Appendix F

2022 Walla Walla District TDG Report

USACE Walla Walla District QA/QC Evaluation of the 2022 Water-Year FMS TDG Monitoring Data

Includes:

McNary, Ice Harbor,
Lower Monumental, Little Goose,
Lower Granite, and Dworshak Projects

USACE Walla Walla District QA/QC Evaluation of the 2022 Water-Year FMS TDG Monitoring Data

Prepared by:
Hydrology Section
Walla Walla District
U.S. Army Corps of Engineers
Walla Walla, Washington

and

Kennewick Field Office
U.S Geological Survey
Kennewick, Washington

Prepared for:
Northwestern Division Regional Office
U.S. Army Corps of Engineers
Portland, Oregon

November 2022

TABLE OF CONTENTS

FIGURES

TABLES

ABSTRACT

The U.S. Army Corps of Engineers (USACE), Walla Walla District (CENWW), operated fourteen fixed-monitoring system (FMS) stations (eight seasonal and six year-round) for total dissolved gas (TDG), barometric pressure (BP), and temperature as part of their 2022 water-quality program. These stations are located on the Columbia, Lower Snake and Clearwater Rivers. This report provides a summary of the 2022 water-year quality assurance/ quality control (QA/QC) evaluation. Highlights include:

- Data completeness for the combined BP, TDG, and temperature data received averaged 98.6 percent for the 14 monitoring sites used in 2022.
- The TDG data received from the individual sites ranged from 85.7 percent to 100.0 percent complete. Sixty percent of all invalid TDG data was due to measurements that were considered too low, primarily at the Lower Monumental forebay (LMNA), Anatone (ANQW), Lower Granite tailwater (LGNW) and Little Goose tailwater (LGSW) stations. The second most frequent cause of missing information was a defective TDG sonde at LGSW that accounted for 13 percent of the total amount of unacceptable TDG data.
- The TDG sensors from the 14 FMS stations were removed from the field and calibrated in the laboratory every three weeks from April 2022 through August 2022. From September 2021 through March 2022, the six annual FMS stations were calibrated at four-week intervals.
- The sensor pre-deployment check had calculated mean ambient pressure, ambient pressure plus 300 mmHg, and temperature differences of -0.43 mmHg, -0.54 mmHg, and 0.05 °C, respectively. The sensor post-deployment check revealed mean ambient pressure, ambient pressure plus 100 mmHg, and temperature differences of 0.44 mmHg, -0.64 mmHg, and 0.03 °C, respectively.
- The calculated median values for the 166 *in-situ* field checks with the replacement probes were:
    1. TDG; 0.0 percent with minimum and maximum station medians of -0.3 and 0.0 percent, respectively.
    2. BP; 0.00 mmHg with station medians ranging from -0.10 to 0.10 mmHg.
    3. Water temperature; -0.01 ºC with station median values ranging from -0.07 ºC to 0.03 ºC.
- Station repairs and maintenance were also completed during the 2022 water year:
    1. The Pasco station (PAQW) was relocated back to the shore from the floating platform due to a build-up of woody debris during high flow in June that caused it to flip over on its side.
    2. Damage to the LGNW station during high flows in June necessitated temporary sonde deployment in the river using a tethered cage.
    3. Sediment build-up at four of the deployment pipes was removed with compressed air.

1.0 INTRODUCTION

Walla Walla District (CENWW) of the U.S. Army Corps of Engineers (USACE) operates six hydropower projects in the Columbia, Snake, and Clearwater River basins: McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak dams. These six dams are included in the basin-wide fixed-monitoring system (FMS) network. The tailwater stations at the six projects are operated throughout the year (Figure F-1; Table F-1). The remaining eight forebay and riverine stations record hourly data from the beginning of April through 31 August, and typically bracket that period, with some exceptions noted below.

Three water-quality related parameters are monitored at these facilities. One is total dissolved gas (TDG). This parameter is of interest since gas supersaturation results when air is entrained as water flows over the spillways and plunges into the stilling basin where water pressure causes the air to go into solution. The river subsequently becomes shallow beyond the stilling basin and the result is water supersaturated with TDG relative to atmospheric conditions. The U.S. Environmental Protection Agency (USEPA) has established an upper limit of 110 percent TDG for protection of freshwater aquatic life as well. Greater than 110 percent TDG can cause gas bubble trauma in fish and adversely affect other aquatic organisms. The TDG water quality standards in Washington and Oregon were relaxed during the 2022 fish passage season (up to 125 percent for12 hours and 126 percent for 2 hours in tailwater reaches in Washington, and up to 125 percent for 12 hours and 127 percent for 2 hours in Oregon tailwater reaches [https://pweb.crohms.org/tmt/documents/fpp/2022/]) but remained unchanged in Idaho.

Barometric pressure, water temperature, and TDG measurements were completed hourly at the Columbia, Snake, and Clearwater River stations, and at 15-minute intervals at the Dworshak station. All data was transmitted via the Geostationary Operational Environmental Satellite Program (GOES) system to USACE and USGS databases. The water quality data stored in the Corps Water Management System (CWMS) database can be accessed at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/. The link to real-time USGS data for Washington is http://waterdata.usgs.gov/wa/nwis/current/?type =quality.

2.0 PURPOSE AND SCOPE

The purpose of TDG monitoring is to provide managers, agencies, and interested parties with near real-time data for managing stream flows, spill, and percent TDG downstream from power-producing dams, as well as meeting the legal requirements of the 2020 Columbia River System Operations Biological Opinion. An additional purpose of this report is to show that CENWW complied with the USACE TDG Monitoring Plan (https://www.nwd.usace.army.mil/CRWM/Water-Quality/) during 2022. Compliance included achieving greater than 95 percent completeness for the entire data set, accomplishing the lab and field calibration using established criteria, and utilizing the primary and secondary standards called for in the plan.

As with any data collection activity, an important component that cannot be overlooked is the quality of the data. Measurement of data quality allows determination of the usefulness and relevance of the data for current and future decision processes. As such, this report:

- Describes the data collection methods.

- Evaluates quality assurance/ quality control (QA/QC) data for the FMS stations at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite reservoirs. Additionally, this data-collection system provided water quality information for; (a) the Clearwater River downstream of Dworshak Dam, and at Peck, (b) the Columbia River near Pasco, and (c) the Snake River near Anatone, Washington (Figure F-1; Table F-1).
  - The QA/QC data includes:
    1. Instrument Data: This data was used to evaluate how an instrument performed as a function of the magnitude and direction that individual sensors deviated over time from their respective laboratory standards. These relationships were determined for each sensor before and after each deployment.
    2. Station Data: These data present comparisons between an in-place instrument that was deployed at a given station for a specified cycle and a newly calibrated QA/QC instrument (field standard). The Sutron® barometers at each station were evaluated with a Novalynx® hand-held barometer that served as a portable field standard for barometric pressure. All fourteen stations were visited for routine maintenance once every three weeks between 1 April and 31 August. The six year-round stations were maintained once every four weeks for the remainder of the year.
    3. Data Completeness: The information transmitted to the databases were evaluated to determine whether they were within expected ranges.

3.0 METHODS

3.1 DATA COLLECTION

The instrumentation at each FMS station consisted of components provided by CENWW and the USGS Kennewick, Washington, offices. A 12-volt battery charged by a solar panel powered each station. Fifty-one Hydrolab® multi-parameter probes (*i.e.*, MS4A's and MS5's) were utilized. Forty-three of these units were provided by CENWW and the remaining eight belonged to the USGS.

3.2 LABORATORY PROCEDURES

The TDG sensor measures the sum of the partial pressures of gaseous compounds dissolved in the water and reports the result in millimeters of mercury (mmHg). The TDG sensor requires a two-step calibration procedure (*i.e.*, adjustments are made at two points on the calibration curve) that is completed prior to and after deployment. The atmospheric pressure calibration point (Lab BP) is equal to the atmospheric pressure at the time of calibration as measured with a ParoScientific® digiquartz barometric pressure standard that is calibrated yearly at the factory. The differences between Lab BP and the pressure measured by the sonde were recorded before and after deployment as Δ(BP). The slope of each sensor response was also evaluated to ensure that measurements were interpolated correctly over the full range of expected field values. To accomplish this task, a Heise™ PTE-1 hand-held certified pressure calibrator, calibrated yearly at the factory (primary standard) and an Ashcroft 2089 digital test gauge, also calibrated yearly at the factory, were used to apply pressure to the TDG sensor. Three hundred millimeters of mercury were added to Lab BP during the pre-deployment check and the differences between Lab BP+300 and the sensors' response were recorded as Δ(BP+300). Similar tests were

completed post-deployment when 100 mmHg was added to Lab BP, and the resulting differences were recorded as Δ(BP+100). Pre-deployment pressure tests were made without a membrane installed. Post-deployment tests were made with a dry membrane in place.

Each sonde also includes a sensor for reporting water temperature in degrees Celsius (°C). Sensor thermometers are factory calibrated and cannot be adjusted. However, temperature sensor performance was evaluated pre- and post-deployment by comparing instrument readings to two Digi-Sense Traceable Scientific Thermistor Thermometers. Both of these instruments were checked quarterly against a National Institute of Standards and Technology (NIST) traceable Oakton Digital Temp-360 W lab thermistor.

3.3 FIELD PROCEDURES

The differences in barometric pressure, water temperature, and TDG between a secondary standard instrument (*i.e.,* replacement sensor) and the fixed station monitors after three or four weeks of field deployment were measured and recorded as part of the field inspection and calibration procedure. These differences, defined as the secondary standard value minus the field instrument value, were used to compare and quantify the precision between two independent instruments. The Sutron® barometers were checked using a Novalynx® M2 Series hand-held digital barometer that is calibrated yearly at the factory. The water temperature and TDG comparisons were made *in situ* with the secondary standard (*i.e*., a recently calibrated Hydrolab®) positioned alongside the field Hydrolab®.

3.4 DEFINING INVALID AND MISSING DATA VALUES

The provisional real-time data were examined daily during the workweek by CENWW and/or USGS employees. Missing values and those that appeared to be outside the expected range were flagged. If a reasonable explanation (*e.g*., routine maintenance, data collection platform [DCP] failure, or defective membrane) could be attributed to the incident, then the data point, or points, was not included in the final data set used for this analysis. Outlying data points that could not be attributed to a specific cause were retained.

4.0 RESULTS AND DISCUSSION

4.1 INVENTORY-WIDE SENSOR QA/QC PERFORMANCE

4.1.1 Pre-deployment (completed without membrane)

The pre-deployment evaluation of the sensors consisted of 178 individual checks for barometric pressure (Table F-2). The evaluation of the pressure sensors to the standard revealed a calculated mean of -0.43 mmHg, and a range of -2.26 to 0.88 mmHg (Table F-2; Figure F-3). TDG sensors outside of the expectable range of 2 mmHg were recalibrated. Three hundred millimeters of mercury was added to the TDG sensor in the laboratory using the laboratory barometer as the baseline standard. The difference between the TDG pressure sensor with 300 mmHg of added pressure and the instrument was compared against the expected value. The sensor pressure differences ranged from -0.24 percent to 0.27 percent with a calculated mean and median of -0.05 percent (Figure F-4; Tables F-2 and F-3).

The dissimilarities between the NIST-traceable thermometer and the sensor thermistors were also quite small. The calculated mean and median values for all the instruments were 0.05 ºC

and 0.06 °C, respectively. These calculated values were based on 178 measurements where the minimum and maximum differences for individual sensors ranged from -2.09 °C to 0.20 °C (Tables F-2 and F-3; Figure F-5). The instrument manufacturer's specification is ±0.20 °C for all instruments within a sample pool.

4.1.2 Post-deployment (completed with membrane in place)

The evaluation of the post-deployment QA/QC data also displayed mostly favorable results. A total of 149 data points were used for the evaluation. The differences between the laboratory barometric pressure and that recorded by the TDG sensors ranged from -26.71 mmHg to 99.48 mmHg, with a mean of 0.44 mmHg (Tables F-2 and F-4; Figure F-3). The extreme range of values noted this year was attributed to a defective TDG sensor and a ruptured membrane. The results of the post calibration checks using barometric pressure +100 mmHg showed a calculated mean of -0.01 percent, and a range of -5.07 to 6.66 percent (Table F-2; Figure F-4).

There were 149 post deployment checks available for the temperature evaluation. Temperature post calibration checks resulted in a calculated mean of 0.03 °C and a median of 0.05 °C, with a range of -2.40 °C to 0.17 °C (Tables F-2 and F-4; Figure F-5).

4.2 System-wide Station QA/QC Performance

The analysis of the differences between in-place barometric air pressure, TDG pressure, and temperature instruments with secondary standards was generally favorable, albeit with a few outliers (Figures F-6 through F-8).

A total of 166 readings were used to calculate the mean and median values for barometric pressure (Table F-5). The median of all the differences between the station barometers and the secondary standards was 0.00 mmHg (Table F-5; Figure F-6). Median values for individual stations ranged from -0.10 to 0.10 mmHg (Table F-6; Figure F-6). Barometers that did not meet manufacturer's accuracy of ±0.7 mmHg they were either reset or replaced.

A total of 166 readings were used to calculate the mean and median values for TDG instrument pressure (Table F-5). The overall median for the percent TDG differences between the in-place and replacement sensors was 0.0 percent saturation (Table F-5; Figure F-7). Individual station median values ranged from -0.3 percent saturation to 0.0 percent saturation (Table F-6). High values of 350 mmHg (47.0 percent) and 172 mmHg (23.4 percent) at Lower Granite tailwater (LGNW) and Anatone (ANQW), respectively, were the result of compromised TDG membranes (Table F-6; Figure F-7). The low measurement of -32 mmHg (-4.3 percent) at Lower Monumental forebay was due to a defective sonde.

A total of 166 readings were used to calculate the temperature differences between the in-place and replacement sondes (Table F-5). The calculated mean and median temperature differentials for the field data were both -0.01 °C (Table F-5). The median values for individual stations ranged from -0.07 ºC to 0.03 ºC (Table F-6; Figure F-8). The manufacturer's specification for the temperature sensor is ±0.20 °C.

4.3 FMS Data Completeness and Station Statistics

Percent completeness for the real-time TDG, barometric pressure, and temperature data were 97.3, 99.8, and 98.7 percent, respectively (Table F-7; Figure F-9). The most frequent reason

attributed to missing or anomalous information in the real-time data set were values considered to be too low (0.54 percent of the combined station performance, which is equivalent to 38.5 percent of all missing and invalid data shown in the last column of Table F-8). The second and third leading causes of missing/anomalous data were sonde/sensor malfunctions (0.36 percent of the combined station performance or 25.8 percent of the total affected data) followed by missing data (0.28 percent of the combined station performance or 20.0 percent of the 3,452 hours of affected data).

4.3.1 Barometric Pressure

Barometric pressure data from the fourteen stations averaged 99.8 percent complete. Barometric pressure data was 100 percent complete at ten of the fourteen FMS stations including McNary forebay (MCNA), Ice Harbor forebay (IHRA), Lower Monumental tailwater (LMNW), Lower Monumental forebay (LMNA), Little Goose Tailwater (LGSW), Little Goose forebay (LGSA), Lower Granite forebay (LWG), Anatone (ANQW), Peck (PEKI), and Dworshak (DWQI) (Table F-7). The four remaining stations were greater than 95 percent complete (Tables F-8 and F-9). One hundred fifty-nine of the 199 hours of missing data were due to the capsized floating platform at Pasco (PAQW) last June.

4.3.2 Total Dissolved Gas

The TDG data from the fourteen stations averaged 97.3 percent complete (Table F-7). The three stations that experienced the greatest amount of data loss were Lower Monumental forebay (LMNA), Anatone (ANQW), and Pasco (PAQW), where the final data set statistics ranged from 85.7 percent to 92.7 percent complete (Table F-7). Sediment accumulation in the deployment pipe was the primary cause of anomalous data at ANQW, while a defective TDG sensor led to data that was considered too low and consequently removed from the database for LMNA (Table F-8 and F-10). The majority of the missing data from PAQW was due to the capsized floating platform.

4.3.3 Temperature

The temperature data from the fourteen FMS stations averaged 98.7 percent complete. Six stations (McNary tailwater [MCPW], McNary forebay [MCNA], Ice Harbor forebay [IHRA], Little Goose forebay [LGSA], Anatone [ANQW], and Dworshak [DWQI]) attained 100 percent completeness (Table F-7). Six of the remaining eight stations were all greater than 99 percent complete (Tables F-8 and F-11). The two stations with the lowest percent completeness were Pasco (PAQW) and Ice Harbor tailwater (IDSW) at 92.7 and 92.6 percent, respectively. The issue at PAQW was the capsized float while a defective temperature sensor at IDSW led to missing or erroneous data.

4.4 Deployment Pipe Clean-Out

Sediment build-up occurred in four tailwater deployment pipes during the 2022 water year that resulted in measurements that were considered too low. The Little Goose tailwater (IDSW) pipe was the first one that required maintenance and was cleared on 21 October 2021. The Ice Harbor tailwater pipe was the next one that was cleared on 2 February 2022. The deployment pipes at Anatone (ANQW) and Peck (PEKI) were purged on 21 March and 22 March, respectively. The PEKI pipe was again cleared on 28 April 2022.

4.5 NOTABLE STATION MAINTENANCE

The Pasco station (PAQW) was relocated from the floating platform in the Columbia River back to the shore-based station last June. Woody debris in the river during the spring freshet was caught on the upstream end of the float, as well as the anchor cable, resulting in the float getting tipped on its' side (Figure 10). TDG measurements during the remainder of the spill season were made by placing the sonde in a steel cage that was tethered to shore. The station is scheduled to be rebuilt prior to the start of the 2023 spill season.

The Lower Granite tailwater station (LGNW) was also damaged during mid-June when flow in the Snake River exceeded 200 kcfs. The deployment pipe lost its' anchor point and was detached from the irrigation box (Figure 11). The TDG sonde was deployed in a cage tethered to the shore for the remainder of the summer. A station rebuild is scheduled to start this fall and will be completed at the beginning of 2023.

5.0 SUMMARY

Hourly TDG, temperature, and barometric pressure data recorded during the 2022 water year at fourteen FMS stations were evaluated. The six tailwater sites were maintained throughout the year. The seasonal riverine stations at Peck (PEKI), Anatone (ANQW), and Pasco (PAQW) were added at the beginning of April and remained active through 31 August. The forebay stations at the four lower Snake River hydroelectric projects, as well as the one at McNary Dam also came on-line 1 April. The combined data completeness for all stations and parameters was 98.6 percent.

The USGS Kennewick field office performed routine station maintenance, completed emergency repairs, operated the DCPs, and assisted with station repairs under a cooperative agreement with CENWW. The preventative maintenance schedule provided for calibration and routine maintenance at three-week intervals during the fish spill season and once every four weeks during the rest of the year. Station performance was hampered primarily by low data values, malfunctioning sondes/sensors, and missing data.

The pre-deployment QA/QC checks showed a mean difference of -0.43 mmHg when the TDG sensors were compared to barometric pressure and -0.05 percent when 300 mmHg of pressure was added. The calculated means for the post-deployment evaluations were 0.44 mmHg and 0.06 percent when the TDG sensors were compared to barometric pressure and barometric pressure plus 100 mmHg, respectively. The calculated mean temperature difference was 0.05 °C for pre-deployment and 0.03 °C for post-calibration.

The 51 instruments used to perform this year's monitoring met the manufacturers' specifications. Field checks completed during routine maintenance between the in-place sonde and the secondary standard demonstrated that the air barometric pressure, percent TDG, and temperature differences averaged 0.03 mmHg, 0.30 percent, and -0.01 °C, respectively.

FIGURES

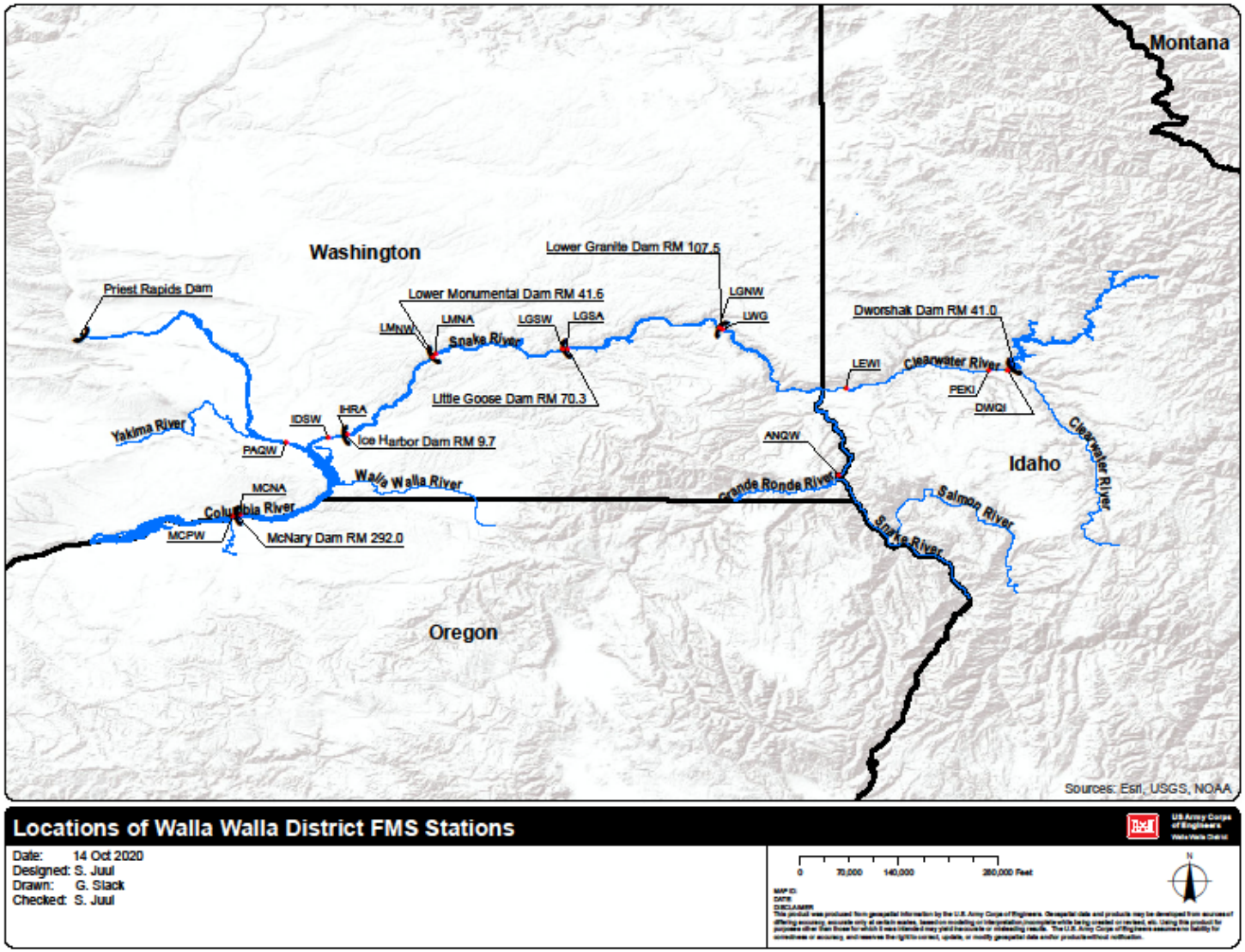

Figure F-1. Locations of Walla Walla District's FMS stations.

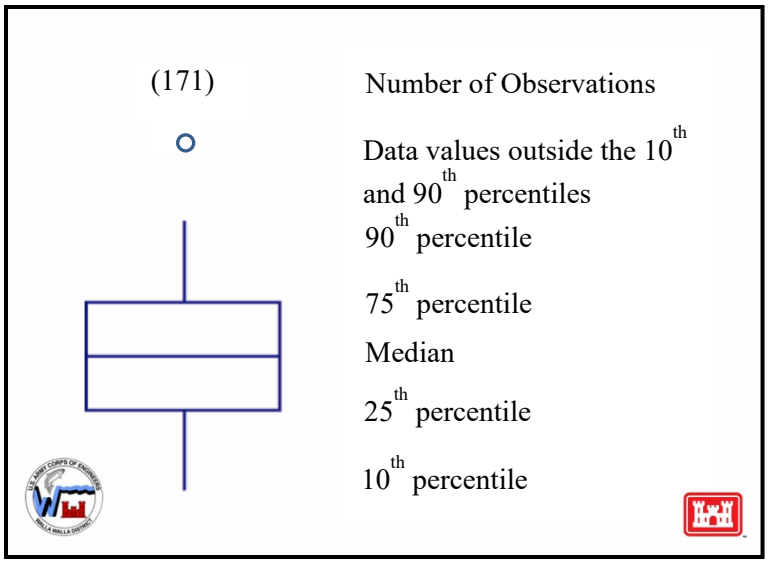

Figure F-2. Explanation key for the box plot information.

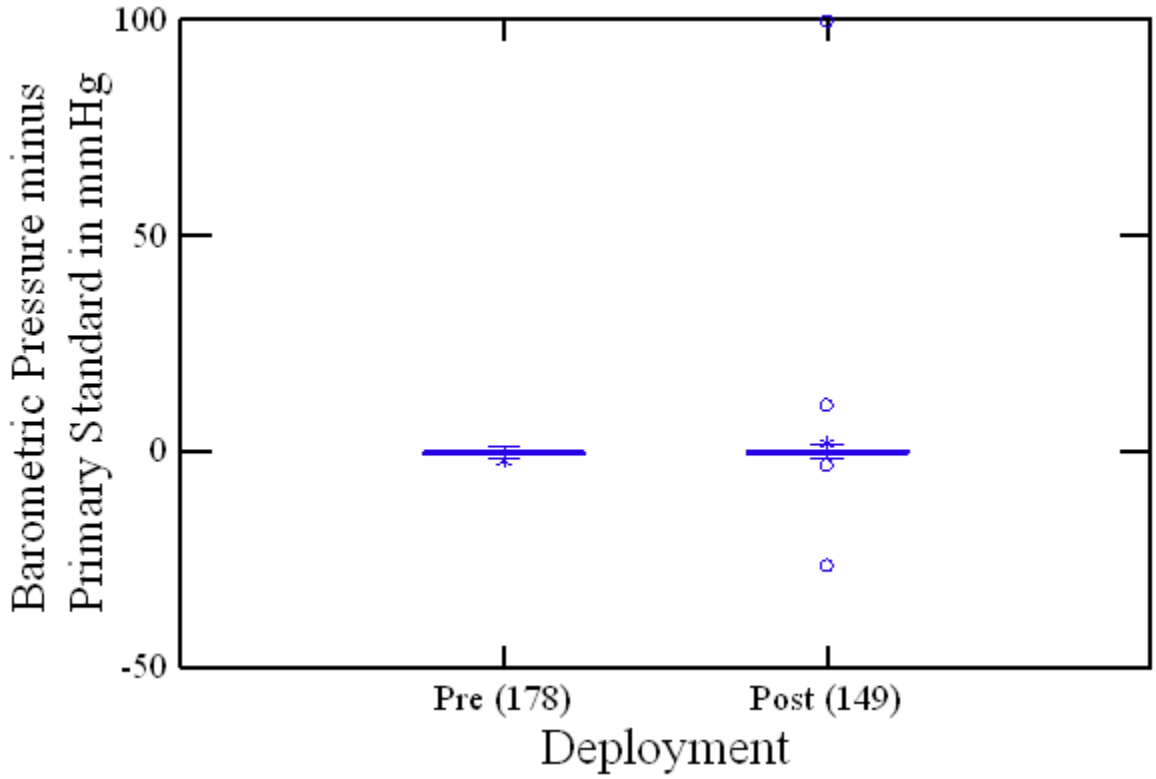

Figure F-3. Summary box plots of the pre-and post-deployment check of the barometric pressure versus the primary standard during the 2022 monitoring season.

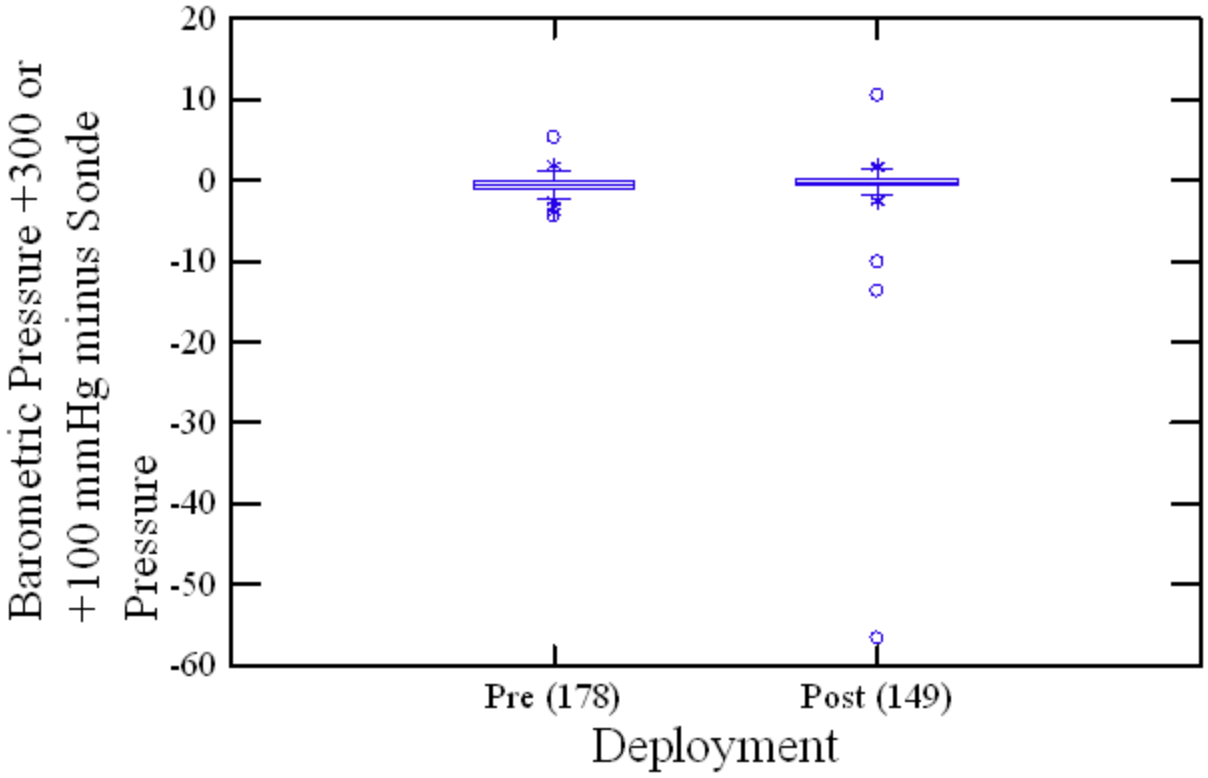

Figure F-4. Summary box plots of the pre-and post-deployment check of the Hydrolab® TDG sensors with the addition of 300 and 100 mmHg, respectively, during the 2022 monitoring season.

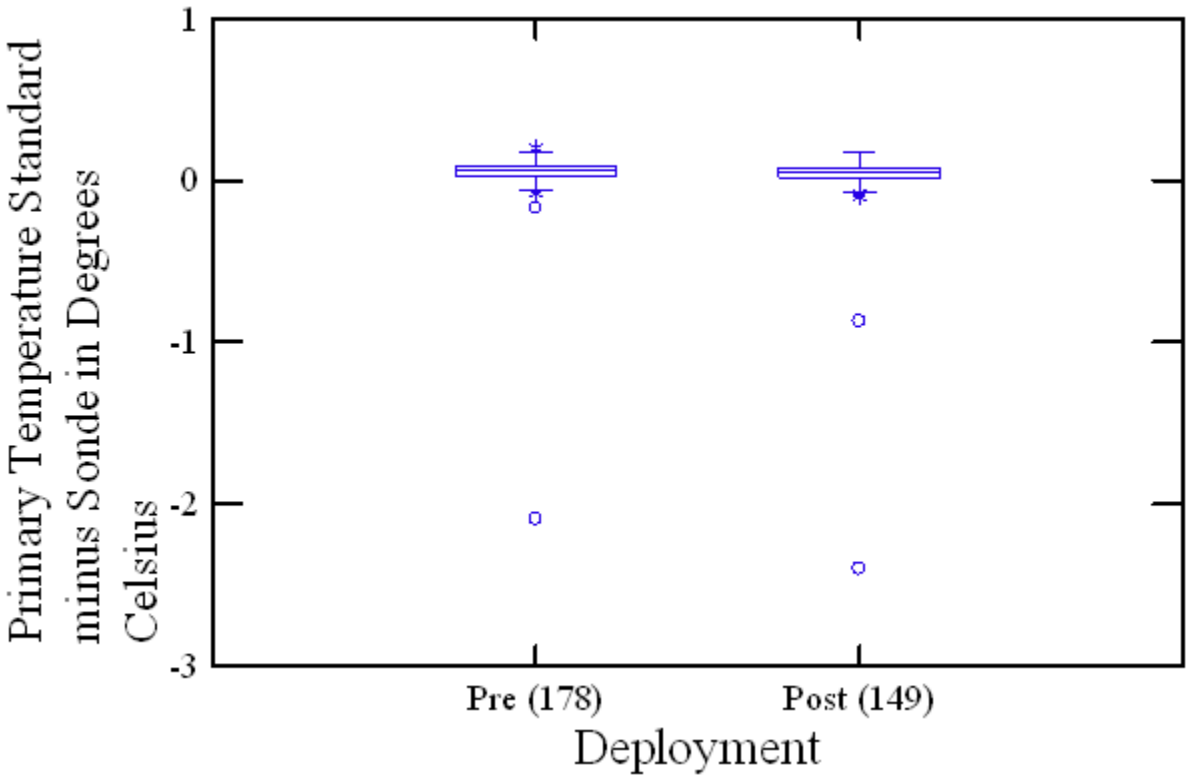

Figure F-5. Summary box plots of the pre- and post-deployment check of the Hydrolab® temperature sensors during the 2022 monitoring season.

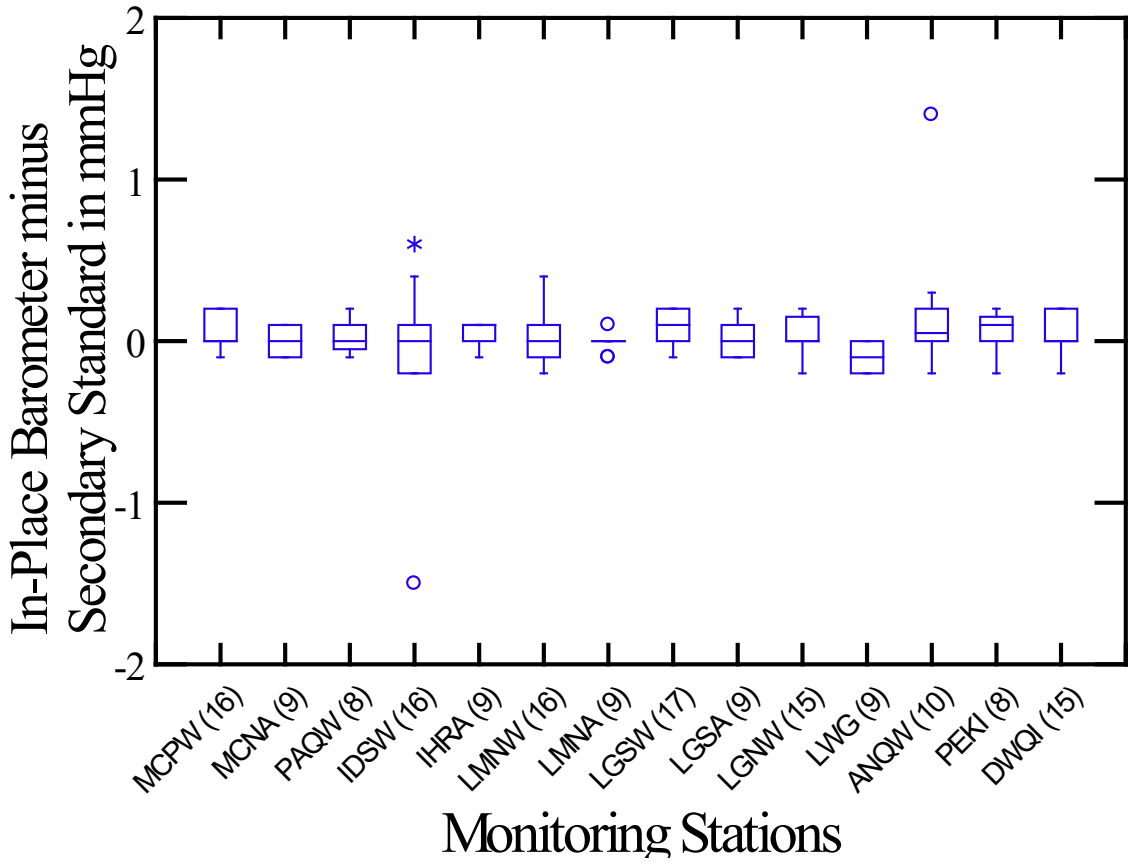

Figure F-6. Box plots of the field barometric pressure sensors check in mmHg by site during the 2022 monitoring season.

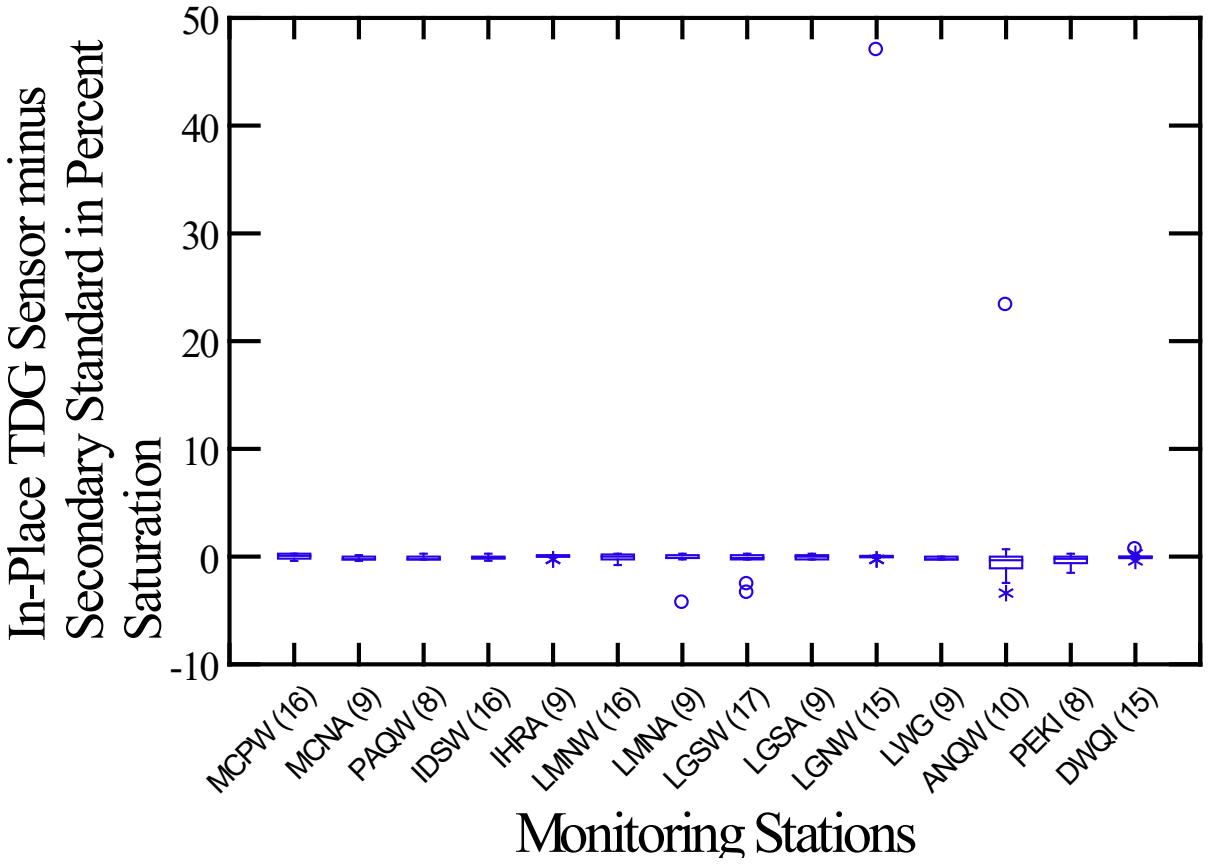

Figure F-7. Box plots of the field total dissolved gas sensor check verses secondary standard in percent saturation by site during the 2022 monitoring season.

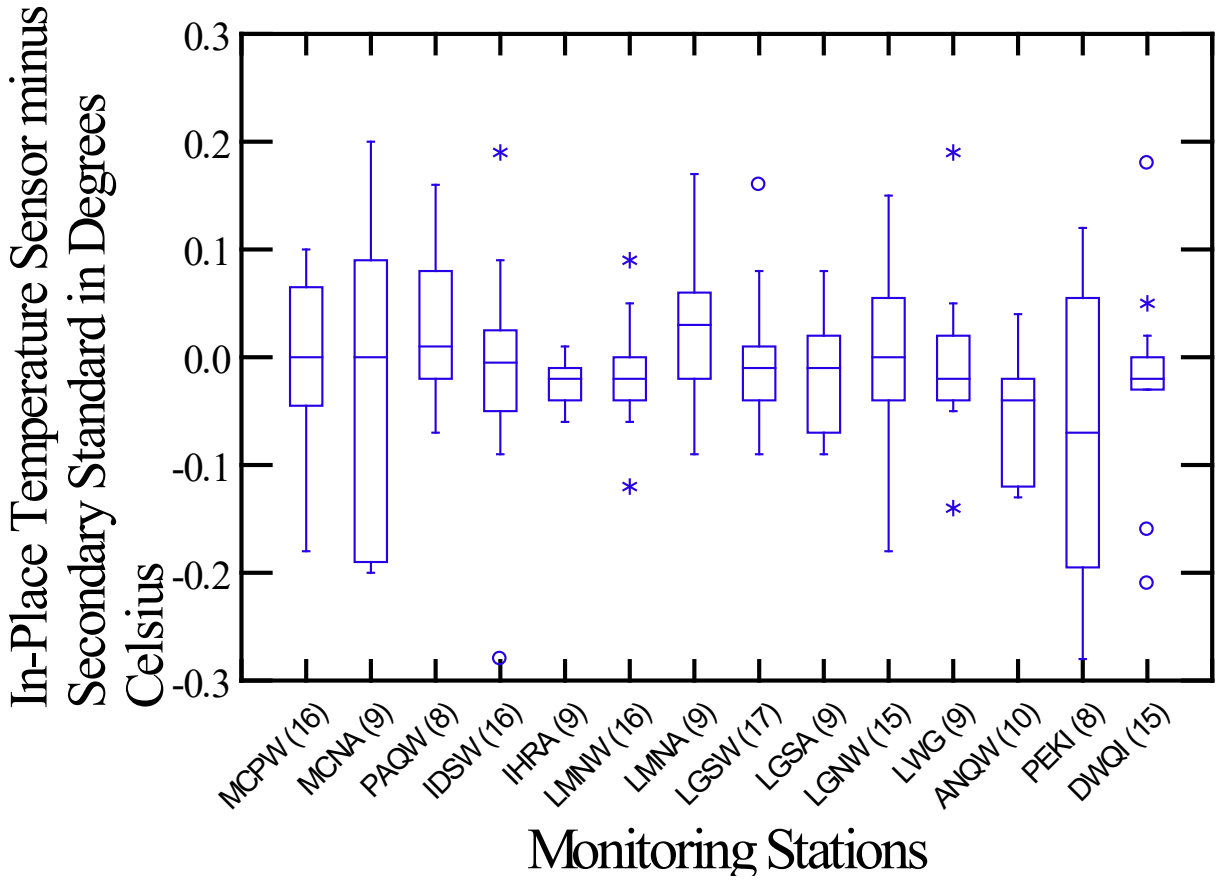

Figure F-8. Box plots of the field temperature sensors check verses secondary standard in degrees Celsius by site during the 2022 monitoring season.

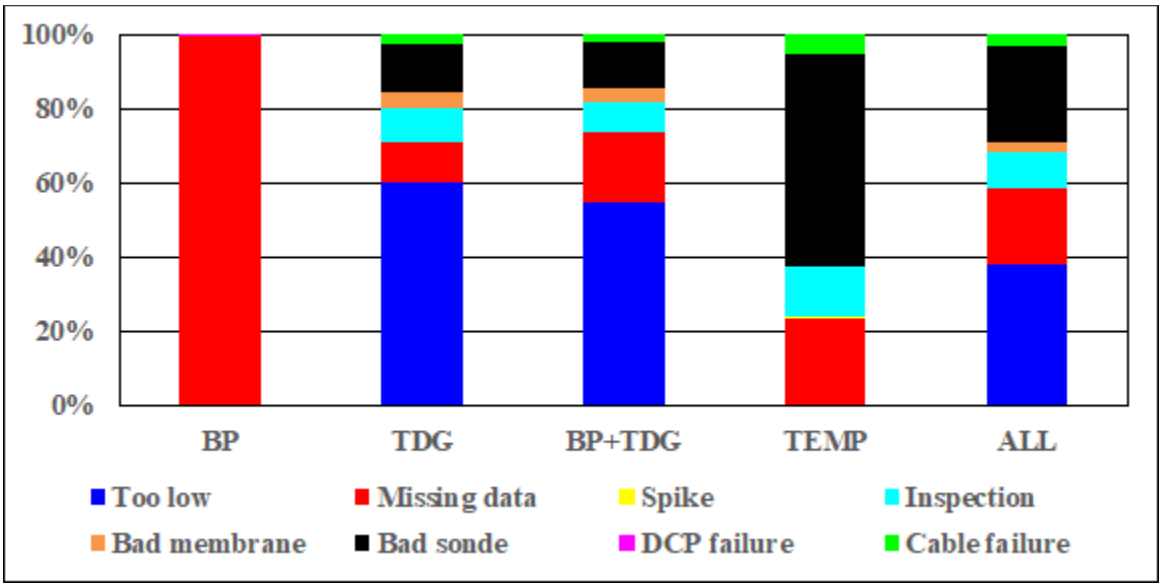

Figure F-9. Percentages for the reasons invalid or anomalous barometric pressure, TDG, and temperature data were removed from the databases during the 2022 monitoring season

Figure F-10. Overturned Pasco (PAQW) floating TDG platform.

Figure F-11. Lower Granite tailwater (LGNW) deployment pipe separated during June 2022 high flows.

TABLES

Table F-1. CENWW FMS station identification and location information.

Station Number	Station Name	Station ID	Latitude (NAD 83)	Longitude (NAD 83)	Elevation (NGVD 29)	River Mile	DCP ID	XMIT Time
12514400	Columbia River at Pasco, WA	PAQW	46 13 23.9016 N	119 06 59.04 W	345	329.1	17D6E32C	0:27:10
13334300	Snake River Near Anatone, WA	ANQW	46 05 50.7579 N	116 58 41.2382 W	807	167.5	17D63544	0:16:10
13341000	N.F. Clearwater River at Dworshak Hatchery, ID	DWQI	46 30 11.6464 N	116 19 16.4090 W	1,150	0.5	DE90FB26	0:03:05*
13341050	Clearwater River Near Peck, ID	PEKI	46 30 00.9396 N	116 23 32.4163 W	930	37.4	17D613A8	0:14:10
13343590	Lower Granite Dam Forebay, WA	LWG	46 39 34.1727 N	117 25 34.8564 W	738	107.5	17D643D4	0:17:10
13343595	Lower Granite Dam Tailwater, WA	LGNW	46 39 58.0726 N	117 26 19.2595 W	645	106.7	17D650A2	0:18:10
13343855	Little Goose Dam Forebay, WA	LGSA	46 34 58.3188 N	118 01 32.9831 W	638	70.3	17D66538	0:19:10
13343860	Little Goose Dam Tailwater, WA	LGSW	46 35 00.5280 N	118 02 37.4186 W	560	69.6	17D6764E	0:20:10
13352595	Lower Monumental Dam Forebay, WA	LMNA	46 33 44.6559 N	118 32 08.3477 W	540	41.6	17D686CA	0:21:10
13352600	Lower Monumental Dam Tailwater, WA	LMNW	46 33 04.5051 N	118 32 58.9500 W	445	40.4	17D695BC	0:22:10
13352950	Ice Harbor Dam Forebay, WA	IHRA	46 15 05.2792 N	118 52 43.0096 W	440	10.0	17D6A026	0:23:10
13353010	Ice Harbor Dam Tailwater, WA	IDSW	46 14 27.5868 N	118 57 13.7130 W	340	6.1	17D6B350	0:24:10
14019220	McNary Dam Forebay, WA	MCNA	45 56 28.9200 N	119 17 35.4400 W	340	292.0	17D6D6B6	0:26:10
14019240	McNary Dam Tailwater, WA	MCPW	45 56 02.7775 N	119 19 35.4628 W	240	290.7	17D5F754	0:12:10

Note: * Indicates the station transmits at 15-minute intervals as opposed to the standard hourly rate of transmission.

Table F-2. Summary of the laboratory results evaluating the overall differences between laboratory standards and the sensors pre- and post-deployment during the 2022 water year.

Deployment	Observations	Statistic	Delta BP mmHg (%)	Delta (BP+300) mmHg (%)	Delta (BP+100) mmHg (%)	Delta Temp. °C
Pre	178	Minimum	-2.26 (-0.30)	-4.46 (-0.24)	----	-2.09
		25 Percentile	-0.88 (-0.12)	-1.01 (-0.10)	----	0.03
		Median	-0.39 (-0.05)	-0.50 (-0.05)	----	0.06
		75 Percentile	-0.03 (0.00)	-0.05 (-0.01)	----	0.09
		Maximum	0.88 (0.12)	5.27 (0.27)	----	0.20
		Mean	-0.43 (-0.06)	-0.54 (-0.05)	----	0.05
Post	149	Minimum	-26.71[(a)] (-3.53)	----	-56.71[(a)] (-5.07[(a)])	-2.40
		25 Percentile	-0.55 (-0.07)	----	-0.60 (-0.07)	0.02
		Median	-0.18 (-0.02)	----	-0.27 (-0.02)	0.05
		75 Percentile	0.37 (0.05)	----	0.22 (0.03)	0.08
		Maximum	99.48[(b)] (13.38[(b)])	----	10.51 (6.66)	0.17
		Mean	0.44 (0.06)	----	-0.64 (-0.01)	0.03

Notes: (a) Due to possible defective sensor
(b) Due to membrane failure

Table F-3. Pre-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2022 water year.

Sensor ID	Δ (PT – BP)			Δ [PT- (BP+300)]			Δ (Water Temperature)		
	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (ºC)	Median (ºC)
13b	2	-0.60 to -0.51	-0.56	2	-0.60 to -0.51	--0.55	2	0.10 to 0.12	0.11
26	3	-0.15 to 0.28	-0.08	3	-0.15 to 0.28	-0.08	3	0.06 to 0.07	0.07
27	3	-0.87 to -0.08	-0.74	3	-3.87 to -0.08	-0.87	3	0.08 to 0.09	0.09
29	5	-0.18 to 0.73	0.15	5	-0.61 to 1.15	-0.18	5	-0.03 to 0.08	0.02
32	4	-0.85 to 0.34	-0.67	4	-0.66 to 0.26	-0.22	4	0.04 to 0.08	0.06
33	4	-1.39 to -0.05	-0.95	4	-1.39 to -0.05	-0.95	4	0.00 to 0.11	0.01
34	5	-0.86 to 0.24	-0.30	5	-1.86 to 0.18	-0.41	5	-2.09 to 0.09	0.07
35	5	-1.20 to 0.11	-0.55	5	-3.20 to 0.11	-1.55	5	0.00 to 0.08	0.02
36	3	-1.15 to -0.07	-1.11	3	-1.15 to -0.07	-1.11	3	-0.05 to 0.00	-0.04
37	4	-1.07 to -0.87	-0.96	4	-0.90 to -0.03	-0.47	4	-0.03 to 0.04	0.02
39	3	-1.33 to 0.00	-1.08	3	-1.20 to -0.33	-1.08	3	0.02 to 0.08	0.06
41	5	-0.25 to 0.51	-0.20	5	-0.49 to -0.14	-0.22	5	-0.01 to 0.10	0.02
42	1	0.00 to 0.00	0.00	1	1.00 to 1.00	1.00	1	0.10 to 0.10	0.10
43	5	-0.80 to -0.07	-0.66	5	-0.80 to 0.03	-0.36	5	-0.08 to 0.03	0.03
44	4	-1.00 to 0.06	-0.60	4	-1.00 to 0.06	-0.60	4	0.08 to 0.11	0.09
45	3	0.02 to 0.62	0.34	3	-2.38 to 0.34	0.02	3	0.03 to 0.04	0.04
47	4	-0.28 to 0.23	-0.03	4	-0.28 to 0.98	0.09	4	0.04 to 0.17	0.09
49	7	-1.03 to 0.01	-0.31	7	-2.31 to 0.01	-0.35	7	0.04 to 0.13	0.09
50	4	-1.47 to -0.12	-1.11	4	-1.47 to -0.12	-1.11	4	0.09 to 0.15	0.12
51	5	-1.14 to 0.56	-0.25	5	-2.14 to 0.56	-0.25	5	0.06 to 0.10	0.06
52	5	-0.71 to 0.58	0.21	5	-0.71 to 0.23	-0.05	5	0.09 to 0.13	0.11
53	5	-1.06 to -0.03	-0.15	5	-2.05 to 0.94	-0.21	5	0.00 to 0.07	0.03
54	3	-0.74 to 0.29	0.07	3	-0.93 to -0.71	-0.74	3	0.02 to 0.09	0.05
55	5	-1.06 to 0.10	-0.67	5	-1.26 to 0.33	-0.90	5	0.03 to 0.08	0.05
56	4	-1.52 to 0.11	-0.55	4	-1.89 to 0.80	-1.20	4	0.00 to 0.11	0.06
57	5	-1.24 to 0.00	-1.02	5	-1.24 to 0.00	-1.24	5	0.03 to 0.13	0.10
58	5	-1.23 to 0.28	-0.90	5	-1.23 to 1.10	-0.24	5	-0.08 to 0.03	0.02
60	2	-0.63 to -0.39	-0.51	2	-0.39 to 0.37	-1.01	2	0.08 to 0.11	0.09
61	5	-0.64 to -0.14	-0.29	5	-4.46 to -0.14	-0.29	5	0.06 to 0.09	0.07
62	6	-0.99 to 0.11	-0.40	6	-2.20 to 1.86	-0.79	6	-0.01 to 0.17	0.01
63	1	-0.75 to -0.75	-0.75	1	-0.75 to -0.75	-0.75	1	0.03 to 0.03	0.03
64	3	-1.22 to -0.06	-0.61	3	-1.22 to -0.61	-1.06	3	0.06 to 0.08	0.08
65	4	-0.94 to -0.62	-0.69	4	-0.94 to 0.38	-0.69	4	0.04 to 0.11	0.09
66	3	-0.02 to 0.80	0.42	3	-1.02 to 0.42	-0.20	3	0.09 to 0.14	0.14
67	1	-0.38 to -0.38	-0.38	1	-0.38 to -0.38	-0.38	1	0.10 to 0.10	0.10
68	3	-0.49 to -0.08	-0.30	3	-2.30 to 0.51	-1.08	3	0.10 to 0.14	0.14
69	1	-0.80 to -0.80	0.80	1	0.80 to 0.80	0.80	1	0.06 to 0.06	0.06
70	1	-0.55 to -0.55	-0.55	1	-0.55 to -0.55	-0.55	1	0.08 to 0.08	0.08
71	1	0.00 to 0.00	0.00	1	0.00 to 0.00	0.00	1	-0.01 to 0.01	0.01
32432	1	-0.22 to -0.22	-0.22	1	-0.22 to -0.22	-0.22	1	0.12 to 0.12	0.12
32435	1	0.37 to 0.37	0.37	1	0.37 to 0.37	0.37	1	0.12 to 0.12	0.12
35131	3	-0.48 to 0.31	0.00	3	-0.69 to 0.00	-0.48	3	-0.02 to 0.10	-0.02

Table F-3. Pre-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2022 water year (continued).

Sensor ID	Δ (PT – BP)			Δ [PT- (BP+300)]			Δ (Water Temperature)		
	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (° C)	Median (° C)
36902	2	0.27 to 0.61	0.44	2	0.61 to 5.27	2.94	2	0.02 to 0.06	0.04
USGS #1	4	-1.11 to 0.00	-1.05	4	-0.11 to 1.00	-0.05	4	0.01 to 0.20	0.04
USGS #2	3	-0.91to -0.05	-0.86	3	-0.86 to 1.09	-0.05	3	0.06 to 0.13	0.10
USGS #4	3	-2.26 to 0.00	-0.76	3	-0.76 to 0.00	-0.26	3	0.04 to 0.20	0.06
USGS #5	2	-0.70 to -0.41	-0.56	2	-1.41 to -0.70	-1.05	2	-0.03 to 0.00	-0.02
USGS #6	3	-1.37 to 0.88	-0.78	3	-0.78 to -0.12	-0.37	3	-0.17 to 0.10	0.07
USGS #9	3	-0.60 to -0.14	-0.23	3	-0.60 to 0.00	-0.14	3	-0.03 to 0.01	-0.01
USGS #10	6	-1.13 to -0.59	-0.92	6	-1.70 to 0.10	-1.01	6	0.02 to 0.13	0.08
USGS #11	5	-1.59 to -0.42	-1.12	5	-2.59 to -0.42	-1.12	5	0.01 to 0.10	0.04

Table F-4. Post-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2022 water year.

	Δ (BP – PT)			Δ [PT - BP+100)]			Δ (Water Temperature)		
Sensor ID	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (mmHg)	Median (mmHg)	Obs. (#)	Range (º C)	Median (º C)
13b	2	-0.29 to 0.38	0.05	2	-0.29 to 0.38	0.05	2	0.08 to 0.13	0.11
26	3	-0.20 to 0.40	0.35	3	-0.60 to 0.35	-0.20	3	0.05 to 0.06	0.05
27	3	-0.44 to 0.89	0.10	3	-0.90 to 0.89	-0.44	3	0.03 to 0.08	0.04
29	4	-0.14 to 10.51	1.08	4	-2.63 to 10.51	1.33	4	0.00 to 0.07	0.04
32	2	0.00 to 0.14	0.07	2	0.00 to 0.14	0.07	2	0.04 to 0.05	0.04
33	4	-0.47 to 99.48	-0.12	4	-0.52 to 0.96	-0.00	4	-0.02 to 0.16	0.10
34	4	-0.72 to 0.54	-0.04	4	-13.72 to -0.03	-1.26	3	-0.08 to 0.06	-0.03
35	3	-1.43 to 0.51	0.42	3	-1.43 to 0.42	-0.49	3	-0.02 to 0.06	0.04
36	2	-1.04 to -0.36	-0.70	2	-1.04 to -0.36	-0.70	2	-0.05 to 0.02	-0.02
37	3	-1.12 to -0.29	-0.51	3	-10.12 to -0.29	-0.51	3	-0.04 to 0.07	-0.03
39	3	-1.22 to -0.40	-0.69	3	-1.22 to 0.60	-0.69	3	0.06 to 0.09	0.06
41	5	-0.86 to 0.24	0.15	5	-0.86 to 0.24	0.15	5	-0.02 to 0.08	0.03
42	1	-1.70 to -1.70	-1.70	1	-0.70 to -0.70	-0.70	1	0.00 to 0.00	0.00
43	5	-0.09 to 1.24	0.73	5	-0.27 to 1.24	0.61	5	0.02 to 0.04	0.04
44	4	-0.86 to 0.71	-0.19	4	-0.86 to 0.71	-0.19	4	0.04 to 0.08	0.05
45	3	-0.05 to 1.68	-0.03	3	-1.32 to -0.03	-0.15	3	0.01 to 0.10	0.03
47	4	-0.47 to 1.18	0.91	4	-0.94 to 0.76	-0.15	4	0.05 to 0.13	0.09
49	5	-1.30 to 0.66	-0.32	5	-0.38 to 0.66	-0.30	5	0.04 to 0.16	0.12
50	3	-0.82 to -0.55	-0.70	3	-1.70 to -0.55	-0.82	2	0.06 to 0.10	0.08
51	3	-1.23 to 0.55	-0.16	3	-1.23 to 0.55	-0.16	3	-0.07 to 0.12	0.03
52	4	-0.61 to 1.53	0.40	4	-0.61 to 1.20	0.06	4	0.04 to 0.11	0.10
53	4	-0.82 to -0.21	-0.38	4	-0.82 to -0.21	-0.38	4	0.01 to 0.06	0.05
54	2	0.09 to 0.91	0.50	2	0.09 to 0.91	0.50	2	0.01 to 0.04	0.02
55	6	-1.28 to 0.13	-0.57	6	-0.90 to 0.13	-0.26	6	0.00 to 0.07	0.04
56	4	-26.71 to 0.20	-0.99	4	-56.71 to 0.20	-0.99	4	-0.87 to 0.10	0.06
57	4	-3.41 to -0.27	-0.81	4	-1.41 to 0.16	-0.53	4	0.07 to 0.12	0.08
58	4	-1.23 to 0.13	-0.05	4	-1.23 to 0.13	-0.55	4	-0.01 to 0.04	0.02
60	2	0.30 to 0.39	0.34	2	-0.70 to 0.39	-0.16	2	-2.40 to 0.07	-1.17
61	4	-0.11 to 0.39	0.23	4	-0.11 to 0.39	0.23	4	0.05 to 0.08	0.06
62	4	-1.20 to 0.65	-0.04	4	-1.20 to 0.65	-0.04	4	0.00 to 0.03	0.01
63	1	-0.78 to -0.78	-0.78	1	0.22 to 0.22	0.22	1	-0.03 to 0.03	0.03
64	2	0.00 to 0.84	0.42	2	0.00 to 0.84	0.42	1	0.03 to 0.03	0.03
65	3	-0.46 to 0.33	0.12	3	-0.46 to 0.33	0.12	3	0.01 to 0.12	0.05
66	3	0.46 to 1.67	0.48	3	0.46 to 1.67	0.48	3	0.01 to 0.12	0.10
67	1	0.22 to 0.22	0.22	1	0.22 to 0.22	0.22	1	0.12 to 0.12	0.12
68	3	-0.81 to -0.26	-0.40	3	-0.81 to -0.26	-0.40	3	0.11 to 0.15	0.12
69	1	0.30 to 0.30	0.30	1	0.30 to 0.30	0.30	1	0.12 to 0.12	0.12
70	1	0.01 to 0.01	0.01	1	0.01 to 0.01	0.01	1	0.04 to 0.04	0.04
71	1	-0.32 to -0.32	-0.32	1	-0.32 to -0.32	-0.32	1	-0.03 to -0.03	-0.03
32432	1	1.57 to 1.57	1.57	1	1.57 to 1.57	1.57	1	-0.12 to 0.12	0.12
35131	3	-0.70 to 0.78	0.43	3	-0.70 to 0.78	0.43	3	-0.10 to 0.04	-0.03
36902	1	0.55 to 0.55	0.55	1	-0.45 to -0.45	-0.45	1	0.10 to 0.10	0.10

Table F-4. Post-deployment quality assurance data for the individual sensors utilized at the FMS stations during the 2022 water year (continued).

	Δ (BP – PT)			Δ [PT – (BP+100)]			Δ (Water Temperature)		
Sensor ID	**Obs. (#)**	**Range (mmHg)**	**Median (mmHg)**	**Obs. (#)**	**Range (mmHg)**	**Median (mmHg)**	**Obs. (#)**	**Range (°C)**	**Median (°C)**
USGS 1	4	-1.09 to -0.54	-0.65	4	-1.09 to -0.54	-0.65	4	0.02 to 0.17	0.07
USGS 2	3	-0.47 to -0.14	-0.29	3	-0.47 to -0.14	-0.29	3	-0.04 to 0.15	0.02
USGS 4	2	0.00 to 0.49	0.25	2	0.49 to 1.00	0.75	2	-0.10 to 0.04	-0.03
USGS 5	2	0.08 to 1.33	0.71	2	0.08 to 1.33	0.71	2	-0.02 to 0.05	0.02
USGS 6	2	-0.84 to -0.36	-0.60	2	-0.84 to -0.36	-0.60	2	0.03 to 0.04	0.04
USGS 9	2	-0.34 to -0.31	-0.32	2	-0.34 to -0.31	-0.32	1	-0.06 to -0.06	-0.06

Table F-5. Summary of the field results for the differences between the in-place and replacement sensors during 2022 water year.

Statistic	Delta BP (mmHg)	Delta TDG (% sat)	Delta Temp. (° C)
Number	166	166	166
Minimum	-1.50	-4.3	-0.28
Maximum	1.40	47.0	0.20
Mean	0.03	0.3	-0.01
Median	0.00	0.0	-0.01

Table F-6. Summary of the field results for the differences between the in-place and replacement sensors by station during 2022 water year.

Station ID	Delta Barometric Air Pressure			Delta Total Dissolved Gas					Delta Water Temperature		
	# Obs.	Range (mmHg)	Median (mmHg)	# Obs.	Range (mmHg)	Median (mmHg)	Range (% Sat)	Median (% Sat)	# Obs.	Range (°C)	Median (°C)
MCPW	16	-0.1 to 0.2	0.00	16	-3.0 to 2.0	0.5	-0.4 to 0.3	0.0	16	-0.18 to 0.10	0.00
MCNA	9	-012 to 0.1	0.00	9	-3.0 to 1.0	-2.0	-0.4 to 0.1	-0.3	9	-0.20 to 0.20	0.00
PAQW	8	-0.17 to 0.2	0.00	8	-2.0 to 2.0	-2.0	-0.3 to 0.3	-0.3	8	-0.07 to 0.16	0.01
IDSW	16	-0.1.5 to 0.6	0.00	16	-3.0 to 2.0	-1.0	-0.4 to 0.3	-0.1	16	-0.28 to 0.19	-0.01
IHRA	9	-0.1 to 0.1	0.10	9	-2.0 to 1.0	0.0	-0.3 to 0.1	0.0	9	-0.06 to 0.01	0.02
LMNW	16	-0.2 to 0.4	0.00	16	-6.0 to 2.0	0.0	-0.8 to 0.3	0.0	16	-0.12 to 0.09	-0.02
LMNA	9	-0.1 to 0.1	0.00	9	-32.0 to 2.0	-1.0	-4.3 to 0.3	0.1	9	-0.09 to 0.17	0.03
LGSW	17	-0.1 to 0.2	0.10	17	-25.0 to 2.0	-1.0	-3.3 to 0.3	-0.1	17	-0.09 to 0.16	-0.01
LGSA	9	-0.1 to 0.2	0.00	9	-2.0 to 2.0	0.0	-0.3 to 0.3	0.0	9	-0.09 to 0.08	-0.01
LGNW	15	-0.2 to 0.2	0.00	15	-2 to 350.0[(a)]	0.0	-0.3 to 47.0	0.0	15	-0.18 to 0.215	0.00
LWG	9	-0.2 to 0.0	-0.10	9	-2.0 to 0.0	-2.0	-0.3 to 0.0	-0.3	9	-0.14 to 0.19	-0.02
ANQW	10	-0.2 to 1.4	0.05	10	-25.0[(b)] to 172.0[(a)]	-2.5	-3.4 to 23.4	-0.3	10	-0.13 to 0.04	-0.04
PEKI	8	-0.2 to 0.2	0.10	8	-11.0 to 2.0	-1.5	-1.5 to 0.3	-0.2	8	-0.28 to 0.12	-0.07
DWQI	15	-0.2 to 0.2	0.00	15	-3.0 to 5.0	0.0	-0.4 to 0.7	0.0	15	-0.21 to 0.18	-0.02

Notes: (a) Defective membrane
(b) Sediment accumulation in deployment pipe

Table F-7. Database completeness with the number and percent of all missing or invalid barometric pressure, total dissolved gas, and temperature points for each FMS station during the 2022 water year.

Station ID	Monitoring Period	Barometric Pressure		Total Dissolved Gas		Temperature	
		Number Missing/ Anomalous	Percent Complete	Number Missing/ Anomalous	Percent Complete	Number Missing/ Anomalous	Percent Complete
MCPW	1 Oct – 30 Sep	1	99.99	35	99.60	**0**	**100.00**
MCNA	1 Apr – 31 Aug	**0**	**100.00**	**0**	**100.00**	**0**	**100.00**
PAQW	1 Apr – 31 Aug	159	95.67	268	92.71	268	92.71
IDSW	1 Oct – 30 Sep	22	99.75	52	99.41	652	92.55
IHRA	1 Apr – 31 Aug	**0**	**100.00**	**0**	**100.00**	**0**	**100.00**
LMNW	1 Oct – 30 Sep	**0**	**100.00**	2	99.98	1	99.99
LMNA	1 Apr – 31 Aug	**0**	**100.00**	527	85.66	2	99.95
LGSW	1 Oct – 30 Sep	**0**	**100.00**	447	94.90	1	99.99
LGSA	1 Apr – 31 Aug	**0**	**100.00**	**0**	**100.00**	**0**	**100.00**
LGNW	1 Oct – 30 Sep	18	99.79	387	95.59	71	99.19
LWG	1 Apr – 31 Aug	**0**	**100.00**	24	99.35	24	99.35
ANQW	1 Apr – 31 Aug	**0**	**100.00**	438	88.08	**0**	**100.00**
PEKI	1 Apr – 31 Aug	**0**	**100.00**	29	99.21	26	99.29
DWQI	1 Oct – 30 Sep	**0**	**100.00**	**0**	**100.00**	**0**	**100.00**

Table F-8. Summary of the total hours of barometric pressure, total dissolved gas, and temperature data that were missing or considered invalid in the 2022 water year.

Reason	BP Hours (%)	TDG Hours (%)	BP+TDG Hours (%)	Temp. Hours (%)	All Hours (%)
Too Low		1,328 (1.62)	1,328 (0.81)		1,328 (0.54)
Missed transmit					
Missing data	199 (0.24)	246 (0.30)	445 (0.27)	246 (0.30)	690 (0.28)
Spike				5 (0.00)	5 (0.00)
Inspection		200 (0.24)	200 (0.12)	142 (0.17)	342 (0.14)
Defective membrane		92 (0.11)	92 (0.06)		92 (0.04)
Defective sonde		290 (0.35)	290 (0.18)	601 (0.73)	890 (0.36)
DCP failure	1 (0.00)		1 (0.00)		1 (0.00)
Cable failure		52 (0.06)	52 (0.03)	52 (0.06)	104 (0.04)
Totals	**200 (0.24)**	**2,207 (2.69)**	**2,407 (1.47)**	**1,045 (1.28)**	**3,452 (1.40)**

Table F-9. Number and percent of all missing or invalid barometric pressure data for each FMS station during the 2022 water year, along with the reasons for those designations.

Station ID	Too Low # (%)	Missed Transmit # (%)	Missing DCP Data # (%)	Spike # (%)	Inspection # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	-	-	-	-	-	1 (0.01)	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	-	-	159 (4.33)	-	-	-	-	-	-
IDSW	-	-	22 (0.25)	-	-	-	-	-	-
IHRA	-	-	-	-	-	-	-	-	-
LMNW	-	-	-	-	-	-	-	-	-
LMNA	-	-	-	-	-	-	-	-	-
LGSW	-	-	-	-	-	-	-	-	-
LGSA	-	-	-	-	-	-	-	-	-
LGNW	-	-	18 (0.21)	-	-	-	-	-	-
LWG	-	-	-	-	-	-	-	-	-
ANQW	-	-	-	-	-	-	-	-	-
PEKI	-	-	-	-	-	-	-	-	-
DWQI	-	-	-	-	-	-	-	-	-

Table F-10. Number and percent of all missing or invalid total dissolved gas data for each FMS station during the 2022 water year, along with the reasons for those designations.

Station ID	Too Low # (%)	Missed Transmit # (%)	Missing DCP Data # (%)	Spike # (%)	Inspection # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	-	-	-	35 (0.40)	-	-	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	-	-	153 (4.16)	-	115 (3.13)	-	-	-	-
IDSW	-	-	-	-	-	-	-	-	52 (0.59)
IHRA	-	-	-	-	-	-	-	-	-
LMNW	-	-	-	-	2 (0.02)	-	-	-	-
LMNA	527 (14.34)	-	-	-	-	-	-	-	-
LGSW	154 (1.76)	-	-	-	3 (0.03)	-	290 (3.31)	-	-
LGSA	-	-	-	-	-	-	-	-	-
LGNW	308 (3.51)	-	69 (0.79)	-	-	10 (0.11)	-	-	-
LWG	-	-	24 (0.65)	-	-	-	-	-	-
ANQW	340 (9.25)	-	-	-	51 (1.39)	47 (1.28)	-	-	-
PEKI	-	-	-	-	29 (0.79)	-	-	-	-
DWQI	-	-	-	-	-	-	-	-	-

Table F-11. Number and percent of all missing or invalid temperature data for each FMS station during the 2022 water year, along with the reasons for those designations.

Station ID	Too Low # (%)	Missed Transmit # (%)	Missing DCP Data # (%)	Spike # (%)	Inspection # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	-	-	-	-	-	-	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	-	-	153 (4.16)	-	115 (3.13)	-	-	-	-
IDSW	-	-	-	-	-	-	601 (6.86)	-	52 (0.59)
IHRA	-	-	-	-	-	-	-	-	-
LMNW	-	-	-	1 (0.01)	-	-	-	-	-
LMNA	-	-	-	2 (0.05)	-	-	-	-	-
LGSW	-	-	-	-	1 (0.01)	-	-	-	-
LGSA	-	-	-	-	-	-	-	-	-
LGNW	-	-	69 (0.79)	2 (0.02)	-	-	-	-	-
LWG	-	-	24 (0.65)	-	-	-	-	-	-
ANQW	-	-	-	-	-	-	-	-	-
PEKI	-	-	-	-	26 (0.71)	-	-	-	-
DWQI	-	-	-	-	-	-	-	-	-