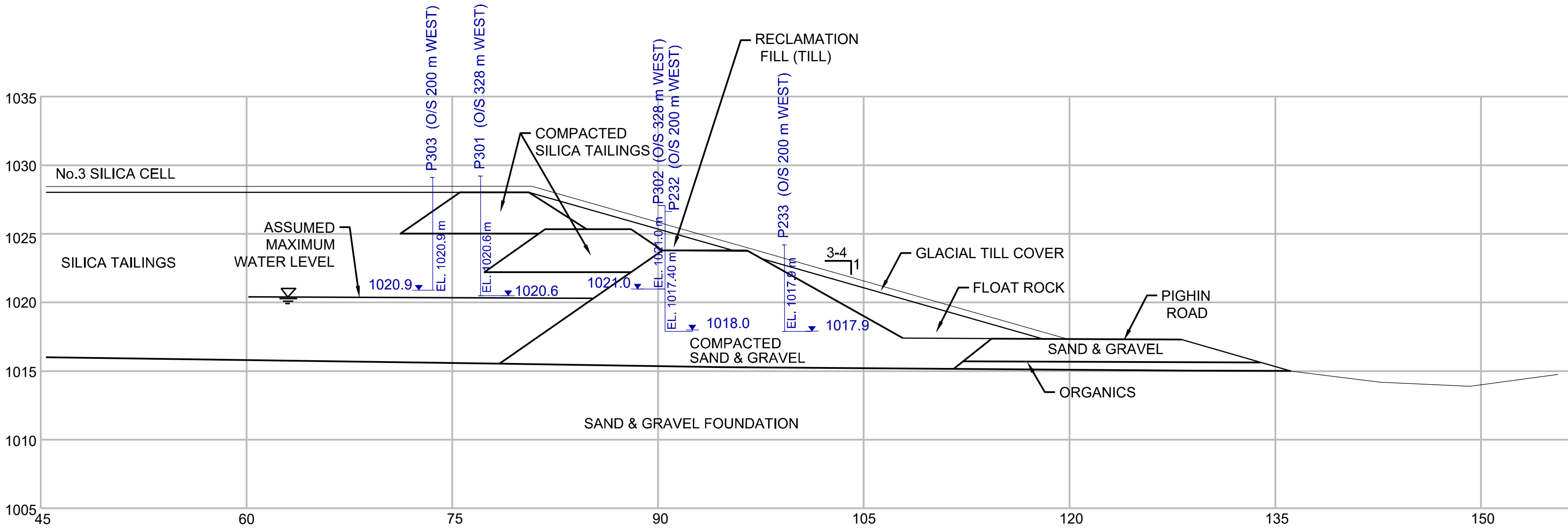
FIG No.
FIGURE 8

KCC-D-B

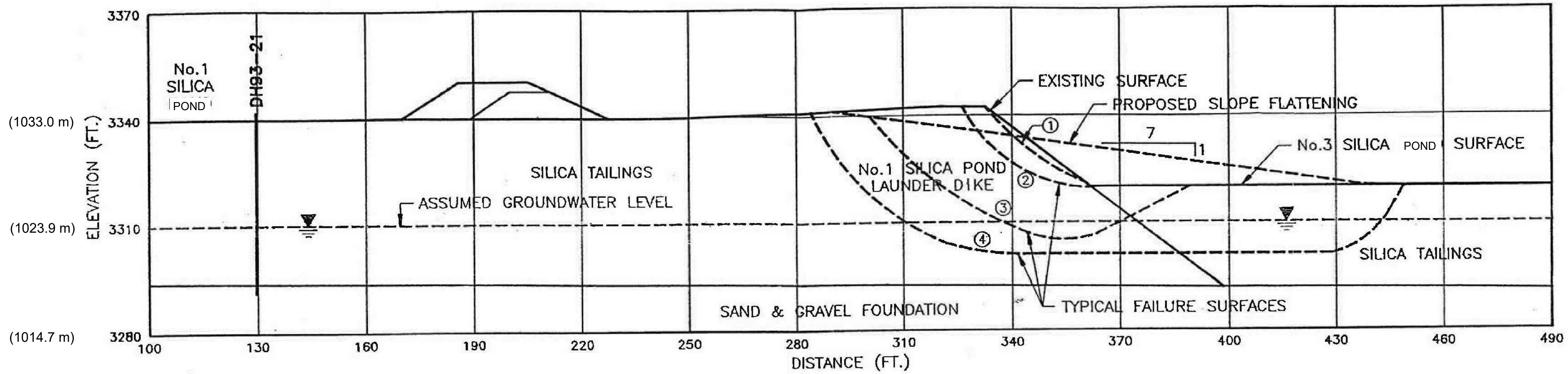
Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 8_SilDykes.dwg Layout=Figure 8 February 11, 2019 2:23:23 PM



E SECTION
FIG 8
SCALE = 1:500



F SECTION
FIG 8
SCALE = 1:500



G SECTION
FIG 8
N.T.S

(1014.7 m)

NOTES:

1. UNITS ARE IN METERS, UNLESS INDICATED OTHERWISE ON FIGURE.
2. SECTION A & B WERE GENERATED FROM DRAWINGS B-2716-06-211 & B2716-06-210, RESPECTIVELY, IN REPORT TITLED "SULLIVAN MINE GEOTECHNICAL DESIGN BASIS FOR TAILINGS DIKES - OVERVIEW SUMMARY REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
3. MAXIMUM ANNUAL PIEZO ELEVATION.

LEGEND:

●	PNEUMATIC PIEZOMETER
⌖ P205	STANDPIPE PIEZOMETER
⌖ SP206	STANDPIPE PIEZOMETER AND SETTLEMENT PLATE
P91-01	PIEZOMETER
▼ 1023.8	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1021.4	PIEZOMETER TIP

1:500 0 5 10 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

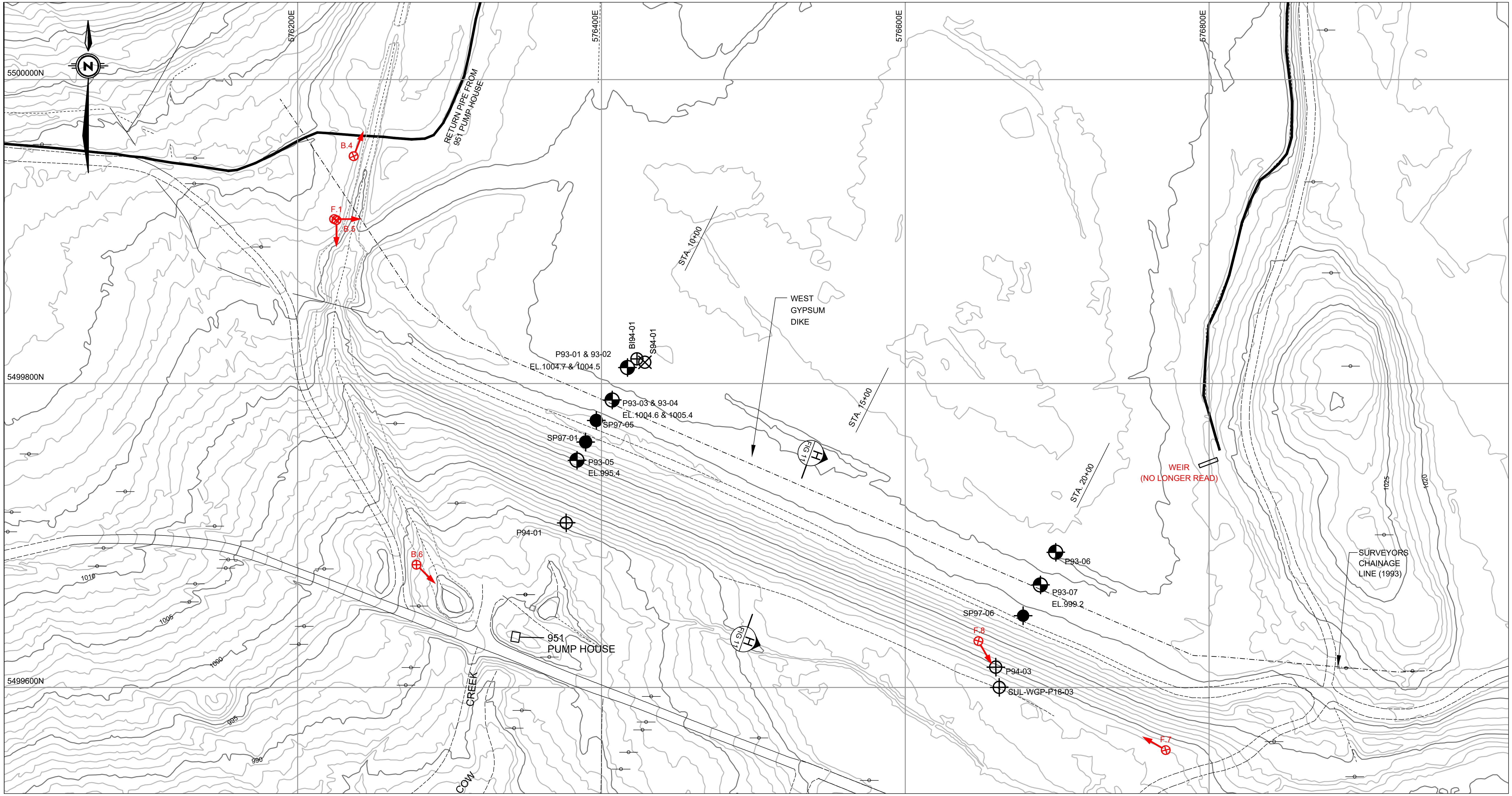
TITLE
SILICEOUS DIKES
TYPICAL SECTIONS

PROJECT No.
A05807A18

FIG No.
FIGURE 9

KCC-D-B

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 9_SilDykes Sections.dwg Layout=Figure 9 February 11, 2019 2:02:42 PM



1:2 500 0 25 50 m

NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. STATIONING IS IN FEET.
5. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

◕	P93-15	1993 STANDPIPE PIEZOMETER
⊕	P94-01	STANDPIPE PIEZOMETER
●	SP97-01	SETTLEMENT PLATE
⊕	BI94-02	INCLINOMETER
⊗	S94-02	SONDEX SETTLEMENT GAUGE
	EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

5.01 PHOTO NUMBER

LOCATION WHERE PHOTO WAS TAKEN

DIRECTION OF VIEW

5.01 PANORAMA

CLIENT
Teck

Klohn Crippen Berger

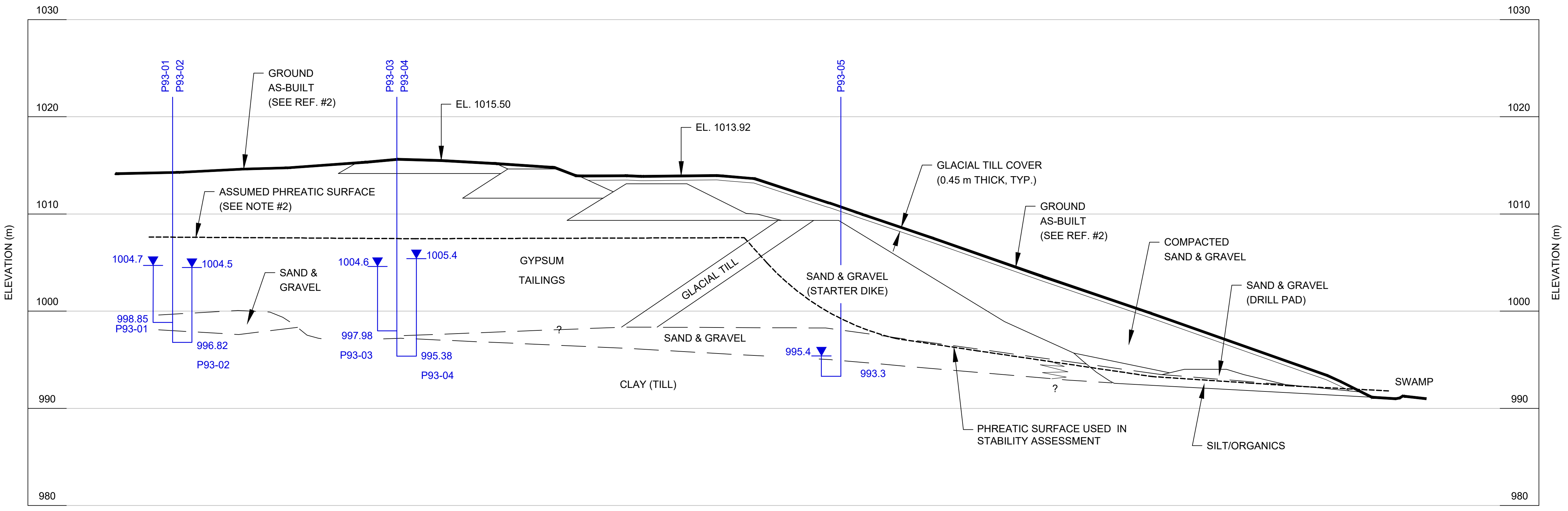
PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
INSTRUMENT LOCATION PLAN
WEST GYPSUM DIKE

PROJECT No. A05807A18

FIG No. FIGURE 10

KCC-D-B



H
FIG 10
SECTION
SCALE = 1:500

REFERENCES:

1. KLOHN-CRIPPEN SUMMARY REPORT "SULLIVAN MINE - GEOTECHNICAL DESIGN BASIS FOR TAILINGS DIKES", JANUARY 9, 2002.
2. TM TECH SERVICES DRAWINGS K100 A 3230, K100 A 3231, JANUARY 29, 2007.
3. KLOHN CRIPPEN BERGER "SULLIVAN MINE - STABILITY REVIEW OF GYPSUM DIKES", NOVEMBER 26, 1993.

NOTES:

1. UNITS ARE IN METERS UNLESS OTHERWISE STATED.
2. PHREATIC SURFACE IS THAT ASSUMED IN KLOHN CRIPPEN BERGER REPORT ENTITLED "SULLIVAN MINE - STABILITY REVIEW OF GYPSUM DIKES" NOVEMBER, 1993.

LEGEND:

P93-01 PIEZOMETER
1006.30 MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1000.2 PIEZOMETER TIP

1:500 0 5 10 m

CLIENT
Teck
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

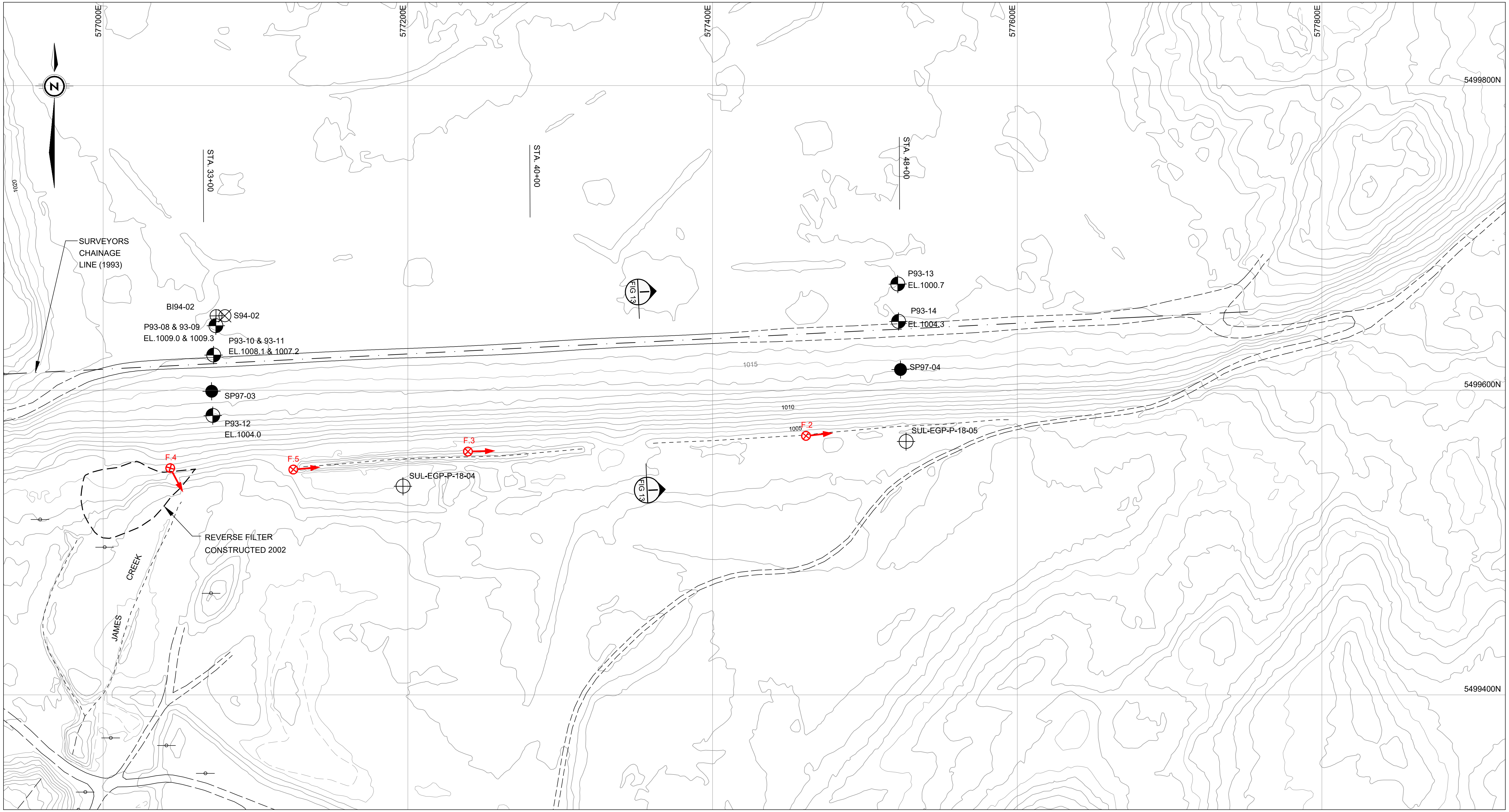
TITLE
WEST GYPSUM DIKE
TYPICAL SECTION

PROJECT No.
A05807A18
FIG No.
FIGURE 11

KCC-D-B

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 11_WestGyp Section.dwg Layout=Figure 11 February 11, 2019 2:03:07 PM

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 12_EastGyp.dwg   Layout=Figure 12   February 11, 2019 2:03:21 PM



1:2 500 0 25 50 m

NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. STATIONING IS IN FEET.
5. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

◐ P93-15	1993 STANDPIPE PIEZOMETER
⊕ P94-01	STANDPIPE PIEZOMETER
● SP97-01	SETTLEMENT PLATE
⊕ BI94-02	INCLINOMETER
⊠ S94-02	SONDEX SETTLEMENT GAUGE
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

PHOTO NUMBER

← ⊗ LOCATION WHERE PHOTO WAS TAKEN

DIRECTION OF VIEW

5.01 ⊕ PANORAMA

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
Teck

Klohn Crippen Berger

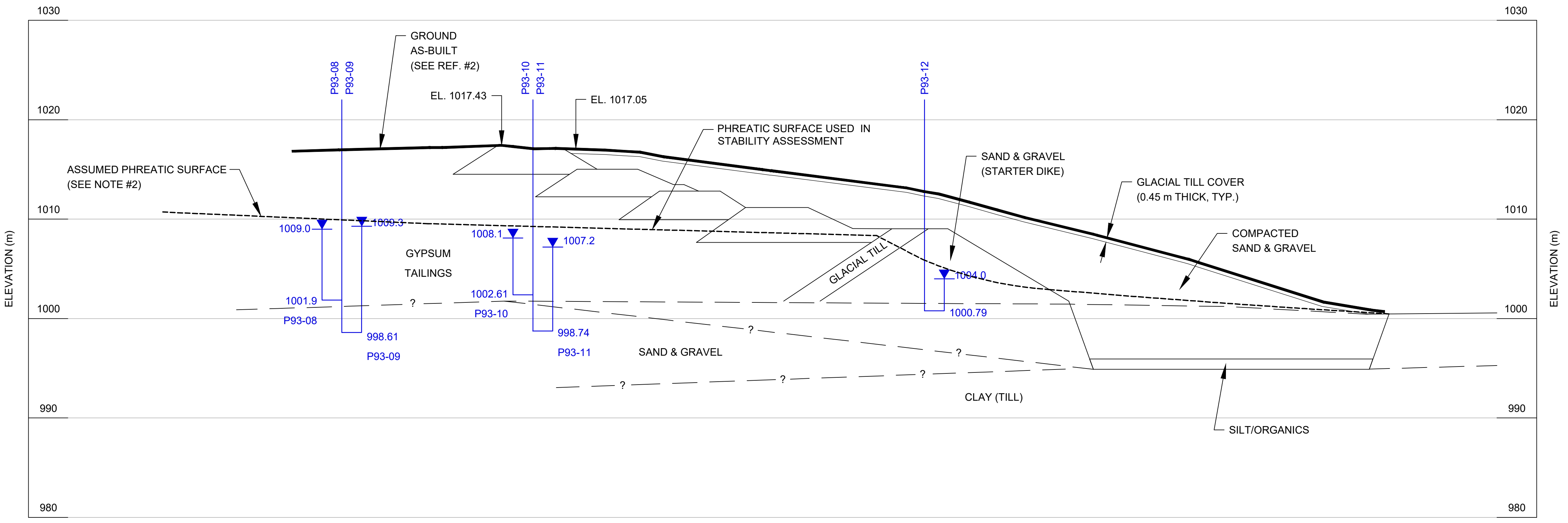
PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
INSTRUMENT LOCATION PLAN
EAST GYPSUM DIKE

PROJECT No.
A05807A18

FIG No.
FIGURE 12

KCC-D-B



I SECTION
FIG 12 SCALE = 1:500

REFERENCES:

1. KLOHN-CRIPPEN SUMMARY REPORT "SULLIVAN MINE - GEOTECHNICAL DESIGN BASIS FOR TAILINGS DIKES", JANUARY 9, 2002.
2. TM TECH SERVICES DRAWINGS K100 A 3230, K100 A 3231, JANUARY 29, 2007.
3. KLOHN CRIPPEN BERGER "SULLIVAN MINE - STABILITY REVIEW OF GYPSUM DIKES", NOVEMBER 26, 1993.

NOTES:

1. UNITS ARE IN METERS UNLESS OTHERWISE STATED.
2. PHREATIC SURFACE IS THAT ASSUMED IN KLOHN CRIPPEN BERGER REPORT ENTITLED "SULLIVAN MINE - STABILITY REVIEW OF GYPSUM DIKES" NOVEMBER, 1993.

LEGEND:

P93-01	PIEZOMETER
1006.30	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD
1000.2	PIEZOMETER TIP

1:500 0 5 10 m

CLIENT
Teck
Klohn Crippen Berger

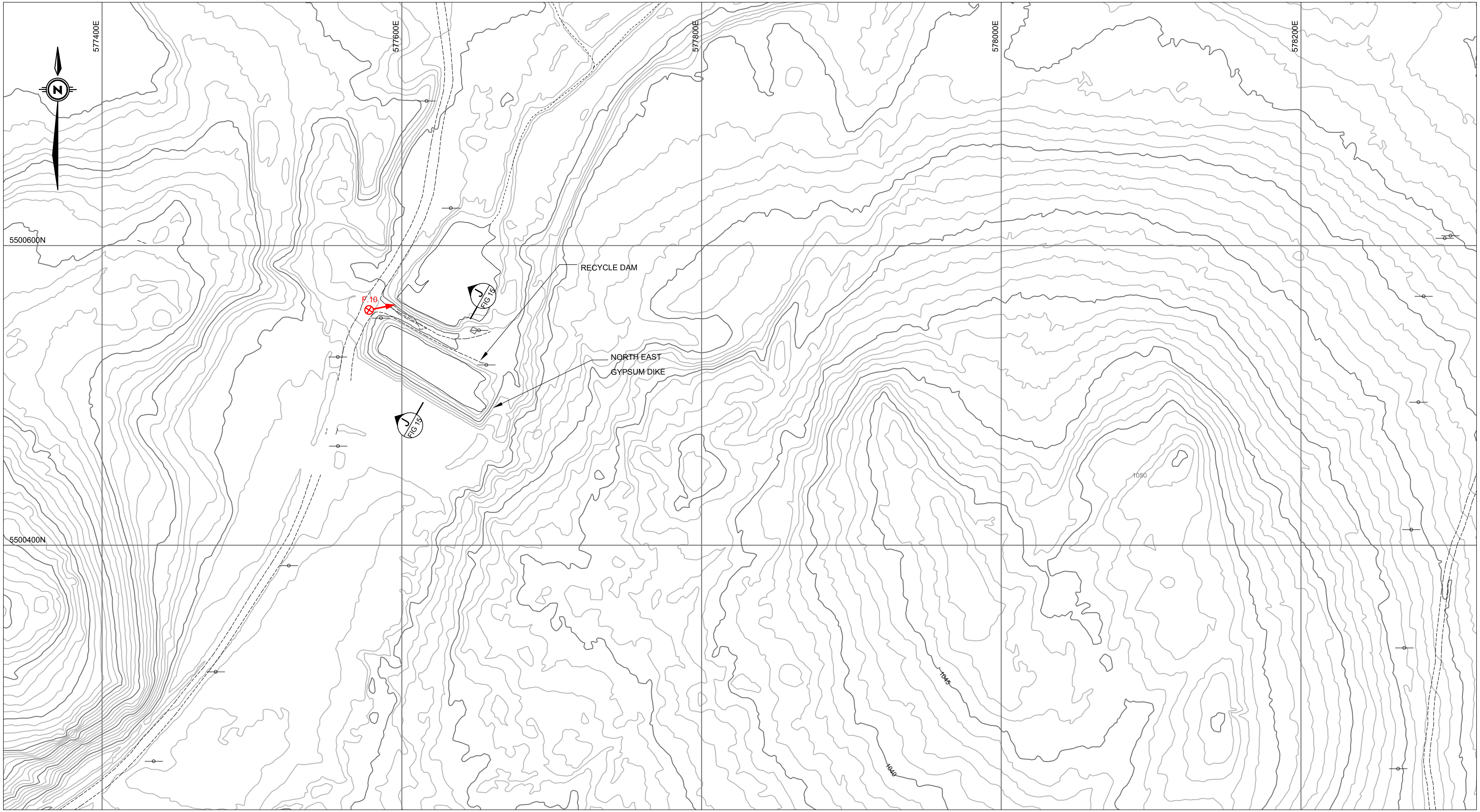
PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
EAST GYPSUM DIKE
TYPICAL SECTION

PROJECT No. A05807A18
FIG No. FIGURE 13

KCC-D-B

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 13_EastGyp Section.dwg Layout=Figure 13 February 11, 2019 2:03:32 PM



1:2 500 0 25 50 m

NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

LOCATION AND DIRECTION OF PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

5.35

PHOTO NUMBER

LOCATION WHERE PHOTO WAS TAKEN

DIRECTION OF VIEW

5.35

PANORAMA

CLIENT

Teck

Klohn Crippen Berger

PROJECT

SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE

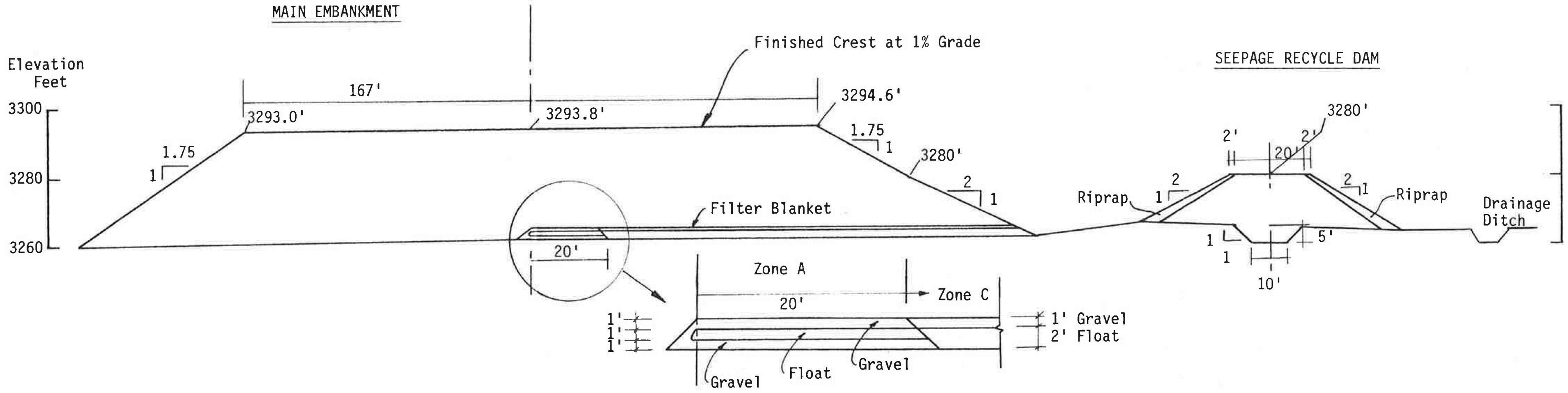
INSTRUMENT LOCATION PLAN
NORTHEAST GYPSUM DIKE
AND RECYCLE DAM

PROJECT No.
A05807A18

FIG No.
FIGURE 14

KCC-D-8

Z:\ACGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 14_NEGyp.dwg Layout=Figure 14 February 11, 2019 2:03:42 PM



J
FIG 14
SECTION
SCALE = N.T.S.

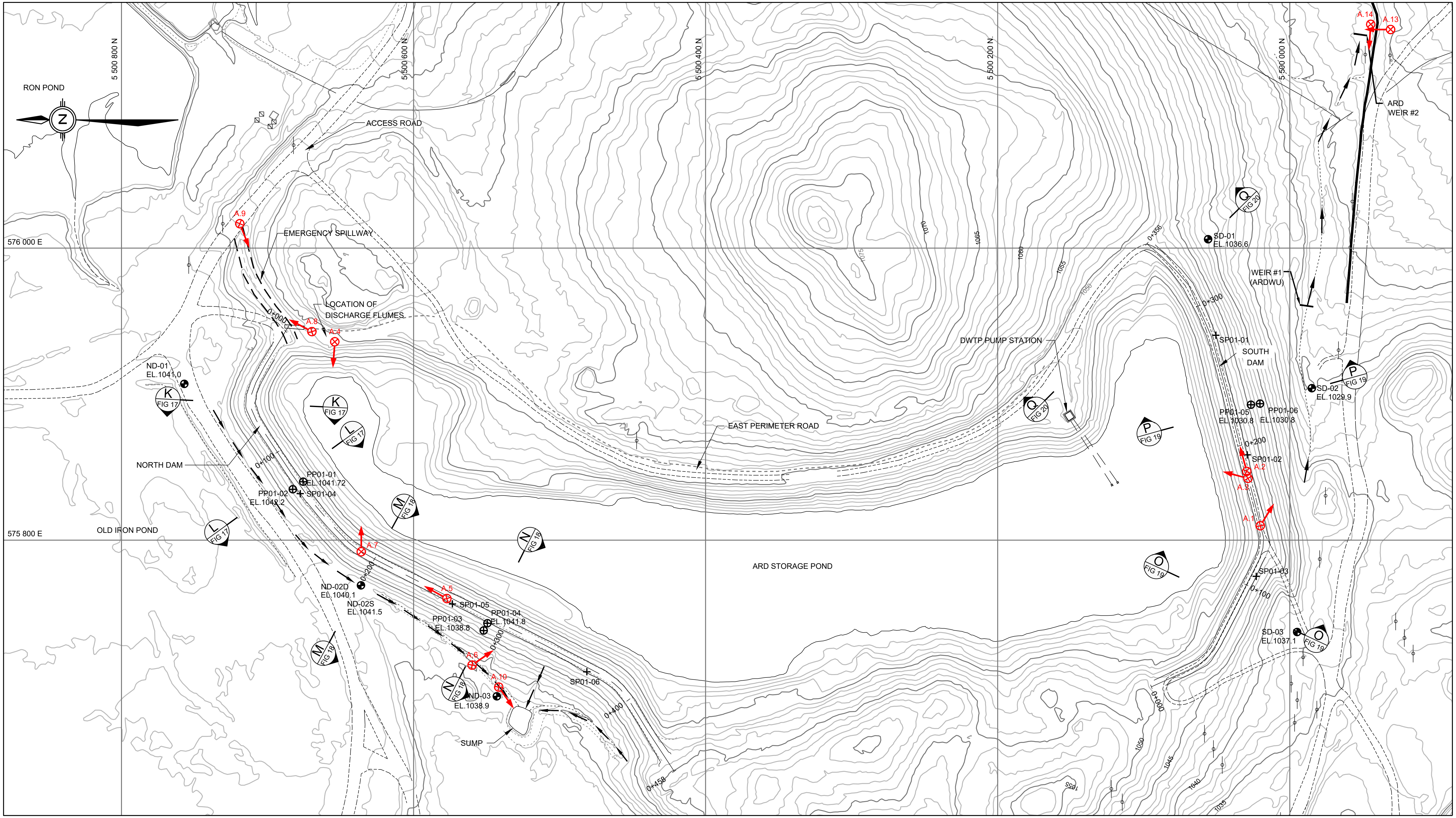
CLIENT
Teck
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
NORTHEAST GYPSUM DIKE AND RECYLCE DAM
TYPICAL SECTION

PROJECT No.
A05807A18

FIG No.
FIGURE 15



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD 83).

LEGEND:

⊕	PNEUMATIC PIEZOMETER
◐	STANDPIPE PIEZOMETER
+	SETTLEMENT PIN
►—►	SEEPAGE COLLECTOR DITCH
EL.1032.1	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

LOCATION AND DIRECTION OF
PHOTOGRAPHS TAKEN DURING ANNUAL INSPECTION

6.01 — PHOTO NUMBER

⊗ — LOCATION WHERE PHOTO WAS TAKEN

← — DIRECTION OF VIEW

6.01 ⊕ — PANORAMA

1:2 500 0 25 50 m

CLIENT
Teck

Klohn Crippen Berger

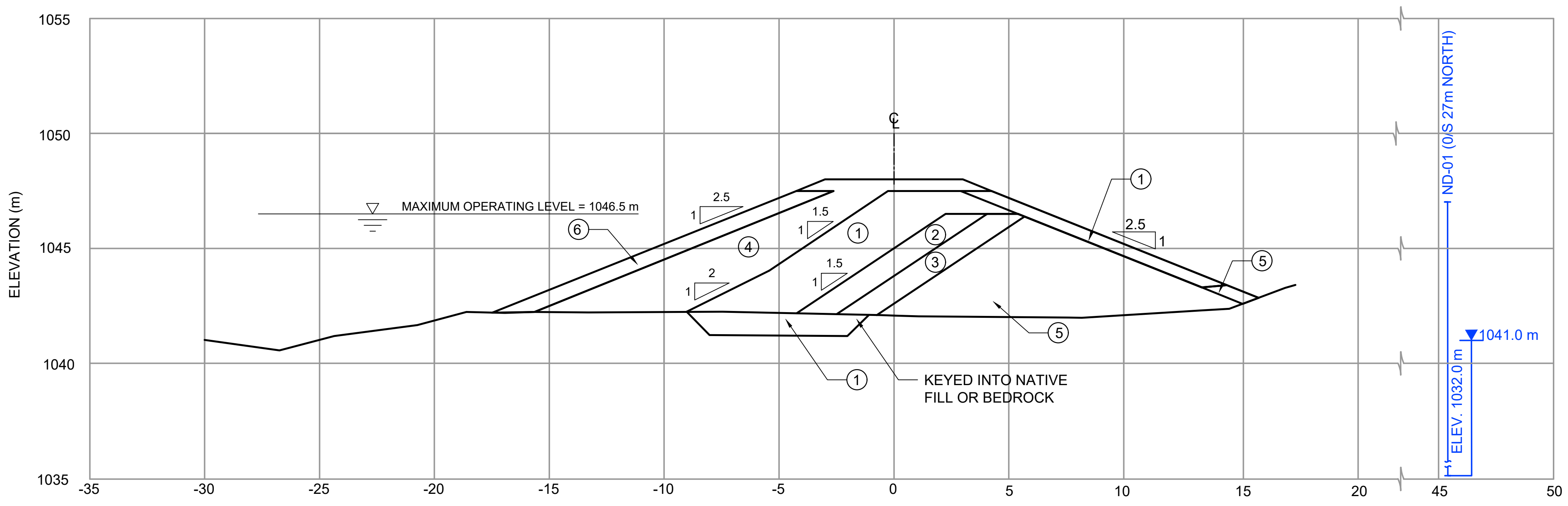
PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
ARD STORAGE POND
PLAN AND LAYOUT

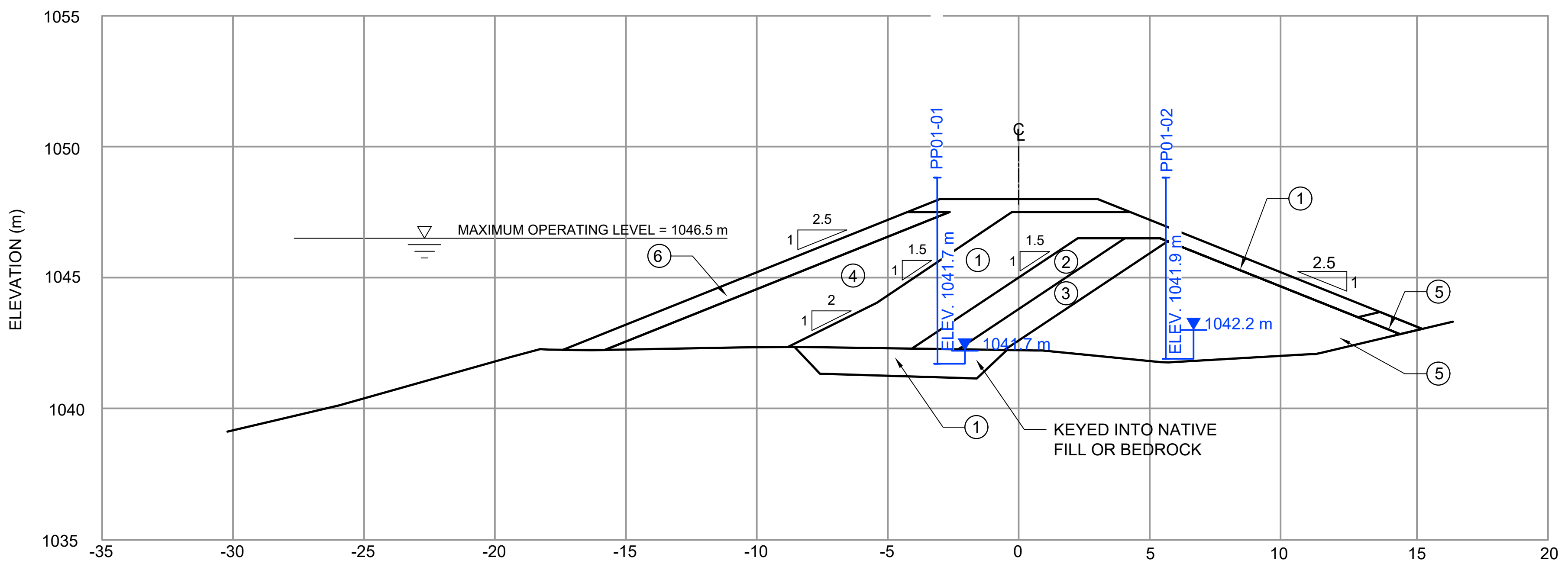
PROJECT No.
A05807A18

FIG No.
FIGURE 16

KCC-D-B



K **SECTION** (STA. 060)
16 SCALE = 1:250



L **SECTION** (STA. 120)
16 SCALE = 1:250

NOTES:

1. UNITS ARE IN METERS, UNLESS INDICATED OTHERWISE ON FIGURE.
2. SITE LAYOUT PLAN WAS DEVELOPED FROM DRAWING B-8304, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 - CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
3. SECTIONS K TO Q WERE GENERATED FROM SURVEYED DAM CROSS SECTIONS PROVIDED BY TM TECH SERVICES SHEETS 3 & 4, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
4. FOUNDATION AREA OF THE DAM WAS CLEARED, GRUBBED AND STRIPPED TO COMPETENT TILL OR BEDROCK.
5. KEY TRENCH EXCAVATED MIN. 1.0 m INTO TILL

LEGEND:

⊕	PNEUMATIC PIEZOMETER
◕	STANDPIPE PIEZOMETER
+	SETTLEMENT PIN
─►─►─	TOE DITCH
1023.7	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

ZONE	MATERIALS
①	GLACIAL TILL
②	SAND FILTER
③	SAND AND GRAVEL FILTER
④	SAND AND GRAVEL
⑤	FLOAT ROCK
⑥	RIPRAP

1:250 0 2.5 5.0 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

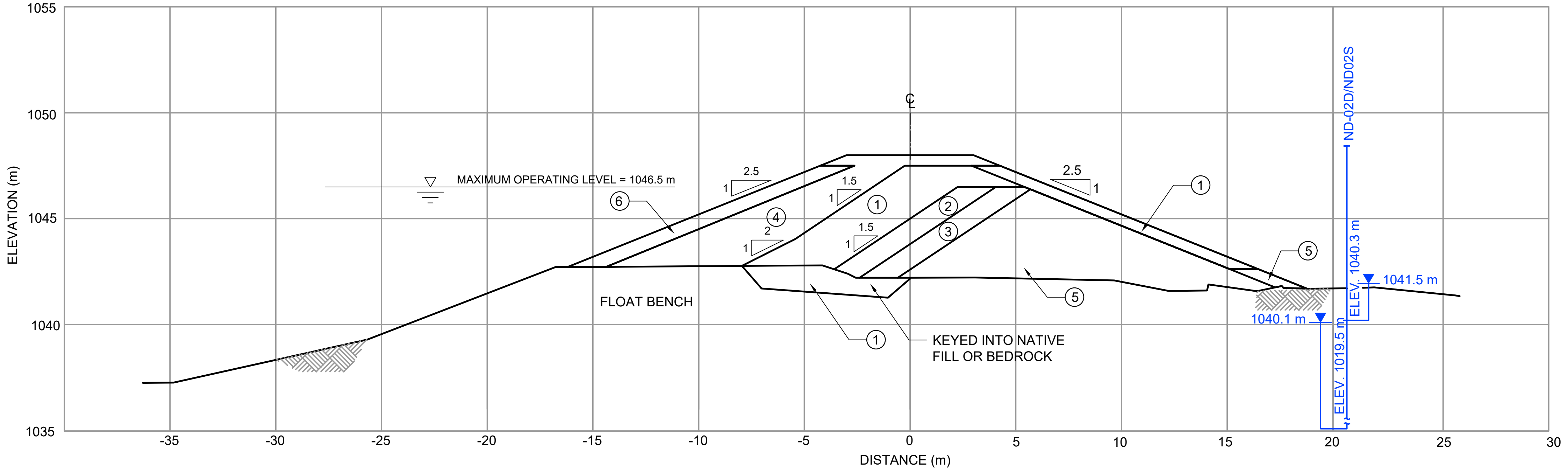
TITLE
ARD STORAGE POND
NORTH DAM SECTIONS

PROJECT No.
A05807A18

FIG No.
17

KCC-D-B

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 17-18.dwg Layout=17 February 11, 2019 2:04:16 PM



M SECTION (STA. 200)
16 SCALE = 1:250

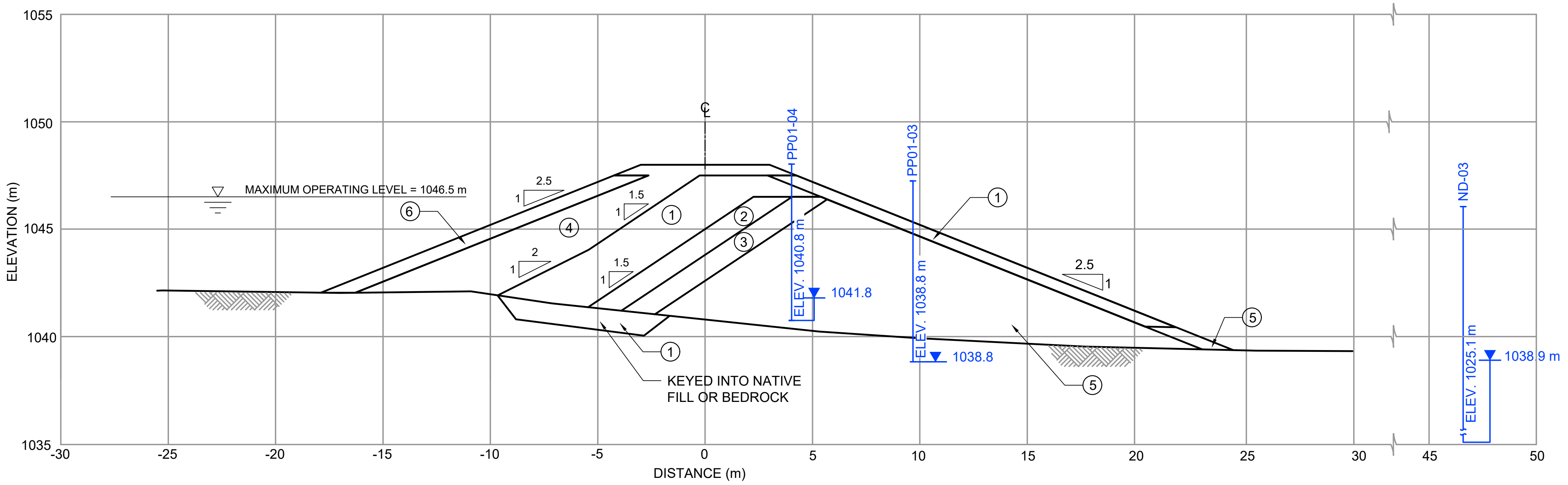
NOTES:

1. UNITS ARE IN METERS, UNLESS INDICATED OTHERWISE ON FIGURE.
2. SITE LAYOUT PLAN WAS DEVELOPED FROM DRAWING B-8304, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 - CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
3. SECTIONS K TO Q WERE GENERATED FROM SURVEYED DAM CROSS SECTIONS PROVIDED BY TM TECH SERVICES SHEETS 3 & 4, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
4. FOUNDATION AREA OF THE DAM WAS CLEARED, GRUBBED AND STRIPPED TO COMPETENT TILL OR BEDROCK.
5. KEY TRENCH EXCAVATED MIN. 1.0 m INTO TILL

LEGEND:

⊕	PNEUMATIC PIEZOMETER
◕	STANDPIPE PIEZOMETER
+	SETTLEMENT PIN
→→	TOE DITCH
1023.7	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

ZONE	MATERIALS
①	GLACIAL TILL
②	SAND FILTER
③	SAND AND GRAVEL FILTER
④	SAND AND GRAVEL
⑤	FLOAT ROCK
⑥	RIPRAP



N SECTION (STA. 280)
16 SCALE = 1:250

1:250 0 2.5 5.0 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

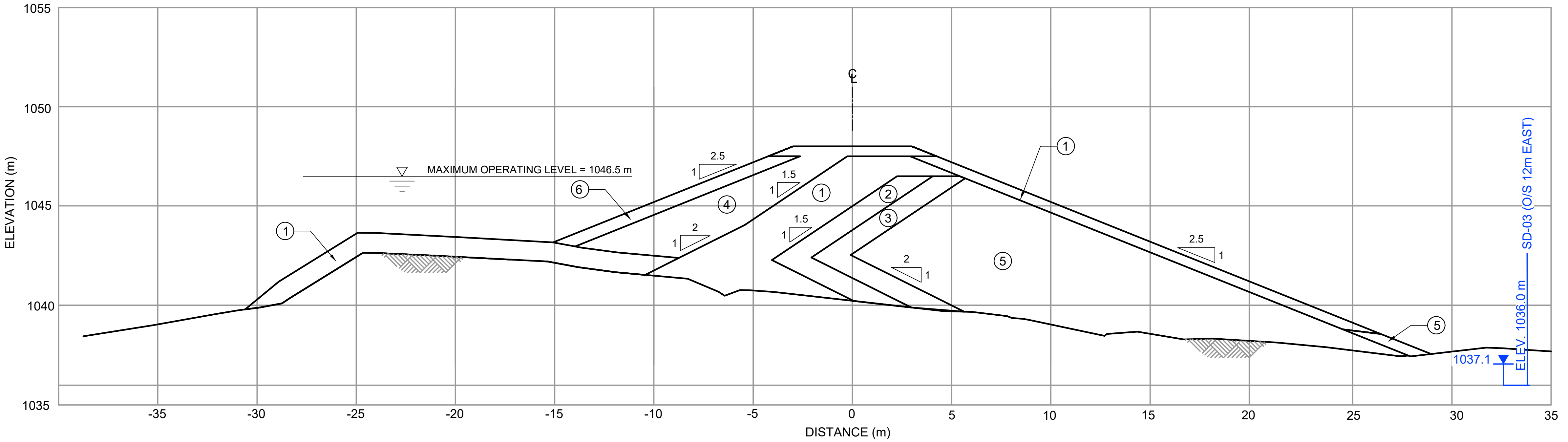
TITLE
ARD STORAGE POND
NORTH DAM SECTIONS

PROJECT No.
A05807A18

FIG No.
18

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 17-18.dwg Layout=18 February 11, 2019 2:04:24 PM

KCC-D-B



O SECTION (STA. 080)
16 SCALE = 1:250

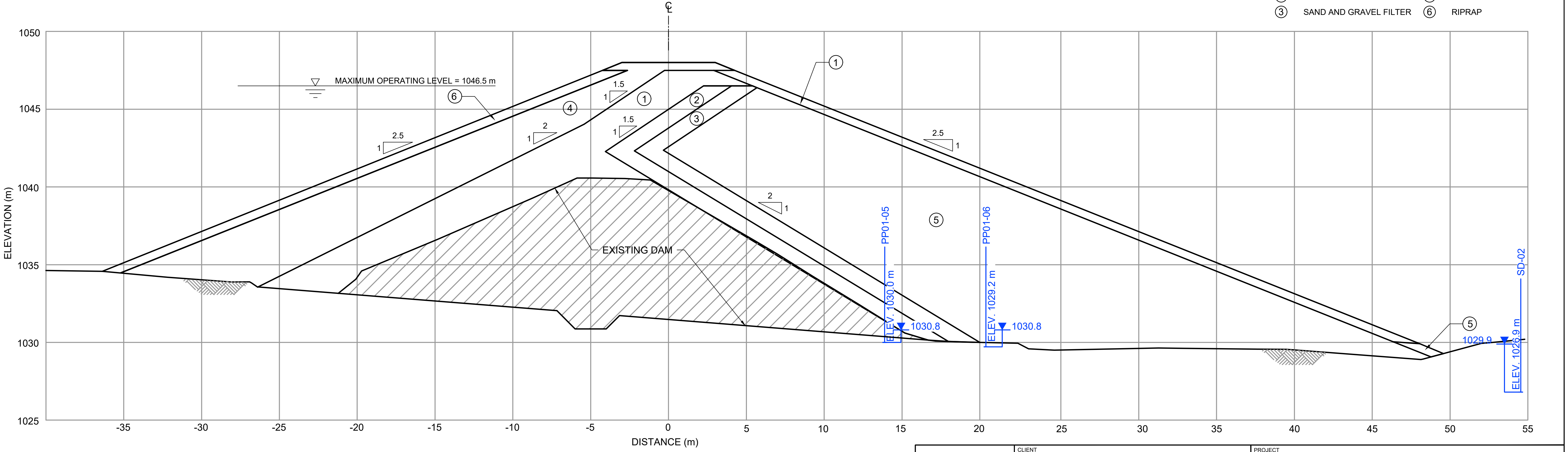
NOTES:

1. UNITS ARE IN METERS, UNLESS INDICATED OTHERWISE ON FIGURE.
2. SITE LAYOUT PLAN WAS DEVELOPED FROM DRAWING B-8304, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 - CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
3. SECTIONS K TO Q WERE GENERATED FROM SURVEYED DAM CROSS SECTIONS PROVIDED BY TM TECH SERVICES SHEETS 3 & 4, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
4. FOUNDATION AREA OF THE DAM WAS CLEARED, GRUBBED AND STRIPPED TO COMPETENT TILL OR BEDROCK.
5. KEY TRENCH EXCAVATED MIN. 1.0 m INTO TILL
6. PRIOR TO PLACEMENT OF TILL OVER BEDROCK, EXPOSED SURFACE WAS THOROUGHLY CLEANED USING COMPRESSED AIR. THE BEDROCK SURFACE WAS TREATED WITH DENTAL CONCRETE AS DIRECTED BY THE ENGINEER.
7. WITHIN THE FOOTPRINT OF THE UPSTREAM GRANULAR ZONE OF THE DAM, AN IMPERVIOUS BLANKET (ZONE 1) WAS CONSTRUCTED TO COVER EXPOSED BEDROCK. THE BLANKET EXTENDED MIN. 2 m BEYOND THE TOE OF THE DAM AS DIRECTED BY THE ENGINEER.

LEGEND:

⊕	PNEUMATIC PIEZOMETER
◕	STANDPIPE PIEZOMETER
+	SETTLEMENT PIN
→→	TOE DITCH
1023.7	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

ZONE	MATERIALS	ZONE	MATERIALS
①	GLACIAL TILL	④	SAND AND GRAVEL
②	SAND FILTER	⑤	FLOAT ROCK
③	SAND AND GRAVEL FILTER	⑥	RIPRAP



P SECTION (STA. 220)
16 SCALE = 1:250

1:250 0 2.5 5.0 m

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

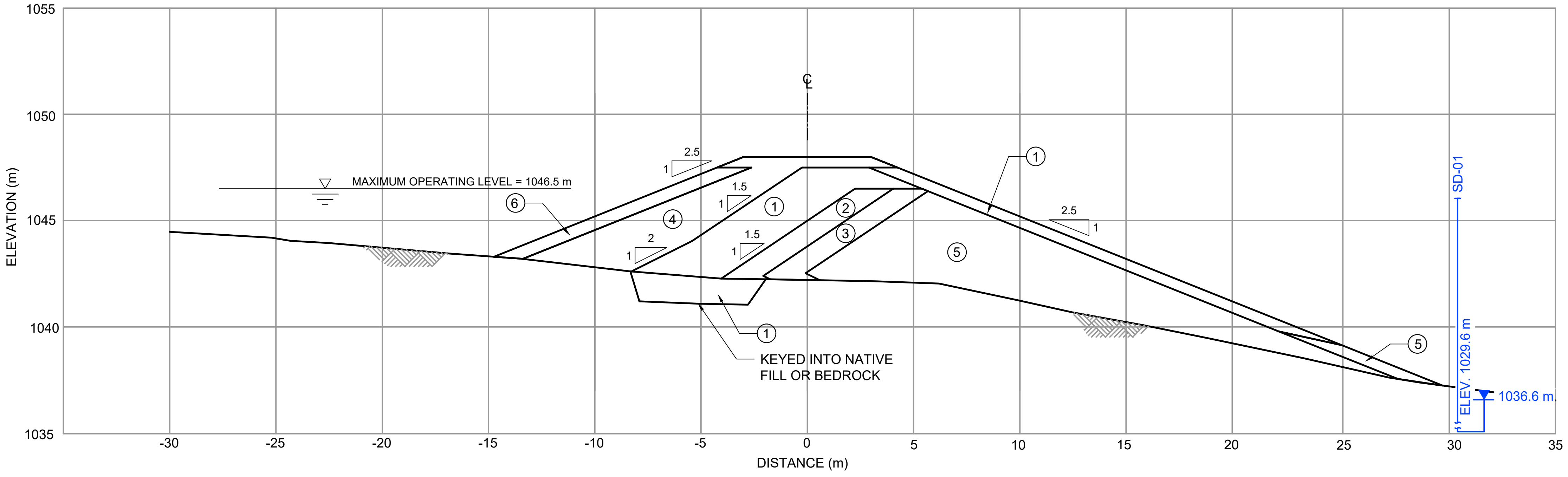
TITLE
ARD STORAGE POND
SOUTH DAM SECTIONS

PROJECT No.
A05807A18

FIG No.
19

KCC-D-B

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 19-20.dwg Layout=19 February 11, 2019 2:04:36 PM



Q SECTION (STA. 320)

16 SCALE = 1:250

NOTES:

1. UNITS ARE IN METERS, UNLESS INDICATED OTHERWISE ON FIGURE.
2. SITE LAYOUT PLAN WAS DEVELOPED FROM DRAWING B-8304, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 - CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
3. SECTIONS K TO Q WERE GENERATED FROM SURVEYED DAM CROSS SECTIONS PROVIDED BY TM TECH SERVICES SHEETS 3 & 4, IN REPORT TITLED "SULLIVAN MINE TAILINGS FACILITY STORAGE POND NO. 1 CONSTRUCTION RECORD REPORT" DATED JANUARY 2002 BY KLOHN CRIPPEN.
4. FOUNDATION AREA OF THE DAM WAS CLEARED, GRUBBED AND STRIPPED TO COMPETENT TILL OR BEDROCK.
5. KEY TRENCH EXCAVATED MIN. 1.0 m INTO TILL
6. PRIOR TO PLACEMENT OF TILL OVER BEDROCK, EXPOSED SURFACE WAS THOROUGHLY CLEANED USING COMPRESSED AIR. THE BEDROCK SURFACE WAS TREATED WITH DENTAL CONCRETE AS DIRECTED BY THE ENGINEER.
7. WITHIN THE FOOTPRINT OF THE UPSTREAM GRANULAR ZONE OF THE DAM, AN IMPERVIOUS BLANKET (ZONE 1) WAS CONSTRUCTED TO COVER EXPOSED BEDROCK. THE BLANKET EXTENDED MIN. 2 m BEYOND THE TOE OF THE DAM AS DIRECTED BY THE ENGINEER.

LEGEND:

⊕	PNEUMATIC PIEZOMETER
◕	STANDPIPE PIEZOMETER
+	SETTLEMENT PIN
→→	TOE DITCH
1023.7	MAXIMUM RECORDED PIEZO LEVEL (m) DURING REPORTING PERIOD

ZONE	MATERIALS
①	GLACIAL TILL
②	SAND FILTER
③	SAND AND GRAVEL FILTER
④	SAND AND GRAVEL
⑤	FLOAT ROCK
⑥	RIPRAP

1:250 0 2.5 5.0 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

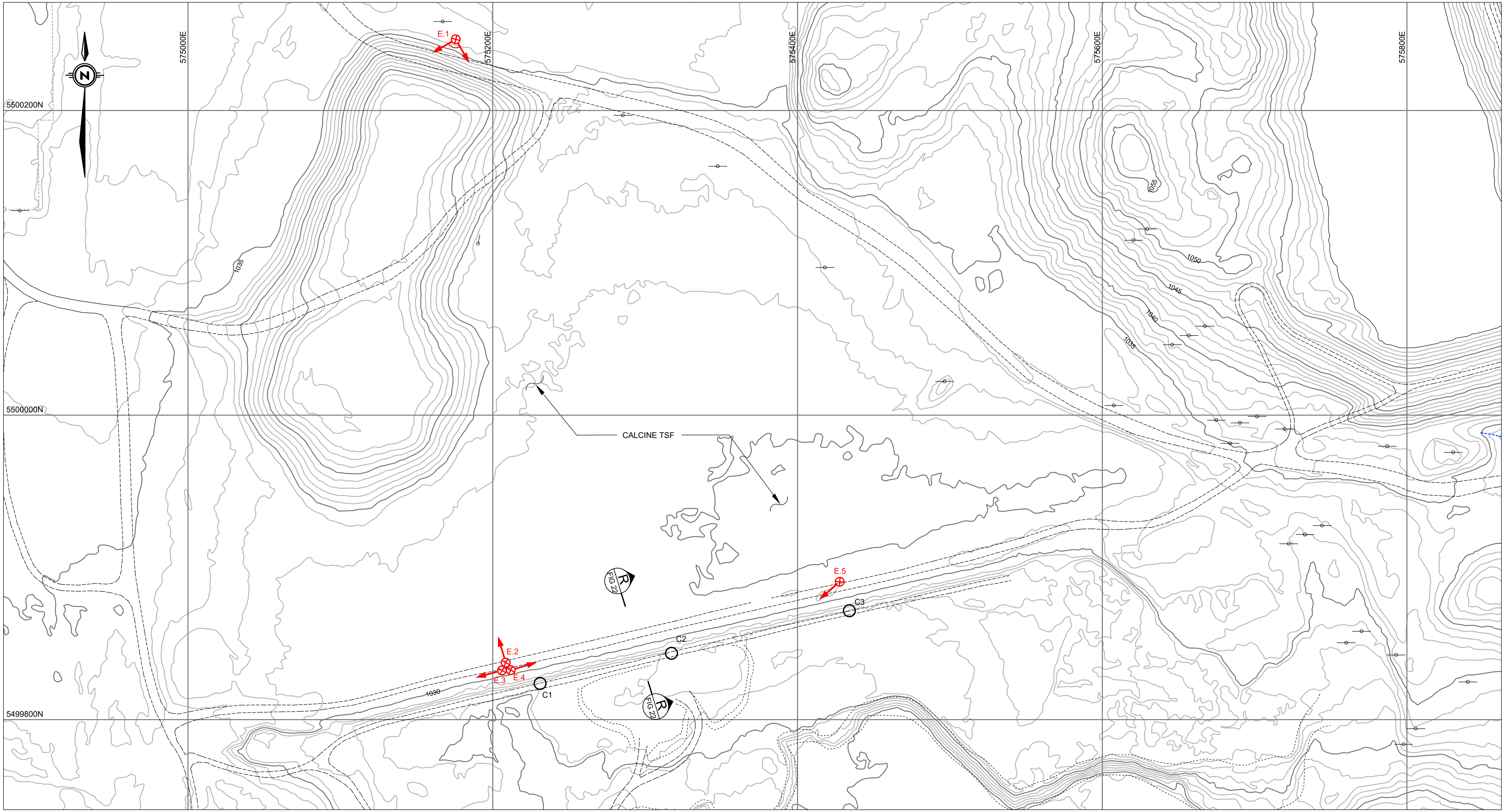
TITLE
ARD STORAGE POND
SOUTH DAM SECTIONS

PROJECT No.
A05807A18

FIG No.
20

KCC-D-B

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 19-20.dwg Layout=20 February 11, 2019 2:04:44 PM



NOTES:

1. GENERAL TOPOGRAPHY FROM LIDAR DATED DECEMBER 2012.
2. ELEVATIONS ARE GEODETIC.
3. MAP COORDINATE SYSTEM = U.T.M. (NAD83). CONTOUR INTERVAL IS ONE METRE.
4. INSTRUMENTATION LOCATIONS ARE BASED ON RECORDS PROVIDED BY TECK PERSONNEL FOR THIS REPORT. NO ATTEMPT HAS BEEN MADE TO VERIFY THE ACCURACY OF THE LOCATIONS.

LEGEND:

○ C1 MONITORING WELL - ABANDONED

LOCATION AND DIRECTION OF PHOTOGRAPHS DURING ANNUAL INSPECTION

7.01 ⊗ PHOTO NUMBER
LOCATION WHERE PHOTO WAS TAKEN
DIRECTION OF VIEW

7.01 ⊕ PANORAMA

1:2 500 0 25 50 m

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE CONFIDENTIAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND AUTHORIZATION FOR USE AND/OR PUBLICATION OF DATA STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

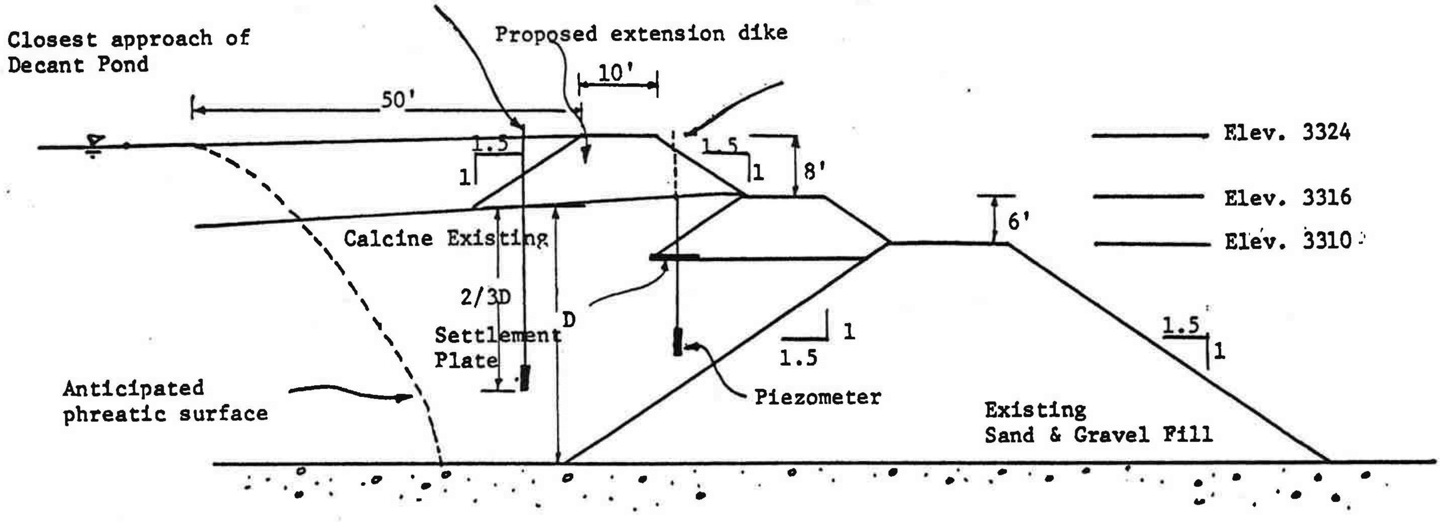
TITLE
INSTRUMENT LOCATION PLAN
CALCINE DIKE

PROJECT No.
A05807A18

FIG No.
FIGURE 21

KCC-D-B

Z:\ACGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 21_Calcine.dwg Layout=Figure 18 February 11, 2019 2:05:04 PM



R SECTION
FIG 21 SCALE = N.T.S.

CLIENT
Teck
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

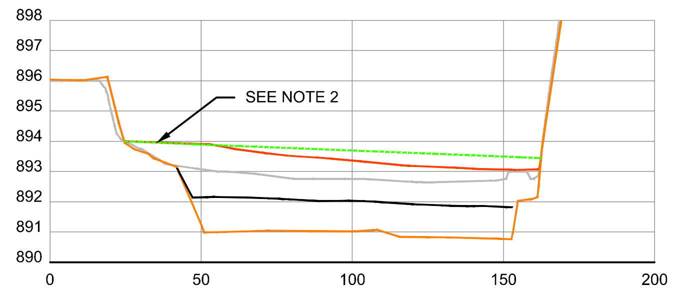
TITLE
CALCINE DIKE
TYPICAL SECTION

PROJECT No.
A05807A18

FIG No.
FIGURE 22

KCC-D-B

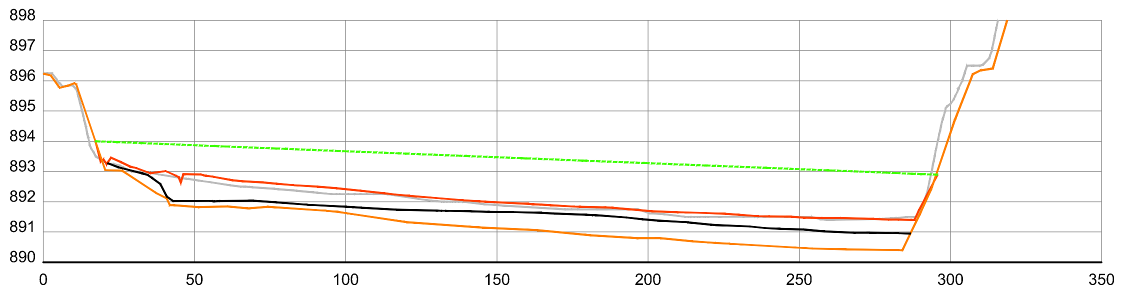
Z:\ACGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 22_Calcine Section.dwg Layout=Figure 19 February 11, 2019 2:05:18 PM



S SECTION

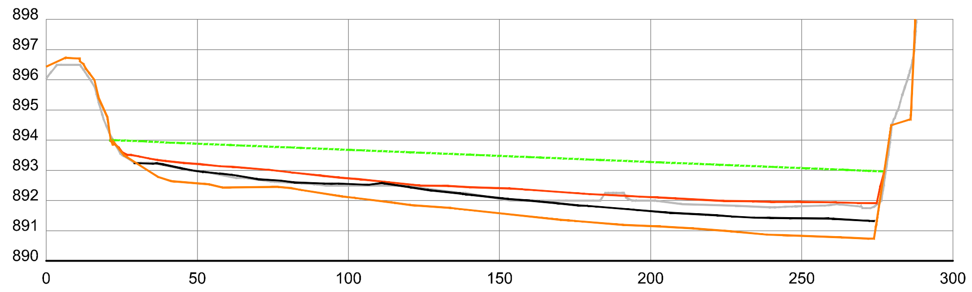
SCALE = 1:2500

NOTE:EXCESS SLUDGE DEPOSIT RELOCATED OCTOBER 2015



U SECTION

SCALE = 1:2500

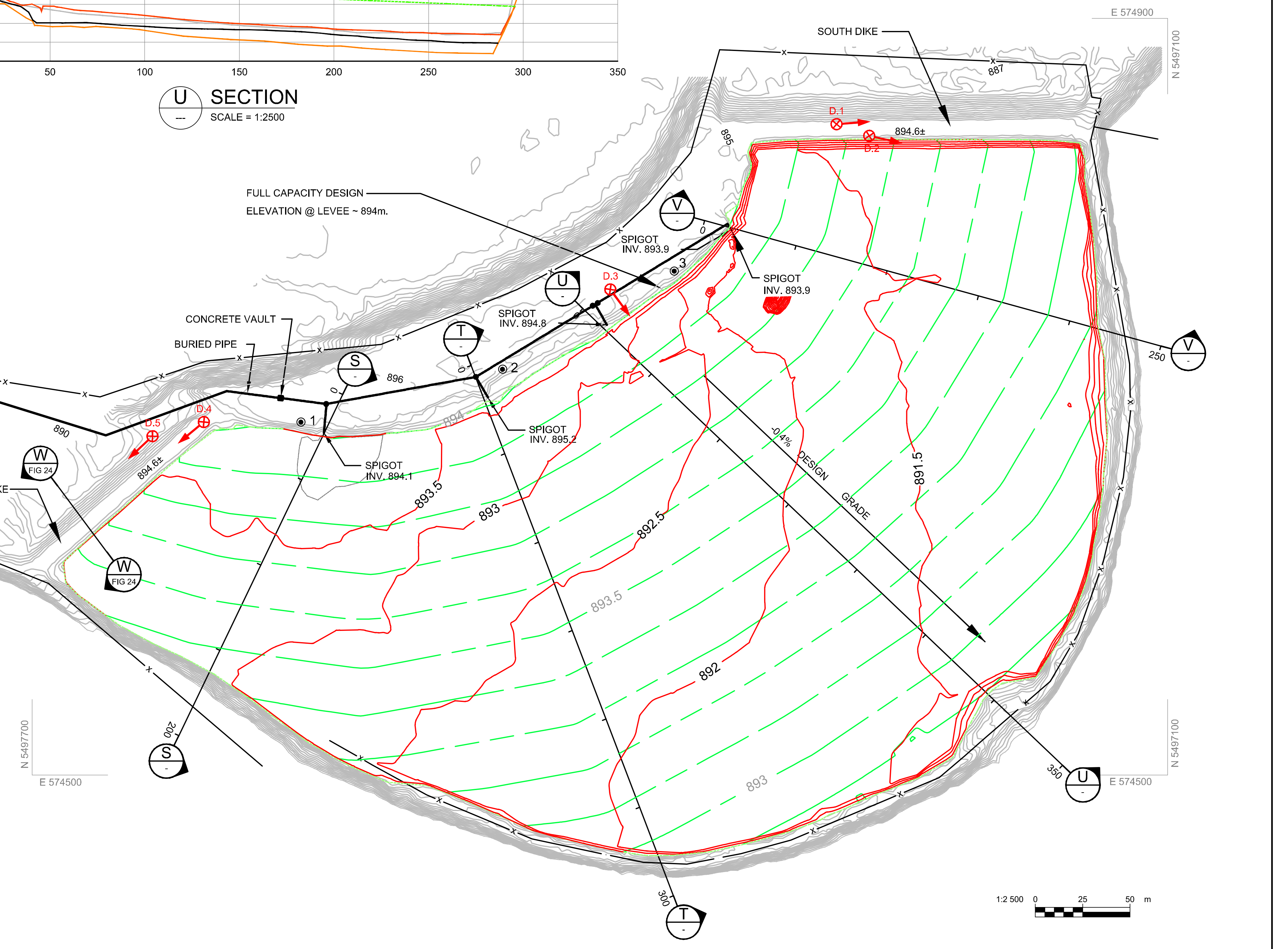


T SECTION

SCALE = 1:2500

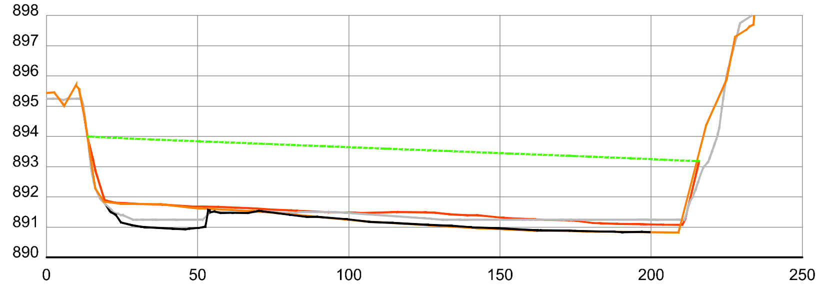
VOLUME SUMMARY

2001 SURVEY TO FULL POOL @ 0.4% GRADIENT ~ 278,000 cu.m.	
2001(MAY 8) SURVEY TO 2009(SEPT 18)	~ 52,430 cu.m.
2012 LIDAR SURFACE TO FULL POOL	~ 182,550 cu.m.
2015 SURFACE TO FULL POOL	~ 163,630 cu.m.



V SECTION

SCALE = 1:2500



LEGEND:

LOCATION AND DIRECTION OF PHOTOGRAPHS
TAKEN DURING 2015 INSPECTION

PHOTO NUMBER

8.01 ⊗

LOCATION WHERE
PHOTO WAS TAKEN

DIRECTION OF VIEW

2001 SURFACE
2009 SURVEY
2012 LIDAR SURVEY
2015 SURVEY (INTERVAL 0.5m)
FULL POOL DESIGN SURFACE (INTERVAL 0.25m)
FULL POOL PERIMETER (128,500 sq.m.)
• DENOTES SHUT OFF STANDPIPE
◉ 1 CONTROL MONUMENT PLACED 2015

NOTES:

1. SLUDGE IMPOUNDMENT LAYOUT AND CROSS SECTIONS PROVIDED BY TM TECH SERVICES, DRAWING NO. K101A2243 DATED SEPTEMBER 9 2015.
2. EXCESS SLUDGE AT SPIGOT NO. 1 RELOCATED OCTOBER 27, 2015.

CLIENT
Teck

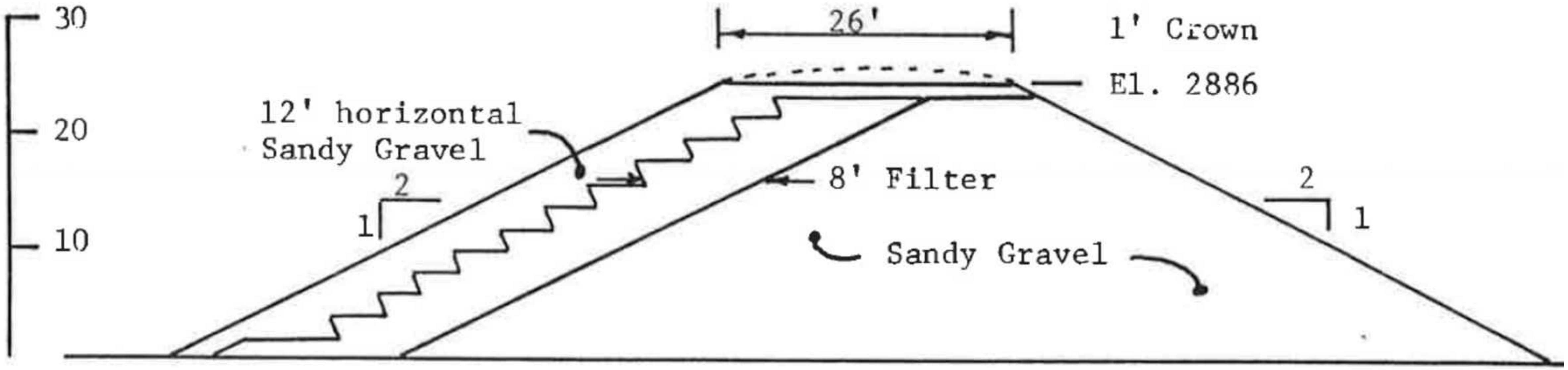
Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
SLUDGE IMPOUNDMENT DIKES
PLAN

PROJECT No.
A05807A18

FIG No.
FIGURE 23



AS CONSTRUCTED

W
FIG 23
SECTION
SCALE = N.T.S.

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
SLUDGE IMPOUNDMENT DIKES
TYPICAL SECTION

PROJECT No.
A05807A18

FIG No.
FIGURE 24

KCC-D-B

Z:\ACGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure 24_Sludge Typical Section.dwg Layout=Figure 21 February 11, 2019 1:59:52 PM

APPENDIX I

2018 Dam Safety Inspection Forms

Kimberley Inspection Checklist
ARD Storage Pond

Date: May 23, 2018

Inspected by: K. Masterson, D Chin, P. Fines

Weather: Sunny 18°C

Pond Elevation 1042.99 m

Any snow on the ground: Yes/ [✓ No]

Operational Limits: 1035m to 1046.5m

North Dam	Remarks
Dam Crest Surface	→ Crest in good condition
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	→ – → some grass – gravelled surface
Animal activity (rodent burrows)	N/A , ~~one burrow noted past the toe~~
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	–
Slope protection (riprap)	– Good condition
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	– some small shrubs
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	
Slope protection (grass)	– grassed
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
North/East Gypsum Dike

Date: May 23, 2018

Inspected by: K. Masterson
B Chin. P. Fires

Weather: Sunny, Hot (~27°C)

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	grassed along crest.
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	- Gypsum covers upstream slope
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	~~grassed~~ N/A
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	→ seepage collects @ toe - Recycle dam ~~Gypsum Tails [illegible]~~
Slope protection (grass)	→ grass + shrubs some erosion
Surface erosion/gullying	Some erosion.
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
DWTP Sludge Impoundment
(North)

Date: May 23, 2018

Inspected by: K. Masterson
P. Fines

Weather: Sunny, Hot (~27°C)

Any snow on the ground: Yes/ [✓ No]

Observations	**Remarks**
Dam Crest Surface	- repair done @ low spot + width adjusted ramp (east end)
Cracks N/A	→ crest good condition.
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	N/A
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A)
Vegetation growth	Some shrub growth.
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	
Slope protection (grass)	grassed. w/ other vegetation Grass sparse
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
DWTP Sludge Impoundment
(South)

Date: May 23, 2018

Inspected by: K. Masterson
P. Fines

Weather: Sunny, Hot (~27 °C)

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	
Cracks N/A	good condition - low spots southend of dike.
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	None
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	- generally good condition.
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	→ Shrubs starting to grow + get length
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	- generally good condition.
Slope protection (grass)	- sparse grass + other vegetation
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
West Gypsum Cell

Date: May 23, 2018

Weather: Sunny Hot (~27°C)

Inspected by: K. Masterson, P. Fines, B. Chin

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	Generally good condition
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	→ grasses growing.
Animal activity (rodent burrows)	- N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope / Pond Surface	
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	→ surface reclaimed + grassed.
Animal activity (rodent burrows)	N A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	generally good condition.
Slope protection (grass)	→ grassed slopes.
Surface erosion/gullying	-N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
Iron Pond

Date: May 23, 2018

Inspected by: K. Maclean P Fines B. Chin

Weather: Sunny (~22°C)

Pond Elevation

Any snow on the ground: Yes/ [✓ No]

Operational Limits: 1037.6m to 1038.9m

IRON DYKE	Remarks
Dam Crest Surface	
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	gravel/fill access - some vegetation
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	/ Pond surface → well vegetated
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	- vegetation well established
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	
Slope protection (grass)	{ grass growing well some areas North end w/ erosion gulley (near stations A2)
Surface erosion/gullying	
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
ARD Storage Pond

Date: May 23, 2018 May 24, 2018

Inspected by: K. Masbrson P. Frey B. Chin

Weather: Sunny | Hot ~(20°C)

Pond Elevation 1042.99m

Any snow on the ground: Yes/ [✓ No]

Operational Limits: 1035m to 1046.5m

South Dam	Remarks
Dam Crest Surface	good condit.
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	- slopes grassed - crest gravel road.
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	
Slope protection (riprap)	- good condition
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	- ~~grassed~~. small shrubs
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	
Slope protection (grass)	grassed slopes
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
Calcine TSF

Date: May 24, 2018

Inspected by: K. Masterson, B. Chin
P. Fines

Weather: Sunny Partial Cloudy
~22°C

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	- gravel road. along crest
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	→ flat → no upstream slope tails/reclaim material sloped to dike crest.
Slope protection (riprap)	N/A
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	N/A - tails pond surface grassed → trees planted.
Animal activity (rodent burrows)	N/A
Any unusual conditions	
Dam Downstream Slope and Toe	Downstream slope supported by land fill ~~No Downstream slope. [illegible]~~
Slope protection (grass)	grassed in spots ~ upper 2 m → 4 m
Surface erosion/gullying	generally fill N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
Old Iron Dike

Date: May 24, 2018

Inspected by: K. Masterson P Fines B. Chin

Weather: Sunny/partial Clouds ~22°C

Any snow on the ground: Yes/ No

Observations	Remarks
Dam Crest Surface	- Crest in good condition
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	- gravel road along crest.
Animal activity (rodent burrows)	- N/A
Any unusual conditions	- N/A
ponding of water	- N/A
Dam Upstream Slope	
Slope protection (riprap)	N/A - grassed, reclaimed tailings pond.
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	- grassed upstream slope.
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	- toe + slope in good condition
Slope protection (grass)	- grass/vegetation well established.
Surface erosion/gullying	- N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
Iron TSF Divider Dike

Date: May 24, 2018

Inspected by: K. Masterson, P. Fines, B. Chin

Weather: Sunny Partly Cloudy ~22°C

Any snow on the ground: Yes/ No

Observations	Remarks
Dam Crest Surface	
Cracks	N/A
Erosion	N/A
Settlement/depressions	N/A
Vegetation growth	- gravel road.
Animal activity (rodent burrows)	- N/A
Any unusual conditions	N/A
ponding of water	N/A
Dam Upstream Slope	- slope graded to [illegible] @ closure for surface water drainage
Slope protection (riprap)	- grassed tails pond surface
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A
Vegetation growth	- grassed tail's pond surface w/ trees.
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	- tails + reclaim material buttressed slope except upper ~2 m.
Slope protection (grass)	grassed.
Surface erosion/gullying	N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
East Gypsum Cell

Date: May 24, 2018

Inspected by: K. Masterson P. Fines B. Chin

Weather: Sunny Partly Cloudy ~15°C

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	- good condition
Cracks	-N/A
Erosion	N/A
Settlement/depressions	- N/A
Vegetation growth	- gravel access road. - some grass
Animal activity (rodent burrows)	- N/A
Any unusual conditions	- N/A
ponding of water	- N/A
Dam Upstream Slope	
Slope protection (riprap)	- grassed, reclaimed
Surface erosion/gullying	- N/A
Slides or sloughing	- N/A
Settlement/depressions	- N/A
Bulging	- N/A
Cracks	- N/A
Vegetation growth	- grassed
Animal activity (rodent burrows)	N/A
Any unusual conditions	N/A
Dam Downstream Slope and Toe	
Slope protection (grass)	- grass, some areas sparse
Surface erosion/gullying	- N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A

Kimberley Inspection Checklist
No. 2 Siliceous Cell

Date: May 23, 2018

Weather: Sunny hot ~25°C

Any snow on the ground: Yes/ [✓ No]

Inspected by: K. Masterson, B Chin
P. Fraes.

Observations	Remarks
Dam Crest Surface	Generally in good condition
Cracks	n/a
Erosion	n/a
Settlement/depressions	n/a
Vegetation growth	- grassed surface
Animal activity (rodent burrows)	n/a
Any unusual conditions	n/a
ponding of water	n/a
Dam Upstream Slope	good condition
Slope protection (riprap)	- grassed - reclaimed surface.
Surface erosion/gullying	n/a
Slides or sloughing	n/a
Settlement/depressions	n/a
Bulging	n/a
Cracks	n/a
Vegetation growth	well grassed on reclaim surface
Animal activity (rodent burrows)	n/a
Any unusual conditions	n/a
Dam Downstream Slope and Toe	
Slope protection (grass)	- grassed slopes
Surface erosion/gullying	no erosion noted.
Slides or sloughing	none
Settlement/depressions	none
Bulging	none

Kimberley Inspection Checklist
No. 3 Siliceous Cell

Date: May 23, 2018

Inspected by: K. Masterson, B. Chin
P. Fines

Weather: Sunny Hot ~25 °C

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	generally in good condition
Cracks	n/a
Erosion	n/a
Settlement/depressions	n/a
Vegetation growth	grassed surface
Animal activity (rodent burrows)	n/a
Any unusual conditions	n/a
ponding of water	n/a
Dam Upstream Slope	generally good condition
Slope protection (riprap)	– grassed reclaimed surface
Surface erosion/gullying	n/a
Slides or sloughing	n/a
Settlement/depressions	n/a
Bulging	n/a
Cracks	n/a
Vegetation growth	n/a
Animal activity (rodent burrows)	n/a
Any unusual conditions	n/a
Dam Downstream Slope and Toe	
Slope protection (grass)	– grassed slopes
Surface erosion/gullying	– N/A
Slides or sloughing	– N/A
Settlement/depressions	– N/A
Bulging	– N/A

Kimberley Inspection Checklist
No. 1 Siliceous Cell

Date: May 23, 2018

Inspected by: K. Masterson, P. Snes
B. Chin

Weather: Sunny - 25°C (hot)

Any snow on the ground: Yes/ [✓ No]

Observations	Remarks
Dam Crest Surface	- upper slope flattened 15H:1V
Cracks	+ surrounded by sil ponds
Erosion	#2 + 3
Settlement/depressions	
Vegetation growth	
Animal activity (rodent burrows)	
Any unusual conditions	
ponding of water	
Dam Upstream Slope	
Slope protection (riprap)	
Surface erosion/gullying	
Slides or sloughing	
Settlement/depressions	
Bulging	
Cracks	
Vegetation growth	→ surface of pond reclaimed grassed
Animal activity (rodent burrows)	sloped to drain to spillway.
Any unusual conditions	
Dam Downstream Slope and Toe	
Slope protection (grass)	- grassed
Surface erosion/gullying	- N/A
Slides or sloughing	N/A
Settlement/depressions	N/A
Bulging	N/A
Cracks	N/A

APPENDIX II

2018 Photographs

Appendix II
Photographs

A ARD Pond

Photo A.1 Downstream Slope of ARD Pond South Dam

Photo A.2 Crest and Upstream Slope of ARD Pond South Dam

Photo A.3 Overview of ARD Pond from South Dam

Photo A.4 Upstream Face of ARD Pond North Dam

Photo A.5 Crest and Downstream face of ARD Pond North Dam

Photo A.6 Localized Depressions on Downstream Face of ARD Pond North Dam

Photo A.7 Looking across ARD Pond Towards Inlet of ARD Pond

Photo A.8 ARD Pond Spillway

Photo A.9 ARD Pond Spillway looking towards Iron Pond

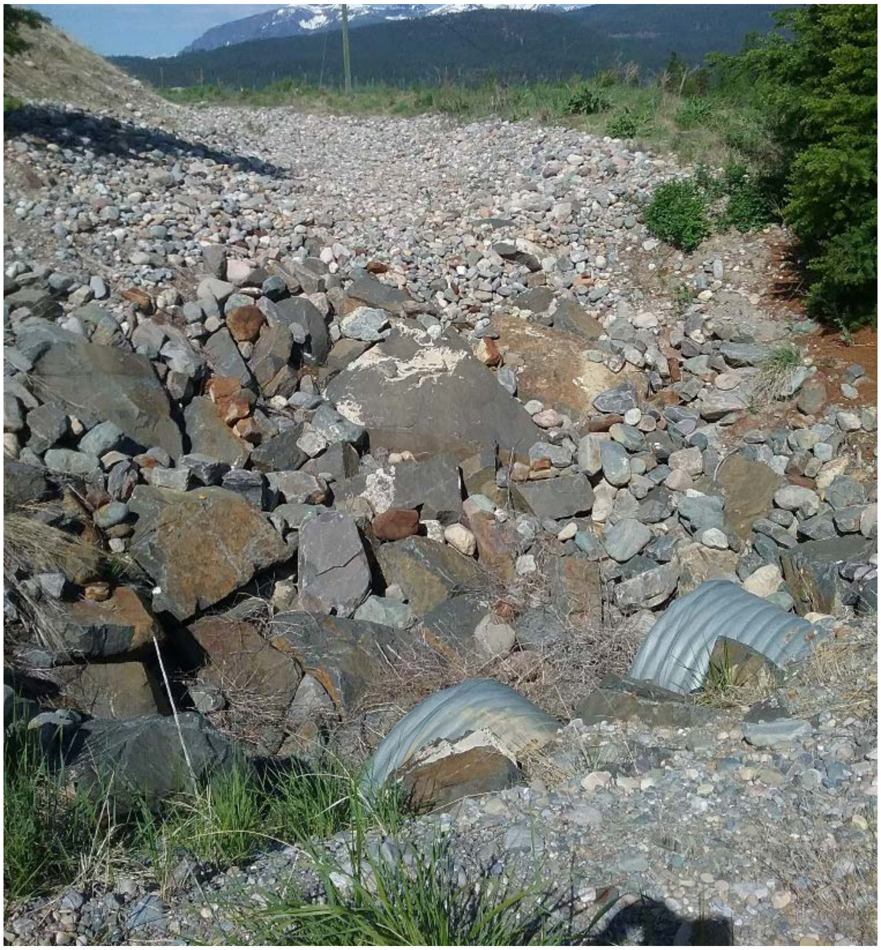


Photo A.10 Sump downstream of ARD North Dam

Photo A.11 Weir #1 Downstream of ARD Pond. Channel requires cleaning

Photo A.12 Weir #1 Downstream of ARD Pond. Channel requires cleaning

Photo A.13 Weir #2 Downstream of ARD Pond. Bank requires maintenance

Photo A.14 Channel approaching Weir #2 Downstream of ARD Pond.

B Emergency Spillway

Photo B.1 Approach swale to the Emergency Spillway

Photo B.2 Access Road Across Approach Swale

Photo B.3 Upstream End of the Emergency Spillway looking downstream

Photo B.4 Emergency Spillway looking upstream

Photo B.5 Emergency Spillway looking downstream

Photo B.6 Downstream End of the Emergency Spillway

C Siliceous TSF

Photo C.1 Diversion Channel Upstream of Siliceous TSF looking downstream

Photo C.2 Downstream Slope of Siliceous Dike

Photo C.3 Overview of Siliceous TSF

Photo C.4 Siliceous TSF Emergency Spillway

D Sludge Impoundment

Photo D.1 Sludge Impoundment South Dike Crest and Downstream Slope

Photo D.2 Upstream Face of Sludge Impoundment South Dike

Photo D.3 Overview of Sludge Impoundment

Photo D.4 Sludge Impoundment North Dike Crest

Photo D.5 Sludge Impoundment North Dike Downstream Slope

E Calcine TSF

Photo E.1 Overview of Excavation Area in Calcine TSF looking towards the dam

Photo E.2 Overview of Excavation Area in Calcine TSF Looking Upstream from Dam Crest

Photo E.3 Dam Crest and Downstream Slope of Calcine Dike looking west

Photo E.4 Dam Crest and Downstream Slope of Calcine Dike looking east

Photo E.5 Concrete Debris and Landfill Downstream of Calcine TSF

F Gypsum TSF

Photo F.1 Overview of West Gypsum Dike and Spillway

Photo F.2 Animal Burrows at Toe of West Gypsum Dike

Photo F.3 Badger Hole near Toe of East Gypsum Dike

Photo F.4 Decommissioned Decant Pipe downstream of East Gypsum Dike

Photo F.5 **Ditch Downstream of East Gypsum Dike**

Photo F.6 **Seepage Collection Ditch Downstream of Gypsum Dikes**

Photo F.7 Downstream Slope of West Gypsum Dike

Photo F.8 Animal Burrow in West Gypsum Dike

Photo F.9 Drainage Swale across Gypsum TSF

Photo F.10 Recycle Dam

G Iron TSF

Photo G.1 Downstream Slope and Toe of Iron Dike

Photo G.2 Seepage Collection Ditch at Toe of Iron Dike

Photo G.3 Seepage from Toe of Iron Dike

Photo G.4 Overview of Reclaimed Iron TSF

Photo G.5 Overview of Reclaimed Iron TSF

Photo G.6 Overview of Reclaimed Iron TSF

Photo G.7 Downstream Slope and Toe of Iron Dike

Photo G.8 Seepage Collection Ditch downstream from Iron TSF (Weir #4)

Photo G.9 Silting of Channel upstream of Weir #4

H Old Iron TSF

Photo H.1 Overview of Old Iron Dike

Photo H.2 Crest and Downstream Slope of Old Iron Dike

Photo H.3 Crest and Downstream Slope of Old Iron Dike

I Iron Pond

Photo I.1 Overview of tailings area and Iron Pond

Photo I.2 Overview of Iron Pond

Photo I.3 Overview of tailings area and Iron Pond

APPENDIX III

Quantifiable Performance Objectives and 2018 Instrumentation Monitoring

Appendix III
Quantifiable Performance Objectives and 2018 Instrumentation Monitoring

III.1 QUANTIFIABLE PERFORMANCE OBJECTIVES

Quantifiable Performance Objectives (QPOs) have been established for all of the instrumentation and for the freeboard under normal operating conditions for those tailings facilities which have ponds, i.e., ARD Pond and Iron Pond. The QPOs are discussed below.

III.1.1 Piezometric

Pneumatic, standpipe and vibrating wire piezometers are all used at site to monitor phreatic surfaces within the tailings facilities and foundations. The threshold levels established for the piezometers, required monitoring frequency and current readings are summarized in Section III.2 Table AIII.3

The following is required when a threshold level is reached for a single instrument:

- Data, data reductions and calculations are checked for accuracy and correctness.
- If no errors are found in the calculations, the Mine Manager is notified that an anomalous reading has been observed and that further assessment must be conducted. The EOR is notified at this time. The EOR will evaluate data for reliability, review data within the general vicinity of the individual instrument. The EOR may require the following:
  - Check of readout equipment to verify that it is functioning correctly and to verify calibration.
  - Re-read instrument and other nearby instruments for confirmation.
  - Adjust on-going monitoring frequency as required.
- If it is observed that an instrument or piece of readout equipment has stopped functioning, the Mine Manager and subsequently the EOR should be notified immediately. If considered critical, a replacement instrument should be installed.

If several instruments within an area of the dikes or dams are observed to exceed the threshold levels then the following is required:

- The Mine Manager and EOR should be notified within 24 hours.
- Monitoring frequency will be increased as needed based on assessment of common trend.
- EOR to assess the dam integrity and may recommend analyses, site visit or implementation of remedial actions as required.

III.1.2 Settlement

There are several methods used to monitor settlement at the Sullivan Mine tailings facilities. These include settlement plates, Sondex settlement gauges, and surveys.

Threshold levels have been established for the various settlement measurements. These are summarized along with survey results and required monitoring frequency in Section III.2 Table AIII.4.

The following response is required when the threshold level is exceeded at one instrument:

- Notify EoR within 24 hours upon verification of reading exceedance.
- EoR to evaluate data for reliability, and review survey data within the general vicinity of the individual survey monument in question. EoR may recommend repeat measurement and increased on-going monitoring frequency.

If more than one instrument within the facility indicates exceedance of the threshold level then the following is required:

- Notify EoR within 24 hours upon verification of reading exceedance.
- Repeat reading within 1 week.
- EoR to assess dam integrity and may recommend analyses, site visit or other action.

III.1.3 Lateral Movement

There is one inclinometer installed in the East Gypsum Dike to monitor lateral movements. A threshold level has been established for the inclinometer and is provided along with the required monitoring frequency in Section III.2 Table AIII.4.

The following response is required when the threshold level is exceeded:

- Data reductions are checked for accuracy and correctness.
- EoR to evaluate data for reliability, and review other instrumentation in vicinity of the slope inclinometer. Repeat measurement and/or measurement of other instruments may be recommended.
- EoR to assess dam integrity and may recommend analyses, site visit or other action.

III.1.4 Seepage

There are 4 weirs installed to measure seepage from the ARD Pond South Dam and the Iron Dike. Threshold levels have been established and are provided along with the required monitoring frequency in Section III.2 Table AIII.5.

The following response is required when the threshold level is exceeded:

- Data and data reductions are checked for accuracy and correctness.
- EoR to evaluate data for reliability, and review other instrumentation in the vicinity. Repeat measurement and/or measurement of other instruments may be recommended.
- EoR to assess dam integrity and may recommend analyses, site visit or other action.

III.1.5 Freeboard

There are three threshold levels which have been set for the ARD Pond and the Iron Pond, which are provided in Section III.2 Table AIII.6.

Threshold Level 1 indicates when the pumps should be started to transfer water to either the Drainage Water Treatment Plant (ARD Pond) or to the ARD Pond (Iron Pond).

Threshold Level 2 indicates when water levels are approaching maximum operating levels. When Threshold Level 2 is met or exceeded, transfer of water should continue as well as notifying the EOR and minimizing inflows. For the ARD Pond this could include diverting 3700/39000 to the Iron Pond and for the Iron Pond, stop pumping to the Iron Pond and divert runoff if possible.

Threshold Level 3 indicates when water levels are within 0.5 m of the spillway inverts. When Threshold Level 3 is met or exceeded, continue with transfer of water, minimizing inflows, notification of the EOR and notify MEMPR/MOE of potential spill as well as enacting Emergency Preparedness and Response Plan (EPRP).

III.1.6 Visual Inspections

As part of the QPOs, a series of regularly scheduled inspections is required to ensure that the tailings facilities are operating as intended and to identify problems and issues so that necessary corrective actions may be implemented in a timely manner. The main types of inspections are as follows:

- routine inspections (performed by Teck staff);
- event driven inspections (performed by Teck staff, and the Engineer of Record depending on the event);
- annual Inspection (performed by the Engineer of Record); and
- dam safety review (performed by an independent and qualified professional engineer).

Routine Visual Inspections

Routine visual inspections are performed by Teck staff and documented using one of the standard inspection forms, which are included in Appendix E of the OMS Manual. Two types of forms are provided: one for Weekly/Bi-weekly inspections and forms for Monthly/Annual inspections.

The minimum visual inspection frequency for each of the structures can be found in Table III.1.

Table III.1 Visual Inspection Requirements for the Dikes and Dams at Sullivan Mine

Dike		CDA Classification	Pond Elevation	Visual Inspection Requirements
ARD Pond Dikes		Very High	< 1040 m	Monthly
			>1040 m	Weekly (a Monthly Inspection form must be filled in once per month if pond is high for an extended period of time, i.e. greater than one month)
Iron Dike (STA 0+00 to 10+00)		High	N/A	Monthly
Iron Dike (STA 10+00 to end of dam)		High	N/A[*1]	Annually
Old Iron TSF	Old Iron Dike	Low	N/A[*1]	Annually
	Iron TSF Divider Dike	Low		
Siliceous Cell Dikes #1, #2 and #3		Low		Annually
Gypsum TSF	West Gypsum Dike	High		Annually
	East Gypsum Dike	High		
Northeast Gypsum Dike and Recycle Dam		Low		Annually
Calcine Dike		Low		Annually
Sludge Pond		Low	N/A	Bi-Weekly during DWTP operations otherwise Annually

The following is a list of general information that should be recorded (monthly and annual inspections):

- signs of depressions and/or movements of the downstream dam/dike slope;
- general condition of the dam/dike crest, toe, and faces, looking for settlement, erosion, seepage, cracking, animal burrows, vegetation growth or other abnormal conditions;
- water levels in active ponds;
- depth of flow in spillways (record zero flow in spillway as 0.0 m^3);
- issues related to blockage and inadequate capacity of spillway channels; and
- seepage noting change in flow rate and visual cloudiness and any new seepage.

Documentation of the routine inspections should be submitted to the Mine Manager following each inspection. If any maintenance requirements or anomalies are identified during the inspection, these must be identified to the mine manager.

The annual routine inspection by Teck staff should be planned such that it does not coincide with the annual inspection performed by the Engineer of Record. The annual routine inspection should include photographs of key features and any potential dam/dike safety concerns.

The completed inspection forms are stored in an electronic data base system, and hard copies of the inspection forms are catalogued and stored at Sullivan Mine.

Event Driven Inspections

In addition to routine inspections, special inspections may be required for significant seismic or climatic events, or anomalous instrumentation readings. Table III.2 presents the specific inspections to be carried out following specified events. All events involve immediate inspection by Teck staff, followed if required by notification to or inspection by the Engineer of Record.

Table III.2 Event Driven Inspections

Item	Event	Action	Comment
Embankments	Earthquake M5 or bigger within 100 km	Immediate inspection by Teck staff	Call the Engineer of Record if damage is noted
		Read all instruments within one week	Send instrument data to the Engineer of Record
	Earthquake M6 or bigger within 100 km	Inspection by the Engineer of Record Read all instruments	
	Rainfall (50 year event): 6 hour > 40 mm 24 hour > 56 mm Snowpack (50 year event): Accumulated snow water equivalent > 360 mm	Check and record water ponding Check dam toe seepage daily Drawdown water level if necessary	
	DWTP water delivery system fails	Check water level in the ARD Pond and Iron Pond daily Check rainfall daily Prepare standby pumps if required	Call the Engineer of Record if one pond is more than 75% full
	Instability or noticeable deformation, displacement of riprap.	Inspection by the Engineer of Record	
Surface Water Conveyance System	Rainfall (50 year event): 6 hour > 40 mm 24 hour > 56 mm Snowpack (50 year event): Accumulated snow water equivalent > 360 mm	Check and record water flow and ponding Check channels for debris Check channels for damage to riprap lining	

Annual Inspections

Annual inspections shall be carried out by the Engineer of Record for the tailings facilities for Sullivan Mine. The objective of the annual inspection is to confirm the routine inspections carried out, and to carry out a review of the conditions of the facilities and facility operation. The site water balance is reviewed to confirm the inputs and assumptions are still valid according to the current conditions.

The Engineer of Record issues an annual inspection report to the Mine Manager containing observations and recommendations. This report provides information to be used to revise the operation, maintenance and surveillance programs as necessary and to assist in planning for future operation of the facility. The annual inspection reports are issued to the British Columbia Ministry of Environment (BC MOE) by March 31 each year (as stated in Permit No. 74). Copies of the annual inspection report are to be stored at Sullivan Mine.

III.2 INSTRUMENT DATA SUMMARY

The lists of active instruments and measurement points, along with alarm threshold levels and maximum readings from the 2018 DSI reporting period, are shown in Tables AIII.3, AIII.4, AIII.5, and AIII.6. Updated instrument readings were provided to KCB by Vast Resources (Vast), TM TECH Services and Teck staff on several occasions from October 2017 to August 2018. Daily, then weekly readings of several selected instruments were taken during the year to better identify potential trends. Vast of Cranbrook, British Columbia is contracted by Teck to read the pneumatic and standpipe piezometers, and TM-TECH Services to survey the settlement plates. The daily/weekly readings for the weirs and ARD Pond standpipes were performed by Teck staff. KCB also selectively read several standpipes during the DSI site visit. Copies of the plots that were produced for each impoundment area are included in Appendix IV through Appendix X.

Table AIII.3 Active Piezometers – Iron TSF

Group Designation	Piezometer No.	Northing	Easting	Elevation Ground (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Threshold Level (m)	Max Measured Piezometer Level In 2018[1] (m)	Max 2018 Level Relative To 2017	Comment
Iron TSF													
Line 6+00	P91 – 1	5500541.5	576470.5	1037.3	N/A	1023.0	Dike	Pneumatic	Three times a year (spring, summer and fall)	1028.4	1025.2 (10 October 2017)	↑	
	P91 – 2A	5500512.5	576459.9	1029.7	N/A	1020.1	Road	Pneumatic		1026.9	1024.6 (10 October 2017)	↑	
	P91 – 2B	5500511.9	576462.4	1029.3	N/A	1021.5	Road	Pneumatic		1026.9	1025.1 (10 October 2017)	↑	
Line 16+00	SB – P15	5500739.4	576803.0	1033.9	N/A	1029.0	Iron TSF	Pneumatic		1036.2	1034.9 (10 October 2017)	↑	
	P91 – 3A	5500660.4	576707.5	1038.4	N/A	1008.6	Dike	Pneumatic		1024.8	1024.0 (10 October 2017)	↑	
	P91 – 3B	5500661.3	576708.4	1038.3	N/A	1023.7	Dike	Pneumatic		1025.8	1025.1 (10 October 2017)	↑	
	P91 – 3C	5500660.4	576709.0	1038.9	N/A	1021.3	Dike	Pneumatic		1025.8	1022.6 (10 October 2017)	↑	
	P91 – 4	5500630.6	576730.8	1031.5	N/A	1017.2	Bench	Pneumatic		1022.0	1021.7 (10 October 2017)	↑	Max. 2018 reading above trigger level. Recent reading lower.
	P92 – 20	5500593.9	576760.7	1033.0	N/A	1010.4	Bench	Pneumatic		1015.9	1015.7 (10 October 2017)	↓	Near Trigger level. Recent reading lower.
	P92 – 21	5500595.8	576762.3	1033.0	N/A	1012.2	Bench	Pneumatic		1015.9	1016.2 (10 October 2017)	↑	Max. 2018 reading above trigger level. Recent reading lower.
Line 24+00	P91 – 5A	5500482.1	576931.7	1039.7	N/A	1017.7	2400 Bench at Dike	Pneumatic		1031.8	1034.0 (10 October 2017)	↑	
	P91 – 5B	5500786.8	576930.2	1039.7	N/A	1026.7	2400 Bench at Dike	Pneumatic		1030.0	1027.7 (10 October 2017)	↑	
	P91 - 6	5500752.7	576941.0	1031.5	N/A	1020.5	2400 Bench at Dike	Pneumatic		1023.6	1023.5 (3 August 2018)	↑	Near Trigger level (within fluctuation range)
Line 30+00	P92 – 1	5500893.9	577066.3	1035.1	N/A	1021.1	91 Dike	Pneumatic		1033.0	1031.4 (25 April 2018)	↓	
	P92 – 2	5500865.9	577113.8	1028.6	N/A	1024.0	Slope	Pneumatic	Monthly	1027.8	1027.7 (19 December 2017)	↑	Near Trigger level (within fluctuation range). Recent reading lower
Line 38+00	P92 – 6	5501125.1	577156.5	1042.1	N/A	1024.2	91 Dike	Pneumatic	Three times a year (spring, summer and fall)	1033.6	1033.0 (25 April 2018)	↑	
	P92 – 7	5501118.0	577174.9	1040.2	N/A	1029.6	Slope	Pneumatic		1032.7	1031.7 (25 April 2018)	↑	
	P92 – 9	5501097.9	577314.6	1029.9	N/A	1025.3	Toe	Pneumatic		1028.4	1028.2 (25 April 2018)	↑	Near Trigger level (within fluctuation range) Recent reading lower
Line 42+00	P92 – 11	5501217.8	577335.4	1031.5	N/A	1025.0	Toe	Pneumatic		1028.4	1027.2 (24 April 2018)	↔	
	P91 – 11A	5501258.1	577172.2	1042.4	N/A	1027.0	91 Dike	Pneumatic		1036.7	1034.4 (10 October 2017)	↑	
	P91 – 11B	5501258.1	577172.2	1042.3	N/A	1029.9	91 Dike	Pneumatic		1036.7	1034.2 (10 October 2017)	↑	
	P91 – 12	5501209.4	577418.1	1040.9	N/A	1029.7	Slope	Pneumatic		1034.5	1033.8 (25 April 2018)	↑	
	P92 - 16	5501237.6	577246.4	1037.3	N/A	1027.6	Slope	Pneumatic		1030.6	1029.7 (25 April 2018)	↓	

Group Designation	Piezometer No.	Northing	Easting	Elevation Ground (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Threshold Level (m)	Max Measured Piezometer Level In 2018[1] (m)	Max 2018 Level Relative To 2017	Comment
Iron TSF													
Line 45+00	P92 - 13	5504074.8	577182.3	1040.5	N/A	1031.3	91 Dike	Pneumatic		1037.3	1034.9 (10 October 2017)	↑	
	P92 - 14	5504071.7	577199.9	1037.4	N/A	1029.6	Slope	Pneumatic		1036.8	1034.5 (3 August 2018)	↑	
	P92 - 15	5501320.2	577314.9	1030.3	N/A	1029.0	Toe	Pneumatic		1030.3	1029.1 (10 October 2017)	↔	
Toe Piezometers	P92 – H	5500665.1	576891.7	1025.6	N/A	998.1	21+00	Standpipe	Weekly	1032.0	1026.6 (24 April 2018)	↑	Pressure gauge no longer read, VWP with data logger installed in standpipe.
	P92 – 25	5500806.7	577125.8	1022.9	N/A	999.0	28+00	Pneumatic	Monthly	1032.0	1030.0 (25 April 2018)	↑	
	P92 – 26	5500550.3	576802.5		1019.8	1009.1	16+00	Standpipe	Three times a year (spring, summer and fall)	1015.0	1014.4 (25 April 2018)	↓	
	P5	5501660.5	577228.4	1039.1	1041.6	1037.4	Siliceous Cell #1	Standpipe	Annually	1039.5	1039.0 (3 August 2018)	↔	

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m., 2. 2018 reporting period runs from October 1, 2017 to August 31, 2018

Table AIII.3 Active Piezometers – Old Iron TSF

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Threshold Level	Max Measured Piezometer Level In 2018[1]	Max 2018 Level Relative To 2017	Comment
Old Iron TSF													
Old Iron Dike	P93 – 17	5500680.3	575451.9	1043.0	1043.0	1025.8	Dike	Standpipe	Three times a year (spring, summer and fall)	1037.3	1037.8 (20 April 2018)	↑	Max. 2018 reading above trigger level. Recent reading is below trigger level
	P93 – 18	5500701.7	575475.6	1044.4	1044.7	1028.3	Dike	Standpipe		1039.0	1039.3 (20 April 2018)	↑	Max. 2018 reading above trigger level. Recent reading is below trigger level.
	P96 – 08				N/A	Unknown	MCE Buttress	Pneumatic		2.6[2]	-	-	Replaced.
	~~P96 – 02~~	~~Not available~~	~~Not available~~	~~Not available~~	~~Not available~~	~~Not available~~	~~MCE Buttress~~	~~Pneumatic~~		~~3.6~~	-	-	Destroyed.
	~~P96 – 11~~	~~Not available~~	~~Not available~~	~~Not available~~	~~Not available~~	~~Not available~~	~~MCE Buttress~~	~~Pneumatic~~		~~1.5~~	-	-	Slow leak, erratic data, replaced.
	P96 – 12				N/A	Unknown	MCE Buttress	Pneumatic		0.9[2]	0.8 m (10 October 2017)	↑	
	SUL-OID-VWP-18-01 A&B	5500688.4	575449.2	1043.4	Tip A:	1025.8	MCE Buttress	VWP	Remotely monitored (hourly readings). Review data monthly.	Pending review	No reading to date	N/A	August 2018 install, replaced P96-08
					Tip B:	1036.5		VWP		Pending review	No reading to date	N/A	
	SUL-OID-VWP-18-02 A&B	5500633.2	575431.2	1040.1	Tip A:	1016.6	MCE Buttress	VWP		Pending review	No reading to date	N/A	August 2018 install, replaced P96-11
					Tip B:	1035.5		VWP		Pending review	No reading to date	N/A	
Iron TSF Divider Dike	P93 – 19	5500962.3	575892.0	1042.6	1043.6	1025.6	Dike	Standpipe	Annual	1040.15	1039.9 (3 August 2018)	↑	Dike is fully buttressed. P93-19 (near trigger level) and P93-20 are read to provide U/S info for Old Iron Dike.
	P93 – 20	5501191.4	575943.2	1044.1	1045.3	1026.4	Dike	Standpipe		1041.25	1040.9 (3 August 2018)	↑	

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m., 2. 2018 reporting period runs from October 1, 2017 to August 31, 2018.
2. Installation elevation not known.

Table AIII.3 Active Piezometers – Siliceous TSF

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing (m)	General Location	Instrument Type	Recommended Reading Frequency	Threshold Level	Max Measured Piezometer Level In 2018[1]	Max 2018 Level Relative To 2017	Comment
Siliceous Dikes													
West Side Siliceous Dike #1	P5	5501660.5	577228.4	1039.1	1041.6	1037.4	Cell #1	Standpipe	P105 and P5 annually unless change >0.5 m or at trigger levels then read all Piezometers	1039.5	1039.0 (3 August 2018)	↔	
	SP101	5501176.3	577719.3	1035.4	1036.4	1021.6	Cell #1	Standpipe		1023.9	1021.7 (3 August 2018)	↔	
Middle Siliceous Dike #1	P105	5501220.6	577927.9	1033.0	1033.2	1021.3	Cell #1	Standpipe		1022.0	1022.1 (3 August 2018)	↔	Max. 2018 reading above trigger level
	SP104	5501248.9	577910.8	1035.4	1035.1	1021.1	Cell #1	Standpipe		1022.0	1021.2 (3 August 2018)	↔	
East Side Siliceous Dike #1	SP106	5501410.5	578028.7	1034.1	1034.7	1020.9	Cell #1	Standpipe		1021.4	1021.1 (3 August 2018)	↓	Near Trigger level
Crest Siliceous Dike #2	P231	5500962.2	577497.5	1031.2	1031.2	1019.5	Cell #2	Standpipe	Annual	1022.3	1021.2 (3 August 2018)	↑	
	P257	5500971.0	577407.3	1031.3	1030.4	1022.0	Cell #2	Standpipe		1025.0	1023.4 (3 August 2018)	↑	
	P91 – 13	5500964.5	577413.7	1029.7	N/A	1020.0	Toe	Pneumatic	Three times a year (spring, summer and fall)	1025.0	1022.7 (10 October 2017)	↔	Near Trigger level (within fluctuation range)
Lines 3+00/7+00 Siliceous Dike #3	P303	5500977.6	577855.0	1029.1	1029.3	1020.9	7+00 Crest	Standpipe	P232, P301 and P303 annually unless change >0.5 m then read all Piezometers	1022.3	1020.9 (3 August 2018)	↔	Dry
	P301	5500976.3	577751.6	1028.1	1029.4	1020.6	3+00 Crest	Standpipe		1022.3	1020.6 (3 August 2018)	↓	Dry
	P302	5500945.8	577751.8	1025.7	1027.2	1021.0	3+00 Slope	Standpipe		1021.2	1021.0 (6 November 2017)	↔	Dry
	P232	5500968.5	577854.3	1026.7	1027.3	1017.4	7+00 Slope	Standpipe		1019.3	1018.0 (3 August 2018)	↔	
	P233	5500919.8	577876.4	1023.6	1024.3	1017.9	7+00 Slope	Standpipe		1019.3	1017.9 (3 August 2018)	↔	
	SUL-SD3-VWP-18-06 A&B	5500975.7	577751.2	1029.2	Tip A:	1008.8	3+00 Crest	VWP	Remotely monitored (hourly readings). Review data monthly.	Pending review	No reading to date	N/A	August 2018 install, replaced P301
					Tip B:	1018.5		VWP		Pending review	No reading to date	N/A	
	SUL-SD3-VWP-18-07	5500920.1	577753.0	1017.1	Tip A:	1006.1	3+00 Toe	VWP		Pending review	No reading to date	N/A	August 2018 install, replaced P302
	SUL-SD3-VWP-18-08 A&B	5500985.8	577874.7	1029.6	Tip A:	1009.6	7+00 Crest	VWP		Pending review	No reading to date	N/A	August 2018 install, replaced P303
					Tip B:	1017.3		VWP		Pending review	No reading to date	N/A	
	SUL-SD3-VWP-18-09	5500919.4	577852.5	1016.8	Tip A:	1013.4	7+00 Toe	VWP		Pending review	No reading to date	N/A	August 2018 install
Siliceous Dike #3	SUL-SD3-P-18-10	5501022.5	578270.0	1018.1	1019.4	1004.8	Toe	Standpipe	Monthly	Pending review	No reading to date	N/A	August 2018 install
	SUL-SD3-P-18-11	5501452.7	578349.6	1022.1	1023.5	1013.1	Toe	Standpipe		Pending review	No reading to date	N/A	August 2018 install

Notes:

1. No settlement plate or other instruments are required for long term monitoring of the Siliceous TSF Dikes.
2. Water levels are considered equal if differences are smaller than 0.1 m.
3. 2018 reporting period runs from October 1, 2017 to August 31, 2018

Table AIII.3 Active Piezometers – Gypsum TSF

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing Elevation (m)	General Location	Instrument Type	Recommended Reading Frequency	Threshold Level	Max Measured Piezometer Level In 2018[1]	Max 2018 Level Relative To 2017	Comment
Gypsum TSF													
West Gypsum Dike Line 10+00	P93 – 1	5499811.6	576419.4	1013.8	1014.9	1000.0	Upstream	Standpipe	Three times a year (spring, summer and fall)	1008.0	1004.7 (10 October 2017)	↔	
	P93 – 2	5499811.0	576420.9	1014.4	1014.4	996.8	Upstream	Standpipe		1008.0	1004.5 (10 October 2017)	↓	
	P93 – 3	5499789.6	576411.6	1017.5	1016.1	998.0	Crest	Standpipe		1008.0	1004.6 (10 October 2017)	↑	
	P93 – 4	5499790.2	576409.5	1017.5	1016.4	995.4	Crest	Standpipe		1008.0	1005.4 (10 October 2017)	↑	
	P93 – 5	5499751.1	576388.7	1011.1	1011.9	993.3	Downstream	Standpipe		1008.0	995.4 (3 August 2018)	↑	
West Gypsum Dike Line 20+00	~~P93 – 6~~	~~5499691.8~~	~~576696.5~~	~~1014.4~~	~~1014.9~~	~~997.9~~	~~Upstream~~	~~Standpipe~~	Three times a year (spring, summer and fall)	~~1008.0~~	-	-	Standpipe blocked at ~ 10.4 m
	P93 – 7	5499670.8	576688.2	1015.3	1016.6	997.2	Crest	Standpipe		1008.0	999.2 (10 October 2017)	↑	
	SUL-WG-P-18-03	5499599.9	576662.0	1001.5	1002.9	984.5	Toe	Standpipe	Monthly	Pending review	No reading to date	N/A	August 2018 install
East Gypsum Dike Line 33+00	P93 – 8	5499642.3	577074.1	1017.2	1017.7	1001.9	Upstream	Standpipe	Annual	1010.1	1009.0 (3 August 2018)	↔	
	P93 – 9	5499642.6	577072.6	1017.2	1017.8	998.9	Upstream	Standpipe		1010.1	1009.3 (24 April 2018)	↑	
	P93 – 10	5499640.6	580423.8	1017.5	1018.0	1002.6	Crest	Standpipe		1009.5	1008.1 (3 August 2018)	↑	
	P93 – 11	5499622.5	577071.1	1017.5	1018.0	998.7	Crest	Standpipe		1008.6	1007.2 (3 August 2018)	↔	No reading available for 2017
	P93 – 12	5499583.8	577073.5	1013.5	1013.0	1000.8	Toe	Standpipe		1004.7	1004.0 (3 August 2018)	↓	
	SUL-EG-P-18-04	5499537.0	577196.9	1004.6	1005.9	998.1	Toe	Standpipe	Monthly	Pending review	No reading to date	N/A	August 2018 install
East Gypsum Dike Line 48+00	P93 – 13	5499669.6	577521.5	1016.8	1017.6	1000.3	Upstream	Standpipe	Annual	1002.5	1000.7 (3 August 2018)	↔	
	P93 – 14	5499645.3	577521.9	1017.2	1017.7	1004.3	Crest	Standpipe		1005.6	1004.3 (3 August 2018)	↔	Dry, blocked at 13.3 m
	SUL-EG-P-18-05	5499566.3	577527.0	1003.1	1004.5	995.8	Toe	Standpipe	Monthly	Pending review	No reading to date	N/A	August 2018 install

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m.
2. 2018 reporting period runs from October 1, 2017 to August 31, 2018

Table AIII.3 Active Piezometers – ARD Storage Pond

Group Designation	Piezometer No.	Northing	Easting	Ground Elevation (m)	Top of Casing Elevation (m)	Tip/Bottom of Casing Elevation (m)	General Location	Instrument Type	Recommended Reading Frequency	Threshold Level	Max Measured Piezometer Level In 2018[1]	Max 2018 Level Relative To 2017	Comment
ARD Storage Pond													
North Dam	PP01-01	5500675.6	575840.0	N/A	N/A	1041.7	North Dam	Pneumatic	Monthly, with additional readings taken weekly when the Pond level is above 1040 masl, or daily when the Pond level is above 1045 masl. The pneumatic piezometers are to be read monthly.	1042.7	1041.72 (3 August 2018)	↔	
	PP01-02	5500682.7	575834.9	N/A	N/A	1041.9	North Dam	Pneumatic		1042.7	1042.2 (20 April 2018)	↓	
	PP01-03	5500552.0	575738.1	N/A	N/A	1038.8	North Dam	Pneumatic		1039.8	1038.82 (3 August 2018)	↔	
	PP01-04	5500549.5	575743.1	N/A	N/A	1040.8	North Dam	Pneumatic		1041.8	1041.3 (20 April 2018)	↑	
	ND-01	5500756.6	575907.3	1042.2	1042.7	1032.0	North Abutment	Standpipe		1042.2	1041.0 (20 April 2018)	↔	
	ND-02D	5500636.4	575769.0	1042.2	1042.7	1019.5	Toe	Standpipe		1041.5	1040.1 (27 April 2018)	↑	
	ND-02S	5500636.3	575768.9	1042.2	1042.7	1040.3	Toe	Standpipe		1041.5	1041.5 (28 March 2018)	↓	Max. 2018 reading at trigger level. Recent readings lower than trigger.
	ND-03	5500542.8	575693.1	1038.4	1039.2	1025.1	Toe	Standpipe		1039.2	1038.9 (20 April 2018)	↔	
South Dam	PP01-05	5500026.7	575892.8	N/A	N/A	1030.0	South Dam	Pneumatic		1031.0	1030.8 (30 May 2018)	↑	
	PP01-06	5500020.4	575893.4	N/A	N/A	1029.2	South Dam	Pneumatic		1030.5	1030.8 (20 April 2018)	↑	Max. 2018 reading above trigger level. Recent reading lower than trigger.
	SD-01	5500056.6	576006.3	1041.0	1041.6	1029.6	South Abutment	Standpipe		1041.0	1036.6 (13 April 2018)	↑	
	SD-02	5499985.4	575904.0	1029.9	1030.5	1026.9	Toe	Standpipe		1029.9	1029.9 (20 April 2018)	↔	Max. 2018 reading at trigger level. Recent readings lower than trigger.
	SD-03	5499995.4	575737.2	1037.0	1038.1	1036.0	South Abutment	Standpipe		1037.0	1037.1 (23 March 2018)	↔	Max. 2018 reading above trigger level. Recent readings lower than trigger.

Notes:

1. Water levels are considered equal if differences are smaller than 0.1 m.
2. 2018 reporting period runs from October 1, 2017 to August 31, 2018.

Table AIII.4 Active Settlement and Inclinometer Measuring Instruments

Type	Instrument Number	Initial Elevation (m)	Location	Threshold Level	Recommended Reading Frequency	Measured Level in 2018 (m)	Comment
Iron Dike							
Settlement plates	SP330[1]	1037.40	2+00	>25 mm over 3 years	Every 3 Years	1040.644	Less than 40 mm of settlement since 2007
	SP331[1]	1042.44	9+00			1041.400	Less than 65 mm of settlement since 2007
	SP332[2]	1041.79	9+00			1041.942	Less than 45 mm of settlement since 2007
	SP 92 – 07	1034.91	16+00			1034.851	Less than 35 mm of settlement since 2007
	SP 99 – 01[3]	1042.07	4+00			1041.107	Less than 45 mm of settlement since 2007
Inclinometer	~~BI91 – 02~~			~~N/A~~	~~Inactive~~	~~N/A~~	Casing damaged. Do not replace unless indications of dike movement observed.
Dike Crest Survey	-	-	0+00 to 12+00 centerline, U/S, D/S dike crest	1042 m	Annually	1042	Recent survey shows elevations greater than or equal to design crest elevation.
Gypsum TSF Dikes							
Settlement plates at West Gypsum Dike	SP97 – 01	1014.592	Line 10+00 Slope	>60 mm over 3 years	Annually	1014.317	Settled 0 mm since 2017
	SP97 – 05	1015.568	Line 10+00 Crest			1014.599	Settled 23 mm since 2017
	SP97 – 06	1015.936	Line 20+00 Slope			1015.339	Settled 22 mm since 2017
Sondex gauge and Inclinometer at West Gypsum Dike	S94 – 01	N/A	Line10+00 Upstream	>90 mm over 3 years	Every 3 Years	N/A	Reading taken in 2016. Cumulative change since 1994 of 1.577, incremental change since 2012 of 0.12. Next reading scheduled for 2019.
	~~BI94-01~~	~~N/A~~	~~Line10+00 Upstream~~	~~N/A~~	~~Inactive~~	~~N/A~~	Inclinometer blocked since 2006 (last read in 2004). Do not replace unless other instruments indicate signs of movement.
Settlement plates at East Gypsum Dike	SP97 – 03	1017.676	Line 33+00	>60 mm over 3 years	Annually	1017.060	Settled 17 mm since 2017
	SP97 – 04	1017.457	Line 48+00		Annually	1016.924	Settled 28 mm since 2017
Sondex gauge and Inclinometer at East Gypsum Dike	S94 – 02	N/A	Line 33+00 Upstream	>60 mm over 3 years	Every 3 Years	N/A	Reading taken in 2016. Cumulative change since 1994 of 0.937, incremental change since 2012 of 0.08. Next reading scheduled for 2019.
	BI94 – 02	N/A	Line 33+00 Upstream	>25 mm horizontal movement over 3 years	Every 3 Years	N/A	<5 mm movement parallel to dike and no change perpendicular to dike.
Settlement plates at N.E. Gypsum Dike	SW (S1)	1019.264	Main Dike	>5 mm over 3 years	Every 3 Years	1019.276	Less than 2 mm of settlement since 2007
	SE (S2)	1019.073	Main Dike		Every 3 Years	1019.097	Essentially 0 mm of settlement since 2007
ARD Storage Pond							
Settlement Plates	SP01-01	1048.009	North Dam	>25 mm over 3 years	Every 3 Years	1048.013	Less than 7 mm of settlement since 2001
	SP01-02	1048.224	North Dam			1048.222	Less than 15 mm of settlement since 2001
	SP01-03	1048.113	North Dam			1048.105	Less than 19 mm of settlement since 2001
	SP01-04	1048.311	South Dam			1048.315	Less than 8 mm of settlement since 2001
	SP01-05	1048.310	South Dam			1048.326	Essentially 0 mm of settlement since 2001
	SP01-06	1048.351	South Dam			1048.351	Less than 9 mm of settlement since 2001
Sludge Impoundment Dikes							
Dike Crest Survey	-	-	North Dike centerline, U/S, D/S dike crest	894.6	Annually	894.6	Recent survey shows elevations greater than or equal to design crest elevation.
			South Dike centerline, U/S, D/S dike crest	894.6	Annually	894.6	Recent survey shows elevations greater than or equal to design crest elevation. Exception: southern most portion of the South Dike crest is currently below design elevation by approximately 0.5 m due to access ramp.

Notes: (1) SP330 and 331 lowered in 2006. (2) SP332 raised in 2004. (3) SP99-01 lowered in 2006.

Table AIII.5 Active Seepage Measurements October 1, 2017 – August 31, 2018

Structure/ Weir	**Min. Current Reading Frequency**	**Threshold Level**	**Weir Readings and Observations – October 1, 2017 to August 31, 2018**																					
			October		November		December		January		February		March		April		May		June		July		August	
			Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow	Min. flow	Max. flow
			m^3/day	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**	**m^3/day**
ARD Pond/Weir #1 (ARDWU)	Weekly with daily readings between March 1 and May 30. Daily readings when the pond level is > 1045 m. Read for 3 days following rainfall event >10 mm.	150 m^3/day	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Flow under weir	Flow under weir	23.1	Flow under weir	145.3	36.4	128.8	13.3	128.8	23.1	53.3	Dry	23.1	Dry	Dry
ARD Pond/Weir #2		175 m^3/day	Dry	Dry	Dry	23.1	Dry [3]	13.4	2.5 [3]	17.9	0.5	36.2	0.5	85.1	2.5	241.2	6.6	73.3	13.4	97.9	Dry	13.4	Dry	Dry
AIP[1] Dike/Weir #3 (AIPWU)	Weekly with daily readings between March 1 and May 30. Read for 3 days following rainfall event >10 mm.	50 m^3/day	2.3	22.4	2.3 [3]	9.2	2.3 [3]	35.3	2.3	12.9	0.1 [3]	22.4	2.3 [3]	71.9	22.4	124.8	9.2	51.7	4.0	22.4	2.3	6.3	2.3	22.4
AIP[1] Dike/Weir #4		500 m^3/day	4.4	53.1	2.6	62.7	0.0 [3]	29.6	0.0 [3]	13.7	Flow under weir [3]	53.1	Flow under weir [3]	338.4	13.7	1084.3	36.6	238.4	18.2	125.8	4.4	36.6	1.3	13.7
West Gypsum Cell/Toe of Gravel Buttress at Cow Creek (STA. 11+00)	Visual Reading Annually	Cloudy flow	Flow is clear (observed as part of May 2018 site visit)																					
East Gypsum Cell/Toe of Dike Adjacent to James Creek	Visual Reading Annually	Cloudy flow	Flow is clear (observed as part of May 2018 site visit)																					

Notes:

1. AIP = Iron Pond
2. N/A – Flow could not be measured as it was by-passing weir.
3. One or several readings were reported as "frozen"

Table AIII.6 Active Pond Water Level Monitoring Locations

Type	Description	Location	Primary Purpose	Reading Frequency	Threshold Level 1	Threshold Level 2	Threshold Level 3	General Water Level Information (m)
Iron Pond Water Level	Electronic readout unit.	Iron Dike Pump Station	Overtopping	Daily	1038.5 (Pump to ARD Pond)	1038.9 (As for Level 1 and notify EOR, minimize inflows, consider pumping to DWTP)	1040.5 (As for Level 2 and notify MEMPR/MOE, enact EPRP)	1036.5 (Measured low water) 1038.8 (Measured high water) 1041.0[1] (Spillway invert) 1042.0 (Top of dike)
Pond Water Level	Electronic readout unit with pressure transducer in bottom of wet well at el. 1034 m.	Pump wet well, data transmitted to DWT control room through the PLC system	Dam Stability	Daily	1045.5 (Pump to DWTP)	1046.5 (As for Level 1 and notify EOR, minimize inflows (e.g. divert 3700/3900 to Iron Pond))	1046.9 (As for Level 2 and notify MEMPR/MOE, enact EPRP)	1034.7 (Measured low water) 1044.6 (Measured high water) 1046.5 9 Maximum operating level) 1047.4 (Spillway invert) 1048.0 (Top of dam)

Notes:

1. The surveyed as-constructed invert elevations for the Iron Pond/Emergency Spillway varied from 1040.8 m to 1041.4 m, with the design elevation being 1041.0 m.

Precipitation Data Summary 2008 - 2018

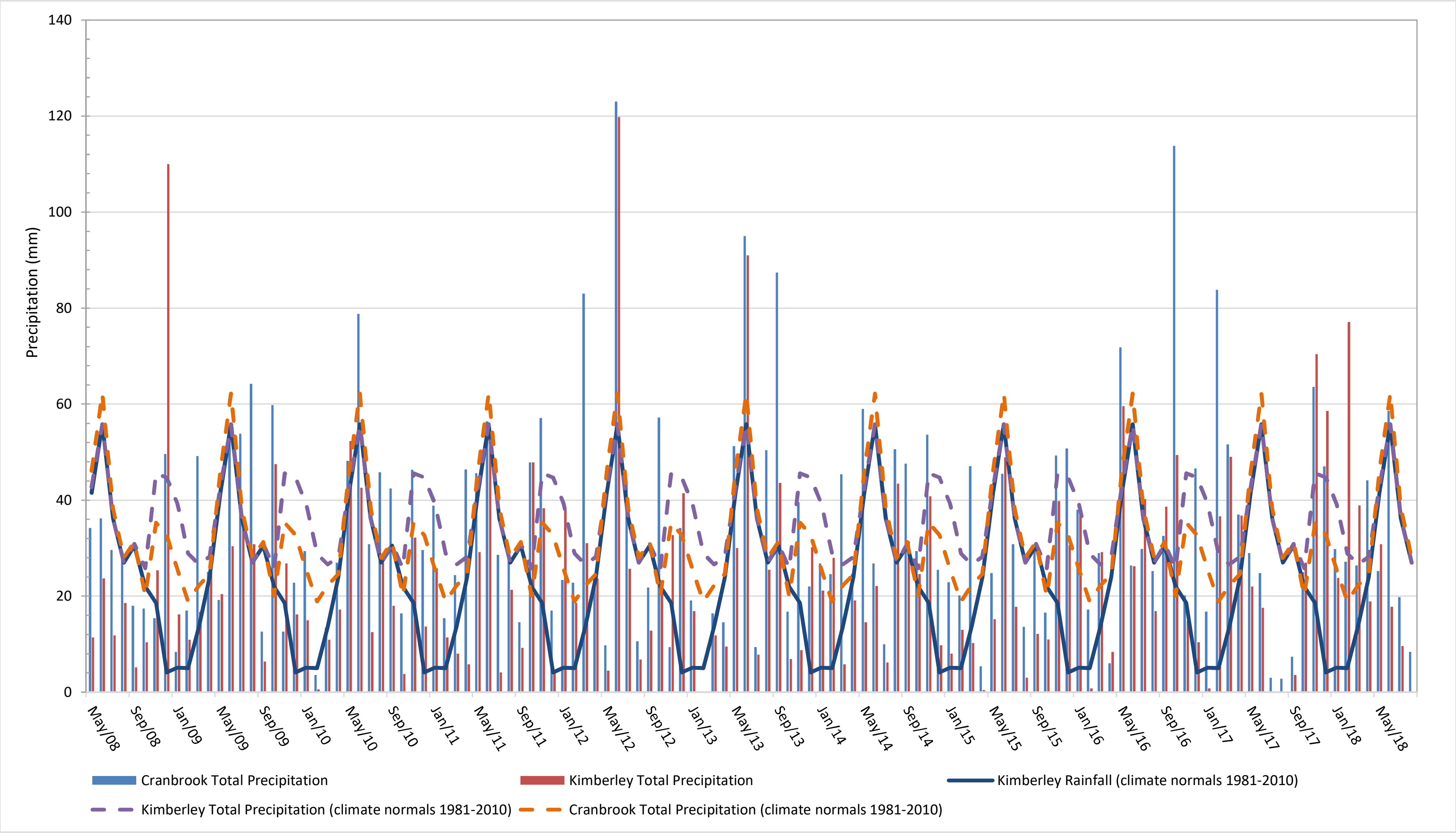
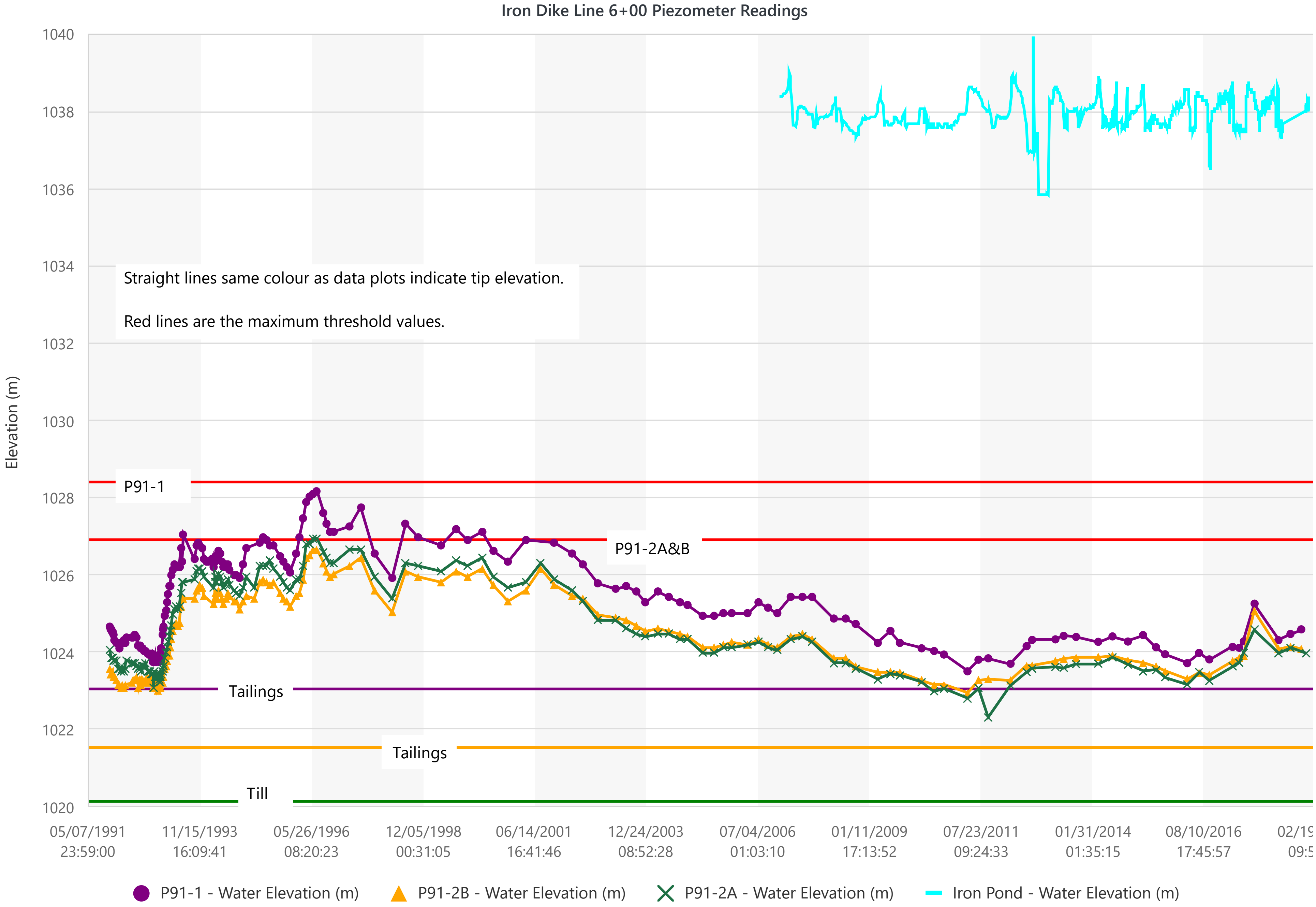


Figure AIII-1

APPENDIX IV

Iron Dike Instrumentation Data

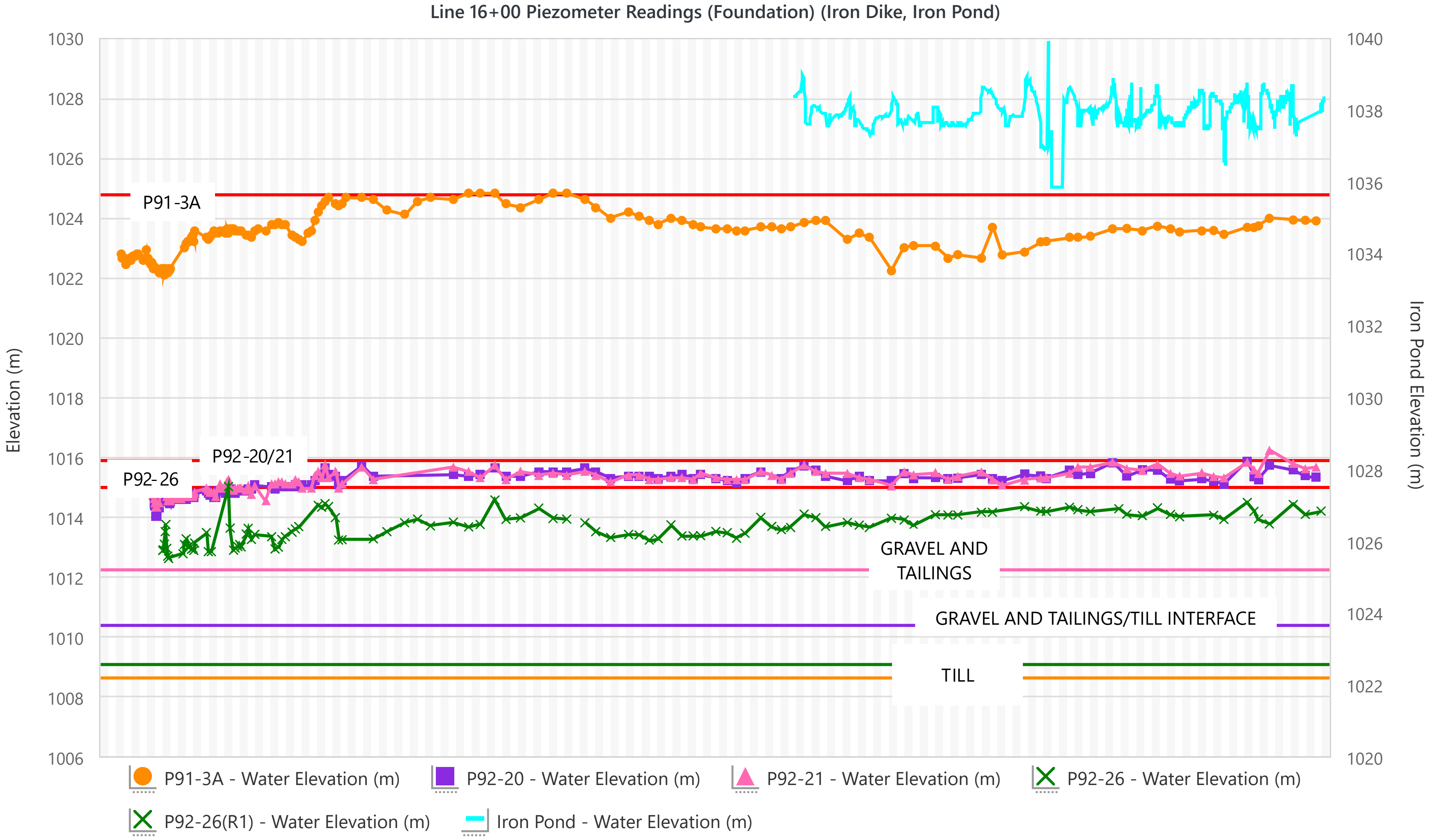


Iron Dike Line 6+00 Piezometer Readings

Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Figure IV-1 STN 6+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure IV-2 STN 16+00 Foundation

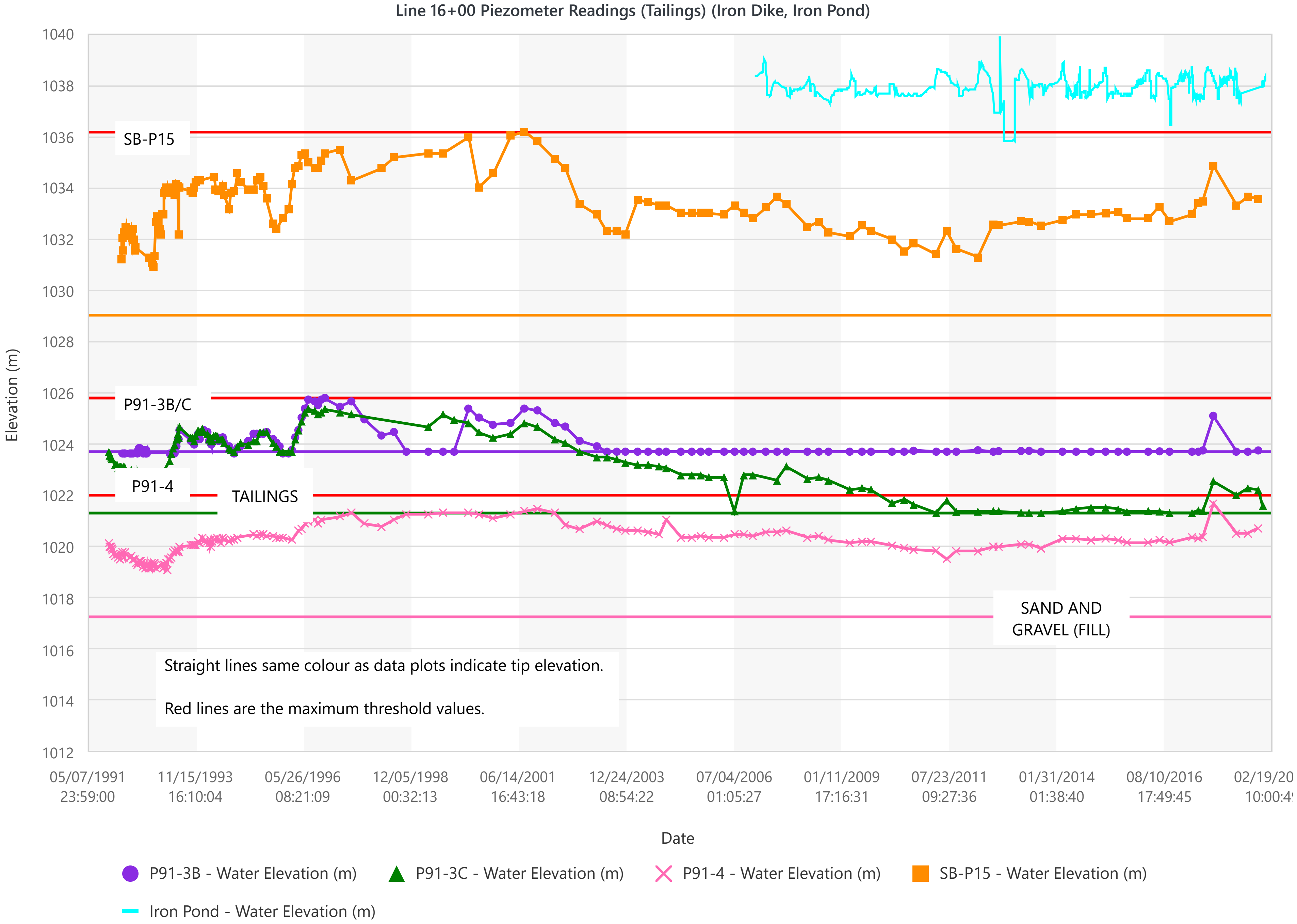


Figure IV-3 STN 16+00 Tailings

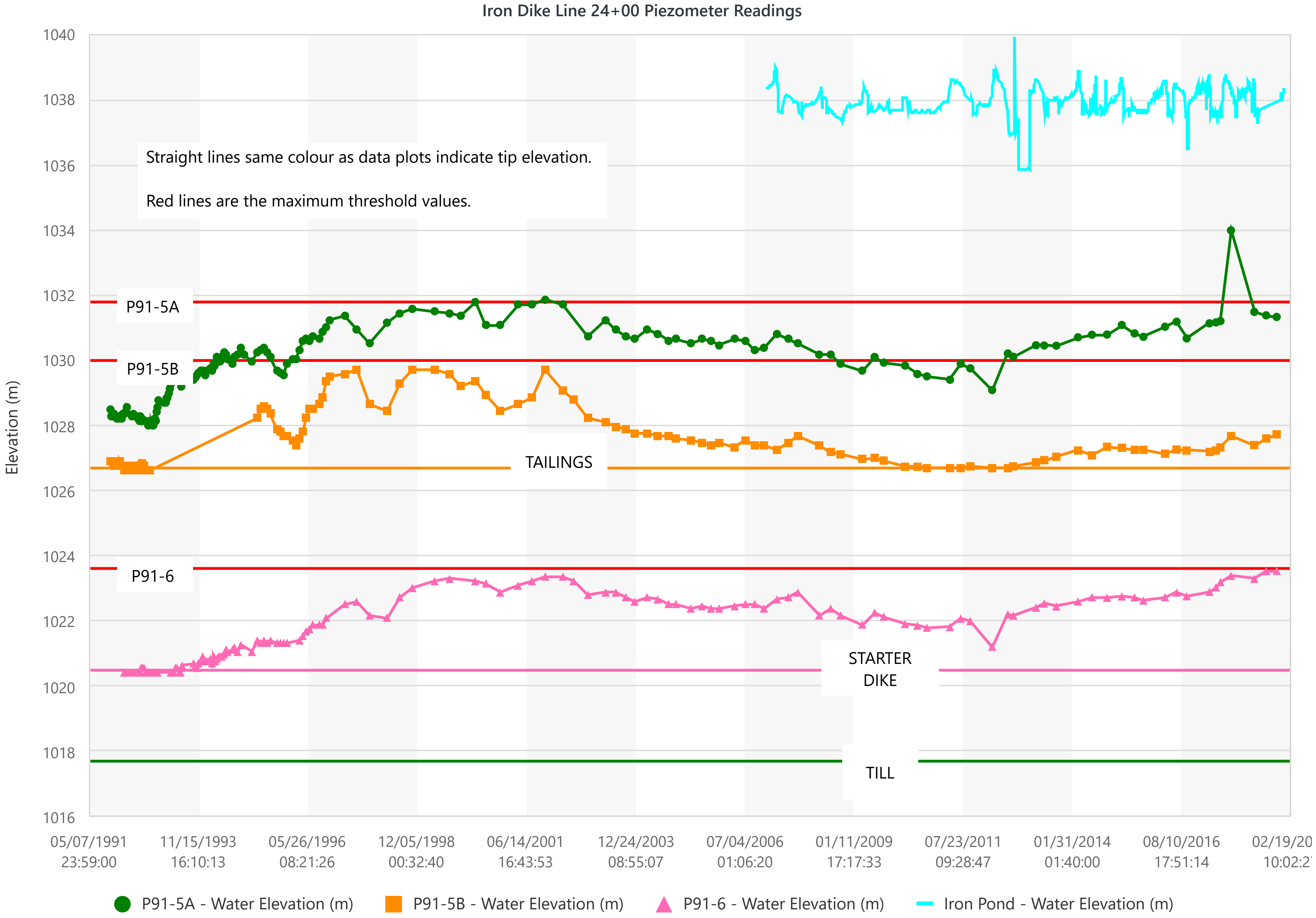


Figure IV-4 STN 24+00

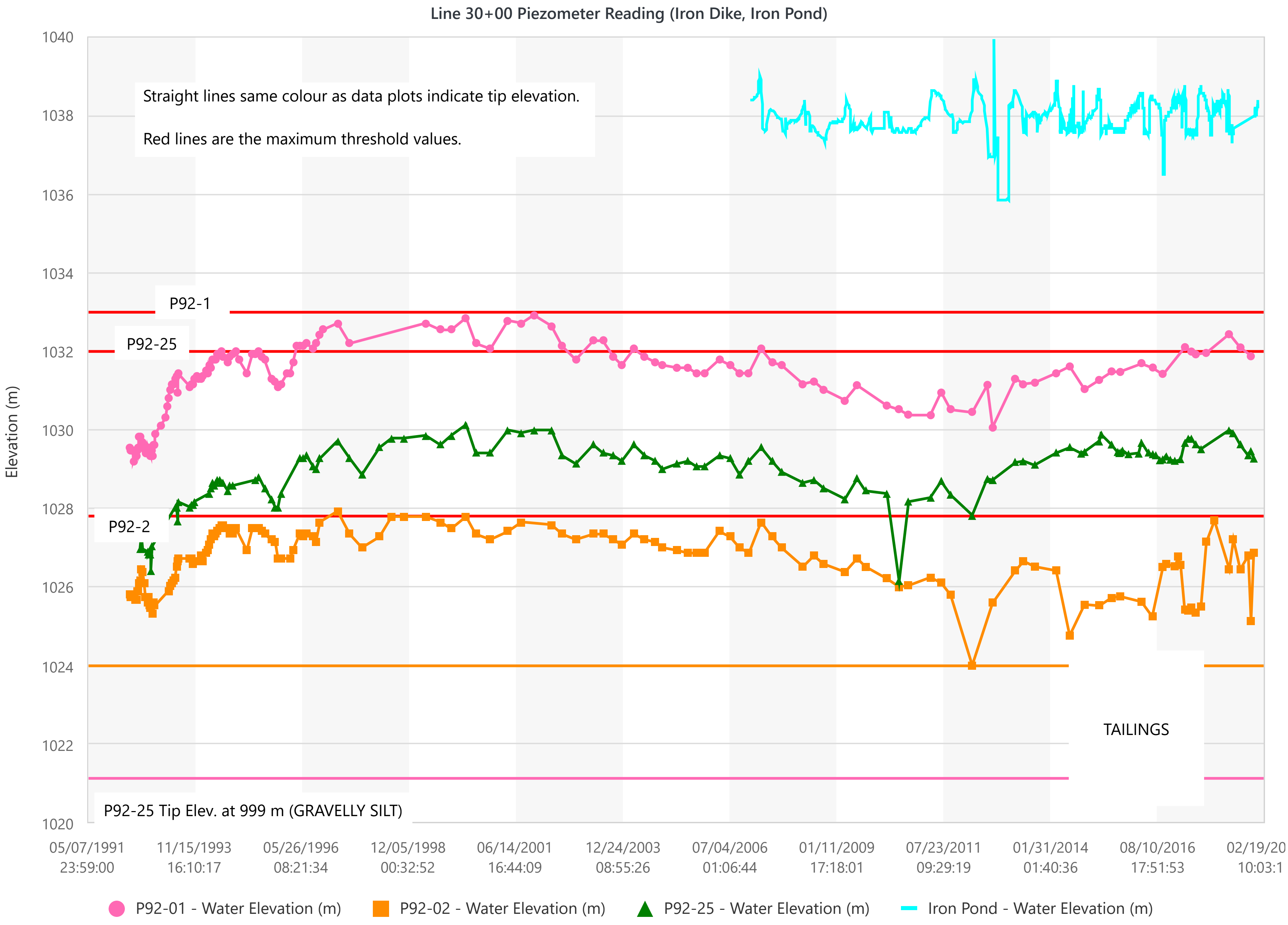


Figure IV-5 STN 30+00

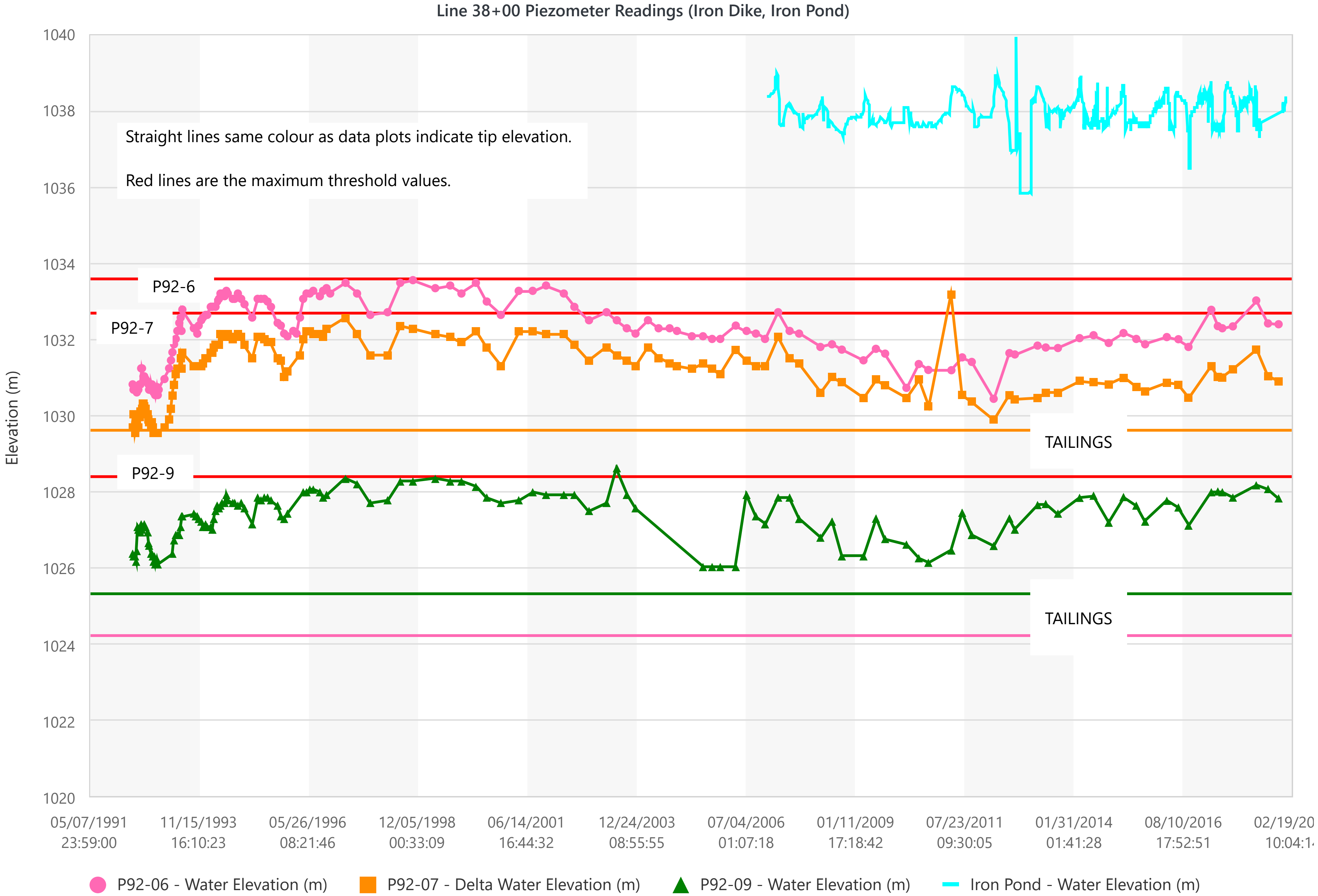


Figure IV-6 STN 38+00

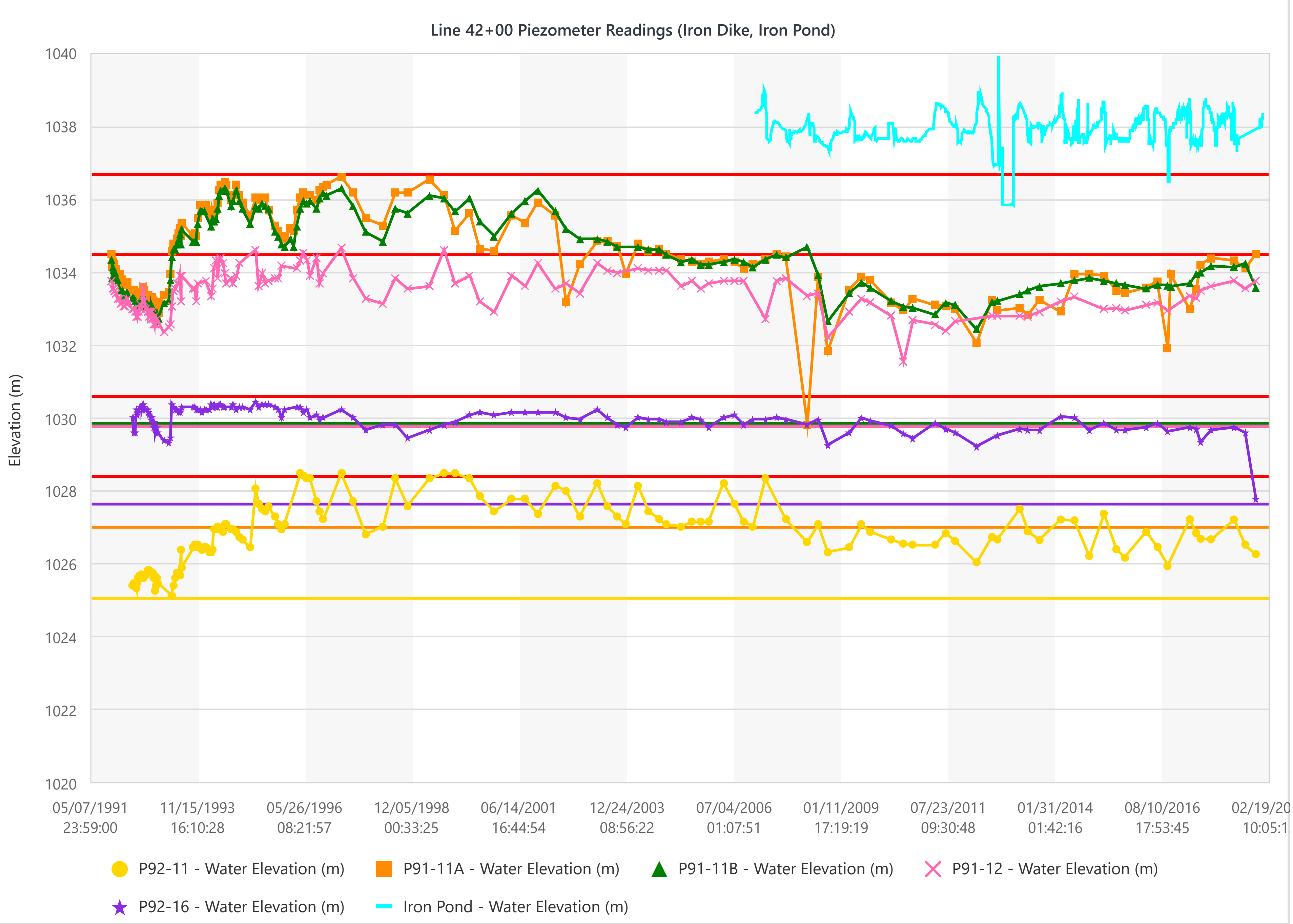
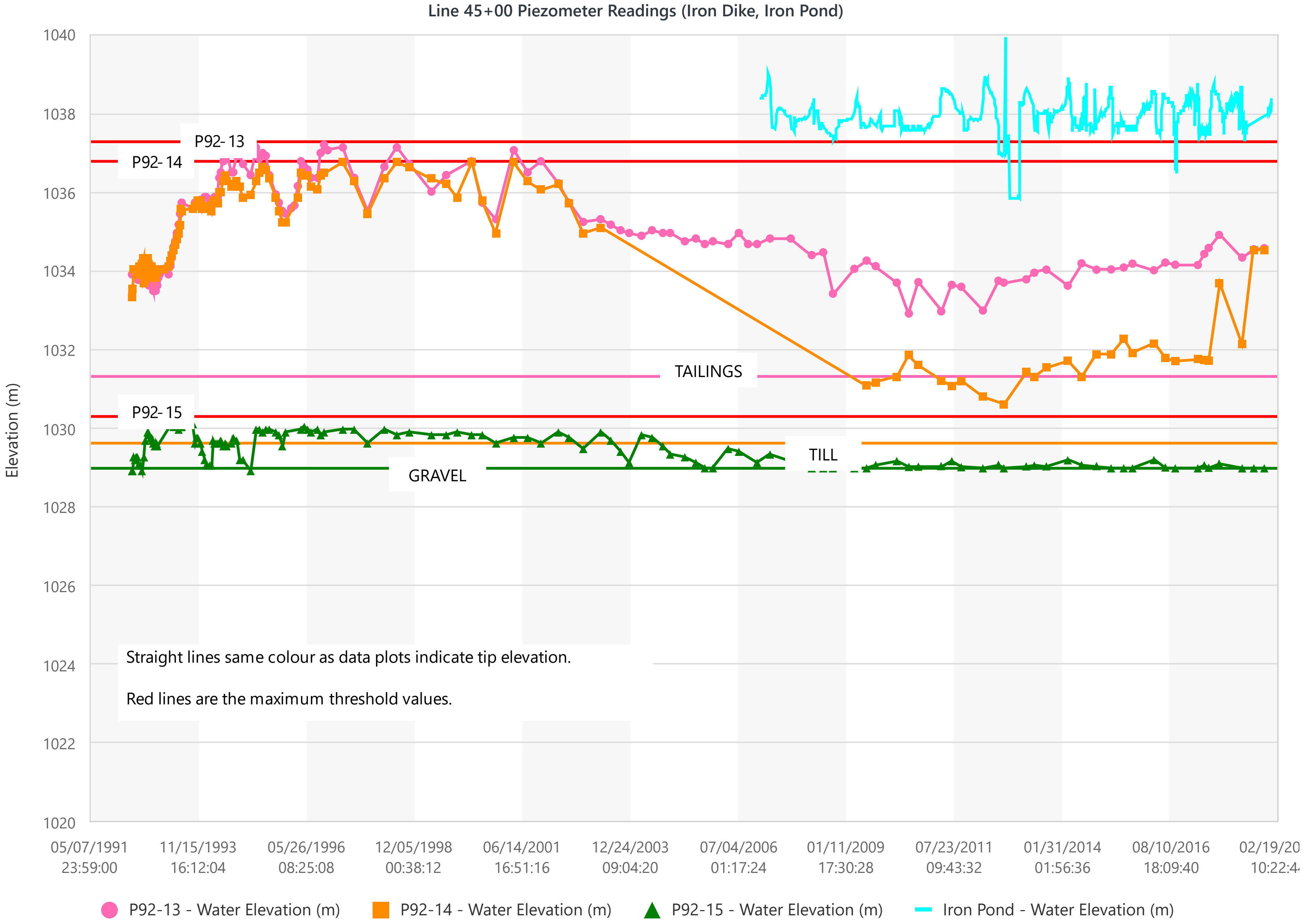


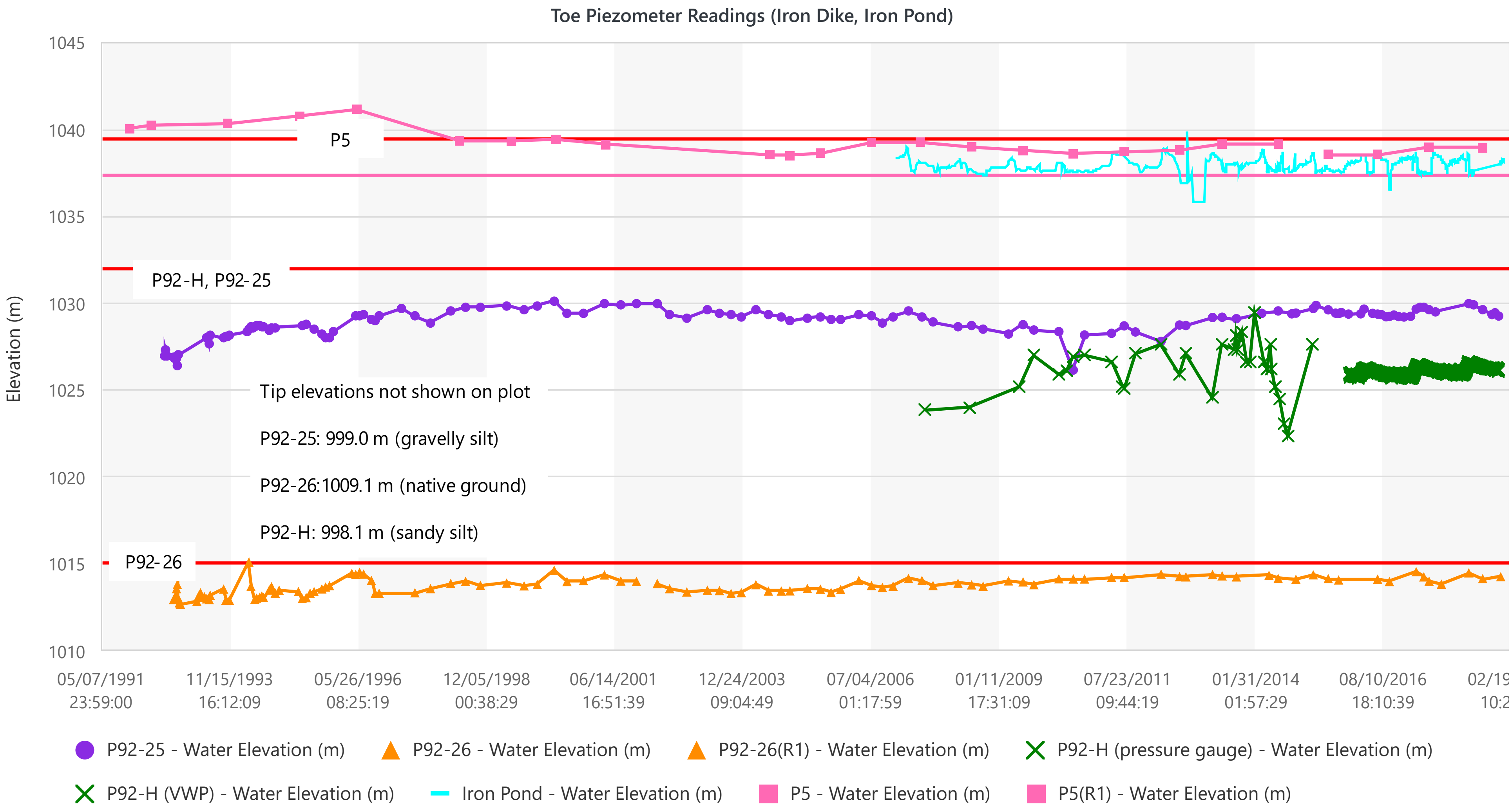
Figure IV-7 STN 42+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Figure IV-8 STN 45+00



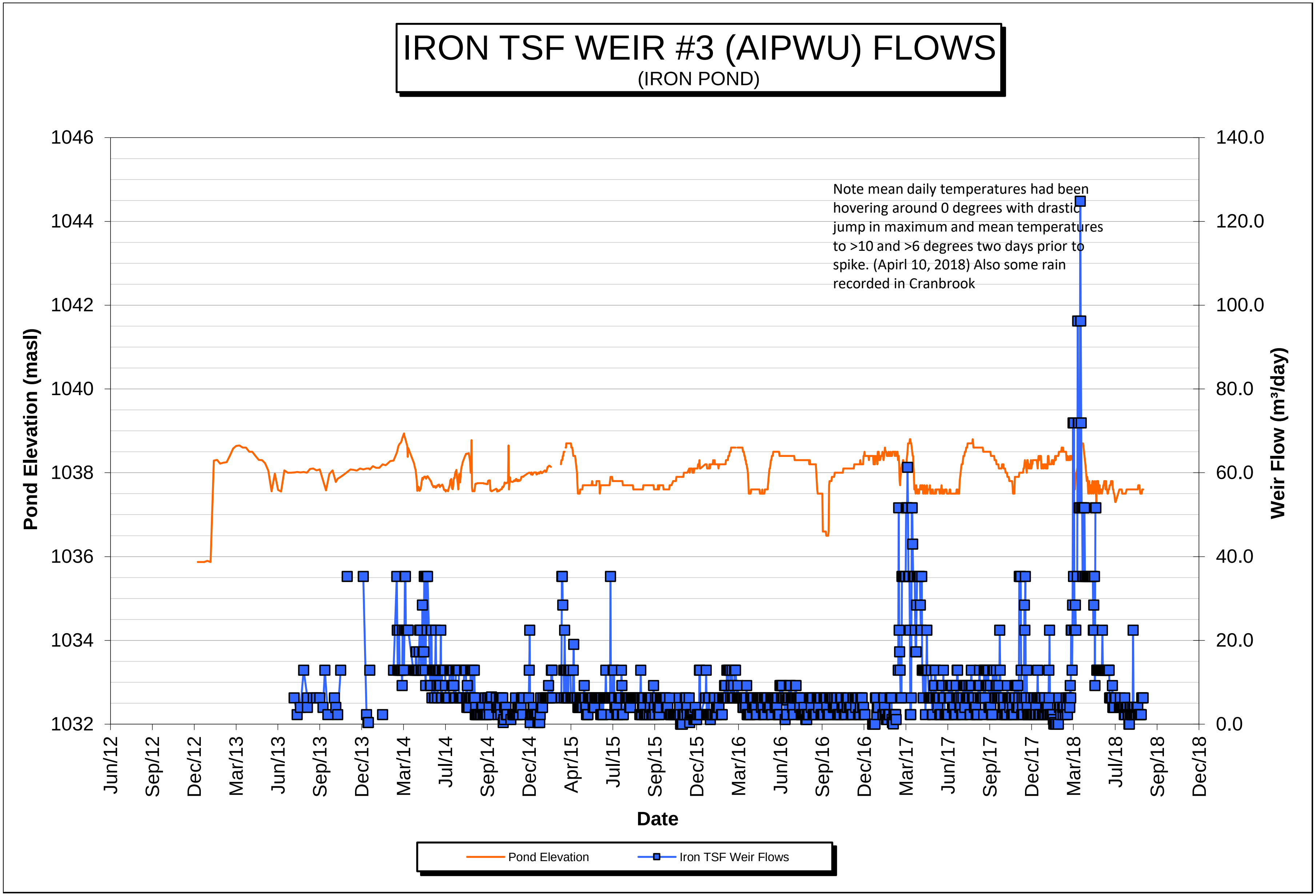
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

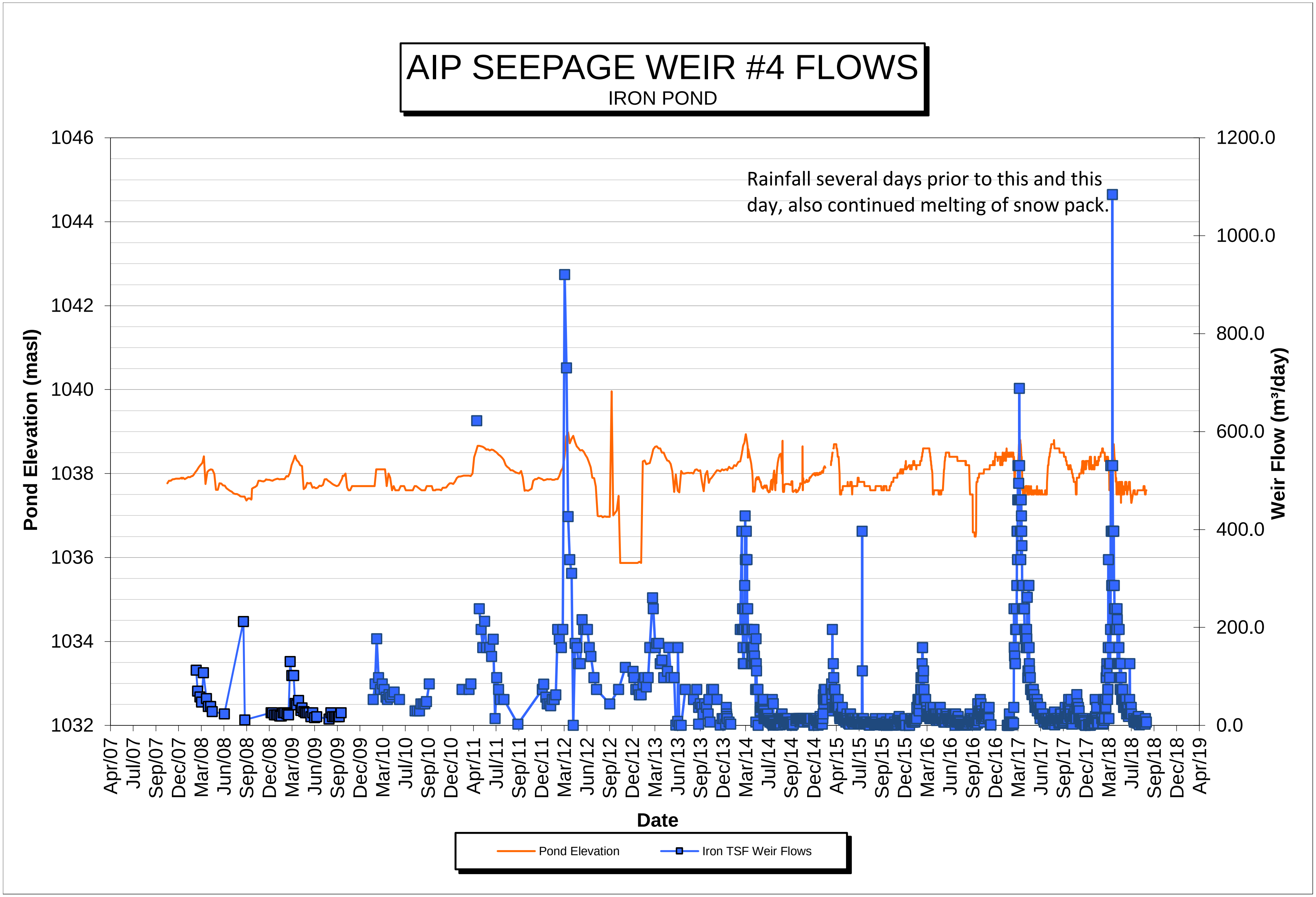
SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure IV-9 Toe Piezometers



Note mean daily temperatures had been hovering around 0 degrees with drastic jump in maximum and mean temperatures to >10 and >6 degrees two days prior to spike. (Apirl 10, 2018) Also some rain recorded in Cranbrook

Figure II-10 Weir #3 - AIP (AIPWU) time plot



Rainfall several days prior to this and this day, also continued melting of snow pack.

Figure II-11 Weir #4 - AIP_time plot

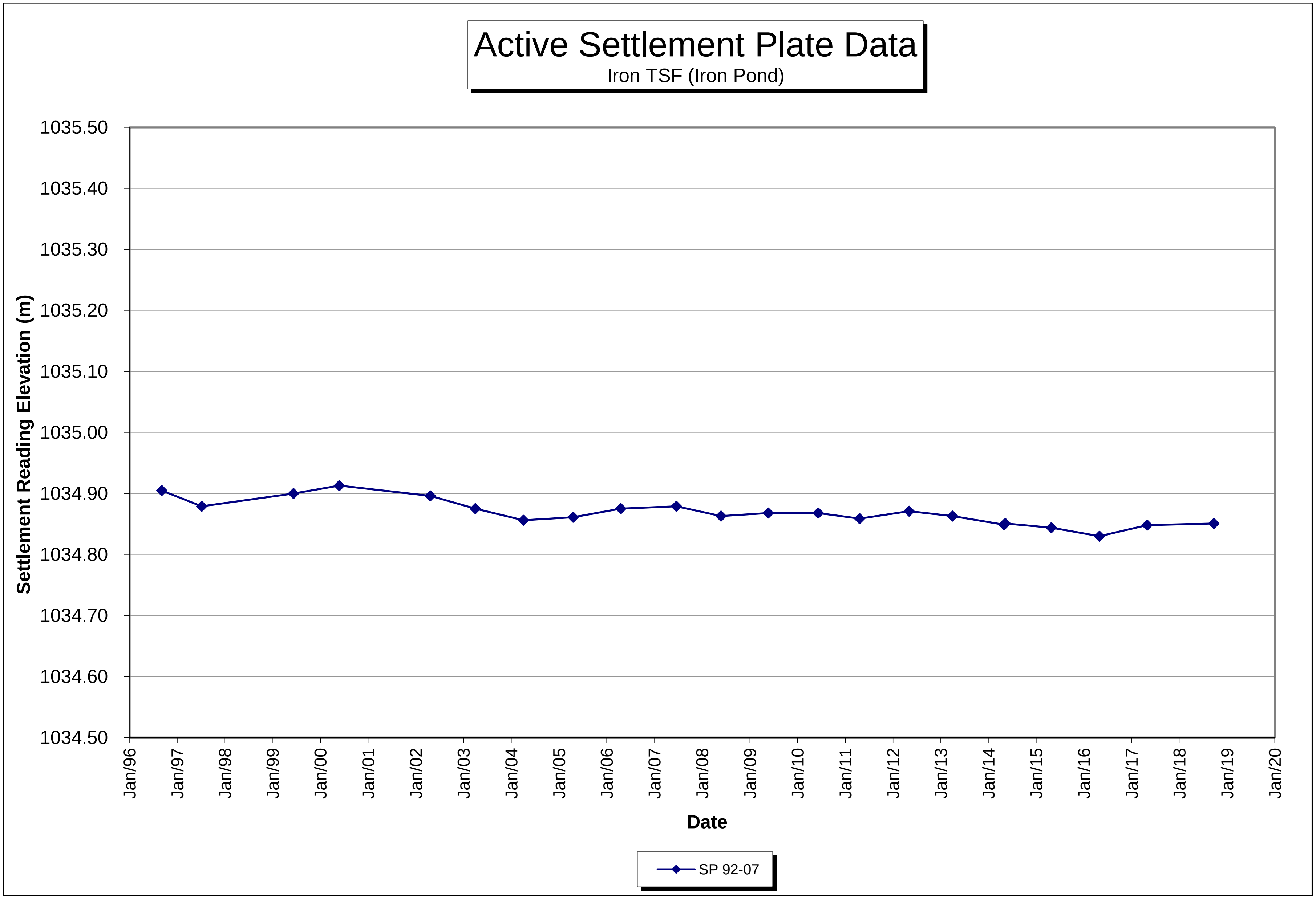


Figure IV-12 SP 92-07

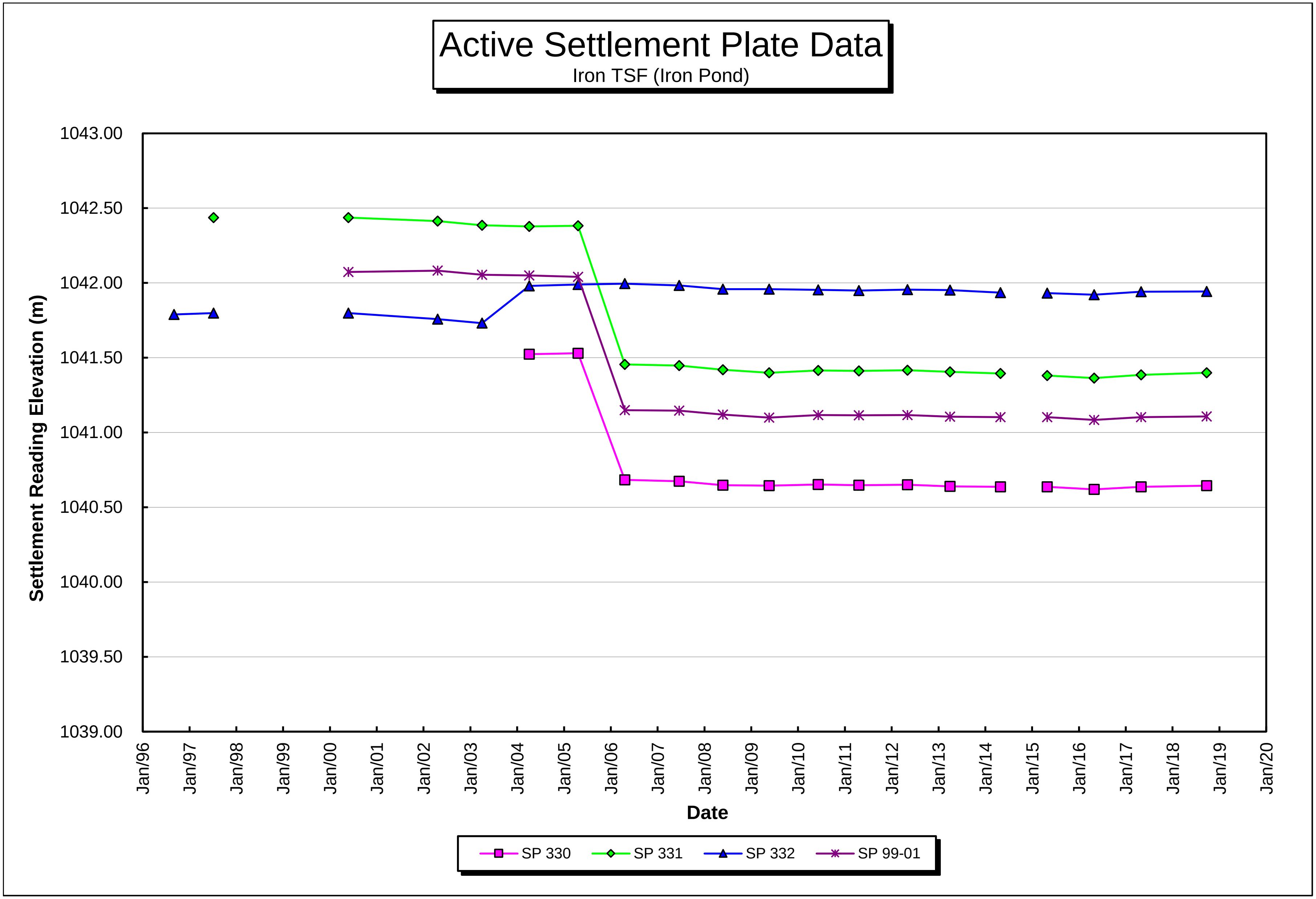
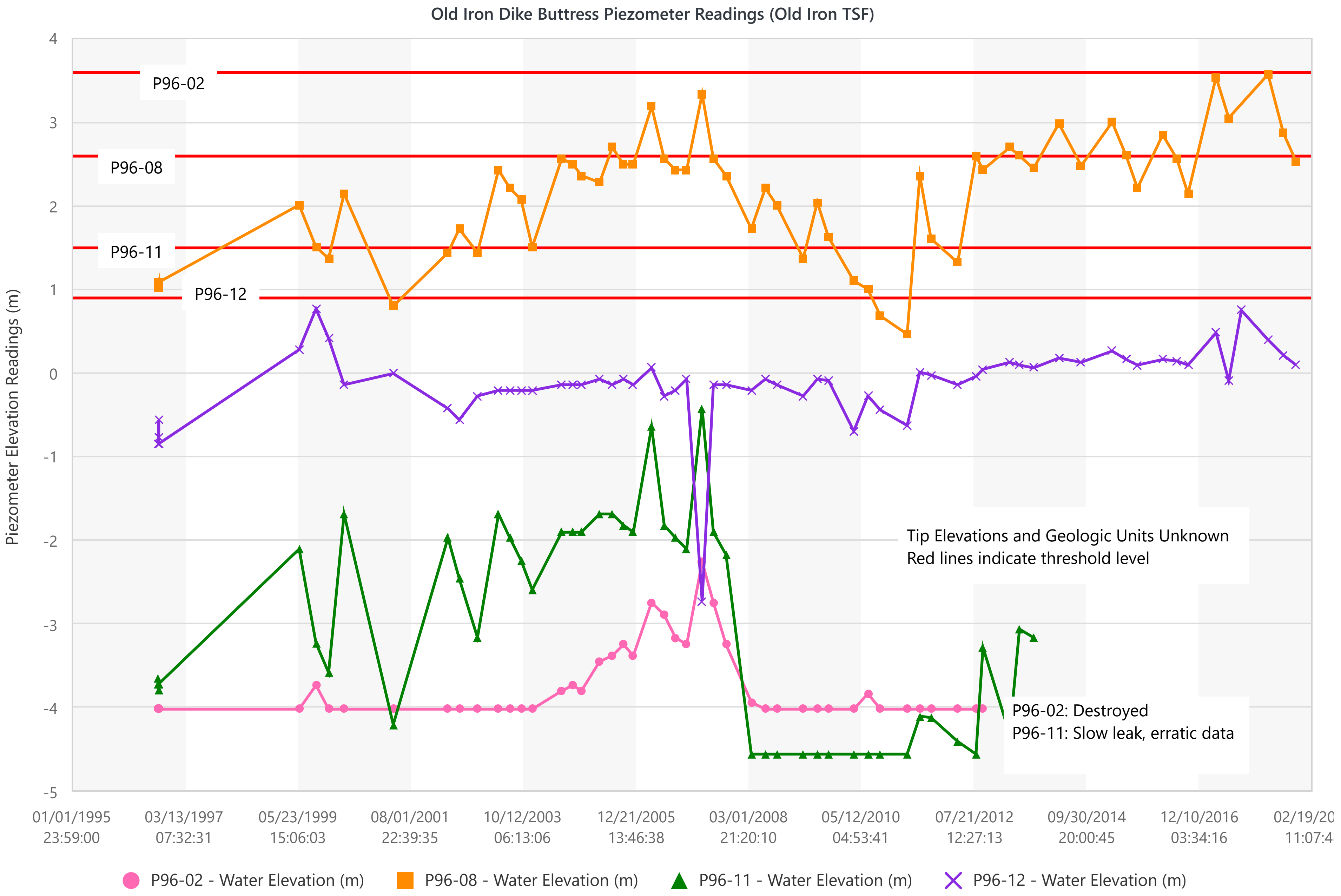


Figure IV-13 SP 330 - 332 and SP 99-01

APPENDIX V

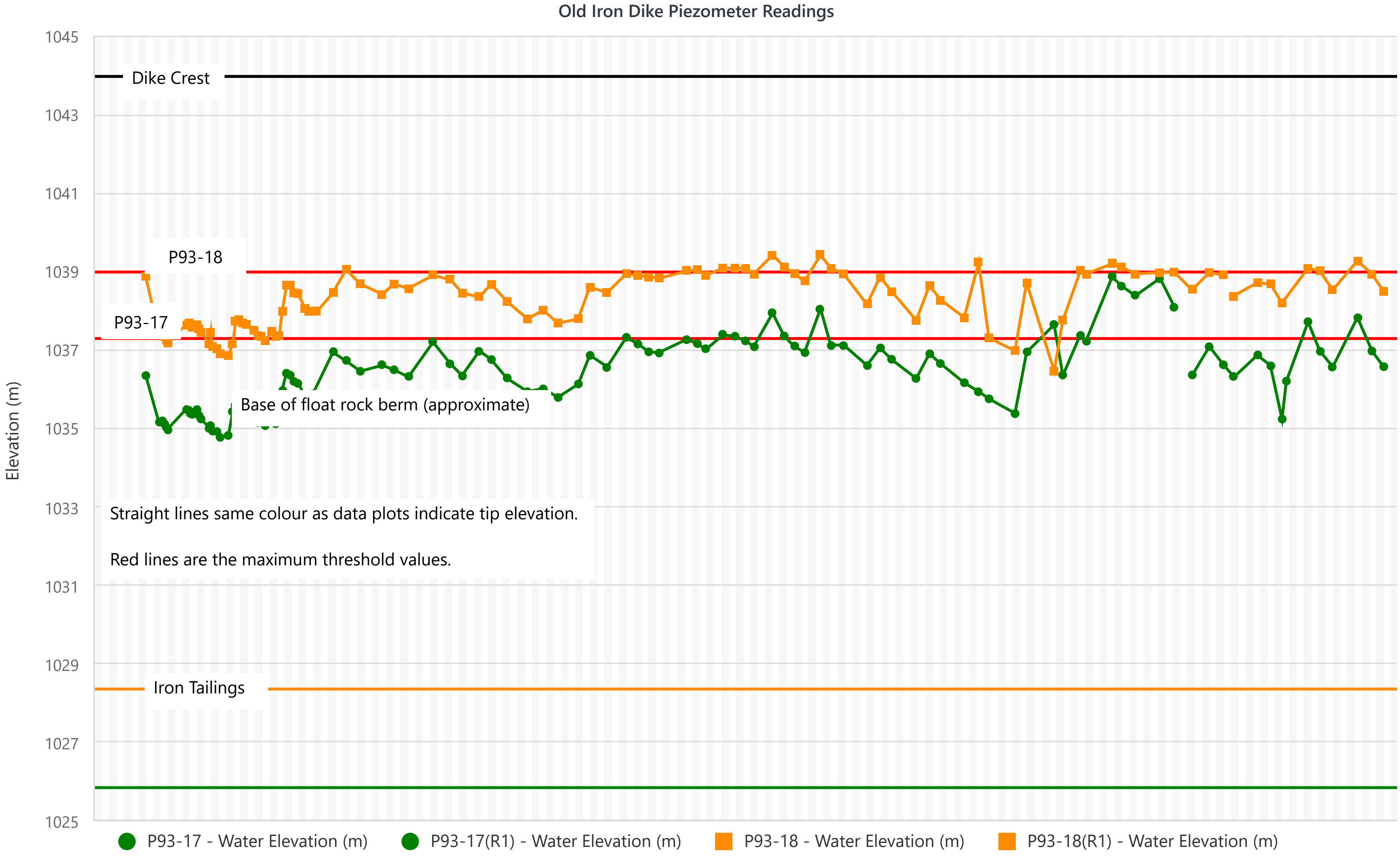
West Iron Cell Dikes Instrumentation Data



Tip Elevations and Geologic Units Unknown
Red lines indicate threshold level

P96-02: Destroyed
P96-11: Slow leak, erratic data

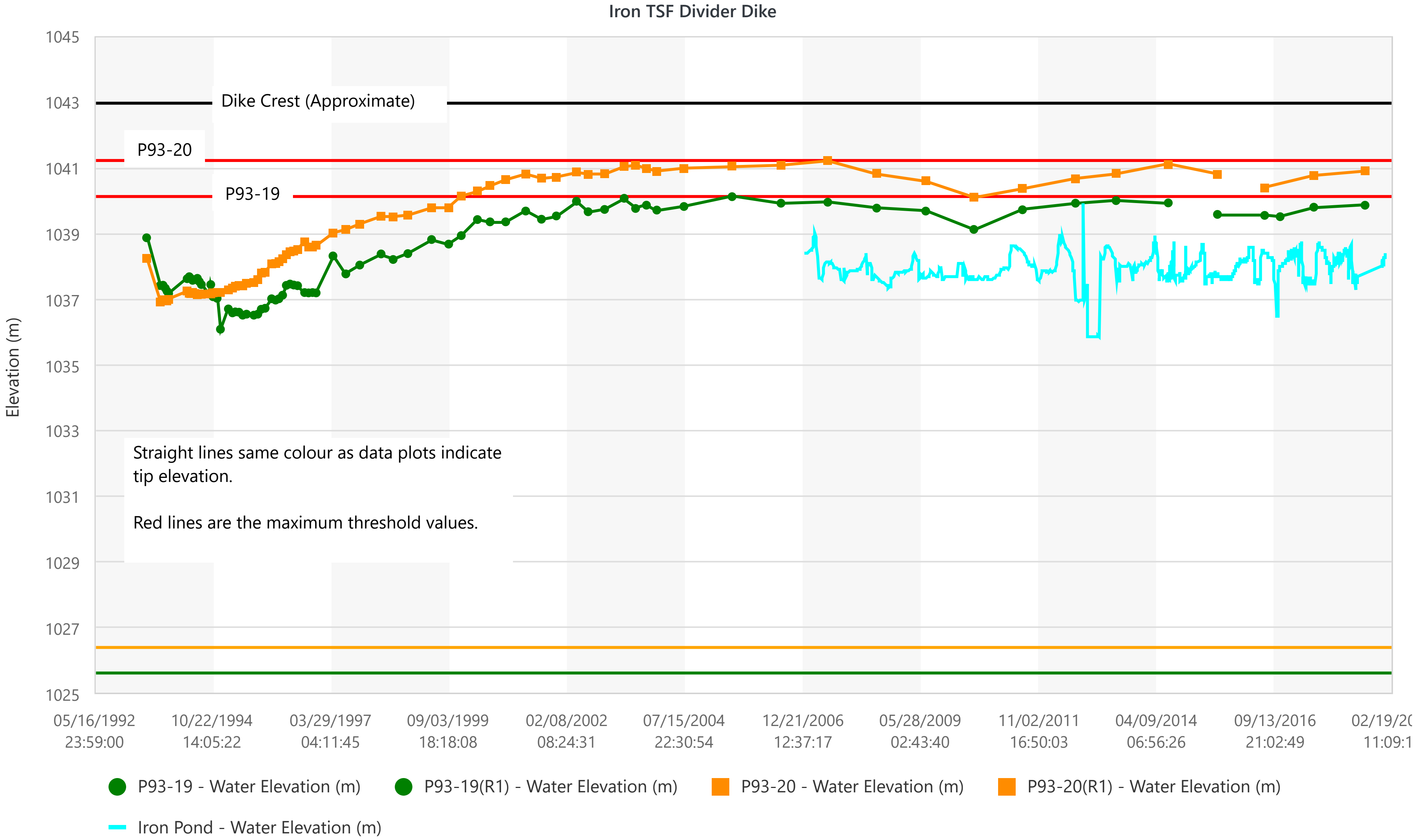
Figure V-1 Old Iron Dike Buttress



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure V-2 Old Iron Dike



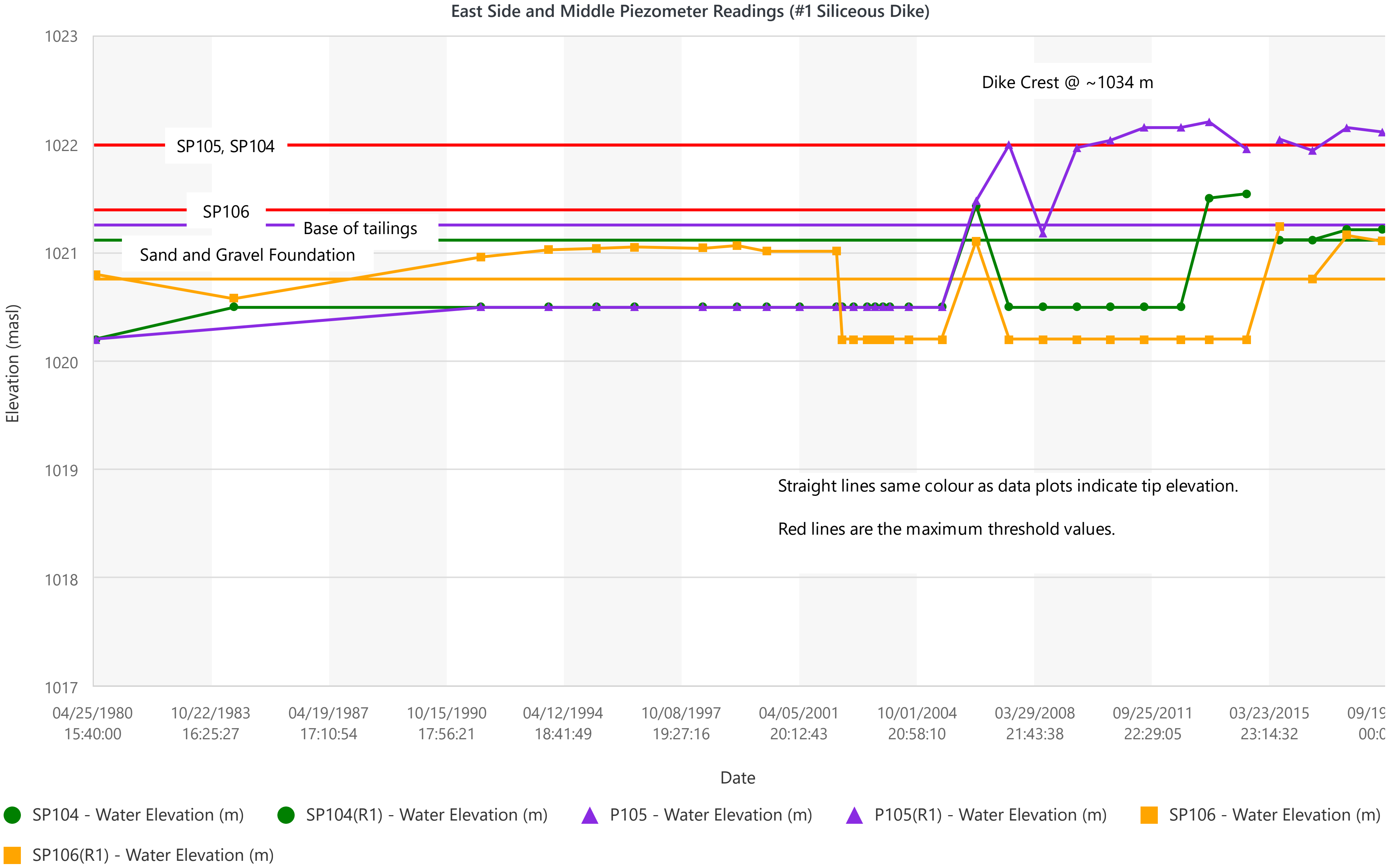
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure V-3 Iron TSF Divider Dike

APPENDIX VI

Siliceous Dikes Instrumentation Data



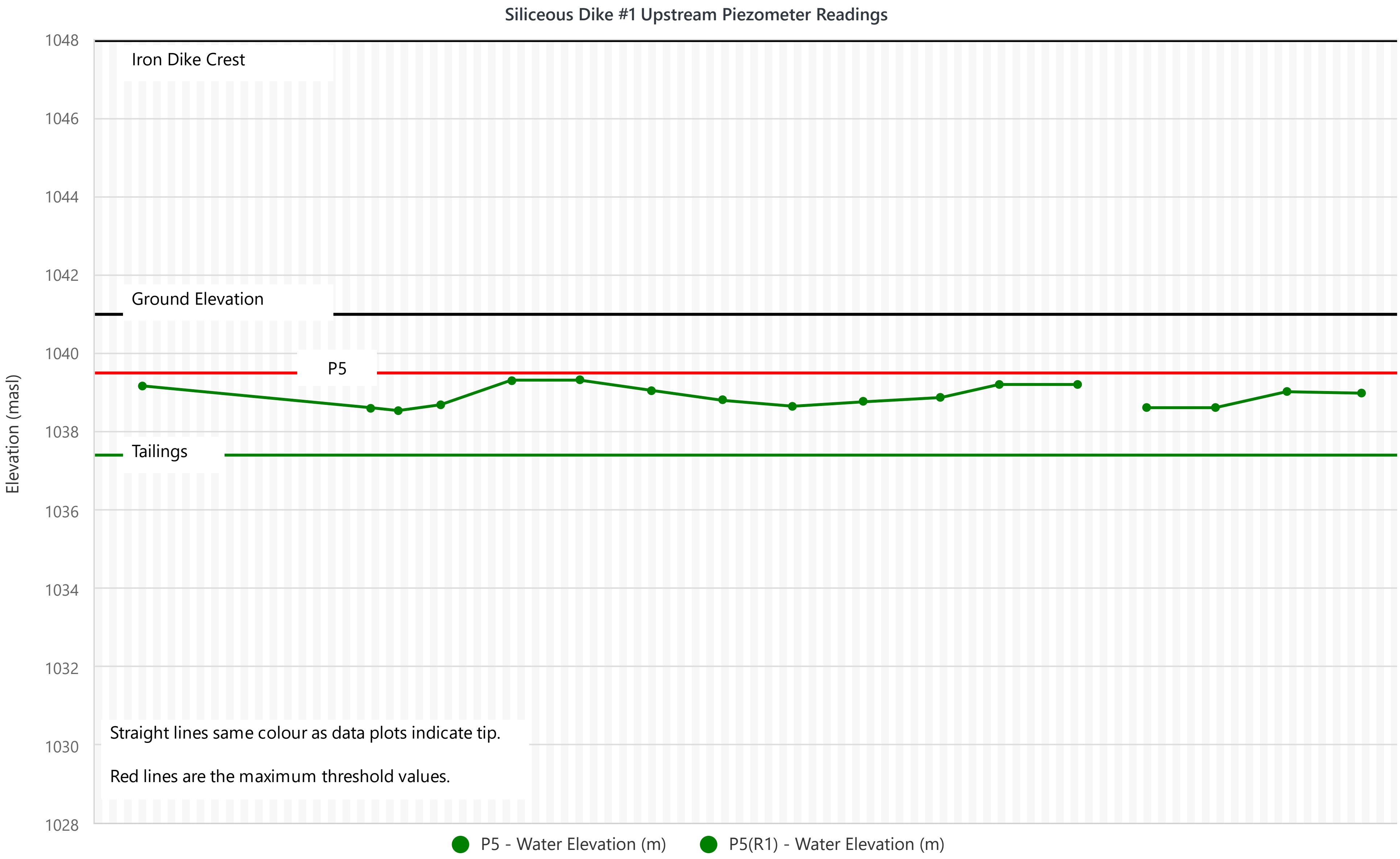
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VI-1 East and Middle



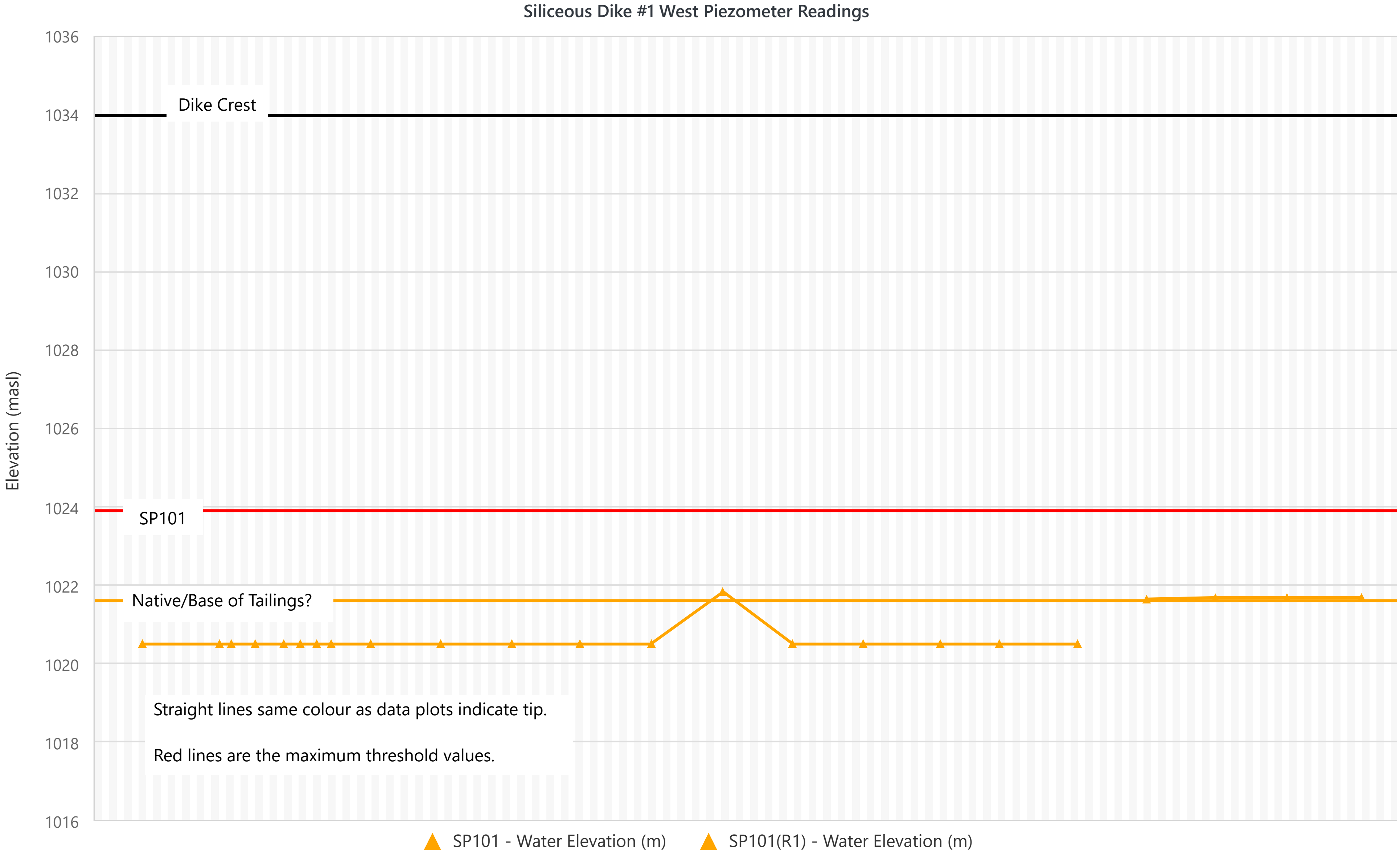
Straight lines same colour as data plots indicate tip.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

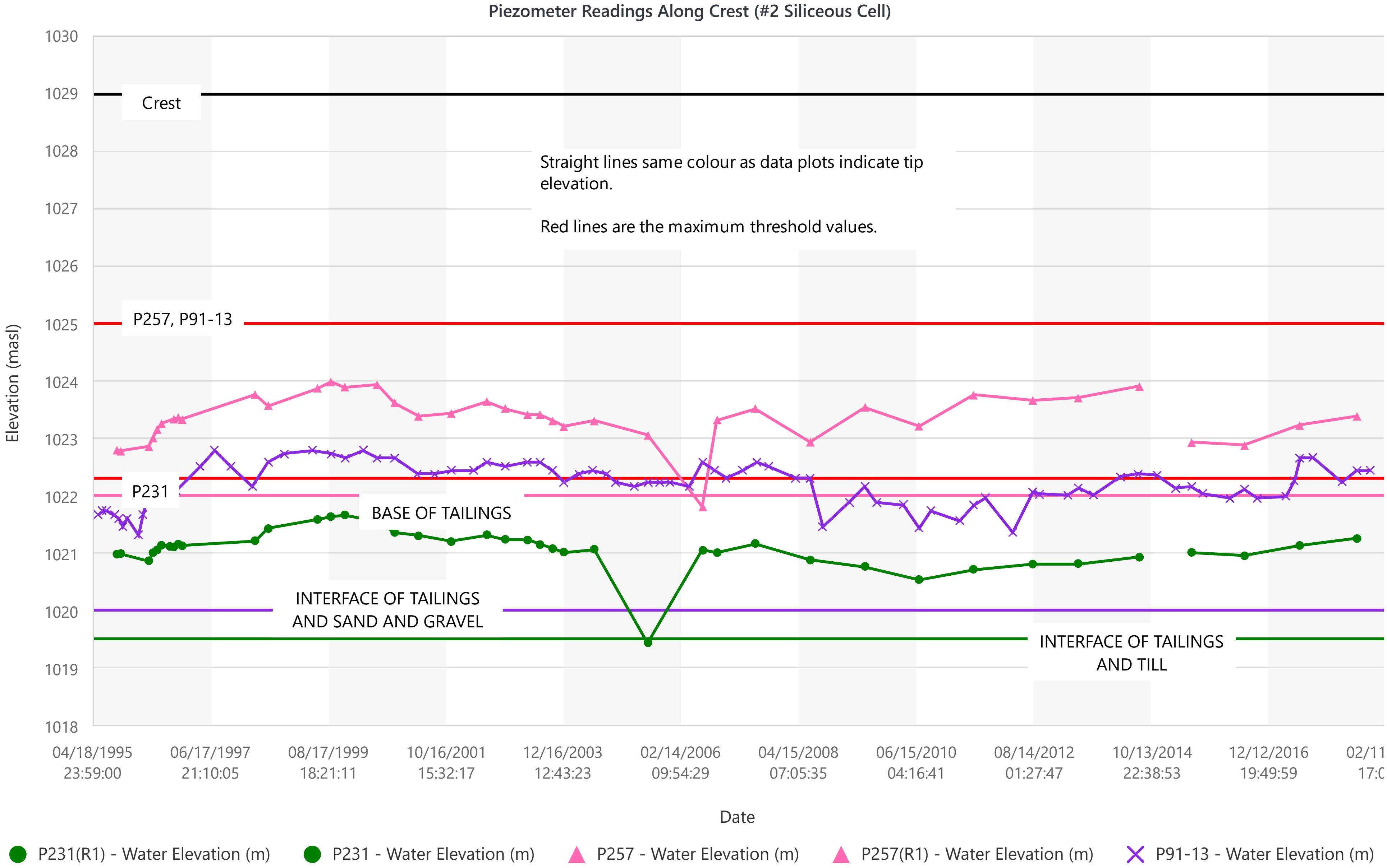
Figure VI-2 Upstrear



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

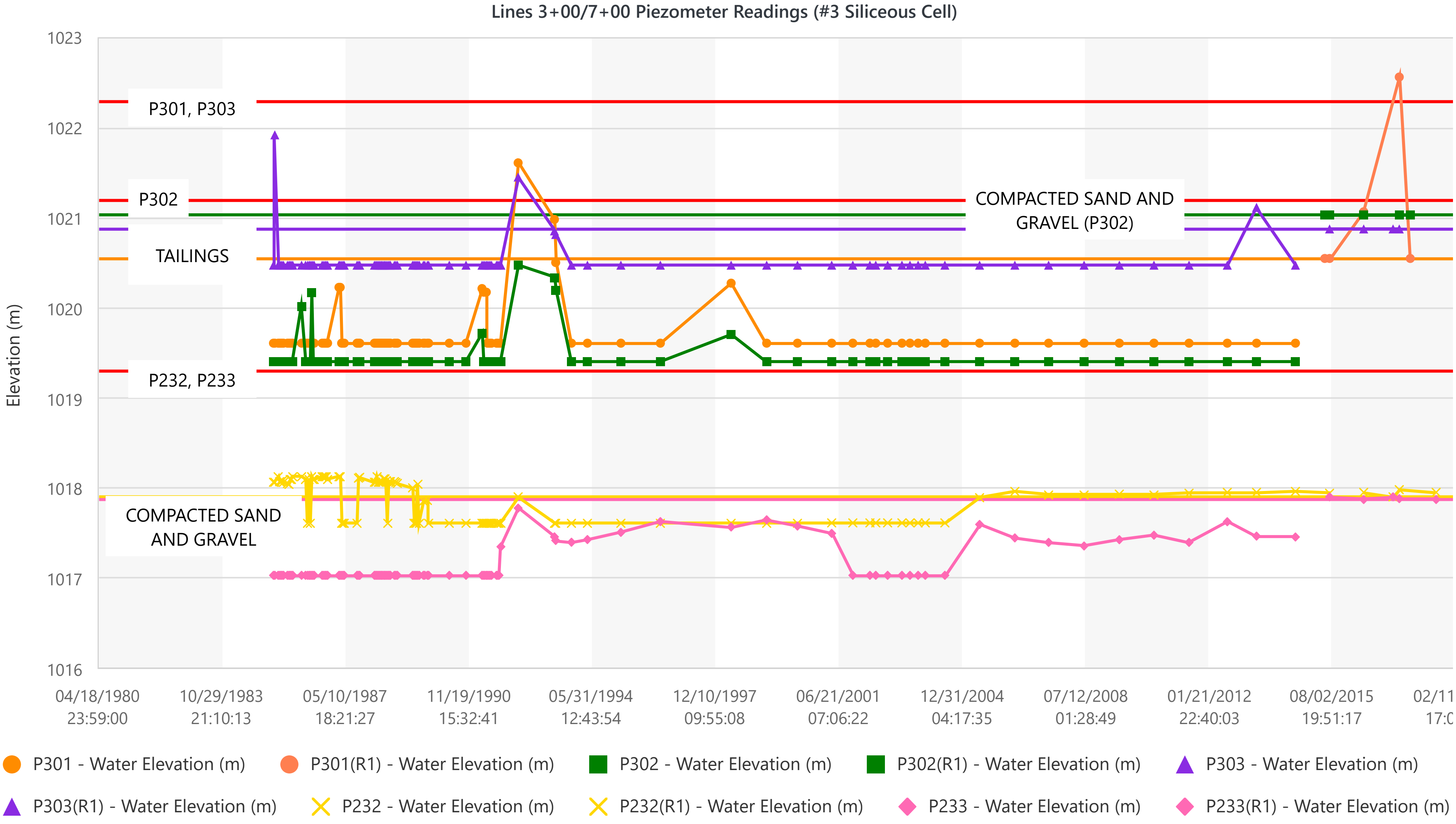
Figure VI-3 West



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VI-4 Sil2 Crest



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

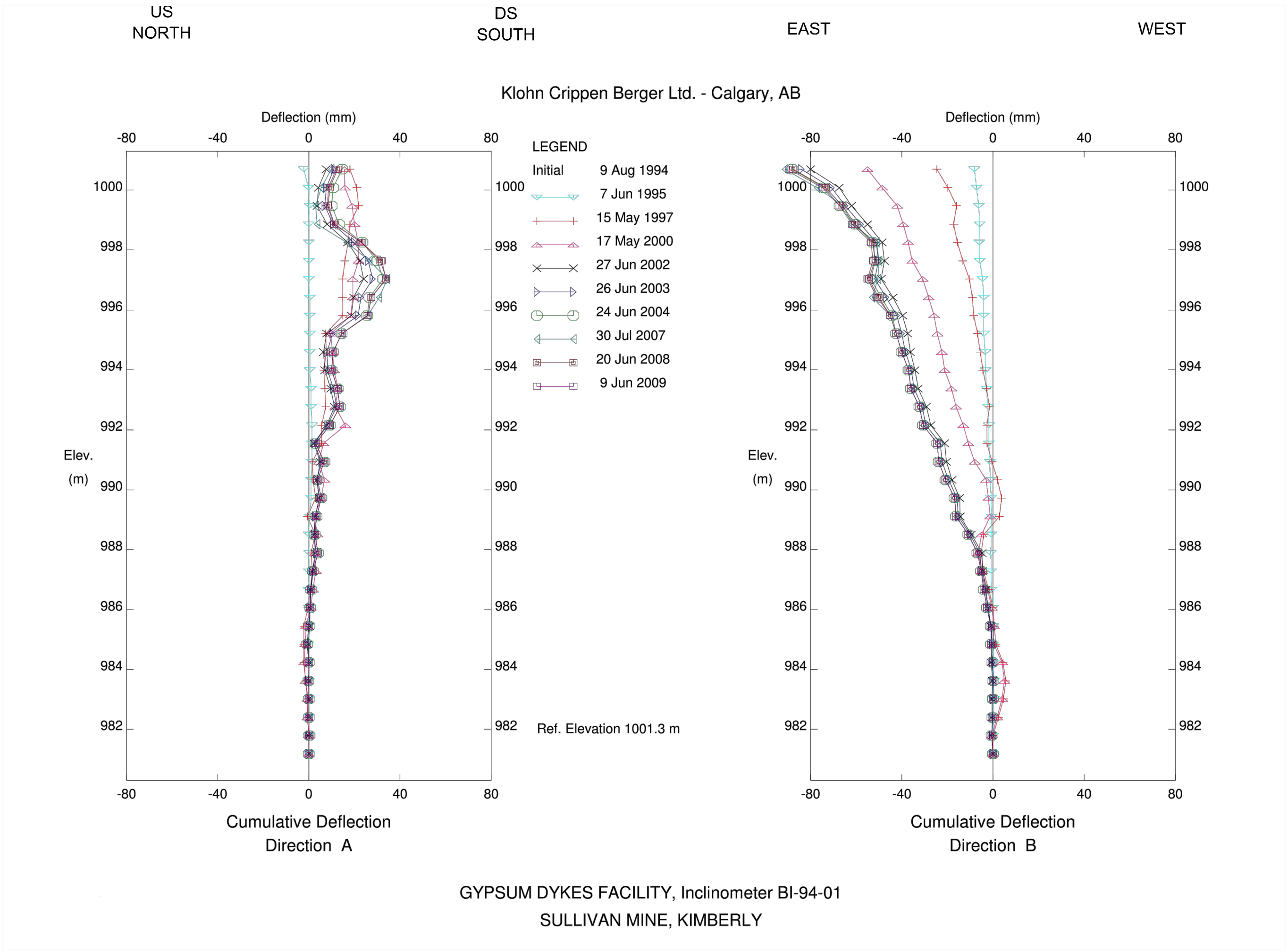
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

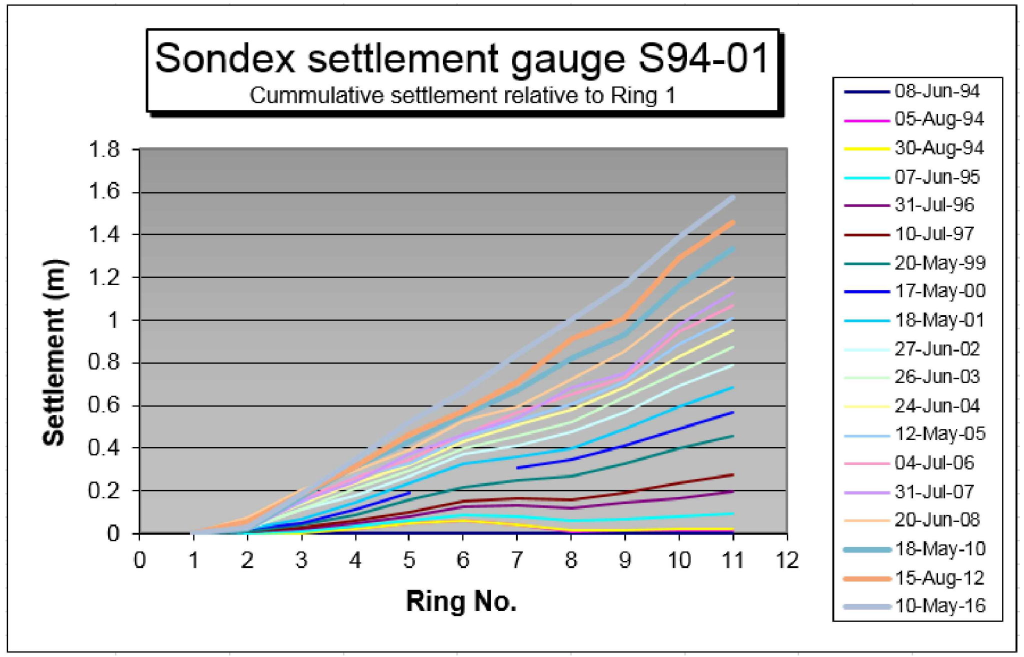
Figure VI-5 Sil 3 Pond South

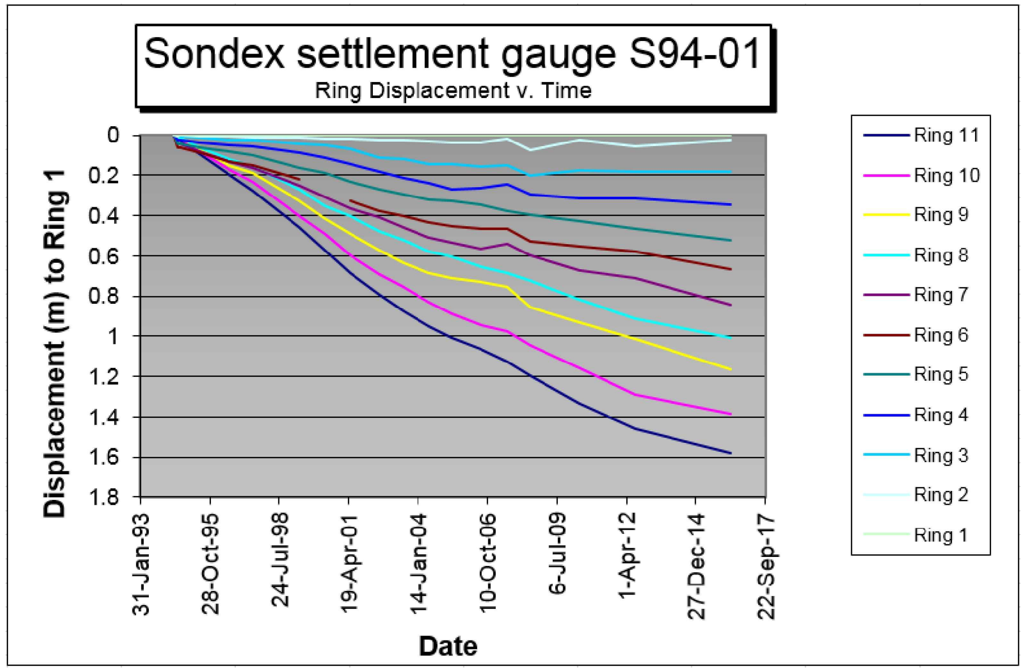
APPENDIX VII

West Gypsum Dike Instrumentation Data



(CAN NO LONGER READ. BLOCKED AT 4.7 m BELOW THE GROUND SURFACE)





CLIENT

Teck

Klohn Crippen Berger

PROJECT

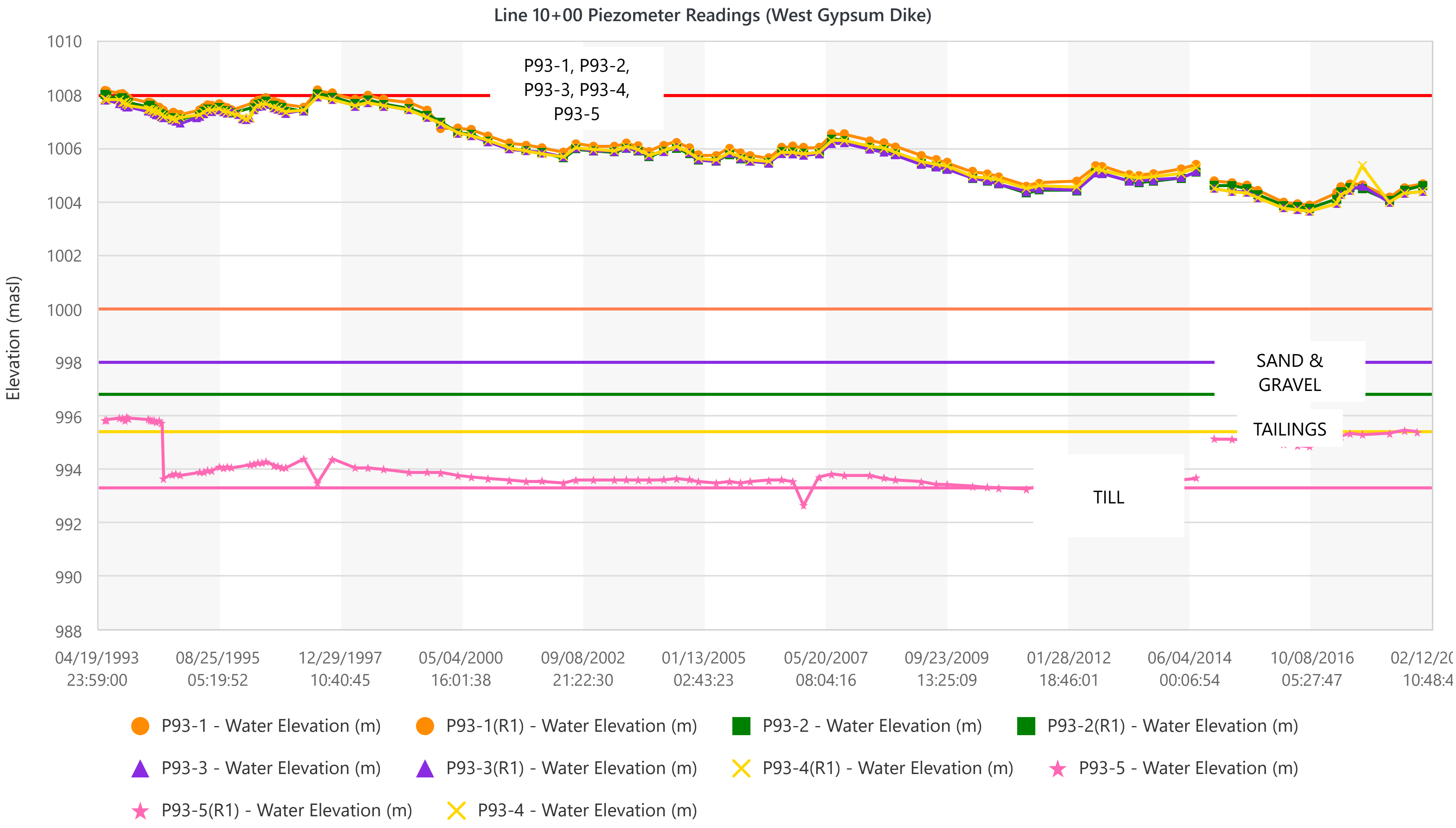
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE

WEST GYPSUM DIKE
SONDEX AND
INCLINOMETER PLOTS

PROJECT No.
A05807A18

FIG. No.
FIGURE VII-1



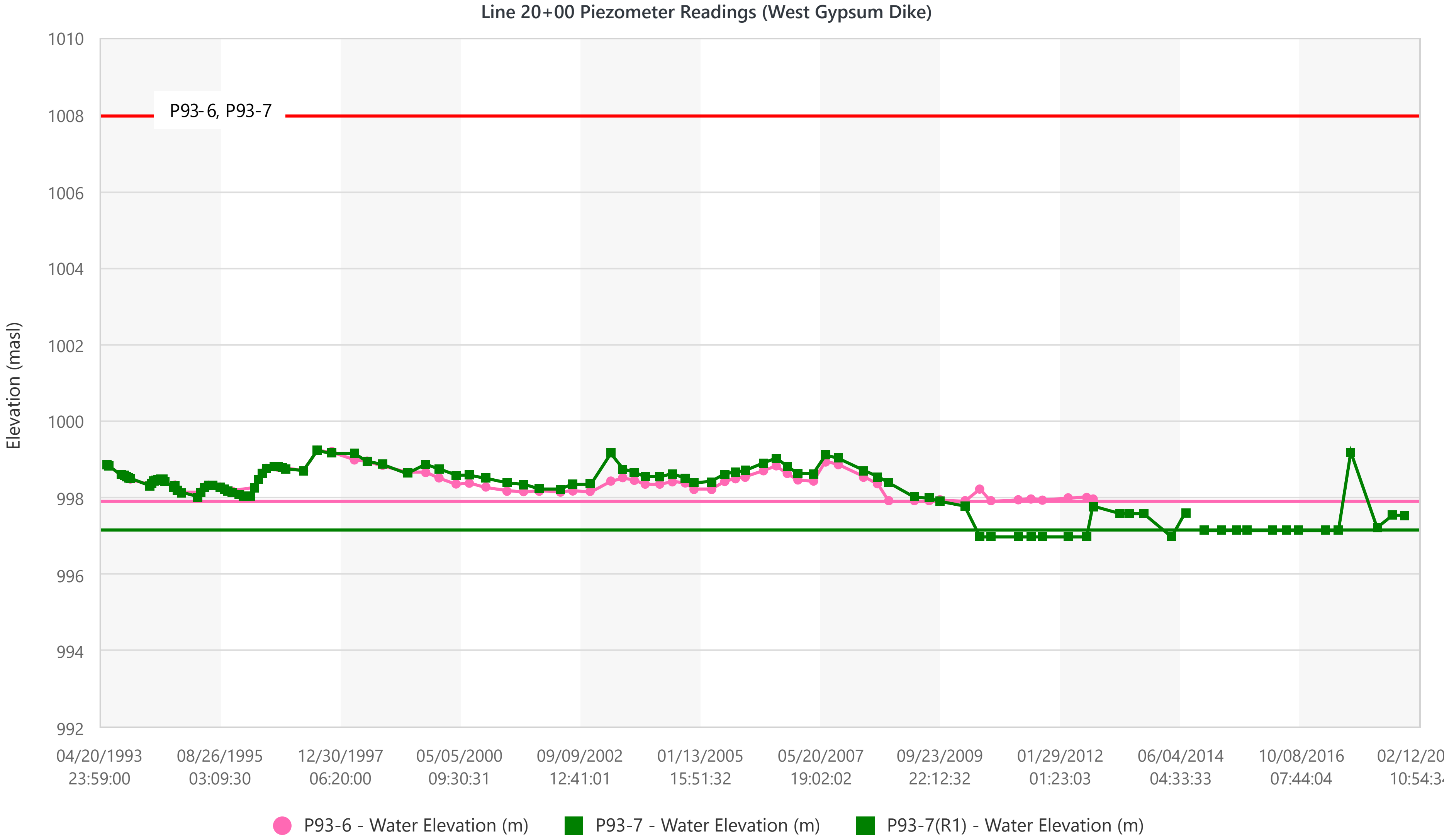
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of

Figure VII-2 Line 10+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

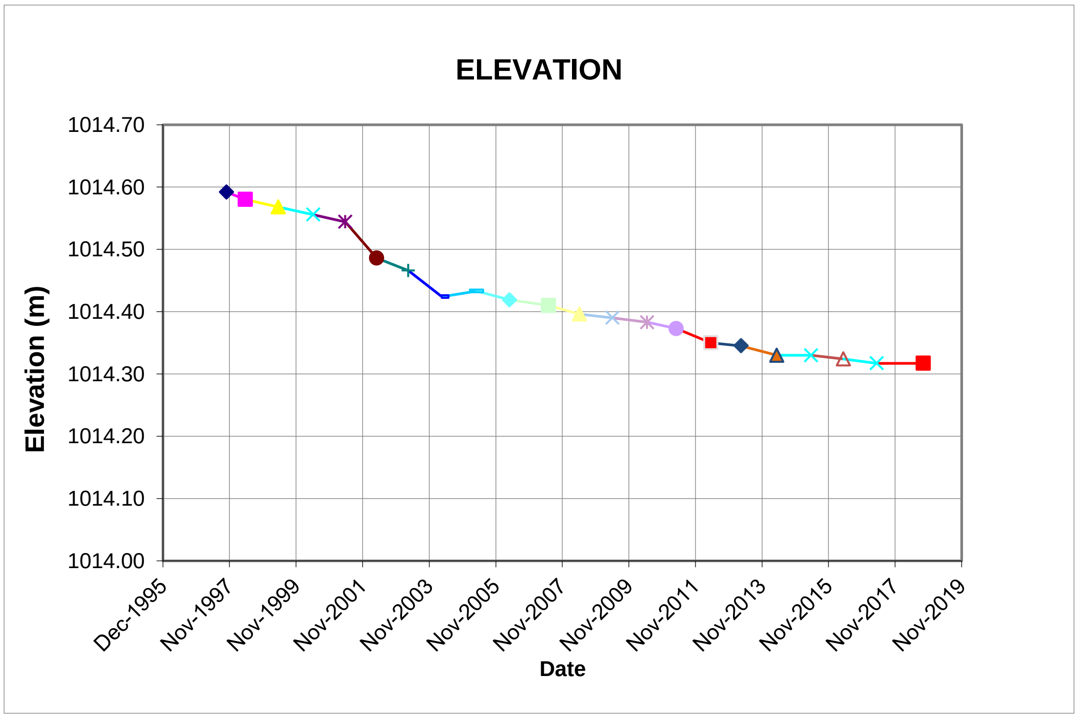
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

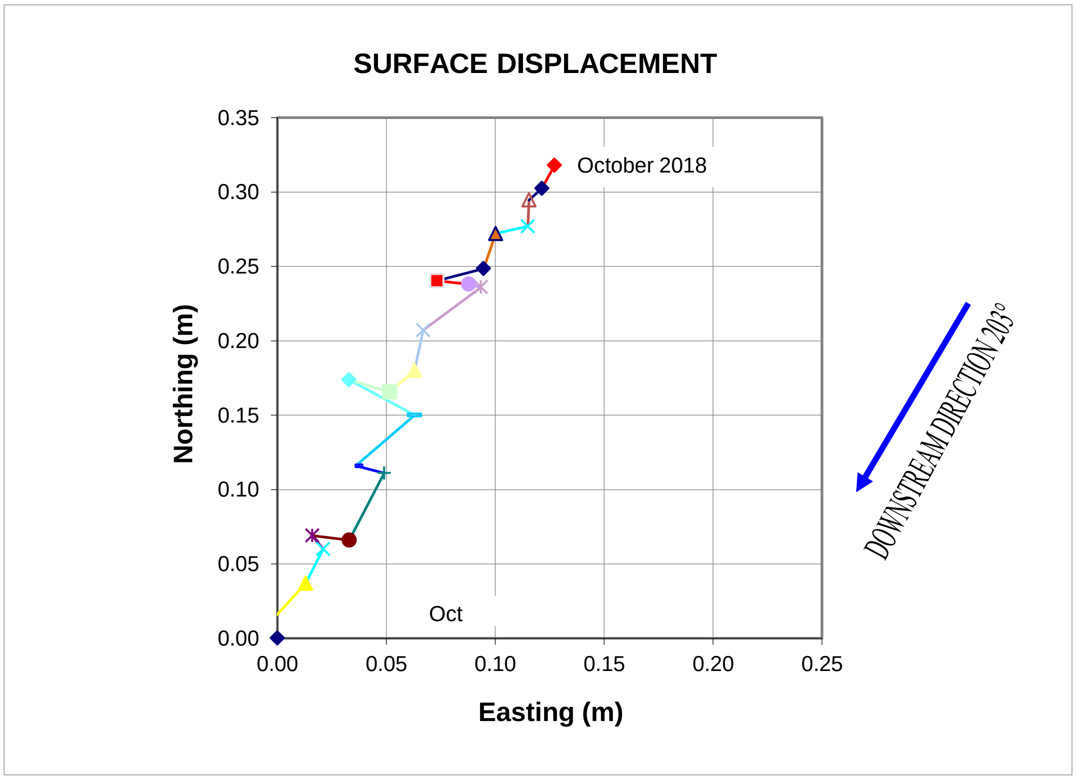
SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VII-3 Line 20+00

SP97-01 Line 10+00

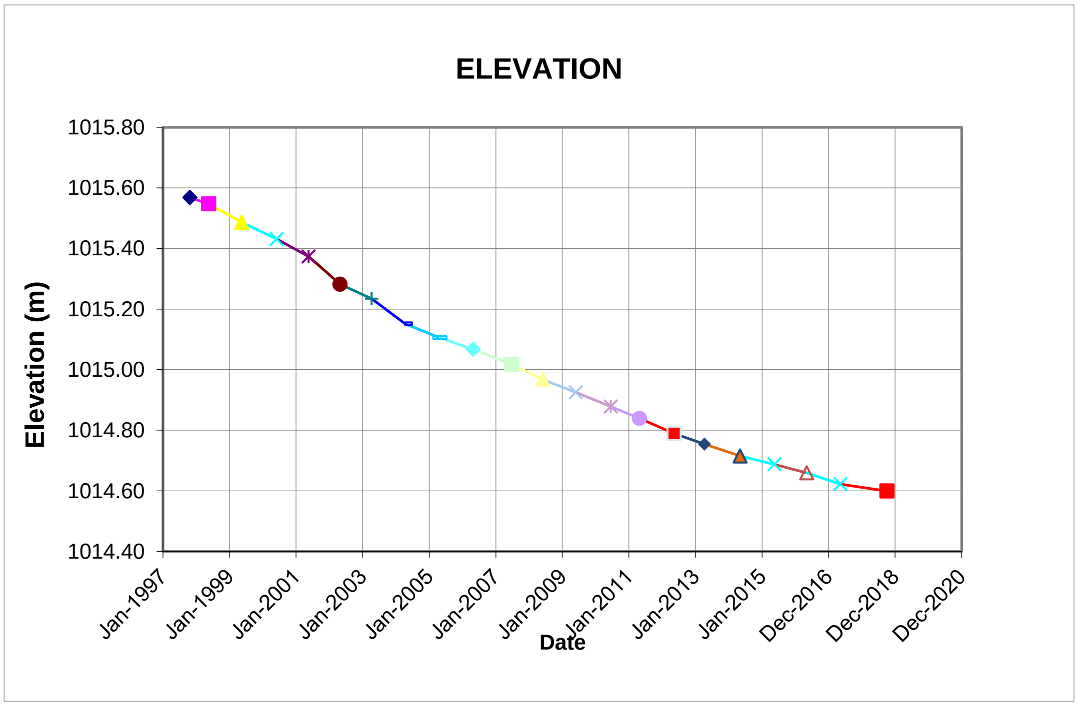
SETTLEMENT PLATES - WEST GYPSUM DIKE





SP97-05 Line 10+00

SETTLEMENT PLATES - WEST GYPSUM DIKE



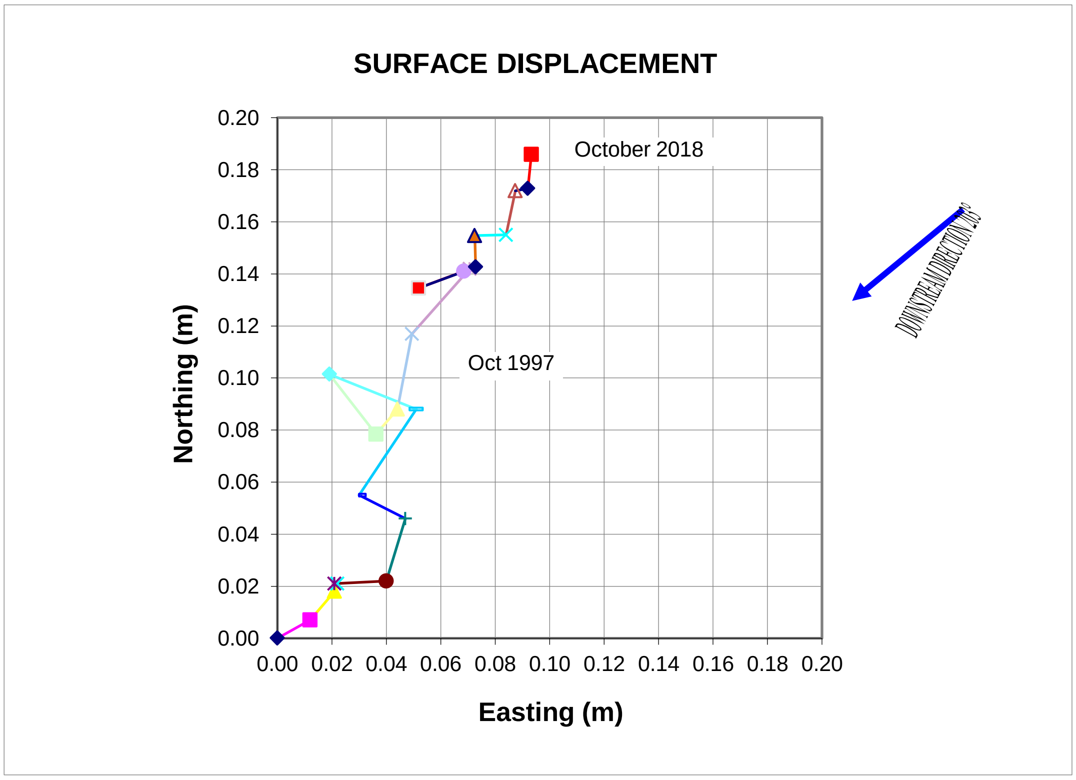
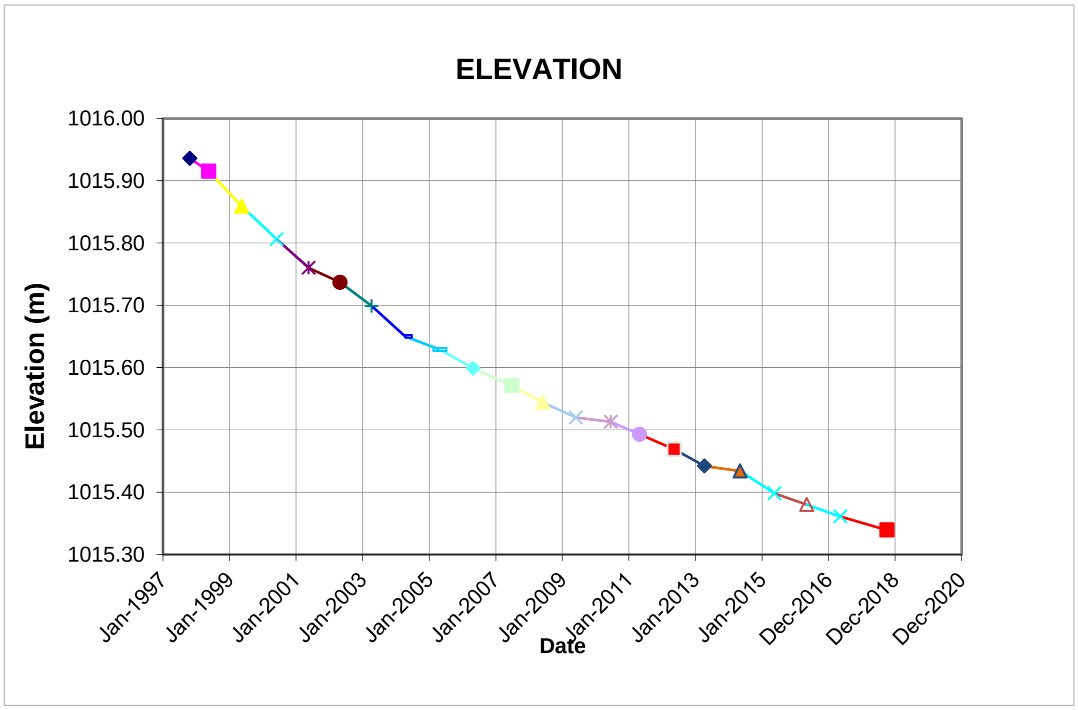
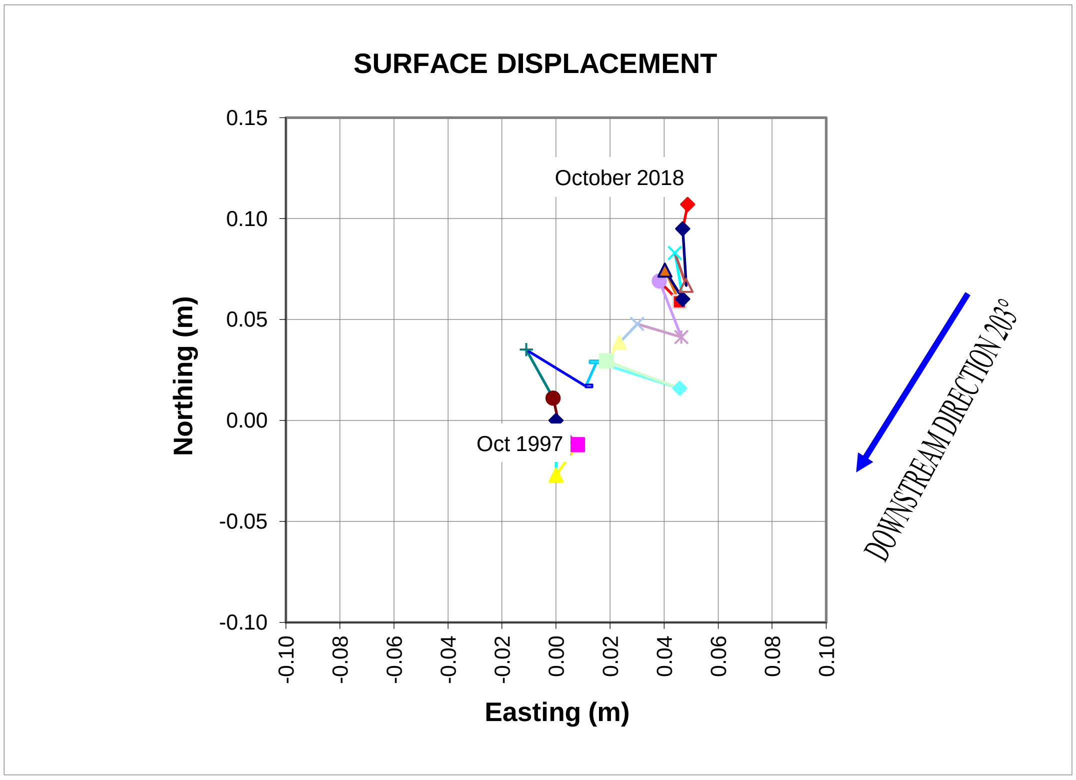


Figure VII-5-SP97-05

SP97-06 Line 20+00

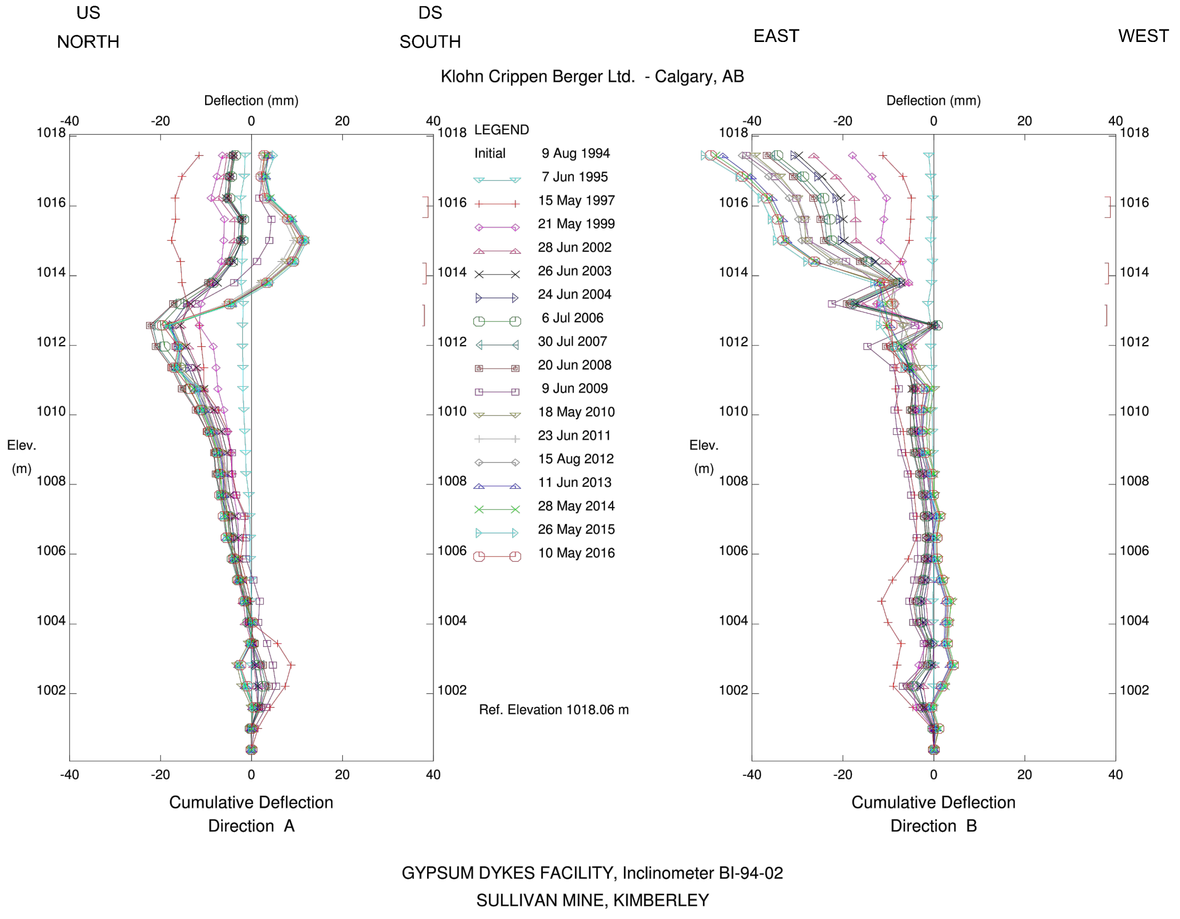
SETTLEMENT PLATES - WEST GYPSUM DIKE

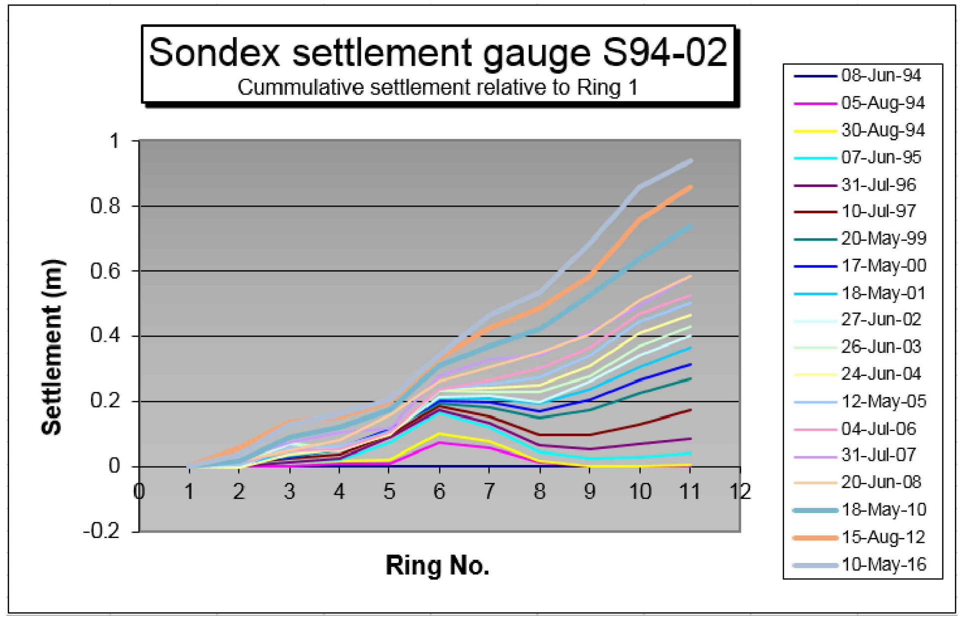


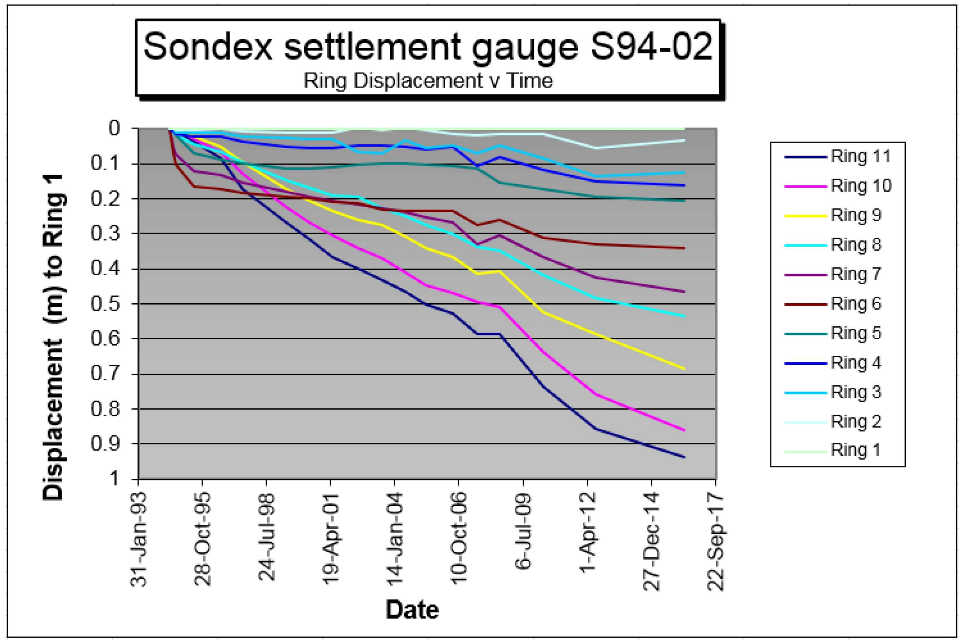


APPENDIX VIII

East Gypsum Dike Instrumentation Data







CLIENT

Teck

Klohn Crippen Berger

PROJECT

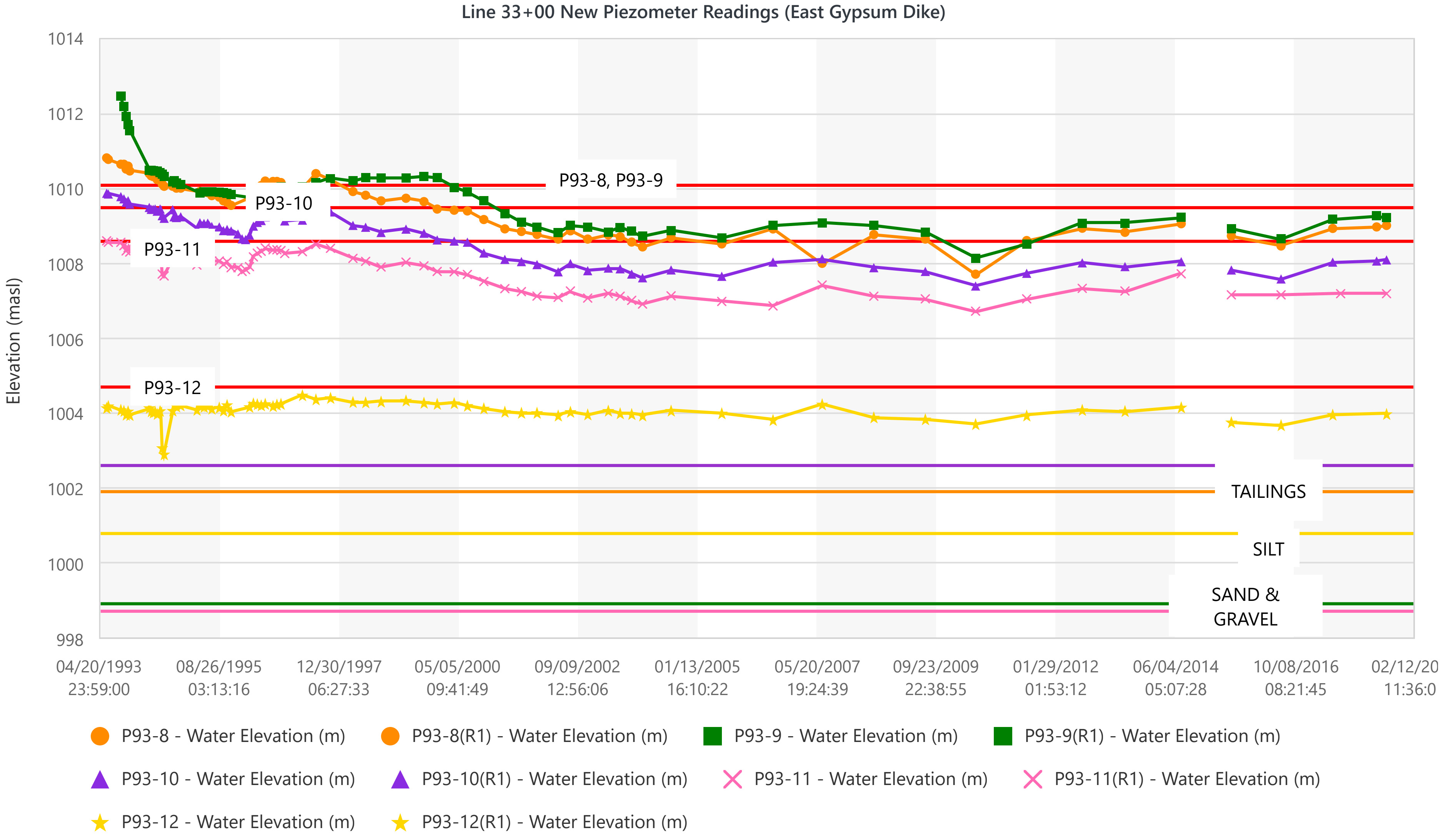
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE

EAST GYPSUM DIKE
SONDEX AND
INCLINOMETER PLOTS

PROJECT No.
A05807A18

FIG. No.
FIGURE VIII-1



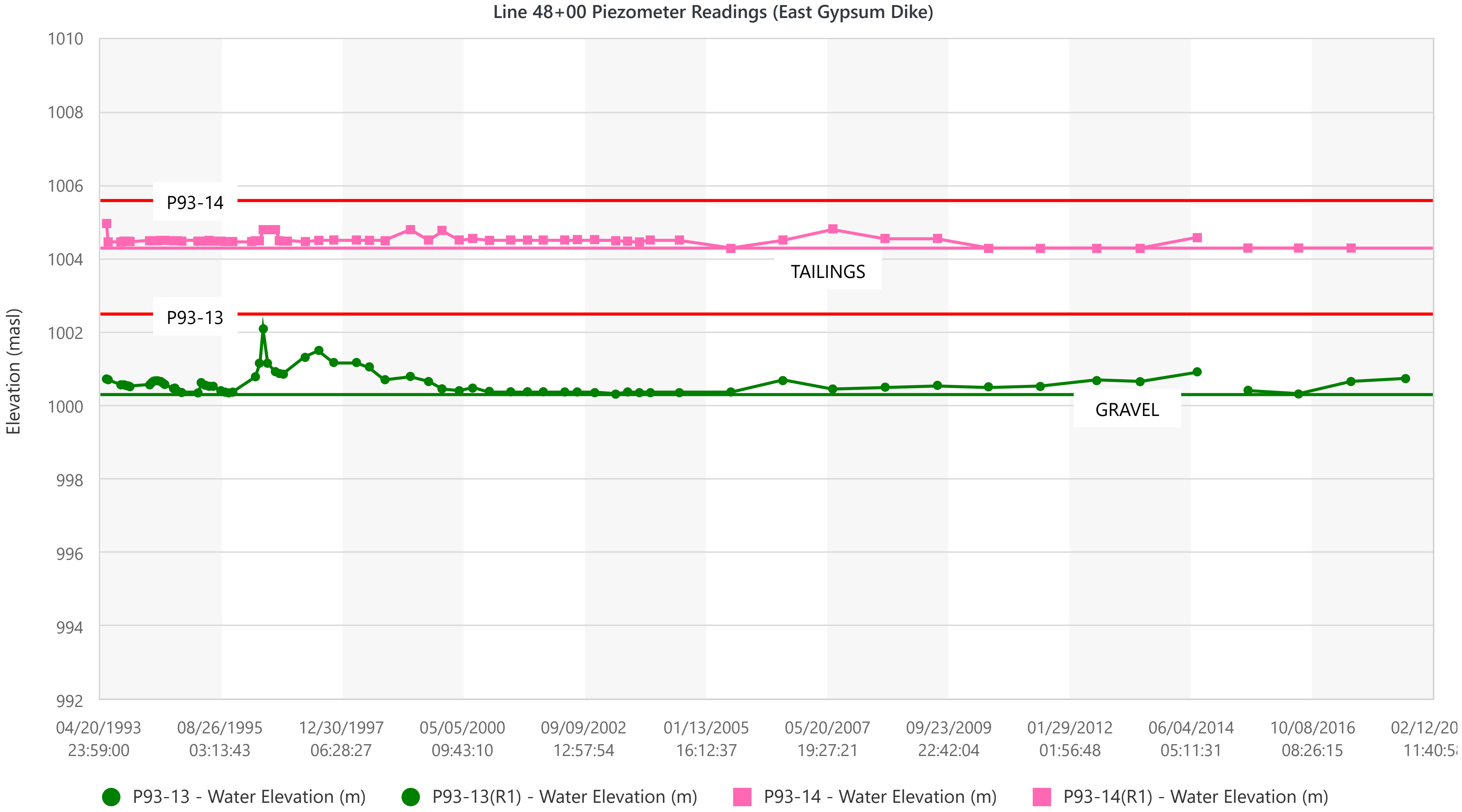
Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VIII-2 Line 33+00



Straight lines same colour as data plots indicate tip elevation.

Red lines are the maximum threshold values.

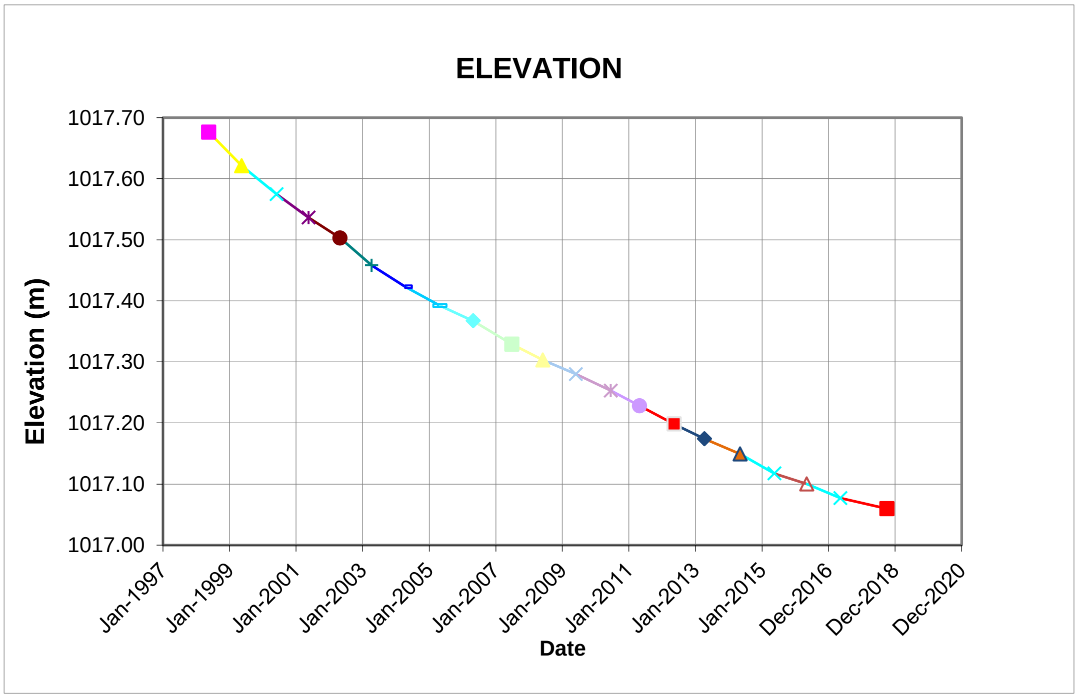
Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Older data will appear below tip elevation if previously read "dry" or if previous top of casing elevation was incorrect due to damage.

SPxxx represents readings to point of flushing. SPxxx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure VIII-3 Line 48+00

SP97-03 Line 33+00

SETTLEMENT PLATES - EAST GYPSUM DIKE



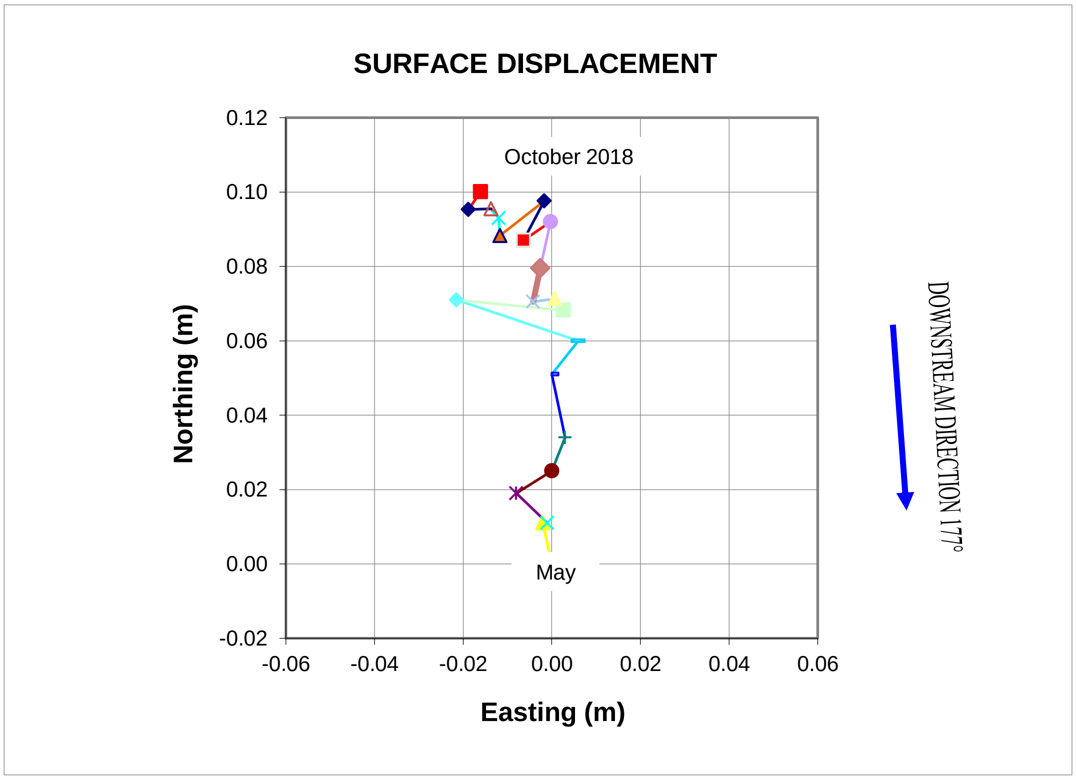
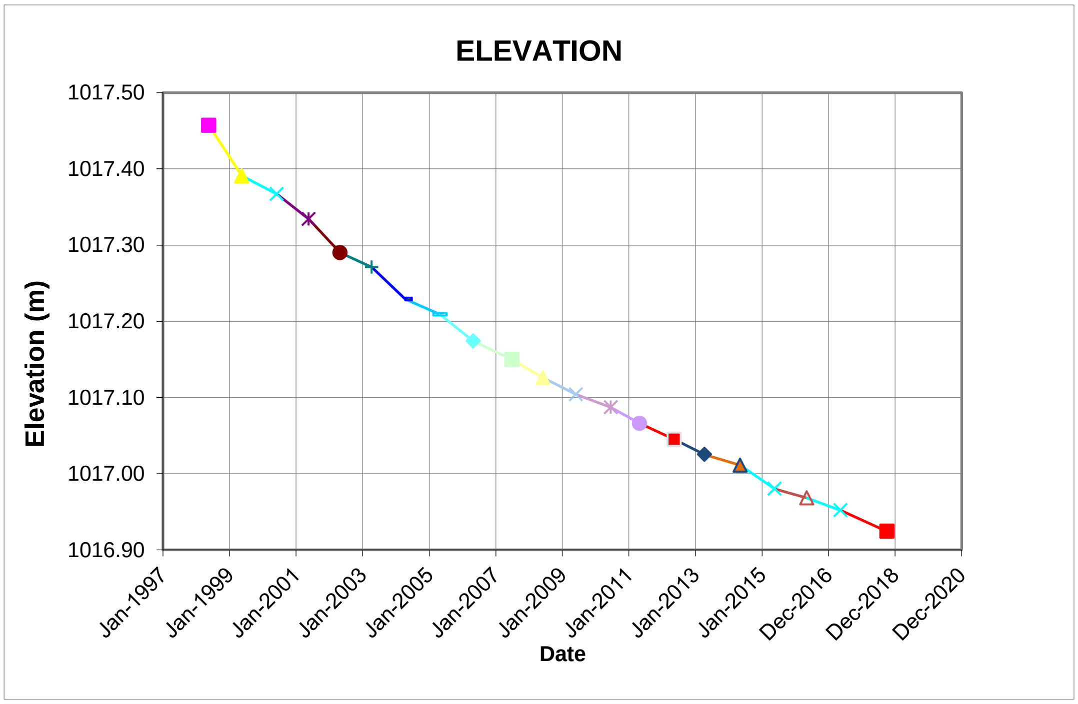
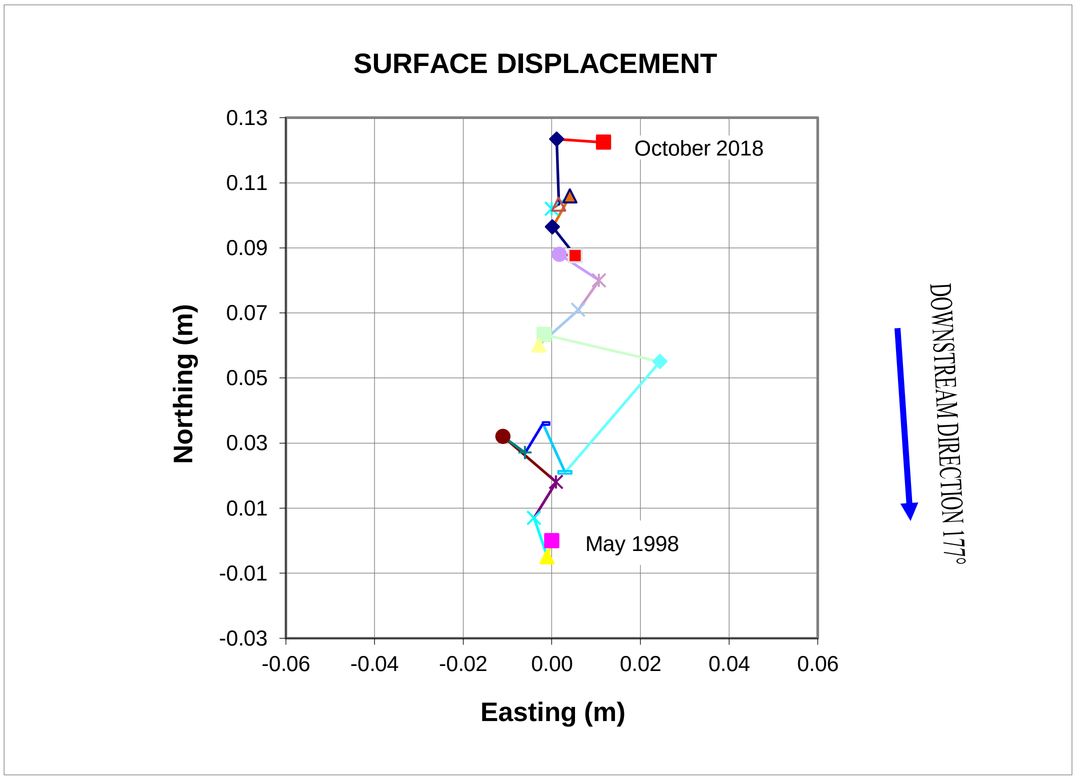


Figure VIII-4-SP97-03

SP97-04 Line 48+00

SETTLEMENT PLATES - EAST GYPSUM DIKE





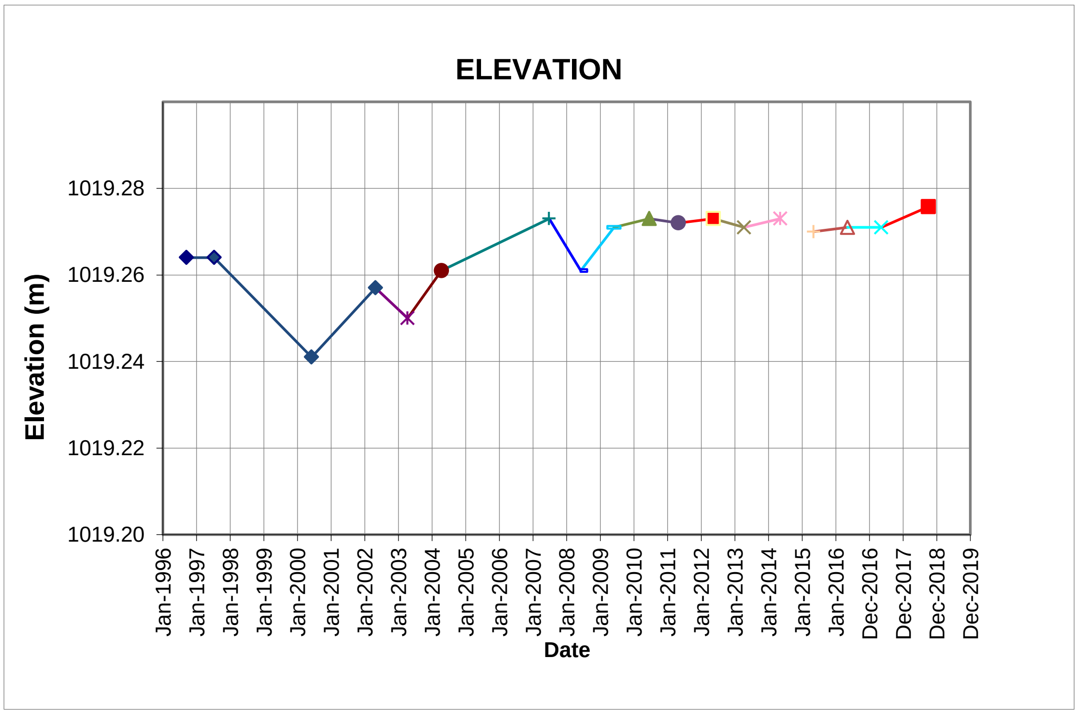
APPENDIX IX

Northeast Gypsum Dike Instrumentation Data

SETTLEMENT PLATES - NE GYPSUM DIKE

W Pipe

NE Gypsum Dike



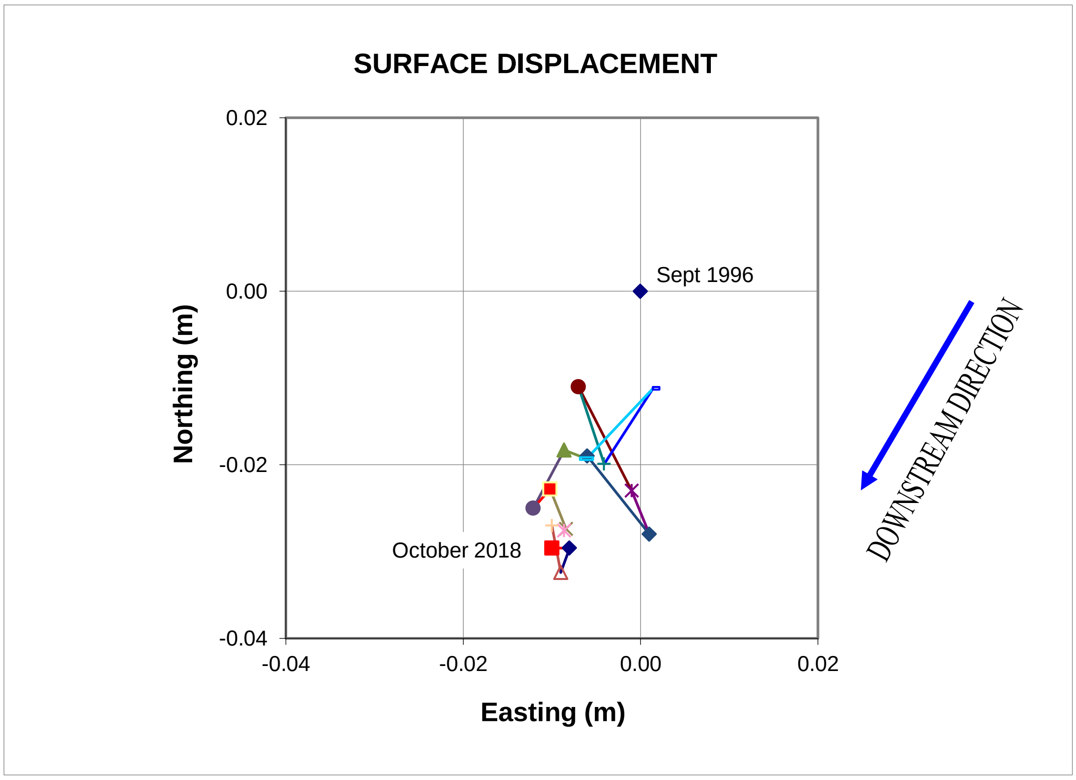
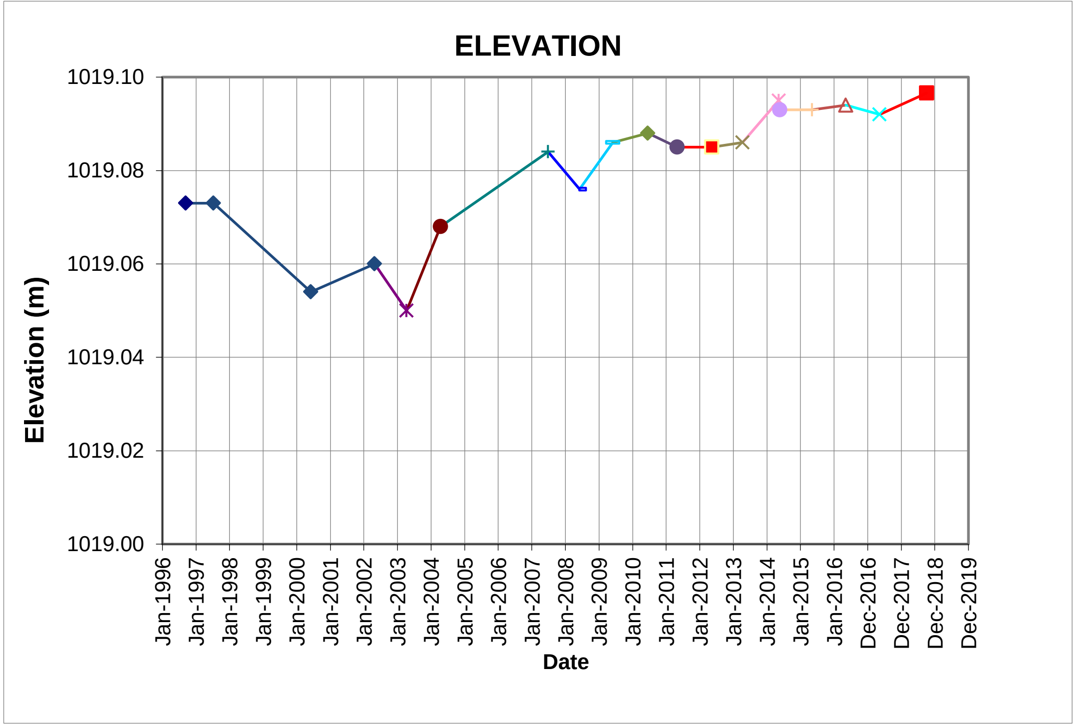


Figure IX-1 NE Gypsum Dike W pipe

SETTLEMENT PLATES - NE GYPSUM DIKE

E Pipe

NE Gypsum Dike



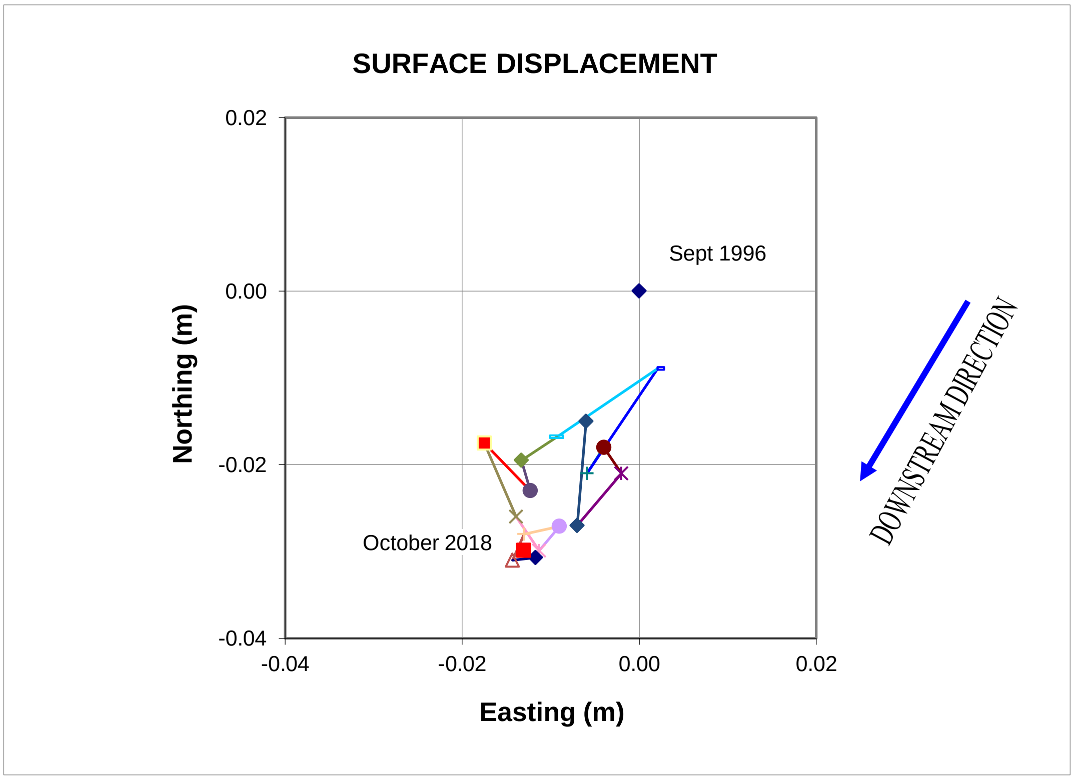


Figure IX-2 NE Gypsum Dike E pipe

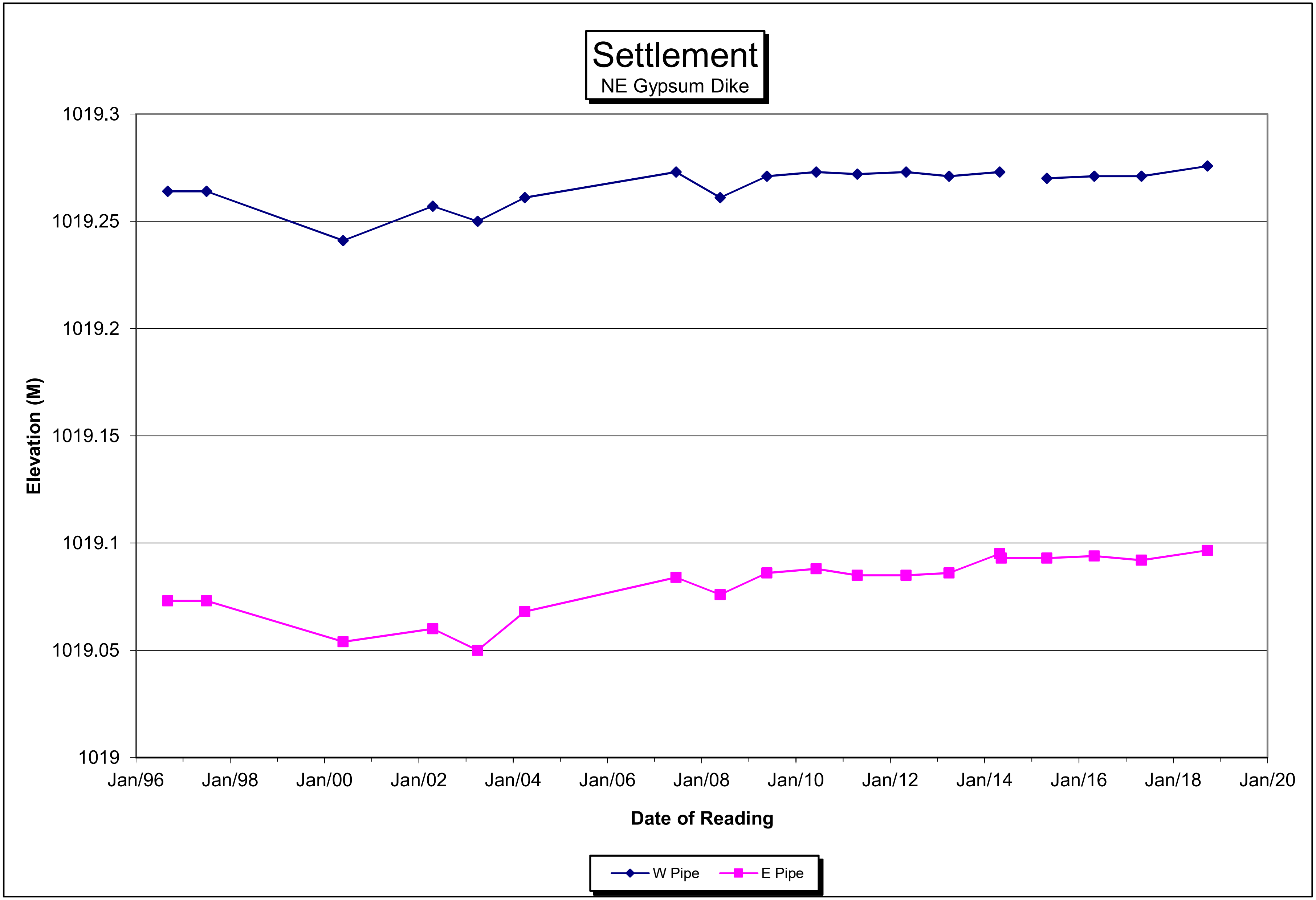
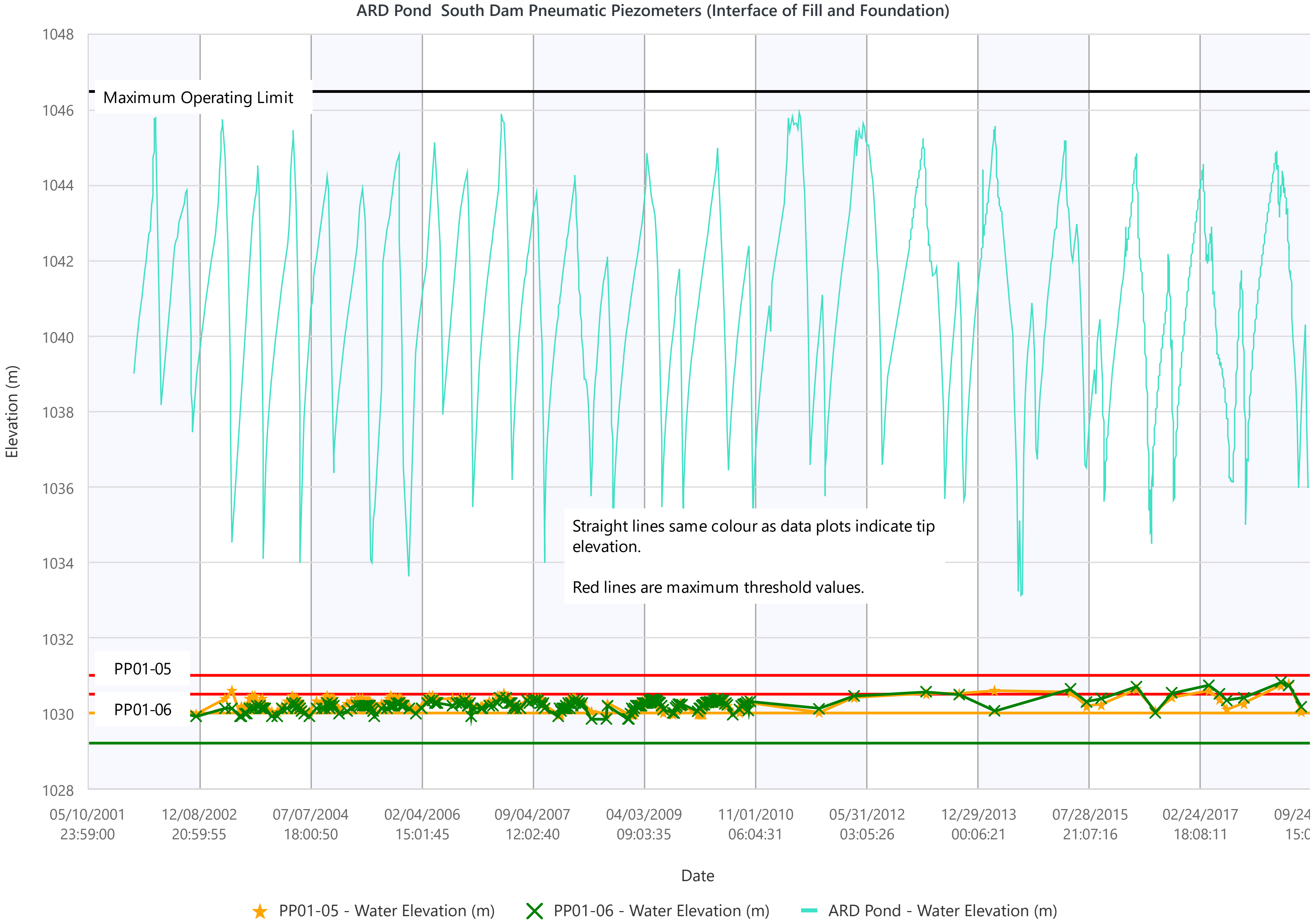

Settlement
NE Gypsum Dike
Elevation (M)
1019.3
1019.25
1019.2
1019.15
1019.1
1019.05
1019
Jan/96
Jan/98
Jan/00
Jan/02
Jan/04
Jan/06
Jan/08
Jan/10
Jan/12
Jan/14
Jan/16
Jan/18
Jan/20
Date of Reading
W Pipe
E Pipe

Figure IX-3

APPENDIX X

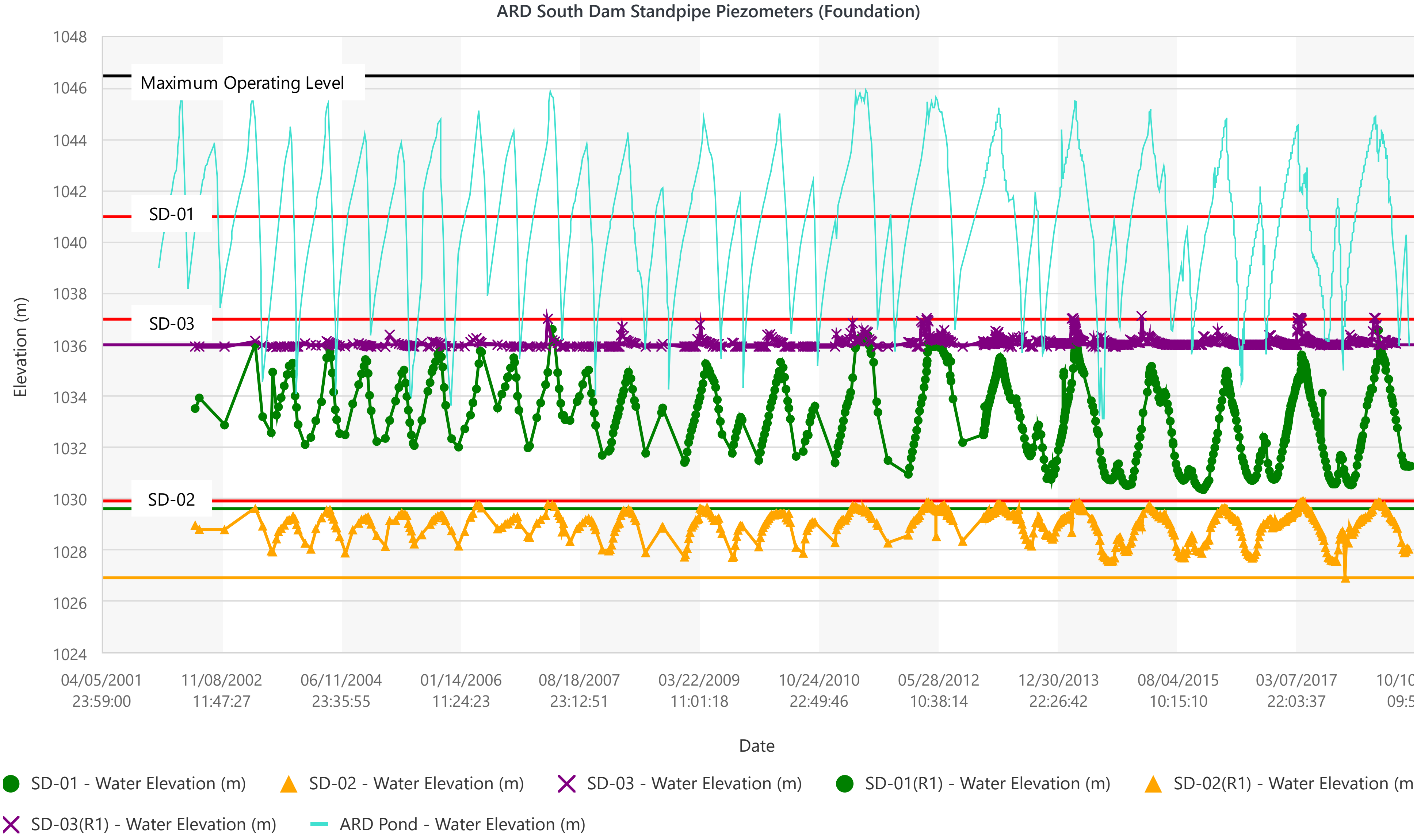
ARD Pond - South Dam and North Dam Instrumentation Data



Straight lines same colour as data plots indicate tip elevation.

Red lines are maximum threshold values.

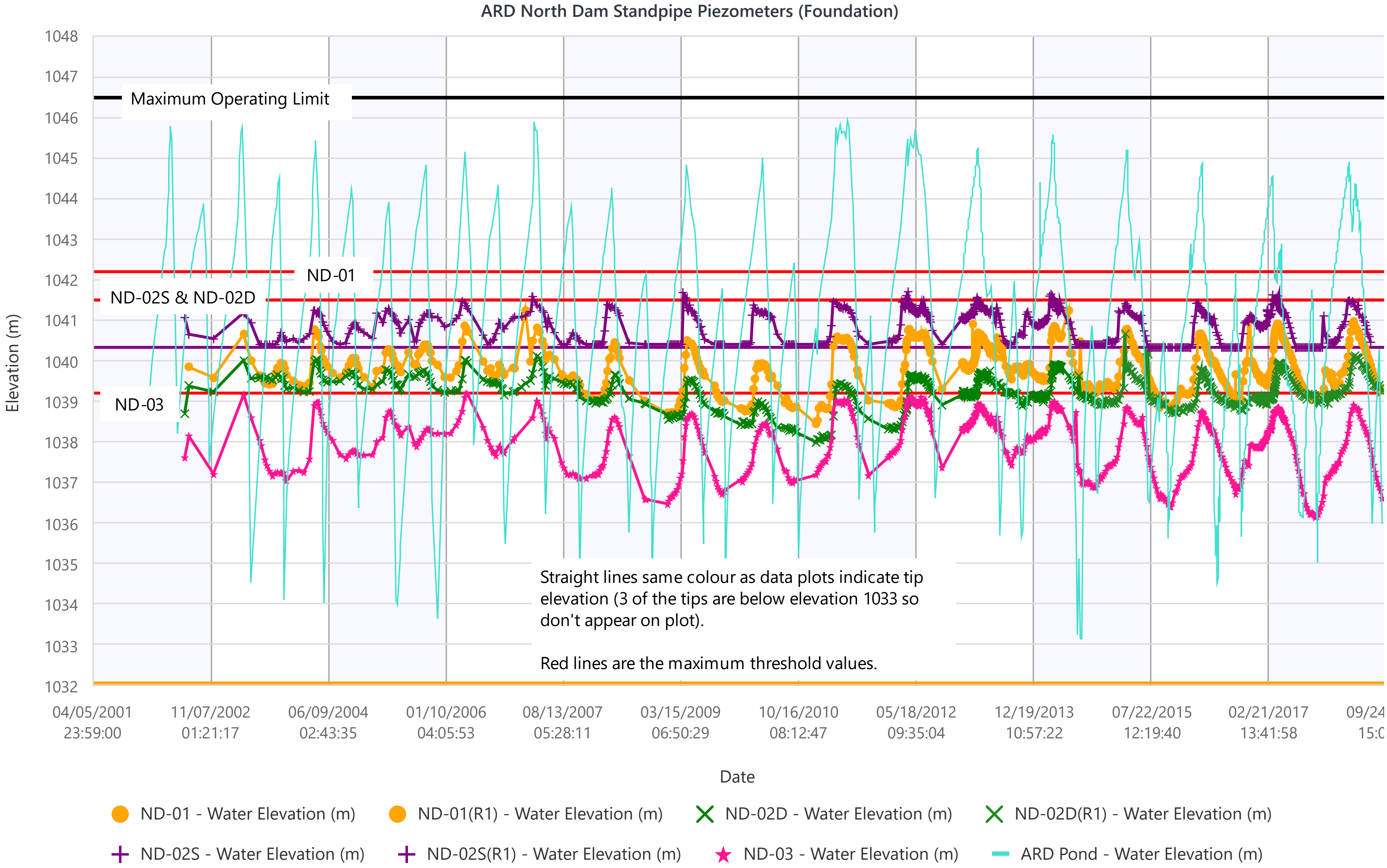
Figure X-1 South Dam



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Only noticeable for those instruments which record "dry" or if previous top of casing elevation was incorrect due to damage.

SD-xx represents readings to point of flushing. SD-xx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure X-2 South Dam Standpipe



Standpipe piezometers were flushed in July/August 2014. Not all sediment was removed and some casings also cut or extended/repaired at this time. Therefore a new top of casing and new depth to bottom of standpipe was recorded for many instruments. Only noticeable for those instruments which record "dry" or if previous top of casing elevation was incorrect due to damage.

ND-xx represents readings to point of flushing. ND-xx(R1) represents readings post flushing. If no (R1) plot then no change to top of casing elevation or depth to bottom of standpipe.

Figure X-3 North Dam Standpipes

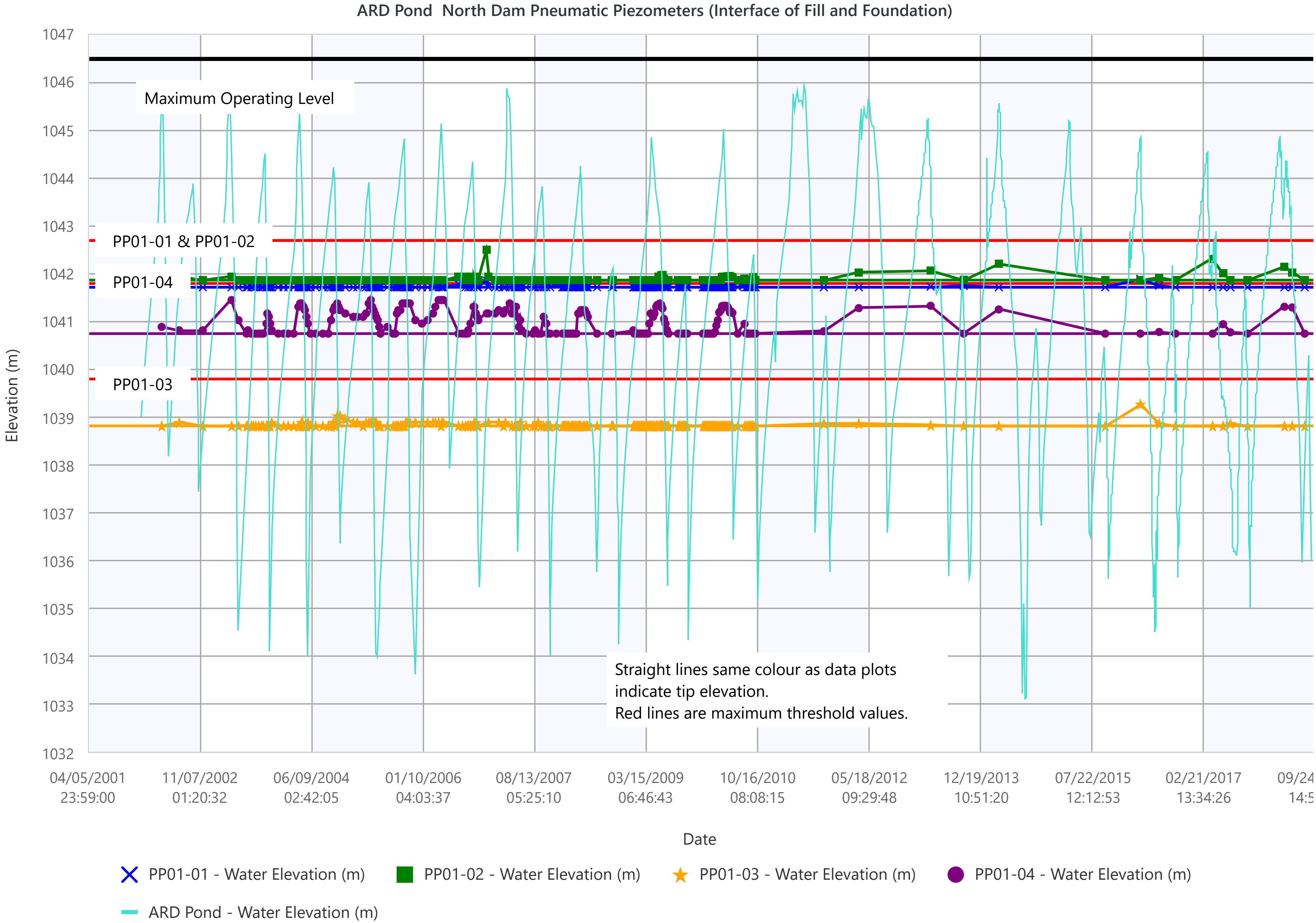


Figure X-4 North Dam Piezometers

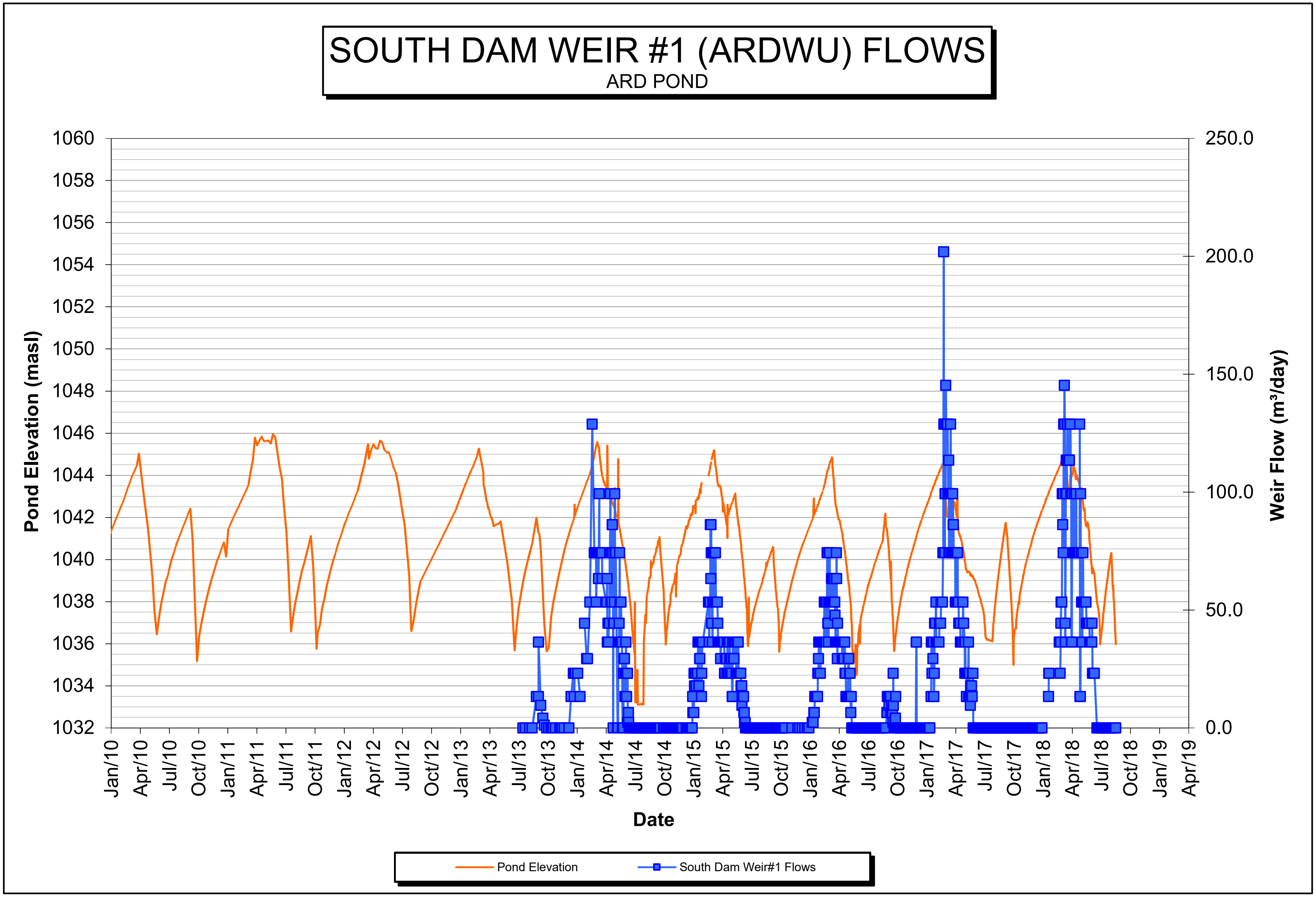


Figure VX-5 ARD Weir #1 (ARDWU) time plot

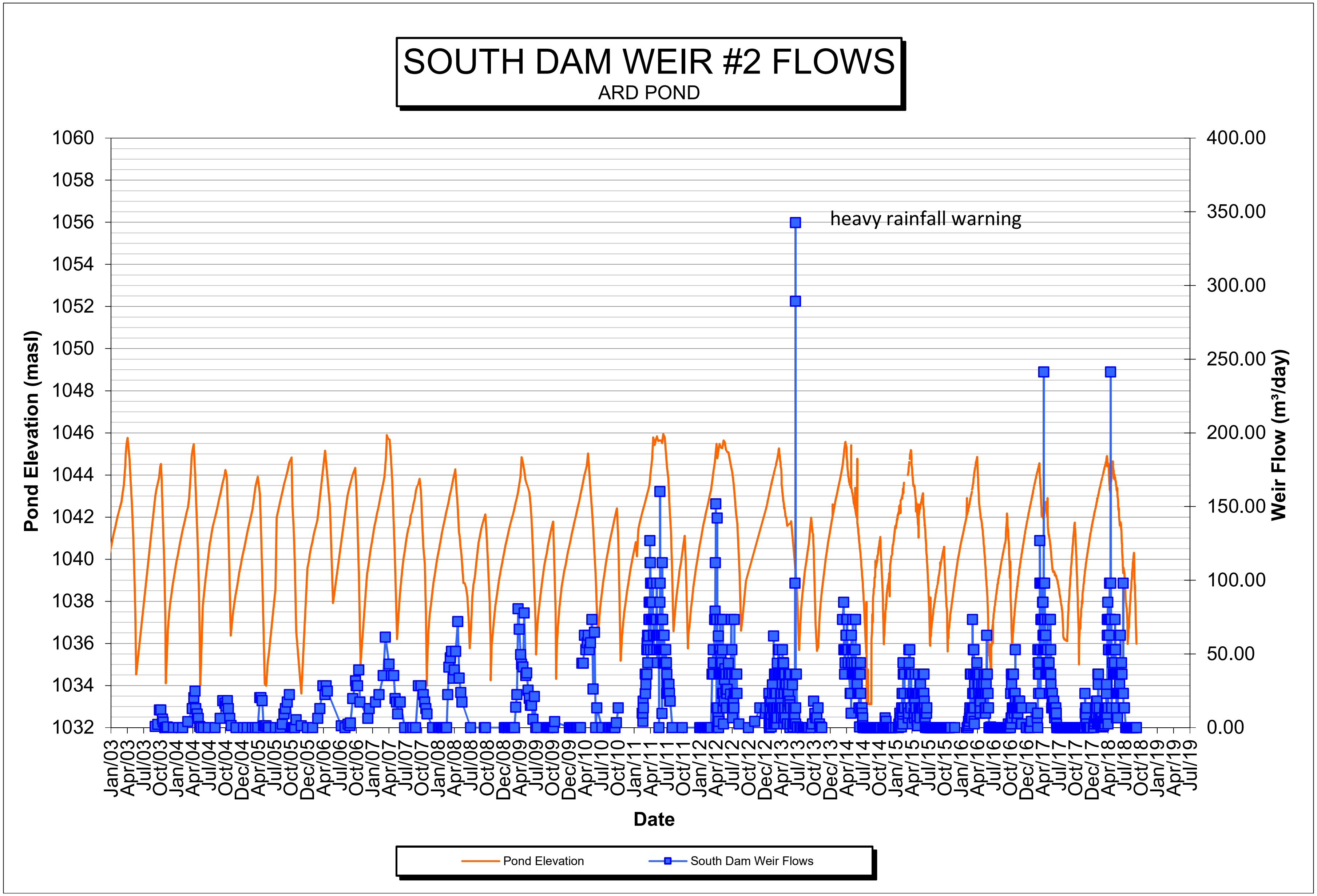


Figure VX-6 ARD Weir #2 time plot

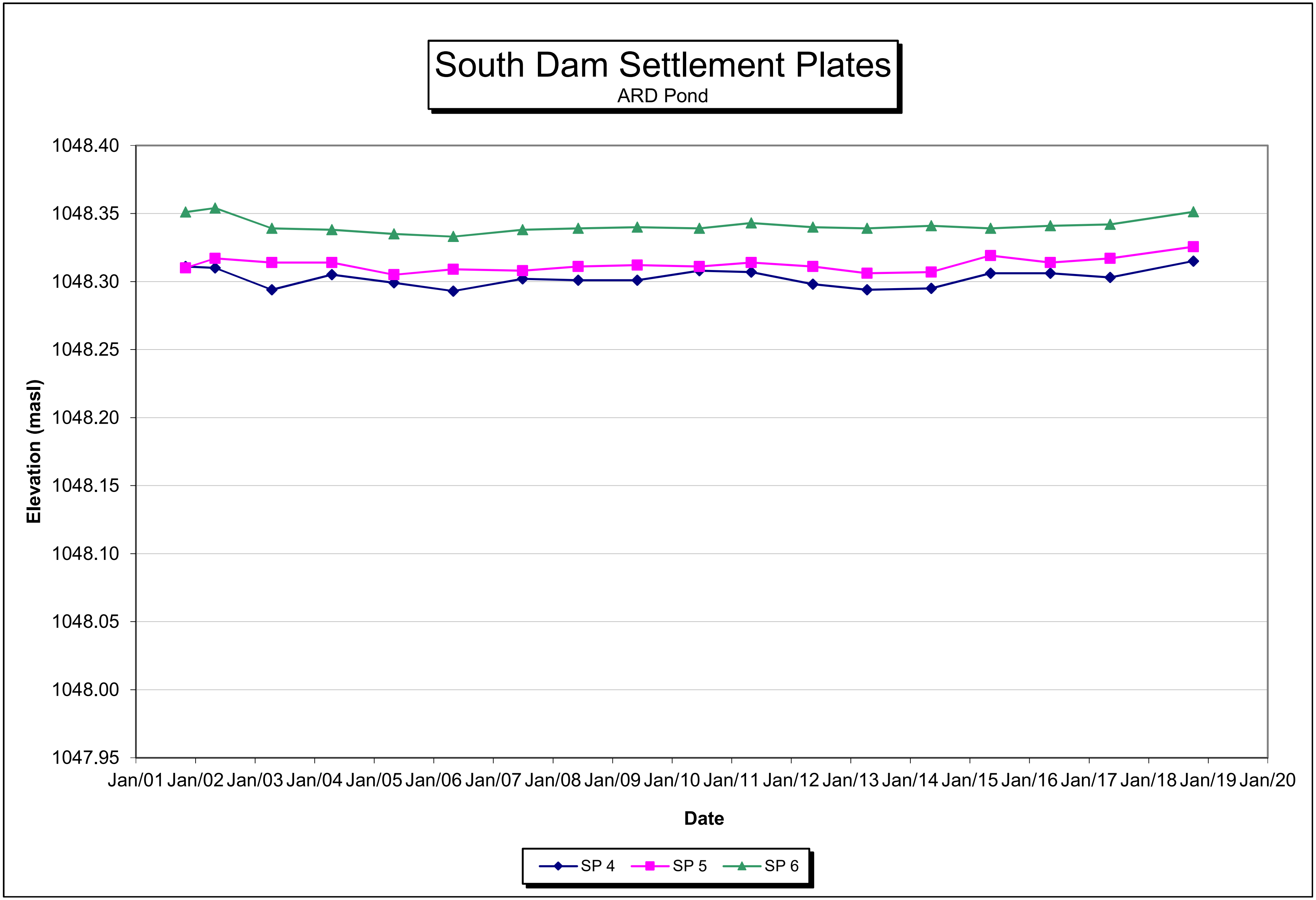


Figure X-7 SD Settlement

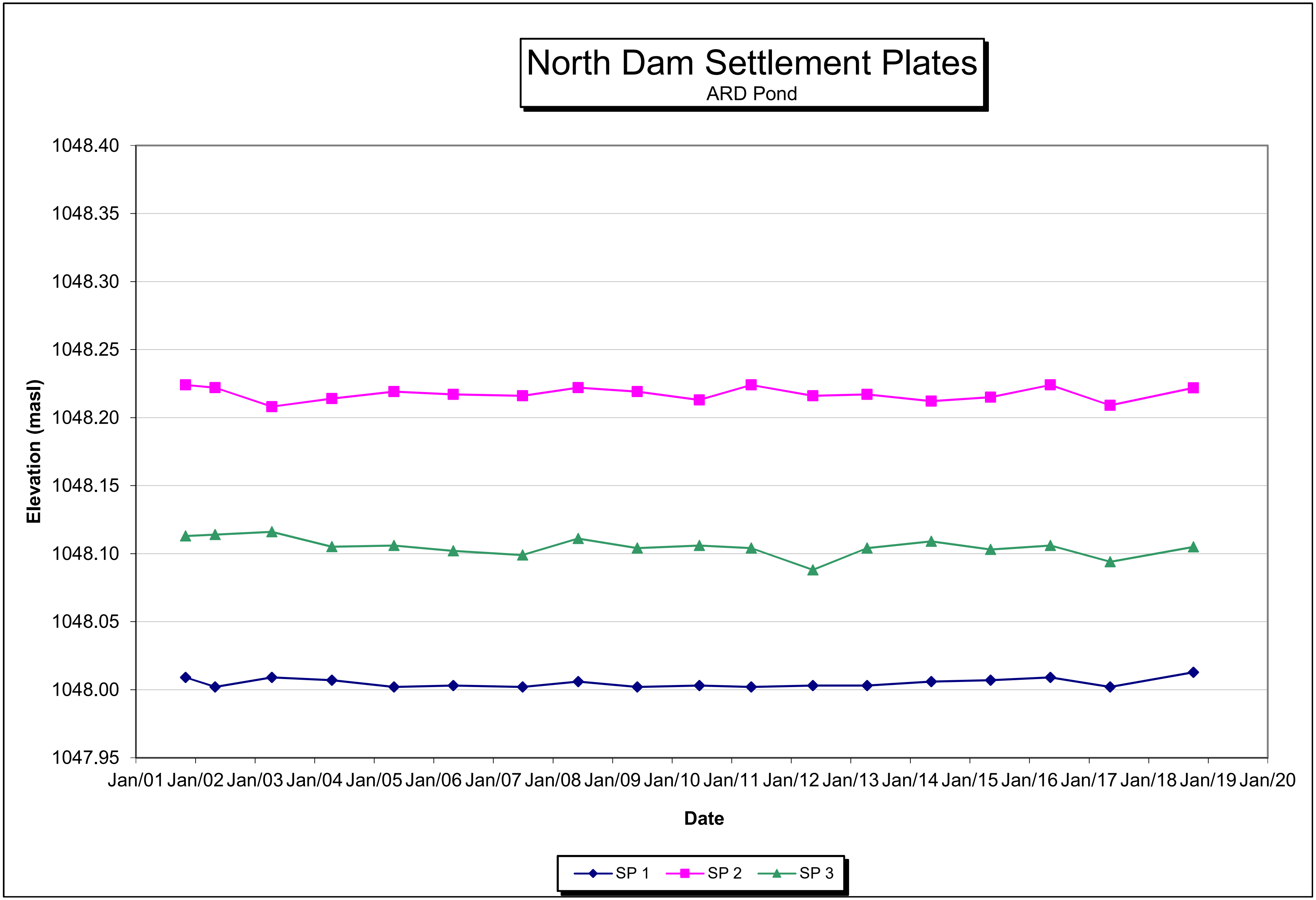
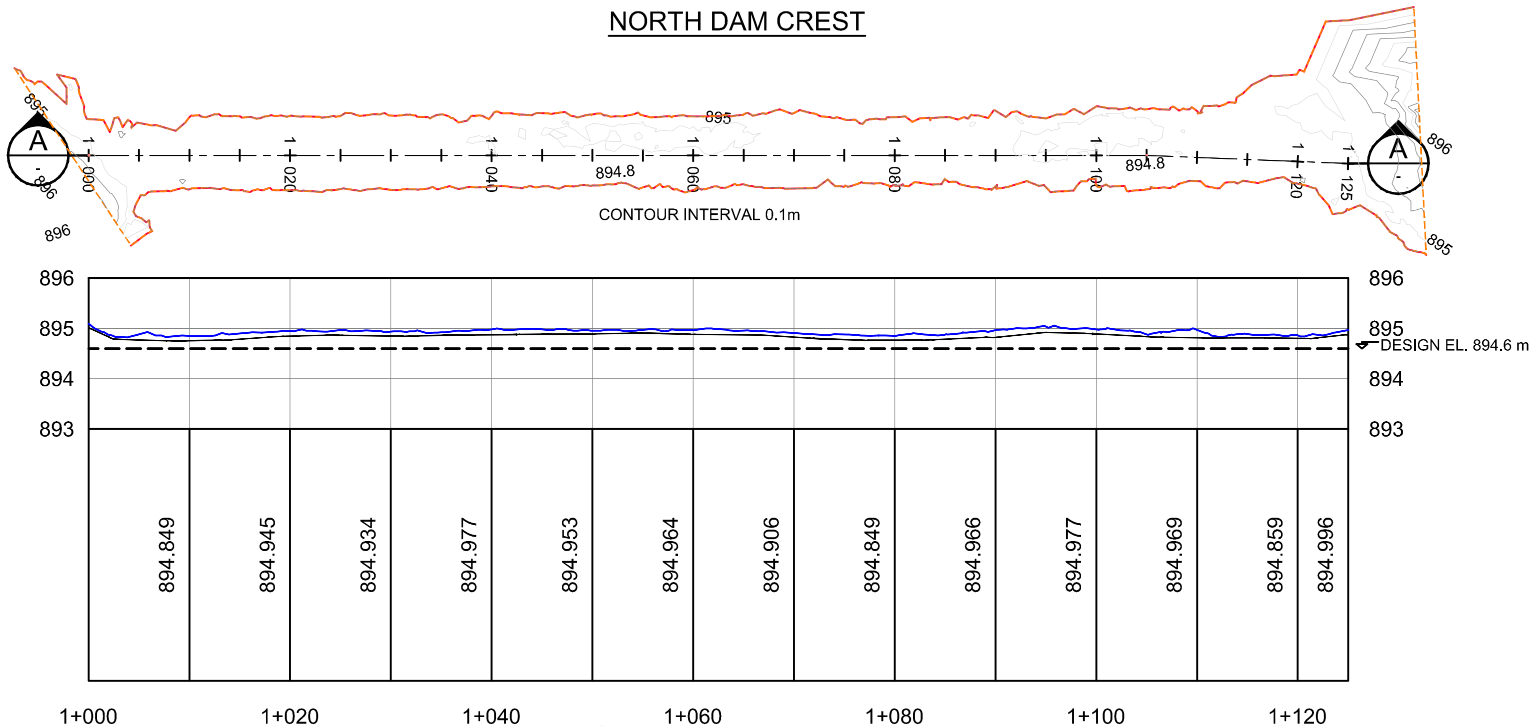


Figure X-8 ND Settlement

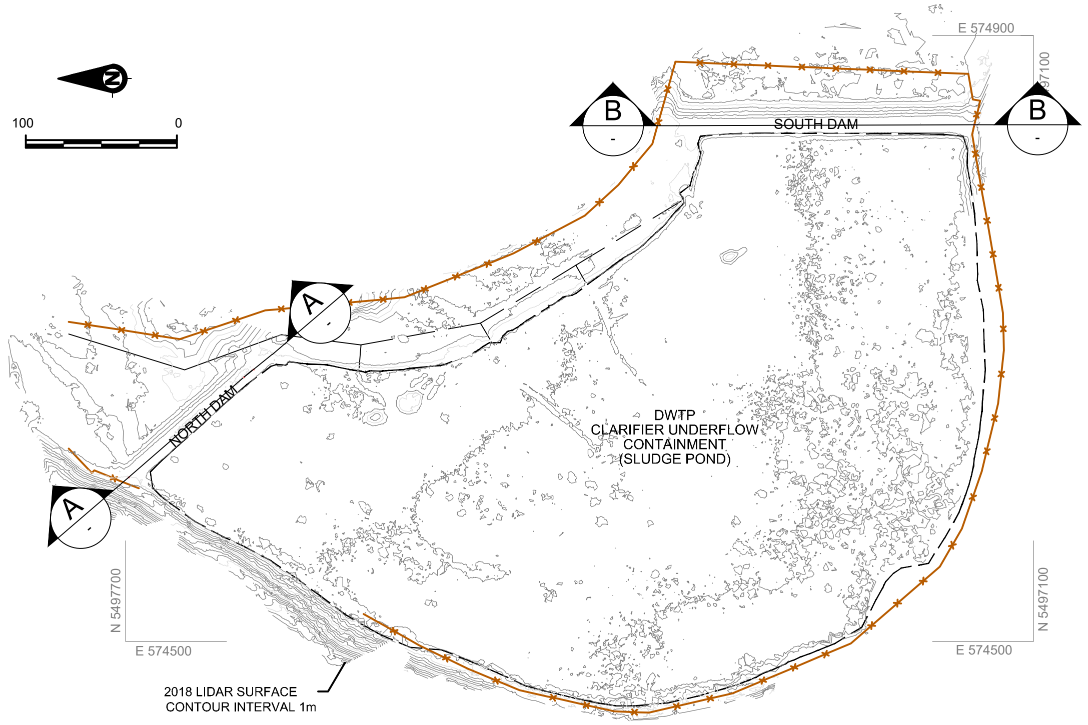
APPENDIX XI

Sludge Impoundment Dike Crest Survey

NORTH DAM CREST

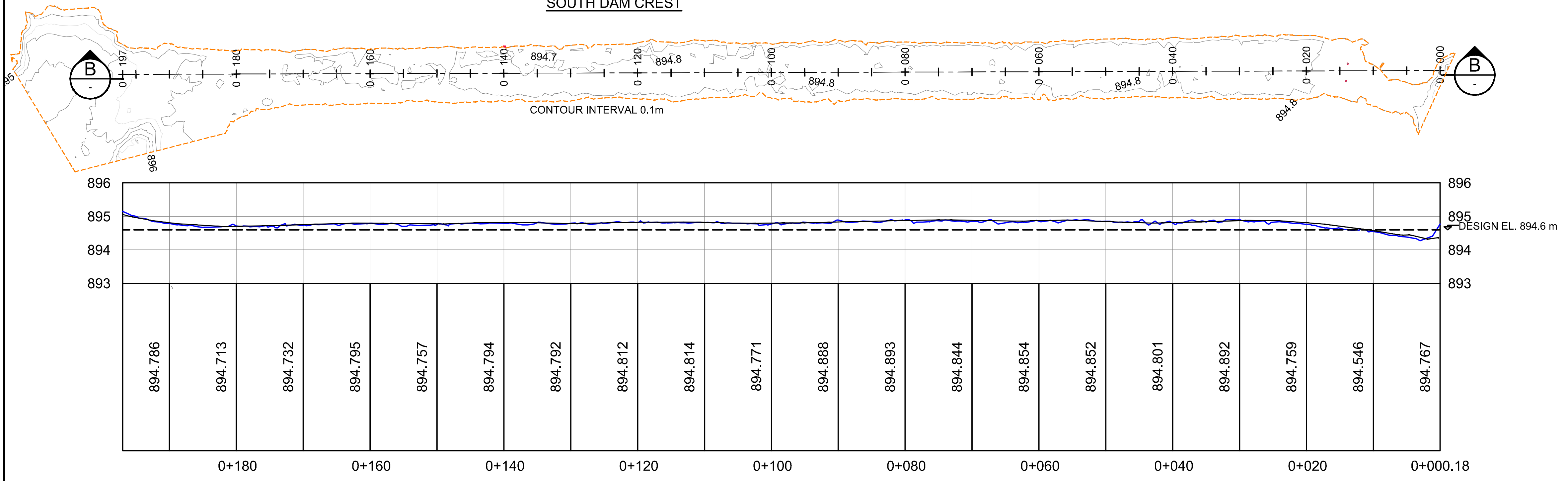


A PROFILE
SCALE 1:750 HORZ.
1:150 VERT.



KEY PLAN 1:5000

SOUTH DAM CREST



B PROFILE
SCALE 1:750 HORZ.
1:150 VERT.

1:150 0 1.5 3 m
1:750 0 7.5 15 m

CLIENT
Teck

Klohn Crippen Berger

PROJECT
SULLIVAN MINE
2018 DAM SAFETY INSPECTION

TITLE
SLUDGE POND
DIKE CREST PROFILES

PROJECT No.
A05807A18

FIG No.
FIGURE XI-1

Z:\A\CGY\Alberta\A05807A18 TML 2018 Sullivan Mine DSI\400 Drawings\Figure XI-1.dwg Layout=FIGURE IX-1 October 12, 2018 1:48:22 PM

KCC-D-8

APPENDIX XII

Summary of Climate and Water Balance Data

Appendix XII
Summary of Climate and Water Balance Data

Figure XII.1 ARD Storage Pond Area-Volume Curve

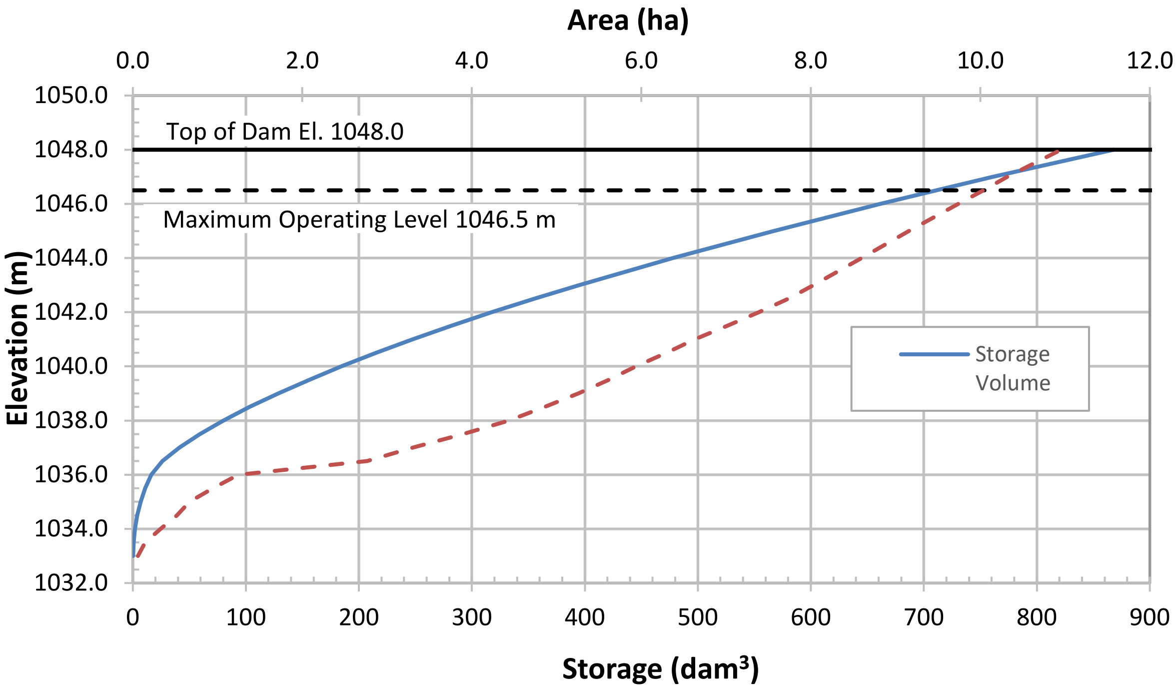


Figure XII.2 Iron Pond Stage-Volume Curve