

APPENDIX B

**CORPS OF ENGINEERS PLAN OF
ACTION FOR DISSOLVED GAS
MONITORING IN 2004**

CORPS OF ENGINEERS PLAN OF ACTION FOR DISSOLVED GAS MONITORING IN 2004



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CORPS OF ENGINEERS PLAN OF ACTION FOR DISSOLVED GAS MONITORING IN 2004

1.0 INTRODUCTION

This Plan of Action for 2004 summarizes the role and responsibilities of the Corps of Engineers as they relate to dissolved gas monitoring, and identifies channels of communication with other cooperating agencies and interested parties. The Plan summarizes what to measure, how, where, and when to take the measurements and how to analyze and interpret the resulting data. It also provides for periodic review and alteration or redirection of efforts when monitoring results and/or new information from other sources justifies a change. Some information on the complementary activities of other participating agencies is provided at the end of this document.

2.0 GENERAL APPROACH

The total dissolved gas (TDG) monitoring program consists of a range of activities designed to provide management information about dissolved gas and spill conditions. These activities include time-series measurements, data analysis, synthesis and interpretation, and calibration of numerical models. Four broad categories of objectives are involved:

- 1) data acquisition, to provide decision-makers with synthesized and relevant information to control dissolved gas supersaturation on a real-time basis,
- 2) real-time monitoring, to ascertain how project releases affect water quality relative to ESA Biological Opinion measures and existing state and tribal dissolved gas standards;
- 3) trend monitoring, to identify long-term changes in basin wide dissolved gas saturation levels resulting from water management decisions; and
- 4) model refinement, to enhance predictive capability of existing models used to evaluate management objectives.

Portland, Seattle and Walla Walla Districts have direct responsibilities for TDG monitoring at their respective projects, including data collection, transmission, and analysis and reporting. The Division's Reservoir Control Center (RCC) will coordinate this activity with the Districts and other State and Federal agencies and private parties as needed to insure the information received meet all real-time operational and regulatory requirements. Districts and Division roles and functions are described in more detail in later sections of this document.

The Corps considers TDG monitoring a high priority activity with considerable potential for adversely affecting reservoir operations and ongoing regional efforts to protect aquatic biota. It will make all reasonable efforts toward achieving at least a data quality and reliability level comparable to that provided in previous years.

Furthermore, the Corps believes it is important to maintain a two-way communication between those conducting the monitoring and the users of monitoring information. These interactions give decision-makers and managers an understanding of the limitations of monitoring and, at the same time, provide the technical staff with an understanding of what questions should be answered. Therefore, comments and recommendations received from users were and continue to be very useful in establishing monitoring program priorities and defining areas requiring special attention.

3.0 DISTRICTS/DIVISION RESPONSIBILITIES

3.1 Portland, Seattle and Walla Walla Districts Functions

Portland, Seattle and Walla Walla Districts will perform all the activities required at their TDG monitoring sites. Data will be collected and transmitted from those sites systematically and without interruption to the Corps Water Management System (CWMS). CWMS is a comprehensive water management system incorporating the acquisition, transformation, verification, storage, display, analysis, and dissemination of information using a relational database (ORACLE) to store the data. Some of the gauges will record year round while other will be seasonal (see Table 4 at the end of this appendix). At most gauges, normal seasonal monitoring will be from 1 April through 15 September. However, the Chelan County gauges will operate from 1 April through 31 August and the Hungry Horse gauge will operate from 1 April through 30 September. Should spill occur in association with the Spring Creek hatchery release, monitoring stations downstream of Bonneville Dam will be activated. Activation of these monitoring stations will be coordinated with the Portland District.

District responsibilities include but are not limited the following tasks:

- preparing annual monitoring plan of action and schedule, as described in RPA 131 of the National Marine Fisheries Service 2000 Biological Opinion
- procuring data collection/transmission instruments
- preparing and awarding equipment and service contracts
- performing initial instrument installation and testing
- setting up and removal of permanent monitoring installations, if requested
- evaluate existing stations, as described in RPA 132 of the National Marine Fisheries Service 2000 Biological Opinion
- collecting and transmitting TDG data to CWMS
- reviewing data for early detection of instrument malfunction
- making periodic calibration, service and maintenance calls once every 2 weeks
- providing emergency service calls as needed and/or when so notified
- performing special TDG measurements, if needed
- keeping records of instrument calibration and/or adjustments
- retrieving, servicing, and storing instruments at the end of the season
- providing final data corrections to the Division office
- performing data analysis to establish/strengthen spill vs. TDG relationship
- preparing an annual activity report
- document and report QA/QC performance

All three Districts will also be responsible for (1) preparing an annual report on instrument performances, and (2) providing the necessary material including test and data analyses, charts, maps, etc. for incorporation in the Corps' Annual TDG Report, which will be finalized by the Division. Additional monitoring at selected locations may be required on an "as needed" and depending upon available funding. Dissemination of data to outside users will remain a Division responsibility to avoid duplication and uncoordinated service.

3.2 Division's Functions

The Division will be responsible for overall coordination of the TDG monitoring program with the Districts, other State and Federal agencies and cooperating parties. The Leader of the Water Quality Team, CENWD-CM-WR-N, is the designated TDG Division Program Coordinator reporting through the chain of command through Chief, Reservoir Control Center and Chief, Water Management Division to the Director of Programs.

The Division TDG Program Coordinator will provide overall guidance to District counterparts to ensure that the monitoring program is carried out in accordance with the plan outlined in this document, including close adherence to a general schedule and operating QA/QC protocols. The individual will be the main point of contact for all technical issues related to the TDG monitoring at Corps projects. The coordinator will refer problems of common regional interest to relevant forums such as the Water Quality Team (WQT) for peer review and open discussion. The individual will facilitate final decision-making on technical issues based on all relevant input from interested parties.

The Division TDG Program Coordinator will meet with District counterparts in late January or early February to discuss and firm up detailed implementation plan and schedule for the current year. Discussion will cover monitoring sites, equipment, data collection and transmission procedures, service and maintenance, budget, communication needs, etc. A set of specific performance measures will be jointly prepared as a basis for reviewing and monitoring District performances. A post-season review meeting will be held annually to provide a critique of the operations and identify areas needing changes and/or improvements.

4.0 2004 ACTION PLAN

The 2004 Action Plan consists of the following eight phases observed in previous years, plus winter monitoring. These phases are as follows:

- (1) Program start-up;
- (2) Instrument Installation;
- (3) In-season Monitoring and Problem Fixing;
- (4) Instrument Removal and Storage;
- (5) Winter Monitoring;
- (6) Data Compilation, Analysis and Storage;
- (7) Program Evaluation and Report; and
- (8) Special Field Studies

The Plan of Action for all three Districts is similar to the one in 2003, with the exception of some fixed monitoring station changes.

A NOAA Fisheries Forum Water Quality Team Subcommittee has met every year since 2001 in the fall to consider actions concerning RPA 132 of the Biological Opinion. RPA 132 calls the action agencies to develop a plan and conduct a systematic review and evaluation of the TDG fixed monitoring stations in the forebays of all the mainstem Columbia and Snake River dams, in coordination with the Water Quality Team. The Fixed Monitoring Station (FMS) Subgroup of the Water Quality Team (WQT) met on December 9th, 2003 to complete the review of the FMS system for the Federal Columbia River Power System (FCRPS). After consideration of the discussions at this meeting, the following recommendations (Table 1) for changes to the FMS have been established:

Table 1
Fixed Monitoring Station Subgroup Recommendations for 2004 Spill Season

Fixed Monitoring Station	Recommendation/Comments
Camas/ Washougal	Recommend no change in this site at this time. However, the WQT is currently reviewing the purpose, representativeness, and value as a TDG management tool of this station. Until these issues are addressed, this station will remain in service during the 2004 spill season (see discussion below).
Warrendale	The site is inconsistent with other tailwater sites in the system due to considerable mixing with powerhouse waters. The WQT is currently reviewing use of this station along with Camas/Washougal and the new BON Tailrace monitor on Bradford Island. Until all issues are addressed, this station will remain in service during the 2004 spill season and will be used as the Bonneville tailrace monitor for spill management purposes (see discussion below).
BON Tailrace	Install real-time monitor on Bradford Island in the spill water channel just downstream of the aerated zone (near "Turtle Rock"). Evaluate potential use of this site for spill management at Bonneville Dam. However, this station will not be used for spill management purposes until the issues with respect to Camas/Washougal are addressed.
BON Forebay	Recommend no change in this site.
TDA Tailrace	The station is currently inconsistent with other tailwater sites in the system due to considerable mixing with powerhouse flows. Continue to utilize this site for spill management but recommend additional investigations to identify a more suitable monitor location.

TDA Forebay	Recommend no change to this station.
JDA Tailrace	Recommend no change in this site.
JDA Forebay	Relocate monitor to the upstream end of the navigation lock. Deploy monitor at a depth of 15 meters.
MCN Tailrace	Recommend no change in site location.
MCN Forebay	Maintain existing station locations, data recording, and applications. Recommend 2004 as a transition year to evaluate alternative stations as follows: Locate one monitor near upstream end of navigation lock guide wall and deployed at a depth of 15 meters. Locate a second monitor on a float at the Boat Restricted Zone (BRZ) on the Oregon side of the forebay. Both instruments should be remote logging devices. Data are to be made available monthly for review by the WQT.
Pasco	Recommend no change in this site.
IHR Tailrace	Recommend no change in this site.
IHR Forebay	Maintain existing station locations, data recording, and applications. Recommend 2004 as a transition year to evaluate alternative stations as follows: Locate monitor near the upstream end of the navigation lock guide wall and deployed at a depth of 15 meters. Instrument should be remote logging device. Data are to be made available monthly for review by the WQT.
LMN Tailrace	Recommend no change in this site.
LMN Forebay	Maintain existing station locations, data recording, and applications. Recommend 2004 as a transition year to evaluate alternative stations as follows: Locate monitor near the upstream end of the navigation lock guide wall and deployed at a depth of 15 meters. Instrument should be remote logging device. Data are to be made available monthly for review by the WQT.
LGS Tailrace	Recommend no change in this site.
LGS Forebay	Maintain existing station locations, data recording, and applications. Recommend 2004 as a transition year to evaluate alternative stations as follows: Locate monitor near the upstream end of the navigation lock guide wall and deployed at a depth of 15 meters. Instrument should be remote logging device. Data are to be made available monthly for review by the WQT.
LWG Tailrace	Recommend no change in this site.

LWG Forebay	Maintain existing station locations, data recording, and applications. Recommend 2004 as a transition year to evaluate alternative station as follows: Locate monitor near the existing monitor on the navigation lock guide wall and deployed at a depth of 15 meters. Instrument should be remote logging device. Data are to be made available monthly for review by the WQT.
DWR Tailrace	Recommend no change in this site.
Peck	Recommend no change in this site.
Lewiston	Recommend no change in this site.
Anatone	Recommend no change in this site.
Pasco	Recommend no change in this site.
Albeni Falls Tailrace	Install monitor. No monitor has been operated at this site previously.
Albani Falls Forebay	Install monitor. No monitor has been operated at this site previously.
Libby Tailwater	Recommend no change in this site.
Chief Joseph Tailwater	Recommend no change in this site.
Chief Joseph Forebay	Recommend no change in this site.

At the December 9th and January 13th meetings Water Quality Team meeting, discussion of the fixed monitoring sites downstream of Bonneville dam took place. At these meetings, the Corps presented a recommendation to eliminate the Warrendale FMS and begin monitoring Bonneville tailwater TDG levels from Bradford Island at a location just downstream of the aerated zone (near “Turtle Rock”). The fish and wildlife agencies (NOAA Fisheries, Fish Passage Center, and the U.S. Fish and Wildlife Service) all supported this relocation contingent upon the discontinued use of the gauge at Camas/Washougal to manage spill at Bonneville Dam. Water quality agencies from the States of Oregon and Washington indicated support for the relocation because it would be consistent with the preferred location for tailwater TDG gauges as specified in the “Total Maximum Daily Load (TMDL) for Lower Columbia River Total Dissolved Gas.” The State of Washington has deleted specific reference to the Camas/Washougal site for compliance determination in its water quality regulations adopted in 2003. EPA must still approve the new standards (anticipated sometime in 2004) before they are fully in effect, so some revision of the rule is still possible. The State of Oregon has required the

use of the Camas/Washougal site for compliance monitoring in the Order issued by its Environmental Quality Commission. However, the State water quality agency stated a willingness to amend this order should a decision be made to change the monitoring site. As a result, the Corps is recommending no specific changes in the locations of TDG gauging stations downstream of Bonneville dam for spill management. Due to structural changes at Bonneville dam, the Corps is planning on continued TDG monitoring at the Bradford Island site in the future to determine how use of these new facilities affect TDG entrainment in the tailwaters. The data from the Bradford Island site will not be used for spill management for the 2004 spill season.

4.1 Phase 1: Program Start-Up

Responsible parties (See Table 3 at the end of this appendix) will be invited to a TDG-FMS Coordination meeting some time in late January or early February for final discussions on the plan of action. This will ensure a good mutual understanding of the most current objectives of the dissolved gas monitoring program, including data to be collected, instrument location, procedures to be used, special requirements, etc. The draft plan will be presented for peer review at a February meeting of the WQT.

All three Districts will ensure that adequate funding is available for 2004 monitoring activities. Portland District, having decided to continue to use the service of the USGS (Portland Office) in 2004, will prepare the necessary contracts to secure those services and provide for rental and associated maintenance of the USGS's Sutron data collection platforms. Walla Walla District, which will begin using the services of the USGS (Pasco Office) in 2004, will also prepare the necessary contracts to secure those services. Seattle will renew or develop new contractual arrangements as needed for the operation of the Chief Joseph and Libby stations, and the installation and maintenance of the new monitors at Albeni Falls. All maintenance and service contracts should be completed at least two weeks before the instruments are installed in the field. Where applicable, the Districts will ensure that real estate agreements and right of entry are finalized between the landowners and the Corps. All paper work for outside contracting will be completed no later than 31 January.

To date, the districts have been initiating the necessary contracts to continue operation and maintenance of the FMS's through the 2003-2004 winter monitoring season and the 2004-monitoring season. Districts and division have finalized the current QA/QC protocols. Temperature loggers have been placed in Dworshak Reservoir for winter monitoring. All districts will continue GOES satellite transmission.

Discussions between districts, division and contractors are expected to continue through February, at which time a final plan of action will be produced. It is also understood that the following entities will continue to operate their monitoring instruments in 2004:

- U.S. Bureau of Reclamation, below Hungry Horse, at the International Boundary and above and below Grand Coulee Dam;
- Mid-Columbia PUDs (Douglas, Chelan and Grant Counties), above and below all five PUD dams on the Columbia River; and

- Idaho Power Company, in the Hells Canyon area (as part of its Federal Energy Regulatory Commission's license renewal requirement).

4.2 Phase 2: Instrument Installation

Instruments to be installed and their assigned locations are listed in Table 4 and shown in Figure 2. Some of them are already in place for the 2003-2004 winter monitoring. The Corps network will essentially remain the same as in 2003. However, unlike previous years, the station below Libby Dam will be active through the entire 2004 spill season. In previous years, the Libby tailwater gauge was only operational at times when spill was occurring.

Forebay and tailwater gauges will be installed at Albeni Falls sometime this winter and are expected to be fully operational during the entire 2004 spill season.

All instruments are scheduled to be in place and duly connected to their Sutron, Zeno, or Geomation DCP's no later than 1 April for all stations except the stations downstream of Bonneville dam which may need to be activated earlier should spill occur in conjunction with the Spring Creek hatchery release. Otherwise, the stations below Bonneville will be activated by 1 April like all other monitoring sites.

Corps stations that remain in service during the 2002-2003 winter will continue their operation with minimum interruption into the spring, following the necessary instrument service and maintenance check-up and site equipment (piping) upgrades. These stations include the following: Dworshak tailwater, Pasco (temperature), Anatone (temperature), Lower Granite forebay and tailwater, Ice Harbor forebay and tailwater, McNary forebay (Oregon and Washington sides) and tailwater, Bonneville forebay, and Warrendale. The Anatone gauge is operated seasonally for temperature and TDG. The Walla Walla District currently provides funding to the USGS to collect temperature data year-round at their gauging station located in the same reach. The Pasco gauge is operated for TDG and temperature seasonally (1 April through 15 September) but only operated as a QC/QA station for the remainder of the year. An assessment of monitoring site integrity will be conducted; any damages that may have occurred over the winter will be fixed before proceeding on to calibration and testing. Selected project personnel may be requested to assist on this task as needed.

4.3 Phase 3: In-season Monitoring and Problem Fixing

Actual data collection and transmission will begin no later than 10 March at the monitoring stations below Bonneville dam if spill at Bonneville is performed as part of the Spring Creek Hatchery release. Otherwise, the data collection and transmission will begin no later than 1 April for the entire monitoring network.. The exact starting date will be coordinated with the Corps' Reservoir Control Center (CENWD-CM-WR-N), project biologists and cooperating agencies, based on run-off, spill, and fish migration conditions.

The following data will be collected approximately every hour:

- Water Temperature (°C)
- Barometric Pressure (mm of Hg)
- Total Dissolved Gas Pressure (mm of Hg)
- Gage depth (feet)

Data will be collected at least hourly and transmitted at least every four hours. If feasible, the previous 12 hours of data will also be sent to improve the capability of retrieving any data that may have been lost during the preceding transmission. For Portland, Seattle, and Walla Walla Districts, data transmission will be done via the GOES Satellite, to the Corps' ground-receive station in Portland. After decoding, all data will be stored in the CWMS database. Per their contract with Portland District, the USGS is planning to have the satellite data going into CWMS and ADAPS (internal to the USGS) simultaneously to allow for some pre-screening. Data transmission at Libby and Albeni Falls (gauges operated by the Seattle District) will also be done via radio to the NWS HEC-DSS database to provide back-up data in case of GOES transmission failure.

Given their direct relevance to fish mortality, the first three parameters (Temperature, Barometric Pressure, and TDG) will be collected on a first priority basis.

Daily reports summarizing TDG and related information will be posted on the Technical Management Team's (TMT) home page. To the extent feasible, the measured TDG data will be compared with SYSTDG model predicted values so that suspicious values can be flagged. Data filtering through other methods will also be made. Information provided on the homepage will include the following data:

- Station Identifier
- Date and Time of the Probe Readings
- Water Temperature, °C
- Barometric Pressure, mm of Hg
- TDG Pressure, mm of Hg
- Calculated TDG Saturation Percent (%)
- Project Hourly Spill, Kcfs (QS)
- Project Total Hourly Outflow (Total River Flow), Kcfs (QR)
- Number of Spillway Gates Open
- Probe depth, ft
- Calculated Compensation Depth, ft

Spill bay stop settings, if different from the numbers provided in the Fish Passage Plan, also will be reported to and coordinated with the TMT. Stop-settings, however, will not be part of the water quality data set available on the TMT home page.

The Reservoir Control Center staff will perform reconciliation of data received to CWMS based on input from the field before the data are permanently stored in the Corps' Water Quality Data Base. Additional data posting in the TMT home page will continue.

4.3.1 Data Quality Process

The NMFS 2000 Biological Opinion RPA 131 stipulates that the "Action Agencies shall monitor the effects of TDG." Further explanation of the RPA includes a discussion of Quality Control and Quality Assurance including redundant and backup monitoring, bi-weekly calibration, and spot-checking of monitoring equipment. In an effort to address these concerns the US Army Corps of Engineers has established Data Quality Criteria for the fixed monitoring stations at its projects. These Data Quality Criteria describe the accuracy, precision and completeness of the data needed at each station. The fixed monitoring stations will be assessed at the end of the monitoring season against these criteria and a performance report will be created. Adjustments will be made to the individual fixed monitoring stations that do not perform to the objectives described.

As a general overview, the Data Quality criteria for fixed monitoring stations (FMS) include having two dedicated TDG probes (hydrolab) for each site, which provides redundancy instead of redundant stations. The "extra" TDG probes (hydrolab) for each site is lab calibrated before its bi-monthly rotation into the field. Once it is deployed, it is again calibrated and/or checked. The data from the FMS operated by the Portland and Walla Walla Districts is sent to USGS and USACE-NWD. The USGS reviews this data and performs corrections. The Seattle District reviews and corrects their data. There is a goal of 95% data completeness. The Data Quality Criteria was presented to the WQT in February 2003. The WQT discussed and approved the approach at the March 2003 WQT meeting.

4.3.1.1 Data Quality Criteria

The proposed data quality criteria for fixed monitoring station cover three main parts:

- A. **Calibration Protocols:** laboratory and field calibrations
- B. **Reviewing Data Quality:** data quality checks and dealing with suspect data
- C. **Completeness of Data**

The items are described as following:

A. Calibration Protocols

There are two general types of calibrations performed on Fixed monitoring stations (FMS): lab calibrations and field calibration.

1. Laboratory Calibration

There are four data quality criteria associated with laboratory calibration, including *i*) calibration of the secondary TDG standard, *ii*) the secondary barometric pressure standard, *iii*) the field instrument TDG sensor, and *iv*) secondary standard thermistor. Each is described as follows:

i. Calibration of Secondary TDG Standard

Calibrate the TDG sensor at two points using the primary National Institute of Standards and Technology (NIST) standard. The TDG pressure must be +/- 2 mm Hg

at both pressures; otherwise the secondary standard is recalibrated. Pressures at which the sensor is calibrated must bracket the expected range of field measurements. For an index of primary and secondary standards (see Table 2).

Table 2
Primary and Secondary Standards

PARAMETER	PRIMARY STANDARD	SECONDARY STANDARD
Temperature	NIST traceable thermometer	Lab Hydrolab
Barometer Pressure	NIST traceable barometer or digital pressure gauge.	Hand held barometer
Total Gas Pressure	Digital pressure gauge calibrated to NIST	TDG Probe

ii. Calibration of Secondary Barometric Pressure Standard

Calibrate the secondary standard barometer at ambient barometric pressure to the NIST standard. The barometer must be +/- 1 mm Hg of the primary standard (NIST certified instrument) otherwise the secondary standard is recalibrated.

iii. Calibration of Field Instrument TDG sensor

The two point TDG sensor calibration must agree within +/- 2 mmHg at both pressures, otherwise the sensor is recalibrated. Pressures at which the sensor is calibrated must bracket the expected range of field measurements.

iv. Calibration of Secondary Standard Thermistor

The instrument's thermistor must agree within +/- 0.2°C with the primary NIST standard. This variance will be monitored and if the probe performs outside this range, it will be returned to the manufacturer for maintenance. A check or verification still constitutes a calibration and should be documented in records.

2. Field Calibration

There are two data quality criteria associated with field calibration: Calibrations and Performance checks. Calibrations include two fixed points and two point TDG sensor calibration.

i. Calibrations

- Two Fixed Points: In order to reduce TDG calibration variability, two fixed points should be chosen and incorporated in the TDG calibration protocol. For example, calibrate the first point to ambient barometric pressure, and the second point to 200 mmHg over barometric pressure. The calibrated range for this example brackets 100-126 % TDG saturation. This ensures the same calibration curve is established each time for every instrument.

- Two Point TDG Sensor Calibration: Following a two-week deployment, a two point TDG sensor calibration must agree within +/- 4 mmHg at both pressures. Pressures at which the sensor is calibrated must bracket the expected range of field measurements. If the pressure is not +/- 4 mmHg of the standard, the data will be considered “suspect” and handled as described in “Reviewing Data Quality”.

ii. Performance checks

There are four data quality criteria associated with performance checks: TDG pressure compared to secondary standard; standby probes deployed; thermistor compared to secondary standard; and field barometer compared to secondary standard. Each is described as follows:

- TDG Pressure Compared to Secondary Standard: After the deployment period, prior to removal of the field instrument, the TDG pressure will be compared to the secondary standard. The actual decision point regarding adjusting the data would be in the lab following the two point TDG sensor calibration described in field instrument post calibration. The field comparison actually involves sampling precision and should not be used as a decision point for shifting data.
- Standby Probe Deployed: During initial deployment of a new TDG probe, after sufficient time for equilibration (up to one hour), the TDG pressure must be +/- 10 mmHg of the secondary standard otherwise another (standby) probe is deployed.
- Thermistor Compared to Secondary Standard: During initial deployment of the new instrument, the thermistor will be +/- 0.4°C of the secondary standard, corrected for calibration, or the instrument will be replaced with a standby.
- Field Barometer Compared to Secondary Standard: At each visit the field barometer reading should be the same as the secondary standard or the field barometer will be calibrated.

The sensor must be deployed to a depth where the compensation depth is sufficient to accommodate the change in pressure relative to the atmosphere, otherwise the TDG measurements may be underestimated. If the site does not accommodate maintaining the probe at greater than the compensation depth for more than 95% of the measuring cycle, investigations will begin to re-locate the fixed monitoring station.

The Corps, or their contractors, will have an adequate inventory of spare instruments that will be maintained to ensure that at least one backup monitor will be made available for deployment as necessary. A malfunctioning instrument will be repaired within 24 to 48 hours, depending on the remoteness of the instrument location and TDG conditions (weekends may require a longer response time). High priority will be placed on fixing a faulty instrument when TDG are or expected to be in excess of the current state standards.

Corps staff and/or contractors will maintain TDG instruments. Instruments needing repairs that are beyond the staff's capability will be shipped to the manufacturer. In-

house water quality and information management will do repairs of communication network staff. USGS Stennis Center (MS) staff will handle Service and repairs of the Sutron DCPs. Service and repairs of the Zeno DCPs will be performed by a contractor.

To better understand the physical process of dissolved gas distribution across the reservoirs and its dissipation along the various pools, selected transects studies will continue to be conducted on an as-time-permits basis. An additional objective for this activity is to be able to define how representative readings from current monitoring sites really are with respect to the entire river reach.

To help reduce response time in determining whether an emergency field visit is needed, the following decision-making procedure was developed by the WQT:

- No emergency trips are made for the parameter of temperature or oxygen.
- For gas and barometric pressure, if more than 25% of the hourly values are missing, then an emergency trip is needed.
- If the difference in values between two consecutive stations is larger than 20 mm Hg for gas pressure, or 14 mm Hg for barometric pressure, then an emergency trip is triggered. Criterion 3 does not apply if:
 - a. there is a transient “spike” for a parameter.
 - b. if the higher-than-expected gas pressure value is associated with spill operations.
- If gas parameters at a station do not fall within any of the Corps Engineering Research and Development Laboratory (ERDC) generated/RCC generated gas production curves, are not caused from operational or structural changes, and these data persist for over 48 hours, then an emergency visit is triggered.
- If there is uncertainty with an abnormal reading at a gas monitoring station that persists for more than 48 hours, the COE will notify WQT members as soon as possible via email. The WQT should develop a recommendation to TMT, and to IT if necessary. If the COE plans to change fish passage actions because of the uncertainty, it should notify both the TMT & WQT members of the proposed change. TMT members will determine whether or not a meeting or conference call is needed and advise the COE of this need. The COE will then convene a TMT meeting, if requested to do so. If an abnormal reading at the gas monitoring station persists for more than 48 hours, the Corps will adopt the 2000 Plan of Action language on the subject. According to the May 2, 2000 letter from the Corps to NMFS, "If the WQT chairs determine a water quality issue exists, the issue will be framed by the WQT and forwarded from the chairs of the WQT to the chair of TMT or IT, as appropriate. Each state's fishery and water quality agencies and tribes will work together prior to any TMT meeting on this issue to balance and assure consistency of the proposed actions with fishery management requirements and state water quality standards."

B. Reviewing Data Quality

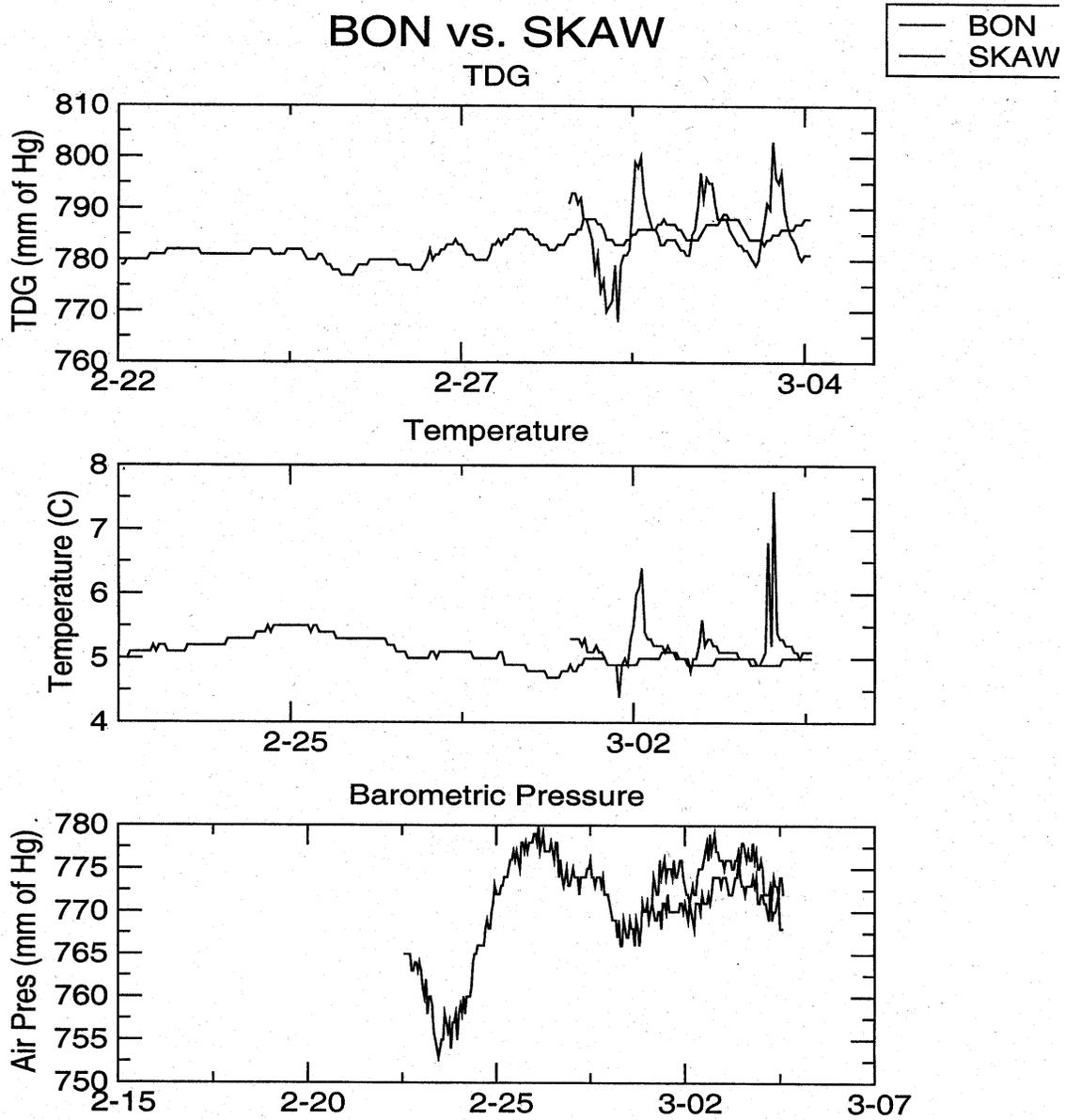
The data from the fixed monitoring stations will be sent to the USACE-NWD's CWMS database which stores the raw data. At the same time, data from the FMS operated by the Portland and Walla Walla Districts is sent to the USGS's ADAP database. The USGS performs the review, correction and deletion process described below on ADAP's data, thus storing corrected data.

1. Reviewing Data

Once data are received, one or more of the following review processes occur:

- **Visually look at the tables of data:** There are certain signs in the data that may indicate mechanical problems. An instance, when the TDG pressure rises to 1,000 mmHg suddenly, and remains at that level, there may be a membrane tear. If there are extreme changes in any parameter, this shows that the data is erroneous.
- **A data checklist is completed.** The data quality checklist shown below provides an example of questions that can be used to assist in identifying problems with data.
- **Review graphs of the data.** Creating graphs of the data can show unusual spikes in a parameter and draw your attention to the data quickly. Spikes in graphed data can suggest further investigation may be necessary. For instance, a sudden rise of 5 °C in one hour stands out and is suspect. The graph shown below is an example of what is currently used.

Figure 1: Graphs for Data Review



2. Dealing with Suspect Data

Once suspect data are identified, one of the following actions can be taken:

- **Correct the data:** If there is a constant amount of shift or a continual drift, the data can be corrected using the USGS NWIS software. This is not usually the case. Sensor drift can be handled using a linearly prorated correction.

- **Delete the data:** If there appears to be no means of correcting the data, then it is deleted from the USGS ADAPS database and they inform the Corps of the erroneous data. The Corps can then decide what to do with the erroneous data.

If data recorded by the fixed sensors are different from those recorded during the calibration procedure, appropriate correction will be made to the current as well as past data already stored in CWMS as soon as possible. Data corrections will be provided to the USACE-NWD on an on-going basis so that they can be incorporated into the database.

C. Completeness of Data:

Completeness of data includes how completeness is calculated and the data quality criteria goal.

1. Completeness Calculation

The calculation of data set completeness is based on temperature and %TDG, which encompasses barometric pressure and TDG pressure. Data completeness is not based on the completeness of one parameter but of an entire suite.

2. Completeness Goal

Data collected at each site will be 95% of the data that could have been collected during the defined monitoring period.

4.4 Phase 4: Instrument Removal and Storage

Water quality monitors will be removed shortly after the end of the monitoring season (15 September) by Corps staff or the USGS, except for those that are slated for continued winter monitoring. Those removed will be serviced by the maintenance and service contractors and stored at a convenient location until the beginning of the next monitoring season. A selected number of monitors and spare DCPs will be available for off-season special monitoring activities upon request. Seattle District owns its Sutron and Geomation DCPs, and maintains and stores them as needed.

4.5 Phase 5: Winter Monitoring.

The same few stations that were selected for winter operation in 2002-2003 will be retained for compliance monitoring in the following 2003-2004 winter (see Table 4 at the end of this appendix).

4.6 Phase 6: Data Compilation, Analysis and Storage

Time and resource permitting, Corps staff and contractors will fill data gaps, perform statistical analyses, and develop trends and relationships between spill and TDG saturation. Efforts will be made to use the SYSTDG model, and finding ways to facilitate and/or improve user access to the TDG and TDG-related database. The SYSTDG model (developed by ERDC) will be available for in-season gas production predictions and

screening. Data collected at and transmitted from all network stations will be ultimately stored at CENWD-CM-WR-N, where they can be accessed through a data management system such as HEC-DSS or download the information from the TMT website.

4.7 Phase 7: Program Evaluation and Summary Report

An annual report will be prepared after the end of the normal (spring and summer) monitoring season to summarize the yearly highlights of the TDG monitoring program. Preparation for the annual report will begin with a post-season review, with participation by the Northwest Division Office, the three Corps districts, the Bureau of Reclamation, the Mid-Columbia PUD's, and the NMFS forum WQT. The report will include a general program evaluation of the adequacy and timeliness of the information received from the field, and how that information is used to help control TDG supersaturation and high water temperature in the Columbia River basin. Information on the performance of the instruments (including accuracy, precision and bias associated with each parameter) and the nature and extent of instrument failures will be documented. This summary should include statistics on data confidence limits. Division staff will prepare the Annual TDG Monitoring Report based on field input, other material provided by each District, and recommendations by the WQT. This report will also contain suggestions and recommendations to improve the quality of the data during the FY2005 monitoring program.

4.8 Phase 8: Special Field Studies

As provided for in Phase 3, additional monitoring of dissolved gas saturation will be conducted on an as-needed basis. The current plan for additional monitoring includes:

Bonneville Tailwaters: The Corps plans on operating a TDG FMS at the Turtle Rock site on Bradford Island with the intent of evaluating the influence of newly constructed fish passage facilities on TDG levels. Additional spot monitoring during use of the new facilities may occur on an as-needed basis.

The Dalles Tailwaters: The current location of the TDG FMS is inconsistent with other tailwater sites in the system and is inconsistent with the site specified in the Lower Columbia River TDG TMDL. The Corps will investigate alternative sites for TDG monitoring during the 2004 spill season.

McNary Forebay: The Corps plans on operating two additional monitors in the McNary Forebay. One will be located near the upstream end of the navigation lock guide wall at a depth of 15 meters. The second will be locate a second monitor on a float at the Boat Restricted Zone (BRZ) on the Oregon side of the forebay. Data from these sites will be compared to data from the existing TDG FMS to determine whether site relocation is recommended.

Lower Snake River Projects: A second TDG gauge will be operated in the forebays of all four of the Lower Snake River projects at a depth of 15 meters. The extra monitor at

Lower Granite will be at the same site as the current FMS but just at a lower depth. The extra monitors at the other three projects will be at a different location.

5.0 COOPERATION WITH PARTICIPATING AGENCIES

The Bureau of Reclamation, Douglas County PUD, Chelan County PUD, and Grant County PUDs currently monitor for total dissolved gases at their mainstem projects and have maintained a cooperative effort with the Corps in collecting and reporting total dissolved gas and related water quality parameters. It is expected that this cooperation will extend through the 2004 spill season. Idaho Power Company is believed to have been collecting some TDG information in the Hells Canyon Complex for use in numerical modeling for FERC re-licensing efforts. However, this information has not been as widely disseminated as the data from the rest of the TDG monitoring network. Following are the action plans for the cooperating agencies.

Bureau of Reclamation. Bureau of Reclamation TDG monitoring will continue at International Boundary and the Grand Coulee forebay and tailrace, and the Hungry Horse sites in 2004. Hourly data transmission to CWMS will continue via the GOES satellite.

Douglas County PUD. TDG monitoring will continue at the forebay and tailrace of Wells Dam in 2004. Hourly data from both of these stations will continue to be sent to the Corps.

Chelan County PUD. The physical monitoring of TDG to be conducted in 2004 will be very similar to the monitoring conducted from 2000 to 2003. Chelan will continue to monitor TDG in the forebay and tailrace of both Rocky Reach and Rock Island Dams. The PUD will continue to use Common Sensing monitors in the forebay and Hydrolab Datasonde 4s in the tailrace. Data will continue to arrive to the Corps hourly, and efforts will be made to repair malfunctioning probes within 48 hours. Monitoring instruments will be calibrated every three to four weeks or as necessary. Chelan will also continue to conduct weekly transects in the tailraces of both projects to validate the locations of the tailrace monitors and may institute some forebay transects to verify that forebay readings are representative of the conditions in the river at large.

Public Utility District No. 2 of Grant County (Grant PUD). Grant PUD currently operates and maintains four-fixed site water quality stations that continuously monitor (24 hours - year-round) total dissolved gas (TDG), temperature (°C), dissolved oxygen (DO; mg/l), pH (units), and turbidity (NTUs). Fixed site monitors are located midway across the river channel in the forebay and tailrace of each dam. Grant PUD also maintains a fixed site monitoring station located in the Rock Island Dam tailrace from September 1 through April 1 (of each year). The Public Utility District No.1 of Chelan County operates and monitors this site the remaining part of the year (during spring and summer spill seasons) as part of their water quality data collection requirements.

Each fixed site water quality monitoring station is equipped with a Hydro-Lab Corporation Model DS4A®, DS4® or Minisonde® multi-probe enclosed in a submerged

conduit. Multi-probes are connected to an automated system that allows Grant PUD to monitor TDG, temperature, DO, pH and turbidity on an hourly basis (year-round). A barometer is located at each fixed site and provides the atmospheric pressure readings necessary to correct the partial pressure readings taken by the Hydro-Lab multi-probes.

All locations are connected to an automated system that allows Grant PUD to monitor water quality data on an hourly basis. Data is collected and recorded onto a Sutron 8210 data collection platform (DCP) at the top of hour. A PCBase2 operating system transmits hourly water quality data via radio/antenna links to a PC at each dam. Data is transferred from the PC to an Access database from which daily reports can be generated and distributed.

Multi-probe calibration and maintenance for fixed monitoring sites follow established guidelines by USGS (Personnel communication, D. Tanner) and Hydro-Lab Corporation. Fixed site multi-probes are exchanged bi-weekly with a previously calibrated (12-72 Hours) probe. Calibration is conducted in a controlled laboratory environment using certified equipment and recommended standard solutions. A secondary probe (QA) is deployed at each site for quality control/analysis assurance during maintenance and calibration. The QA probe is used to monitor probe sensor deviation and suggest future deployment or re-calibration maintenance.

Grant PUD currently posts total dissolved gas, temperature, discharge (kcfs), spill (kcfs) and spill percentage (%) data to its web-site (www.gcpud.org/stewardship/waterquality.htm) on a daily basis. The data presented is generally posted by 12:00 pm each day and is from the previous day (1-day lag during week - 3-day lag over weekends). The one-day lag-time is necessary to conduct a QA/QC on all water quality data. Specific details of Grant PUDs fixed site water quality monitors, maintenance and calibration procedures, and quality assurance methods can be reviewed in Grant PUDs Final License Application, License Technical Appendix E-3.F (Duvall and Dresser 2003).

Table 3. List of Contact Persons in 2004

Project	Name	Position	Phone #	E-Mail
Internat'l Bndry., Hungry Horse, Grand Coulee	Dr. Sharon Churchill	FMS Oversight	((509) 754-0254	schurchill@ pn.usbr.gov
	Dave Zimmer	Water Quality Regional Coord.	(208) 378-5088	dzimmer@ pn.usbr.gov
	Jim Doty	Hydromet Data Transmission	(208) 378-5272	jdoty@ pn.usbr.gov
Chief Joseph, Libby	Marian Valentine	Coordinator	(206) 764-3543	marian.valentine@ usace.army.mil
	Kent Easthouse	Oversight	(206) 764-6926	Kent.b.easthouse @usace.army.mil
	Ray Strode	Trouble-shooting	(206) 764-3529	ray.strode@ usace.army.mil
Wells (Douglas)	Rick Klinge	Coordinator	(509) 884-7191	rklinge@dcpud.org
Rocky Reach, Rock Isl.(Chelan)	Waikele (Kelee) Hampton	Coordinator	(509) 663-8121 x 4627	waikele@ chelanpud.org
	Mike Blalock	Data Manager	(509) 669-1732	
Wanapum, Priest Rapids (Grant)	Cliff Sears	Coordinator	(509) 754-6612	csears@ gcpud.org
	Tom Dresser	Data Management, QA/QC, Maintenance and Calibration	(509) 754-5088 Ext. 2312	tdresse@ gcpud.org
Dworshak, Low. Granite, Little Goose, Low. Monumental, Ice Harbor, McNary, Pasco, Anatone	Dave Reese	Coordinator	(509) 527-7283	david.l.reese@ usace.army.mil
	Steve Juul	Oversight	(509) 527-7281	steve.t.juul@ usace.army.mil
	Russ Heaton	Oversight	(509) 527-7282	russ.d.heaton@ usace.army.mil
John Day, The Dalles, Bonne- ville, Warrendale, Skamania,Cama s	Jim Britton	Coordinator	(503) 808-4888	james.l.britton@ usace.army.mil
	Joe Rinella	USGS/Contract Coordinator	(503) 251-3278	jrinella@ usgs.gov
	Dwight Tanner	USGS/Oversight	(503) 251-3289	dqtanner@ usgs.gov
COE Northwest Division Program Coordination	Jim Adams	Coordinator	(503) 808-3938	james.r.adams@ usace.army.mil
	Laura Hamilton	Oversight	(503) 808-3939	laura.j.hamilton@ usace.army.mil

Table 4. 2004 Dissolved Gas Monitoring Network

STATION CODE	STATION NAME	OWNERS	DATES OF OPERATION
CIBW	US/Can Boundary	USBR	Year Round
HGHW	Below Hungry Horse	USBR	April 1 – September 30
FDRW	Grand Coulee Forebay	USBR	Year Round
GCGW	Grand Coulee Tailwater	USBR	Year Round
ALFI	Albeni Falls Forebay	COE – NWS	April 1 – September 15
ALDI	Albeni Falls Tailwater	COE – NWS	April 1 – September 15
LBQM	Libby Tailwater	COE – NWS	April 1 – September 15
CHJ	Chief Joseph Forebay	COE – NWS	April 1 – September 15
CHQW	Chief Joseph Tailwater	COE – NWS	April 1 – September 15
WEL	Wells Forebay	DOUGLAS CO.	April 1 – September 15
WELW	Wells Tailwater	DOUGLAS CO	April 1 – September 15
RRH	Rocky Reach Forebay	CHELAN CO.	April 1 – August 31
RRDW	Rock Reach Tailwater	CHELAN CO.	April 1 – August 31
RIS	Rock Island Forebay	CHELAN CO.	April 1 – August 31
RIGW	Rock Island Tailwater	CHELAN CO.	April 1 – August 31 [†]
WAN	Wanapum Forebay	GRANT CO.	Year Round †
WANW	Wanapum Tailwater	GRANT CO.	Year Round †
PRD	Priest Rapids Forebay	GRANT CO.	Year Round †
PRXW	Priest Rapids Tailwater	GRANT CO.	Year Round †
PAQW	Columb. R. Above Snake	COE – NWW	April 1 – September 15
DWQI	Dworshak Tailwater	COE – NWW	Year Round
PEKI	Peck/Clearwater	COE – NWW	April 1 – September 15
LEWI	Lewiston/Clearwater	COE – NWW	April 1 – September 15
ANQW	Upper Snake at Anatone	COE – NWW	April 1 – September 15
LWG	Lower Granite Forebay	COE – NWW	Year Round
LGNW	Lower Granite Tailwater	COE – NWW	Year Round
LGS	Little Goose Forebay	COE – NWW	April 1 – September 15
LGSW	Little Goose Tailwater	COE – NWW	April 1 – September 15
LMN	Lower Monum. Forebay	COE – NWW	April 1 – September 15
LMNW	Lower Monum. Tailwater	COE – NWW	April 1 – September 15
IHR	Ice Harbor Forebay	COE – NWW	Year Round
IDSW	Ice Harbor Tailwater	COE – NWW	Year Round
MCQW	McNary Forebay – WA	COE – NWW	Year Round
MCQO	McNary Forebay – OR	COE – NWW	Year Round
MCPW	McNary Tailwater	COE – NWW	Year Round
JDY	John Day Forebay	COE – NWP	April 1 – September 15
JHAW	John Day Tailwater	COE – NWP	April 1 – September 15
TDA	The Dalles Forebay	COE – NWP	April 1 – September 15
TDDO	The Dalles Tailwater	COE – NWP	April 1 – September 15
BON	Bonneville Forebay	COE – NWP	Year Round
CCIW	Bonneville Tailwater	COE-NWP	April 1 – September 15
WRNO	Warrendale	COE – NWP	Year Round
CWMW	Camas/Washougal	COE – NWP	March 10 – September 15

‡Data for 1 Sep to Mar 31 available at the Grant Co. Website
<http://www.gcpud.org/stewardship/waterquality.htm>

† Data located at Grant Co. Website.

All other data located at <http://www.nwd-wc.usace.army.mil/tmt/>

USBR= U.S. Bureau of Reclamation

COE = Corps of Engineers, NWP= Portland District, NWS= Seattle District, NWW=
Walla Walla District

