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Aquatic Ecology Section
Yolo Bypass Chlorophyll *a* and Phaeophytin *a* Sampling Meta Data
Last updated: August 2016

I. Contact Information

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II. Study Elements and Objectives

Largely supported by the Interagency Ecological Program (IEP), DWR has operated a fisheries and invertebrate monitoring program in the Yolo Bypass since 1998. The project has provided a wealth of information regarding the significance of seasonal floodplain habitat to native fishes. Basic objectives of the project are to collect baseline data on lower trophic levels (phytoplankton, zooplankton, and invertebrate drift), juvenile and adult fish, hydrology, and physical conditions. As the Yolo Bypass has been identified as a high restoration priority by the US Fish and Wildlife Service and National Marine Fisheries Service biological opinions for Delta Smelt (*Hypomesus transpacificus)* and winter and spring-run Chinook Salmon (*Oncorhynchus tshawytscha*), and by California EcoRestore, these baseline data are critical for evaluating success of future restoration projects. In addition, the data have already served to increase our understanding of the role of the Yolo Bypass in the life history of native fishes and its ecological function in the San Francisco Estuary. Key findings include: (1) Yolo Bypass is a major factor regulating year class strength of splittail, *Pogonichthys macrolepidotus* (Sommer et al., 1997; Feyrer et al., 2006; Sommer et al., 2007a); (2) Yolo Bypass is a key migration corridor for adult fish of several listed and sport fish (Harrell and Sommer 2003); (3) it is one of the most important regional rearing areas for juvenile Chinook Salmon (Sommer et al., 2001a; 2005); (4) Yolo Bypass is a source of phytoplankton to the food web of the San Francisco Estuary (Jassby and Cloern 2000; Schemel et al., 2004; Sommer et al., 2004); and (5) Inundation of the Yolo Bypass enhances the quantity and quality of phytoplankton carbon to the downstream estuary (Lehman et al. 2007).

The collection of chlorophyll data is one element of the Aquatic Ecology Section's (AES), Yolo Bypass Fish Monitoring Program conducted under the IEP umbrella. The monitoring of chlorophyll *a* and phaeophytin *a* concentration was initiated to compare seasonal and annual variations in primary production between the Sacramento River channel and the Yolo Bypass, the river's seasonal floodplain (Sommer et al. 2003). The collection of chlorophyll samples is an important element in determining the annual patterns of productivity that support the aquatic food web.

Key findings to date include: (1) Chlorophyll *a* levels were significantly higher in the Yolo Bypass than in the Sacramento River during the winters and springs of 2000-2001, and chlorophyll *a* was inversely related to flow in both systems (Sommer et al. 2004), (2) Chlorophyll *a* is correlated with hydrologic conditions, with highest levels during floodplain drainage, likely due to increased inundation area and water residence time (Schemel et al. 2004), (3) The floodplain enhanced the quality and quantity of phytoplankton carbon available to the aquatic food web, and 14-37% of this biomass was exported to the estuary downstream (Lehman et al. 2008).

III. Study Area and Sample Sites

A. *General Information*

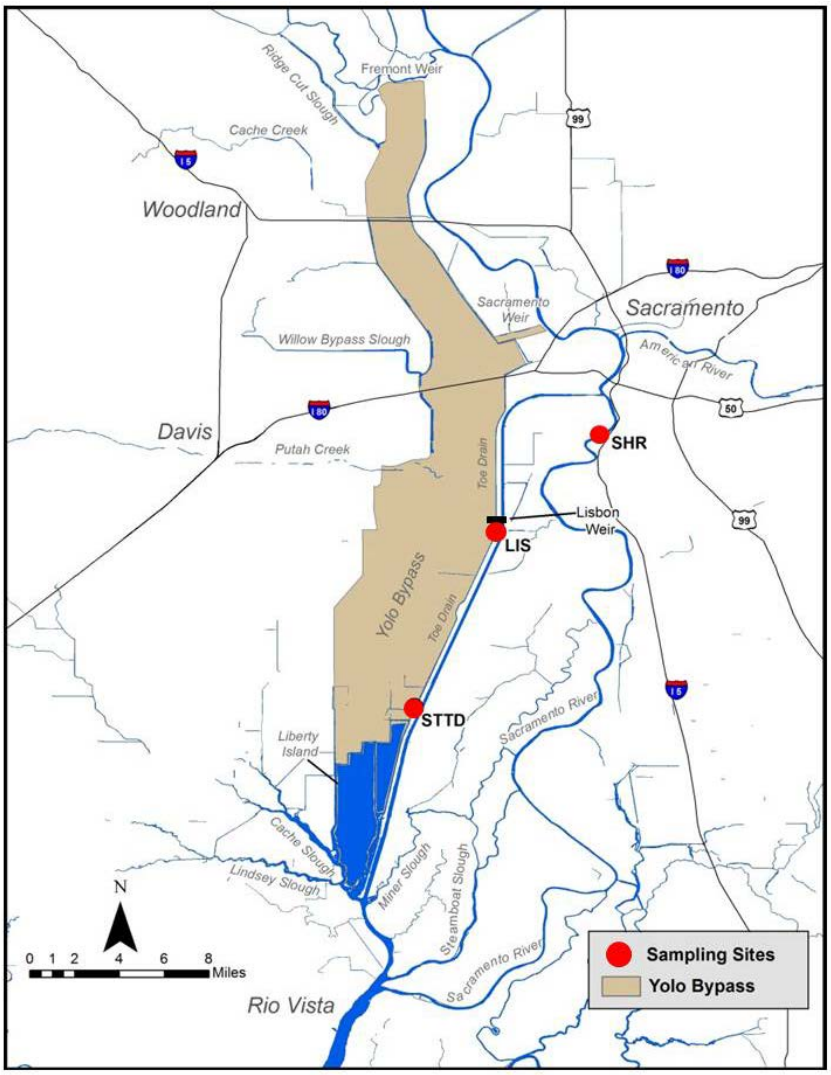
There are three fixed sampling site locations for this study: (1) Toe Drain of Yolo Bypass at our rotary screw trap (STTD), (2) Toe Drain of the Yolo Bypass at Lisbon Weir (LIS), and (3) Sacramento River at Sherwood Harbor (SHR). These sites are currently sampled at least twice monthly on an ebb tide on the same day or within one day of one another. During inundation events, sampling increases to weekly as detailed below.

B. *Name and Location Information of Chlorophyll Sampling* Sites

Currently Sampled Stations

Station	Location	latitude			longitude			Start Year
		degrees	minutes	seconds	degrees	minutes	seconds	
STTD	Yolo Bypass – Toe Drain at Screw Trap	38	21	12.46	121	38	34.71	2001
LIS	Yolo Bypass – Toe Drain at Lisbon Weir	38	28	29.09	121	35	18.94	2013
SHR	Sacramento River at Sherwood Harbor	38	31	56.77	121	31	41.1	2001

Map of Sampling Stations



IV. Period of Record

Chlorophyll monitoring began in 2001 and continues through the present.

V. Sampling Frequency

From 2001-2010, sampling was typically conducted at least once monthly from January through June at two sites: One at the rotary screw trap in the Yolo Bypass Toe Drain (STTD), and the other at Sherwood Harbor in the Sacramento River (SHR). Since 2011, sampling has been conducted at least biweekly (every other week) year-round and weekly during floodplain inundation and drainage events.

Beginning in March of 2013, a sampling site at Lisbon Weir was added to regular chlorophyll sampling. Sampling is conducted at this site at least once monthly year-round. More frequent sampling is conducted up to weekly at LIS and STTD immediately before, during, and immediately after pulsed agricultural drainage flows in the early fall, and during floodplain inundation and drainage events. This data is also collected to validate onsite continuous chlorophyll data (relative florescence units) which is measured using a Yellow Springs Instruments 6600 multi-parameter sonde.

Sampling Frequency by Month and Year

Yolo Bypass Screw Trap at Toe Drain (STTD)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2001	0	4	5	3	4	2	0	0	0	0	1	6	25
2002	7*	2	2	2	3	2	0	0	0	0	0	0*	18
2003	6*	5	3	2	8*	4	0	0	0	0	0	0	28
2004	2*	2*	3*	2	2	1	0	0	0	0	0	0	12
2005	5	3	4	4	2*	2	0	0	0	0	0	0*	20
2006	4*	3*	4*	4*	3*	3	0	0	0	0	0	0	21
2007	0	1	2	2	2	2	0	0	0	0	0	0	9
2008	2	2	2	2	2	2	0	0	0	0	0	0*	12
2009	1	2	2	2	2	2	0	0	0	0	0	0	11
2010	4*	4	3	2	2	0	0	0	0	0	0	0*	15
2011	2*	2	2*	2*	2	3	2	2	2	2	3	2	27
2012	2	2	2	2	3	2	2	2	3	3	2	2*	27
2013	5	4	3	3	2	2	2	2	2	3	1	2	31
2014	3	2	2	2	2	2	1	4	4	5	2	3	32
2015	4	4	7	5	3	6	5	4	2	3	2	2	47
Total	47	42	46	40	42	35	12	14	13	16	10	17	335

*****Months with overtopping at Fremont Weir.

Sacramento River at Sherwood Harbor (SHR)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2001	0	5	4	3	4	2	0	0	0	0	0	0	18
2002	6*	2	2	2	3	2	0	0	0	0	0	0*	17
2003	6*	5	3	2	8*	4	0	0	0	0	0	0	28
2004	1*	2*	3*	2	2	1	0	0	0	0	0	0	11
2005	5	3	4	4	2*	1	0	0	0	0	0	0*	19
2006	3*	3*	4*	4*	3*	3	0	0	0	0	0	0	20
2007	0	2	2	2	2	2	0	0	0	0	0	0	10
2008	2	2	2	2	2	2	0	0	0	0	0	0*	12
2009	1	2	2	2	2	2	0	0	0	0	0	0	11
2010	4*	4	3	2	2	1	0	0	0	0	0	0*	16
2011	2*	2	2*	3*	2	3	2	2	2	2	3	2	27
2012	2	2	2	2	3	2	2	2	2	3	2	2*	26
2013	5	4	3	3	2	2	2	2	2	3	1	2	31
2014	3	2	2	2	2	2	2	3	2	2	2	3	27
2015	4	4	6	5	4	4	5	5	2	2	2	2	45
Total	44	44	44	40	43	33	13	14	10	12	10	11	318

*Months with overtopping at Fremont Weir

Yolo Bypass at Lisbon Weir (LIS)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2013	-	-	4	3	2	2	2	3	5	6	3	2	32
2014	4	2	2	2	2	2	2	4	4	5	1	3	33
2015	6	4	6	5	3	7	5	2	0	0	1	2	41
Total	10	6	12	10	7	11	9	9	9	11	5	7	106

Number of Sampling Events by Station and by Year

Station	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
STTD	26	18	29	15	20	21	9	12	12	16	27	27	31	26	47	289
SHR	18	17	29	13	19	20	10	12	12	16	27	26	31	27	45	277
LIS	-	-	-	-	-	-	-	-	-	-	-	-	32	33	41	65
Total	44	35	58	28	39	41	19	24	24	32	54	53	94	86	133	631

VI. Field Collection Methods

A. Grab Samples

Chlorophyll/phaeophytin *a* surface grab samples are collected in 1 liter HDPE containers, rinsed with site water prior to water collection. The container is filled to the top, leaving as little air space as possible. When there is sufficient flow (typically from January – June), samples are collected during the ebb tide from the rotary screw trap anchored in the middle of the channel and Sacramento River/Sherwood Harbor samples are taken dockside. In the absence of sufficient downstream flow, typically from July-Nov., Sacramento River and rotary screw trap samples are taken from a boat moving approximately 2-3 mph near the screw trap or dock. Lisbon Weir samples, regardless of flow, are taken from the flow station walkway nearshore during ebb tide. All samples are immediately placed on wet ice in a cooler until return to the DWR office.

Water quality parameters are recorded when the sample is collected. Temperature (C), electrical conductivity (uS/cm), dissolved oxygen (mg/L), and pH are measured using a YSI 556 Multiprobe System. Turbidity is measured from a water sample collected in a glass vial and later analyzed at the office using a Hach 2100Q Portable Turbidimeter. Secchi depth (cm) is also measured. Other factors including tide stage, weather, and trap condition code are also recorded.

VII. Lab Processing Methods

A. *Chlorophyll/Phaeophytin a Sample Filtration and Preparation for Lab Analysis*

Within 30 minutes of returning to the office, approximately 500ml of each sample is filtered (250 ml is filtered if sample exceeds 30 NTU).

1. Two 47-mm diameter glass-fiber filters with a 1.0 µm pore size are placed on top of each other on the filtration manifold using forceps. There is no up/down orientation to the filter. The filter funnel(s) are attached and checked to see that they are seated correctly. Valves are left in the closed (horizontal) position.
2. The sample water is mixed completely by gently agitating sample bottles. The water to be filtered is measured in a volumetric flask (500 ml) for samples under 30 NTU. If sample turbidity exceeds 30 NTUs, water to be filtered is reduced to 250 ml. Volume is recorded.
3. 1 - 2 ml MgCO3 solution (super-saturated in deionized (DI) water) is added to the sample prior to filtration. This buffers the sample against low pH, which can cause degradation of chlorophyll into pheophytin.
4. The content of the volumetric flask is poured into the filter funnel. The volumetric flask is then rinsed twice with deionized water and contents also poured into the filter funnel.
5. Vacuum pump is turned on. Pressure is set between 7-10 psi (do not exceed 10 psi).
6. The valve is opened and the sample water is filtered through the glass fiber filter, using vacuum suction. Sample is filtered until the rate of flow through the glass fiber filter decreases markedly and most of the sample water has passed through the filter.
7. The inside of the filter funnel(s) is rinsed with DI water.
8. The vacuum pump is run until the filters are mostly dry and then the filter funnels are removed.
9. With the vacuum pump running, the top filter is removed and folded in half with the chlorophyll-side inside, using forceps to avoid loss of sample. Take care to not touch the pigments with the forceps and avoid touching the filter paper with your fingers. If there is any observed discoloration to the bottom filter, both filters are discarded a new water sample is filtered.
10. The chlorophyll sample (filter) is placed into the pre-labeled envelope. The volume of water filtered and the sample time is recorded on the envelope.
11. The envelope and chlorophyll sample are then placed in the freezer or on dry ice immediately.

B. *Sample Analysis (DWR's Bryte Laboratory – STD method 10200H)*

This method is used to determine the level of chlorophyll *a* and the degradation product phaeophytin *a* by UV-Vis spectrometry for the purpose of estimating phytoplankton biomass.

1. Sample Preparation

Once submitted to the lab, the glass fiber filters are cut into small pieces and placed into a round bottom grinding tube. Approximately five to seven ml of 90% aqueous acetone (90% acetone and 10% saturated magnesium carbonate solution) is added to the tube. The sample is ground using a TFE pestle. Care should be taken while grinding so the sample does not become hot due to friction between the pestle and the grinding tube. Once the sample is sufficiently ground, as fine as possible, the sample is transferred to a 15ml glass centrifuge tube with rinses. A final volume of 10ml is desired. Yet with two filters often used to filter a representative 1000ml sample, more than 10ml is sometimes needed to rinse the contents of the grinding tube into the centrifuge tube. Once the sample has been transferred to the centrifuge tube, the sample volume is noted. (The extract volume will be used for final calculation.) Once all of the samples have been ground, they must steep for a minimum of two hours. Place them in a dark cool place.

2. Sample Analysis

Spectrometer is turned on and allowed to warm up for at least a half-hour.

While the instrument is warming up, samples are centrifuged for five minutes at approximately 500G.

Spectrometer is autozeroed. Extraction solution is added to both the reference and sample cells. Cell windows are wiped with a chem-wipe. Reference cell is placed in the rear cell holder in the instrument and the sample cell in the front cell holder. Note: Reference cell is left in the instrument throughout the run except for adding more solution if necessary.

When ready, start button is clicked on at the top left of the main window. Chlorophyll a scan is completed between the wavelengths 750nm and 590nm. When the Start button turns green after the chlorophyll a has been scanned, the instrument is ready for the next scan.

Without removing the sample cell, 170ul of 0.1N hydrochloric acid is added directly to it. After 90 seconds, the start button is activated. While the 90 seconds is counting down, the sample is gently stirred in the cell with a TFE stirring rod. Start button is activated after 90 seconds. This begins the phaeophytin *a* scan between the wavelengths 750nm and 590nm.

When the scan is complete, the sample cell is removed and rinsed three times with acetone. With a 10ml glass syringe with a five-inch stainless steel needle, the needle is inserted into the centrifuge tube and the supernate is pulled up. The needle is removed and a 0.2um solvent resistant nylon filter is placed on the syringe. 5ml is filtered directly into the sample cell. Cell windows are wiped and the cell is replaced in the instrument. Following the steps in running a blank, the samples are run.

3. QA/QC

A blank is run at the beginning of each run; at every five samples and then at the end of the run. There are no standards run with this method. Only blanks and field duplicates.

4. Calculation

The formula included in Standard Methods, Method 10200H, is used calculate the chlorophyll *a* and pheaophytin *a* concentrations.

VIII. Data Management and Quality Assurance/Quality Control

A. Field Data

Field data are collected and recorded onto datasheets by DWR personnel. These data are then entered monthly by DWR personnel into an Access database. Field data are subsequently reviewed by a second staff member for accuracy and completeness. Annually, after all samples are processed for the year, lab data are reviewed for accuracy and completeness.

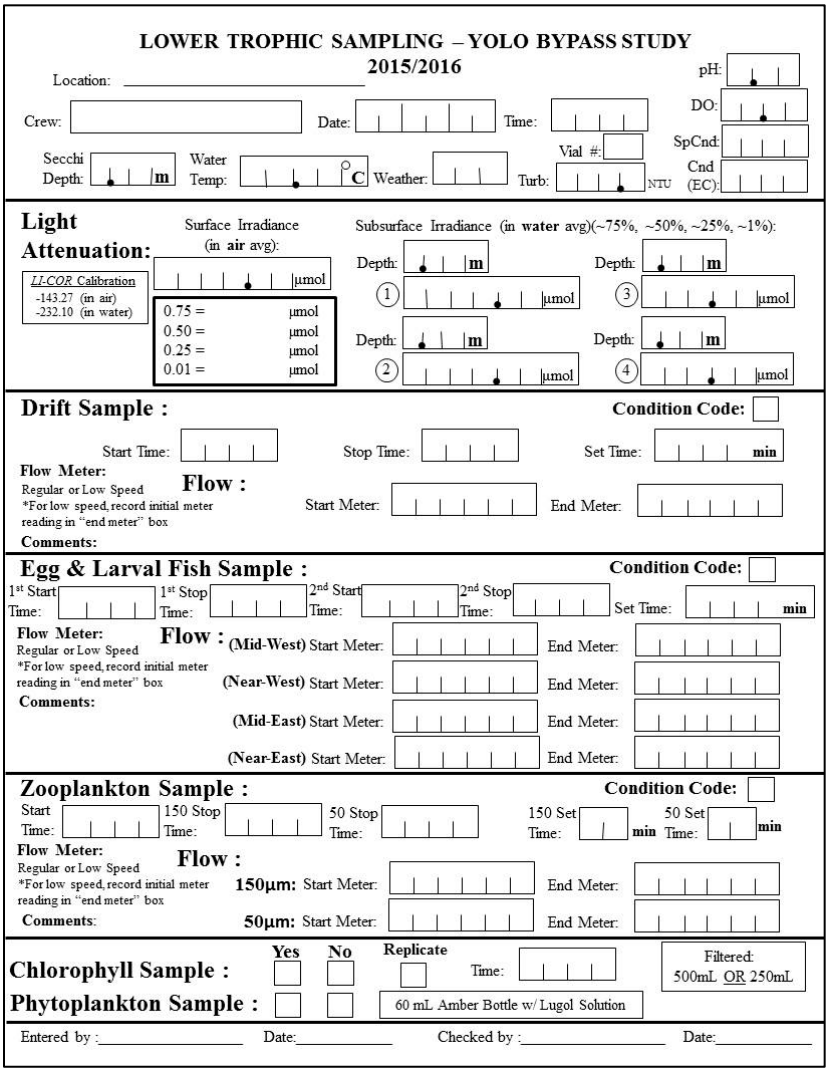
B. Field Datasheet

Paper datasheets are archived in binders, and stored at the West Sacramento, Industrial Blvd. DWR office. Scans are made of datasheets are made annually and stored on a server.

C. Laboratory Data

Laboratory results are received via email from the DWR Bryte Chemical Laboratory, and entered into the AES Access database. Electronic copies of results for laboratory analyses are archived on DWR/AES Network drives. Hard copies are printed and stored in binders at the West Sacramento, Industrial Blvd. DWR office. Data is also archived electronically in the DWR Water Data Library, accessible at: http://www.water.ca.gov/waterdatalibrary/ .

Field Datasheet


LOWER TROPHIC SAMPLING – YOLO BYPASS STUDY
2015/2016

Location: _____ pH: DO: SpCnd: Cnd (EC):

Crew: Date: Time: Vial #:

Secchi Depth: m Water Temp: °C Weather: Turb: NTU

Light Attenuation: Surface Irradiance (in air avg): µmol

LI-COR Calibration -143.27 (in air) -232.10 (in water)

0.75 = µmol
0.50 = µmol
0.25 = µmol
0.01 = µmol

Subsurface Irradiance (in water avg)(~75%, ~50%, ~25%, ~1%):

Depth: m ① µmol Depth: m ③ µmol

Depth: m ② µmol Depth: m ④ µmol

Drift Sample : Condition Code:

Start Time: Stop Time: Set Time: min

Flow Meter: Regular or Low Speed *For low speed, record initial meter reading in "end meter" box

Flow : Start Meter: End Meter:

Comments:

Egg & Larval Fish Sample : Condition Code:

1st Start Time: 1st Stop Time: 2nd Start Time: 2nd Stop Time: Set Time: min

Flow Meter: Regular or Low Speed *For low speed, record initial meter reading in "end meter" box

Flow : (Mid-West) Start Meter: End Meter:
(Near-West) Start Meter: End Meter:
(Mid-East) Start Meter: End Meter:
(Near-East) Start Meter: End Meter:

Comments:

Zooplankton Sample : Condition Code:

Start Time: 150 Stop Time: 50 Stop Time: 150 Set Time: min 50 Set Time: min

Flow Meter: Regular or Low Speed *For low speed, record initial meter reading in "end meter" box

Flow : 150µm: Start Meter: End Meter:
50µm: Start Meter: End Meter:

Comments:

Chlorophyll Sample : Yes No Replicate Time: Filtered: 500mL OR 250mL

Phytoplankton Sample : 60 mL Amber Bottle w/ Lugol Solution

Entered by :_____ Date:_____ Checked by :_____ Date:_____

IX. Chain of Custody and Sample Handling

Following filtration, Chlorophyll/phaeophytin *a* filters containing the samples are folded and placed into an enveloped pre-labeled with the sample date, sample location, and volume of water filtered. The envelope and samples are placed in the freezer or on dry ice (especially if sample is being transported) immediately. Samples

are generally delivered to the DWR Bryte Chemical Laboratory within the week of collection, as samples must be analyzed within 28 days after collection.

A Chain of Custody form is completed for every sample and delivered with the sample to the Bryte Chemical Laboratory. Following Completion of laboratory analysis, Bryte Laboratory personnel make a notation on the Chain of Custody form, and the document is then filed with the analysis report. Copies of the files are maintained in the DWR archives.

Sample Chain of Custody Form

State of California | Department of Water Resources | The Resources Agency

Bryte Chemical Laboratory Chain of Custody

Submittal ID & Run/Submittal Name: ES0216B0012 - Yolo Bypass 2013

Container Summary

Manila Envelope, , Filt		6
Bottle Check: Lab Initials: MC	Field Initials: MF Total:	6

Send Report To: Jared Frantzich
3500 Industrial Blvd.

West Sacramento CA 95691
Activity Unit: 0330

Sampled By:

Instructions to Lab:

Notice: Please deliver samples to the lab as soon as possible. Allow time for lab handling and preparation after delivery. The lab is not responsible for missed holding times due to late delivery. SEE YOUR LAB ANALYSIS GROUPS FOR MINIMUM SAMPLE HOLD TIME. Samples must be transported in accordance with method and handling requirements, on ice and arrive below 6°C if transported overnight.

Submitted By: Signature: [signature] Date Relinquished: 02/10/2016

Print Name: Marijade Farmegia Phone Number: (916) 376-9834

Received By: Signature: [signature] Print Name: Marilyn Carroll

Date and Time Received: 2/10/16 1515 Condition When Received: 0 °C Iced? Yes No

Chlorophyll a - Please indicate one of the following:

Arrived Frozen ☒ Will be frozen by lab w/in required time Not frozen w/in required time Chlorophyll a was not collected

Nutrients - Please indicate one of the following:

Arrived Frozen Will be frozen by lab w/in required time Not frozen w/in required time Nutrients were not collected ☒

Submittal ID: ES0216B0012

DWR Sample Code/ID	Collection Date	Collection Time	EC	Station No.	Station Name	Matrix	Add'l Note	Cost Code	Spectrometric Determination of Chlorophyll	Fld Filtered
ES0216B0070	2/8/2016	10:07	175 µS/cm	A0200000	SHER	Water, Natural		V10041200000		
ES0216B0071	2/9/2016	10:14	781 µS/cm	A0D82120386	Toe Drain at STTD	Water, Natural		V10041200000		
ES0216B0072	2/9/2016	13:40	779 µS/cm	A0D82851352	Toe Drain at Lisbon	Water, Natural		V10041200000		

DWR Sample Code/ID	Collection Date 2/8/2016	Collection Time: 10:07	EC: 175 µS/cm
ES0216B0073	Station No.: A0200000	Station Name: SHER	Matrix: Water, Natural
Add'l Note:		Cost Code:	V10041200000
Spectrometric Determination of Chlorophyll	Fld Filtered		

DWR Sample Code/ID	Collection Date 2/9/2016	Collection Time: 10:14	EC: 781 µS/cm
ES0216B0074	Station No.: A0D82120386	Station Name: Toe Drain at STTD	Matrix: Water, Natural
Add'l Note:		Cost Code:	V10041200000
Spectrometric Determination of Chlorophyll	Fld Filtered		

DWR Sample Code/ID	Collection Date 2/9/2016	Collection Time: 13:40	EC: 779 µS/cm
ES0216B0075	Station No.: A0D82851352	Station Name: Toe Drain at Lisbon	Matrix: Water, Natural
Add'l Note:		Cost Code:	V10041200000
Spectrometric Determination of Chlorophyll	Fld Filtered		

Checklist for Sample Submittal by Field Personnel

- [x] Correct collection dates and times are on the COC.
- [x] An EC result per "Normal" (sample type) collection event has been written on the COC.
- [x] The number of containers being submitted matches the container count on the COC.
- [ ] * Please correct the count if it is not the same and initial the appropriate area to confirm.
- [x] Container label's DWR Sample Code/ID matches what is on the COC.
- [ ] Canceled collection events on still on the COC are crossed out and clearly marked as not sampled "N.S." with your initials.
- [ ] *If the N.S. reason needs to go to the WDL please write the reason on the COC or enter the reason in FLIMS with the "Reason Going to WDL" checkbox checked.
- [x] Volumes for chlorophyll a samples are written on either the label or the packet.
- [x] The "Send Report To:" contact on the COC is correct.
- [x] The "Submitted By:" signature, printed name and phone number are on the COC.
- [ ]

Checklist for Bryte Lab Sample Receiving Personnel

- [x] The DWR Sample Code/ID on the container labels matches the COC.
- [x] Collection dates and times are on the COC for every collection event.
- [x] The EC for every "Normal" collection event is written on the COC.
- [x] The Priority Code for the submittal/samples is 5. If it is >5 alert Bryte management prior to field personnel leaving.
- [x] The volume for chlorophyll samples are written on the packet or label.
- [x] The container count matches COC.
- [x] The container count has been initialed on COC by both parties to confirm.
- [ ] ~~UNF~~ROZEN sample temperature is written on the COC. No Unfrozen samples
- [x] Check the appropriate box on the COC regarding NUTRIENT or CHL A samples that should be frozen OR check the box that says they were not collected.
- [ ] Sites that were not collected are crossed out and clearly marked as not sampled "N.S." with field personnel initials.
- [ ] ~~If the "N.S."~~ reason needs to go to the Water Data Library (WDL) the reason is written on the COC.
- [ ] -- CHECKLIST FOR SAMPLE RECEIVING IN FLIMS (LAB INTERNAL USE ONLY) --
- [x] All applicable EC's are in FLIMS before the project is submitted. Enter parent EC for "Duplicate" or "Replicate" collection events.
- [x] The collection date and time in FLIMS matches the COC.
- [ ] The "N.S." collection events have been canceled in FLIMS.
- [ ] ~~If there is a~~ "N.S." reason written on the COC it is in FLIMS and the "Reason Going to WDL" box is checked.

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