Appendix F

2025 Walla Walla District TDG Report

USACE Walla Walla District QA/QC Evaluation of the 2025 Water-Year FMS TDG Monitoring Data

Water Quality Technicians, Dave Towsley & Dustin Polach, performing maintenance on the McNary forebay temperature string

Includes:

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

USACE Walla Walla District QA/QC Evaluation of the 2024 Water Year FMS TDG Monitoring Data

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

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

Table of Contents

FIGURES

TABLES

Table F-1: Table showing the FMS stations and the percent complete data for barometric pressure, total dissolved gas, and temperature.

Table F-2: Table of factors responsible for missing and inaccurate data in hours and overall percentages.

Table F-3: Number and percent of all missing or invalid barometric data for each FMS during the 2025 water year and the reasons for those designations.

Table F-4: Number and percent of all missing or invalid Total dissolved gas data for each FMS for the 2025 water year and reasons for the designations.

Table F-5: Number and percent of missing or invalid temperature data for each of the FMS stations during the 2025 water year and reasons for those designations.

Table F-6: Ranges and medians of the differences between the in-place sensors and the secondary standards during for barometric pressure, total dissolved gas, and temperature.

Table F-7: Summary table of differences between the in-place probes and the secondary standards as well as amount of time elapsed during field checks.

Table F-8: Summary data of the pre calibrations and post calibrations performed in the laboratory against the lab standards for barometric pressure, total dissolved gas, and temperature.

Abstract

The U.S. Army Corps of Engineers (USACE), Walla Walla District (CENWW), operated 14 fixed-monitoring system (FMS) stations (eight seasonal and seven year-round) for total dissolved gas (TDG), barometric pressure (BP), and temperature as part of their 2025 water-quality program. These stations are located on the Columbia, Lower Snake and Clearwater Rivers. This report provides a summary of the 2025 water year quality assurance/quality control (QA/QC) evaluation. Highlights include:

- Data completeness for BP was 99.86 percent, TDG was 98.95 percent, and temperature was 99.86 percent for the 14 sites operated in 2025.
- TDG data from the individual FMS stations ranged from 93.46 to 100.00 percent complete. Defective membranes accounted for the highest cause of incomplete data at 63 percent with the next highest cause being sediment buildup in the deployment pipe at 31 percent.
- The TDG sensors from the six annual FMS stations were calibrated in the laboratory at four-week intervals from September 2024 through March 2025. The 14 FMS stations were removed from the field and calibrated in the laboratory every three weeks from April 2025 through August 2025. The seasonal FMS were shut down for the season in September 2025 and the remaining stations again went back to being calibrated on four-week intervals.
- There was a total of 164 sensor pre deployment checks that had a calculated mean difference in ambient pressure of -0.37 mmHg, a mean of -0.24 mmHg for the difference in ambient pressure plus 300 mmHg, and a mean of 0.12 °C for the difference in temperature. For the 148-post deployment checks the calculated means for the differences in ambient pressure, ambient pressure plus 100 and temperature are as follows: -0.22 mmHg, -0.64 mmHg, and -0.30 °C.
- From the 115 station visits the calculated median values for the in-situ field checks were as follows:
    1. TDG; -0.14 % Saturation with the station medians ranging -0.40 % for the minimum and 0.10 % for the maximum
    2. BP; 0.00 mmHg with the station medians ranging from -0.35 for the minimum and 0.20 for the maximum.
    3. Temperature; 0.00 °C with the station medians ranging from -0.04 for the minimum and 0.04 for the maximum.
- Station repairs and maintenance were also completed during the 2025 water year:
    1. Began steps to update the Dworshak tailwater (DWQI) station box with an updated DCP to improve the functionality of the station moving forward.
    2. Blowouts with compressed air were completed on affected tailwater stations (ANQW, LMNW, PAQW) to clear out sediment buildup that was affecting data.

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 spring TDG water quality standards in Washington and Oregon were as follows: 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. Idaho continued to adhere to the upper limit of 110 percent TDG without any exceptions.

The next water-quality parameter monitored at the facilities is barometric pressure (BP). The real time barometer readings were collected by the FMS and used to compare to the TDG value. The barometric pressure was divided by the TDG and divided by 100 to compute the percent saturation mentioned above.

Water Temperature data was also collected at the FMS stations and was used to monitor riverine conditions and guide flow augmentation operations at Dworshak to manage temperature in the Lower Granite tailrace

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 (DWQI) station. All data was transmitted via the Geostationary Operational Environmental Satellite Program (GOES) system to the USACE Corps Water Management System (CWMS) database. The water quality data stored in the CWMS database can be accessed at http://www.nwd-wc.usace.army.mil/ftppub/water_quality/tdg/.

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 2025. 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 QA/QC data for the FMS stations at McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak hydropower projects. Additionally, this data-collection system provided water quality information for; (a) the Clearwater River at Peck, Idaho, (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® M2000 Series hand-held barometer that served as a portable field standard for barometric pressure. The hand-held barometer was checked monthly against a National Institute of Standards and Technology (NIST) traceable lab barometer. 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. A 12-volt battery charged by a solar panel powered each station. Forty-six Hydrolab® multi-parameter probes (*i.e.*, MS4a's and MS5's) were utilized for temperature, depth, and TDG parameters. FMS stations were equipped with Sutron® data control platforms (DCP) and barometers.

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-2 hand-held certified pressure calibrator, calibrated yearly at the factory (primary standard), and a Ralston® pneumatic cylinder hand pump 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 the dry field deployed membrane in place prior to maintenance.

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 a NIST-traceable Fluke 1586A Super-DAQ® Precision Temperature Scanner. Thermistors reporting greater than ±0.20 °C difference from the lab standard were sent to the factory for calibration.

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 station barometers were checked using 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 employees. Missing values and those that appeared to be outside the expected range were flagged. If a reasonable explanation (*e.g*., routine maintenance/instrument inspection, 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

The pre-deployment evaluation of the sensors on the multiparameter probes consisted of 162 observations and checks of barometric pressure (Table F-8). The pre-deployment calibrations were done without a membrane on the TDG sensor of the sonde. The reading from the instrument was evaluated in comparison to the ambient pressure reading from the lab standard. The calculated mean from these evaluations was -0.38 mmHg, with a range of -3.41 mmHg to 4.00 mmHg (Table F-8). The sensors outside the acceptance range of ± 2 mmHg were recalibrated. If they still did not meet the acceptance range after recalibration the sonde was not deployed in the field. Three hundred millimeters of mercury were then added to the TDG sensor using the lab barometer as the baseline. The difference between the baseline and the sensor were

compared and used to calculate the mean and range of -0.24 mmHg and -3.41 mmHg to 4.00 mmHg respectively (Table F-8).

Variations in water temperature measured by the NIST- traceable thermometer and the sensor thermistors were minimal. The calculated mean was 0.12°C and median was 0.07 °C. These values were calculated based on 162 pre deployment checks of temperature where the minimum value was -0.13 °C and the maximum was 4.00 °C (Table F-8). The instrument manufacturer's specification is ± 0.20 °C for all instruments. Instruments outside this range are sent back to the manufacturer for recalibration.

4.1.2 Post-deployment

The post deployment QA/QC evaluation consisted of 148 checks that yielded favorable results. Post-deployment checks were done with the membrane in place on the TDG sensor after being retrieved from the field. Like the pre-deployment checks the differences between the laboratory barometric pressure and the TDG sensors were recorded and used for the calculations. The data from these checks ranged from -2.38 mmHg to 4.00 mmHg, with a mean of -0.22 mmHg (Table F-8). Results of the checks using barometric pressure + 100 yielded similar results with a calculated mean of -0.64 mmHg and a range of -5.40 mmHg to 4.00 mmHg (Table F-8).

The 148 post-deployment checks also consisted of checks for temperature. Temperature evaluation of the post-calibration checks resulted in a calculated mean of -0.30 °C, with a range of -9.71 °C to 4.00 °C (Table F-8).

4.2 System-wide Station QA/QC Performance

The QA/QC analysis of the fixed-monitoring system (FMS) stations consisted of a side-by-side comparison between the existing deployed probe and a newly lab calibrated probe. The results of this analysis were largely favorable with scattered outliers due to data being affected by external forces such as membrane failures and sedimentation issues (Figures F-1 to F-5).

There was a total of 115 readings that were used to calculate the mean and median values for the barometric pressure checks (Table F-7) The mean of all the differences between the station barometers and the secondary standard was 0.11 mmHg (Table F-7). The median for stations came to 0.00 mmHg with a range of -0.90 mmHg to 0.80 mmHg (Figure F-3 & Table F-7). Barometers that were outside the manufacturer's accuracy of ± 0.2 mmHg were replaced or reset.

A total of 115 readings were taken for temperature and used for the data analysis. The differences in temperature between the in place and replacement sondes were recorded and yielded a mean and median temperature differential of 0.18 °C and 0.00 °C respectively with a range of -0.90 °C to 0.70 °C (Figure F-4 & Table F-7). The manufacturer's specification for the temperature sensor is ±0.20 °C. Sondes that were outside of this range were sent back to the manufacturer for recalibration or replacement of the temperature sensor.

A total of 115 readings were taken for TDG and used to calculate the mean and median values of the difference between the in place TDG sensor and the lab calibrated replacement. The difference in pressure, difference in percent TDG, and difference in percent saturation were all categories with calculated means, medians, and ranges. The median and mean were -1 mmHg and 2 mmHg for the difference in pressure, -0.11 % and 18.77 % for difference in percent, and -0.14 % and 18.80 % for percent saturation (Figure F-5 & Table F-7). Overall, the TDG data was

within a reasonable range with a few blown membranes throughout the year and sedimentation issues that lead to long periods of affected data. Membranes with issues were removed from the overall data and will be covered in the data completeness section.

4.3 FMS Data Completeness and Station Statistics

Missing data as well as inaccuracies within the real time data set that was recorded were noted and removed from the overall data set recorded in the database. Overall, the percent completeness for the real time TDG, barometric pressure, and temperature data from all stations were 98.95%, 99.86%, and 99.86% respectively. The missing data was largely due to membrane failures, DCP issues, and sedimentation (Figure F-6, Table F-1, Table F-2).

4.3.1 Barometric Pressure

Barometric pressure from the FMS stations averaged 99.86% complete showing very little cases of inaccurate or missing data. Barometric pressure was 100% complete at most of the stations with McNary tailwater (MCPW), Ice harbor tailwater (IDSW), Lower Monumental tailwater (LMNW), Little Goose tailwater (LGSW), Peck (PEKI), and Dworshak (DWQI) showing missing data. LGSW and DWQI contributed the highest to the missing barometric pressure data with 43 and 86 hours respectively. Missed transmissions from the DCP to the satellite as well as defects in the DCP itself were the causes of the missing barometric pressure data (Table F-3).

4.3.2 Total Dissolved Gas

Total dissolved gas data from the FMS stations averaged 98.95% percent complete. Peck (PEKI), LMNW, DWQI, and Lower Granite tailwater (LGNW) were the two stations with the lowest percent of complete data (Table F-1). The incompleteness was mainly caused by sediment being built up in the deployment structures extending out into the river as well as failures of the TDG membrane itself. Sediment makes it difficult for the TDG sensor equipped on the sonde to make accurate reading leading to a slow drop in the total dissolved gas readings. Blown membranes make field side by sides a challenge as well as lead to inaccurate data spikes. (Table F-4).

4.3.3 Temperature

Temperature data from the FMS stations averaged 99.86% complete (Table F-1). LGSW and DWQI were the stations with the most hours of inaccurate or incomplete temperature data at 44 and 86 hours respectively (Table F-5). Missing temperature data was mainly caused by failures of the DCP itself as well as transmission failures from the antenna itself.

4.4 Deployment Pipe Clean-Out

Sediment build-up in the tailwater deployment pipes tends to occur at four of the FMS stations as follows Ice Harbor tailwater (IDSW), Anatone (ANQW), Peck (PEKI), and Pasco (PAQW). To attempt to limit the buildup, seasonal stations such as PEKI and ANQW were cleaned out prior to bringing the station online. Sediment-affected stations were cleared out using compressed air.

Despite best efforts to clean the deployment pipes the noted stations still had periods of incomplete data due to sediment buildup and thus were cleaned out additionally as needed.

4.5 Notable Station Maintenance

No notable large scale station maintenance such as full-blown station rebuilds was completed on the FMS stations in the 2025 water year. The water quality team has been working closely with Dworshak's project personnel to create a plan to replace and update the outdated DCP, a Sutron 8310, at the tailwater station (DWQI) with a Campbell DCP for improved station reliability. At the time of this report the new station box has been put together and hung by Dworshak and the lead electrical engineer has begun working to create the program that will have the same functions for data recording and live data accessibility for real time water management decisions as the previous one. While we are currently still operating with the original equipment as we aim to make the switch in the 2026 water year once adequate side by side field testing showing comparable data has been completed.

5.0 SUMMARY

Hourly TDG, temperature, and barometric pressure data recorded during the 2025 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 the beginning of April. The combined data completeness for all stations was 99.56%.

The CENWW Hydrology Section performed routine station maintenance, completed emergency repairs, operated the DCPs, and station repairs throughout the water year. 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 affected mainly by sediment build-up and defective or broken sondes.

The pre-deployment QA/QC checks showed a mean difference of -0.38 mmHg when the TDG sensors were compared to barometric pressure and -0.25 mmHg when 300 mmHg of pressure was added. The calculated means for the post-deployment evaluations were -0.22 mmHg and -0.64 mmHg when the TDG sensors were compared to barometric pressure and barometric pressure plus 100 mmHg, respectively. The calculated mean temperature difference was 0.12 °C for pre-deployment and -0.30 °C for post-calibration.

Overall, the TDG instruments used to perform the monitoring for this year met the manufacturers' specifications as shown during the field checks.

FIGURES

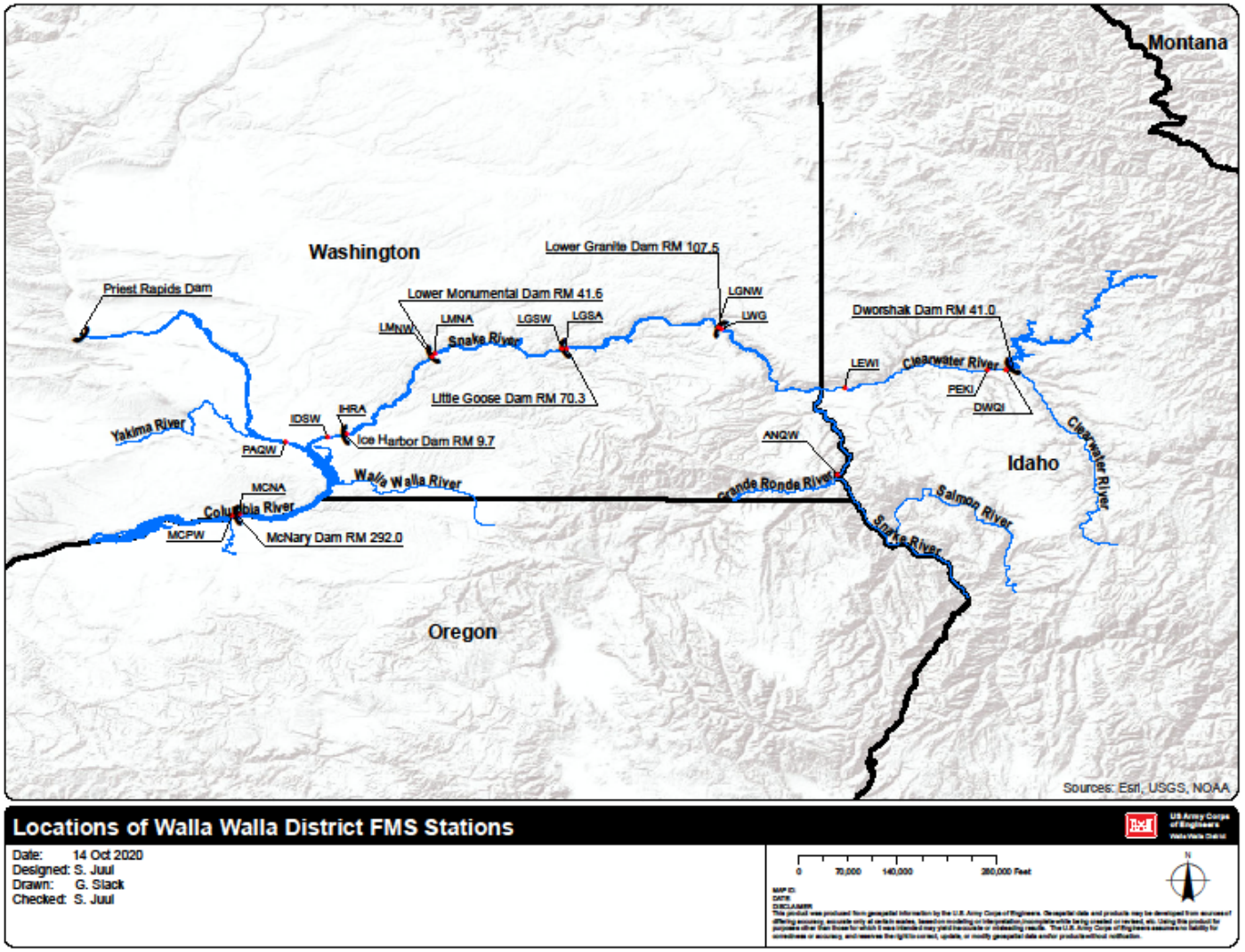

Figure F-1. Locations of Walla Walla District's FMS stations.

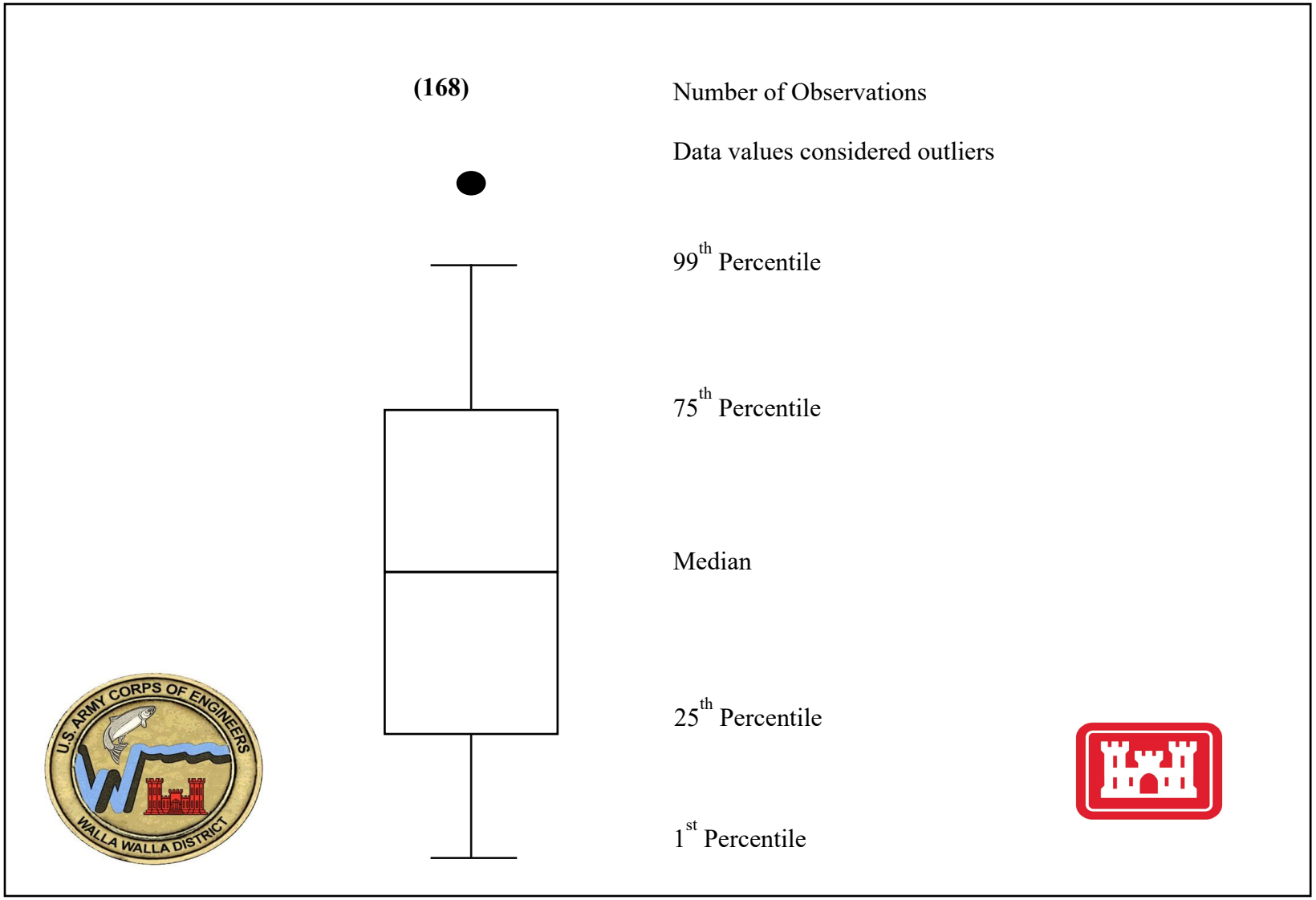

Figure F-2. Explanation key for the box plot information.

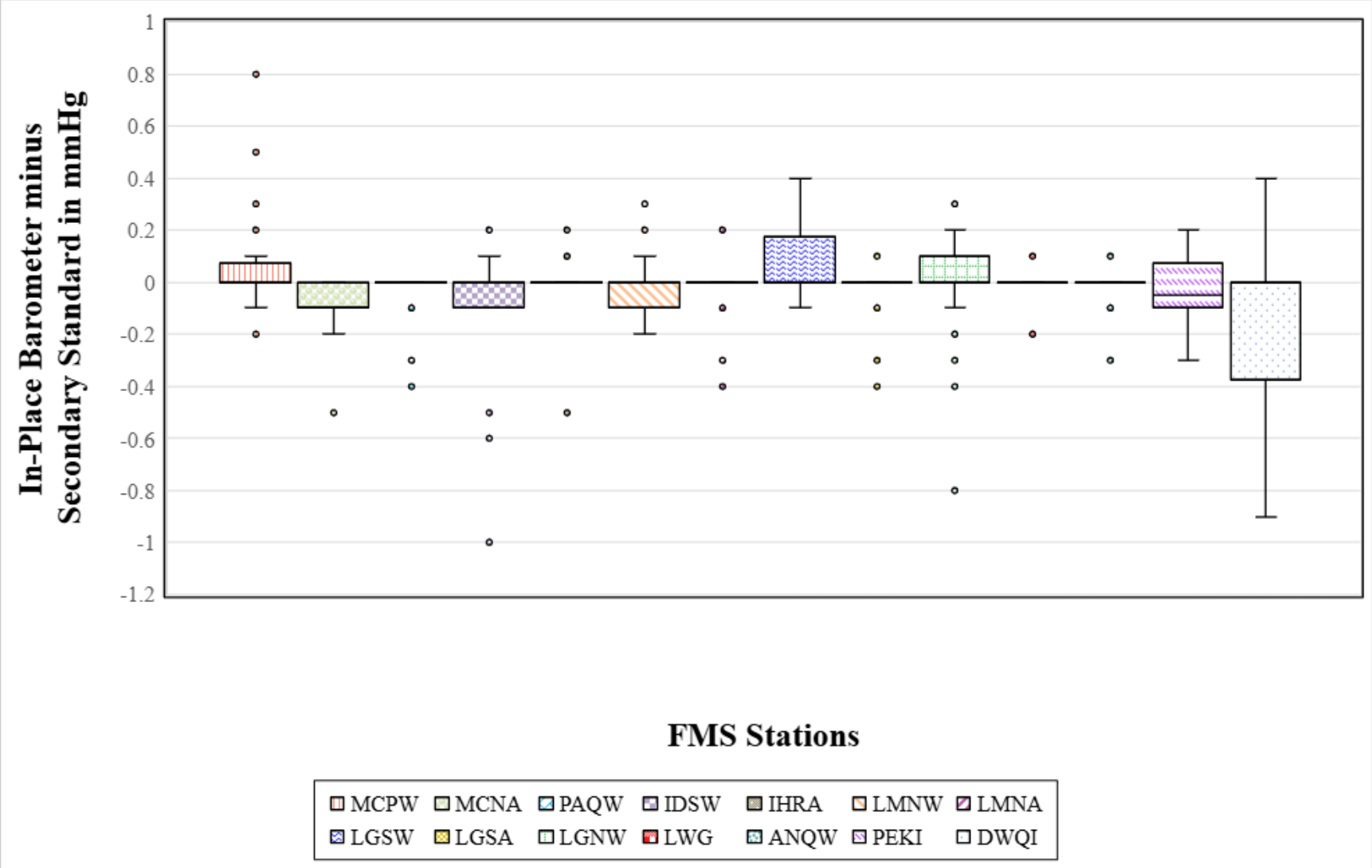

Figure F-3: **Box plot showing difference between in place barometer minus the secondary standard for each FMS**.

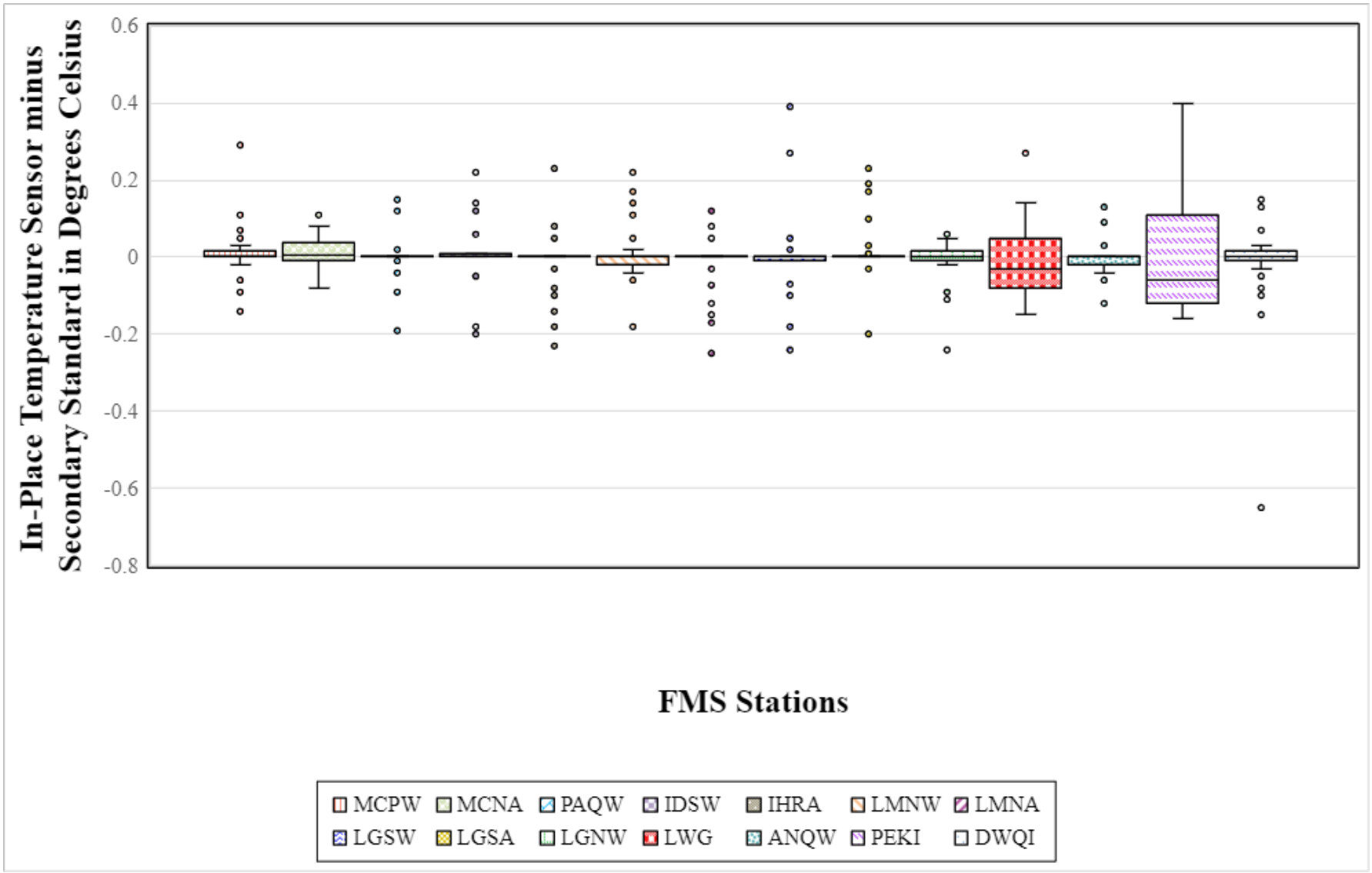

Figure F-4: Box Plot showing the difference in temperature between the in-place sensor and secondary standard per FMS.

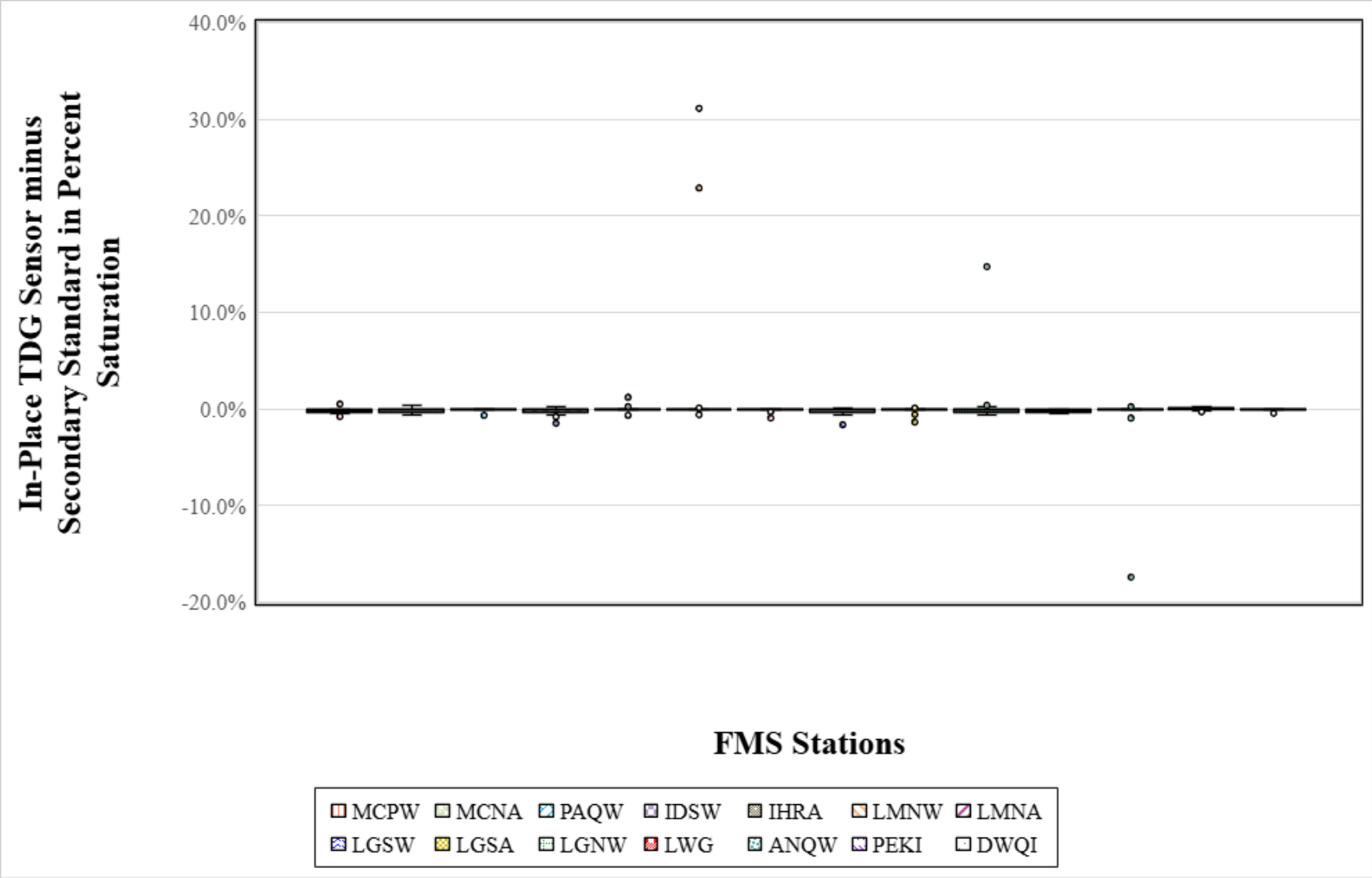

Figure F-5: Box plots showing the differences between the in place and secondary standard TDG sensors per FMS.

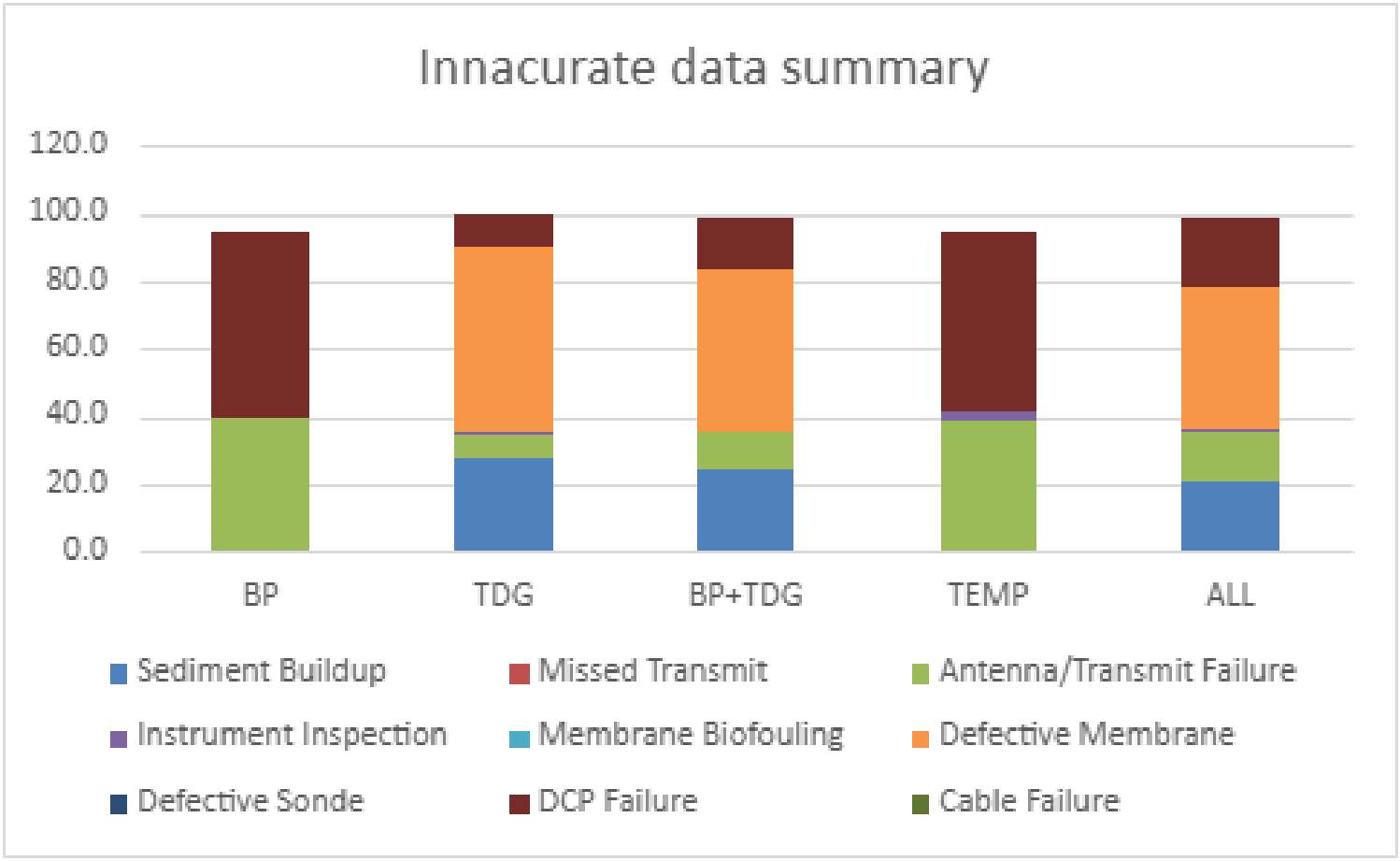

Figure F-6: Summary of missing data causes

TABLES

Summary of Data Completeness

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	6	99.93	6	99.93	6	99.93
MCNA	1 Apr – 31 Aug	**0**	**100.00**	**1**	**99.97**	1	99.97
PAQW	1 Apr – 31 Aug	**0**	**100.00**	1	99.97	**1**	**99.97**
IDSW	1 Oct – 30 Sep	6	99.93	6	99.93	6	99.93
IHRA	1 Apr – 31 Aug	**0**	**100.00**	**1**	**99.97**	1	99.97
LMNW	1 Oct – 30 Sep	6	99.93	126	98.56	7	99.92
LMNA	1 Apr – 31 Aug	**0**	**100.00**	**0**	**100.00**	**0**	**100.00**
LGSW	1 Oct – 30 Sep	43	99.51	100	98.86	44	99.50
LGSA	1 Apr – 31 Aug	**0**	**100.00**	**8**	**99.78**	**0**	**100.00**
LGNW	1 Oct – 30 Sep	0	100.00	287	96.72	0	100.00
LWG	1 Apr – 31 Aug	0	100.00	0	100.00	0	100.00
ANQW	1 Apr – 31 Aug	0	100.00	18	99.51	0	100.00
PEKI	1 Apr – 31 Aug	8	99.78	240	93.46	8	99.78
DWQI	1 Oct – 30 Sep	86	99.02	127	98.55	86	99.02
Average			99.86		98.95		99.86

Table F-1: Table showing the FMS stations and the percent complete data for barometric pressure, total dissolved gas, and temperature.

Summary Table of All Hours of Missing Data and the Reasons

Reason	BP Hours (%)	TDG Hours (%)	BP+TDG Hours (%)	Temp. Hours (%)	All Hours (%)
Sediment Buildup	0	258 (0.31)	258 (0.16)	0	258 (0.10)
Missed Transmit	0	0	0	1 (0.00)	1 (0.00)
Antenna/Transmit Failure	61 (0.07)	61 (0.07)	122 (0.07)	61 (0.07)	183 (0.07)
Instrument Inspection	0	4 (0.00)	4 (0.00)	4 (0.00)	8 (0.00)
Membrane Biofouling	0	0	0	0	0
Defective Membrane	0	513 (0.63)	513 (0.31)	0	513 (0.21)
Defective Sonde	0	0	0	0	0
DCP Failure	86 (0.10)	86 (0.10)	171 (0.10)	86 (0.10)	257 (0.10)
Cable Failure	0	0	0	0	0
Totals	154 (0.18)	921 (1.12)	1076 (0.65)	160 (0.18)	1235 (0.50)
	(99.82)	**(98.88)**	**(99.35)**	**(99.82)**	**(99.50)**

Table F-2: Table of factors responsible for missing and inaccurate data in hours and overall percentages.

Table of All Missing Barometric Data

Station ID	Sediment Build-up # (%)	Missed Transmit # (%)	Antenna/ Transmit Failure # (%)	Instrument Inspection # (%)	Membrane Biofouling # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	6 (0.07)	-	-	-	-	-	-
MCNA	-	-	-	-	-	-	-	-	-
PAQW	-	-	-	-	-	-	-	-	-
IDSW	-	-	6 (0.07)	-	-	-	-	-	-
IHRA	-	-	-	-	-	-	-	-	-
LMNW	-	-	6 (0.07)	-	-	-	-	-	-
LMNA	-	-	-	-	-	-	-	-	-
LGSW	-	-	43 (0.49)	-	-	-	-	-	-
LGSA	-	-	-	-	-	-	-	-	-
LGNW	-	-	-	-	-	-	-	-	-
LWG	-	-	-	-	-	-	-	-	-
ANQW	-	-	-	-	-	-	-	-	-
PEKI	-	-	-	-	-	-	-	-	-
DWQI	-	-	-	-	-	-	-	85.5 (0.98)	-

Table F-3: Number and percent of all missing or invalid barometric data for each FMS during the 2025 water year and the reasons for those designations

Table of All Missing Total Dissolved Gas Data

Station ID	Sediment Build-up # (%)	Missed Transmit # (%)	Antenna/ Transmit Failure # (%)	Instrument Inspection # (%)	Membrane Biofouling # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	6 (0.07)	-	-	-	-	-	-
MCNA	-	-	-	1 (0.03)	-	-	-	-	-
PAQW	-	-	-	1 (0.03)	-	-	-	-	-
IDSW	-	-	6 (0.07)	-	-	-	-	-	-
IHRA	-	-	-	1 (0.03)	-	-	-	-	-
LMNW	-	-	6 (0.07)	-	-	120 (1.37)	-	-	-
LMNA	-	-	-	-	-	-	-	-	-
LGSW	-	-	43 (0.49)	1 (0.01)	-	56 (0.64)	-	-	-
LGSA	-	-	-	-	-	8 (0.22)	-	-	-
LGNW	-	-	-	-	-	287 (3.28)	-	-	-
LWG	-	-	-	-	-	-	-	-	-
ANQW	18 (0.49)	-	-	-	-	-	-	-	-
PEKI	240 (6.54)	-	-	-	-	-	-	-	-
DWQI	-	-	-	-	-	41.5 (0.47)	-	85.5 (0.98)	-

Table F-4: Number and percent of all missing or invalid Total dissolved gas data for each FMS for the 2025 water year and reasons for the designations.

Table of All Missing Temperature Data

Station ID	Sediment Build-up # (%)	Missed Transmit # (%)	Antenna/ Transmit Failure # (%)	Instrument Inspection # (%)	Membrane Biofouling # (%)	Defective Membrane # (%)	Defective Sonde # (%)	DCP Failure # (%)	Cable Failure # (%)
MCPW	-	-	6 (0.07)	-	-	-	-	-	-
MCNA	-	-	-	1 (0.03)	-	-	-	-	-
PAQW	-	-	-	1 (0.03)	-	-	-	-	-
IDSW	-	-	6 (0.07)	-	-	-	-	-	-
IHRA	-	-	-	1 (0.03)	-	-	-	-	-
LMNW	-	1 (0.01)	6 (0.07)	-	-	-	-	-	-
LMNA	-	-	-	-	-	-	-	-	-
LGSW	-	-	43 (0.49)	1 (0.01)	-	-	-	-	-
LGSA	-	-	-	-	-	-	-	-	-
LGNW	-	-	-	-	-	-	-	-	-
LWG	-	-	-	-	-	-	-	-	-
ANQW	-	-	-	-	-	-	-	-	-
PEKI	-	-	-	-	-	-	-	-	-
DWQI	-	-	-	-	-	-	-	85.5 (0.02)	-

Table F-5: Number and percent of missing or invalid temperature data for each of the FMS stations during the 2025 water year and reasons for those designations.

Summary of Differences Between In-place and Secondary Sensors

	Delta Barometric Air Pressure			Delta Total Dissolved Gas					Delta Water Temperature		
Station ID	# Obs.	Range (mmHg)	Median (mmHg)	# Obs.	Range (mmHg)	Median (mmHg)	Range (% Sat)	Median (% Sat)	# Obs.	Range (°C)	Median (°C)
MCPW	14	-0.10 to 0.20	0.05	14	-3.0 to 3.0	-1.00	-0.40 to 0.40	-0.1%	14	-0.14 to 0.29	0.02
MCNA	9	-0.10 to 0.10	0.00	9	-2.0 to 2.0	-1.00	-0.27 to 0.27	-0.1%	9	-0.08 to 0.11	0.00
PAQW	9	-0.10 to 0.30	0.00	9	-2.0 to 1.0	-1.00	-0.27 to 0.13	-0.1%	9	-0.19 to 0.15	-0.01
IDSW	14	-0.30 to 0.10	-0.10	14	-3.0 to 2.0	-1.50	-0.40 to 0.26	-0.2%	14	-0.20 to 0.22	0.00
IHRA	9	-0.10 to 0.10	0.10	9	-3.0 to 1.0	-1.00	-0.40 to 0.13	-0.1%	9	-0.23 to 0.23	-0.03
LMNW	13	-0.10 to 0.10	0.00	13	-3.0 to 1.0	-2.00	-0.40 to 0.13	-0.3%	13	-0.18 to 0.22	-0.02
LMNA	8	-0.10 to 0.00	0.00	9	-3.0 to 1.0	0.00	-0.40 to 0.13	-0.1%	9	-0.25 to 0.12	-0.06
LGSW	14	-0.10 to 0.20	0.05	14	-3.0 to 3.0	-2.00	-0.40 to 0.40	-0.3%	14	-0.24 to 0.39	0.01
LGSA	9	-0.20 to 0.20	0.00	9	-4.0 to 2.0	-2.00	-0.54 to 0.27	-0.3%	9	-0.20 to 0.23	0.01
LGNW	14	-0.10 to 0.10	0.00	14	-2.0 to 1.0	-0.50	-0.27 to 0.13	-0.1%	14	-0.24 to 0.06	-0.01
LWG	9	-0.20 to 0.20	0.00	9	-2.0 to 0.0	-2.00	-0.27 to 0.00	-0.3%	9	-0.15 to 0.27	-0.03
ANQW	8	-1.10 to 2.20	0.05	8	-3.0 to 2.0	0.50	-0.41 to 0.27	0.1%	8	-0.12 to 0.13	-0.01
PEKI	9	-0.10 to 0.10	0.00	9	-2.0 to 2.0	0.00	-0.27 to 0.27	0.0%	9	-0.16 to 0.40	-0.06
DWQI	13	-0.60 to 0.20	-0.10	13	-2.0 to 1.0	0.00	-0.27 to 0.14	0.0%	13	-0.10 to 0.15	0.02

Table F-6: Ranges and medians of the differences between the in-place sensors and the secondary standards during for barometric pressure, total dissolved gas, and temperature.

Summary Table of Field in-situ Checks

Summary of all data			TDG			
	Δ BP (mmHg)	**Δ Temp** (°C)	**Δ PT** (mmHg)	**% Δ** (mmHg)	**Δ** (% sat)	**Δ time**
Count	152	154	154	154	153	154
Max	2.20	0.40	3	0.41%	0.40%	20:11
Min	-1.10	-0.25	-4	-0.50%	-0.54%	0:04
Mean	-0.01	0.00	-1	-0.12%	-0.13%	10:11
Median	0.00	0.00	-1	-0.13%	-0.13%	3:43

Summary of all data			*TDG*			
	Δ BP (mmHg)	**Δ Temp** (°C)	**Δ PT** (mmHg)	**% Δ** (mmHg)	**Δ** (% sat)	**Δ time**
Count	115	115.1586667	123.4666667	115.0105705	115.0113202	115.3613889
Max	0.80	0.70	233	30.03%	31.17%	17:10
Min	-0.90	-0.90	-128	-17.51%	0.00%	0:00
Mean	0.11	0.18	2	18.77%	18.80%	6:57
Median	0.00	0.00	-1	-0.14%	-0.14%	2:26

Table F-7: Summary table of differences between the in-place probes and the secondary standards as well as amount of time elapsed during field checks.

Pre and Post Calibrations Summary for FY25

Deployment	Observations	Statistic	Delta BP mmHg (%)	Delta (BP+300) mmHg (%)	Delta (BP+100) mmHg (%)	Delta Temp. °C
Pre	162	Minimum	-3.41 (-0.46)	-3.41 (-0.4)	----	-0.13
		25 Percentile	-0.67 (-0.09)	-0.63 (-0.07)	----	0.04
		Median	-0.38 (-0.05)	-0.24 (-0.03)	----	0.07
		75 Percentile	-0.05 (-0.01)	0.1 (-0.01)	----	0.17
		Maximum	4 (4)	4 (400)	----	4.00
		Mean	-0.38 (-0.05)	-0.24 (-0.04)	----	0.12
Post	148	Minimum	-2.38 (-0.32)	----	-5.4 (-20)	-9.71
		25 Percentile	-0.63 (-0.09)	----	-1.14 (-0.11)	-0.04
		Median	-0.3 (-0.04)	----	-0.5 (-0.06)	0.03
		75 Percentile	0.29 (0.04)	----	-0.07 (-0.01)	0.09
		Maximum	4 (4)	----	4 (400)	4.00
		Mean	-0.22 (-0.03)	----	-0.64 (-0.46)	-0.30

Table F-8: Summary data of the pre calibrations and post calibrations performed in the laboratory against the lab standards for barometric pressure, total dissolved gas, and temperature.