REPORT

Chapter 9.0 Tide Gauge Results

2021 Marine Environmental Effects Monitoring Program (MEEMP) and Non-Indigenous Species / Aquatic Invasive Species (AIS) Monitoring Program

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21 October 2022

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9.0 TIDE GAUGE RESULTS

9.1 Introduction

In 2021, Baffinland Iron Mines Corporation (Baffinland) undertook water level measurements with a tide gauge stationed at the Milne Port Ore Dock. The tide gauge monitoring program is intended to satisfy requirements of the Mary River Project's (the Project) Ecological Effects Monitoring (EEM) programs and address Terms and Conditions No. 1, 76 and 83 of Project Certificate (PC) No. 005. This is the fifth year this program has been running. This report presents the results of the tide gauge monitoring program during the 2021 season. A brief summary of results across all years is also provided below. Please see Appendix A for the tide gauge installation instructions, Appendix B for the tide gauge calibration documents, and Appendix C for the tide gauge data deliverable.

9.2 Methodology

9.2.1 Unit Conventions

All dates and times are reported in Coordinated Universal Time (UTC), four hours ahead of the local time zone, Eastern Daylight Time (EDT). All horizontal positions are reported in Universal Transverse Mercator (UTM) coordinates referenced to the North American Datum of 1983 (NAD83). Elevations are referenced to the Canadian Geodetic Vertical Datum (CGVD).

9.2.2 Design

The approach to installing the tide gauge on the Milne Port Ore Dock ladder was identical to that of 2020 (Golder, 2021). This was necessary to keep a repeatable installation location and elevation from season to season, which is essential to support inter-annual comparison of water level data.

An RBRconcerto CTD sensor was used to measure conductivity, temperature, and water levels at the Milne Port Ore Dock. To circumvent similar issues that occurred in previous years, an RBRsolo D logger was deployed as a redundancy to measure water levels in case of the RBRconcerto failing. The RBR sensors are both designed to be simple, but accurate and self-contained instruments capable of working in cold (rated to -5 ˚C) and corrosive (i.e., saline) environments. The RBR sensors were mounted in an aluminum housing unit which was secured to the Milne Port ore dock ladder through two welded L-brackets. The ladder is typically installed during the open water period (approximately July to October). The Ore Dock ladder was chosen as the sampling location as it provides a stable mounting point that can be reinstalled each year as part of standard port operations. The RBR sensors and the sampling specifications are summarized in Table 1. Additional details on the tide gauge design, installation and recovery, and mounting hardware are provided in the Milne Port Tide Gauge Installation and Recovery Instructions (Attachment 1).

Table 1: Tide Gauge Instrumentation and Sampling Strategy

Instrumentation	Sampling Strategy	Instrument Accuracy
Sensor: RBRconcerto CTD	**Measurement Interval:** 300 s **Sampling Rate:** 1 Hz **Averaging Duration:** 60 s	**Temperature accuracy:** ±0.002˚C **Conductivity accuracy:** ±0.005 mS/cm **Pressure accuracy:** ±0.05% of full-scale range (0.025 dbar)
Sensor: RBRsolo D	**Sampling Rate:** 1 Hz	**Pressure accuracy:** ±0.05% of full-scale range

9.2.3 Deployment and Recovery

Prior to deployment the RBR sensors were calibrated at the factory. Calibration results are well within the nominal instrument accuracy in Table 1. The standard deviation of calibration errors over the full-scale range of calibration (0 – 60 dbar) is approximately -0.000758 dbar or less than 1 mm. The calibration certificates are included in Attachment 2. Additionally, the RBR sensors were visually inspected, programmed, and synchronized to UTC time. The deployment and recovery of the RBR sensors, attached to the Milne Port Ore Dock ladder, was conducted by Baffinland personnel with remote support provided by Golder personnel on 12 July 2021 and 31 October 2021, respectively. Post-deployment, a GPS RTK (real-time kinematic) survey was conducted to determine the elevation and position of the ladder top plate (Table 2). This involved surveying three points on the ladder top plate and calculating an average elevation. The standard deviation of the elevation measurements is approximately 3.3 cm. Following recovery of the RBR sensors, the data was downloaded by Baffinland personnel and sent to Golder.

Table 2: RTK GPS Survey 2021

Survey Point	Easting (m)	Northing (m)	UTM Zone	Ladder Top Plate Elevation (m, CGVD)	Tide Gauge Elevation (m, CGVD)[1]	Tide Gauge Elevation (m, Chart Datum)
Point 01	503251.208	7976647.873	17W	3.754	-2.661	-1.461
Point 02	503251.316	7976647.975	17W	3.699	-2.716	-1.516
Point 03	503251.412	7976648.066	17W	3.695	-2.720	-1.520
Average Elevation, m				**3.716**	**-2.699**	**-1.499**
Standard Deviation, m				**0.03297**		

Notes: CGVD=Canadian Geodetic Vertical Datum; Horizontal datum is UTM NAD 83, Zone 17W; Elevations assume Chart Datum is 1.2 m below CGVD; [1]Distance from the tide gauge pressure sensor to the surveyed steel ladder top plate is 6.415 m based on an email communication with Baffinland personnel (Ritgen, 2020)

Table 3 shows the elevation of the ladder top plate and tide gauge measured in the Milne Port tide gauge programs from 2017 to 2021. It is noted that both the ladder top plate and the tide gauge have been deployed in the same location and configuration each year, however, the results of the RTK GPS survey show the elevation of the ladder top plate and tide gauge increasing year-on-year, with a total elevation difference of 0.24 m (standard deviation of 0.0943m and trend of 0.0569 m/year).

Table 3: Elevation of Ladder Top Plate and Tide Gauge from 2017 to 2021

Year	Ladder Top Plate Elevation (m CGVD)	Tide Gauge Elevation (m CGVD)
2017	3.474	-2.941
2018	3.501	-2.914
2019	3.568	-2.847
2020	3.586	-2.829
2021	3.716	-2.699
Standard Deviation, m	**0.0943**	
Trend, m/year	**0.0569**	

Figure 1: Left: RTK Survey of the ore dock ladder top plate. Right: Ore dock ladder following removal, with the tide gauge housing shown on the bottom right of the ladder. (Ritgen, 2020)

9.2.4 Data Processing

A preliminary review of the data recorded by the RBR sensors was performed following the recovery. Quality checks included the following:

- Reviewing time series measured by the instruments, including various diagnostic parameters.
- Checking internal recorder and file status.
- Plotting and viewing the time series data.

The data from the RBR sensors was extracted from raw instrument format to ASCII using the instrument specific software Ruskin®. The RBRconcerto successfully recorded for the entire duration of the deployment, so full data processing was carried out for the RBRconcerto (which measures conductivity, temperature, and pressure) but not the backup RBRsolo (which only measures pressure). Plots of measured water quality parameters were generated, and post-processing and quality-checking of data was completed using the MATLAB® (Mathworks, 2019) scientific computing software and included:

- Measurements made by the instrument while it was out of water, as determined from either the pressure or salinity gauge, were replaced with a -999 value.
- Data were filtered for values above a maximum water temperature and salinity. The maximum water temperature was defined as 15 ˚C and salinity as 36 PSU. Filtered values were replaced with a -999 value.
- Where applicable, data were filtered for periods when the change in pressure between consecutive samples exceeded 0.5 dbar (approximately 0.5 m of water). Filtered values were replaced with a -999 value.
- Flagged and missing data values, identified onboard the instrument, were replaced with a -999 value. Additional manual editing to remove or flag spurious data was performed as necessary.
- The instrument deployment and recovery dates and percentage of valid data from the deployment period is provided in Table 4. Quality Controlled (QC) data are provided in Attachment 3.

Table 4: Recorded Data Statistics for the RBRconcerto CTD Sensor

Instrument	Date/Time Deployed (UTC)	Date/Time Recovered (UTC)	Total Records Recorded (#)	Total Records Expected (#)	Flagged and Missing Data (#)	Percent Valid Data (%)
RBRconcerto CTD	12 July 2021, 18:05:00	31 October 2021, 19:55:00	31991	31991	0	100

9.3 Data Summary

9.3.1 Tide Gauge

Time series of temperature, conductivity, salinity, and water level referenced to CGVD as measured by the RBRconcerto at the Milne Port Ore Dock over the length of the deployment are shown in Figure 2. The tide gauge shows a distinct seasonal pattern for near-surface water in Milne Inlet. This pattern was observed in previous years and is discussed in more detail below (Golder, 2018; 2019; 2020; 2021).

The processes observed in the dataset fall into two general time periods which have been identified every year since the tide gauge monitoring began. The first time period is from the tide gauge's deployment on 12 July 2021 to early September. During this time, the RBRconcerto measured large fluctuations in temperature and salinity. The temperature fluctuated between approximately 0 and 8 degrees C and the salinity fluctuated between approximately 4 and 32 PSU. This range is most likely the result of freshwater runoff from Phillips Creek during the spring freshet and the melting of sea ice in Milne Inlet near Milne Port. These processes cause the surface layer to be warmer and less saline than the water column beneath the pycnocline. As the water level varies with the tidal cycle, the tide gauge switches between being positioned in the warmer, fresher water of the surface layer and the colder, more saline water at greater depth.

The second time period is from early September to the tide gauge's retrieval on 31 October 2021. This time period begins after the spring freshet ends and sees the temperature and salinity time series stabilize. A small diurnal fluctuation is observed in the temperature and salinity data in September but mostly ceases beginning in October. It is likely that these diurnal fluctuations are driven by tidal forcing, upwelling/downwelling during wind events, and continued freshwater runoff. As the water level varies with the tidal cycle, the tide gauge switches between being positioned in the warmer, fresher water of the surface layer and in the colder, more saline water at greater depth. Overall, temperature was generally lower and salinity was generally higher in the second time period than in the first time period. In the second time period, temperature ranged from -1 to 3 degrees C, with a mean of 1 degree C; and salinity ranged from 20 to 32 PSU, with a mean of 29 PSU. This likely occurs in response to the autumn weather conditions. Air temperature in Milne Port decreases and fall storms with high winds cause the surface layer of the water column to become well mixed with the layers below. This results in generally colder and more saline surface waters, as observed in the temperature and salinity measurements from early September to the end of the deployment.

The water level data shows that tides in Milne Port follow a mixed semidiurnal tidal cycle. 8 neap tides and 8 spring tides occurred during the tide gauge deployment. The mean water level observed was -0.04 m CGVD. The maximum water level observed was 1.16 m CGVD and the minimum water level observed was -1.14 m CGVD. This range is very consistent with the data from the previous four years.

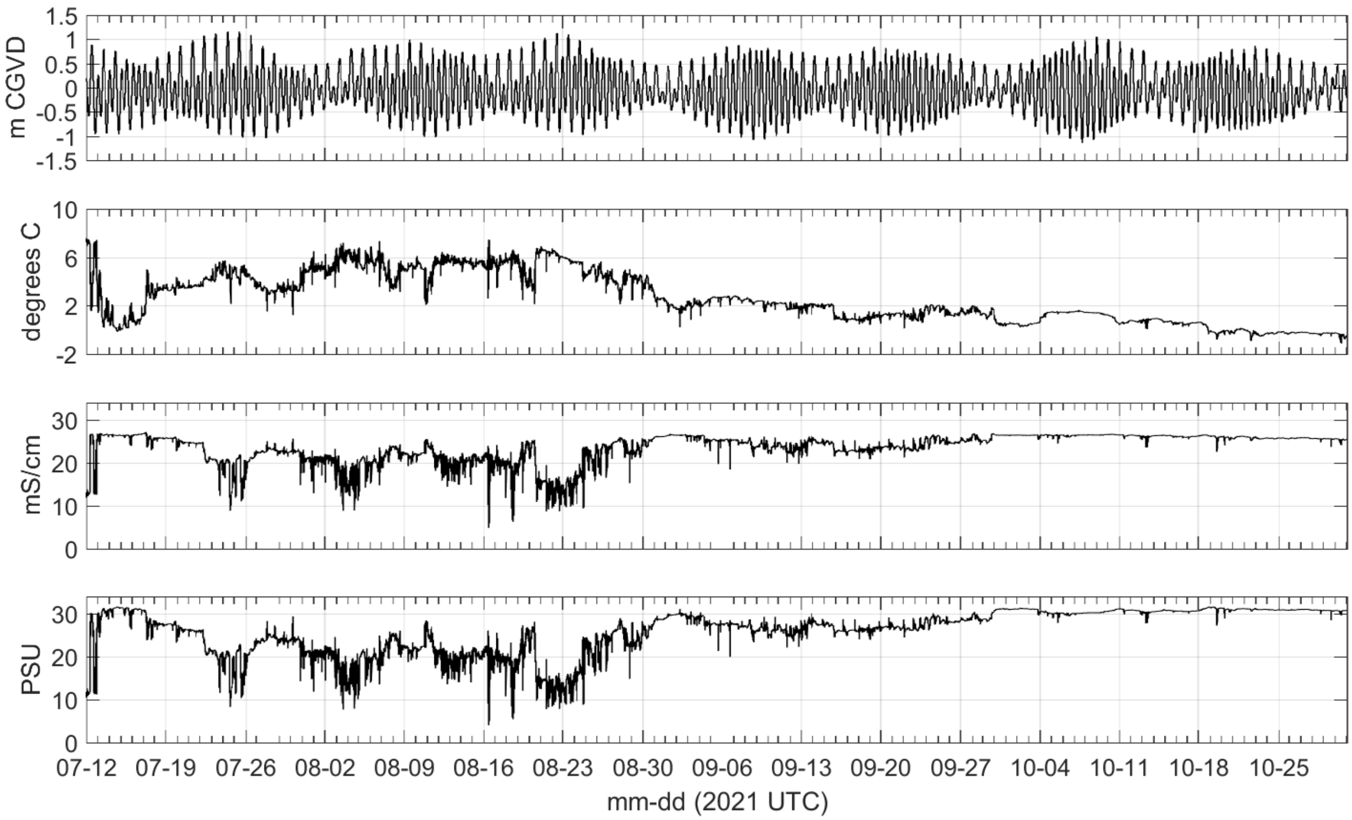


Figure 2: Time series of water level, temperature, conductivity, and salinity measured at Milne Port Tide Gauge by the RBRconcerto CTD Sensor from 12 July 2021 to 31 October 2021 in UTC.

9.3.2 Monitoring Effects of Climate Change Induced Sea Level Change

As noted in the introductory statements, the tide gauge monitoring program is intended to satisfy requirements of the Mary River Project's (the Project) Ecological Effects Monitoring (EEM) programs and address Terms and Conditions No. 1, 76 and 83 of Project Certificate (PC) No. 005.

The objective of Condition No. 1 is to provide feedback on the impacts that climate change might be having on the port facilities. The condition states that the Proponent shall use GPS monitoring or a similar means of monitoring at both Steensby Port and Milne Port, with tidal gauges to monitor the relative sea levels and storm surges at these sites. It should be noted that quantitative measurements of relative sea level change are generally considered beyond the scope of project environmental effects monitoring.

The results of GPS surveys of the tide gauge position show the elevation of the tide gauge to be increasing year-on-year at a mean rate of 0.0569 m/year. This elevation trend is approximately a factor of 10 larger than the estimated isostatic uplift in the region (James et al., 2014; James et al., 2021). The NAD83V70VG model of vertical land motion for Canada (Robin et al., 2020 cited in James et al., 2021) indicates uplift rates of approximately 5 mm/year for northern Baffin Island.

There is currently substantial uncertainty regarding the contribution of both global sea level rise and land uplift rates on year-to-year differences in water level elevation measured by the Milne Port tide gauge. A significant proportion of the uncertainty derives from measurement error in the elevation of the ladder top plate position (see Table 1 and Table 2).

Nonetheless significant trends in relative sea level are likely too small to be measurable in the short term given that relative sea-level projections indicate that relative sea level will either fall or be near neutral for northern Baffin Island (James et al, 2021). Sea level projections are made relative to the solid surface of the Earth, and land uplift from regional isostatic adjustments for Northern Baffin Island is projected to offset projected global and regional sea-level rise for the short to medium term future. In other words, relative changes in sea level are likely to be very small differences between two small quantities both with high uncertainty. Within the next 30 to 50 years relative sea-level projections indicate either falling or near neutral relative sea-level (James et al, 2021). Global sea level change is therefore unlikely to result in any significant climate change-induced sea level impact on the project in the foreseeable future.

Significantly more accurate local elevation control as well as high precision atmospheric pressure correction of the water surface elevation measurements would be required to quantify long term relative sea level change using the Milne Port tide data as changes in relative sea level are expected to be on the scale of fractions of a millimeter per year. The elevation and position of the ladder top plate would need to be precisely surveyed relative to an elevation control monument in the Port. Should Baffinland determine that this is required, Golder recommends that in 2022, the elevation of the ladder top plate be surveyed relative to a local geodetic survey control monument using a precision survey instrument such as a theodolite or total station which employs optical levelling. Golder recommends that the geodetic data regarding the survey control monument also be monitored and retained over time so that changes in ground position (uplift/subsidence) can be evaluated in relation to tide levels monitored using the tide gauge. If records are available, the geodetic history of the Port survey control point could be analysed together with past water level records to evaluate past trends in ground elevation to establish local rates of uplift/subsidence.

Another factor which impacts sea level measurements by pressure sensor are atmospheric pressure variations. The Milne Port gauge is not vented to the atmosphere therefore atmospheric pressure variations influence the levels measured by the instrument. Baffinland could consider analysis of the historical atmospheric pressure record (2017 – present) for processing the water level record with greater precision. For additional data, Baffinland could also consider developing site specific tidal constituents to develop time series of the predicted tide. The latter would allow calculation of anomalies between measured and predicted tides, which would allow quantification of storm surge effects at Milne Port.

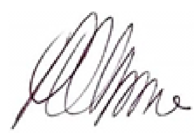
9.4 Raw Data

In addition to this report, Golder has provided the tide gauge data that was processed and quality checked following the methods described in Section 9.2.4. The data is provided as a text file in Attachment 3. All dates and times are reported in UTC time.

9.5 Closure

This report presents the results of the 2021 Tide Gauge Monitoring Program for Milne Port. We trust the information contained in this report is sufficient for your present needs. Should you have any additional questions regarding the project, please do not hesitate to contact the undersigned.

Golder Associates Ltd.



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9.6 References

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APPENDIX 9A

Tide Gauge Installation Instructions

TECHNICAL MEMORANDUM

DATE June 21, 2021 **Project No.** 1663724

TO Justin Dee
Baffinland

CC Benjamin Widdowson

FROM Evan Elder **EMAIL evan_elder@golder.com**

MILNE PORT TIDE GAUGE INSTALLATION AND RECOVERY INSTRUCTIONS

Golder Associates Ltd. (Golder) was retained by Baffinland in 2021 to re-install the tide gauge, an RBRconcerto CTD first deployed in 2017 at Milne Port to provide water level monitoring on-site during the open-water season (typically July to October). In 2021, an RBRsolo D logger will be added for redundancy. The objective of this technical memorandum is to provide installation instructions for the tide gauge at Milne Port and itemize the necessary consumables for installation.

1.0 ALUMINUM MOUNTING SYSTEM OVERVIEW

The tide gauge is housed inside a 26-inch long aluminum square tube (4-inch diameter) to provide protection from vessels and reduce wind and wave effects. The aluminum square tube is mounted to the ladder with two steel L brackets that will be welded to the side of the bottom of the steel ladder located on the ore dock (Figure 1).

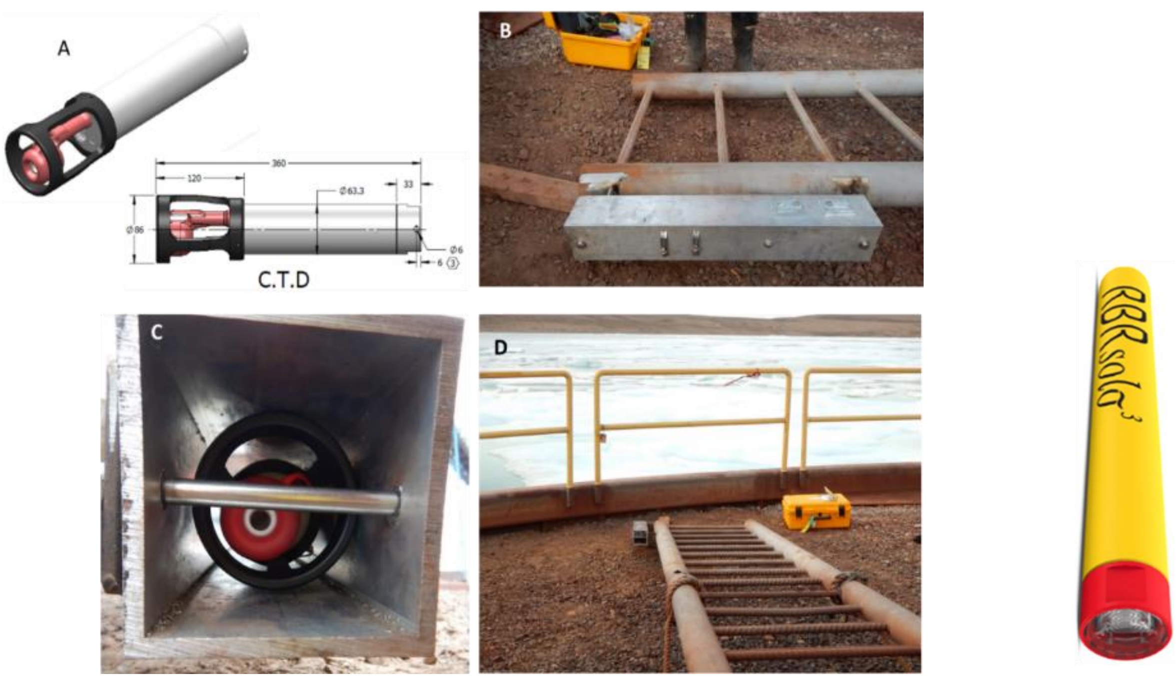

Figure 1: Overview of tide gauge installation. In 2021, an RBRsolo (right) will be included for redundancy.

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2.0 TIDE GAUGE INSTALLATION

Step 1) Two 1/4" diameter holes need to be drilled in the aluminum tube. These holes will be used to add a length of 3mm 316 stainless steel wire rope as redundant security against a hardware failure (Figure 2). On the outside of the aluminum tube two zinc anodes should be replaced with new anodes and secured with one stainless steel bolt (316 stainless 1/2" x 1”) per anode (Figure 5).

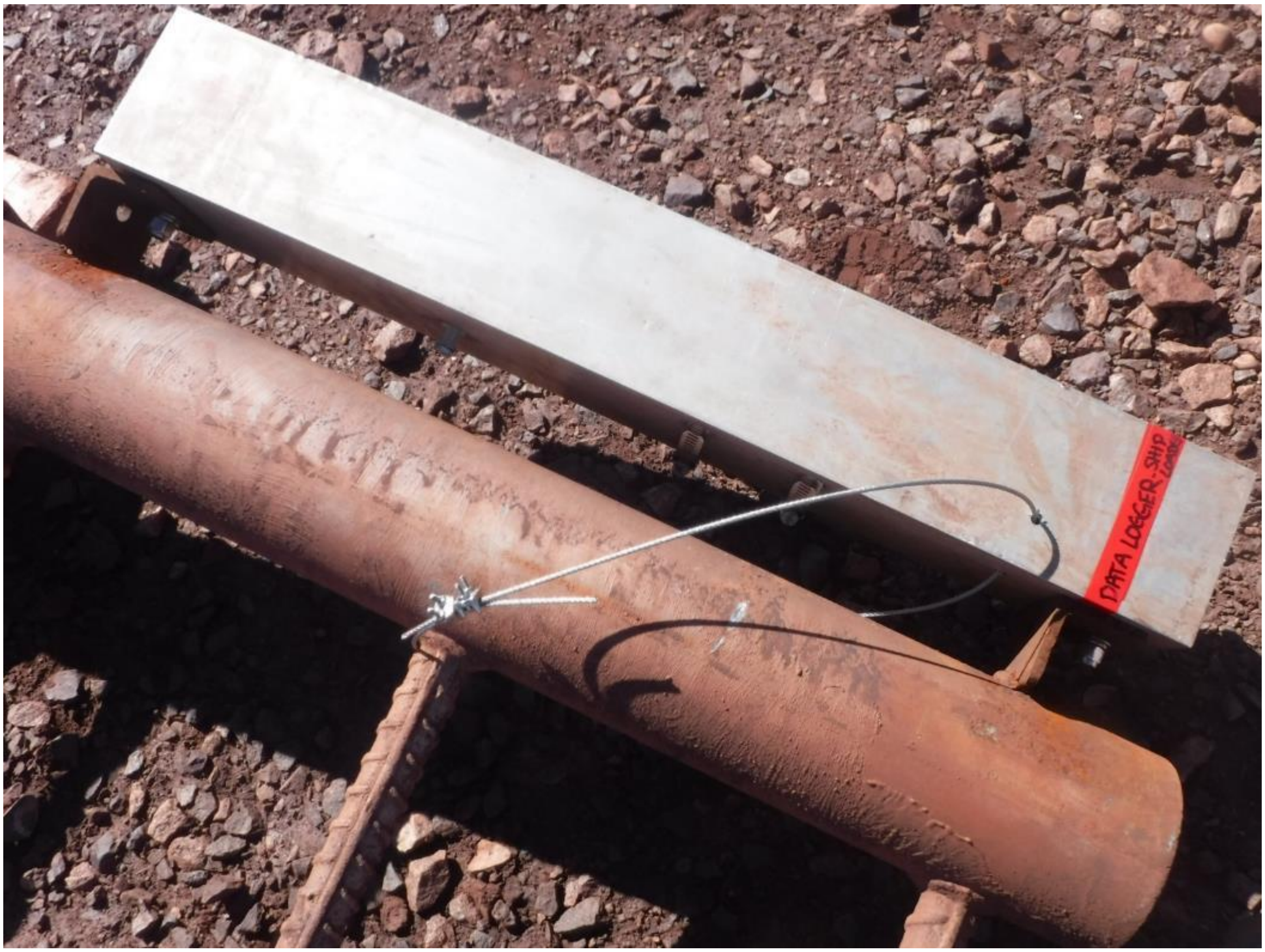


Figure 2: Hardware attaching aluminum tube to steel L brackets and wire rope for redundancy of the L bracket attachments.

Step 2) The redundant tide gauge (RBRsolo – small yellow cylinder) should be hose clamped to the primary tide gauge (RBRconcerto – white cylinder). The sensor on the RBRsolo (red end) should be facing the same direction as the sensor end of the RBRconcerto (red/black end). This configuration is shown in Figure 3. Measure and record the distance between the sensor on the primary tide gauge and the sensor on the redundant tide gauge.

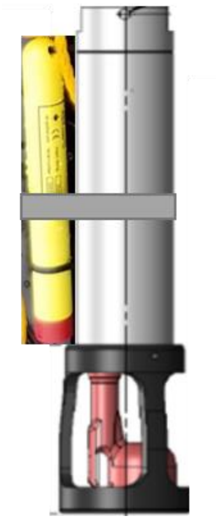


Figure 3: Configuration of an RBRsolo hose clamped to an RBRconcerto.

Step 3) The primary tide gauge (RBRconcerto – white Delrin cylinder) should be mounted inside the aluminum square tube with one stainless steel bolt (316 stainless 1/4" x 4 1/2”), washer, nylon shoulder washer, lock nut (Figure 4) and two stainless steel hose clamps wrapping around the body of both RBR loggers, using caution to not overtighten against the plastic housing. The bolt should be passed through the hole on the end cap of the primary tide gauge, making sure not to twist the end cap in the process, and secured to the square tube with nylon shoulder washers inserted in the drilled holes on the aluminium square tube (Figure 5). The white RBRconcerto (not the yellow RBRsolo) should rest against the aluminum tube.

Figure 4: Hardware attaching aluminum tube to L brackets and view of the primary tide gauge mounted in the tube. Arrow shows location of the ¼" bolt that should pass through the end cap of the primary tide gauge. Note that the redundant tide gauge is not shown in this photo, but would be sitting to the right of the primary tide gauge in this photo.

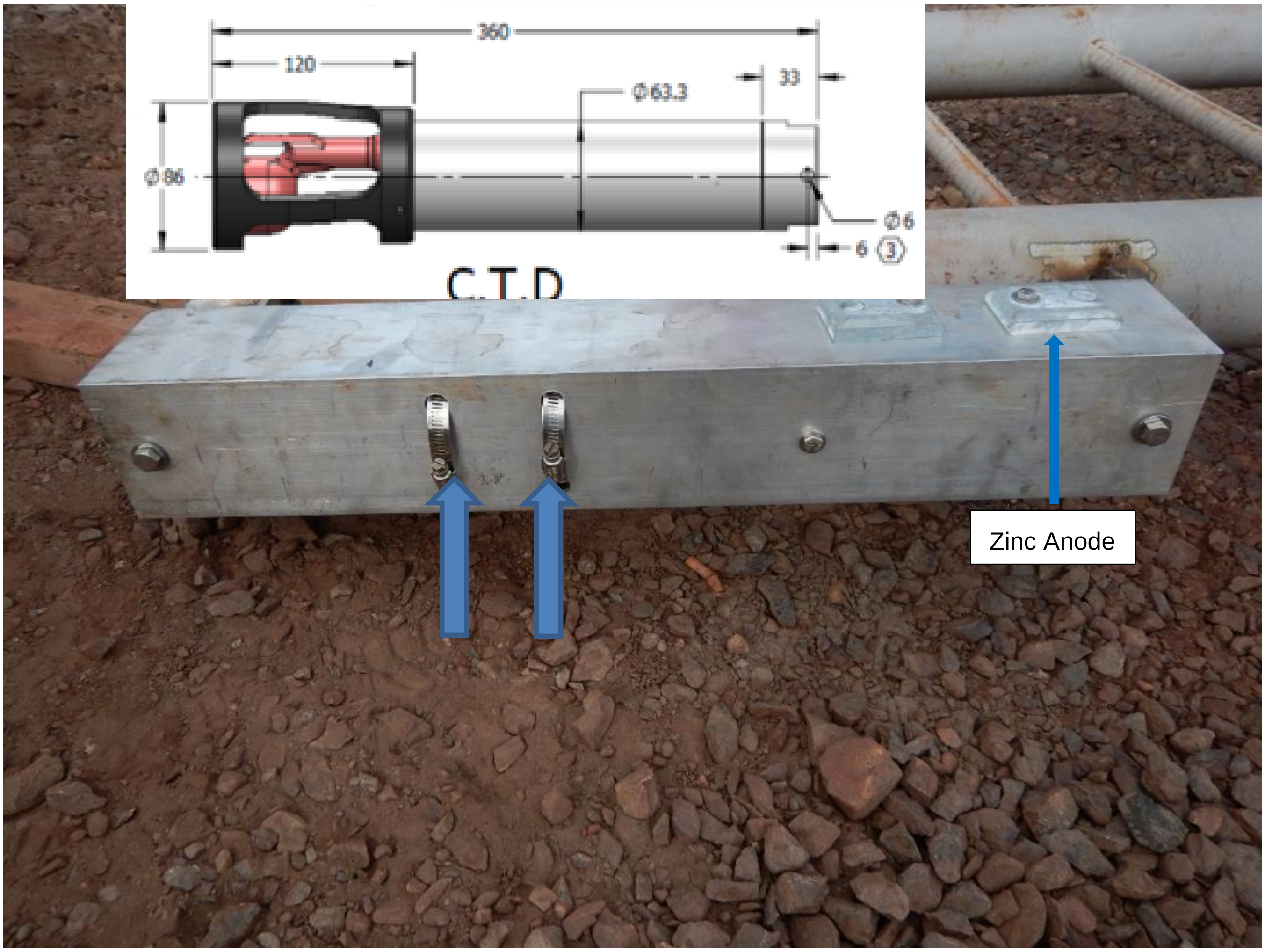


Figure 5: Hardware attaching primary and redundant tide gauge to tube. Arrows show the location of the hose clamps which mount the tide gauges to the square tube and the zinc anodes. In 2021, the two hose clamps should go around both the primary tide gauge and redundant tide gauge.

Step 4) The aluminum square tube is mounted to the ladder at two steel L brackets that are welded to the side of the bottom of the steel ladder located on the ore dock. The primary tide gauge should be mounted such that the red and black end cap is pointing downwards towards the seabed. The integrity of the welds on the ladder should be inspected before mounting the square tube. Mount the aluminum tube to the L brackets with stainless steel bolts (316 stainless 3/8" x 5"), washers, nylon shoulder washers, lock washers and lock nuts (Figure 6).

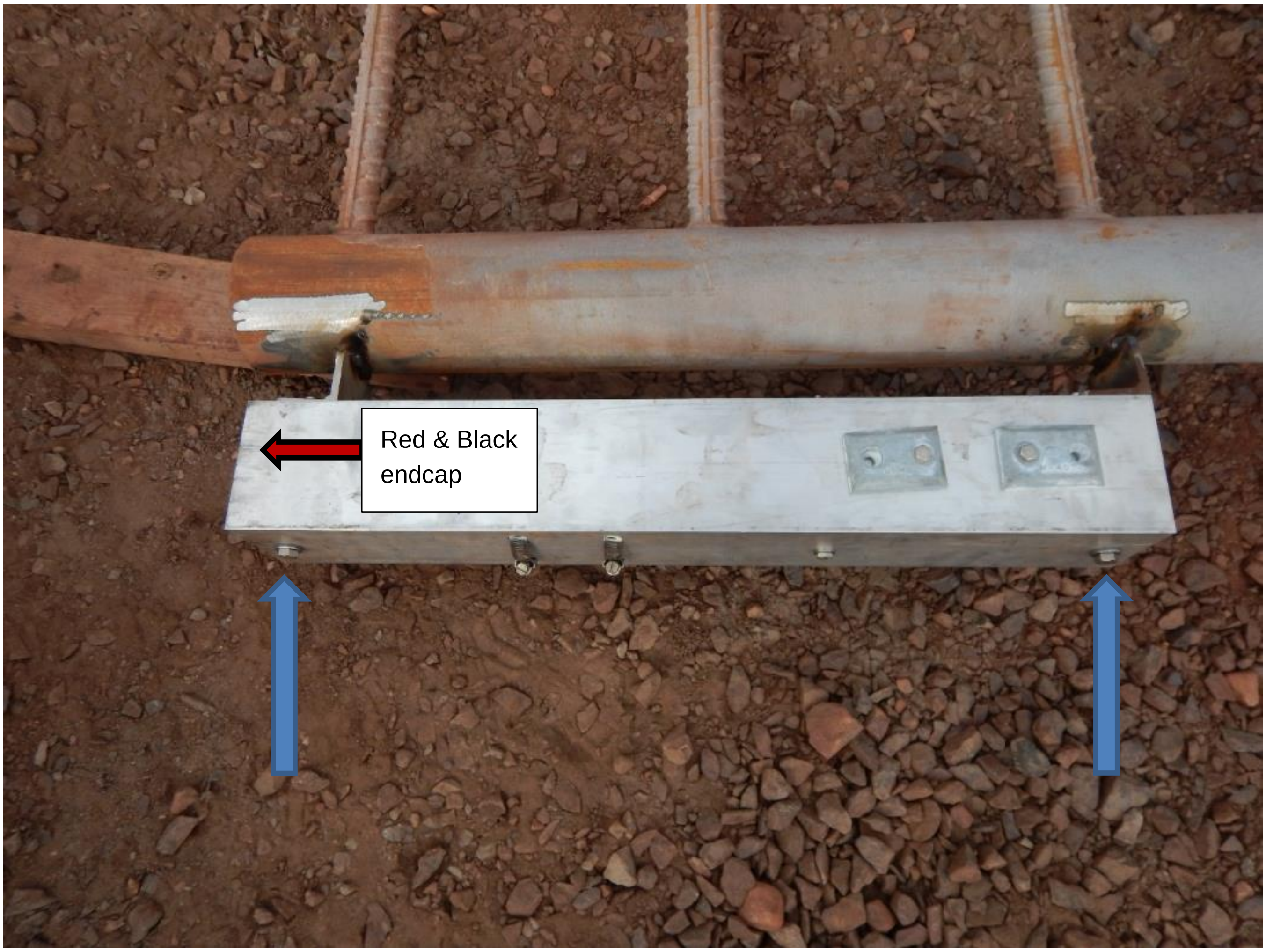


Figure 6: Aluminum square tube mounted to the bottom of the steel ladder located at the ore dock. Arrows show location of mounting bolts which attach the square tube to the welding tabs on the steel ladder.

Step 5) Add a length of 3 mm 316 stainless steel wire rope passed through the two holes on the square tube, and around the bottom ladder rung, and join wire rope together with 2 wire rope clips (1/8" stainless steel). This is to provide a redundant mounting system (Figure 2).

Step 6) Take photos during each step of the installation process for documentation purposes and provide a record of hardware used and any changes to the above steps.

Step 7) In 2018 the elevation and position of the ladder was surveyed using five survey points measured from an RTK GPS system. The following table provides the survey position and elevation of the primary tide gauge pressure sensor in 2018. The pressure sensor is located behind the plastic sensor cover on the downward facing end of the primary tide gauge (Figure 7). The distance from the bottom of the aluminum tube to a point at the top plate of the ladder and from the pressure sensor to a point at the top plate of the ladder was measured as 6.57 m and 6.42 m in 2018, respectively.

An RTK GPS survey will need to be conducted in 2021 to reference the steel ladder top plate and provide a reference for instrument to chart datum. Additionally, the distance from the primary tide gauge pressure sensor to the ladder top plate and from the bottom of the aluminum tube to the ladder top plate should be measured.

Table 1: RTK GPS survey 2018

Survey Point	Easting (m)	Northing (m)	UTM Zone	Elevation (m, CGVD)	Tide Gauge Elevation (m, CGVD)[1]
Point 01	503227.211	7976633.252	17W	3.505	-2.915
Point 02	503227.205	7976633.246	17W	3.516	-2.904
Point 03	503227.205	7976633.242	17W	3.491	-2.93
Point 04	503227.197	7976633.241	17W	3.495	-2.925
Point 05	503227.215	7976633.268	17W	3.496	-2.924
Average Elevation				3.501	-2.920

Notes: CGVD=Canadian Geodetic Vertical Datum; [1]Distance from the tide gauge pressure sensor to the surveyed steel ladder top plate is 6.42 m

Figure 7: Pressure sensor location, shown by the arrow, on the downward facing end of the primary tide gauge

Figure 8: RTK GPS survey conducted in 2018

3.0 HARDWARE LIST

The following is a list of necessary hardware to complete the tide gauge installation:

Item Description	Quantity
26” aluminum square tube	1
Stainless steel L-brackets	2
316 stainless steel hex bolt 5”- 3/8”	2
316 stainless steel lock nut 3/8”	2
316 stainless steel lock washer 3/8”	2
316 stainless steel washer 3/8”	4
Nylon shoulder washer 3/8”	4
316 stainless steel hex bolt 4 1/2”- 1/4”	2
316 stainless steel lock nut 1/4”	2
316 stainless steel washer 1/4”	4

Item Description	Quantity
Nylon shoulder washer 1/4"	2
Zinc anode	2
316 stainless steel hex bolt 1” – 1/2"	2
316 stainless steel washer 1/2"	2
316 stainless steel lock nut 1/2"	2
316 stainless steel ½” band width hose clamps 2 9/16”-3 1/2” diameter	2
3mm 316 stainless steel wire rope	1 roll
1/8” stainless steel wire rope clip	2

4.0 TIDE GAUGE RECOVERY

Upon recovery of the tide gauge from the ore dock ladder the following steps should be done.

Step 1) The distance from the primary tide gauge pressure sensor (Figure 7) and the bottom of the aluminum tube to the steel ladder top plate (Figure 8) should be recorded and accompanied by a photo of the measurements (i.e. a photo of the tape measure). The distance from the secondary tide gauge sensor to the primary tide gauge sensor should also be recorded.

Step 2) If determined applicable, data from both of the two tide gauges should be downloaded using the computer software program Ruskin before shipping. The software program Ruskin can be obtained from https://rbr-global.com/products/software. The following steps should be followed when using Ruskin:

- Unscrew the tide gauge end cap to expose the USB port and battery compartment.
- Plug one end of the data cable (found in the RBR logger box) into the RBR logger and the other end of the cable into the computer. The cable for both loggers should be a USB-C cable.
- Open the software program Ruskin. The instrument should appear in the Navigator tab under the subheading Instruments.
- Click on the Download tab and select “download”. Save the .RSK file to a location on the local machine.
- Disconnect the USB cable from the logger and computer.
- Screw the tide gauge end cap back on.
- DO NOT select stop logging or enable logging.
- DO NOT remove the batteries from the instrument.

APPENDIX 9B

Tide Gauge Calibration Documents

Conductivity Calibration Certificate

RBRconcerto³ C.T.D|fast8 s/n: 207642

References: Autosal8400B#66289, MS-315#15506, SSW P163, RC#002

Reference Resistance (ohm)	Reference Conductivity (mS/cm)	Voltage Ratio, V	Measured Conductivity (mS/cm)	Calibration Error (mS/cm)
open	0.0000	-0.000104	-0.0003	-0.0003
694.023	6.1094	0.039142	6.1089	-0.0005
331.918	12.7744	0.081960	12.7742	-0.0002
150.011	28.2649	0.181483	28.2663	0.0014
100.007	42.3974	0.272263	42.3974	0.0000
75.013	56.5240	0.363012	56.5238	-0.0002
55.511	76.3819	0.490584	76.3821	0.0001
47.018	90.1790	0.579215	90.1787	-0.0003

Coefficients

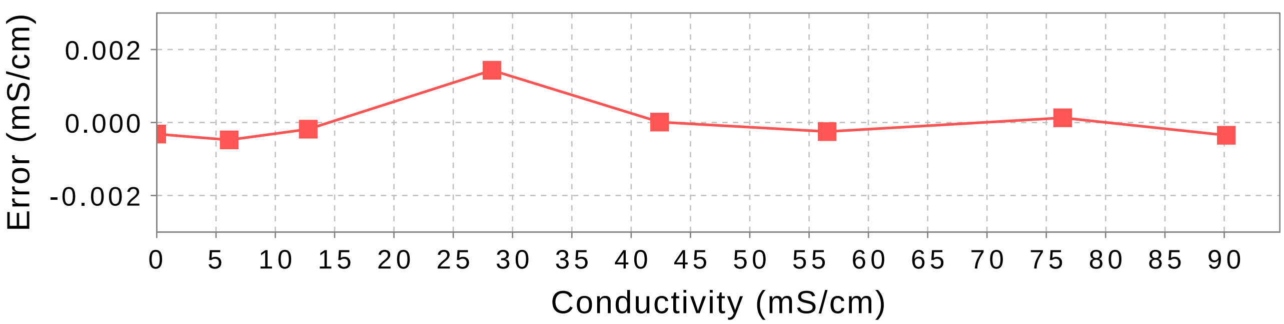
C0:	**15.885748E-3**
C1:	**155.6639**
X0:	**435.98202E-6**
X1:	**-8.058266E-6**
X2:	**600E-9**
X3:	**14.90292**
X4:	**10**

Bath	Voltage Ratio	Temperature (ITS-90)	Salinity (PSS-78)	Conductivity (mS/cm)
T15S35	0.2749927	14.90292	35.0002	42.8223
T25S35	0.3428941	25.30215	35.0038	53.3921

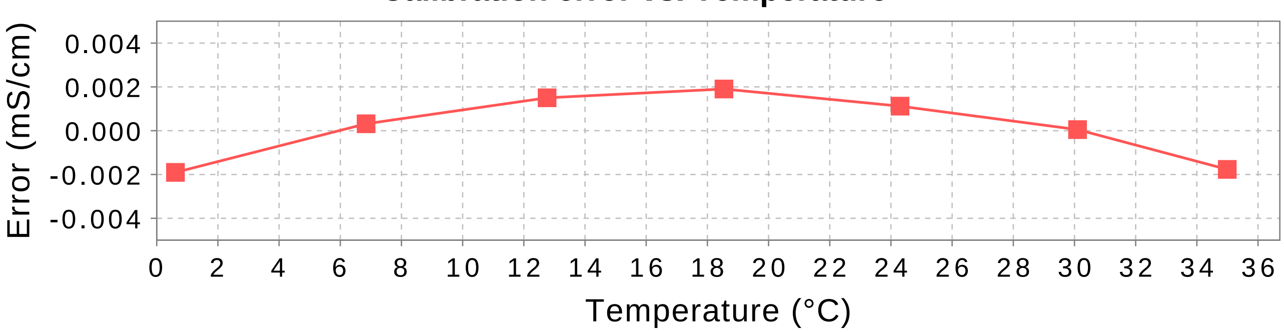
Cell Constant @T15S35 = 4.24004 1/cm

$$C_{cor} = \frac{C_0 + C_1 * V - X_0 * (T - X_3)}{1 + X_1 * (T - X_3) + X_2 * (P - X_4))}$$

Calibration error vs. Conductivity



Calibration error vs. Temperature



Calibration Date: 2021-06-09
Issue Date: 2021-06-09
File Name: 207642_20210609_1636C.rsk

Operator: jwalker

Approver: kmalorny

Pressure Calibration Certificate

RBRconcerto³ C.T.D|fast8 s/n: 207642
Instrument rating: 50 dbar s/n: K296591
Nominal accuracy: 0.05%FS (0.025 dbar)
Reference instrument: Mensor CPC6050 s/n: 41000CAM

Applied pressure, P_{app} (dbar)	Voltage ratio, V	Measured pressure, P_c (dbar)	Calibration error (dbar)
10.058	0.048683	10.0568	-0.0009
15.000	0.069505	15.0016	0.0019
19.999	0.090546	19.9997	0.0003
25.000	0.111586	24.9991	-0.0004
30.000	0.132625	29.9992	-0.0006
34.999	0.153661	34.9994	-0.0000
40.000	0.174695	39.9992	-0.0003
45.000	0.195735	45.0005	0.0006
50.000	0.216768	50.0000	0.0002
55.000	0.237808	55.0002	0.0003
60.000	0.258848	59.9998	-0.0004

Coefficients

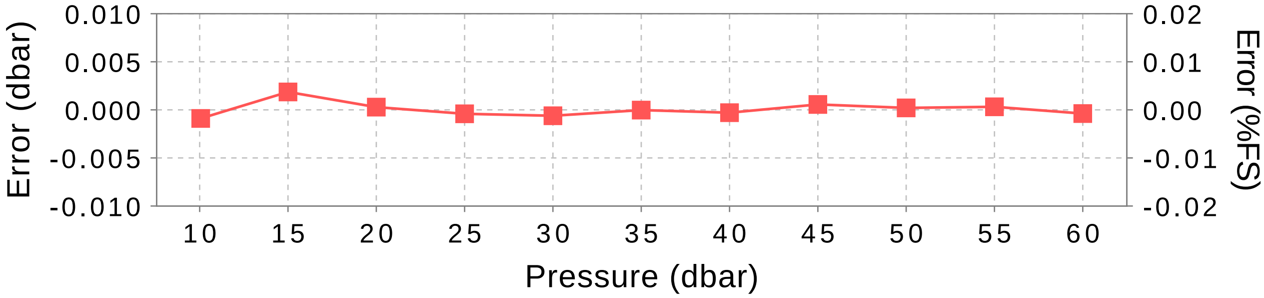
C0:	-914.03097E-3
C1:	237.17517
C2:	3.0330358
C3:	-5.737307
X0:	10.0577
X1:	7.842538E-3
X2:	48.955848E-6
X3:	214.32402E-9
X4:	-93.56487E-6
X5:	21.411144

$$P_c = X_0 + \frac{P_m - X_0 - X_1(T - X_5) - X_2(T - X_5)^2 - X_3(T - X_5)^3}{1 + X_4(T - X_5)}$$

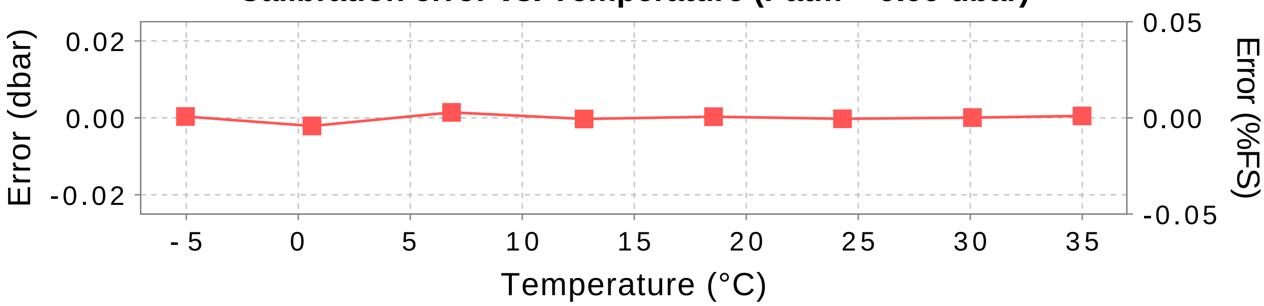
Head (mm) = 582

$$P_m = C_0 + C_1 V + C_2 V^2 + C_3 V^3$$

Calibration error vs. Pressure (Tcal = 21.4°C)



Calibration error vs. Temperature (Patm = 9.99 dbar)



Calibration Date: 2021-06-08
Issue Date: 2021-06-08
File Name: 207642_20210608_1308P.rsk

Operator: afalicki

Approver: kmalorny

Temperature Calibration Certificate

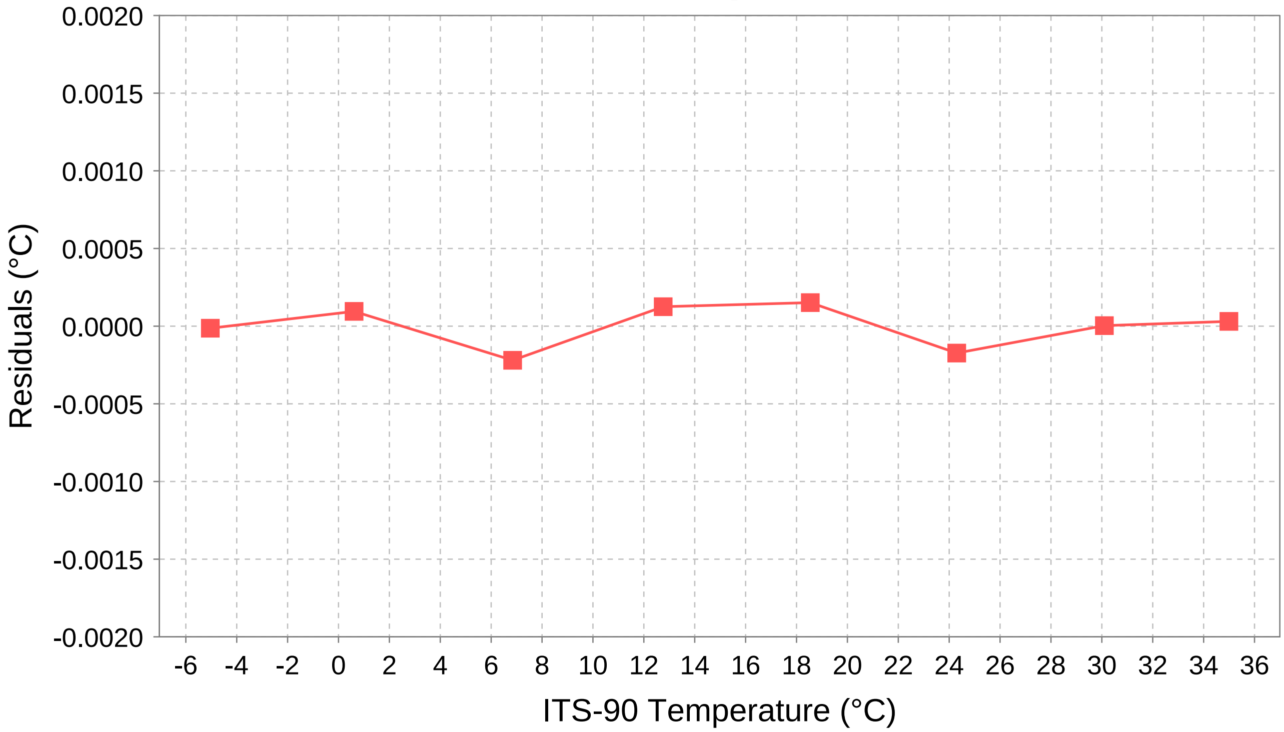
Logger ID: RBRconcerto³ Serial No: 207642 Channel No: 2

Reference Temperature, ITS-90	Voltage ratio, V	Measured Temperature, ITS-90	Calibration error
-5.03738	0.809066	-5.03740	-0.00001
0.61233	0.759575	0.61242	0.00010
6.84396	0.698114	6.84374	-0.00022
12.76012	0.634821	12.76024	0.00013
18.54150	0.570482	18.54165	0.00015
24.29690	0.506246	24.29672	-0.00017
30.09958	0.443430	30.09958	0.00000
34.99299	0.393305	34.99302	0.00003

Coefficients

C0:	3.3555604E-3
C1:	-255.52773E-6
C2:	2.389719E-6
C3:	-87.325716E-9

Residuals vs. Temperature



Calibration Date: 2021-06-04
Issue Date: 2021-06-07
Calibration ID: 47061

Operator: kmalorny

Approver: kmalorny

RBR

Pressure Calibration Certificate

RBRsolo³ D s/n: 207643

Instrument rating: 20 dbar s/n: M135739

Nominal accuracy: 0.05%FS (0.01 dbar)

Reference instrument: Mensor CPC6000 s/n: 612676

Applied pressure, P_{app} (dbar)	Voltage ratio, V	Measured pressure, P_c (dbar)	Calibration error (dbar)
10.096	0.139343	10.0955	-0.0008
12.000	0.162607	12.0018	0.0017
13.999	0.186948	13.9998	0.0004
16.001	0.211277	16.0002	-0.0003
18.000	0.235554	17.9994	-0.0005
20.000	0.259806	19.9997	-0.0004
22.000	0.284019	22.0000	-0.0001
24.000	0.308199	24.0003	0.0002
26.000	0.332342	26.0005	0.0005
28.000	0.356448	28.0004	0.0003
30.000	0.380514	29.9997	-0.0004

Coefficients

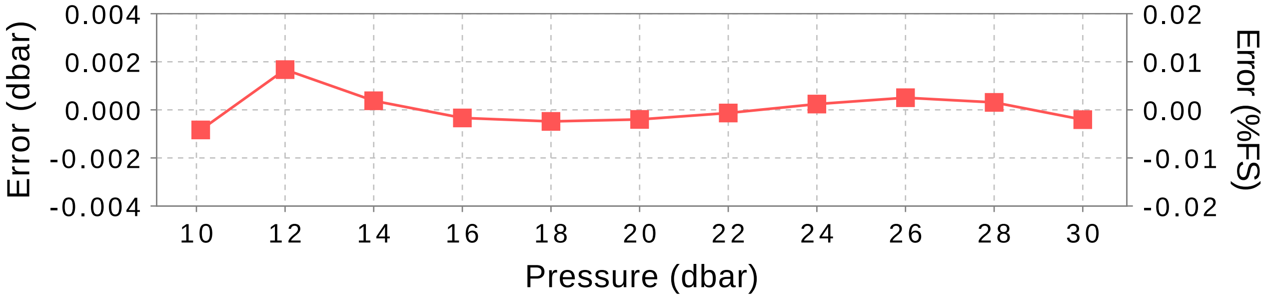
C0:	-665.38525E-3
C1:	81.00648
C2:	3.3388352
C3:	-965.59364E-3
X0:	10.0963
X1:	7.7618468E-3
X2:	78.86402E-6
X3:	572.53436E-9
X4:	293.02313E-6
X5:	21.342314

$$P_c = X_0 + \frac{P_m - X_0 - X_1(T - X_5) - X_2(T - X_5)^2 - X_3(T - X_5)^3}{1 + X_4(T - X_5)}$$

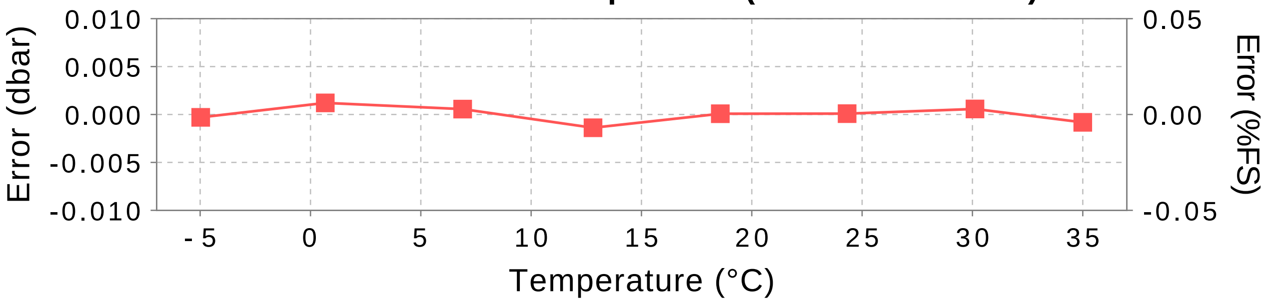
Head (mm) = 589

$$P_m = C_0 + C_1 V + C_2 V^2 + C_3 V^3$$

Calibration error vs. Pressure (Tcal = 21.3°C)



Calibration error vs. Temperature (Patm = 10.03 dbar)



Calibration Date: 2021-06-09

Issue Date: 2021-06-10

File Name: 207643_20210610_1033P.rsk

Operator: afalicki

Approver: kmalorny

APPENDIX 9C

Tide Gauge Data Deliverable (delivered electronically)