WATER QUALITY MONITORING PLAN

EMERGENCY DROUGHT BARRIER

Version April 24, 2015

California Department of Water Resources

Problem Statement

The Department of Water Resources (DWR) determined that data from a network of water quality and flow stations is needed to assess how the emergency drought barrier (Barrier) shown on Figure 1 will affect flow, water quality, and biological constituents in the west, central, and north Delta. DWR staff created a GIS map (accessible at: http://bit.ly/1kPdKtI) that shows all of the current monitoring locations in the Delta, along with what constituents are monitored at each location. The map shows there is an extensive network of DWR and United States Geological Survey (USGS) continuous water quality and flow stations in the central and north Delta. After assessing the current monitoring programs in the Delta, DWR staff determined there were gaps in the existing monitoring network with respect to the proposed drought barrier location, especially in the west and north Delta. New water quality and flow stations, and additional parameter monitoring is needed to augment the existing network. Figure 2 shows the existing and proposed stations that will be used to monitor the drought barrier effects on water quality and flow conditions (see table 1 for station names). Data from these stations will also be used to assess compliance with permit requirements and to refine hydrodynamic and water quality models that can be used to improve planning for future drought responses. DWR and USGS plan to monitor the flow and water quality constituents outlined in this plan from May 1, 2015 through May 1, 2016. A new monitoring plan will be drafted next year if drought conditions continue beyond May 1, 2016 and monitoring would be beneficial.

Background - Hydrodynamics

Flows into the Sacramento-San Joaquin Delta are dominated by four main influences: Sacramento River/Yolo Bypass, San Joaquin River, eastside rivers (mainly the Mokelumne and Cosumnes Rivers) and the Pacific Ocean (tides). Tidal/seawater flow under the Golden Gate Bridge averages a peak of about 2.3 million cubic feet per second but this tidal energy quickly reduces as it funnels through the Carquinez Strait and disperses into the Delta channels. To counter this energy flow, the Sacramento River and Yolo Bypass, which provides over 75% of the fresh inflow into the Delta, pushes against this tidal force to help repel seawater or salinity intrusion into the Delta. Therefore the Sacramento River plays a significant role in maintaining a high level of water quality in the Delta. Efficiently using the Sacramento River flow to maintain good water quality and a healthy Delta ecosystem year-round are two of DWR’s primary goals.

As the Sacramento River flows past Freeport, some of the flow is diverted into several sloughs before flowing past Rio Vista to converge with the San Joaquin River at Antioch. During normal or below normal water years, there is enough Sacramento River flow throughout the year that natural diversions into Sutter and Steamboat Sloughs will not negatively impact overall Delta water quality. However during successive dry years such as the current situation, significant diversions into Sutter and Steamboat Sloughs from the Sacramento River reduces the amount of fresh water flows entering into the central Delta to repel salinity intrusion from the Bay. The preferred flow path for Sacramento River water is into either the Delta Cross Channel or Georgiana Slough towards the central Delta. Computer model runs have shown that keeping the central Delta as fresh as possible is an effective way to maintain the freshwater/seawater interface west of Antioch. Computer runs have also shown that allowing saline water to make up the majority of water flowing through Franks Tract would drastically reduce the Department’s ability to maintain adequate water quality throughout the Delta.

Figure 1. Emergency Drought Barrier Location

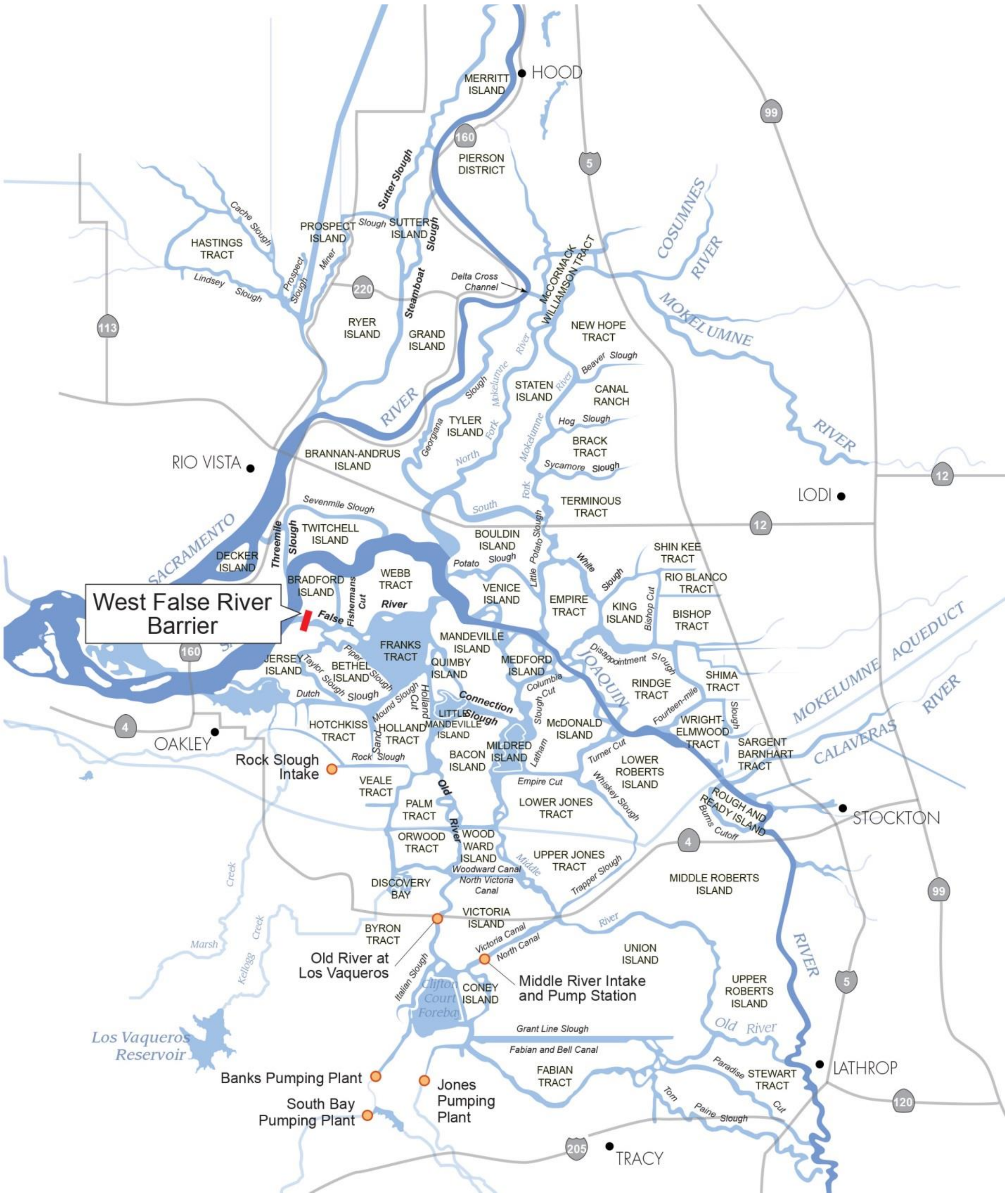
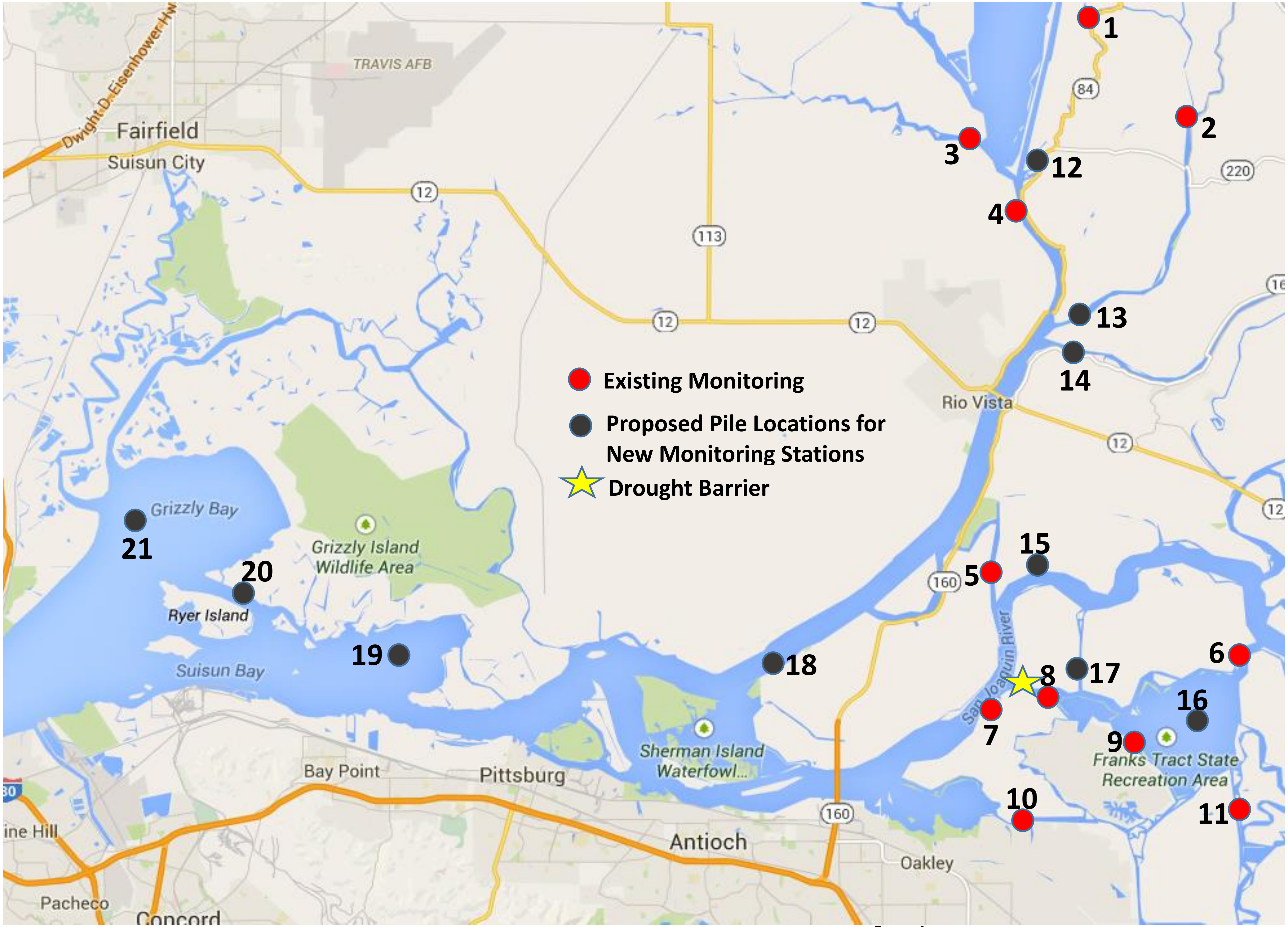


Figure 2. Existing and Proposed Water Quality Monitoring Stations



Installing a drought barrier in the central Delta is an extremely important option available to the Department to address the current drought situation. The West False River barrier would provide a significantly longer path for saline seawater to mix with freshwater before entering into Franks Tract, which will also help keep the central Delta water fresher.

Monitoring Objective

Installing the West False River barrier is projected to maintain overall Delta water quality to acceptable levels. However, this barrier may also produce localized impacts that our computer models may not be able to predict. Therefore DWR believes it is prudent to establish a network of temporary water quality, flow, and water level stations to quantify potential changes near the barrier. This network will:

1. Document changes to local or regional water quality conditions that may be due to the barrier
2. Assist in calibrating and improving computer models
3. Meet monitoring requirements specified in environmental permits

Monitoring – Sampling Locations

DWR will install new temporary water quality monitoring stations as well as augment existing stations in areas that may be impacted by the emergency drought barrier. Water quality and water level instruments will be installed at sites upstream and downstream of the False River barrier to define any localized impacts. (Note: The San Joaquin River at Jersey Point (SJJ) station is about 8/10 of a mile downstream from where the West False River barrier will be installed. SJJ will be used to define conditions immediately downstream of the barrier.) DWR has also proposed a number of new sites in the west, central, and north Delta to monitor the spatial extent of salinity intrusion and the effectiveness of the barrier. The water quality monitoring plan will consist of two components: 1) continuous water quality and flow monitoring, and 2) discrete sampling for chlorophyll and nutrients. See Figures 2 through 4 for the approximate location of the existing and proposed west, central, and north Delta monitoring stations. Tables 1 through 3 provide the name of each monitoring station and the constituents that will be monitored.

Table 1. Existing (1-11) and proposed (12-21) monitoring stations

#	Station Name	Continuous Data (15-minute data)	Discrete data (monthly)	CA Data Exchange Center (CDEC ID)
1	Miner Slough at HWY 84	Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen	N/A	HWB
2	Steamboat Slough below Sutter Slough	Water temperature, specific conductance	***Chlorophyll, nutrients, bromide, organic carbon***	***Station will be telemetered***
3	Liberty Island	Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen	N/A	LIB

4	Cache Slough at Ryer Island	Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen	N/A	RYI
5	Three Mile Slough at San Joaquin River	Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen	Chlorophyll, nutrients, bromide, organic carbon	TSL
6	Old River at Franks Tract near Terminous	Flow, stage, water velocity, water temperature, specific conductance, turbidity, chlorophyll, and dissolved oxygen	Chlorophyll, nutrients, bromide, organic carbon	OSJ
7	San Joaquin River at Jersey Point	Flow, stage, water velocity, water temperature, specific conductance, and turbidity	N/A	SJJ
8	False River	Flow, stage, water velocity, water temperature, specific conductance, turbidity, chlorophyll, and dissolved oxygen	Chlorophyll, nutrients, bromide, organic carbon	FAL
9	Bethel Island near Piper Slough	Water temperature, specific conductance, turbidity, and dissolved oxygen	Chlorophyll, nutrients, bromide, organic carbon	BET
10	Dutch Slough at Jersey Island	Flow, stage, water velocity, water temperature, specific conductance, turbidity	N/A	DSJ
11	Holland Cut near Bethel Island	Flow, stage, water velocity, water temperature, specific conductance, turbidity, and *dissolved oxygen*	Chlorophyll, nutrients, bromide, organic carbon	HOL
12	***Miner Slough***	***Water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
13	***Steamboat Slough***	***Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
14	***Sacramento River at Steamboat Slough***	***Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***

15	***Lower San Joaquin River***	***Water temperature, specific conductance, turbidity, chlorophyll, pH, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
16	***Franks Tract, mid tract***	***Water temperature, specific conductance, turbidity, chlorophyll, pH, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
17	***Fisherman's Cut***	***Flow, stage, water velocity, water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
18	***Sacramento River near Sherman Island***	***Water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
19	***Honker Bay***	***Water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
20	***Grizzly Bay***	***Water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***
21	***Suisun Bay – Cutoff near Ryer***	***Water temperature, specific conductance, turbidity, and dissolved oxygen***	***Chlorophyll, nutrients, bromide, organic carbon***	***Proposed Station – Data will be telemetered***

Monitoring – Continuous Methods

DWR and USGS will collect data for the following constituents in 15-minute intervals at a one meter depth by deploying Yellow Spring Instrument (YSI) 6600 sondes and Acoustic Doppler Current Profilers:

- Water temperature (ºC)
- Dissolved oxygen (mg/L)
- Specific conductance (µS/cm)
- Turbidity (NTU)
- Flow (cfs)
- Stage (ft)
- Velocity (m/s)

YSI 6600 sondes are approximately two feet long and 3-1/2 inches in diameter. They are completely submersible and self-contained, operating on a minimum of nine volts of battery power from eight C-cell alkaline batteries. Deployment data are logged in each sonde's internal memory. For detailed information on YSI instrumentation, visit http://www.ysi.com/index.php.

In addition to the YSI 6600 sondes, field staff will use at least three other field instruments to test the validity of the sonde data:

- YSI-63 handheld unit that measures water temperature, pH, and specific conductance
- YSI Pro-ODO Luminescent Dissolved Oxygen handheld unit to check dissolved oxygen concentrations
- HACH 2100P turbidimeter to measure turbidity

Staff will perform the following two procedures to check whether the sondes are still operating properly and measuring accurately:

- A post-deployment accuracy check on the day the sondes are removed and before the instruments are cleaned.
- A comparison between the data measured by the handheld field instruments and the data collected by the sonde at the closest 15 minute time interval.

The accuracy of sonde probes while deployed in the field can be negatively affected by probe malfunction, drift away from initial calibration, and/or fouling caused by biological growth on the probe reading surface. DWR and USGS staff will perform the post-deployment accuracy check by the following procedure prior to cleaning the sonde probes:

- Placing the sonde probes in fresh calibration standards with known values
- Operating the sondes in the standards and recording the values the sondes are reading
- Rating the values collected during the accuracy check for each constituent as excellent, good, fair, or poor based on their deviation from the calibration standard according to the USGS technical report "Guidelines and Standard Procedures for Continuous Water Quality Station Operation, Record Computation, and Data Reporting"

The ratings obtained from the accuracy check indicate the quality, accuracy, and reliability of the data that the sonde collected while in the field. In addition to the post-deployment accuracy check, DWR and USGS staff will compare the water temperature, specific conductance, dissolved oxygen, and turbidity data measured in the field by the handheld instruments (the YSI-63, YSI Pro-ODO, and HACH 2100P) to the sonde data that is closest in time. While taking the field measurements, DWR and USGS staff will attempt to collect the field readings at the same depth that the sonde probes are measuring at (1 meter) and as close to the sonde pipe as possible. Because the field instruments are calibrated regularly, a large difference between the sonde and field readings could indicate inaccuracy of the sonde data during the deployment period. DWR and USGS staff considers these comparisons between the field and sonde readings and the ratings obtained from the post-deployment accuracy check while assessing data quality when entering the continuous data into a database.

Monitoring – Discrete Methods for Chlorophyll and Nutrients

Sampling of the following constituents will be conducted monthly at the stations listed in Tables 1:

- chlorophyll *a* (µg/L)
- pheophytin *a* (µg/L)
- dissolved ammonia (mg/L as Nitrogen)

- dissolved bromide (mg/L)
- dissolved nitrite + nitrate (mg/L as Nitrogen)
- dissolved organic carbon (mg/L as Carbon)
- dissolved organic nitrogen (mg/L as Nitrogen)
- dissolved orthophosphate (mg/L as Phosphorous)
- total kjeldahl nitrogen (mg/L as Nitrogen)
- total organic carbon (mg/L as Carbon)
- total phosphorus (mg/L as Phosphorus)

DWR staff (only) will collect samples for all the constituents listed above at a 1-meter depth using a Van Dorn water sampler. Water from the container will be used to fill two plastic sampling containers at each site. One of the containers will be used for analysis of chlorophyll *a* and pheophytin *a*, and the other container for the analysis of ammonia, nitrite + nitrate, organic nitrogen, and orthophosphate. All sample bottles must be stored in a cooler that contains ice to preserve the samples at 4 ºC and to keep them out of the sunlight.

After the samples are collected, staff must transport them to a site for water filtration. For the chlorophyll *a* and pheophytin *a* samples, approximately 500 mL of sample water is passed through a 47 mm diameter glass fiber filter with a 1.0 µm pore size at a pressure of 10 inches of mercury. After filtration, the filters are immediately frozen to preserve them for future analysis. The ammonia, nitrite + nitrate, organic nitrogen, bromide, and orthophosphate samples are filtered through a 0.45 µm pore size membrane filter into a half-pint polyethylene bottle. The filtered samples and frozen filters will then be transported to DWR's Bryte Laboratory for analysis. A summary of the lab methods for the nutrients measured are shown in Table 2.

Table 2. Summary of lab methods for the discrete water quality constituents

Constituent	Lab Method[1]
Chlorophyll *a*	Standard Method 10200 H, Spectrometric Determination of Chlorophyll
Pheophytin *a*	Standard Method 10200 H, Spectrometric Determination of Chlorophyll
Dissolved Ammonia	EPA 350.1
Dissolved Bromide	EPA 300.0
Dissolved Nitrite+Nitrite	Modified Standard Method 4500-NO3-F
Dissolved Organic Carbon	EPA 415.1 (D)
Dissolved Organic Nitrogen	EPA 351.2
Dissolved Orthophosphate	Modified EPA 365.1
Total Kjeldahl Nitrogen	EPA 351.2
Total Organic Carbon	EPA 415.1 (T)
Total Phosphorus	EPA 365.4

Additional Discrete Monitoring During Barrier Installation and Removal

Settleable solids and turbidity samples will be collected during the installation and removal of the drought barrier. The purpose of this sampling is to document and monitor changes in suspended particles that may occur during in-water construction activities. Monitoring will occur twice daily, morning and afternoon to document Grab samples from the shore are captured approximately 300 feet upstream and 300 feet downstream of the active construction site.

Settleable Solids – For each test a technician will ensure (1) the sediment is suspended in the sample before transferring 1.00 liters into a graduated lmhoff cone and (2) the cone remains fixed, level, and undisturbed for one hour. The technician will record on a field sheet (1) the time when the sample was captured and (2) the amount of sediment in milliliters that has settled out of suspension.

Turbidity – The technician will use the remaining sample water to take a turbidity meter reading using a Hach 2100P instrument. The technician will ensure (1) the sample bottles are rinsed out at least three times with DI water and (2) the sample bottles are made clear by carefully wiping with a lint free cloth (included in the instrument kit) and two or three drops of oil (also in the instrument kit). The technician will record on a field sheet: (1) the time when the sample was captured (2) the level of turbidity in units NTU (<>) read from the instrument.

RETESTING PROTOCOL

If either test exceeds the following criteria, the field technician will immediately conduct a follow-up test.

Settleable Solids – An accumulation greater than one milliliter per liter

Turbidity – A difference greater than 15 NTU between upstream and downstream samples

If the results of the follow-up test do not meet these criteria, the field technician will notify the Contractor and on-site Project Manager.

Data Availability and Reporting

The continuous data from each central and north Delta station will be posted on the California Data Exchange Center (CDEC): http://cdec.water.ca.gov/. The CDEC codes for new stations will be listed on DWR's Emergency Drought Barrier webpage after the sites are established. DWR staff plan to post monthly water quality data summaries on the webpage. The summaries will be archived when a new summary is posted. Interested parties will have access to all the monthly summaries, so they can view how water quality conditions are changing over time. Chlorophyll and nutrient data will be posted on the webpage as soon as the results are available. Since chlorophyll and nutrient data must be analyzed at a lab, it could take up to a month to get results back. Requests for water quality and flow data that have been checked for accuracy can be emailed to Shaun Philippart at Shaun.Philippart@water.ca.gov.

DWR will complete a final report detailing the localized and regional effects of the drought barrier on water quality. Specific research questions will be postulated in the report, such as "how effective was the barrier in repelling salt water intrusion into the central Delta?" The final version of the report will be complete by January 2017.