APPENDIX J

WALLA WALLA DISTRICT
TDG REPORT

(Includes McNary, Ice Harbor, Lower Monumental, Little Goose Lower Granite and Dworshak)

Evaluation of Water-Year 2004 Fixed-Monitoring Station Data:
Walla Walla District

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ABSTRACT

The U.S. Army Corps of Engineers (USACE), Walla Walla District (CENWW), operated sixteen fixed-monitoring system (FMS) stations (eight seasonal and eight rear-round) for total dissolved gas (TDG), barometric pressure (BP), and temperature as part of their 2004 water-quality program. These stations are located on the Columbia, Lower Snake and Clearwater Rivers. This report provides a summary of the 2004 water-year data along with the corresponding quality assurance/ quality control (QA/QC) evaluation. Field instrument calibration revealed with only minor differences between the in-place and replacement sondes with overall averages of -0.10 mm Hg for BP, 0.07 percent TDG saturation, and 0.003 ^{o}C. The hourly measurements for all three parameters were greater than 99 percent complete: BP 99.91 percent, TDG 99.55 percent, and temperature 99.88 percent. None of the 1 April through 15 September temperature measurements exceeded 20 ^{o}C at the Dworshak and Peck stations. The average percentage increased to 26.7 percent for the 108-mile reach of the lower Snake River and 31.8 percent for the three stations at McNary. Total gas saturation did not exceed 125 percent at any station between 1 April and 15 September. The 12-hour 115 percent forebay criterion was not surpassed at Lower Granite, but did exceed the threshold for two days at Little Goose and Lower Monumental, four days at Ice Harbor, nine days at McNary on the Washington side, and twenty-four days on the Oregon side of the river. The 12-hour 120 percent tailwater criterion was not exceeded during the same interval at Lower Granite and Little Goose, once at Lower Monumental, twice at Ice Harbor, and during seven days at McNary.

1.0 INTRODUCTION

Six hydropower projects – McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, and Dworshak – that are operated by the Walla Walla District (CENWW) of the U.S. Army Corps of Engineers (USACE) are included in the basin-wide FMS station network. Eight of the stations (*i.e.*, three at McNary Dam, two at Ice Harbor Dam, two at Lower Granite Dam, and one at Dworshak Dam) are operated throughout the year (Figure 1; Table 1). The remaining eight stations record data from 1 April through 15 September.

Three water-quality 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 saturation for protection of freshwater aquatic life. Concentrations above this level can cause gas bubble trauma in fish and adversely affect other aquatic organisms (USEPA, 1986). The State of Washington water-quality standards (WADOE, 1997) provide exemptions to this criterion when water is spilled for fish passage, as well as during high river discharge events. WAC 173-201A-070 states that the averages of the twelve highest daily TDG values during these periods can reach 115 percent in the forebays and 120 percent in the tailwaters. The one-hour maximum TDG measurement cannot exceed 125 percent. Two additional parameters that influence TDG saturation are barometric pressure and water temperature. As such, measurements for these two constituents are also recorded and stored in the database.

Measurements were completed hourly at all stations and transmitted via the Geostationary Operational Environmental Satellite Program (GOES) system to the Columbia River Operational Hydromet Management System (CROHMS) data base at the USACE Northwestern Division (CENWD) office in Portland, Oregon every four hours. The CENWD website is the official U.S. Government source for the entire total dissolved gas monitoring system (TDGMS) and can be accessed at http://www.nwd-wc.usace.army.mil/TMT/wqwebpage/mainpage.htm.

2.0 PURPOSE AND SCOPE

The purpose of gas monitoring is to provide managers, agencies, and interested parties with near real-time data for managing stream flows and TDG levels downstream from power-producing dams. 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 data for current and future decision processes.

This 2004 report:

- Describes the data collection methods.
- Evaluates quality assurance/ quality control (QA/QC) data for the TDGMS stations at McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite reservoirs. Additionally, this data-collection system provided water-

quality information for the Clearwater River downstream of Dworshak Dam, the Columbia River near Pasco, and the Snake River near Anatone, Washington (Figure 1; Table 1).

- The QA/QC data includes:
  1. Instrument Data. These data were 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 two-week deployment.
  2. Station Data: These data present comparisons between an in-place instrument that was deployed at a given station for a two-week cycle and a newly calibrated QA/QC instrument (field standard). The Honeywell® barometers at each station were evaluated with a hand-held barometer that served as a portable field standard for barometric pressure. Sixteen stations were visited for maintenance two times per month between 1 April and 15 September. Eight stations were maintained on the same bi-weekly schedule for the entire year.

- Provides a synopsis of the station TDG, temperature, and barometric pressure data.

3.0 METHODS

3.1 Data Collection

The instrumentation at each FMS station consisted of components provided by CENWW and the U.S. Geological Survey (USGS). A 12-volt battery charged by a solar panel and/or 120-volt alternating-current line powered each station. The Hydrolab® multi-parameter probes (*i.e.*, twenty Minisondes, six Minisonde 4a's, and eight Datasondes), cables, and Honeywell® PPT16 electronic barometers were provided by CENWW. The Sutron® Model 8210 data collection platforms (DCP) and associated satellite linkages were rented from the USGS. The DCP transmitted the most recently logged eight hours of data to the GOES system every four hours. The data were automatically decoded and transferred to the CROHMS database.

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 (mm Hg). 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 hand-held barometer (Thommen Classic) that was checked quarterly against a wall-mounted mercury barometer (Princo Instruments Model 453). The differences between Lab BP and the pressure measured by the sonde [Δ(BP-PT)] were recorded before and after deployment. 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™ certified pressure calibrator (primary standard) was used to apply pressure to the TDG sensor. Two hundred mm Hg were added to Lab BP during the pre-deployment check and the differences between Lab BP+200 and the sondes' response were recorded as Δ[(BP+200)-PT]. Similar tests were completed post-deployment when 100 mm Hg was added to Lab BP, and the resulting differences were recorded as Δ[(BP+100)-PT]. Pre-deployment pressure tests were made without a membrane installed. Post-deployment tests were made with a dry membrane in place.

Each sonde also contains a sensor for reporting water temperature in degrees Celsius (°C). Sonde thermometers are factory calibrated and cannot be adjusted. However, temperature sensor performance were evaluated pre- and post-deployment by comparing instrument readings to a National Institute of Standards and Technology (NIST)-traceable digital thermistor and NIST-traceable probe (Barnant 600-1075 thermistor and YSI 400 series probe). Both of these instruments were checked quarterly against a NIST mercury thermometer standard.

3.3 Field Procedures

The differences in barometric pressure, water temperature, and TDG between a secondary standard instrument and the fixed-station monitors after two 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 Honeywell barometer was checked using the Thommen hand-held barometer. The water temperature and TDG comparisons were made *in situ* with the secondary standard (a recently calibrated Hydrolab®) positioned alongside the field Hydrolab®.

3.4 Defining Invalid and Missing Data Values

The 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, 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.

Several discrepancies were identified between the data in the CROHMS database and Automated Data Acquisition and Processing System (ADAPS) database operated by the USGS during the preparation of this report. Most of the inconsistencies were categorized as missing in CROHMS but present in ADAPS. The more problematic stations included the ones at Dworshak, Ice Harbor forebay, and Ice Harbor tailwater. Data from other stations, such as Pasco, Lewiston, and Lower Monumental forebay, matched in both databases. To arrive at the most representative database for this report, the information stored in ADAPS was used as the foundation. The information in the CROHMS database was then cross-referenced to ADAPS and merged where necessary to arrive at a final set of data.

4.0 RESULTS AND DISCUSSION

4.1 Inventory-wide Sonde QA/QC Performance

The pre-deployment evaluation of the sondes consisted of 300, or more, individual checks for each parameter (Table 2). The average difference between the laboratory barometric pressure and the value determined by the sonde sensors was –0.43 mm Hg. This calculated mean was based on 312 measurements where the median differences for individual sondes ranged from -1.75 mm Hg to 1.00 mm Hg (Figure 2; Table 3). The data for the tests that were completed with the addition of 200 mm Hg above atmospheric pressure showed similar results. The average difference between the applied pressure and that measured by all the sondes was -0.41 mm Hg, with medians for individual sondes spanning the same range determined for the ones where no additional pressure was applied (Figure 3) – thereby verifying response linearity.

The dissimilarities between the NIST-traceable thermometer and the sonde thermistors were also quite small. The average for all the instruments was only 0.03 ^oC. This calculated value was based on 311 measurements, with the medians for individual sonde ranging from –0.18 ^oC to 0.40 ^oC (Figure 3). The calculated 0.40 ^oC was due to instrument #17 (Figure 3), and this sonde was removed from service after two deployments.

The evaluation of the post-deployment QA/QC data also displayed favorable results. The difference between the laboratory barometric pressure and that recorded by the sondes averaged –0.33 mm Hg (Table 2; Figure 4). This mean was based on 279 data points from sondes with median values ranging from –2.00 mm Hg to 2.00 mm Hg (Table 4). The addition of 100 mm Hg above atmospheric pressure caused the mean Δ[(BP+100)-PT] to change non-significantly to 0.30 mm Hg when 232 measurements were considered. Instrument medians ranged from a low of –0.50 mm Hg to 2.00 mm Hg (Figure 4). Sonde thermistor performance remained favorable after deployment, averaging to within 0.10 ^oC of the NIST traceable-standard. Individual temperature sensors had median values ranging from –0.17 ^oC to 0.45 ^oC (*i.e.*, sonde #17) (Figure 3)

4.2 System-wide Station QA/QC Performance

The analysis of the station QA/QC data showed that the in-place barometric air pressure, TDG, and temperature instruments performed well when compared to the secondary standards. The mean of all the differences calculated between the station barometers and the secondary standards was –0.10 mm Hg (Table 5). The two stations that departed from this median to the greatest extent were Anatone (0.80 mm Hg) and Lewiston (-0.95 mm Hg) (Figure 5; Table 6). However, the calculated median values for both of these cases were not significantly different at the 95% confidence level from most of the other stations shown in Figure 5.

Temperature differentials in the field had a median value that was less than 0.01 ^{o}C (Table 5). Median values for individual stations ranged from –0.04 ^{o}C to 0.03 ^{o}C (Figure 5; Table 6).

The overall median for the TDG differences was 0.54 mm Hg, or 0.07 percent saturation (Figure 6; Table 5). The median values for individual stations were also within the data quality guidelines, ranging from 1 to 3 mm Hg or 0.33 to 1.08 percent saturation (Table 6). Two notable outliers occurred at IHR on 13 September 2004 and MCPW of 31 August 2004. In the first case, the in-place sonde response was 388 mm Hg high due to a ruptured membrane and the previous sixty-seven hours of data were deleted from consideration. The late-August event at McNary tailwater was attributed to a faulty sonde. The TDG measurements gradually increased to 87 mm Hg higher than they actually were and the ten days of affected were deleted.

4.3 FMS Data Completeness and Station Statistics

Data completeness and station statistics were evaluated for several applicable intervals. Data completeness for all three parameters was determined for the entire year for the eight annual stations, and from 1 April through 15 September for the seasonal sites. The 1 April through 15 September interval was applied to the frequency analysis of the temperature data to make comparisons consistent. The TDG data analysis encompassed a greater diversity of timelines due to the differing fish spill periods at each project, as well as other intervals when there was involuntary spill due to elevated river discharge (Table 7).

The entire data set for all stations included 678 hourly values, or 0.66 percent, that were either missing or considered invalid (Table 8). The largest group consisted of 233 hourly measurements (34.36 percent) that were attributed to a defective sonde at McNary tailwater (Table 9). This incident was the primary contributor to the 1.04 percent loss of data at that site (Figures 7 and 8). The second largest group was missing data due to transmission errors and unknown causes, and accounted for 200 data points, or 29.5 percent of the entire set. These two categories were the main factors for omitted data at McNary forebay on the Oregon side, Pasco, Lower Monumental tailwater, Lower Granite tailwater, Anatone, and Dworshak (Figure 8). The remaining 245 values (36.14 percent) were related to routine maintenance, DCP failure, change to daylight savings time, and data spikes.

4.3.1 Temperature

Greater than 99 percent of the temperature data from the FMS stations passed QA/QC. The Little Goose tailwater site had the lowest accounting at 99.5 percent (Table 10). However, the stations at Pasco, Lower Monumental forebay, Little Goose Forebay, Lewiston, and Peck were all 99.98 percent complete.

Since the intervals of data collection differed at various stations, the 1 April through 15 September time period was utilized to make consistent comparisons. Several noteworthy features were identified as a result of this process, including:

- None of the hourly temperature readings exceeded 20 ^{o}C at the Dworshak and Peck stations (Table 11). However, one measurement of 20.1 ^{o}C was recorded at the downstream Lewiston station.
- Seventy-three percent of the values recorded at the Dworshak site were between 5 ^{o}C and 8 ^{o}C (Table 11; Figure 9). Downstream mixing with the mainstem of the Clearwater River and warming broadened the frequency distributions at Peck and Lewiston where the maxima were observed between 10 ^{o}C and 12 ^{o}C.
- The stations at Anatone, Lower Granite forebay, Ice Harbor forebay, and McNary forebay on both the Oregon and Washington sides experienced temperatures greater than 20 ^{o}C more than 35 percent of the time (Table 11).
- Conversely, the lowest frequencies occurred at the Lower Granite tailwater and Little Goose tailwater stations at 0.2 percent and 12.6 percent, respectively (Table 11).
- The FMS stations at the four lower Snake River projects had bimodal temperature distributions (Figures 10 and 11). The first peak at Lower Granite tailwater occurred between 10 ^{o}C and 11 ^{o}C, and between 12 ^{o}C to 14 ^{o}C at the other seven locations. The secondary peaks occurred between 20 ^{o}C and 22 ^{o}C at Lower Granite forebay, Little Goose forebay, Lower Monumental forebay, Lower Monumental tailwater, Ice Harbor forebay, and Ice Harbor tailwater.
- There was also a distinct downstream trend in the number of values that were greater than 20 ^{o}C at the tailwater stations: 0.2 percent at Lower Granite Dam, 12.6 percent at Little Goose Dam, 28.8 percent at Lower Monumental Dam, and 36.0 percent at Ice Harbor Dam (Table 12). The reason for the progression was that the cooling effects of water released from Dworshak Reservoir were more noticeable at the upstream projects.
- Almost 3 percent additional data points at the Oregon side of McNary Dam were greater than 20 ^{o}C relative to the information from the sonde located on the Washington side (Figure 12; Table 12). This is the same percentage noted last year.
- The McNary Dam tailwater station averaged 5.2 percent fewer measurements that were greater than 20 ^{o}C than the mean of the two FMS sites in the forebay.

4.3.2 Total Dissolved Gas

The TDG data from all of the stations combined were approximately 99.5 percent complete (Table 10). Fifteen of the sixteen stations were greater than 99 percent complete – the exception was McNary tailwater. The data set for this downstream station was 97.13 percent complete while the second lowest percentage was calculated for Ice Harbor forebay at 99.10 percent – both of these stations experienced short-term equipment failure as previously described. The stations at Pasco, Lower Monumental forebay, Little Goose forebay, Lewiston, and Peck were all 99.98 percent complete.

The fish-spill seasons differed among the dams, and there were also differences with respect to the number of data points that were above established thresholds (Table 13). The 12 July through 8 August flow augmentation program at Dworshak Dam did not result in any 110 percent exceedances at the tailwater site, or at the downstream Peck and Lewiston stations. The number of instances when the average of the twelve highest daily values was greater than 115 percent at forebay stations ranged from zero at Lower Granite Dam to 17.4 percent at Ice Harbor Dam (Table 13). The McNary Dam forebay stations on the Oregon and Washington sides of the river were also different with respect to the number of exceedances, with 17.0 percent at MCQO and 6.4 percent at MCQW. The tailwater stations showed a general downstream increase in the number of days when the 120 percent 12-hour average was exceeded. The threshold was not surpassed at the Lower Granite and Little Goose projects. The Lower Monumental tailwater station surpassed the criteria on one day (4.8 percent of spill period) while the Ice Harbor project had a two-day occurrence (1.4 percent of the total). The Columbia River station downstream from McNary Dam had the highest occurrence of 7 days, or 9.6 percent (Table 13). No hourly TDG measurements exceeded 125 percent saturation at any of the projects between April and the end of September.

The TDG values recorded at the Lower Granite forebay station are of additional interest. Between 1 April and 15 September there were 223 data points, or 5.5 percent of the total, that were greater than 110 percent. However, there were no measurements above this threshold at the upstream stations on the Clearwater and Snake Rivers. This observation illustrates the importance of pursuing studies to better understand in-reservoir process and their effects on gas saturation.

There were also instances during late-May and early-June when involuntary spill occurred as a result of increased runoff. The release of water from Dworshak Reservoir between 27 May and 12 June to lower the pool and prevent flooding resulted in 326 hourly data points that exceeded the 110 percent threshold (Table 13). Forced spill at the lower Snake River projects during the same general period also produced hourly values that were greater than 110 percent. The four tailwater stations reported anywhere from thirteen hourly 110 percent exceedances below Little Goose Dam to 165 downstream from Lower Granite Dam. However, the tailwater 120 percent daily standard was not surpassed at any of the projects during these spill events, and neither was the analogous 115 percent forebay waiver.

There were both similarities and differences between stations with respect to the frequency distributions of the TDG data. Because spill seasons differed by project, the following comparisons are based on 1 April through 15 September information for consistency:

- None of the hourly data from the Anatone and Lewiston stations were greater than 110 percent, while only 0.1 percent of the data points at Peck were above than this threshold (Table 14). However, the frequency distributions at each of these locations were different (Figure 13; Table 14). The maxima at Peck and Lewiston were shifted farther to the left such that 59.1 percent and 53.0 percent of the respective data were less than 102 percent. In comparison, 44.1 percent of the data occurred below the same level at the Anatone station; this resulted from the differences in water temperatures between the two rivers and the effect of Charles Law.

- The frequency distributions at the lower Snake River projects are shown in Figures 14 and 15, and Tables 14 and 15. The distributions of the hourly data from the four forebay stations were similar, where 54.5 percent to 60.1 percent of the values were less than 104 percent saturation. The tailwater stations showed a downstream distribution shift that was most noticeable below Ice Harbor Dam. Almost 80 percent of the data was less than 104 percent saturation below Lower Granite Dam and had decreased by about four percent at Little Goose Dam. However, downstream from Lower Monumental Dam only 61.9 percent of the data was less than 104 percent saturation, while the station downstream from Ice Harbor Dam only displayed 13.3 percent below this threshold (almost 75 percent of the data points were greater than 110 percent at IDSW).
- Data from the two McNary forebay stations were similarly distributed with maxima between 109 percent and 112 percent saturation (Figure 16; Table 14). The McNary Dam tailwater station displayed two peaks with 11.8 percent of the data between 107 percent and 110 percent saturation and a smaller peak at 118 to 119 percent saturation.

4.4 Speed-No-Load and Other Project Operation Effects on TDG

Speed-no-load operations, powerhouse outages, and scheduled project operations did contribute to a few cases of elevated TDG during the 2004 water year. For example, maintenance work occurred at Lower Granite Dam between 20 September and 23 September. TDG concentrations exceeded 115 percent during 42 hourly measurements (43.75 percent of the time). Fourteen hourly measurements surpassed 120 percent (14.58 percent of the hourly measurements), but the 12-hour average was only exceeded once. A scheduled powerhouse outage also occurred at the Lower Monumental project between 30 August and 3 September. In this case, only 17 hourly measurements (17.71 percent of the total) were greater than 115 percent, and only one value exceeded 120 percent.

5.0 SUMMARY

Hourly TDG, temperature, and barometric data recorded during the 2004 water year at sixteen FMS stations were evaluated. Half of these CENWW sites were operated throughout the year and the other half were monitored from 1 April through 15 September.

The USGS Pasco field office was contracted to perform routine station maintenance, complete emergency repairs, and operate the DCPs. Their pre-deployment QA/QC checks showed average differences of -0.43 mm Hg and -0.41 mm Hg when the TDG sensor was compared to barometric pressure and barometric pressure plus 200 mm Hg, respectively. The mean temperature difference was 0.03 ^{o}C. The post-deployment checks were of equal quality with mean BP, BP+100 mm Hg, and temperature differences of –0.33 mm Hg, 0.30 mm Hg, and 0.10 ^{o}C, respectively. Field checks during routine maintenance demonstrated that the air barometric pressure, percent TDG, and temperature averaged–0.10 mm Hg, 0.07 percent, and 0.003 ^{o}C, respectively, with respect to the secondary standards.

The available hourly barometric pressure, TDG, and temperature data from all of the stations were 99.91 percent, 99.55 percent, and 99.88 percent complete, respectively. Only one temperature data point from the Clearwater River surpassed 20 ^{o}C. However, 26.7 and 31.8 percent the 1 April through 15 September values recorded at the eight lower Snake River and four Columbia River sites, respectively, were above this threshold. The lowest percentages occurred downstream from Lower Granite Dam (0.2 percent) and Little Goose Dam (12.6 percent). As a comparison, 37.4 percent of the temperature data from the same period was greater than 20 ^{o}C at the upstream Anatone station. The 12-hr 115% maximum daily average was not surpassed in the forebay of Lower Granite Dam during the fish-spill season, but was exceeded 17.4 percent of the time at the Ice Harbor forebay station. The 120 percent tailwater criterion was not exceeded during fish spill at the Lower Granite and Little Goose stations. The same threshold was surpassed on seven days, or 9.6 percent of the time, downstream from McNary Dam.

Speed-no-load operations and powerhouse outages at the Lower Granite and Lower Monumental projects also led to supersaturated gas conditions. One four-day event in late September 2003 at the Lower Granite project led to 14 hourly downstream measurements that were greater than 120 percent (the 12-hour average criterion was only surpassed on one day). An earlier four-day scheduled maintenance operation at Lower Monumental Dam only led to one value that surpassed 120 percent.

6.0 REFERENCES

U.S. Environmental Protection Agency (USEPA). 1986. *Quality criteria for water*: Washington, D.C., EPA-440-5-86-001.

WADOE. 1997. *Water quality standards for surface waters of the State of Washington*: Chapter 173-201A. State of Washington Department of Ecology, Olympia, Washington.

FIGURES

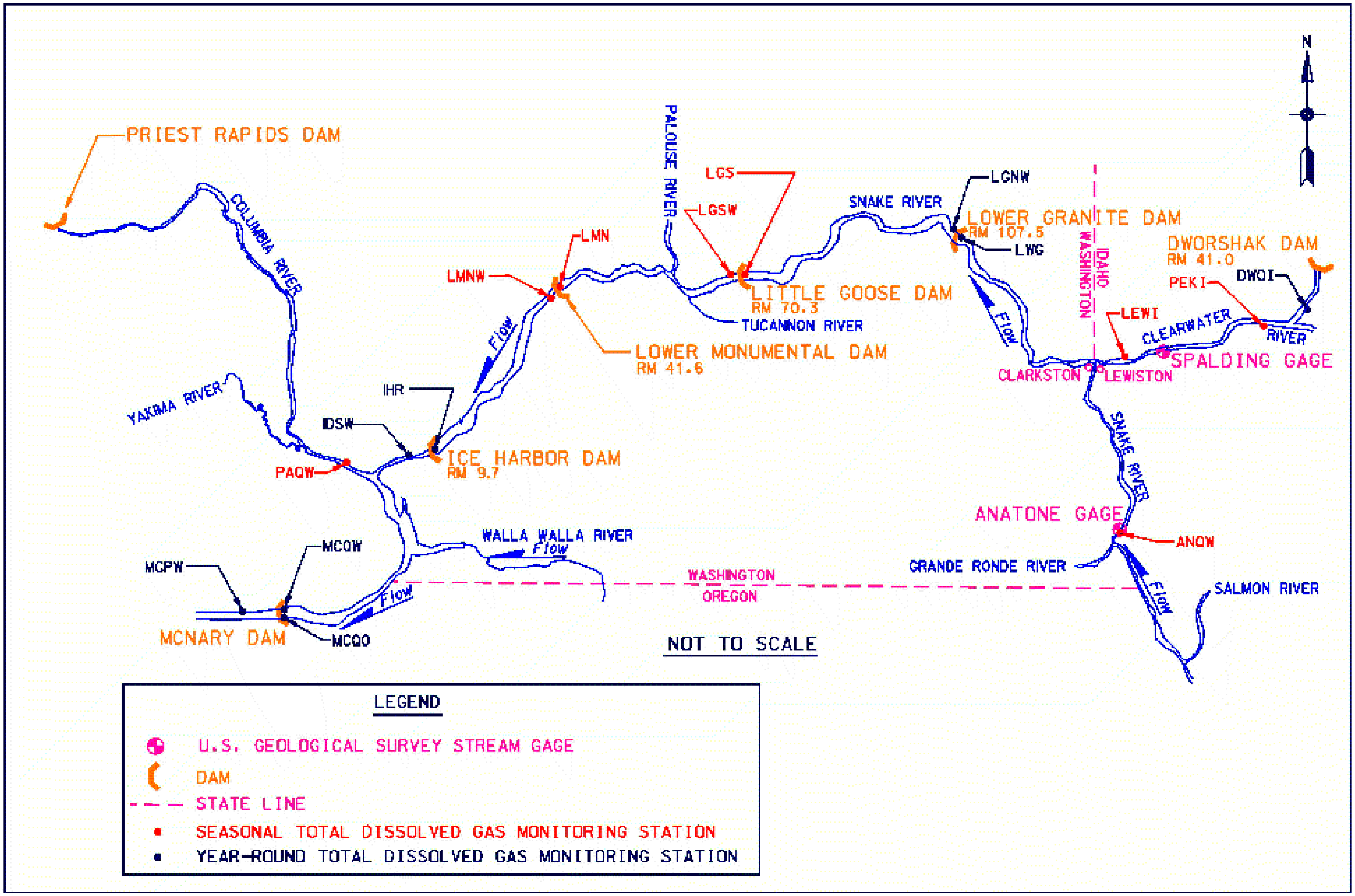


Figure 1. Locations of Walla Walla District's FMS stations.

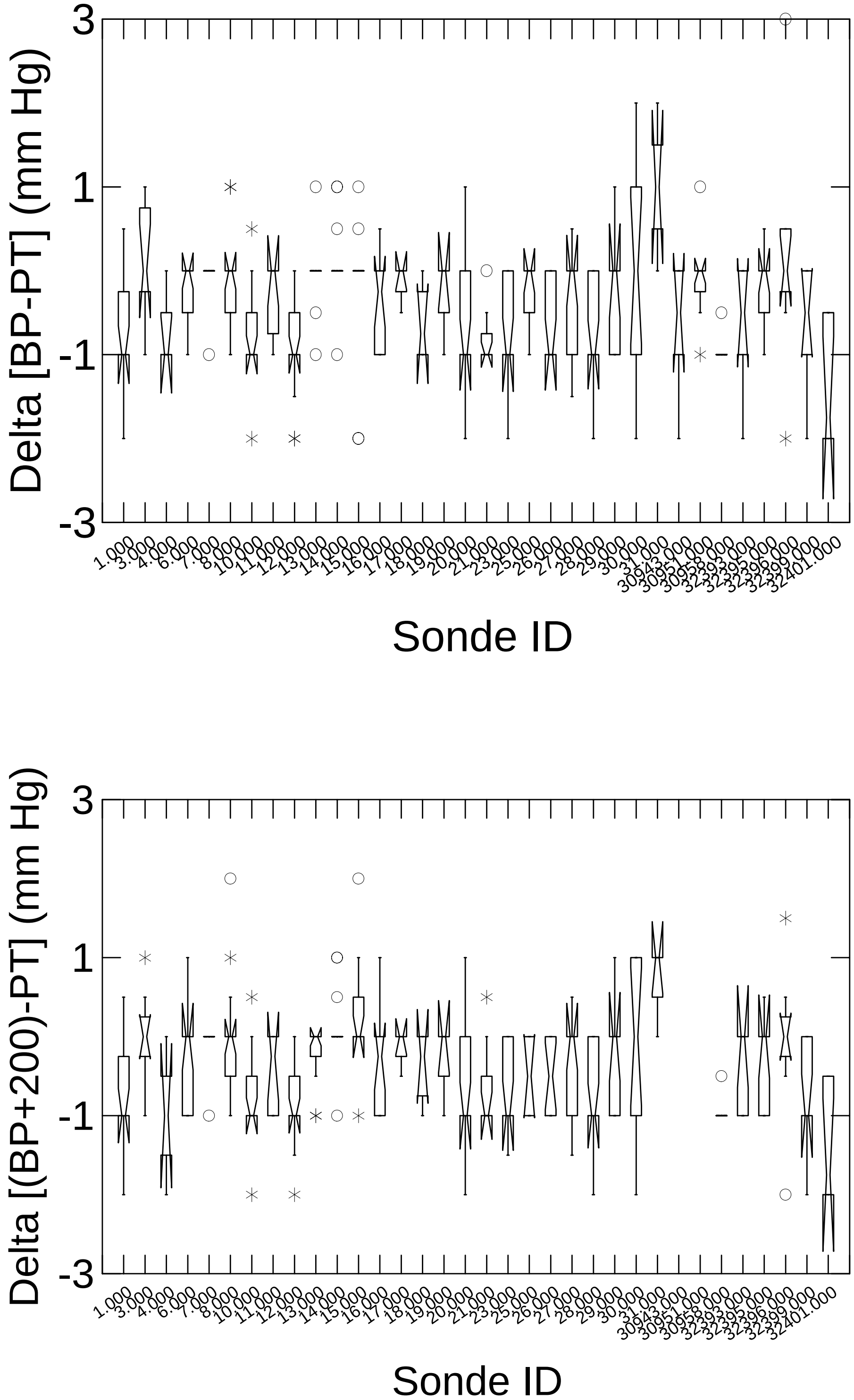


Figure 2. Box plots of the pre-deployment check of the Hydrolab® TDG sensors with and without additional pressure.

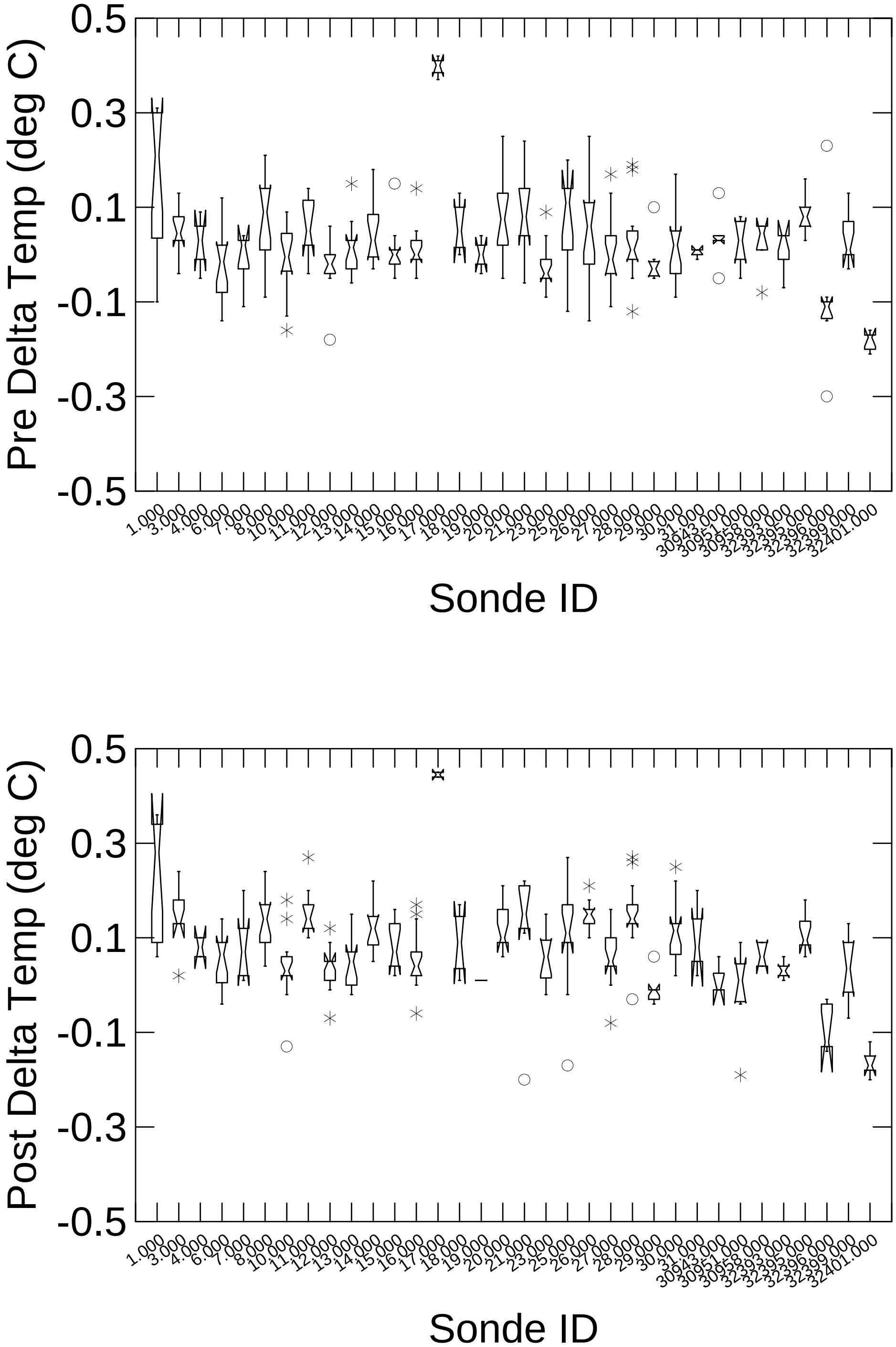
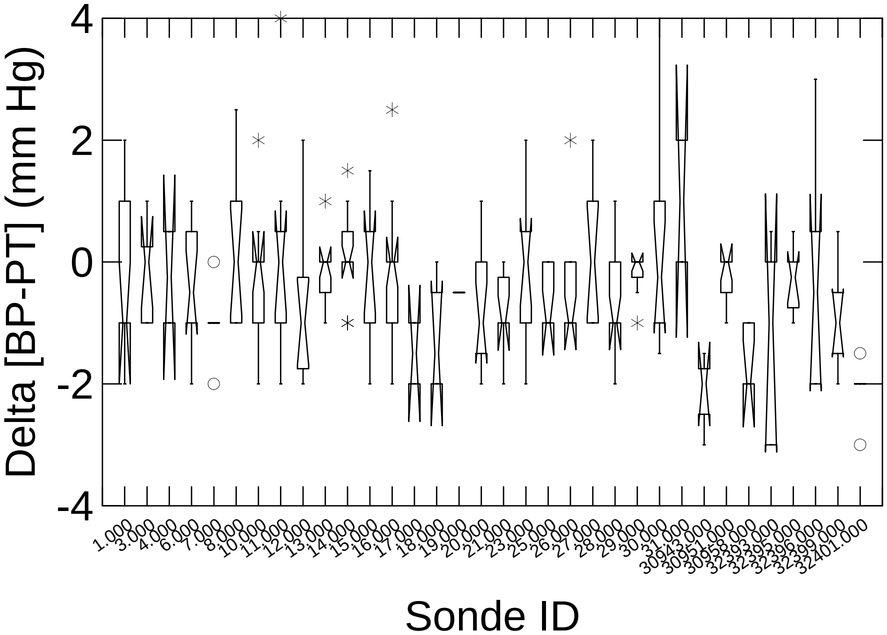


Figure 3. Box plots of the pre- and post-deployment check of the Hydrolab® temperature sensors.



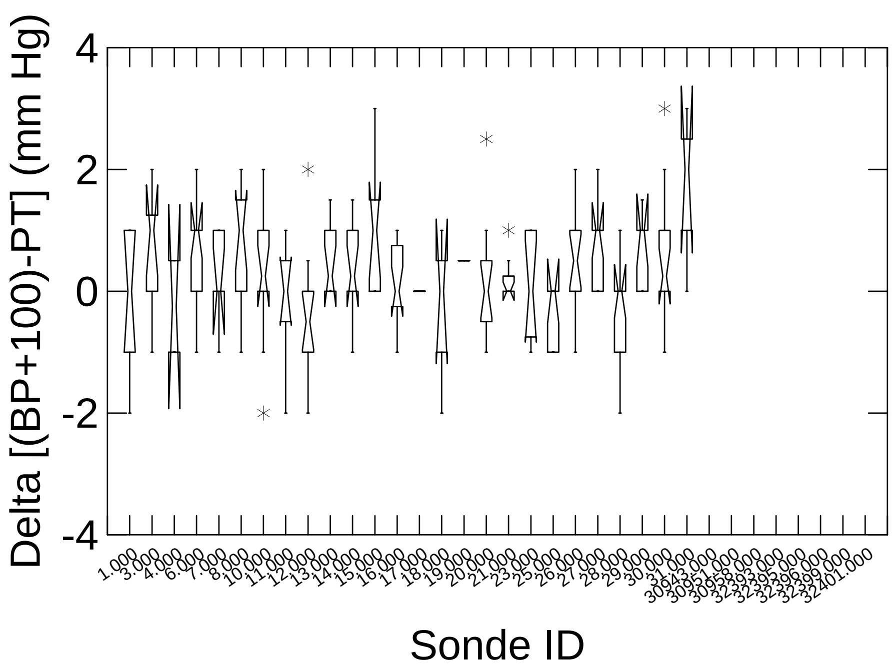


Figure 4. Box plots of the post-deployment check of the Hydrolab® TDG sensors with and without additional pressure.

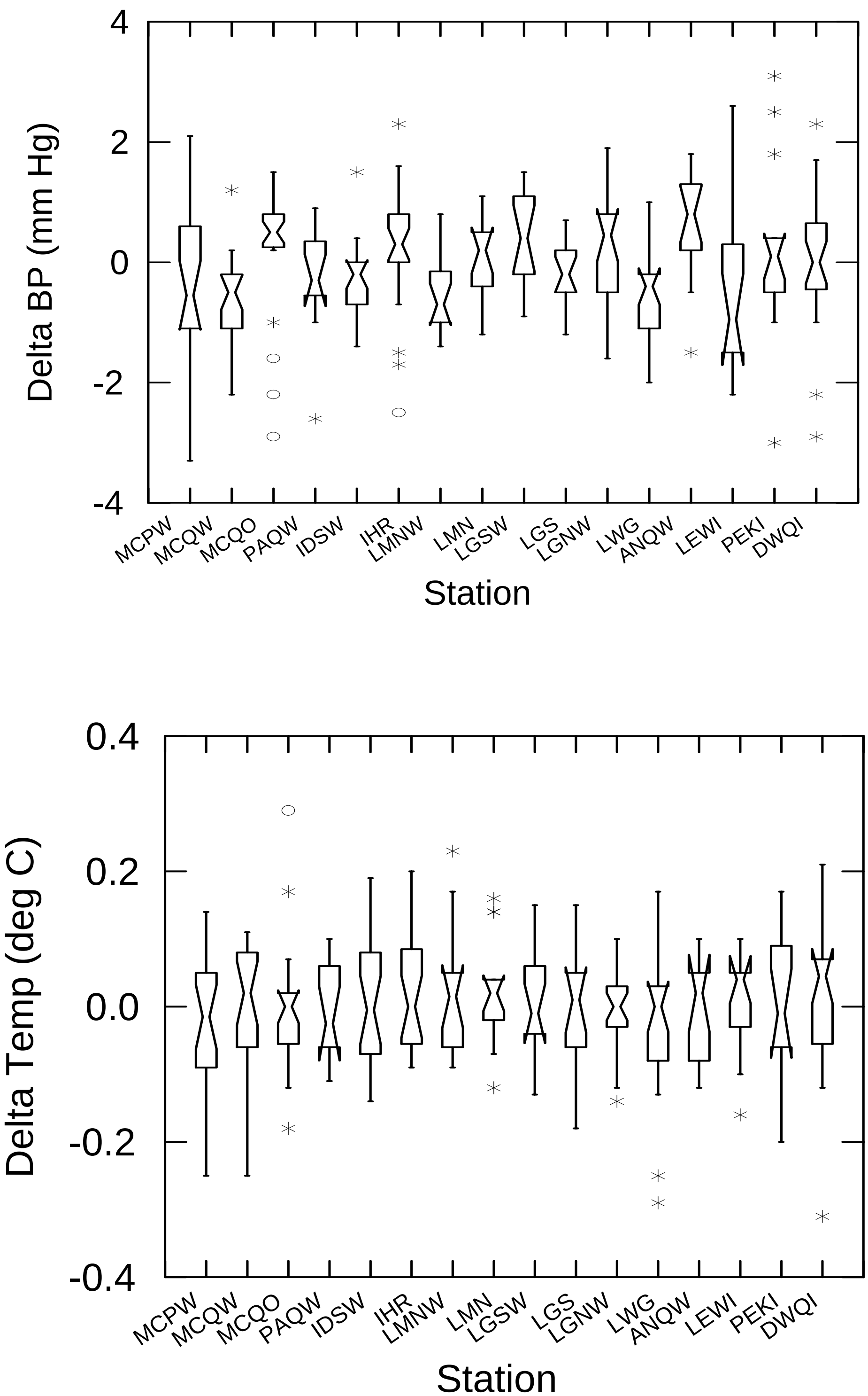
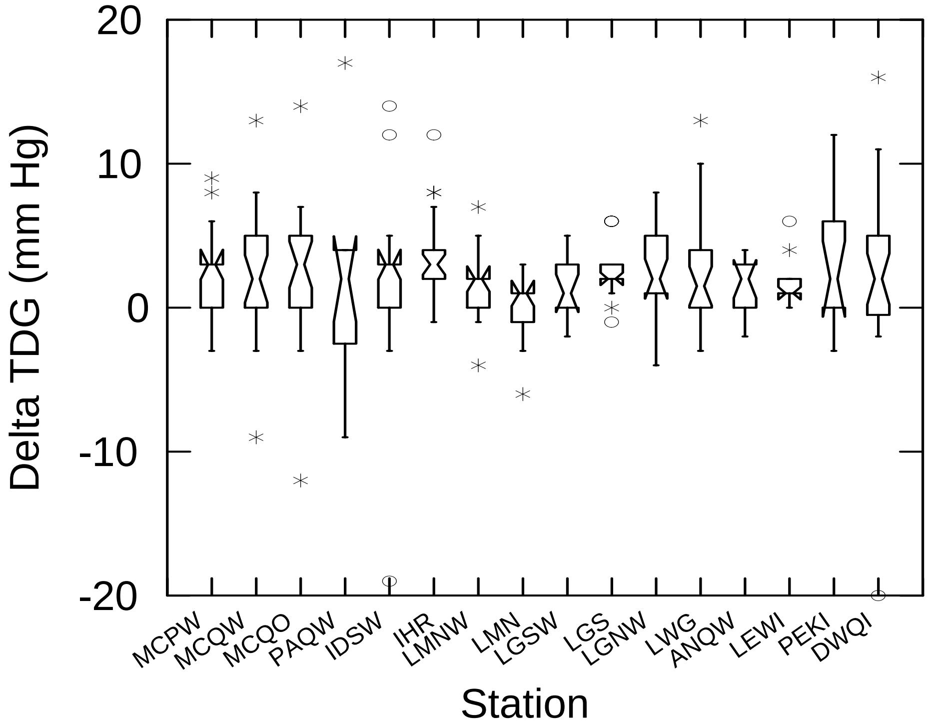


Figure 5. Box plots of the differences between the in-place and secondary standards for barometric air pressure and water temperature at each station during routine maintenance checks.



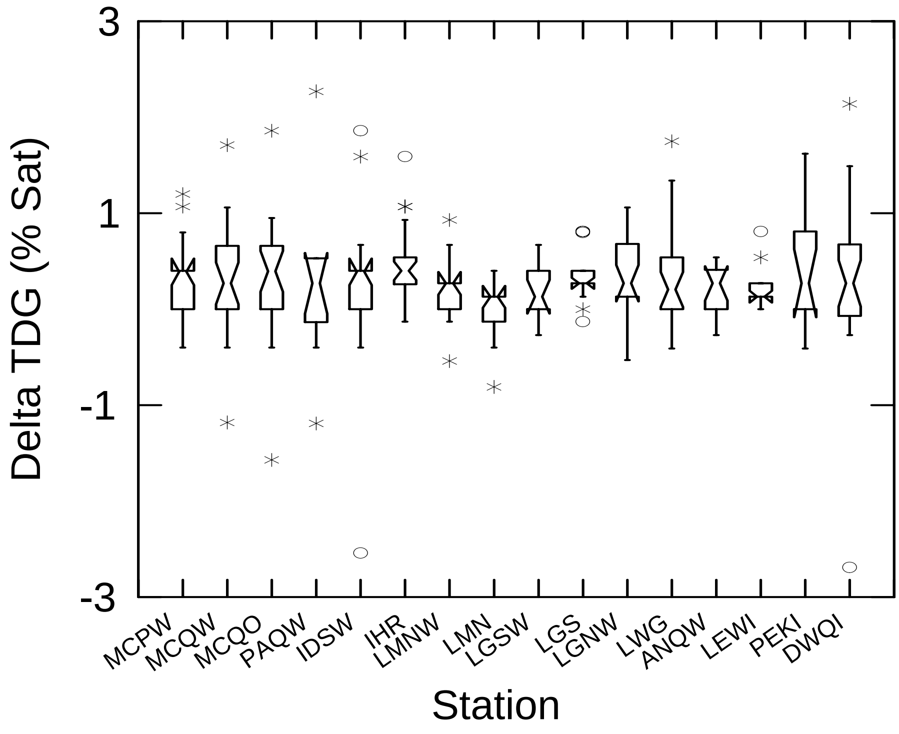


Figure 6. Box plots of the differences between the in-place and secondary TDG standard for each station during routine maintenance checks.

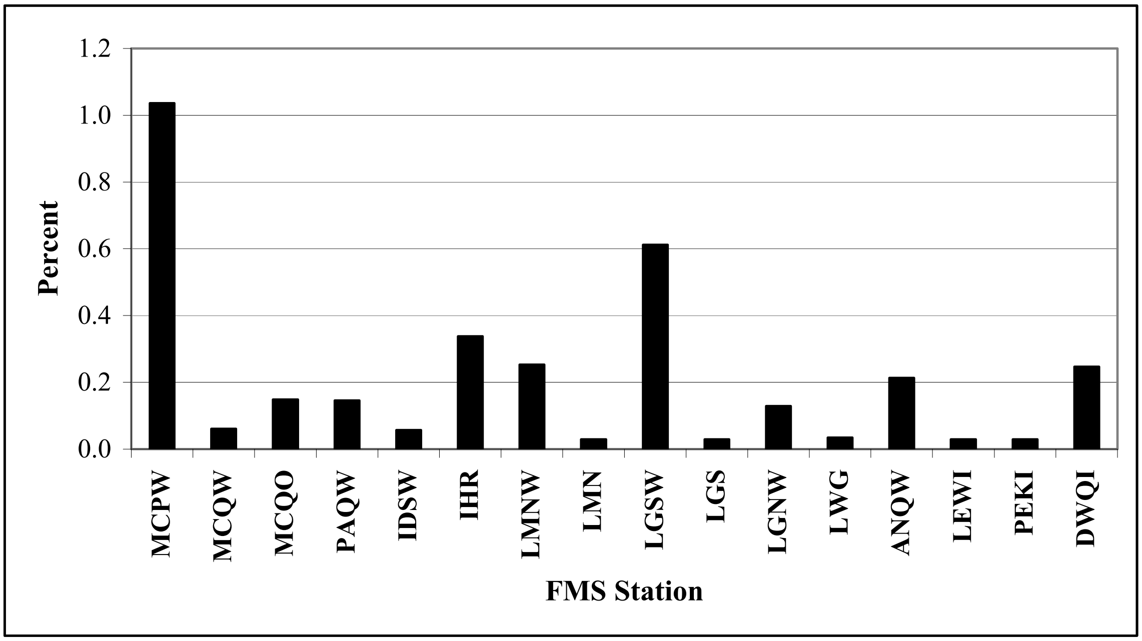


Figure 7. Percent of the total missing and invalid data for each FMS station.

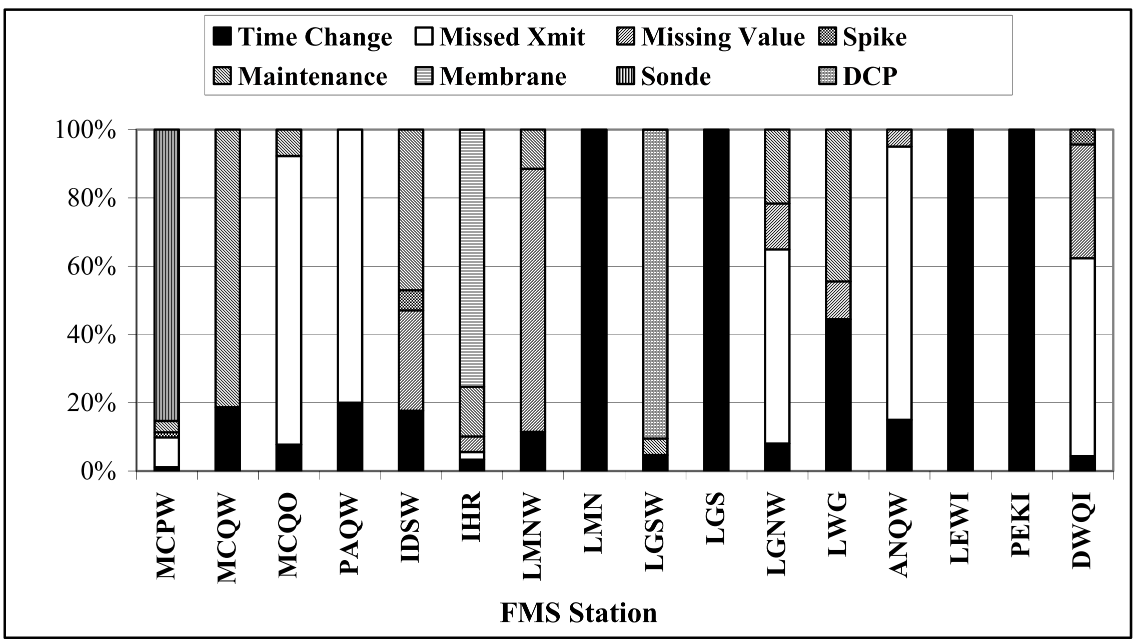


Figure 8. Percent of missing and invalid data by category for each FMS station.

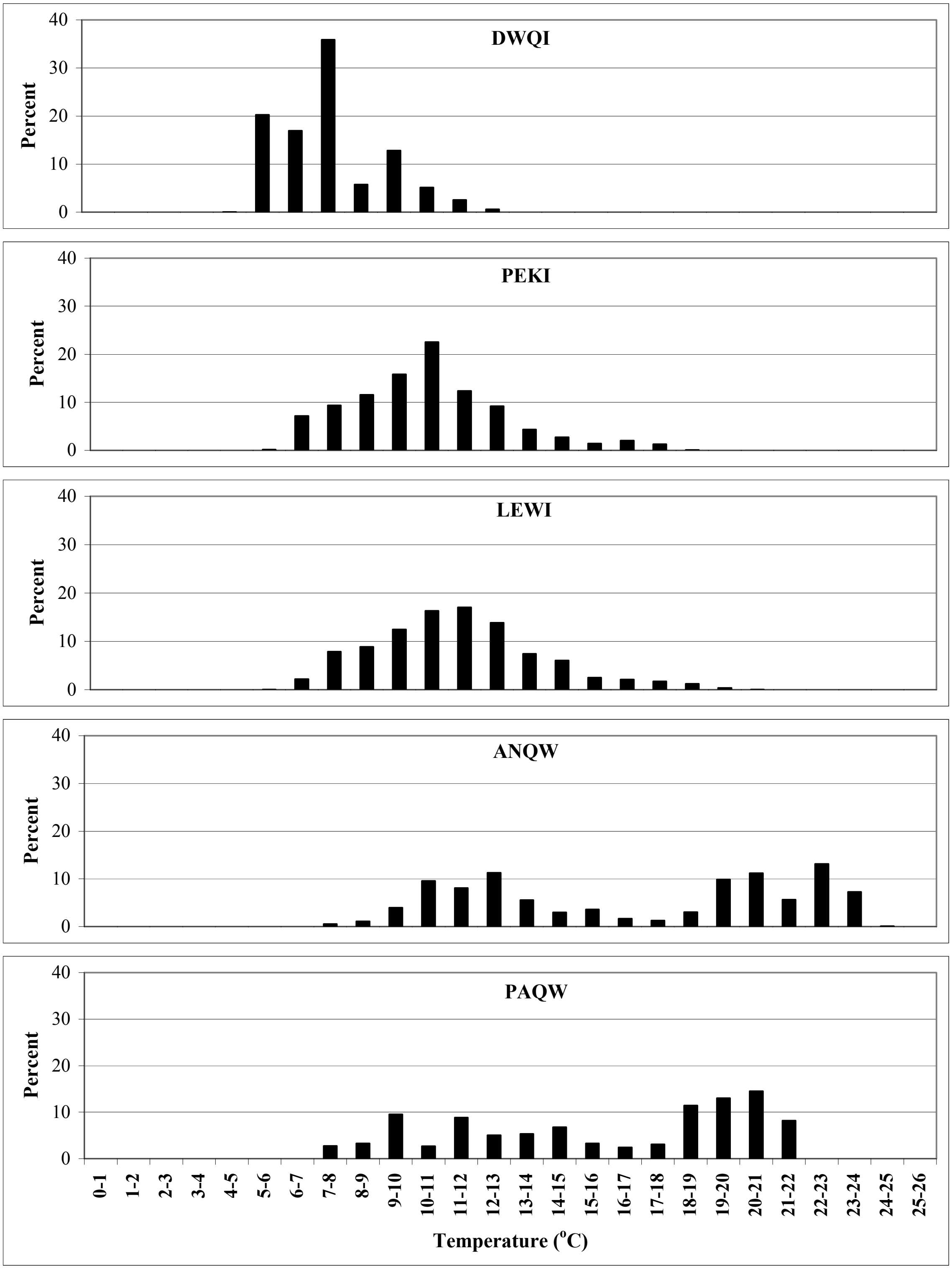


Figure 9. Frequency distributions for the 1 April – 15 September 2004 hourly temperature data recorded at the Dworshak Dam, Peck, Lewiston, Anatone, and Pasco FMS stations.

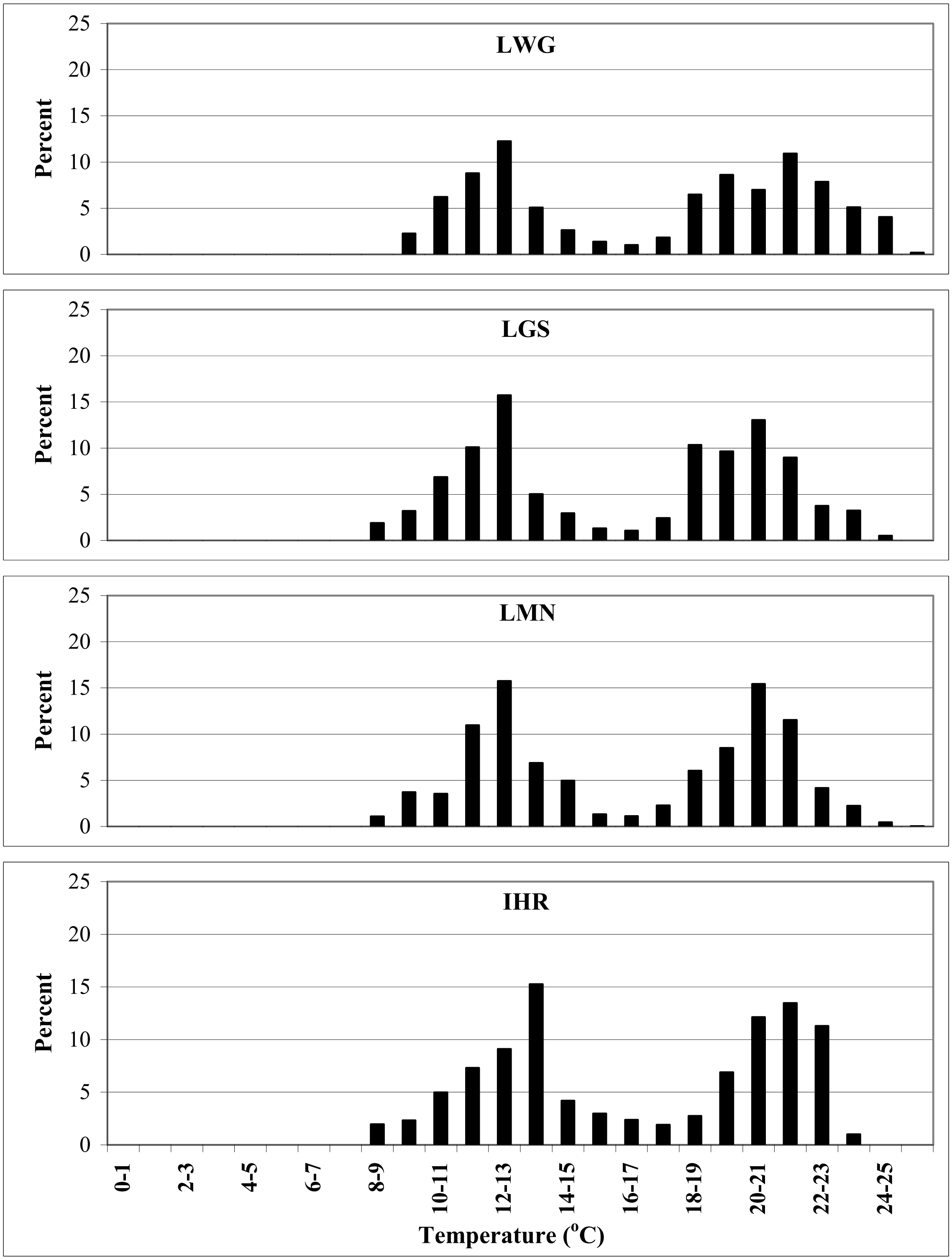


Figure 10. Frequency distributions for the 1 April – 15 September 2004 hourly temperature data recorded at the lower Snake River forebay FMS stations.

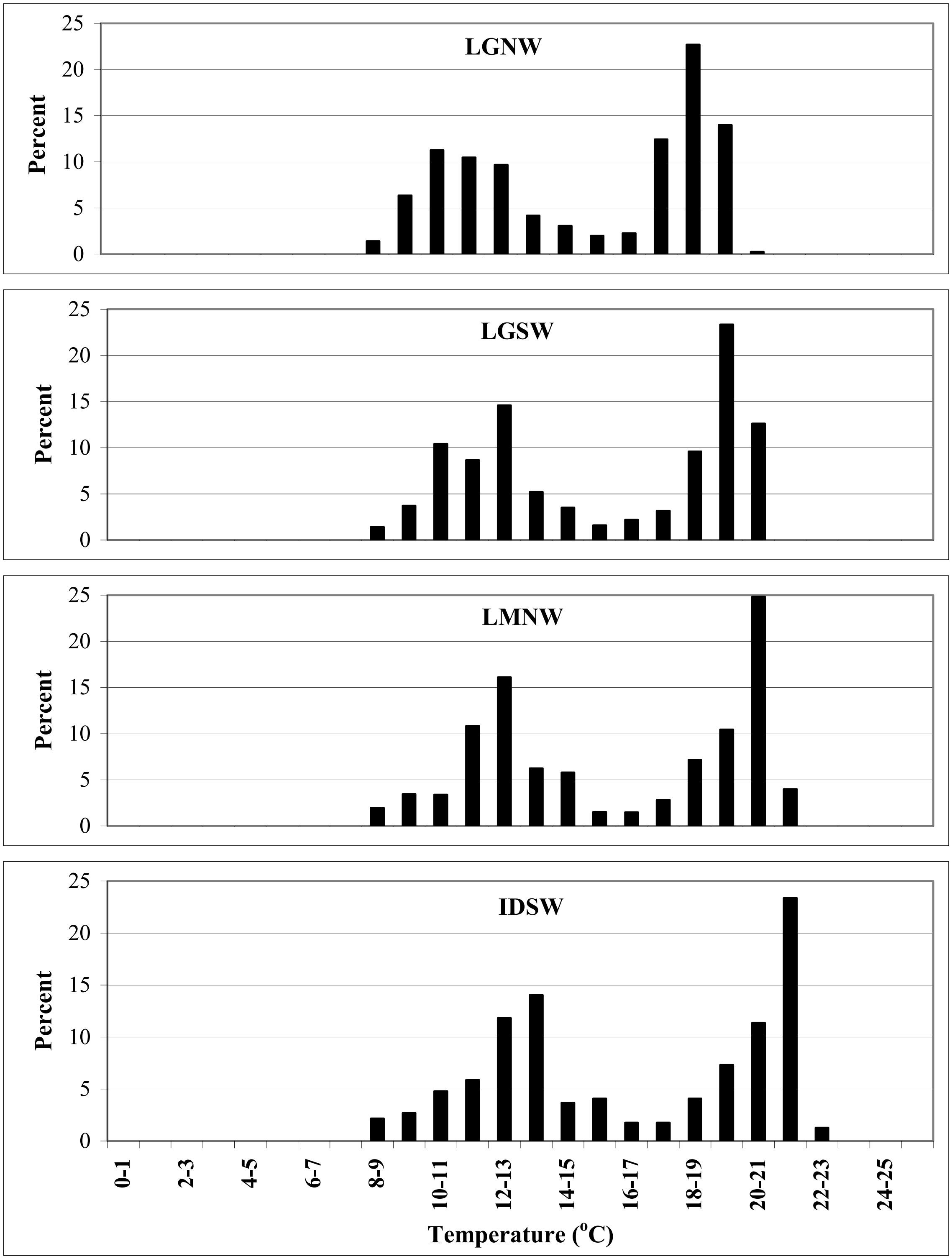


Figure 11. Frequency distributions for the 1 April – 15 September 2004 hourly temperature data recorded at the lower Snake River tailwater FMS stations.

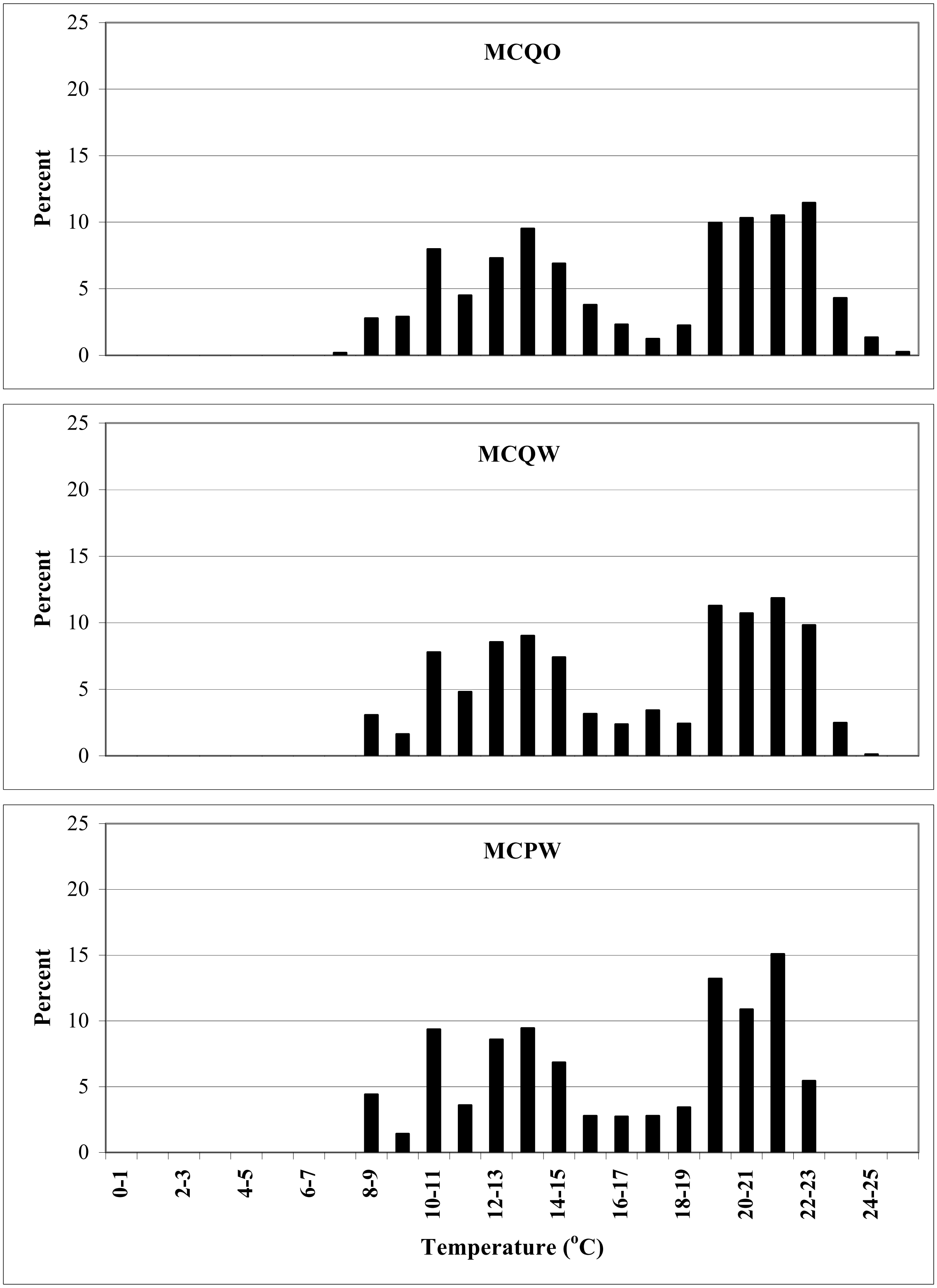


Figure 12. Frequency distributions for the 1 April – 15 September 2004 hourly temperature data recorded at the McNary Dam FMS stations.

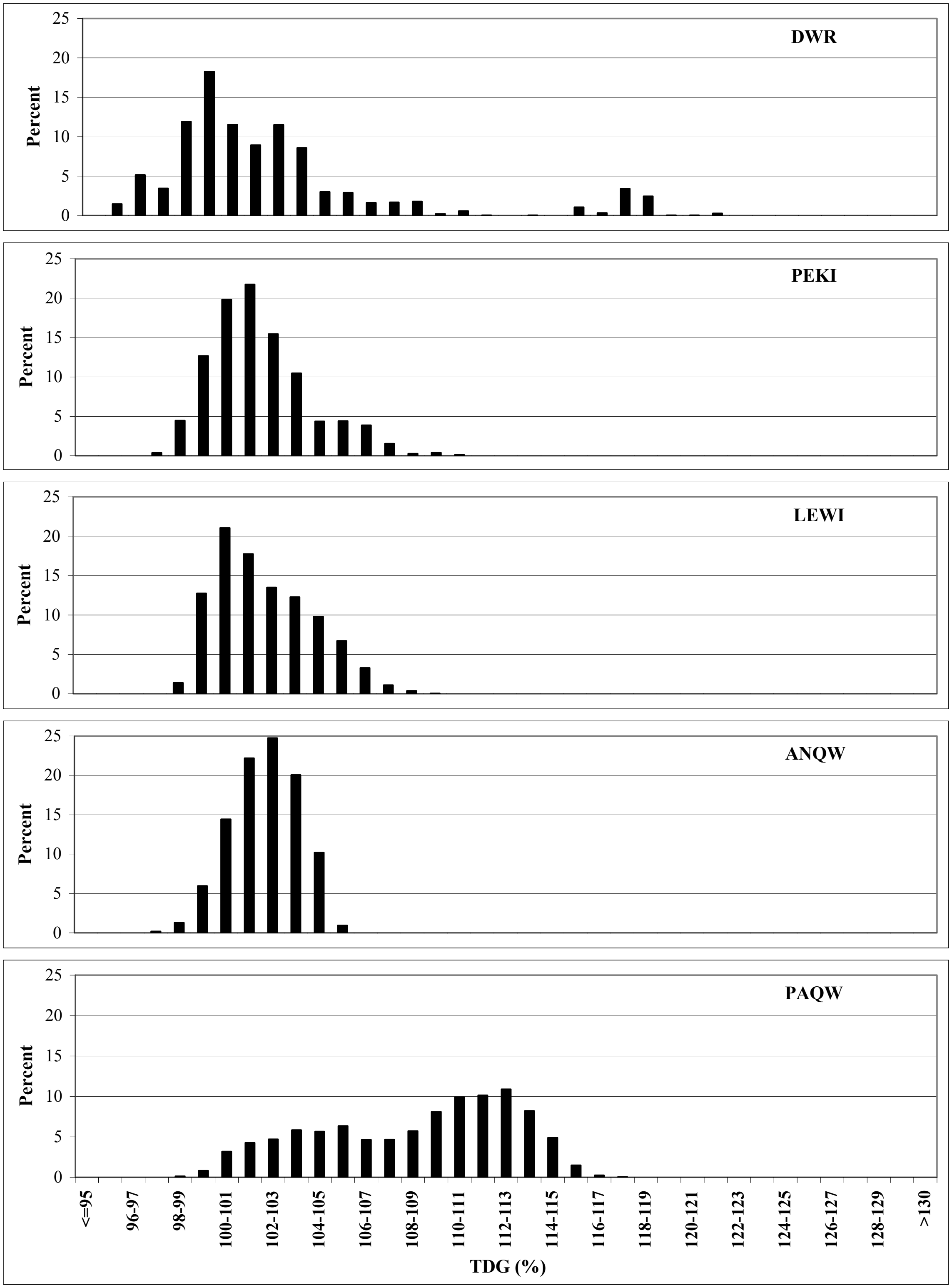


Figure 13. Frequency distributions for the 1 April – 15 September 2004 hourly TDG data recorded below Dworshak Dam, Peck, Lewiston, Anatone, and Pasco FMS stations.

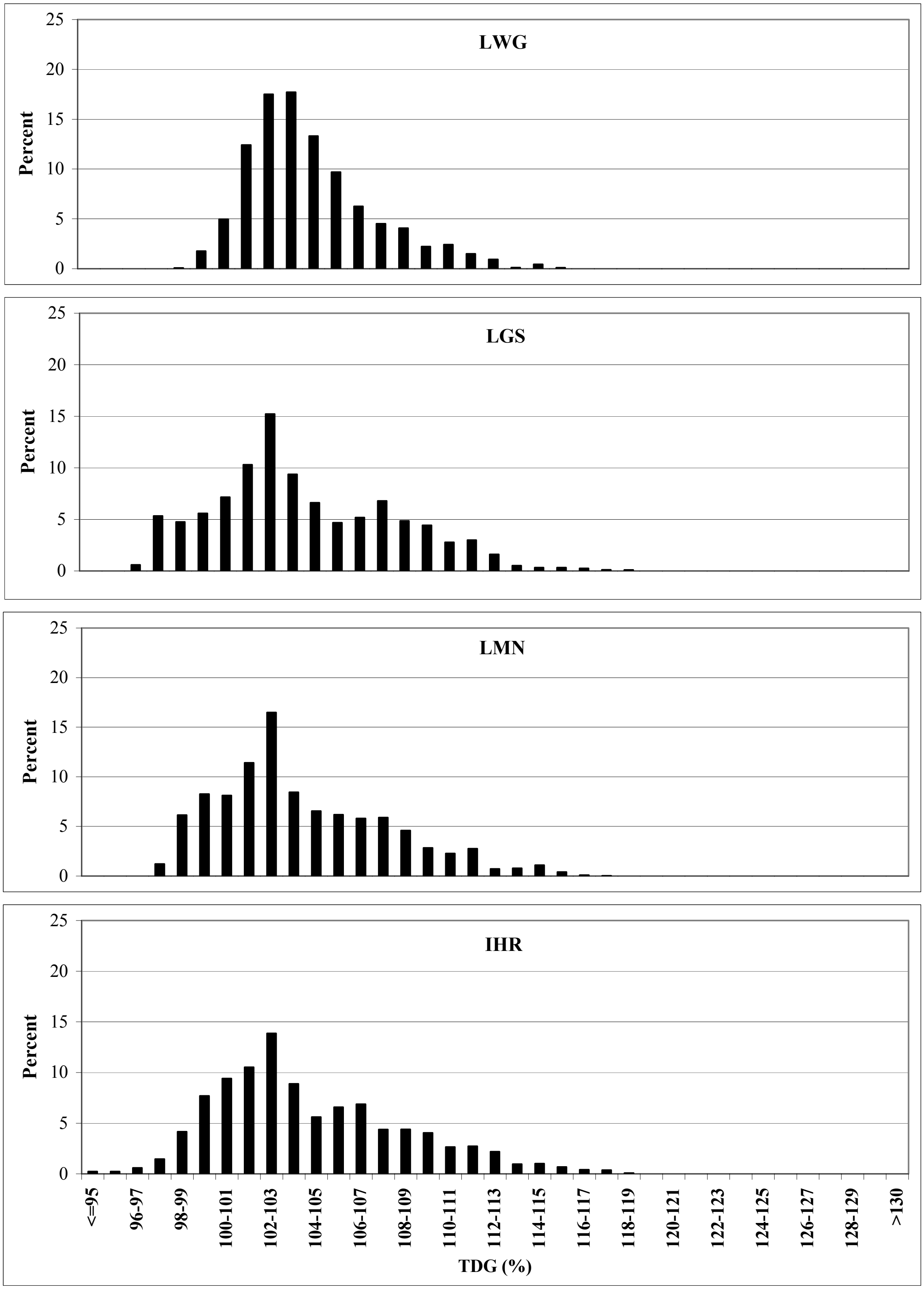


Figure 14. Frequency distributions for the 1 April – 15 September 2004 hourly TDG data recorded at the lower Snake River forebay FMS stations.

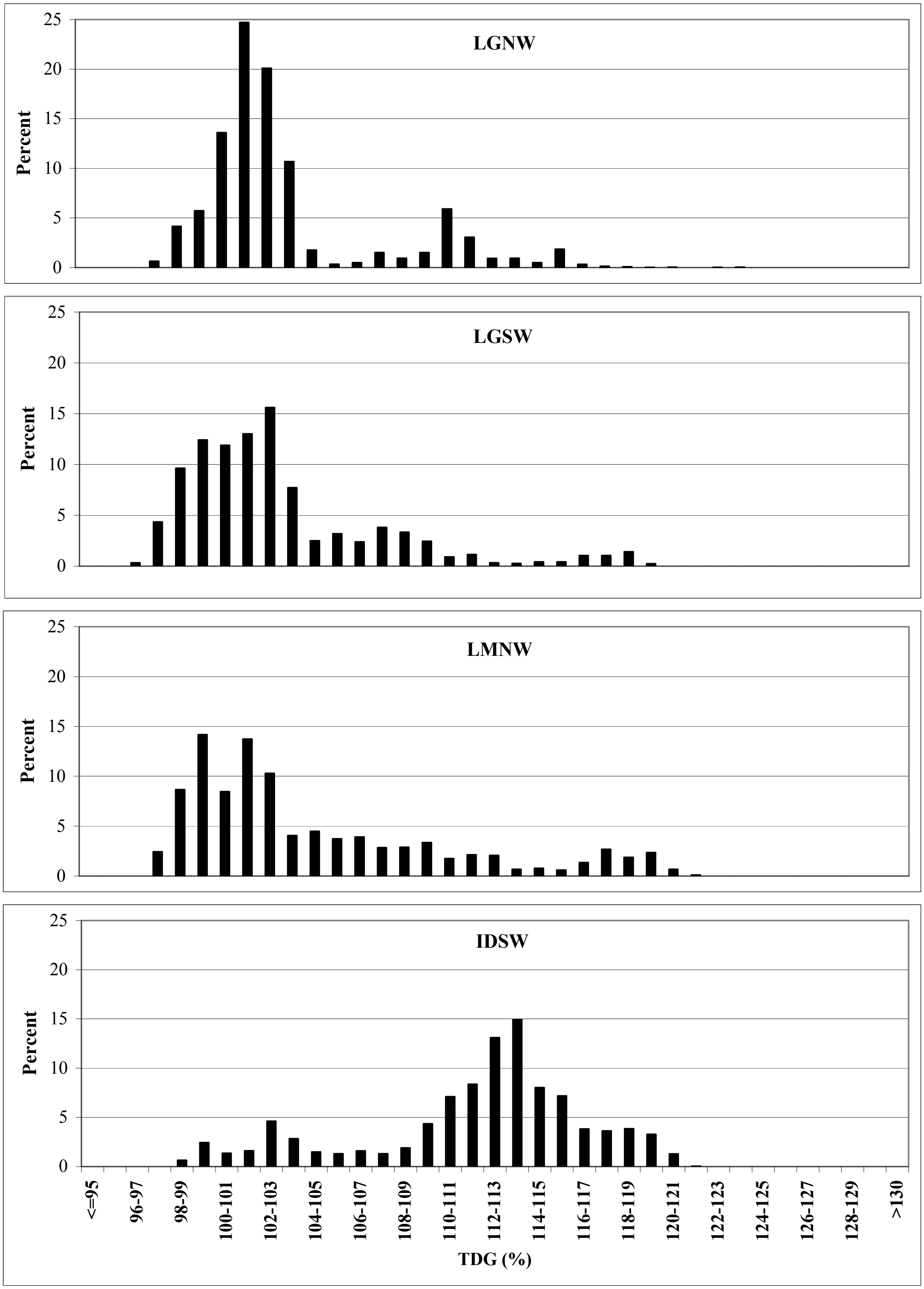


Figure 15. Frequency distributions for the 1 April – 15 September 2004 hourly TDG data recorded at the lower Snake River tailwater FMS stations.

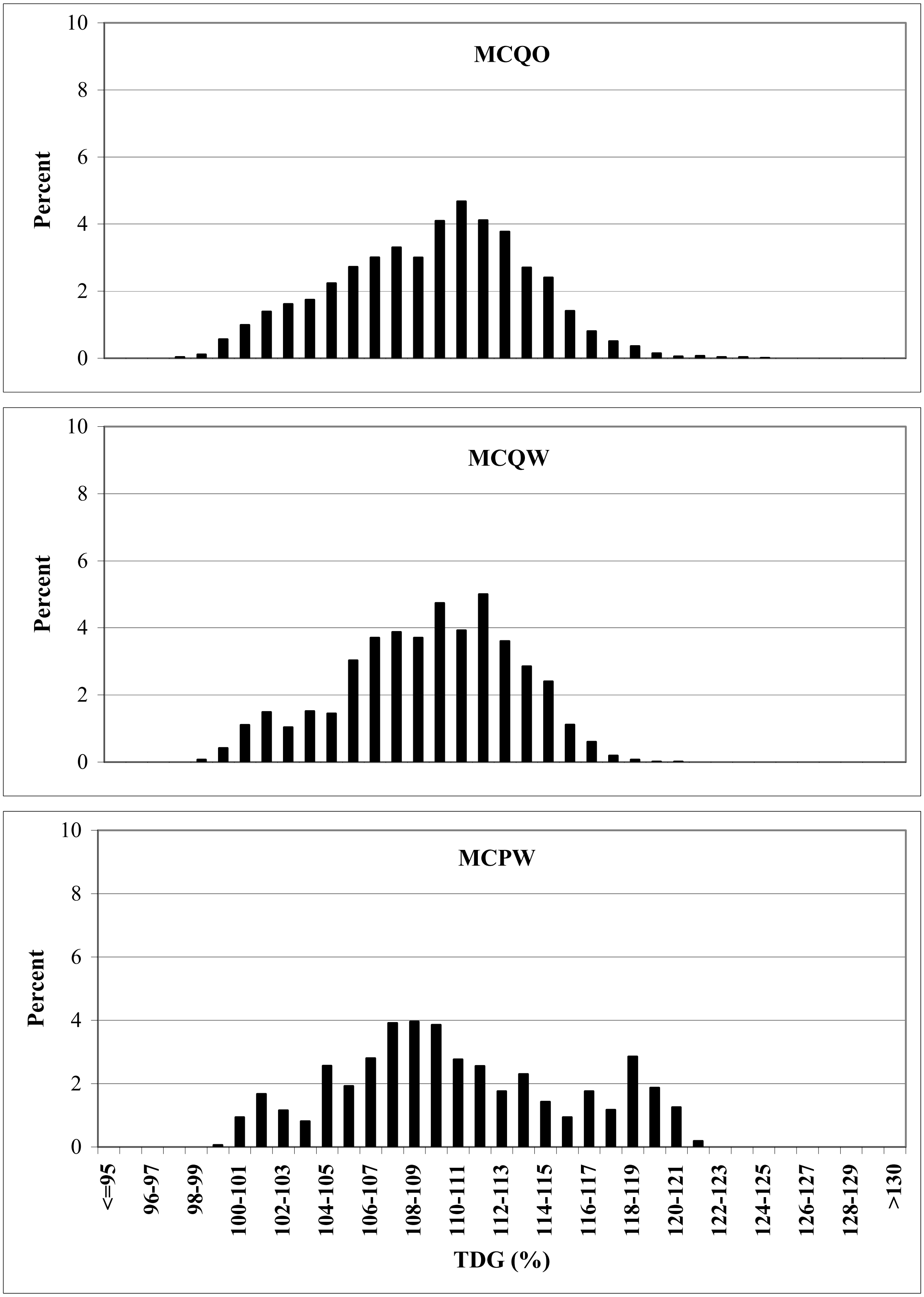


Figure 16. Frequency distributions for the 1 April – 15 September 2004 hourly TDG data recorded at the McNary Dam FMS stations.

TABLES

Table 1. FMS station identification and location information (latitude and longitude referenced to NAD 27).

Station Number	Station Name	USACE ID	DCP ID	XMIT TIME	Latitude	Longitude	Elev. (ft)	Station Type
14019240	McNary Dam tailwater, WA	MCPW	17D5F754	00:12:10	455603.3	1191931.4	240	Annual
14019220	McNary Dam forebay, WA	MCQW	17D6D6B6	00:26:10	455625.8	1191747.4	340	Annual
14019200	McNary Dam forebay, OR	MCQO	17D6C5C0	00:25:10	455557.1	1191744.6	340	Annual
12514400	Columbia River at Pasco, WA	PAQW	17D6E32C	00:27:10	461326.8	1190653.3	345	Seasonal
13353010	Ice Harbor Dam tailwater below Goose Island, WA	IDSW	17D6B350	00:24:10	461428.1	1185709.7	340	Annual
13352950	Ice Harbor Dam forebay, WA	IHR	17D6A026	00:23:10	461457.1	1185241.3	440	Annual
13352600	Lower Monumental Dam tailwater, WA	LMNW	17D695BC	00:22:10	463305.0	1183255.0	445	Seasonal
13352595	Lower Monumental Dam forebay, WA	LMN	17D686CA	00:21:10	463347.0	1183214.5	540	Seasonal
13343860	Little Goose Dam tailwater, WA	LGSW	17D6764E	00:20:10	463501.0	1180233.6	560	Seasonal
13343855	Little Goose Dam forebay, WA	LGS	17D66538	00:19:10	463505.4	1180133.1	638	Seasonal
13343595	Lower Granite Dam tailwater, WA	LGNW	17D650A2	00:18:10	463958.5	1172615.6	645	Annual
13343590	Lower Granite Dam forebay, WA	LWG	17D643D4	00:17:10	463934.6	1172531.2	738	Annual
13334300	Snake R near Anatone, WA	ANQW	17D63544	00:16:10	460551.2	1165837.7	807	Seasonal
13343000	Clearwater River near Lewiston, ID	LEWI	17D62632	00:15:10	462552.5	1165640.4	750	Seasonal
13341050	Clearwater River near Peck, ID	PEKI	17D613A8	00:14:10	463001.3	1162328.9	930	Seasonal
13341000	N F Clearwater River at Dworshak Hatchery, ID	DWQI	17D600DE	00:13:10	463012.0	1161912.9	1,150	Annual

Table 2. Summary of the laboratory results evaluating the overall differences between laboratory standards and the sondes pre- and post deployment during the 2004 water year.

Deployment	Statistic	Δ(BP–PT) (mmHg)	Δ[(BP+200)–PT] (mmHg)	Δ[(BP+100)–PT] (mmHg)	Δ T (^{o}C)
Pre	**Number**	312	300	----	311
	Minimum	-2.00	-2.00	----	-0.30
	Maximum	3.00	4.00	----	0.80
	Mean	-0.43	-0.41	----	0.03
	Median	0.00	0.00	----	0.02
	Std. Dev.	0.76	0.77	----	0.11
Post	**Number**	279	----	232	281
	Minimum	-3.00	----	-2.00	-0.20
	Maximum	6.00	----	4.50	5.36
	Mean	-0.33	----	0.30	0.10
	Median	-0.50	----	0.00	0.09
	Std. Dev.	1.30	----	0.98	0.33

Table 3. Pre-deployment quality assurance data for the individual sondes utilized at the FMS stations during the 2004 water year.

Sonde ID	Δ (BP – PT) # Obs	Δ (BP – PT) Range (mm Hg)	Δ (BP – PT) Median (mm Hg)	Δ [(BP+200) – PT] # Obs	Δ [(BP+200) – PT] Range (mm Hg)	Δ [(BP+200) – PT] Median (mm Hg)	Δ (Water Temperature) # Obs	Δ (Water Temperature) Range (°C)	Δ (Water Temperature) Median (°C)
1	12	-2.0 – 0.5	-1.0	12	-2.0 – 0.5	-1.0	12	-0.10 – 0.31	0.21
3	8	-1.0 – 1.0	0.0	8	-1.0 – 1.0	0.0	8	-0.04 – 0.13	0.04
4	3	-1.0 – 0.0	-1.0	3	-1.0 – 0.0	-1.0	3	-0.05 – 0.09	0.03
6	14	-1.0 – 0.0	0.0	14	-1.0 – 0.0	0.0	14	-0.14 – 0.12	-0.02
7	5	-1.0 – 0.0	0.0	5	-1.0 – 0.0	0.0	5	-0.11 – 0.04	0.02
8	13	-1.0 – 1.0	0.0	13	-1.0 – 1.0	0.0	13	-0.09 – 0.21	0.09
10	12	-2.0 – 0.5	-1.0	12	-2.0 – 0.5	-1.0	12	-0.16 – 0.09	-0.01
11	8	-1.0 – 0.0	0.0	8	-1.0 – 0.0	0.0	8	-0.04 – 0.14	0.05
12	13	-2.0 – 0.0	-1.0	13	-2.0 – 0.0	-1.0	13	-0.18 – 0.06	-0.02
13	12	-1.0 – 1.0	0.0	12	-1.0 – 1.0	0.0	12	-0.06 – 0.15	0.01
14	13	-1.0 – 1.0	0.0	13	-1.0 – 1.0	0.0	13	-0.03 – 0.80	0.03
15	9	-2.0 – 1.0	0.0	9	-2.0 – 1.0	0.0	9	-0.05 – 0.15	0.00
16	14	-1.0 – 0.5	-0.3	14	-1.0 – 0.5	-0.3	14	-0.05 – 0.14	0.00
17	3	-0.5 – 0.0	0.0	3	-0.5 – 0.0	0.0	3	0.37 – 0.42	0.40
18	4	-1.0 – 0.0	-0.8	4	-1.0 – 0.0	-0.8	4	0.00 – 0.13	0.05
19	3	-1.0 – 0.0	0.0	3	-1.0 – 0.0	0.0	3	-0.04 – 0.04	0.00
20	14	-2.0 – 1.0	-1.0	14	-2.0 – 1.0	-1.0	14	-0.05 – 0.25	0.08
21	7	-1.0 – 0.0	-1.0	7	-1.0 – 0.0	-1.0	7	-0.06 – 0.24	0.08
23	13	-2.0 – 0.0	-1.0	13	-2.0 – 0.0	-1.0	13	-0.09 – 0.09	-0.04
25	9	-1.0 – 0.0	0.0	9	-1.0 – 0.0	0.0	13	-0.12 – 0.20	0.11
26	14	-1.0 – 0.0	-1.0	14	-1.0 – 0.0	-1.0	14	-0.14 – 0.25	0.06
27	14	-1.5 – 0.5	0.0	14	-1.5 – 0.5	0.0	14	-0.11 – 0.17	-0.01
28	15	-2.0 – 0.0	-1.0	15	-2.0 – 0.0	-1.0	15	-0.12 – 0.19	0.01

29	8	-1.0 – 1.0	0.0	8	-1.0 – 1.0	0.0	8	-0.05 – 0.10	-0.03
30	13	-2.0 – 2.0	0.0	13	-2.0 – 2.0	0.0	13	-0.09 – 0.17	0.02
31	3	0.0 – 2.0	1.0	3	0.0 – 2.0	1.0	3	-0.01 – 0.01	0.01
30943	5	-2.0 – 0.0	-0.5	ND	ND	ND	5	-0.05 – 0.13	0.03
30951	7	-1.0 – 1.0	0.0	ND	ND	ND	7	-0.05 – 0.08	0.03
30958	6	-1.0 – (-0.5)	-1.0	6	-1.0 – (-0.5)	-1.0	6	-0.08 – 0.06	0.05
32393	6	-2.0 – 0.0	-0.5	6	-2.0 – 0.0	-0.5	6	-0.07 – 0.04	0.04
32395	9	-1.0 – 0.5	0.0	9	-1.0 – 0.5	0.0	9	0.03 – 0.16	0.08
32396	8	-2.0 – 3.0	0.0	8	-2.0 – 3.0	0.0	7	-0.30 – 0.23	-0.11
32399	9	-2.0 – 0.0	-0.5	9	-2.0 – 0.0	-0.5	9	-0.03 – 0.13	0.01
32401	6	-2.0 – (-0.5)	-1.8	6	-2.0 – (-0.5)	-1.8	6	-0.21 – (-0.16)	-0.18

Table 4. Post-deployment quality assurance data for the individual sondes utilized at the FMS stations during the 2004 water year.

Sonde ID	Δ (BP – PT) # Obs	Δ (BP – PT) Range (mmHg)	Δ (BP – PT) Median (mm Hg)	Δ [(BP+100) – PT] #Obs	Δ [(BP+100) – PT] Range (mmHg)	Δ [(BP+100) – PT] Median (mm Hg)	Δ (Water Temperature) #Obs	Δ (Water Temperature) Range (°C)	Δ (Water Temperature) Median (°C)
1	10	-2.0 – 2.0	-1.0	10	-2.0 – 1.0	0.0	10	0.06 – 0.36	0.28
3	7	-1.0 – 1.0	0.0	7	-1.0 – 2.0	1.0	7	0.02 – 0.24	0.13
4	2	-1.0 – 0.5	-0.3	2	-1.0 – 0.5	-0.3	2	0.06 – 0.10	0.08
6	12	-2.0 – 1.0	-0.5	12	-1.0 – 2.0	1.0	12	-0.04 – 0.14	0.06
7	5	-2.0 – 0.0	-1.0	5	-1.0 – 1.0	0.0	5	0.01 – 0.20	0.07
8	13	-1.0 – 2.5	0.0	13	1.0 – 2.0	1.0	13	0.04 – 0.24	0.14
10	10	-2.0 – 2.0	0.0	10	-2.0 – 2.0	0.3	11	-0.13 – 0.18	0.03
11	8	-2.0 – 4.0	0.0	8	-2.0 – 1.0	0.0	8	0.10 – 0.27	0.14
12	12	-2.0 – 2.0	-1.0	12	-2.0 – 2.0	-0.5	12	-0.07 – 0.12	0.05
13	10	-1.0 – 1.0	0.0	10	1.0 – 1.5	0.3	10	-0.02 – 0.15	0.05
14	11	-1.0 – 5.0	0.0	11	-1.0 – 4.5	0.5	12	0.05 – 0.22	0.12
15	9	-2.0 – 5.0	0.0	9	0.0 – 3.0	1.0	9	0.02 – 0.16	0.07
16	15	-2.0 – 2.5	0.0	15	-1.0 – 1.0	0.0	15	-0.06 – 0.17	0.04
17	2	-2.0 – (-1.0)	-1.5	2	0.0 – 0.0	0.0	2	0.44 – 0.45	0.45
18	4	-2.0 – 0.0	-1.5	4	-2.0 – 1.0	0.0	4	0.01 – 0.17	0.09
19	2	-0.5 - -0.5	-0.5	2	0.5 – 0.5	0.5	2	0.01 – 0.01	0.01
20	13	-2.0 – 1.0	-1.0	13	-1.0 – 2.5	0.0	13	0.06 – 0.21	0.10
21	7	-2.0 – 0.0	-1.0	7	0.0 – 1.0	0.0	7	-0.20 – 0.22	0.15
23	11	-2.0 – 2.0	0.0	11	-1.0 – 1.0	0.0	11	-0.02 – 0.15	0.06
25	9	-1.0 – 0.0	-1.0	9	-1.0 – 0.0	0.0	9	-0.17 – 0.27	0.11
26	13	-1.0 – 2.0	-1.0	13	-1.0 – 2.0	0.5	13	0.00 – 0.21	0.15
27	12	-1.0 – 2.0	0.0	12	0.0 – 2.0	1.0	13	-0.08 – 0.16	0.05
28	13	-2.0 – 1.0	-1.0	13	-2.0 – 1.0	0.0	13	-0.03 –	0.14

								0.27	
29	7	-1.0 – 0.0	0.0	7	0.0 – 1.5	1.0	7	-0.04 – 0.06	-0.01
30	12	-1.5 – 4.0	-0.3	12	-1.0 – 3.0	0.3	12	0.02 – 0.25	0.11
31	3	0.0 – 6.0	2.0	3	0.0 – 3.0	2.0	3	0.02 – 0.20	0.08
30943	3	-3.0 – (-1.5)	-2.0	ND	ND	ND	3	-0.01 – 0.06	-0.01
30951	7	-1.0 – 0.0	0.0	ND	ND	ND	7	-0.19 – 0.09	0.01
30958	5	-2.0 – (-1.0)	-2.0	ND	ND	ND	5	0.04 – 0.09	0.06
32393	5	-3.0 – 0.5	-1.0	ND	ND	ND	5	0.01 – 0.06	0.03
32395	8	-1.0 – 0.5	-0.3	ND	ND	ND	8	0.06 – 0.18	0.09
32396	6	-2.0 – 3.0	-0.5	ND	ND	ND	6	-0.14 – 5.36	-0.08
32399	8	-2.0 – 0.5	-1.0	ND	ND	ND	8	-0.07 – 0.13	0.04
32401	5	-3.0 – (-1.5)	-2.0	ND	ND	ND	5	-0.20 – (-0.12)	-0.17

Table 5. Summary of the field results for the differences between the in-place and secondary standards during 2004 water year.

Statistic	Δ BP (mmHg)	Δ TDG (mmHg)	Δ TDG (% Sat)	Δ T (^oC)
Number	294	284	283	286
Minimum	-3.30	-388.00	-52.08	-0.31
Maximum	3.10	34.00	4.52	0.50
Mean	-0.10	0.54	0.07	<0.01
Median	-0.10	2.00	0.27	<0.01
Std. Dev.	1.02	24.20	3.25	0.10

Table 6. Summary of the field results for the differences between the in-place and secondary standards by station during 2004 water year.

	Δ Barometric Air Pressure			Δ Total Dissolved Gas					Δ Water Temperature		
Station ID	# Obs	Range (mm Hg)	Median (mm Hg)	# Obs	Range (mm Hg)	Median (mm Hg)	Range (% Sat)	Median (% Sat)	# Obs	Range (°C)	Median (°C)
MCPW	22	-3.3 – 2.1	-0.6	22	-87 – 9	2.5	-11.6 – 1.2	0.3	22	-0.25 – 0.14	-0.02
MCQW	25	-2.2 – 1.2	-0.5	23	-9 – 13	2.0	1.0 – 1.2	1.1	23	-0.25 – 0.50	0.03
MCQO	24	-2.9 – 1.5	0.5	24	-12 – 14	3.0	1.0 – 1.2	1.0	24	-0.18 – 0.29	0.00
PAQW	11	-2.6 – 0.9	-0.3	12	-9 – 17	2.0	1.0 – 1.1	1.1	12	-0.11 – 0.10	-0.03
IDSW	22	-1.4 – 1.5	-0.2	22	-23 – 14	2.5	1.0 – 1.2	1.0	22	-0.14 – 0.19	-0.01
IHR	23	-2.5 – 2.3	0.3	23	-388 – 34	3.0	0.9 – 2.1	1.0	23	-0.09 – 0.20	0.00
LMNW	15	-1.4 – 0.8	-0.7	13	-4 – 7	2.0	1.0 – 1.2	1.0	14	-0.09 – 0.23	0.02
LMN	14	-1.2 – 1.1	0.2	13	-6 – 3	1.0	1.0 – 1.1	1.0	13	-0.12 – 0.16	0.02
LGSW	14	-0.9 – 1.5	0.4	13	-2 – 5	1.0	1.0 – 1.1	1.0	13	-0.13 – 0.15	-0.01
LGS	14	-1.2 – 0.7	-0.2	13	-1 – 6	2.0	1.0 – 1.1	1.0	13	-0.18 – 0.15	0.01
LGNW	22	-1.6 – 1.9	0.4	21	-4 – 8	2.0	0.9 – 1.1	1.0	22	-0.14 – 0.10	0.00
LWG	22	-2.0 – 1.0	-0.4	22	-3 – 13	1.5	1.0 – 1.1	1.0	22	-0.29 – 0.17	0.00
ANQW	14	-1.5 – 1.8	0.8	13	-2 – 4	2.0	1.0 – 1.1	1.0	13	-0.12 – 0.10	0.02
LEWI	14	-2.2 – 2.6	-0.9	13	0 – 6	1.0	1.0 – 1.1	1.0	13	-0.16 – 0.10	0.04
PEKI	14	-3.0 – 3.1	0.1	13	-3 – 12	2.0	1.0 – 1.1	1.0	13	-0.20 – 0.17	-0.01
DWQI	24	-2.9 – 2.3	0.0	24	-20 - 16	2.0	1.0 – 1.2	1.0	24	-0.31 – 0.21	0.04

Table 7. Fish spill and other spill intervals at the Walla Walla District projects during the 2004 water year.

Station ID	FMS Station Monitoring Period	Designated Fish Spill Period	Other Spill Intervals
MCPW	1 Oct – 30 Sept	12 Apr – 23 Jun	28 Jun – 1 Jul
MCQW	1 Oct – 30 Sept	13 Apr – 31 Aug	Not applicable
MCQO	1 Oct – 30 Sept	13 Apr – 31 Aug	Not applicable
PAQW	1 Apr – 15 Sept	20 Apr – 6 Aug	Not applicable
IDSW	1 Oct – 30 Sept	13 Apr – 31 Aug	Not applicable
IHR	1 Oct – 30 Sept	24 Apr – 14 May	28 May – 7 Jun
LMNW	1 Apr – 15 Sept	24 Apr – 14 May	28 May – 3 Jun; 6 Jun – 7 Jun
LMN	1 Apr – 15 Sept	7 Apr – 23 Apr	28 May – 5 Jun
LGSW	1 Apr – 15 Sept	7 Apr – 23 Apr	28 May – 2 Jun; 4 Jun – 5 Jun
LGS	1 Apr – 15 Sept	3 Apr – 23 Apr	5 May – 6 May; 27 May – 9 Jun
LGNW	1 Oct – 30 Sept	3 Apr – 23 Apr	5 May – 6 May; 27 May – 9 Jun
LWG	1 Oct – 30 Sept	Not applicable	Not applicable
ANQW	1 Apr – 15 Sept	Not applicable	Not applicable
LEWI	1 Apr – 15 Sept	12 Jul – 8 Aug	27 May – 12 Jun
PEKI	1 Apr – 15 Sept	12 Jul – 8 Aug	27 May – 12 Jun
DWQI	1 Oct – 30 Sept	12 Jul – 8 Aug	27 May – 12 Jun

Table 8. Summary of the total hours of barometric pressure, total dissolved gas, and temperature data that were missing or considered invalid in the 2004 water-year data set.

Hours	Percent	Reason
233	34.36	Defective sonde (McNary tailwater)
148	21.83	Missed transmission
67	9.88	Defective membrane (Ice Harbor forebay)
64	9.44	Routine maintenance
57	8.41	DCP failure
52	7.67	Missing value
49	7.23	Time change
8	1.18	Spike

Table 9. Number and percent of all missing or invalid data points for each FMS station during the 2004 water year, along with the reasons for those designations.

Station	Time Change		Missed Transmission		Missing Value		Spike		Routine Maintenance		Defective Membrane		Defective Sonde		DCP Failure	
ID	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
MCPW	3	1.10	24	8.79	0	0.00	4	1.47	9	3.30	0	0.00	233	85.35	0	0.00
MCQW	3	18.75	0	0.00	0	0.00	0	0.00	13	81.25	0	0.00	0	0.00	0	0.00
MCQO	3	7.69	33	84.62	0	0.00	0	0.00	3	7.69	0	0.00	0	0.00	0	0.00
PAQW	3	20.00	12	80.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
IDSW	3	17.65	0	0.00	3	29.41	1	5.88	8	47.06	0	0.00	0	0.00	0	0.00
IHR	3	3.37	2	2.25	4	4.49	0	0.00	13	14.61	67	75.28	0	0.00	0	0.00
LMNW	3	11.54	0	0.00	20	76.92	0	0.00	3	11.54	0	0.00	0	0.00	0	0.00
LMN	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
LGSW	3	4.76	0	0.00	0	0.00	0	0.00	3	4.76	0	0.00	0	0.00	57	90.48
LGS	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
LGNW	3	8.11	20	56.76	3	13.54	0	0.00	8	21.62	0	0.00	0	0.00	0	0.00
LWG	4	44.44	0	0.00	1	11.11	0	0.00	4	44.44	0	0.00	0	0.00	0	0.00
ANQW	3	15.00	17	80.00	2	5.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
LEWI	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
PEKI	3	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
DWQI	3	4.35	40	57.97	19	33.33	3	4.35	0	0.00	0	0.00	0	0.00	0	0.00

Table 10. Number and percent of all missing or invalid barometric pressure, total dissolved gas, and temperature data points for each FMS stations during the water year.

		Barometric Pressure			Total Dissolved Gas			Temperature		
Station ID	**MONITORING PERIOD**	**Number Missing/ Anomalous**	**% Missing**	**% Complete**	**Number Missing/ Anomalous**	**% Missing**	**% Complete**	**Number Missing/ Anomalous**	**% Missing**	**% Complete**
MCPW	1 Oct – 30 Sept	9	0.10	99.80	252	2.87	97.13	12	0.14	99.86
MCQW	1 Oct – 30 Sept	1	0.01	99.99	12	0.14	99.86	3	0.03	99.97
MCQO	1 Oct – 30 Sept	12	0.14	99.86	14	0.16	99.84	13	0.15	99.85
PAQW	1 Apr – 15 Sept	5	0.12	99.98	5	0.12	99.98	5	0.12	99.98
IDSW	1 Oct – 30 Sept	1	0.01	99.99	9	0.10	99.90	5	0.06	99.94
IHR	1 Oct – 30 Sept	3	0.03	99.97	79	0.90	99.10	7	0.08	99.92
LMNW	1 Apr – 15 Sept	8	0.20	99.80	14	0.35	99.65	4	0.10	99.90
LMN	1 Apr – 15 Sept	1	0.02	99.98	1	0.02	99.98	1	0.02	99.98
LGSW	1 Apr – 15 Sept	20	0.50	99.50	23	0.57	99.43	20	0.50	99.50
LGS	1 Apr – 15 Sept	1	0.02	99.98	1	0.02	99.98	1	0.02	99.98
LGNW	1 Oct – 30 Sept	7	0.08	99.92	14	0.16	99.84	13	0.15	99.85
LWG	1 Oct – 30 Sept	1	0.01	99.99	4	0.05	99.95	4	0.05	99.95
ANQW	1 Apr – 15 Sept	7	0.17	99.83	8	0.20	99.80	7	0.17	99.83
LEWI	1 Apr – 15 Sept	1	0.02	99.98	1	0.02	99.98	1	0.02	99.98
PEKI	1 Apr – 15 Sept	1	0.02	99.98	1	0.02	99.98	1	0.02	99.98
DWQI	1 Oct – 30 Sept	18	0.20	99.80	26	0.33	99.70	21	0.24	99.76

Table 11. Summary statistics for the available 2004 water year temperature data recorded at the FMS sites.

Period	Station ID	Min (^oC)	Max (^oC)	Mean (^oC)	Percent >20 ^oC 1 Oct – 30 Sept	Percent >20 ^oC 1 Apr – 15 Sept
10/01/03 – 09/30/04	MCPW	1.6	22.4	12.2	14.4	----
	MCQW	1.4	24.7	12.4	16.1	----
	MCQO	1.1	26.6	12.4	17.8	----
	IDSW	2.3	22.3	12.2	16.5	----
	IHR	1.9	23.8	12.3	17.4	----
	LGNW	1.8	20.3	11.3	0.1	----
	LWG	1.3	25.4	12.1	16.1	----
	DWQI	4.3	12.6	7.2	0.0	----
04/01/04 – 09/15/04	MCPW	8.0	22.4	16.5	----	31.4
	MCQW	8.1	24.7	16.9	----	35.0
	MCQO	7.9	26.6	17.0	----	38.2
	PAQW	7.2	21.7	15.8	----	22.6
	IDSW	8.5	22.3	16.6	----	36.0
	IHR	8.6	23.8	16.8	----	37.9
	LMNW	8.3	21.5	16.1	----	28.8
	LMN	8.4	25.0	16.5	----	33.8
	LGSW	8.6	21.0	15.7	----	12.6
	LGS	8.8	24.8	16.4	----	29.5
	LGNW	8.4	20.3	15.2	----	0.2
	LWG	8.4	25.4	16.7	----	35.1
	ANQW	7.2	24.1	16.8	----	37.4
	LEWI	6.0	20.1	11.3	----	<0.1
	PEKI	5.8	18.3	10.4	----	0.0
	DWQI	5.0	12.5	7.5	----	0.0

Table 12. Percent distributions for the 1 April – 15 September 2004 hourly temperature data from the FMS stations.

°C	DWQI	PEKI	LEWI	ANQW	LWG	LGNW	LGS	LGSW	LMN	LMNW	IHR	IDSW	PAQW	MCQO	MCQW	MCPW
0-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-6	20.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6-7	17.0	7.1	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7-8	35.9	9.4	7.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.2	0.0	0.0
8-9	5.7	11.6	8.9	1.1	0.0	1.4	1.9	1.4	1.1	2.0	2.0	2.2	3.3	2.8	3.1	4.4
9-10	12.8	15.8	12.5	4.0	2.3	6.4	3.2	3.7	3.7	3.5	2.3	2.7	9.5	2.9	1.6	1.4
10-11	5.2	22.6	16.3	9.6	6.2	11.3	6.8	10.4	3.5	3.4	5.0	4.8	2.7	8.0	7.8	9.4
11-12	2.5	12.4	17.0	8.1	8.8	10.5	10.1	8.6	11.0	10.8	7.3	5.9	8.8	4.5	4.8	3.6
12-13	0.6	9.2	13.8	11.3	12.3	9.7	15.7	14.6	15.8	16.1	9.1	11.8	5.0	7.3	8.6	8.6
13-14	0.0	4.3	7.4	5.6	5.1	4.2	5.0	5.2	6.9	6.3	15.3	14.0	5.3	9.5	9.0	9.5
14-15	0.0	2.7	6.1	3.0	2.6	3.1	3.0	3.5	5.0	5.8	4.2	3.7	6.8	6.9	7.4	6.8
15-16	0.0	1.4	2.5	3.6	1.4	2.0	1.3	1.6	1.3	1.5	3.0	4.1	3.3	3.8	3.2	2.8
16-17	0.0	2.1	2.1	1.7	1.0	2.3	1.1	2.2	1.1	1.5	2.4	1.8	2.4	2.3	2.4	2.7
17-18	0.0	1.3	1.7	1.3	1.8	12.4	2.4	3.2	2.3	2.8	1.9	1.8	3.1	1.2	3.4	2.8
18-	0.0	0.1	1.2	3.0	6.5	22.7	10.3	9.6	6.0	7.1	2.8	4.1	11.4	2.3	2.4	3.4

19																
19-20	0.0	0.0	0.4	9.9	8.6	14.0	9.7	23.4	8.5	10.5	6.9	7.3	13.0	10.0	11.3	13.2
20-21	0.0	0.0	0.0	11.2	7.0	0.2	13.0	12.6	15.4	24.9	12.1	11.4	14.5	10.3	10.7	10.9
21-22	0.0	0.0	0.0	5.7	10.9	0.0	9.0	0.0	11.5	4.0	13.5	23.4	8.2	10.5	11.9	15.1
22-23	0.0	0.0	0.0	13.1	7.9	0.0	3.7	0.0	4.2	0.0	11.3	1.3	0.0	11.5	9.8	5.4
23-24	0.0	0.0	0.0	7.3	5.1	0.0	3.2	0.0	2.2	0.0	1.0	0.0	0.0	4.3	2.5	0.0
24-25	0.0	0.0	0.0	0.1	4.0	0.0	0.5	0.0	0.4	0.0	0.0	0.0	0.0	1.3	0.1	0.0
25-26	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0

Table 13. Number and percent of FMS station total dissolved gas data that surpassed the 110 percent, 115 percent, 120 percent, and 125 percent criteria during the 2004 water year.

Station Type	Station ID	Interval	>110% # Obs	>110% %	>115% # Days	>115% %	>120% # Days	>120% %	>125% # Obs	>125% %
Idaho	DWQI	1 Oct – 30 Sept	329	3.8	----	----	----	----	----	----
		27 May – 12 Jun	326	82.0	----	----	----	----	----	----
		12 Jul – 8 Aug	3	0.0	----	----	----	----	----	----
		1 Oct – 26 May; 13 June – 30 Sept	3	0.03	----	----	----	----	----	----
	PEKI	1 April – 15 Sept	5	0.1	----	----	----	----	----	----
	LEWI	1 April – 15 Sept	0	0.0	----	----	----	----	----	----
Free-flowing	ANQW	1 April – 15 Sept	0	0.0	----	----	----	----	----	----
Forebay	LWG	1 April – 15 Sept	223	5.5	0	0.0	----	----	0	0.0
		1 Oct – 30 Sept	223	2.5	----	----	----	----	0	0.0
	LGS	1 April – 15 Sept	----	----	2	1.2	----	----	0	0.0
		3 Apr – 23 Apr	----	----	0	0.0	----	----	0	0.0
		27 May – 9 Jun	24	7.1	0	0.0	----	----	0	0.0
		1 Apr – 2 Apr; 24 Apr – 26 May; 10 Jun – 15 Sept	200	6.3	----	----	----	----	0	0.0
	LMN	1 April – 15 Sept	----	----	2	1.2	----	----	0	0.0
		7 Apr – 23 Apr	----	----	2	11.8	----	----	0	0.0
		28 May –5 Jun	34	15.7	0	0.0	----	----	0	0.0

	1 Apr – 6 Apr; 24 Apr – 27 May; 6 Jun - 15 Sept	64	1.9	----	----	----	----	0	0.0

Table 13. Number and percent of FMS station total dissolved gas data that surpassed the 110 percent, 115 percent, 120 percent, and 125 percent criteria during the 2004 water year (continued).

Station	Station		**>110%**		**>115%**		**>120%**		**>125%**	
Type	**ID**	**Interval**	**# Obs**	**%**	**# Days**	**%**	**# Days**	**%**	**# Obs**	**%**
Forebay	IHR	1 April – 15 Sept	----	----	4	2.4	----	----	0	0.0
		24 Apr – 16 May	----	----	4	17.4	----	----	0	0.0
		28 May – 7 Jun	29	11.0	0	0.0	----	----	0	0.0
		1 Jan – 23 Apr; 17 May – 27 May; 8 Jun - 30 Sept	32	0.4	----	----	----	----	0	0.0
	MCQO	1 April – 15 Sept	----	----	24	14.3	----	----	0	0.0
		13 Apr – 31 Aug	----	----	24	17.0	----	----	0	0.0
		1 Jan – 12 Apr; 1 Sept – 30 Sept	6	0.1	----	----	----	----	0	0.0
	PAQW	1 April – 15 Sept	----	----	6	3.6	----	----	0	0.0
		20 Apr – 6 Aug	----	----	6	5.5	----	----	0	0.0
		1 Apr – 19 Apr; 7 Aug – 15 Sept	0	0.0	0	0.0	----	----	0	0.0
	MCQW	1 April – 15 Sept	----	----	9	5.4	----	----	0	0.0
		13 Apr – 31 Aug	----	----	9	6.4	----	----	0	0.0
		1 Jan – 12 Apr; 1 Sept – 30 Sept	3	0.1	----	----	----	----	0	0.0
Tailwater	LGNW	1 April – 15 Sept	----	----	----	----	0	0.0	0	0.0
		3 Apr – 23 Apr	----	----	----	----	0	0.0	0	0.0
		27 May – 9 Jun	165	43.0	----	----	0	0.0	0	0.0
		1 Jan – 2 Apr; 24 Apr – 26 May; 10 Jun – 30 Sept	108	1.4	----	----	----	----	----	----

Table 13. Number and percent of FMS station total dissolved gas data that surpassed the 110 percent, 115 percent, 120 percent, and 125 percent criteria during the 2004 water year (continued).

Station Type	Station ID	Interval	>110% # Obs	>110% %	>115% # Days	>115% %	>120% # Days	>120% %	>125% # Obs	>125% %
Tailwater	LGSW	1 April – 15 Sept	----	----	----	----	0	0.0	0	0.0
		7 Apr – 23 Apr	----	----	----	----	0	0.0	0	0.0
		28 May – 5 Jun	13	6.0	----	----	0	0.0	0	0.0
		1 Apr – 6 Apr; 24 Apr – 27 May; 6 Jun - 15 Sept	11	0.3	----	----	----	----	----	----
	LMNW	1 April – 15 Sept	----	----	----	----	1	0.6	0	0.0
		24 Apr – 14 May	----	----	----	----	1	4.8	0	0.0
		28 May – 7 Jun	99	37.5	----	----	0	0.0	0	0.0
		1 Apr – 23 Apr; 15 May – 27 May; 8 Jun - 15 Sept	175	5.4	----	----	----	----	----	----
		1 Apr – 23 Apr; 15 May – 27 May; 8 Jun – 29 Aug; 4 Sept - 15 Sept	72	2.3	----	----	----	----	----	----
	IDSW	1 April – 15 Sept	----	----	----	----	2	1.2	0	0.0
		13 Apr – 31 Aug	----	----	----	----	2	1.4	0	0.0
		1 Jan – 12 Apr; 1 Sept – 30 Sept	6	0.1	----	----	0	0.0	0	0.0
	MCPW	1 April – 15 Sept	----	----	----	----	7	4.4	0	0.0
		12 Apr – 23 June	----	----	----	----	7	9.6	0	0.0
		28 June – 1 July	84	86.6	----	----	0	0.0	0	0.0
		1 Jan – 11 Apr; 24 Jun – 30 Sept	308	4.5	----	----	----	----	0	0.0
		1 Jan – 11 Apr; 24 Jun – 27 Jun;	225	3.4	----	----	0	0.0	0	0.0

Table 14. Percent distributions for the 1 April – 15 September 2004 hourly TDG data from the stations that were monitored annually.

% TDG	DWQI	LWG	LGNW	IHR	IDSW	MCQO	MCQW	MCPW
<95	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
95-96	1.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0
96-97	5.1	0.0	0.0	0.6	0.0	0.0	0.0	0.0
97-98	3.4	0.0	0.6	1.5	0.0	0.0	0.0	0.0
98-99	11.9	0.1	4.1	4.2	0.6	0.1	0.1	0.0
99-100	18.3	1.8	5.7	7.7	2.4	0.6	0.4	0.1
100-101	11.5	5.0	13.6	9.4	1.3	1.0	1.1	0.9
101-102	8.9	12.4	24.7	10.5	1.6	1.4	1.5	1.7
102-103	11.5	17.5	20.1	13.9	4.6	1.6	1.0	1.2
103-104	8.6	17.7	10.7	8.9	2.8	1.7	1.5	0.8
104-105	3.0	13.3	1.8	5.6	1.5	2.2	1.4	2.6
105-106	2.9	9.7	0.3	6.6	1.3	2.7	3.0	1.9
106-107	1.6	6.3	0.5	6.9	1.6	3.0	3.7	2.8
107-108	1.7	4.5	1.5	4.4	1.3	3.3	3.9	3.9
108-109	1.8	4.1	0.9	4.4	1.9	3.0	3.7	4.0
109-110	0.2	2.2	1.5	4.0	4.3	4.1	4.7	3.9
110-111	0.6	2.4	5.9	2.7	7.1	4.7	3.9	2.8
111-112	0.0	1.5	3.1	2.7	8.4	4.1	5.0	2.6
112-113	0.0	0.9	0.9	2.2	13.1	3.8	3.6	1.8
113-114	0.0	0.1	0.9	1.0	14.9	2.7	2.8	2.3
114-115	0.0	0.4	0.5	1.0	8.0	2.4	2.4	1.4
115-116	1.0	0.1	1.9	0.7	7.2	1.4	1.1	0.9
116-117	0.3	0.0	0.3	0.4	3.8	0.8	0.6	1.8
117-118	3.4	0.0	0.1	0.4	3.6	0.5	0.2	1.2
118-119	2.4	0.0	0.1	0.1	3.8	0.4	0.1	2.9
119-120	0.0	0.0	0.0	0.0	3.3	0.1	0.0	1.9
120-121	0.0	0.0	0.0	0.0	1.3	0.1	0.0	1.3
121-122	0.3	0.0	0.0	0.0	0.0	0.1	0.0	0.2
122-123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
123-124	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
125-126	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
126-127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
127-128	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
129-130	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>130	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 15. Percent distributions for the 1 April – 15 September 2004 hourly TDG data from the stations that were monitored seasonally.

% TDG	ANQW	PEKI	LEWI	LGS	LGSW	LMN	LMNW	PAQW
<95	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95-96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96-97	0.0	0.0	0.0	0.6	0.3	0.0	0.0	0.0
97-98	0.2	0.3	0.0	5.3	4.4	1.2	2.4	0.0
98-99	1.3	4.5	1.4	4.8	9.6	6.2	8.7	0.1
99-100	6.0	12.7	12.8	5.6	12.4	8.3	14.2	0.8
100-101	14.4	19.8	21.1	7.2	11.9	8.1	8.5	3.2
101-102	22.2	21.8	17.7	10.3	13.0	11.4	13.7	4.3
102-103	24.7	15.5	13.5	15.2	15.6	16.5	10.3	4.7
103-104	20.1	10.5	12.3	9.4	7.7	8.4	4.1	5.8
104-105	10.2	4.4	9.8	6.6	2.5	6.5	4.5	5.7
105-106	0.9	4.4	6.7	4.7	3.2	6.2	3.7	6.4
106-107	0.0	3.9	3.3	5.2	2.4	5.8	3.9	4.6
107-108	0.0	1.5	1.1	6.8	3.8	5.9	2.8	4.7
108-109	0.0	0.3	0.3	4.9	3.3	4.6	2.9	5.7
109-110	0.0	0.4	0.0	4.4	2.4	2.8	3.4	8.1
110-111	0.0	0.1	0.0	2.8	0.9	2.3	1.7	9.9
111-112	0.0	0.0	0.0	3.0	1.1	2.8	2.1	10.1
112-113	0.0	0.0	0.0	1.6	0.3	0.7	2.1	10.9
113-114	0.0	0.0	0.0	0.5	0.3	0.8	0.7	8.2
114-115	0.0	0.0	0.0	0.3	0.4	1.1	0.8	4.9
115-116	0.0	0.0	0.0	0.3	0.4	0.4	0.6	1.5
116-117	0.0	0.0	0.0	0.2	1.0	0.1	1.3	0.2
117-118	0.0	0.0	0.0	0.1	1.0	0.0	2.7	0.0
118-119	0.0	0.0	0.0	0.1	1.4	0.0	1.9	0.0
119-120	0.0	0.0	0.0	0.0	0.2	0.0	2.3	0.0
120-121	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0
121-122	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
122-123	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
123-124	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
124-125	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
125-126	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
126-127	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
127-128	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
128-129	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
129-130	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
>130	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0