



# **TECHNICAL MEMORANDUM 2-4**

## **Bioaccumulation**

### **Yuba River Development Project FERC Project No. 2246**

May 2012

©2012, Yuba County Water Agency  
*All Rights Reserved*



TECHNICAL MEMORANDUM 2-4

## EXECUTIVE SUMMARY

---

In September, 2011, Yuba County Water Agency (YCWA) collected fish of edible size from its three Yuba River Development Project (Project) impoundments: New Bullards Bar Reservoir on the North Yuba River, Log Cabin Diversion Dam Impoundment on Oregon Creek, and Our House Diversion Dam Impoundment on the Middle Yuba River. Fillets from targeted fish species were analyzed for mercury, selenium, copper, arsenic, and silver and the measured mercury concentrations were compared to the California Office of Environmental Health Hazard Assessment's (OEHHA) Advisory Tissue Levels (ATLs). ATLs are screening values developed by OEHHA to help public health managers decide whether or not to ask OEHHA to evaluate the need for a fish ingestion advisory for water bodies under the manager's jurisdiction (Klasing and Brodberg 2008).

Field sampling and laboratory procedures were consistent with the State Water Resources Control Board's Surface Water Ambient Monitoring Program Bioaccumulation Oversight Group Quality Assurance Project Plan (Bonnema 2007).

A total of 47 edible-sized fish was collected: 10 Kokanee salmon (*Oncorhynchus nerka*), 28 rainbow trout (*O. mykiss*), and 9 smallmouth bass (*Micropterus dolomieu*). All fish were collected during a non-spawning period.

Mercury concentrations in the fish tissues ranged from 0.062 to 0.807 parts per million (ppm)<sup>1</sup> wet-weight; arsenic ranged from less than (<) 0.020 to 0.63 ppm wet-weight; copper ranged from 0.11 to 0.35 ppm wet-weight; selenium ranged from <0.15 to 0.74 ppm wet-weight; and silver ranged from <0.003 to 0.020 ppm wet-weight.

Of the 47 fish collected, fillets from 43 contained mercury concentrations greater than OEHHA's ATL of 0.07 ppm wet-weight:<sup>2</sup> 10 of the 10 Kokanee salmon, 24 of the 28 rainbow trout, and 9 of the 9 smallmouth bass. Mercury concentrations in all nine smallmouth bass collected from New Bullards Bar Reservoir were also greater than OEHHA's ATL of 0.44 ppm wet-weight.<sup>3</sup> These results are consistent with results from previous studies performed within the Project Area.<sup>4</sup>

This study was conducted according to Study 2.4, Bioaccumulation, and Federal Energy Regulatory Commission's September 30, 2011 Study Determination, with one exception. Brown trout (*Salmo trutta*), a species targeted in the Study, was not found in either diversion

---

<sup>1</sup> For consistency and to facilitate comparability, all fish tissue units are presented in parts per million (ppm) for this report.

<sup>2</sup> OEHHA considers advising children and women of child-bearing age to limit their consumption of fish to less than eight meals a month from water bodies found to contain mercury fillets with concentrations greater than 0.070 ppm wet-weight (Klasing and Brodberg 2008).

<sup>3</sup> OEHHA considers advising children and women of child-bearing age to avoid fish all together when mercury fillets are found with concentrations greater than 0.44 ppm wet-weight (Klasing and Brodberg 2008).

<sup>4</sup> The Project Area is defined as the area within the existing FERC Project Boundary and the land immediately surrounding the FERC Project Boundary (i.e., within about 0.25-mile of the FERC Project Boundary) and includes Project-affected reaches between facilities and downstream to the next major water controlling feature or structure.

impoundment. However, rainbow trout were found and mercury concentrations in rainbow trout fillets were determined. YCWA consulted with the SWRCB and it was agreed an additional effort was not needed to collect brown trout from the impoundments; however, if YCWA collected brown trout in the impoundments in 2012 during the relicensing Fish Populations Upstream of Englebright Reservoir Study (Study 3.8), up to nine brown trout from each reservoir would be collected (if 9 are found), their tissue analyzed for mercury, and this Bioaccumulation Technical Memorandum (2.4) would be revised to provide the results of those additional results.

**Table of Contents**  
**Description**

<b>Section No.</b>	<b>Description</b>	<b>Page No.</b>
1.0	Study Goals and Objectives .....	1
2.0	Methods.....	1
2.1	Study Area .....	2
2.2	Sample Collection.....	2
2.3	Sample Analyses .....	3
2.4	Consistency with Human Health Protective Thresholds .....	3
2.5	Quality Assurance and Control.....	4
3.0	Results.....	4
3.1	New Bullards Bar Reservoir .....	6
3.2	Log Cabin Diversion Dam Impoundment.....	7
3.3	Our House Diversion Dam Impoundment .....	7
4.0	Discussion.....	7
4.1	Mercury Fish Tissue Studies Performed by Others in the Project Vicinity.....	10
	4.1.1 New Bullards Bar Reservoir—Mercury in Smallmouth Bass .....	15
	4.1.2 Middle Yuba River—Mercury in Rainbow Trout .....	15
4.2	Surface Water Quality.....	15
5.0	Study-Specific Collaboration and Consultation.....	19
6.0	Variances from FERC-Approved Study .....	19
7.0	Attachments to this Technical Memorandum .....	19
8.0	References Cited .....	20

**List of Figures**

<b>Figure No.</b>	<b>Description</b>	<b>Page No.</b>
4.0-1.	Englebright Reservoir safe eating guideline posted on OEHHA’s web-site. ....	9
4.0-2.	Signage at Lake Wildwood.....	10
4.1-1.	Mercury concentrations measured in fish tissue in the Project Vicinity. ....	14
4.2-1.	Locations in the in the study area where water quality samples were collected by YCWA in 2009. ....	16

**List of Tables**  
**Description**

<b>Table No.</b>	<b>Description</b>	<b>Page No.</b>
2.2-1.	Target fish species, sizes and numbers by location. ....	2
2.3-1.	Analytical methods and reporting limits.....	3
3.0-1.	Yuba River Development Project fish tissue analytical results.....	4
3.1-1.	Range of mercury concentrations in fish tissue by location and species.....	6
4.1-1.	Mercury concentrations measured in fish tissue in the Project Vicinity. ....	11
4.2-1.	Trace metal concentration measured in surface water samples collected within the study area in 2009. ....	18

**List of Attachments**

Attachment 2-4A	Moss Landing Marine Laboratories/California Department of Fish and Game Field Notes [Adobe PDF document: 2 MB, 8 pages formatted to print double sided on 8-½ by 11 inch paper]
Attachment 2-4B	Moss Landing Marine Laboratories/Marine Pollution Studies Laboratories Laboratory Quality Assurance [Adobe PDF document: 174 KB, 10 pages formatted to print double sided on 8-½ by 11 inch paper]
Attachment 2-4C	Moss Landing Marine Laboratories/Marine Pollution Studies Laboratories Fish Tissue Data [Adobe PDF document: 84 KB; 4 pages formatted to print double sided on 8-½ by 11 inch paper]

TECHNICAL MEMORANDUM 2-4

# BIOACCUMULATION<sup>5</sup>

---

## 1.0 Study Goals and Objectives

The goal of this Bioaccumulation Study (Study) was to provide the California Office of Environmental Health Hazard Assessment (OEHHA) the information needed for OEHHA to develop consumption recommendations, if indicated, for targeted fish species in the three impoundments (i.e., New Bullards Bar Reservoir, Our House Diversion Dam Impoundment and Log Cabin Diversion Dam Impoundment), each of which is included in Yuba County Water Agency's (YCWA) Yuba River Development Project, Federal Energy Regulatory Commission (FERC) Project No. 2246 (Project). The request for the information was made by the California State Water Resources Control Board (SWRCB) and California Department of Fish and Game (CDFG).<sup>6</sup>

The objective of the Study was to characterize the concentration of methylmercury in resident, edible-sized sport fish in Project impoundments.

Because the majority of mercury found in fish tissue is methylmercury, in this Study total mercury was measured and was assumed to represent methylmercury concentrations.<sup>7</sup> At the request of the California State Water Resources Control Board (SWRCB), fish tissue was also analyzed for arsenic, copper, selenium, and silver.

## 2.0 Methods

Field sample collection and analyses were performed in a manner consistent with the SWRCB's Surface Water Ambient Monitoring Program (SWAMP) Bioaccumulation Oversight Group's (BOG) *Quality Assurance Project Plan (QAPP) [for the] Screening Study of Bioaccumulation in California Lakes and Reservoirs* (Bonnema 2007). The SWAMP BOG QAPP incorporates the collection methods outlined in the California Environmental Protection Agency's (Cal EPA) *General Protocol for Sport Fish Sampling and Analysis* (Cal EPA 2005) and CDFG's Moss Landing Marine Laboratories - Marine Pollution Studies Laboratory (MLML - MPSL) Method #MPSL-102a for handling of fish (CDFG 2005; Davis et al. 2007). Consistency with the SWAMP BOG QAPP ensured that tissue results would be comparable to SWAMP's ongoing statewide fish tissue sampling campaign (Davis et al 2009; Davis et al. 2010).

---

<sup>5</sup> This technical memorandum presents the results of YCWA's Study 2.4, Bioaccumulation, included in YCWA's September 8, 2011 Revised Study Plan for relicensing of the Yuba River Development Project, and approved by FERC in its September 30, 2011 Study Plan Determination. There were no modifications to Study 2.4 subsequent to FERC's September 30, 2011 Study Determination.

<sup>6</sup> OEHHA has not actively participated (i.e., attended any meetings, filed any letters with YCWA or FERC, or specifically requested that this Study be performed).

<sup>7</sup> Of the total amount of mercury found in fish muscle tissue, methylmercury comprises more than 95 percent (ATSDR 1999; Bloom 1992).

## 2.1 Study Area

The study area consisted of 1) New Bullards Bar Reservoir, 2) Our House Diversion Dam Impoundment, and 3) Log Cabin Diversion Dam Impoundment.

## 2.2 Sample Collection

OEHHA requires collection and analysis of at least nine individual fish of each species at a waterbody to develop a consumption recommendation for that species (OEHHA 2009). Hence, nine sport fish of each species, of edible size as defined in Cal EPA (2005), were targeted for collection (Table 2.2-1). Resident salmonid species (Family Salmonidae) and smallmouth bass (*Micropterus dolomieu*) were the target species for New Bullards Bar Reservoir. Rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) were the fish of interest in the diversion impoundments.

**Table 2.2-1. Target fish species, sizes and numbers by location.**

Sampling Location <sup>1</sup>	Species	Fish Targeted		Fish Collected	
		Target Number of Fish for Collection <sup>2</sup>	Edible Size <sup>3</sup> (minimum total length, in mm)	Actual Number of Fish Collected	Total Length (range, in mm) <sup>4</sup>
<b>NEW BULLARDS BAR RESERVOIR</b>					
New Bullards Bar – East Arm near the Willow Creek inlet	Rainbow trout <sup>5</sup>	9	≥200 <sup>6</sup>	10	282-339
	Kokanee salmon <sup>5</sup>	9	≥200	10	252-298
New Bullards Bar – North Arm near the North Yuba River inflow	Smallmouth bass	9	≥305	9	306-370
<b>OUR HOUSE DIVERSION DAM IMPOUNDMENT</b>					
Log Cabin Diversion Dam Impoundment	Rainbow trout	9	≥200	9	214-326
	Brown trout	9	≥200	0	-- <sup>7</sup>
<b>LOG CABIN DIVERSION DAM IMPOUNDMENT</b>					
Our House Diversion Dam Impoundment	Rainbow trout	9	≥200	9	235-276
	Brown trout	9	≥200	0	--

<sup>1</sup> Fish were collected over one or two visits.

<sup>2</sup> OEHHA 2009

<sup>3</sup> Appendix I of Cal EPA 2005

<sup>4</sup> mm indicates millimeters

<sup>5</sup> Kokanee salmon (*O. nerka*) and rainbow trout (*O. mykiss*) are the fish species most routinely sought by fishermen in New Bullards Bar. (Brady, pers. comm. 2010)

<sup>6</sup> ≥ indicates more than

<sup>7</sup> -- indicates not applicable because brown trout were not found at this site by CDFG's MLML - MPSL staffs' field collections on September 20, 2011

Field notes are provided as Attachment 2-4A. CDFG staff from MLML - MPSL collected fish for the study on September 19 and 20, 2011, during a non-spawning period when the target species were expected to be available. Fish were collected by electroshocking or gill netting over one or two visits. For each fish collected, the following attributes were recorded: species; total length or fork length in millimeters (mm), as appropriate; and weight in grams (g). Electroshock and gill net sites were recorded using a hand-held Global Positioning System (GPS) unit.



Consistent with SWAMP BOG QAPP, clean nylon nets and polyethylene gloves were used during fish collection. Fish were kept live until the proper number of fish per species had been collected. As specified in the SWAMP BOG QAPP, fish were then wrapped in tin foil, inserted into zipper-closure bags, and placed immediately on ice for delivery to the Moss Landing Marine Laboratories.

## 2.3 Sample Analyses

Sample preparation and analysis was consistent with the guidance provided in Cal EPA (2005) and Method #MPSL-102a (Table 2.3-1).

**Table 2.3-1. Analytical methods and reporting limits.**

Metal	Analytical Method	Reporting Limit (µg/g wet-weight) <sup>1</sup>
Mercury	US EPA <sup>2</sup> 7473	0.01
Arsenic	US EPA 200.8	0.30
Copper	US EPA 200.8	0.20
Selenium	US EPA 200.8	0.40
Silver	US EPA 200.8	0.01

<sup>1</sup> µg/g = micrograms per gram or parts per million (ppm)

<sup>2</sup> US EPA = United States Environmental Protection Agency

At the laboratory, each individual fish was prepared for muscle tissue analysis (i.e., filleted each fish) and then analyzed the muscle tissue (i.e., without skin) for mercury (total) by the United States Environmental Protection Agency (US EPA) Method 7473 *Mercury in Solids and Solutions by Thermal Amalgamation, and Atomic Absorption Spectrophotometry* (US EPA 1998). Muscle tissue (i.e., fillet) was also analyzed for arsenic, copper, selenium, and silver. Samples were digested using US EPA Method 3052 (Modified) *Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices*, and analyzed using US EPA Method 200.8 (Modified) *Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry* (US EPA 1996; USEPA 1994).

## 2.4 Consistency with Human Health Protective Thresholds

OEHHA's Advisory Tissue Levels (ATLs) are California's current screening values for determining the potential impairment of a body of water due to the presence of pollutants in fish tissue (Davis et al. 2009). Results of mercury analyses were compared to OEHHA's most protective ATLs (Klasing and Brodberg 2008):

- An ATL of 0.070 parts per million (ppm) mercury wet-weight is the concentration at which OEHHA would begin to consider advising children and women of child-bearing age to limit consumption to fewer than eight meals per month.
- An ATL of 0.44 ppm wet-weight is the concentration at which OEHHA may recommend no consumption by children and women of child-bearing age.

By way of comparison, OEHHA’s ATL for an adult male ingesting one serving of fish per week is 0.44 ppm to 1.3 ppm wet-weight.

As required by the Study, concentrations of arsenic, copper, selenium and silver were also measured in fish tissue. However, consistency of these metal results with human health or other criteria/objectives/thresholds is not part of the Study and is, therefore, not discussed in this technical memorandum.

## 2.5 Quality Assurance and Control

Field and laboratory quality assurance was ensured by following standard protocols, consistent with the SWRCB SWAMP BOG QAPP *Screening Study of Bioaccumulation in California Lakes and Reservoirs* (Bonnema 2007). Laboratory quality assurance and quality control documentation is provided as Attachment 2-4B.

## 3.0 Results

The goal of collecting nine fish of two or three different target species from each reservoir (i.e., 18-27 fish per reservoir) was met for New Bullards Bar Reservoir, but not for the two smaller diversion impoundments (Table 2.2-1). On September 19 and 20, 2011, CDFG MLML - MPSL staff collected 10 rainbow trout, 10 Kokanee salmon, and 9 smallmouth bass from New Bullards Bar Reservoir; 9 rainbow trout from the Our House Diversion Dam Impoundment; and 9 rainbow trout from the Log Cabin Diversion Dam Impoundment. CDFG staff did not find brown trout, a target species for the diversion impoundments, in either Our House or Log Cabin diversion dam impoundments.

Analytical results are provided in Table 3.0-1. Mercury concentrations provided in bold text are greater than the mercury ATL of 0.070 ppm wet-weight identified in Section 2.4.

**Table 3.0-1. Yuba River Development Project fish tissue analytical results.**

Species	Date Collected	Total Length (mm) <sup>1</sup>	Fork Length (mm)	Weight (grams)	Percent Moisture	Mercury <sup>2</sup>	Arsenic	Copper	Selenium	Silver
						(ppm wet-weight) <sup>3</sup>				
<b>NEW BULLARDS BAR RESERVOIR</b>										
Rainbow trout	9/19/11	319	297	260	78.2	<b>0.106</b>	0.04	0.16	0.44	<0.003 <sup>4</sup>
		339	326	276	80.7	<b>0.085</b>	0.16	0.12	0.31	<0.003
		297	277	204	77.8	0.068	<0.02	0.14	0.21	<0.003
		314	296	277	77.9	<b>0.096</b>	0.02	0.22	0.32	<0.003
		301	281	217	79.0	<b>0.099</b>	<0.02	0.16	0.21	<0.003
		296	274	219	77.4	<b>0.114</b>	0.04	0.19	0.38	0.016
		289	271	206	77.8	<b>0.143</b>	0.02	0.18	0.18	<0.003
		311	286	238	76.9	<b>0.101</b>	0.03	0.16	0.50	0.006
		318	297	245	78.4	<b>0.128</b>	0.02	0.15	0.32	<0.003
		282	260	178	77.8	<b>0.110</b>	<0.02	0.16	0.32	<0.003

**Table 3.0-1. (continued)**

Species	Date Collected	Total Length (mm) <sup>1</sup>	Fork Length (mm)	Weight (grams)	Percent Moisture	Mercury <sup>2</sup>	Arsenic	Copper	Selenium	Silver
<b>NEW BULLARDS BAR RESERVOIR (continued)</b>										
Kokanee salmon	9/19/11	268	247	180	76.6	<b>0.141</b>	0.03	0.28	0.30	<0.003
		298	272	230	76.2	<b>0.108</b>	0.03	0.29	0.40	<0.003
		257	231	166	74.7	<b>0.097</b>	0.02	0.34	0.33	<0.003
		271	244	172	76.1	<b>0.102</b>	0.02	0.27	0.53	<0.003
		264	239	179	77.8	<b>0.083</b>	0.04	0.35	0.39	0.020
		259	232	169	74.3	<b>0.109</b>	0.02	0.29	0.37	<0.003
		274	247	216	74.8	<b>0.167</b>	0.04	0.35	0.36	<0.003
		263	239	183	76.7	<b>0.114</b>	0.04	0.34	0.49	<0.003
		252	225	162	74.2	<b>0.075</b>	0.07	0.31	0.46	<0.003
		259	234	162	76.3	<b>0.126</b>	0.06	0.28	0.43	<0.003
Smallmouth bass	9/19/11	306	284	265	78.7	<b>0.446</b>	0.03	0.11	0.24	<0.003
		307	286	265	80.3	<b>0.573</b>	0.04	0.12	<0.15	<0.003
		336	317	370	78.8	<b>0.807</b>	0.02	0.12	0.27	<0.003
		334	314	370	79.4	<b>0.550</b>	0.03	0.11	0.51	<0.003
		316	294	335	79.5	<b>0.770</b>	0.03	0.14	0.17	0.014
		327	308	350	79.4	<b>0.644</b>	0.04	0.15	0.39	<0.003
		349	326	505	76.3	<b>0.582</b>	0.03	0.16	<0.15	0.005
		350	327	455	78.3	<b>0.603</b>	0.02	0.11	0.29	<0.003
370	348	550	77.6	<b>0.604</b>	0.02	0.11	<0.15	<0.003		
<b>OUR HOUSE DIVERSION DAM IMPOUNDMENT</b>										
Rainbow trout	9/20/11	260	242	155	76.5	0.063	0.31	0.16	<0.15	<0.003
		246	229	139	77.3	<b>0.090</b>	0.62	0.21	0.74	<0.003
		235	221	123	76.6	<b>0.075</b>	0.14	0.23	<0.15	<0.003
		251	238	158	75.9	0.062	0.25	0.23	<0.15	0.019
		276	261	198	77.4	0.067	0.25	0.23	<0.15	<0.003
		270	255	213	75.2	<b>0.100</b>	0.63	0.25	<0.15	<0.003
		257	243	167	76.6	<b>0.085</b>	0.16	0.12	<0.15	<0.003
		235	220	132	75.4	<b>0.113</b>	0.15	0.26	<0.15	<0.003
		250	233	155	76.5	<b>0.073</b>	0.11	0.23	<0.15	<0.003
<b>LOG CABIN DIVERSION DAM IMPOUNDMENT</b>										
Rainbow trout	9/20/11	293	275	206	76.8	<b>0.114</b>	<0.02	0.19	<0.15	<0.003
		279	267	171	78.3	<b>0.114</b>	0.02	0.18	<0.15	<0.003
		310	291	256	76.7	<b>0.128</b>	<0.02	0.27	<0.15	<0.003
		305	290	247	75.5	<b>0.161</b>	0.05	0.16	<0.15	<0.003
		326	305	288	77.5	<b>0.144</b>	<0.02	0.19	<0.15	<0.003
		214	203	97	76.6	<b>0.073</b>	0.06	0.24	<0.15	0.013
		234	220	123	74.8	<b>0.107</b>	0.15	0.22	<0.15	<0.003
		230	215	120	75.6	<b>0.094</b>	0.06	0.28	<0.15	<0.003
		278	260	181	76.5	<b>0.098</b>	0.02	0.16	<0.15	<0.003

<sup>1</sup> mm indicates millimeters

<sup>2</sup> Mercury concentrations provided in **bold** are greater than the methylmercury ATL of 0.070 ppm wet-weight.

<sup>3</sup> ppm indicates parts per million

<sup>4</sup> Non-detect results were reported as either the numerical method detection limit or reporting limit, as reported by the laboratory, i.e. <0.003

CDFG's MLML - MPSL laboratory's data reports are provided as Attachment 2-4C. A narrative summary of results is provided for each reservoir and diversion below.

### 3.1 New Bullards Bar Reservoir

All three target species were found and collected from New Bullards Bar Reservoir on September 19, 2011 (Table 2.2-1). Mercury concentrations ranged between 0.068 and 0.143 ppm wet-weight in rainbow trout; 0.075 and 0.167 ppm wet-weight in Kokanee salmon; and 0.446 and 0.807 in smallmouth bass (Table 3.0-1; Table 3.1-1). Ten of the 10 Kokanee salmon, 9 of the 10 rainbow trout, and 9 of the 9 smallmouth bass had mercury concentrations greater than the ATL of 0.07 ppm methylmercury wet-weight; a single rainbow trout sample exhibited a mercury concentration less than the ATL. Mercury concentrations in all nine smallmouth bass were also greater than the ATL of 0.44 ppm wet-weight.

**Table 3.1-1. Range of mercury concentrations in fish tissue by location and species.**

Location	Species	Date Samples	Number of fish Sampled	Concentration Range <sup>1</sup>		Average <sup>2</sup>
				(ppm wet-weight) <sup>3</sup>		
<b>NEW BULLARDS BAR RESERVOIR</b>						
New Bullards Bar Reservoir – East Arm near the Willow Creek inlet	Rainbow trout	9/19/11	9	0.068	<b>0.143</b>	<b>0.105</b>
	Kokanee Salmon		10	<b>0.075</b>	<b>0.167</b>	<b>0.112</b>
New Bullards Bar Reservoir – North Arm near the North Yuba River inflow	Smallmouth Bass		10	<b>0.446</b>	<b>0.807</b>	<b>0.620</b>
<b>OUR HOUSE DIVERSION DAM IMPOUNDMENT</b>						
Log Cabin Diversion Dam Impoundment	Rainbow Trout	9/20/11	9	<b>0.073</b>	<b>0.161</b>	<b>0.115</b>
<b>LOG CABIN DIVERSION DAM IMPOUNDMENT</b>						
Our House Diversion Dam Impoundment	Rainbow Trout	9/20/11	9	0.062	<b>0.113</b>	<b>0.081</b>

<sup>1</sup> See Table 3.0-1 for the complete set of results.  
<sup>2</sup> Concentrations in **bold** are greater than the methylmercury ATL of 0.07 ppm.  
<sup>3</sup> ppm indicates parts per million

Arsenic, copper, selenium and silver were also detected in fish tissue (Table 3.0-1). Rainbow trout arsenic concentrations in fillets ranged between non-detect (ND) and 0.16 ppm wet-weight; copper concentrations in fillets ranged between 0.12 and 0.22 ppm wet-weight; selenium concentrations ranged between 0.18 and 0.50 ppm wet-weight; and silver ranged from ND to 0.016 ppm wet-weight.

Kokanee salmon arsenic concentrations in fillets ranged between 0.02 and 0.07 ppm wet-weight; copper concentrations in fillets ranged between 0.27 and 0.35 ppm wet-weight; selenium concentrations ranged between 0.03 and 0.53 ppm wet-weight; and silver ranged from ND to 0.02 ppm wet-weight.

Smallmouth bass arsenic concentrations in fillets ranged between 0.02 and 0.04 ppm wet-weight; copper concentrations in fillets ranged between 0.11 and 0.16 ppm wet-weight; selenium concentrations ranged between ND and 0.51 ppm wet-weight; and silver ranged from ND to 0.014 ppm wet-weight.

### **3.2 Log Cabin Diversion Dam Impoundment**

Rainbow trout, one of the two target species, was collected from Log Cabin Diversion Dam Impoundment on September 20, 2011 (Table 2.2-1). Brown trout, the second of the two target species, was not found. Mercury concentrations in rainbow trout fillets ranged between 0.073 and 0.161 ppm wet-weight (Table 3.0-1; Table 3.1-1). All nine of the rainbow trout had mercury concentrations greater than the ATL of 0.07 ppm methylmercury wet-weight; however all were less than the ATL of 0.44 ppm wet-weight.

Arsenic, copper, selenium and silver were also detected in fish tissue (Table 3.0-1). Rainbow trout arsenic concentrations in fillets ranged between 0.02 and 0.15 ppm wet-weight; copper concentrations in fillets ranged between 0.16 and 0.28 ppm wet-weight; and silver concentrations ranged between ND and 0.013 ppm wet-weight. Selenium was not detected in any fish collected at the method detection limit of 0.15 ppm.

### **3.3 Our House Diversion Dam Impoundment**

Rainbow trout, one of the two target species, was collected from Our House Diversion Dam Impoundment on September 20, 2011 (Table 2.2-1). Brown trout, the second of the two of the target species, was not found. Mercury concentrations in rainbow trout fillets ranged between 0.062 and 0.113 ppm wet-weight (Table 3.0-1; Table 3.1-1). Six of the 9 rainbow trout had mercury concentrations greater than the ATL of 0.07 ppm methylmercury wet-weight; however all were less than the ATL of 0.44 ppm wet-weight.

Arsenic, copper, selenium and silver were also detected in fish tissue (Table 3.0-1). Rainbow trout arsenic concentrations in fillets ranged between 0.11 and 0.63 ppm wet-weight; copper concentrations in fillets ranged between 0.12 and 0.26 ppm wet-weight; selenium concentrations ranged between ND and 0.74 ppm wet-weight; and silver ranged from ND to 0.019 ppm wet-weight.

## **4.0 Discussion**

California's fish ingestion advisory development process is essentially a three step process: 1) with OEHHA's guidance, a public health manager, resource agency, or other entity identifies a potentially impaired waterbody due to the presence of contaminants in fish tissue; 2) if an adequate dataset exists, OEHHA assesses the human health risks posed by the contaminants; and 3) if present, potential risks are communicated to the public.

OEHHA's ATLs are currently California's screening levels for identifying the potential impairment of a body of water due to the presence of pollutants in fish tissue (Davis et al. 2009). In the recent past, mercury in its bioavailable form has been found in fish tissue at concentrations above ATLs and/or other agency screening values,<sup>8</sup> in the North Yuba, the Middle Yuba, the South Yuba, and the lower Yuba rivers (May et al. 2000; OEHHA 2003; CVRWQCB 2009).

---

<sup>8</sup> For example, US EPA's mercury water quality criterion is 0.03 ppm mercury wet-weight (US EPA 2001).

Consequently, the SWRCB has identified as Clean Water Act (CWA) Section (§) 303(d) State Impaired for mercury (SWRCB 2010) the following stream sections in the Project Vicinity:<sup>9</sup>

- New Bullards Bar Reservoir
- Middle Yuba River from Bear Creek to the North Yuba River
- North Yuba River from New Bullards Bar Dam to the confluence with the Middle Yuba River
- Yuba River from the confluence of the North Yuba River and Middle Yuba River to the United States Army Corps of Engineer's (USACE) Englebright Reservoir
- South Yuba River from Lake Spaulding to Englebright Reservoir
- Englebright Reservoir
- Yuba River from Englebright Reservoir to the confluence of the Feather River

Data generated from the Study (Section 3.0) are consistent with historical fish tissue studies performed by others in the Yuba watershed (Section 4.1) and YCWA's 2009 surface water quality sample results (Section 4.2).

Despite having been listed by the SWRCB as being impaired due to mercury contamination, fish consumption recommendations have been developed by OEHHA for only one waterbody in the Project Area<sup>10</sup> - Englebright Reservoir<sup>11</sup> (OEHHA 2009). OEHHA's fish ingestion advisories are risk-based and, in addition to addressing the risk of contaminants, incorporate the health benefits of eating fish. The evaluation requires a statistically significant number of fish (i.e., eight or more of a single species) and the data have to meet quality assurance criteria. Data used to list Project Area waterbodies on the CWA §303(d) State Impaired list did not meet some or all of OEHHA's requirements. In contrast, data generated by this Study are of the quantity and quality required by OEHHA's risk assessors (Section 2.5; Attachment 2-4A, Attachment 2-4B, and Attachment 2-4C).

In the future, should OEHHA determine that fish consumption from Project impoundments poses a human health risk, OEHHA would post a "Safe Eating Guideline" on its web-site.<sup>12</sup> The advisory will be expressed in terms of a recommended number meals per week of a particular fish species that should not be exceeded by a child, woman of child-bearing age, and/or everyone else (Figure 4.0-1). OEHHA does not provide water-side signage, however. As pointed out by the non-government organization, The Sierra Fund (2011), "... *it is currently unclear which entity, agency or department is responsible for posting fish advisories in the field.*" In its 2009-2010 survey of 12 popular fishing spots in the Yuba watershed, The Sierra Fund observed posted fish consumption advisories at only two sites, Englebright Reservoir, as mentioned above, and the privately-owned man-made Lake Wildwood (The Sierra Fund 2011). Englebright Reservoir's fishing advisory was observed at the Joe Miller Recreation Area boat ramp and was

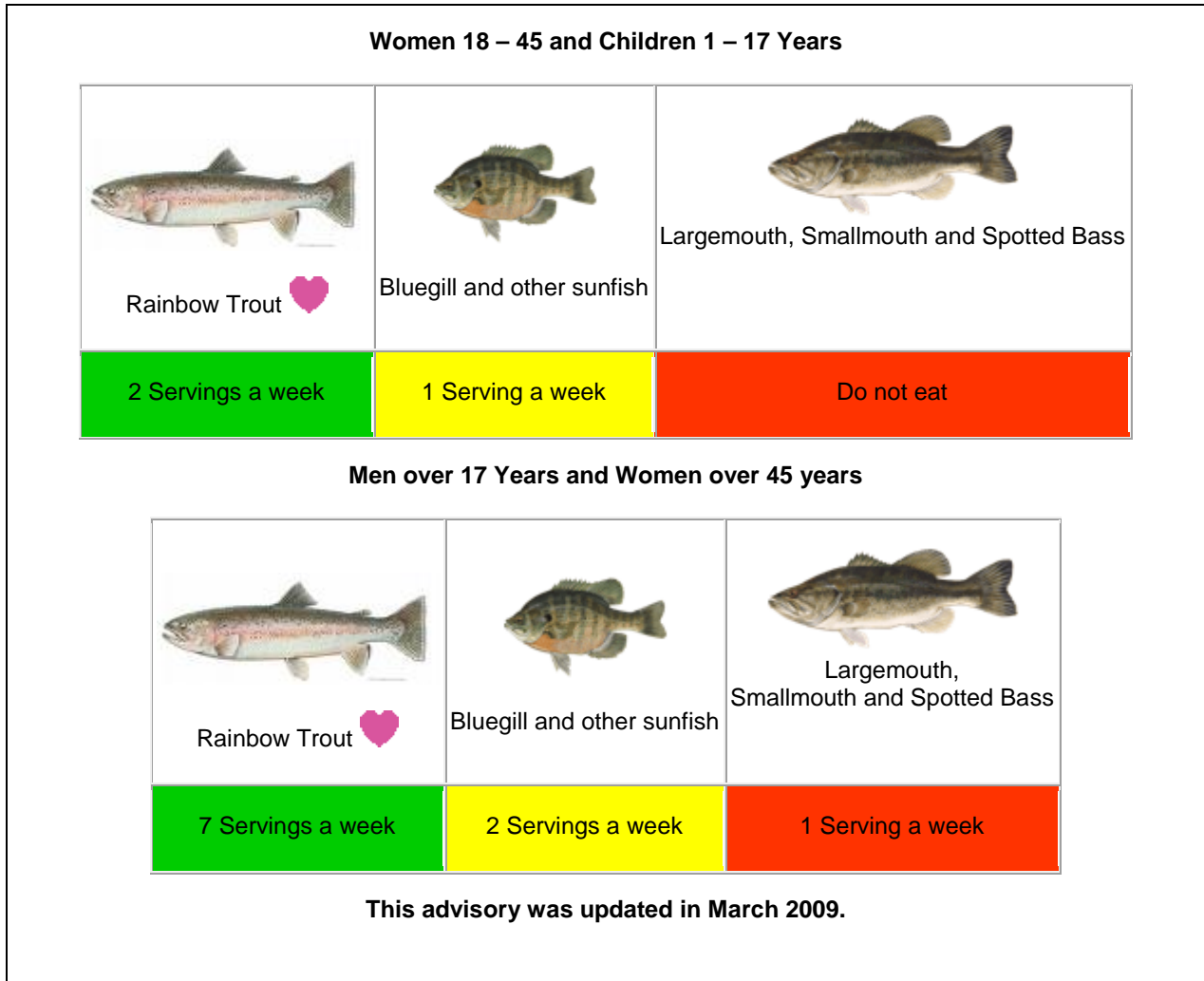
<sup>9</sup> The Project Vicinity is defined as the area surrounding the Project on the order of a United States Geological Survey 1:24,000 topographic quadrangle.

<sup>10</sup> The Project Area is defined as the area within the existing FERC Project Boundary and the land immediately surrounding the FERC Project Boundary (i.e., within about 0.25-mile of the FERC Project Boundary) and includes Project-affected reaches between facilities and downstream to the next major water controlling feature or structure.

<sup>11</sup> Holmberg et al. 2011 discusses of mercury in Englebright Reservoir fish tissue and surface water.

<sup>12</sup> <http://www.oehha.ca.gov/fish.html>

a letter-sized printed black and white sheet on a bulletin board with several other fliers. Erected by the property owners, Lake Wildwood’s signage was observed at the only public access point, near the dam (Figure 4.0-2).



**Figure 4.0-1. Englebright Reservoir safe eating guideline posted on OEHHA’s web-site. (Source: OEHHA 2009)**



Figure 4.0-2. Signage at Lake Wildwood. (Source: The Sierra Fund 2011)

#### 4.1 Mercury Fish Tissue Studies Performed by Others in the Project Vicinity

Since the early 1990's, the Yuba River watershed has been extensively studied by University of California, Davis, and the United States Geological Survey (Alpers et al. 2005; Hunderlach et al. 1999; May et al. 2000; Slotton et al. 1995 *IN* May et al. 2000; and Slotton et al., in preparation *IN* OEHHA 2009). Findings from these studies indicate that: 1) significant amounts of Gold Rush era mercury still exist in sediments, surface water, and fish of the upper Yuba watershed. Sediments are being transported downstream into reservoirs on the Yuba River, where they are largely trapped (Hunderlach et al. 1999; Alpers et al. 2005); and 2) fish tissue concentrations of mercury are greater than human health based criteria at some locations.



Table 4.1-1 summarizes fish tissue data previously collected and analyzed for mercury in the Yuba watershed, including locations sampled for the Study. Locations are mapped in Figure 4.1-1. This information shows that prior to the Study, New Bullards Bar Reservoir’s rainbow trout and Kokanee salmon had not been sampled or analyzed; however, smallmouth bass had been collected on three previous occasions. In addition, prior to the Study, fish tissue had not been collected from Oregon Creek and analyzed for mercury. In contrast, fish had been collected from the Middle Yuba River several times and rainbow trout have been collected from at least three different locations, both upstream and downstream of the Project’s Log Cabin Diversion Impoundment.

**Table 4.1-1. Mercury concentrations measured in fish tissue in the Project Vicinity.**

Sample Location	Species	Number of Fish in Sample	Concentration Range (ppm wet-weight) <sup>1</sup>	Total Length (mm) <sup>2</sup>	Reference
<b>REFERENCE SITES<sup>3</sup></b>					
South Yuba River Near Emigrant Gap	Brown trout	6	0.04–0.06	-- <sup>4</sup>	May et al. 2000
Bear River at Highway 20 (SR 20)	Brown trout	3	0.05–0.1	--	May et al. 2000
<b>UPSTREAM OF THE PROJECT AREA</b>					
North Yuba River near Canyon Creek	Rainbow Trout	5	0.19-0.14 (avg. <sup>5</sup> 0.11)	236 – 311	Slotton et al. 1997
Middle Yuba River 1 mile upstream of Plumbago Road	Rainbow Trout	5	0.05-0.19 (avg. 0.11)	292 – 415	Slotton et al. 1997 <i>IN</i> CVRWQCB 2009
Middle Yuba River upstream of Kanaka Creek (1 mile upstream of Tyler Foote Crossing)	Rainbow Trout	9	0.10-0.24 (avg. 0.16)	210 - 387	
Middle Yuba River just upstream of Oregon Creek and Highway 49	Rainbow Trout	3	0.15-0.21 (avg. 0.18)	204 – 278	
	Sacramento Pikeminnow	2	0.56 and 0.81	321 - 339	
Middle Yuba River 1 mile downstream of the Highway 49 Crossing	Sacramento Pikeminnow	4 (composite)	0.64	≥150 <sup>6</sup>	SWRCB 2002 <i>IN</i> CVRWQCB 2009
South Yuba River below Lake Spaulding	Brown Trout	2	0.07 and 0.07	224 – 249	Slotton et al. 1997 <i>IN</i> CVRWQCB 2009
	Rainbow Trout	3	0.06-0.11 (avg. 0.080)	180 - 228	
South Yuba River at Washington	Rainbow Trout	13	0.10-0.30 (avg. 0.15)	183 – 345	Slotton et al. 1997 <i>IN</i> CVRWQCB 2009
South Yuba River just downstream of Edwards Crossing	Rainbow Trout	2	0.09 and 0.15	182 – 270	May et al. 2000 <i>IN</i> CVRWQCB 2009
South Yuba River near Bridgeport	Smallmouth Bass	3 (composite)	0.069	≥150	SWRCB 2002 <i>IN</i> CVRWQCB 2009
<b>IN THE PROJECT AREA</b>					
Middle Yuba River at Log Cabin Diversion Dam Impoundment	Rainbow Trout	9	0.073-0.161 (avg 0.115)	214-326	Section 3.0
Oregon Creek at Our House Diversion Dam Impoundment	Rainbow Trout	9	0.062-0.113 (avg 0.081)	235-276	Section 3.0
New Bullards Bar Reservoir – East Arm near its confluence with the West Arm	Smallmouth Bass	13	0.22-0.68 (avg. 0.39)	≥150	SWRCB 2002 <i>IN</i> CVRWQCB 2009

**Table 4.1-1. (continued)**

Sample Location	Species	Number of Fish in Sample	Concentration Range (ppm wet-weight) <sup>1</sup>	Total Length (mm) <sup>2</sup>	Reference
<b>IN THE PROJECT AREA (continued)</b>					
New Bullards Bar Reservoir--East Arm near its confluence with the West Arm	Smallmouth Bass	13	0.22 - 0.68 avg 0.39	≥ 150	CVRWQCB 2009
New Bullards Bar Reservoir--East Arm near the Willow Creek inlet	Bluegill	3	0.12-0.39 (avg 0.21)	≥ 150	Melwani et al. 2007 <i>IN</i> CVRWQCB 2009
	Carp	11	0.34-0.83 (avg 0.52)	≥ 150	
	Largemouth Bass	1	0.61	≥ 150	
	Smallmouth Bass	10	0.29-0.72 (avg 0.48)	≥ 150	CVRWQCB 2009
	Carp	6 (composite)	0.61	≥ 150	
	Smallmouth Bass	5 (composite)	0.63	≥ 150	
New Bullards Bar Reservoir – East Arm near the Willow Creek inlet	Rainbow trout	9	0.068-0.143 (avg 0.105)	306-370	Section 3.0
	Kokanee Salmon	10	0.075-0.167 (avg 0.112)	214-326	
New Bullards Bar Reservoir – North Arm near the North Yuba River inflow	Smallmouth Bass	10	0.446-0.807 (avg 0.620)	235-276	Section 3.0
New Colgate Powerhouse Reach, approximately 1.3 miles upstream of USACE’s Englebright Reservoir	Smallmouth Bass	5	0.27 - 0.56 avg of 0.38	≥ 150	CVRWQCB 2009
USACE’s Englebright Reservoir— South Yuba Arm, Hogsback Ravine Arm, and mid-section.	largemouth smallmouth and spotted bass	56	0.45 (mean)	338 (mean)	May et al. 2000 and Slotton et al. 1997 <i>IN</i> CVRWQCB 2001; Slotton et al. in press <i>IN</i> OEHHA 2009
	Bluegill and green sunfish	31	0.30 (mean)	161 (mean)	
	Rainbow trout	49	0.08 (mean)	290 (mean)	
	Carp	1	0.88	440	Slotton et al. 1997
	Hardhead	1	0.47	540	
	Sacramento sucker	5	0.41-0.89	410-523	
USACE’s Englebright Reservoir	Largemouth Bass	Individual fish	0.2 - 1	--	Holmberg 2011 <sup>7</sup>
	Largemouth Bass	composite	0.82 (mean)	--	
	Redear Sunfish	composite	0.25 (mean)	--	
	Black Crappie	composite	0.25 (mean)	--	
Narrows 2 Powerhouse Reach, Lower Yuba River, approximately 2.2 miles downstream of Englebright Dam	Rainbow Trout	9	0.07 - 0.13 avg 0.10	≥ 150	Slotton et al. 1997 in CVRWQCB 2009
Little Deer Creek at Pioneer Park, less than one mile from the confluence with Deer Creek (tributary to Yuba River)	Brown trout	6	0.23 - 0.39 avg 0.32	≥ 150	May et al. 2000; CVRWQCB 2009
<b>DOWNSTREAM OF THE PROJECT AREA<sup>8</sup></b>					
Daguerre Point Dam Reach, Lower Yuba River approximately 0.9 mile upstream of its confluence with the Feather River	Rainbow trout	1	0.02	≥150	SWRCB 2002 <i>IN</i> CVRWQCB 2009
	Sacramento pikeminnow	1	0.46		
	Sacramento sucker	2	0.22 and 0.38		
	Smallmouth bass	4	0.26-0.72 (avg. 0.43)		

**Table 4.1-1. (continued)**

Sample Location	Species	Number of Fish in Sample	Concentration Range (ppm wet-weight) <sup>1</sup>	Total Length (mm) <sup>2</sup>	Reference
<b>DOWNSTREAM OF THE PROJECT AREA<sup>8</sup> (continued)</b>					
Lower Yuba River, approximately 3.6 miles upstream of its confluence with the Feather River	Sacramento pikeminnow	2	0.31 and 1.43	≥150	Davis et al. 2002 <i>IN CVRWQCB</i> 2009
	Sacramento sucker	5 (composite)	0.39		
	Rainbow trout	3	0.08-0.10 (avg. 0.09)	310 (avg.)	Grenier et al. 2007 <i>IN CVRWQCB</i> 2009
	Sacramento pikeminnow	5	0.19-1.58 (avg. 0.84)	≥ 150	
	Sacramento sucker	3	0.11-0.73 (avg. 0.26)	420 (avg.)	

<sup>1</sup> All results are in parts per million (ppm) wet-weight or were assumed to be in wet-weight.

<sup>2</sup> mm indicates millimeters

<sup>3</sup> Identified by the USGS as reference sites in May et al 2000 because location is upstream of mining influences.

<sup>4</sup> -- indicates no data available

<sup>5</sup> ave. indicates average

<sup>6</sup> ≤ indicates less than or equal to

<sup>7</sup> USACE has been collecting fish tissue composite samples and analyzing them for mercury since 2003. When composite sample results exceed USEPA guidelines, individual fish are analyzed. Individual fish concentrations are available for largemouth bass. See Figure 5 of Holmberg 2011.

<sup>8</sup> Additional fish tissue data are available for areas downstream of the Project.

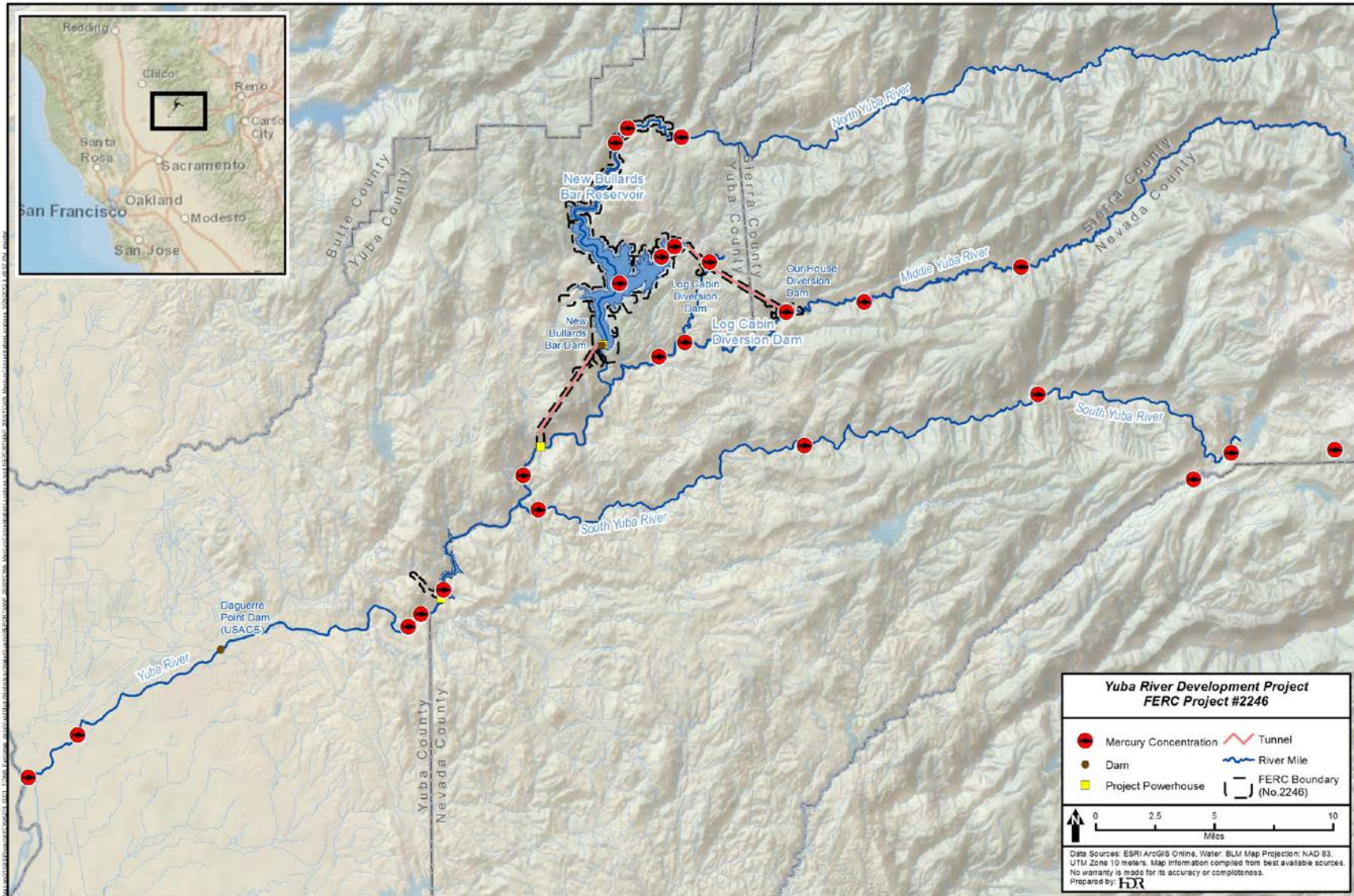


Figure 4.1-1. Mercury concentrations measured in fish tissue in the Project Vicinity.

#### **4.1.1 New Bullards Bar Reservoir—Mercury in Smallmouth Bass**

Smallmouth bass have been collected from New Bullards Bar Reservoir on four different occasions at three different locations: 1) once in the East Arm near the confluence with the Western Arm, 2) twice in the East Arm near the Willow Creek inlet, and 3) once from the North Arm near the North Yuba River inflow (Table 4.1-1). Though fish weights were not available for each case, tissue concentrations were consistently greater than or equal to 0.22 ppm wet-weight in tissue.

Results reported by this Study confirm that mercury is bioaccumulating in smallmouth bass in New Bullards Bar Reservoir and is at concentrations above OEHHA's ATLS.

#### **4.1.2 Middle Yuba River—Mercury in Rainbow Trout**

In 1997, rainbow trout fillets were collected from the Middle Yuba River from three locations: 1) upstream of Kanaka Creek (1 mile upstream of Tyler Foote Crossing); 2) just upstream of Oregon Creek and Highway 49; and 3) 1 mile downstream of the Highway 49 crossing (Table 4.1-1). Though fish sizes and numbers varied, all results were between 0.10 and 0.24 ppm wet-weight mercury and average mercury concentrations from each of these locations were 0.11 ppm wet-weight, 0.16 ppm wet-weight, and 0.18 ppm wet-weight, respectively.

Tissue concentrations collected for this Study are within the same range. Mercury concentrations in Log Cabin Diversion Dam Impoundment rainbow trout ranged between 0.073 and 0.16 ppm wet-weight and averaged 0.12 ppm wet-weight. The results reported by this Study confirm that mercury is bioaccumulating in rainbow trout in the Middle Yuba River and is at concentrations above ATLS.

### **4.2 Surface Water Quality**

In September 2009,<sup>13</sup> YCWA collected surface water samples from 17 locations in the Project Area, eight of which correspond to locations where fish were collected for this Study (Figure 4.2-1; YCWA 2010). Samples were analyzed for 35 analytes including mercury (total), methylmercury (total and dissolved), silver (total and dissolved), copper (total and dissolved), and selenium (total). Surface water samples were sent to Frontier GeoSciences, a California-certified laboratory, for trace metals analyses. Mercury and methylmercury were analyzed at the part-per-trillion level, while arsenic, copper, selenium, silver were analyzed at the part-per-billion level. At these low reporting levels, all mercury (total) concentrations were less than California Toxics Rule aquatic life protective criteria of 0.050 parts per billion (US EPA 2001), while copper, silver, and selenium concentrations were either ND or less than their respective freshwater aquatic-life protective criterion (YCWA 2010).

---

<sup>13</sup> YCWA is augmenting its 2009 water quality dataset in 2012 through relicensing Study 2.3, Water Quality. The three seasons of water quality data will be published in a technical memorandum scheduled to be available in January 2013.

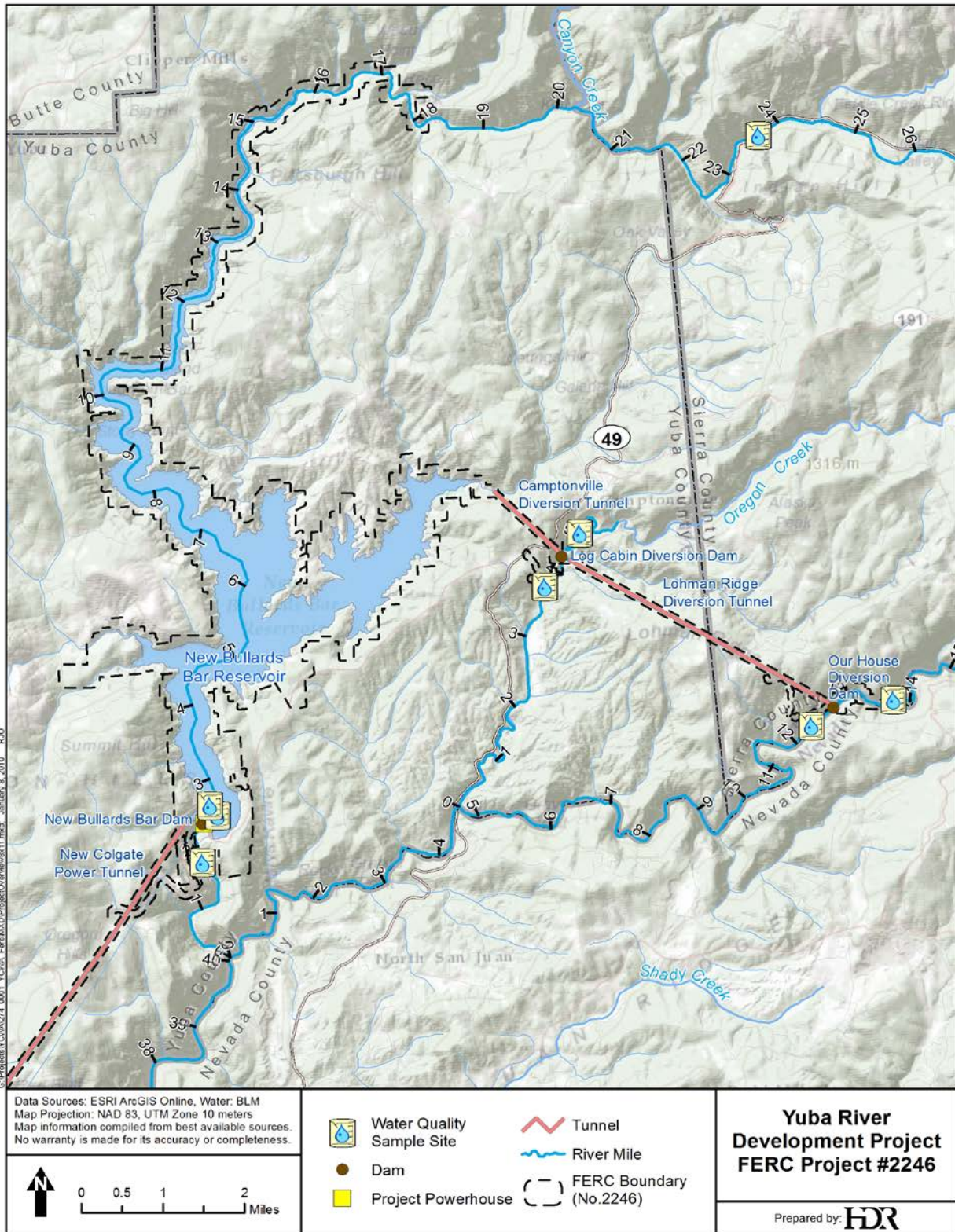


Figure 4.2-1. Locations in the in the study area where water quality samples were collected by YCWA in 2009.

Metals concentration data associated with waters of the Project impoundments are presented in Table 4.2-1. Despite a greater retention time, there is little discernible difference between the water quality within New Bullards Bar Reservoir and the two Project diversion impoundments. The average hydraulic retention time of usable storage within New Bullards Bar Reservoir is approximately 6 months and there is no storage behind the Our House or Log Cabin diversions dams (YCWA 2010). Results essentially hover around the reporting limits of each metal and confirm that surface water sampling can be a poor predictor of whether or not mercury or any other trace metal is bioaccumulating in resident fish.

**Table 4.2-1. Trace metal concentration measured in surface water samples collected within the study area in 2009. (Source: YCWA 2010)**

Analyte	Waterbody	New Bullards Bar Reservoir (North Yuba River)				Our House Diversion Dam Impoundment (Middle Yuba River)		Log Cabin Diversion Dam Impoundment (Oregon Creek)	
	Sample Location	Inflow	Near Dam	Near Dam	Downstream	Near Dam	Downstream	Near Dam	Downstream
	Sample ID	103410-2-1	103410-1-1A	103410-1-1B	103410-2-6	103410-2-2	103410-2-3	103410-2-4	103410-2-5
	Sample Depth	Surface	Surface	Bottom	Surface	Surface	Surface	Surface	Surface
	Date	09/15/2009	09/17/2009	09/17/2009	09/14/2009	09/15/2009	09/15/2009	09/15/2009	09/15/2009
	Units	Result	Result	Result	Result	Result	Result	Result	Result
<b>BASIC WATER QUALITY</b>									
Carbon, Dissolved Organic	mg/L <sup>1</sup>	0.61	1.1	1.1	1.1	0.67	1.2	0.98	0.69
Carbon, Total Organic	mg/L	0.73	1.1	1.2	1.1	0.82	1.4	1.2	0.76
Solids, Total Dissolved	mg/L	70	50	36	51	66	54	92	66
Solids, Total Suspended	mg/L	1.5	1 ND <sup>2</sup>	1 ND	1 ND	1.2	1 ND	4.5	1 ND
Hardness, Total	mg/L	72	38	34	36	75	64	90	79
<b>TOTAL METALS CONCENTRATIONS</b>									
Arsenic	µg/L <sup>3</sup>	4.91	0.39	0.36	0.48	5.42	1.08	4.07	1.01
Copper	µg/L	0.40 Q <sup>4</sup>	0.31 Q	0.41 Q	0.42 Q	0.41 Q	0.41 Q	0.34 Q	0.29 Q
Mercury	ng/L	0.61	0.50 ND	0.82	0.50 ND	0.59	0.71	0.58	0.56
Methyl Mercury	ng/L	0.092	0.050 ND	0.050 ND	0.067 Q	0.096 Q	0.073	0.277	0.077 Q
Selenium	µg/L	0.60 ND	0.60 ND	0.60 ND	0.60 ND	0.60 ND	0.60 ND	0.60 ND	0.60 ND
Silver	µg/L	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND
<b>DISSOLVED METALS CONCENTRATIONS</b>									
Arsenic	µg/L	4.91	0.37	0.36	0.43	5.12	1.08	2.05	1.00
Copper	µg/L	0.51 Q	0.40 Q	0.42 Q	0.43 Q	0.49 Q	0.43 Q	0.37 Q	0.40 Q
Methyl Mercury	ng/L <sup>5</sup>	0.054 ND	0.050 ND	0.050 ND	0.077 Q	0.100 Q	0.050 ND	0.211	0.077 Q
Silver	µg/L	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND	0.020 ND

<sup>1</sup> mg/L indicates milligrams per liter or parts per million (ppm)

<sup>1</sup> ND indicates not detected (value provided is the reporting limit)

<sup>3</sup> µg/L indicates micrograms per liter or parts per billion

<sup>4</sup> Q indicates dissolved or acid soluble concentration is greater than total concentration

<sup>5</sup> ng/L indicates nanograms per liter or parts per trillion



## **5.0 Study-Specific Collaboration and Consultation**

The FERC-approved Study did not require any Study-specific consultation with agencies or other Relicensing Participants.

## **6.0 Variations from FERC-Approved Study**

The Study was conducted following the FERC-approved methods in Study 2.4, Bioaccumulation that was included in YCWA's Revised Study Plan filed with FERC on August 17, 2011 (YCWA 2011), and approved by FERC in its Study Determination on September 30, 2011, with the variance described below.

- The Study required that YCWA collect nine brown trout and nine rainbow trout from both the Our House and Log Cabin diversion dam impoundments and analyze fillets for arsenic, copper, mercury, selenium, and silver. CDFG staff visited the impoundments on September 20, 2011 and collected the target number of rainbow trout at each impoundment, but did not find any brown trout, and suggested an additional effort would not be worthwhile. YCWA consulted with the SWRCB on September 26, 2011 and it was agreed an additional effort was not needed; however, if YCWA collects brown trout in the impoundments in 2012 during the relicensing Fish Populations Upstream of Englebright Reservoir Study (Study 3.8), up to nine brown trout from each impoundment will be collected (if 9 are found), their tissue analyzed for mercury, and the Bioaccumulation Technical Memorandum (2.4) will be revised to provide those additional data.

## **7.0 Attachments to this Technical Memorandum**

This technical memorandum includes three attachments:

Attachment 2-4A	Moss Landing Marine Laboratories/California Department of Fish and Game Field Notes [Adobe PDF document: 2 MB, 8 pages formatted to print double sided on 8-½ by 11 inch paper]
Attachment 2-4B	Moss Landing Marine Laboratories/Marine Pollution Studies Laboratories Laboratory Quality Assurance [Adobe PDF document: 174 KB, 10 pages formatted to print double sided on 8-½ by 11 inch paper]
Attachment 2-4C	Moss Landing Marine Laboratories/Marine Pollution Studies Laboratories Fish Tissue Data [Adobe PDF document: 84 KB; 4 pages formatted to print double sided on 8-½ by 11 inch paper]

## **8.0**      **References Cited**

- Alpers, C. N., M. P. Hunerlach, J. T. May, R. L. Hothem, H. E. Taylor, R. C. Antweiler, J. F. DeWild, and D. A. Lawler. 2005. Geochemical characterization of water, sediment, and biota affected by mercury contamination and acidic drainage from historical gold mining, Greenhorn Creek, Nevada County, California. 1999/2001: U.S. Geological Survey Scientific Investigation Report 2004-5251, 278p. URL: <[pubs.usgs.gov/fs/2005/3014/](http://pubs.usgs.gov/fs/2005/3014/)>.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury (update). Prepared by Research Triangle Institute under contract no. 205-93-0606. Public Health Service, U.S. Department of Health and Human Services.
- Bloom, N. S. 1992. On the chemical form of mercury in edible fish and marine invertebrate tissue. *Can. J. Fish. Aquat. Sci.* 49(5):1010-1017.
- Bonnema, A. 2007. Quality Assurance Project Plan Screening Study of Bioaccumulation in California Lakes and Reservoirs. Moss Landing Marine Labs. Prepared for SWAMP BOG, 49 pages plus appendices and attachments. Revised January 2008. URL: [www.swrcb.ca.gov/water\\_issues/programs/swamp/lakes\\_study.shtml](http://www.swrcb.ca.gov/water_issues/programs/swamp/lakes_study.shtml).
- Brady, B. Bare Bones Guide Service. Personal communication with J. Passovoy, HDR|DTA, January 13, 2010.
- California Department of Fish and Game (CDFG). 2005. Marine Pollution Studies Laboratory at Moss Landing Method #MPSL-102a.
- California Department of Water Resources (CDWR). 2007. Mercury Contamination in Fish from Northern California Lakes and Reservoirs. State of California. The Resources Agency. July. Northern District. URL: [http://www.water.ca.gov/pubs/waterquality/mercury\\_contamination\\_in\\_fish\\_from\\_northern\\_california\\_lakes\\_and\\_reservoirs/mercurycontaminationfinalonline.pdf](http://www.water.ca.gov/pubs/waterquality/mercury_contamination_in_fish_from_northern_california_lakes_and_reservoirs/mercurycontaminationfinalonline.pdf).
- California Environmental Protection Agency (Cal EPA). 2005. General Protocol for Sport Fish Sampling and Analysis. Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. December 2005.
- Central Valley Regional Water Quality Control Board (CVRWQCB). 2009. Clean Water Act Sections 305(b) and 303(d) Integrated Report of the Central Valley Region. Draft Final Staff Report. May. URL: [www.swrcb.ca.gov/centralvalley/water\\_issues/tmdl/impaired\\_waters\\_list/303d\\_list.shtml](http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/303d_list.shtml).
- \_\_\_\_\_. 2001. Final Staff Report on Recommended Changes to California's Clean Water Act Section 303(d) List. California Environmental Protection Agency. December 14. <[http://www.swrcb.ca.gov/centralvalley/water\\_issues/tmdl/impaired\\_waters\\_list/2006\\_303d\\_list.shtml](http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/2006_303d_list.shtml)>.

- Davis, J. A., A. R. Melwani, S. N. Bezalel, J. A. Hunt, G. Ichikawa, A. Bonnema, W. A. Heim, D. Crane, S. Swenson, C. Lamerdin, and M. Stephenson. 2010. Contaminants in Fish from California Lakes and Reservoirs, 2007-2008: Summary Report on a Two-Year Screening Survey. A Report of the Surface Water Ambient Monitoring Program (SWAMP). California State Water Resources Control Board, Sacramento, CA. URL: <[http://www.swrcb.ca.gov/water\\_issues/programs/swamp/lakes\\_study.shtml](http://www.swrcb.ca.gov/water_issues/programs/swamp/lakes_study.shtml)>.
- \_\_\_\_\_. 2009. Contaminants in Fish from California Lakes and Reservoirs: Technical Report on Year One of a Two-Year Screening Survey. A Report of the Surface Water Ambient Monitoring Program (SWAMP). California State Water Resources Control Board, Sacramento, CA. URL: [http://www.swrcb.ca.gov/water\\_issues/programs/swamp/lakes\\_study.shtml](http://www.swrcb.ca.gov/water_issues/programs/swamp/lakes_study.shtml).
- Davis, J. A., T. Flemming, D. Rasmussen, B. Brodberg, M. Lyons, C. Foe, M. Adams, T. Kimball, M. Stephenson, G. Ichikawa, D. Stevens, D. Crane, C. Lamerdin, J. Parker, M. Sigala, B. Jakl, G. Sibbald, M. Puckett, R. Holmes, and A. Bonnema. 2007. Sampling and Analysis Plan for a Screening Study of Bioaccumulation in California Lakes and Reservoirs. Prepared by the Surface Water Ambient Monitoring Program (SWAMP) Bioaccumulation Oversight Group (BOG). San Francisco Estuary Institute, Oakland, CA. September 25. URL: <[http://www.swrcb.ca.gov/water\\_issues/programs/swamp/lakes\\_study.shtml](http://www.swrcb.ca.gov/water_issues/programs/swamp/lakes_study.shtml)>.
- Federal Energy Regulatory Commission. 2011. Study Plan Determination for the Yuba River Development Project. Project No. 2246-058. September 30, 2011.
- Grenier, J. L., A. Melwani, J. Hunt, S. Bezalel, J. Davis, G. Ichikawa, B. Jakl, W. Heim, A. Bonnema and M. Gassel. 2007. California Bay-Delta Authority Fish Mercury Project: Year 1 Annual Report Sport Fish Sampling and Analysis. San Francisco Estuary Institute, Oakland, CA. CBDA Project # ERP 02D-P67 May. <<http://www.sfei.org/cmr/fishmercury/DocumentsPage.htm>>.
- Holmberg D., J. J. Baum P.E., and T. Waldrup. 2011. Evaluating Mercury Issues Resulting from Historical Mining Activities at Two U.S. Army Corps of Engineers Managed Reservoirs in California. Poster presented at the U.S. Army Corp of Engineers' 2011 Infrastructure Systems Conference, June 13 – 17, Atlanta, Georgia. U.S. Army Corps of Engineers Sacramento District, Environmental Engineering Branch, 1325 J Street, Sacramento, California 95814. June. <<http://www.usace-isc.org/home.asp>>.
- Hunerlach, M. P., J. J. Rytuba, and C. N. Alpers. 1999. Mercury Contamination from Hydraulic Placer-Gold Mining in the Dutch Flat Mining District, California. U.S. Geological Survey Water-Resources Investigations. Report 99-4018B, pp. 179-189. URL: <[ca.water.usgs.gov/mercury/dutch/index.html](http://ca.water.usgs.gov/mercury/dutch/index.html)>.
- Klasing, S. and R. Brodberg. 2008. Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminants in California Sport Fish: Chloradane, DDTs, Dieldrin, Methylmercury, PCBs, Selenium, and Toxaphene. Pesticide and Environmental Toxicology Branch Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. June. <http://www.oehha.org/fish/gtlsv/crn062708.html>.

- May, J. T., R. L. Hothem, C. N. Alpers, and M. A. Law. 2000. Mercury Bioaccumulation in Fish in a Region Affected by Historic Gold Mining: The South Yuba River, Deer Creek, and Bear River Watersheds, California, 1999. U.S. Geological Survey Open-File Report 00-367. URL: <[ca.water.usgs.gov/archive/reports/ofr00367/ofr00367.pdf](http://ca.water.usgs.gov/archive/reports/ofr00367/ofr00367.pdf)>.
- Melwani, A. R., S.N. Bezalel, J. A. Hunt, J. L. Grenier, G. Ichikawa, W. Heim, A. Bonnema, C. Foe, D. G. Slotton, and J. A. Davis. 2007. Spatial trends and impairment assessment of mercury in sport fish in the Sacramento-San Joaquin Delta Watershed. Final Technical Report. Fish Mercury Project. San Francisco Estuary Project. October. 39 pp. <http://www.sfei.org/cmr/fishmercury/DocumentsPage.htm>.
- Office of Environmental Health Hazard Assessment (OEHHA). 2009. 2009 Update of California Sport Fish Advisories. California Environmental Protection Agency. Last updated March 18, 2009. URL: <[www.oehha.ca.gov/fish/so\\_cal/index.html](http://www.oehha.ca.gov/fish/so_cal/index.html)>.
- \_\_\_\_\_. 2003. Draft Report and Health Advisory for Fish from Selected Water Bodies in the Bear River, South Yuba River, and Deer Creek Watersheds (Nevada, Placer, and Yuba Counties); a fact sheet by Office of Environmental Health Hazard Assessment – California Environmental Protection Agency. February. URL: <[www.oehha.ca.gov/public\\_info/facts/fishfacts.html](http://www.oehha.ca.gov/public_info/facts/fishfacts.html)>.
- The Sierra Fund. 2011. Gold Country Angler Survey: A Pilot Study to Assess Mercury Exposure from Sport Fish Consumption in the Sierra Nevada. May 2011. URL: [http://www.sierrafund.org/mining/Gold\\_Country\\_Angler\\_Survey.pdf](http://www.sierrafund.org/mining/Gold_Country_Angler_Survey.pdf).
- Slotton, D. G., S. M. Ayers, and C. N. Alpers. In preparation. Mercury concentrations in fishes and zooplankton from Englebright Lake, Yuba River Watershed, California, 2002. U.S. Geological Survey Data Series Report. (Status: Draft report in preparation. USGS approval and publication expected during 2009.)
- Slotton, D. G., S. M. Ayers, J. E. Reuter, and C. R. Goldman. 1997. Gold mining impacts of food chain mercury in northwestern Sierra Nevada streams: Appendix B in Larry Walker Associates, 1997, Sacramento River watershed mercury control planning project: report for the Sacramento Regional County Sanitation District. 74 pp.
- \_\_\_\_\_. 1995. Gold mining impacts on food chain mercury in northwestern Sierra Nevada streams. Technical Completion Report for the University of California Water Resources Center, Project W-816, August 1995.
- State Water Resources Control Board (SWRCB). 2010. 2010 Integrated Report Clean Water Act Sections 303(d) and 305(b). Approved August 4, 2010. Board Resolution No. 2010-0040. Sacramento, California. Available online at: <[http://www.waterboards.ca.gov/water\\_issues/programs/tmdl/integrated2010.shtml](http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml)>.
- United States Environmental Protection Agency (US EPA). 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. Office of Science and Technology Office of Water. Washington, D.C. EPA-823-R-01-001. January 2001.
- \_\_\_\_\_. 1998. Method 7473. Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. US Environmental Protection Agency, Washington, DC.

- \_\_\_\_\_. 1996. Method 3052. Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices. US Environmental Protection Agency, Washington, DC.
- \_\_\_\_\_. 1994. Method 200.8. Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry. US Environmental Protection Agency, Washington, DC.
- Yuba County Water Agency. 2011. Yuba River Development Project Revised Study Plan. FERC Project No. 2246. August 2011.
- \_\_\_\_\_. 2010. Yuba River Development Project Pre-Application Document. FERC Project No. 2246. November 10, 2010.

Page Left Blank

**Technical Memorandum 2-4**

**Bioaccumulation**

**Attachment 2-4A**

**Moss Landing Marine Laboratories  
California Department of Fish and Game  
Field Notes**

**Yuba River Development Project  
FERC Project No. 2246**

May 2012

©2012, Yuba County Water Agency  
*All Rights Reserved*





**Table of Contents**  
**Description**

<b>Section</b>	<b>Description</b>	<b>Page No.</b>
1.	Fish Collection Locations, Lengths, and Weights .....	1
2.	Field Notes .....	3

Page Left Blank

### Yuba County Water District Fish Study - Fish Collection Locations, Lengths, and Weights

<b>Bullards Bar Reservoir Location 1</b>	Latitude	Longitude	Rainbow trout TL, mm	Rainbow trout FL, mm	Weight, gm	Kokanee salmon TL, mm	Kokanee salmon FL, mm	Weight, gm
9/19/2011	39.45435	-121.07917	319	297	260	268	247	180
			339	326	276	298	272	230
			297	277	204	257	231	166
			314	296	277	271	244	172
			301	281	217	264	239	179
			296	274	219	259	232	169
			289	271	206	274	247	216
			311	286	238	263	239	183
			318	297	245	252	225	162
			282	260	178	259	234	162
<b>Bullards Bar Reservoir Location 2</b>	39.50449	-121.12955	Smallmouth bass TL,mm	Smallmouth bass FL,mm	Weight gm			
9/19/2011			306	284	265			
			307	286	265			
			336	317	370			
			334	314	370			
			316	294	335			
			327	308	350			
			349	326	505			
			350	327	455			
			370	348	550			
<b>Log Cabin Diversion Dam</b>	39.411543	- 120.997497	Rainbow trout TL, mm	Rainbow trout FL, mm	Weight gm			
9/20/2011			293	275	206			
			279	267	171			
			310	291	256			
			305	290	247			
			326	305	288			
			214	203	97			
			234	220	123			
			230	215	120			
			278	260	181			
<b>Our House Diversion Dam</b>	39.440387	- 121.058833	Rainbow trout TL, mm	Rainbow trout FL, mm	Weight gm			
9/20/2011			260	242	155			
			246	229	139			
			235	221	123			
			251	238	158			
			276	261	198			
			270	255	213			
			257	243	167			
			235	220	132			
			250	233	155			

Page Left Blank

Los Padres

**SWAMP Tissue Sampling - Fish Abundance**

Entered in d-base (initial/date): \_\_\_\_\_ Pg: \_\_\_\_\_ of \_\_\_\_\_ Pgs

\*StationCode: \_\_\_\_\_ StationName: Los Padres NP Date (mm/dd/yyyy): 30/01/2011

Location #	Organism ID	Tag #	Species Name/Code	Stage	FL (mm)	TL (mm)	Size Range (mm)	Weight (g)	Count	Count Est.	Sex	Anomaly	Condition
Net 1	RBT-01	3899	RAINBOW	A J SA NR	275	293					M F Unk/ LAB		
		2	3900	TROUT	A J SA NR	267	279				M F Unk/ LAB		
		3	1		A J SA NR	291	310				M F Unk/ LAB		
		4	2		A J SA NR	290	305		lab		M F Unk/ LAB		
		5	3		A J SA NR	305	326				M F Unk/ LAB		
		6	4		A J SA NR	203	214				M F Unk/ LAB		
		7	5		A J SA NR	220	234				M F Unk/ LAB		
		8	6		A J SA NR	215	230				M F Unk/ LAB		
		RBT-019 A	3907		A J SA NR	260	270				M F Unk/ LAB		
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			
				A J SA NR						M F Unk/ LAB			

Location # Match fish with Location # from Tissue Collection sheet      Organism ID: Combine composite # and fish # (e.g., fish 1 of composite WC01 is WC01-1) to be uni Tag #: Use if applicable

Species Code: Largemouth Bass (LMB), Smallmouth Bass (SMB), Spotted Bass (SPB), Sacramento Pike Minnow (SPM), Rainbow Trout (RT), Brown Trout (BT), Brook Trout (BKT), White Catfish (WC), Carp (CAR), Channel Catfish (CC), Brown Bullhead (BB), Sacramento Sucker (SS), Redear (RES), Black Crappie (CRP), Bluegill (BG), Tilapia (TIL), Green Sunfish (GRS), Kokanee (KOK)

Stage: Adult (A), Juvenile (J), Subadult (SA), Not Recorded (NR)      Count Est: If appropriate, add < or > if count is estimated

Anomalies: Ambicoloration (A), Albinism (B), Cloudiness (CL), Deformity-skeletal (D), Discoloration (DC), Depression (DS), Fin Erosion (F), Gill Erosion (T), Hemorrhage (H), Lesion (L), Parasite (Par), Popeye (PE), Tumor (T), Ulceration (U), White Spots (W), and any combination      BodyLocation: Branchial Chamber(BRC), Buccal Cavity(BC), Eyes(E), Musculoskeleton(M), Skin/Fins(SF)

Comments: Mark fish requiring further ID; SEPARATE FISH BY LOCATION AND INDICATE LOCATION # ON LABEL

Native

Modified 05/23/07

**SWAMP Tissue Sampling - Electroshocking and Net (Event Type = TI)**

Entered in d-base (initial/date) Pg of Pgs

*StationCode:		*StationName: <u>Burlard Pt</u>		*Group:		*Purpose		Agency	
*FundingCode:		*Date (mm/dd/yyyy): <u>09/19/2011</u>		*Failure Code:					
*Sampling Crew: <u>DS + DS</u>		ArrivalTime: <u>1015</u>	WADEABILITY: YES/NO	BEAUFORT SCALE (see attachment): <u>0</u>	WIND DIRECTION (from):	PHOTOS (RB & LB assigned when facing downstream; RENAME to StationCode_yyy_mm_dd_uniquecode):			
		DepartureTime: <u>1615</u>				1: (RB / LB / BB / US / DS / ##)			
SITE ODOR: <u>None</u> Sulfides, Sewage, Petroleum, Smoke, Other		PRECIPITATION: <u>None</u> Foggy, Drizzle, Rain, Snow							
DOMINANT SUBSTRATE: <u>Concrete, Cobble, Gravel, Sand, Mud, Other</u>		WATERCOLOR: <u>Colorless, Green, Yellow, Brown</u>		2: (RB / LB / BB / US / DS / ##)					
OBSERVED FLOW: <u>NA</u> Dry Waterbody Bed, No Observed Flow, Isolated Pool, 0.1 - 1cfs, 1 - 5 cfs, 5 - 20 cfs, 20 - 50 cfs, 50 - 200 cfs, >200cfs		3: (RB / LB / BB / US / DS / ##)							
Comments:									

**Tissue Collection**

COLLECTION DEVICE: RV Moss Landing, Backpack Model \_\_\_\_\_, Net (length & mesh) \_\_\_\_\_

Target:	Lat (dd.dddd):	Long (dd.dddd):							
GPS Model:	Datum: <u>NAD83</u> WGS84 Other _____	Accuracy (ft/m): <u>8</u>	*GPS/DGPS						
Location: <u>161</u>	*StreamDepth (m):	*StreamWidth (m):	Distance from Bank (m):	Latitude (dd.dddd)	Longitude (-ddd.dddd)	Depth (m)			
COLLECTION METHOD: <u>E-boat, Backpack shocker, Fyke net, gill net, seine, hook &amp; line</u>	Start Time: <u>1205</u>	Coord. 1: <u>39.774</u>	Coord. 2: <u>121.656</u>						
SAMPLE LOCATION: <u>Bank, Thalweg, Midchannel, Open Water, NA</u>	End Time: <u>1205</u>	Coord. 3:	Coord. 4:						
HYDROMODIFICATION: <u>None</u> Bridge, Pipes, Concrete Channel, Grade Control, Culvert,	HYDROMODLOC(to sample): <u>US / DS / NA / WI</u> Other _____	Geoshape: <u>Line Poly Point</u>							
Location: <u>162</u>	*StreamDepth (m):	*StreamWidth (m):	Distance from Bank (m):	Latitude (dd.dddd)	Longitude (-ddd.dddd)	Depth (m)			
COLLECTION METHOD: <u>E-boat, Backpack shocker, Fyke net, gill net, seine, hook &amp; line</u>	Start Time: <u>1355</u>	Coord. 1: <u>39.5135</u>	Coord. 2: <u>121.6791</u>						
SAMPLE LOCATION: <u>Bank, Thalweg, Midchannel, Open Water, NA</u>	End Time: <u>1320</u>	Coord. 3:	Coord. 4:						
HYDROMODIFICATION: <u>None</u> Bridge, Pipes, Concrete Channel, Grade Control, Culvert,	HYDROMODLOC(to sample): <u>US / DS / NA / WI</u> Other _____	Geoshape: <u>Line Poly Point</u>							
Location: <u>163</u>	*StreamDepth (m):	*StreamWidth (m):	Distance from Bank (m):	Latitude (dd.dddd)	Longitude (-ddd.dddd)	Depth (m)			
COLLECTION METHOD: <u>E-boat, Backpack shocker, Fyke net, gill net, seine, hook &amp; line</u>	Start Time: <u>1515</u>	Coord. 1: <u>39.50419</u>	Coord. 2: <u>121.12955</u>						
SAMPLE LOCATION: <u>Bank, Thalweg, Midchannel, Open Water, NA</u>	End Time: <u>1515</u>	Coord. 3: <u>39.51161</u>	Coord. 4: <u>121.12955</u>						
HYDROMODIFICATION: <u>None</u> Bridge, Pipes, Concrete Channel, Grade Control, Culvert,	HYDROMODLOC(to sample): <u>US / DS / NA / WI</u> Other _____	Geoshape: <u>Line Poly Point</u>							
Failure Codes: Dry (no water), Instrument Failure, No Access, Non-sampleable, Pre-abandoned, Other									
Comments:									

Modified 05/25/07

Noble 10/23

SWAMP Tissue Sampling - Fish Abundance										Entered in d-base (initial/date)		Pg. of Pgs		
*StationCode:			StationName: <u>North Bolinas Bay</u>			Date (mm/dd/yyyy): <u>09/19/2001</u>								
Location #	Organism ID	Tag #	Species Name/Code	Stage	FL (mm)	TL (mm)	Size Range (mm)	Weight (g)	Count	Count Est.	Sex	Anomaly	Condition	
251	KOKOI-1	A3848	Rainbow Trout	A J SA NR	247	268		lab			M F Unk/ LAB			
		2		48	A J SA NR	272	298				M F Unk/ LAB			
		3		48	A J SA NR	231	257				M F Unk/ LAB			
		4		49	A J SA NR	244	271				M F Unk/ LAB			
		5		50	A J SA NR	239	264				M F Unk/ LAB			
		6		51	A J SA NR	232	259				M F Unk/ LAB			
		7		52	A J SA NR	247	274				M F Unk/ LAB			
		8		53	A J SA NR	239	263				M F Unk/ LAB			
		9		54	A J SA NR	225	252				M F Unk/ LAB			
					A3855		A J SA NR		231	259				M F Unk/ LAB
RRT01-1	A3856	Rainbow Trout	A J SA NR	297	319						M F Unk/ LAB			
			2	57	A J SA NR	326	339					M F Unk/ LAB		
			3	8	A J SA NR	277	297					M F Unk/ LAB		
			4	9	A J SA NR	296	314					M F Unk/ LAB		
			5	60	A J SA NR	281	301		lab			M F Unk/ LAB		
			6	1	A J SA NR	274	296					M F Unk/ LAB		
			7	2	A J SA NR	271	289					M F Unk/ LAB		
			8	3	A J SA NR	286	311					M F Unk/ LAB		
			9	4	A J SA NR	297	318					M F Unk/ LAB		
					A3865		A J SA NR	260	282				M F Unk/ LAB	
351	SMB01-1	A3866	Smallmouth Bass	A J SA NR	284	306		265			M F Unk/ LAB			
				2	7	A J SA NR	286	307		265		M F Unk/ LAB		
				3	8	A J SA NR	317	336		370		M F Unk/ LAB		
				4	9	A J SA NR	314	334		370		M F Unk/ LAB		

Location #: Match fish with Location # from Tissue Collection sheet      Organism ID: Combine composite # and fish # (e.g., fish 1 of composite WC01 is WC01-1) to be uni Tag #: Use if applicable

Species Code: Largemouth Bass (LMB), Smallmouth Bass (SMB), Spotted Bass (SPB), Sacramento Pike Minnow (SPM), Rainbow Trout (RT), Brown Trout (BT), Brook Trout (BKT), White Catfish (WC), Carp (CAR), Channel Catfish (CC), Brown Bullhead (BB), Sacramento Sucker (SS), Redear (RES), Black Crappie (CRP), Bluegill (BG), Tilapia (TIL), Green Sunfish (GRS), Kokanee (KOK)

Stage: Adult (A), Juvenile (J), Subadult (SA), Not Recorded (NR)      Count Est: If appropriate, add < or > if count is estimated

Anomalies: Ambicoloration (A), Albinism (B), Cloudiness (CL), Deformity-skeletal (D), Discoloration (DC), Depression (DS), Fin Erosion (F), Gill Erosion (T), Hemorrhage (H), Lesion (L), Parasite (Par), Popeye (PE), Tumor (T), Ulceration (U), White Spots (W), and any combination      BodyLocation: Branchial Chamber(BRC), Buccal Cavity(BC), Eyes(E), Musculoskeleton(M), Skin/Fins(SF)

Comments: Mark fish requiring further ID; SEPARATE FISH BY LOCATION AND INDICATE LOCATION # ON LABEL

1	70	294	316	335	F
	71	308	327	350	M
	72	326	349	505	M
	73	327	350	455	F
	A3874	298	378	550	F

Modified 05/23/07

*HDR Auilhouse*

SWAMP Tissue Sampling - Non-Trawl (Event Type = TI) Continued										Entered in d-base (initial/date)		Pg of Pgs	
*StationCode:			*StationName: <i>Lower Divisadero</i>			Trip:					Agency		
*FundingCode:			*Date (mm/dd/yyyy): <i>09/20/2011</i>										
<b>Tissue Collection</b>										Accuracy			
Location: OpenWater/Bank/MidChan # <i>1NC1</i>		*StationDepth (m): <i>1.7</i>		DistanceFromBank(m):		Coord (ft / m)		Latitude (dd.ddddd)		Longitude (-ddd.ddddd)		Depth (m)	
COLLECTION METHOD:		Hook, Net, Seine, Spear, Trap, Shock				Start Time		<i>1</i>		<i>39.440307</i>		<i>121.658833</i>	
COLLECTIONDEVICE:		Hook/Line, Gill Net (mesh size) <i>1/4"</i> , CastNet, Seine, Other <i>1</i>				<i>1155</i>		<i>2</i>		<i>39.41154</i>		<i>5</i>	
HYDROMODIFICATION:		None, Bridge, Pipes, Concrete Channel, Pier, Breakwater				End Time		<i>3</i>					
HYDROMODLOC(to sample):		US / DS / NA / W / Other		GEOSHAPE: Line Poly Point		<i>1320</i>		<i>4</i>					
Location: OpenWater/Bank/MidChan # _____		*StationDepth (m):		DistanceFromBank(m):		Coord (ft / m)		Latitude (dd.ddddd)		Longitude (-ddd.ddddd)		Depth (m)	
COLLECTION METHOD:		Hook, Net, Seine, Spear, Trap, Shock				Start Time		<i>1</i>					
COLLECTIONDEVICE:		Hook/Line, Gill Net (mesh size) _____, CastNet, Seine, Other _____						<i>2</i>					
HYDROMODIFICATION:		None, Bridge, Pipes, Concrete Channel, Pier, Breakwater				End Time		<i>3</i>					
HYDROMODLOC(to sample):		US / DS / NA / W / Other		GEOSHAPE: Line Poly Point				<i>4</i>					
Location: OpenWater/Bank/MidChan # _____		*StationDepth (m):		DistanceFromBank(m):		Coord (ft / m)		Latitude (dd.ddddd)		Longitude (-ddd.ddddd)		Depth (m)	
COLLECTION METHOD:		Hook, Net, Seine, Spear, Trap, Shock				Start Time		<i>1</i>					
COLLECTIONDEVICE:		Hook/Line, Gill Net (mesh size) _____, CastNet, Seine, Other _____						<i>2</i>					
HYDROMODIFICATION:		None, Bridge, Pipes, Concrete Channel, Pier, Breakwater				End Time		<i>3</i>					
HYDROMODLOC(to sample):		US / DS / NA / W / Other		GEOSHAPE: Line Poly Point				<i>4</i>					
Location: OpenWater/Bank/MidChan # _____		*StationDepth (m):		DistanceFromBank(m):		Coord (ft / m)		Latitude (dd.ddddd)		Longitude (-ddd.ddddd)		Depth (m)	
COLLECTION METHOD:		Hook, Net, Seine, Spear, Trap, Shock				Start Time		<i>1</i>					
COLLECTIONDEVICE:		Hook/Line, Gill Net (mesh size) _____, CastNet, Seine, Other _____						<i>2</i>					
HYDROMODIFICATION:		None, Bridge, Pipes, Concrete Channel, Pier, Breakwater				End Time		<i>3</i>					
HYDROMODLOC(to sample):		US / DS / NA / W / Other		GEOSHAPE: Line Poly Point				<i>4</i>					
Location: OpenWater/Bank/MidChan # _____		*StationDepth (m):		DistanceFromBank(m):		Coord (ft / m)		Latitude (dd.ddddd)		Longitude (-ddd.ddddd)		Depth (m)	
COLLECTION METHOD:		Hook, Net, Seine, Spear, Trap, Shock				Start Time		<i>1</i>					
COLLECTIONDEVICE:		Hook/Line, Gill Net (mesh size) _____, CastNet, Seine, Other _____						<i>2</i>					
HYDROMODIFICATION:		None, Bridge, Pipes, Concrete Channel, Pier, Breakwater				End Time		<i>3</i>					
HYDROMODLOC(to sample):		US / DS / NA / W / Other		GEOSHAPE: Line Poly Point				<i>4</i>					

Comments:

Modified 4/29/2009



O. F. H. S. C.

**SWAMP Tissue Sampling - Fish Abundance** Entered in d-base (initial/date) Pg: of Pgs

\*StationCode: StationName: LA 11 Date (mm/dd/yyyy): 09/29/2011

Storage	Location/ CollectionMethod #	Organism ID	Tag #	Species Name/Code	FL (mm)	TL (mm)	Weight (g)	Count	Sex	Range (mm)	Count Est.	Anom	Condition
	NA	RBT-01-1	A3875	RAINBOW	242	260			M F Unk LAB				D W L
		2	6	RAI	229	246			M F Unk LAB				D W L
		3	7		231	235			M F Unk LAB				D W L
		4	8		238	251	1.2		M F Unk LAB				D W L
		5	9		261	276			M F Unk LAB				D W L
		6	80		255	270			M F Unk LAB				D W L
		7	1		243	257			M F Unk LAB				D W L
		8	2		220	235			M F Unk LAB				D W L
		RBT-01-7	A3883		233	250			M F Unk LAB				D W L
		SPM01-1	A3884	COASTAL	270	299			M F Unk LAB				D W L
		2	5	SPM	224	245			M F Unk LAB				D W L
		3	6		249	270	1.0		M F Unk LAB				D W L
		4	7		272	293			M F Unk LAB				D W L
		5	8		256	278			M F Unk LAB				D W L
		SPM01-6	A3889		201	228			M F Unk LAB				D W L
		<del>7</del>							M F Unk LAB				D W L
		<del>8</del>							M F Unk LAB				D W L
		<del>SPM01-9</del>							M F Unk LAB				D W L
		SAS 01-1	A3896	SAR	187	201			M F Unk LAB				D W L
		2	1	Sucker	214	232			M F Unk LAB				D W L
		3	2		211	227			M F Unk LAB				D W L
		4	3		227	236			M F Unk LAB				D W L
		5	4		226	239			M F Unk LAB				D W L
		6	5		233	248			M F Unk LAB				D W L

Location/CollectionMethod #, Match fish with LocationName, Collection Method, and # from Tissue Collection sheet

Organism ID: Combine BAG # and FISH # (e.g., fish 1 of composite WC01 is WC01-1) to be unique

Tag #: Use if applicable; must be unique

Species Code: see attached list for codes

Stage: Adult (A), Juvenile (J), Subadult (SA), Not Recorded (NR)

Count Est: If appropriate, add < or > if count is estimated

Condition: Note whether individual is Dead (D), Weak (W), or Live (L)

Anomalies: Fin Erosion (FinEro), Gill Erosion (GillEro), Lesion (Les), Parasite (Par), Popeye (PE), Tumor (Tum), Hemorrhage (Hem), Skeletal Deformity (SkDef)

Comments: BOG\_Coastal 1) Bag Numbers must be consecutive by previous trips per StationCode, 2) Smaller fish that are bagged by species but not tagged must be bagged by location #.

SAS 01-9 A3898

250 261  
233 244  
222 201

Native

Modified 4/29/2009

Moss Landing Marine Labs  
Dept. of Fish & Game  
7544 Sandholdt Rd.  
Moss Landing, CA. 95039

SAN JOSE CA 950



Carin Loy  
HDR  
2379 Gateway Oaks Dr. Suite 200  
Sacramento, CA 95833

95833423950



**Technical Memorandum 2-4**

**Bioaccumulation**

**Attachment 2-4B**

**Moss Landing Marine Laboratories  
Marine Pollution Studies Laboratories  
Laboratory Quality Assurance**

**Yuba River Development Project  
FERC Project No. 2246**

May 2012

©2012, Yuba County Water Agency  
*All Rights Reserved*

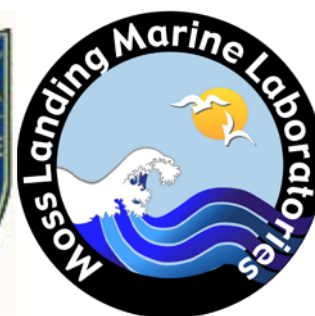


**Table of Contents**  
**Description**

<b>Section</b>	<b>Description</b>	<b>Page No.</b>
1.	Arsenic, Copper, Selenium and Silver (EPA 1638M) Quality Assurance/Quality Control Summary.....	1
2.	Mercury (EPA 7473) Quality Assurance/Quality Control Summary.....	7

Page Left Blank

**Marine Pollution Studies Laboratories**  
**Department of Fish and Game**  
**Moss Landing Marine Laboratories**  
**7544 Sandholdt Road**  
**Moss Landing, CA 95039**



**Project Manager:** Autumn Bonnema  
**Phone:** 831-771-4175  
**Fax:** 831-633-0805  
**e-mail:** bonnema@mml.calstate.edu

**Project Name:** HDR  
**Parameter:** Trace Metals  
**Report Number:** tisTM12-002

**Project Number:** 314  
**Matrix:** Tissue  
**Report Date:** 5 March 2012

## QA/QC SUMMARY

### SAMPLE CUSTODY

Forty tissue samples were received in good condition on 22 September 2011. Samples were stored at -20°C prior to digestion.

### QA/QC DATA QUALITY OBJECTIVES (DQO)

<u>Analyte</u>	<u>Reference Method</u>	<u>Range of Recovery</u>	<u>Relative Precision</u>	<u>Detection Limit</u>	<u>Reporting Limit</u>
Ag	EPA 1638 M	±25%	±25%	0.003 µg/g <sub>wet</sub>	0.010 µg/g <sub>wet</sub>
As	EPA 1638 M	±25%	±25%	0.02 µg/g <sub>wet</sub>	0.06 µg/g <sub>wet</sub>
Cu	EPA 1638 M	±25%	±25%	0.06 µg/g <sub>wet</sub>	0.20 µg/g <sub>wet</sub>
Se	EPA 1638 M	±25%	±25%	0.15 µg/g <sub>wet</sub>	0.40 µg/g <sub>wet</sub>

## **METHOD**

Samples were digested using EPA 3052 (Modified): Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices, and analyzed using EPA 200.8 (Modified): Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry.

## **HOLDING TIME**

The fish samples were digested in October 2011 All samples were analyzed within the EPA holding time of 1 year from collection.

## **CALIBRATION VERIFICATION**

Initial Calibration Verification (ICV) and all Continuing Calibration Verification (CCV) were within DQO of  $\pm 10\%$ .

## **DETECTION LIMIT**

All detection limits listed in the table above were achieved.

## **METHOD BLANKS**

Two method blanks were analyzed with each batch samples. All elements were below detection limits. Samples are all blank corrected with the average blank value for that batch.

## **REPLICATES**

One pair of analytical duplicates selected at random was analyzed with each batch of samples. All RPDs met the DQO of  $\pm 25\%$ .

## **MATRIX SPIKES**

One matrix spike/matrix spike duplicate (MS/MSD) pair was analyzed with each batch of samples. All recoveries and RPDs met the DQO of  $\pm 25\%$ . The native aluminum result was too low to spike, however the Al CRM was within DQO.

## **CERTIFIED REFERENCE MATERIAL**

One SRM 2976 and one DORM-3 was analyzed with each batch of samples. All recoveries met the DQO of  $\pm 25\%$  with the exception of Silver and Chromium. The certified values of these elements are less or too close to the reporting limit.



## **COMMENTS**

## **REFERENCES**

US Environmental Protection Agency Method 3052. 1996. Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices. US Environmental Protection Agency, Washington, DC.

Modifications to EPA 3052

US Environmental Protection Agency Method 200.8. 1994. Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry. US Environmental Protection Agency, Washington, DC.

Modifications to EPA 200.8



Project Manager: Autumn Bonnema  
 Phone: 831-771-4175  
 Fax: 831-633-0805  
 Email: bonnema@mlml.calstate.edu

Quality Assurance/ Quality Control for

HDR

Report: tis TM 12- 002

Batch Number	Lab Number	Station Code	Type	Ag		As		Cu		Se	
				ppm	wet	ppm	wet	ppm	wet	ppm	wet
2011Dig36			Method Blank 1	<0.003		<0.02		<0.06		<0.15	
			Method Blank 2	<0.003		<0.02		<0.06		<0.15	
		NIST 2976	SRM (true value)	0.011							
			SRM	0.013							
			% Recovery	118%							
		NRCC DORM-3	SRM (true value)			6.88		15.5		3.30	
			SRM			6.40		13.6		3.34	
			% Recovery			93%		88%		101%	
	C2_088LMB*		Native	<0.003		0.02		0.09		<0.15	
	C2_088LMBd*		Duplicate	<0.003		0.03		0.09		0.56	
			RPD	NC		NC		NC		NC	
	C2_088LMB*		Native	0.00		0.02		0.09		0.02	
			Spike Value	0.50		0.75		0.75		0.90	
	C2_088LMBsp*		Matrix Spike	0.48		0.76		0.79		0.65	
			Spike Value	0.47		0.71		0.71		0.86	
	C2_088LMBsp*		Matrix Spike Duplicate	0.46		0.76		0.80		0.67	
			% Recovery MS	96%		99%		93%		70%	
			% Recovery MSD	98%		104%		100%		76%	
			RPD	4.00%		0.00%		2.00%		3.00%	
			MDL	0.003		0.02		0.06		0.15	
			RL	0.010		0.06		0.20		0.40	

Batch Number	Lab Number	Station Code	Type	Ag		As		Cu		Se	
				ppm	wet	ppm	wet	ppm	wet	ppm	wet
2011Dig37			Method Blank 1	<0.003		<0.02		<0.06		<0.15	
			Method Blank 2	<0.003		<0.02		<0.06		<0.15	
		NIST 2976	SRM (true value)	0.011							
			SRM	0.013							
			% Recovery	118%							
		NRCC DORM-3	SRM (true value)			6.88		15.5		3.30	
			SRM			6.21		14.1		3.43	
			% Recovery			90%		91%		104%	
	Tag #										
A3876	2011_3735		Native	<0.003		0.62		0.21		0.74	
A3876	2011_3735d		Duplicate	<0.003		0.64		0.19		0.52	
			RPD	NC		3%		NC		NC	
A3876	2011_3735		Native	0.00		0.62		0.21		0.74	
			Spike Value	0.45		3.33		1.03		2.90	
A3876	2011_3735sp		Matrix Spike	0.42		4.04		1.18		3.40	
			Spike Value	0.45		3.33		1.03		2.90	
A3876	2011_3735spd		Matrix Spike Duplicate	0.45		4.00		1.17		3.42	
			% Recovery MS	93%		103%		94%		92%	
			% Recovery MSD	100%		102%		93%		92%	
			RPD	7.00%		1.00%		1.00%		1.00%	
			MDL	0.003		0.02		0.06		0.15	
			RL	0.010		0.06		0.20		0.40	

Batch	Lab	Station	Type	Ag	As	Cu	Se
-------	-----	---------	------	----	----	----	----

Number	Number	Code	ppm <sub>wet</sub>	ppm <sub>wet</sub>	ppm <sub>wet</sub>	ppm <sub>wet</sub>
2011Dig38		Method Blank 1	<0.003	<0.02	<0.06	<0.15
		Method Blank 2	<0.003	<0.02	<0.06	<0.15
		<b>NIST 2976</b>				
		SRM (true value)	0.011			
		SRM	0.018			
		<b>% Recovery</b>	<b>164%</b>			
			* *			
		<b>NRCC DORM-3</b>				
		SRM (true value)		6.88	15.5	3.30
		SRM		6.45	14.9	2.47
		<b>% Recovery</b>		94%	96%	75%
A3882	2011_3735	Native	<0.003	0.15	0.26	<0.15
A3882	2011_3735d	Duplicate	<0.003	0.15	0.27	<0.15
		<b>RPD</b>	<b>NC</b>	<b>NC</b>	<b>NC</b>	<b>NC</b>
A3882	2011_3735	Native	0.00	0.15	0.26	0.00
		Spike Value	0.45	0.73	1.02	1.15
A3882	2011_3735sp	Matrix Spike	0.42	0.86	1.26	0.83
		Spike Value	0.45	0.72	1.02	1.15
A3882	2011_3735spd	Matrix Spike Duplicate	0.37	0.82	1.23	0.87
		<b>% Recovery MS</b>	93%	97%	98%	72%
		<b>% Recovery MSD</b>	82%	93%	95%	76%
		<b>RPD</b>	2.00%	5.00%	7.00%	7.00%
		<b>MDL</b>	<b>0.003</b>	<b>0.02</b>	<b>0.06</b>	<b>0.15</b>
		<b>RL</b>	<b>0.010</b>	<b>0.06</b>	<b>0.20</b>	<b>0.40</b>

\* Qa from different set of samples run with this batch

Method: modified EPA 1638

\*\* Srm value too close to the Rreporting limit foe Ag

NC: not calculable (Either not detected or too close to reporting limit)

Values below the MDL are reported as < -0.003 for Ag

value between the MDL and RL in red

Page Left Blank

**Marine Pollution Studies Laboratories**  
**Department of Fish and Game**  
**Moss Landing Marine Laboratories**  
**7544 Sandholdt Road**  
**Moss Landing, CA 95039**

**Project Manager:** Gary Ichikawa  
**Phone:** 831-771-4162  
**Fax:** 831-633-0805  
**e-mail:** gichikawa@mlml.calstate.edu

**Project Name:** HDR Study September 2011      **Project Number:** 314  
**Parameter:** Total Mercury      **Matrix:** Tissue  
**Report Number:** DMA 12-005t      **Report Date:** 02/03/12

## **QA/QC SUMMARY**

### **SAMPLE CUSTODY**

Forty seven tissue samples were collected September 19-20, 2011, and were received in good condition on September 22, 2011. Samples were immediately frozen at -20°C upon receipt at the lab. Samples were stored at -20°C before and after dissection and/or analysis.

### **QA/QC DATA QUALITY OBJECTIVES (DQO)**

<u>Analyte</u>	<u>Reference Method</u>	<u>Range of Recovery</u>	<u>Relative Precision</u>	<u>Detection Limit</u>	<u>Reporting Limit</u>
Hg	EPA 7473	±25%	±25%	0.004 µg/g <sub>wet</sub>	0.013 µg/g <sub>wet</sub>

### **METHOD**

Samples were analyzed using EPA 7473: Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry.

### **HOLDING TIME**

All samples were analyzed within the EPA holding time of 1 year from collection.

### **CALIBRATION VERIFICATION**

Initial Calibration Verification (ICV) and all Continuing Calibration Verification (CCV) were within DQO of ±25%.

## **DETECTION LIMIT**

All detection limits listed in the table above were achieved.

## **METHOD BLANKS**

Three method blanks were analyzed with each batch samples. All blanks were below detection limits. Samples are not method blank corrected.

## **REPLICATES**

One pair of analytical duplicates selected at random was analyzed with each batch of samples. All RPDs met the DQO of  $\pm 25\%$ .

## **MATRIX SPIKES**

One matrix spike/matrix spike duplicate (MS/MSD) pair was analyzed with each batch of samples. All recoveries and RPDs met the DQO of  $\pm 25\%$ .

## **STANDARD REFERENCE MATERIAL**

One SRM DORM-3 was analyzed with each batch of samples. Percent recovery met the DQO of  $\pm 25\%$ .

## **COMMENTS**

## **REFERENCES**

US Environmental Protection Agency Method 7473. 1998. Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. US Environmental Protection Agency, Washington, DC.

Marine Pollution Studies Laboratories  
 Department of Fish and Game  
 Moss Landing Marine Laboratories  
 7544 Sandholdt Road  
 Moss Landing, CA 95039

Project Manager: **Gary Ichikawa**  
 Phone: **831-771-4162**  
 Fax: **831-633-0805**  
 Email: **gichikawa@mml.calstate.edu**

Quality Assurance/ Quality Control for **HDR Study September 2011** Report: **DMA 12-005t**

Batch Number	Lab Number	Station Code	Type	HgT ( $\mu\text{g/g}$ ) <sub>wet</sub>	HgT ng	Flag
01-17-12a			Method Blank 1	<MDL		
			Method Blank 2	<MDL		
			Method Blank 3	<MDL		
		DORM-3	SRM (true value)	0.362		
			SRM	0.371		
			% Recovery	102.4%		
	A3856	Bullards Bar Res Location 1	Native	0.106		
	A3856-d	Bullards Bar Res Location 1	Duplicate	0.113		
			RPD	6.39		
			Spike Value		63.7	
	A3856	Bullards Bar Res Location 1	Native	0.106	20.8	
	A3856-MS	Bullards Bar Res Location 1	Matrix Spike	0.419	82.5	
	A3856	Bullards Bar Res Location 1	Native	0.106	18.9	
	A3856-MSD	Bullards Bar Res Location 1	Matrix Spike Duplicate	0.439	78.3	
			% Recovery MS		96.8%	
		% Recovery MSD		93.2%		
		RPD		5.20		

Batch Number	Lab Number	Station Code	Type	HgT ( $\mu\text{g/g}$ ) <sub>wet</sub>	HgT ng	Flag
01-18-12a			Method Blank 1	<MDL		
			Method Blank 2	<MDL		
			Method Blank 3	<MDL		
		DORM-3	SRM (true value)	0.362		
			SRM	0.338		
			% Recovery	93.2%		
	A3866	Bullards Bar Res Location 2	Native	0.446		
	A3866-d	Bullards Bar Res Location 2	Duplicate	0.471		
			RPD	5.52		
			Spike Value		263.1	
	A3866	Bullards Bar Res Location 2	Native	0.446	107.1	
	A3866-MS	Bullards Bar Res Location 2	Matrix Spike	1.45	349.3	
	A3866	Bullards Bar Res Location 2	Native	0.446	94.4	
	A3866-MSD	Bullards Bar Res Location 2	Matrix Spike Duplicate	1.64	348.4	
			% Recovery MS		92.0%	
		% Recovery MSD		96.5%		
		RPD		0.24		

Batch Number	Lab Number	Station Code	Type	HgT ( $\mu\text{g/g}$ ) <sub>wet</sub>	HgT ng	Flag
01-19-12a			Method Blank 1	<MDL		
			Method Blank 2	<MDL		
			Method Blank 3	<MDL		
		DORM-3	SRM (true value)	0.362		
			SRM	0.364		
			% Recovery	100.4%		
	A3875	Our House Diversion Dam	Native	0.063		
	A3875-d	Our House Diversion Dam	Duplicate	0.062		
			RPD	1.45		
			Spike Value		37.0	
	A3875	Our House Diversion Dam	Native	0.063	12.5	
	A3875-MS	Our House Diversion Dam	Matrix Spike	0.261	52.0	
	A3875	Our House Diversion Dam	Native	0.063	12.0	
	A3875-MSD	Our House Diversion Dam	Matrix Spike Duplicate	0.263	50.7	
			% Recovery MS		107.0%	
		% Recovery MSD		104.4%		
		RPD		2.67		
		MDL		0.004		
		RL		0.013		

Method: EPA 7473

Page Left Blank



**Technical Memorandum 2-4**

**Bioaccumulation**

**Attachment 2-4C**

**Moss Landing Marine Laboratories  
Marine Pollution Studies Laboratories  
Fish Tissue Data**

**Yuba River Development Project  
FERC Project No. 2246**

May 2012

©2012, Yuba County Water Agency  
*All Rights Reserved*



**Table of Contents**  
**Description**

<b>Section</b>	<b>Description</b>	<b>Page No.</b>
1.	Arsenic, Copper, Selenium, and Silver in Fish Tissue .....	1
2.	Mercury in Fish Tissue .....	2

Page Left Blank



Trace Metal Results

Project Name: HDR  
 Project Number: 314  
 Analyst: Jon Goetzl

Report #: tisTM12-002

Report Date: 3/1/2012

Lab Number	Tag Number	Fish	Location	Sample Type	Date Collected	Date Received	Batch Number	Percent Moisture	Ag ppm wet	As ppm wet	Cu ppm wet	Se ppm wet	
2011-3733	A3856	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	78.1	<0.003	0.04	0.16	0.44	
2011-3733	A3857	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	81.3	<0.003	0.16	0.12	0.31	
2011-3733	A3858	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	77.0	<0.003	<0.02	0.14	0.21	
2011-3733	A3859	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	77.3	<0.003	0.02	0.22	0.32	
2011-3733	A3860	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	79.6	<0.003	<0.02	0.16	0.21	
2011-3733	A3861	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	76.9	0.016	0.04	0.19	0.38	
2011-3733	A3862	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig36	78.1	<0.003	0.02	0.18	0.18	
2011-3734	A 3846	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	75.4	<0.003	0.03	0.28	0.30	
2011-3734	A 3847	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	76.0	<0.003	0.03	0.29	0.40	
2011-3734	A 3848	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	74.9	<0.003	0.02	0.34	0.33	
2011-3734	A 3849	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	75.2	<0.003	0.02	0.27	0.53	
2011-3734	A 3850	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	76.2	0.020	0.04	0.35	0.39	
2011-3734	A 3851	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	74.6	<0.003	0.02	0.29	0.37	
2011-3734	A 3852	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	75.2	<0.003	0.04	0.35	0.36	
2011-3734	A 3853	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	74.3	<0.003	0.04	0.34	0.49	
2011-3734	A 3854	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	74.8	<0.003	0.07	0.31	0.46	
2011-3734	A 3855	KOK	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	74.8	<0.003	0.06	0.28	0.43	
2011-3733	A 3863	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	77.8	0.006	0.03	0.16	0.50	
2011-3733	A 3864	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	78.4	<0.003	0.02	0.15	0.32	
2011-3733	A 3865	RBT	New Bullards Bar Reservoir L1	tissue	9/19/2011	9/22/2011	2011dig37	78.3	<0.003	<0.02	0.16	0.32	
2011-3732	A 3866	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig37	78.8	<0.003	0.03	0.11	0.24	
2011-3732	A 3867	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig37	78.8	<0.003	0.04	0.12	<0.15	
2011-3732	A 3868	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig37	79.4	<0.003	0.02	0.12	0.27	
2011-3732	A 3869	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig37	79.1	<0.003	0.03	0.11	0.51	
2011-3732	A 3870	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig37	78.6	0.014	0.03	0.14	0.17	
2011-3732	A 3871	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig37	78.5	<0.003	0.04	0.15	0.39	
2011-3735	A 3876	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig37	76.7	<0.003	0.62	0.21	0.74	
2011-3732	A 3872	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig38	77.0	0.005	0.03	0.16	<0.15	
2011-3732	A 3873	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig38	78.2	<0.003	0.02	0.11	0.29	
2011-3732	A 3874	SMB	New Bullards Bar Reservoir L2	tissue	9/19/2011	9/22/2011	2011dig38	77.8	<0.003	0.02	0.11	<0.15	
2011-3735	A 3875	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	77.1	<0.003	0.31	0.16	<0.15	
2011-3735	A 3877	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	75.7	<0.003	0.14	0.23	<0.15	
2011-3735	A 3878	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	76.0	0.019	0.25	0.23	<0.15	
2011-3735	A 3879	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	75.9	<0.003	0.25	0.23	<0.15	
2011-3735	A 3880	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	75.1	<0.003	0.63	0.25	<0.15	
2011-3735	A 3881	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	76.9	<0.003	0.16	0.12	<0.15	
2011-3735	A 3882	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	75.2	<0.003	0.15	0.26	<0.15	
2011-3735	A 3883	RBT	Our House Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	75.2	<0.003	0.11	0.23	<0.15	
2011-3738	A 3899	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	77.4	<0.003	<0.02	0.19	<0.15	
2011-3738	A 3900	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	77.9	<0.003	0.02	0.18	<0.15	
2011-3738	A 3901	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	77.2	<0.003	<0.02	0.27	<0.15	
2011-3738	A 3902	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	76.1	<0.003	0.05	0.16	<0.15	
2011-3738	A 3903	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	76.6	<0.003	<0.02	0.19	<0.15	
2011-3738	A 3904	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	76.6	0.013	0.06	0.24	<0.15	
2011-3738	A 3905	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	75.0	<0.003	0.15	0.22	<0.15	
2011-3738	A 3906	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	74.3	<0.003	0.06	0.28	<0.15	
2011-3738	A 3907	RBT	Log Cabin Diversion Dam	tissue	9/20/2011	9/22/2011	2011dig38	77.0	<0.003	0.02	0.16	<0.15	
									<b>MDL</b>	0.003	0.02	0.06	0.15
									<b>RL</b>	0.010	0.06	0.20	0.40

Method: modified EPA 1638

value between the MDL and RL in red  
 Values below the MDL are reported as <0.003 for Ag

**Marine Pollution Studies Laboratories**

Department of Fish and Game

Moss Landing Marine Laboratories

7544 Sandholdt Road  
Moss Landing, CA 95039

Project Manager: **Gary Ichikawa**  
Phone: **831-771-4162**  
Fax: **831-633-0805**  
Email: [gichikawa@mlml.calstate.edu](mailto:gichikawa@mlml.calstate.edu)

**Mercury Results**

Project Name: HDR Study September 2011      Report #: DMA 12-005t  
Project Number: 314  
Analyst: Jessica Masek      Report Date: 2/3/2012

Lab Number	Tag Number	Station Name	Sample Type	Date Collected	Date Received	Batch Number	Percent Moisture	Hg (µg/g) <sub>wet</sub>	Flag
2011-3733	A3856	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	78.20	0.106	
2011-3733	A3857	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	80.70	0.085	
2011-3733	A3858	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	77.82	0.068	
2011-3733	A3859	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	77.93	0.096	
2011-3733	A3860	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	78.97	0.099	
2011-3733	A3861	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	77.40	0.114	
2011-3733	A3862	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	77.80	0.143	
2011-3733	A3863	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	76.95	0.101	
2011-3733	A3864	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	78.43	0.128	
2011-3733	A3865	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	77.83	0.110	
2011-3734	A3846	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	76.57	0.141	
2011-3734	A3847	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	76.23	0.108	
2011-3734	A3848	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	74.65	0.097	
2011-3734	A3849	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	76.11	0.102	
2011-3734	A3850	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	77.81	0.083	
2011-3734	A3851	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	74.34	0.109	
2011-3734	A3852	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	74.84	0.167	
2011-3734	A3853	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	76.66	0.114	
2011-3734	A3854	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	74.17	0.075	
2011-3734	A3855	Bullards Bar Res Location 1	Tissue	9/19/2011	9/22/2011	01-17-12a	76.28	0.126	
2011-3732	A3866	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	78.71	0.446	
2011-3732	A3867	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	80.32	0.573	
2011-3732	A3868	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	78.77	0.807	
2011-3732	A3869	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	79.36	0.550	
2011-3732	A3870	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	79.47	0.770	
2011-3732	A3871	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	79.37	0.644	
2011-3732	A3872	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	76.35	0.582	
2011-3732	A3873	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	78.32	0.603	
2011-3732	A3874	Bullards Bar Res Location 2	Tissue	9/19/2011	9/22/2011	01-18-12a	77.62	0.604	
2011-3738	A3899	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	76.83	0.114	
2011-3738	A3900	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	78.26	0.114	
2011-3738	A3901	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	76.73	0.128	
2011-3738	A3902	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	75.49	0.161	
2011-3738	A3903	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	77.50	0.144	
2011-3738	A3904	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	76.59	0.073	
2011-3738	A3905	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	74.82	0.107	
2011-3738	A3906	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	75.64	0.094	
2011-3738	A3907	Log Cabin Diversion Dam	Tissue	9/20/2012	9/22/2011	01-18-12a	76.49	0.098	
2011-3735	A3875	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	76.47	0.063	
2011-3735	A3876	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	77.35	0.090	
2011-3735	A3877	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	76.65	0.075	
2011-3735	A3878	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	75.92	0.062	
2011-3735	A3879	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	77.38	0.067	
2011-3735	A3880	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	75.22	0.100	
2011-3735	A3881	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	76.64	0.085	
2011-3735	A3882	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	75.36	0.113	
2011-3735	A3883	Our House Diversion Dam	Tissue	9/20/2012	9/22/2011	01-19-12a	76.99	0.073	

**MDL** 0.004  
**RL** 0.013

Method: EPA 7473