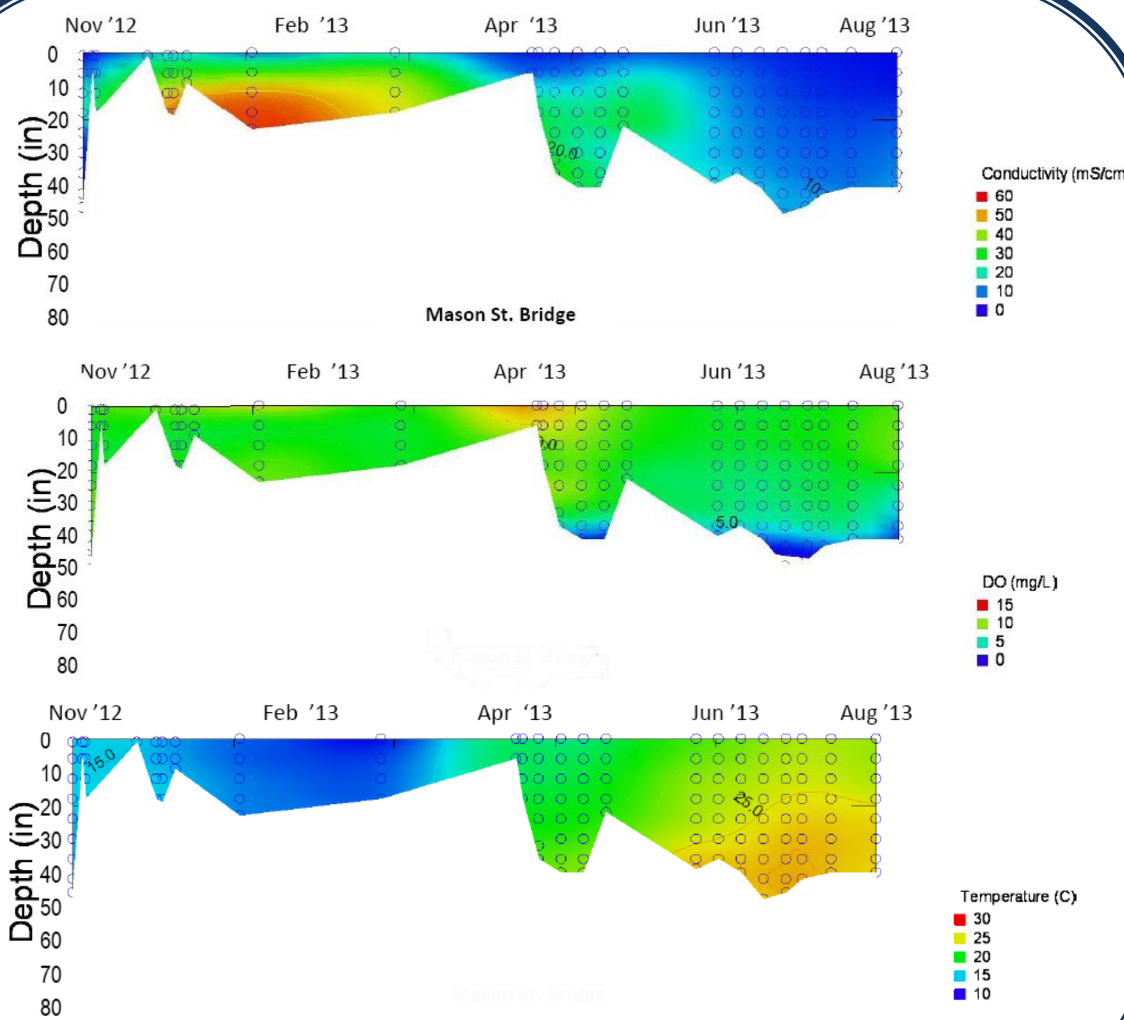
Fiscal Year 2013
Annual Water Quality Report



Season variation in depth, conductivity, dissolved oxygen, and temperature in Mission Lagoon.

City of Santa Barbara
Creeks Division

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Clean Creeks
HEALTHY BEACHES
CITY OF SANTA BARBARA

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Contents

Introduction

The following report described sampling and results that were based on the Fiscal Year 2013 Research and Monitoring Plan (Appendix A). The Research Plan is organized around program elements and research questions that have been reviewed by the Creeks Advisory Committee (CAC). The Research and Monitoring Program is adaptive, and as questions are answered or modified, sampling strategies change as well. The program elements and research questions are provided below. Where possible, the report is organized around the research questions. ***The primary purpose of this report is to serve as an internal record of data collection and analysis. Please see the Creeks Division 2001-2006 report for a discussion of methods, information on water quality criteria, and a glossary of monitoring terms.***

Goals

The goals of the monitoring program are to:

1. Quantify the levels (concentration and flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
2. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
3. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.
4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.

The underlying motivation behind the monitoring program is to obtain information that the City can use to:

1. Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
2. Communicate effectively with the public about water quality.

Changes to Research Plan for Fiscal Year 2013

Several changes were made for the Fiscal Year 2013 Research and Monitoring Plan, including:

1. Tests receiving waters for potential groundwater contaminants.
2. Further investigate potential RV dumping.
3. Conduct monitoring to assist with design decisions for the Mission Lagoon Restoration project.
4. Test for neonicotinoids, a group of pesticides that may be linked to colony collapse disorder in honeybees.
5. Test storm runoff from parking lots covered with coal-based parking lot sealcoat.
6. Conduct additional sampling at the Las Positas Golf Course to support management decisions during dry weather.
7. Collect baseline data for Storm Water Retrofit Projects.
8. Investigate high conductivity in a tributary of Sycamore Creek and also in Honda Creek.

Program Elements and Research Questions

Watershed Assessment

Research questions:

1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?
2. How contaminated and/or toxic is sediment at storm drain outfall sites?
3. Are pharmaceutical and personal care products (PPCPs) reaching creeks via irrigation runoff and water main breaks of reclaimed water?
4. Is contaminated groundwater at cleanup sites reaching creeks?

5. What is the source of the 303(d) impairment for Low Dissolved Oxygen on Mission Creek? How extensive in time and space is the impairment? (see Section C as well)
6. What is the source of the 303(d) impairment for Sodium and Chloride on Sycamore Creek? Is high conductivity near Chelham Creek from natural sources?
7. Is high conductivity in Honda Creek from natural sources?
8. What is the source of the impairment for toxicity on Mission Creek?
9. What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro?
10. Are new pesticides (pyerthroids and neonicotinoids) detected in dry conditions?
11. What are the impacts of reservoir flushing on metals?

Storm Monitoring

Research Questions:

1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms?
2. Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?
3. What are the loads of pyrethroids discharged from Santa Barbara creeks during storms?
4. Is runoff from coal tar sealed parking lots more toxic than runoff from asphalt sealed parking lots?
5. What are the loads of pollutants discharged from Santa Barbara creeks during storms?
6. How do restoration/treatment projects impact water quality during storm events?

Restoration and Water Quality Project Assessment

The Creeks Division has completed several restoration and water quality improvement capital projects over the past several years. Project assessment is used to determine the success of projects in lowering microbial and chemical pollution levels and improving water quality for aquatic organisms. In some cases project monitoring is grant-required, and the remaining is for internal review of project success. Additional monitoring is conducted to ensure that the facility is performing as intended.

Research Questions:

1. Do Creeks Division projects result in improved water quality, as reflected in pre- and post-project, and/or, upstream to downstream, conditions?
2. What is the baseline water quality at future restoration/treatment sites?
3. What are the mechanisms of project success?
4. Are installed projects functioning correctly?

List of Projects and Specific Questions

Westside SURF and Old Mission Creek Restoration

1. Is the UV disinfection equipment functioning?
2. What percentage of flow in Westside Storm Drain is the facility treating?
3. Have habitat scores and index of biological integrity (IBI) scores in Bohnett Park improved?

Arroyo Burro Restoration, including Mesa Creek daylighting

1. Have habitat and IBI scores in Mesa Creek improved?
2. Has water quality in Mesa Creek continued to improve?
3. How does Arroyo Burro Estuary biological integrity compare to other estuaries?

Hope and Haley Diversions

1. Are human waste markers still found in Hope and Haley Storm Drains?
2. What are the loads of fecal indicator bacteria (FIB) that are diverted to the sanitary sewer by these projects?

Golf Course Project Performance (Storm) and Operation (Dry weather)

1. Do treatment elements (Adams bioswale, East Basin, West Basin) reduce pollutant concentrations during storms?
2. What is the quality of water discharged during spillover conditions (East Basin, West Basin)?
3. What are the temporal and spatial patterns of pH, temperature, DO, and conductivity in the East Basin during dry weather?
4. What is the quality of water released prior to storm events from the East Basin and West Basin? What are the conditions in receiving water during releases?

McKenzie Parking Lot LID Retrofit (Storm)

1. Are basins functioning correctly?
2. Is design storm fully infiltrated?
3. What are rainfall, storage, and draw down patterns?

Debris Screens (Creek Walks)

1. Has the installation of catch basin screens lead to decreased trash observed in creeks?
2. Have the catch basin screens lead to decreased rotting plant material and/or FIB in storm drains?

Mission Creek Fish Passage (Dissolved Oxygen)

1. What are the conditions in creek segments where fish spend time waiting for passage conditions (above or below passages)?

Mission Lagoon Restoration and Laguna Channel Disinfection

1. Lagoon Inputs
    a. What does previously collected data show regarding nutrient input in Mission Creek and Laguna Channel?
    b. What are the current nutrient inputs (concentration and flow) from Mission Creek and Laguna Channel during dry weather?
    c. Does groundwater and/or nitrate enter Laguna Channel in the lower reach?
2. Lagoon Water Quality
    a. What does previously collected data show regarding sediment contamination in Mission Lagoon and Laguna Channel?
    b. What are the water quality conditions in the lagoon (DO, temperature, turbidity), at the surface and near the bottom?
    c. How do parameters respond to lagoon breaching and closing?
    d. How does macro-algae cover and biomass change after the lagoon is closed?
    e. What is the daily (weekly) condition of the estuary? Lagoon status, color, amount of floating algae?

Storm Water Infiltration Retrofit Projects (Prop 84)

1. What are the baseline conditions for the project?
3. What is the modeled post-development hydrograph?
4. What are the concentrations of pollutants in runoff from the sites?
5. What is the toxicity of runoff from the sites?
6. What is the modeled pre-development hydrograph?
7. Can we identify reference parking lots for which flow rates can be measured in addition to modeled? Include runon and runoff patterns in consideration of sites.

Bird Refuge Pilot Project

1. Does treatment increase dissolved oxygen levels througout the water column, compared to the untreated area?
2. How far horizontally does the improvement in oxygenation extend?
3. Is the color and/or clarity of the treated area different from the untreated area?
4. Is the odor in the treated area different from the untreated area?
5. Are nutrient levels different in the treated area vs. the untreated area?

6. Does treatment reduce slude and/or sediment depth, thereby increasing water depth, in the outlet arm?
7. What are baseline conditions for future restoration project?

Source Tracking/Illicit Discharge Detection

Research questions:

1. What are the causes of persistent beach warnings that occur?
2. Will Laguna Channel and the East Side Storm Drain show that human waste markers have been eliminated after sewer line repair work is completed? See also Hope and Haley Drains above.
3. RV dumping
    a. Is RV dumping a consistent problem in Santa Barbara?
    b. Does RV dumping and/or leaking occur? Yes
    c. How often/much does RV leaking/dumping occur (time, volume, and percent of RVs in town)?
    d. How does RV dumping/leaking scale to other fecal inputs, e.g. leaking sewers?
4. What are the FIB patterns in storm drains that have been identified visually as "clean" vs. "debris-laden" during CCTV work?
5. Does outfall screening show illicit discharges according to Center for Watershed Protection guidance (Creek Walks)?
6. Are new hot spots emerging?
7. Specific areas of concern: Barger Canyon, Las Positas Creek, San Roque
8. Can we implement a report card system to create an alert for field and sample results that are concerning?
9. Can we develop a field testing kit for enforcement?
10. What is the impact of reservoir flushing on metals and pH?

Creeks Walks/Clean ups

Research Questions:

1. Are there new problems in creeks that need to be addressed? Conduct outfall screening.
2. Can we see anything unusual in lower Arroyo Burro, regarding flow patterns?
3. Is the amount of trash in creeks decreasing over time?
4. Has the installation of catch basin screens lead to decreased trash observed in creeks?
5. Can we see any impairment to San Roque Creek, leading to drop in bioassessment scores?
6. What is the conductivity pattern in tributary to Sycamore Creek?

Bioassessment

The biological assessment element is used to assess and monitor the biological integrity of local creeks as they respond through time to natural and human influences.

Research Questions:

1. What is the baseline of biological integrity for benthic macroinvertebrates in creeks?
2. Are there differences between upper watershed and lower watershed sites?
3. Are there differences among watersheds?
4. How does the biological integrity in our creeks change over time?
5. How does the biological integrity respond to water quality and restoration projects?
6. What is the biological integrity of estuaries in Santa Barbara?

Stations sampled in FY 13.

Access DB Name	Watershed	Subwatershed	Project	Description
AB Cliff	AB		AB Cliff	Arroyo Burro @ Cliff Dr. LTER AB00 & AB44 & AB1850
AB ds SRC	AB		AB Est	Arroyo Burro below confluence with San Roque Creek (@ Hope Ave.) LTER AB40
AB Est Mou	AB		AB Est	Arroyo Burro lagoon mouth, Surface LTER AB31
AB Est Up	AB			Arroyo Burro lagoon just downstream of weir at AB Cliff
ACBRlandin	ACBR		Bird Refuge	Andre Clark Bird Refuge north landing (off Los Patos)
ACBRoutlet	ACBR		Bird Refuge	Andre Clark Bird Refuge outlet (@ Cabrillo Blvd.) by tide gate
BR1SURFACE			Bird Refuge	Bird Refuge site closest to outlet arm beginning (sample taken on surface)
BR4BOTTOM			Bird Refuge	Bird Refuge site closest to tide gate (sample taken on bottom)
CORP WELL				
Haley MH2	MC		Haley Diversion	Manhole upstream of CDS unit
Honda CC	HO			Honda Creek @ City College
Hope AB	AB	Hope	Hope Diversion	culvert at Arroyo Burro Creek under Hope Ave. bridge LTER AB81
LC CPP	LC		Laguna	Laguna Channel @ Chase Palm Park
LC fwyonC	LC		Laguna	Laguna Channel under freeway onramp- center
LC Pump	LC			Laguna Channel just upstream of Pump House
LHC MesaPk	LHC			Lighthouse Creek @ Mesa Park
MC Gutierr	MC	Haley	Haley Diversion	Mission Creek @ Gutierrez St. bridge LTER MC82
MC Haley	MC	Haley	Haley Diversion	MC at Haley
MC Monteci	MC		Haley Diversion	Mission Creek @ Montecito St. bridge LTER MC00, MC21, & MC40
Mesa lower	AB	Mesa	AB Est	Mesa Creek lower (formerly below culvert).
Mesa upper	AB	Mesa	AB Est	Mesa Creek upper (formerly above culvert)
Oak Main	MC			location where water discharges from main Parking Lot at Oak Park off of Junipero
Oak Picnic	MC			location where water discharges from paved area at Oak Park picnic area
Oak Stage	MC			location where water discharges from paved area near the Oak Park stage
Oak Tennis	MC			location where water discharges from Parking Lot at Oak Park tennis courts
OMC W Anap	MC	OMC	SURF	Old Mission Creek @ W. Anapamu/Bohnett Park LTER MC46 SURF570
SC Railroa	SC			Sycamore Creek @ Ninos Dr/railroad bridge
SRC us AB	AB			San Roque Creek upstream of Arroyo Burro
Stevens Pk	AB	SRC		location where water discharges from main Parking Lot at Stevens Park (near trash enclosure)
SURF down	MC	OMC	SURF	SURF facility downstream (after filter and uv treatment)
SURF up	MC	OMC	SURF	SURF facility upstream (before filter and uv treatment)
WS Neighbo	MC			location where water discharges from WS Neighborhood Center parking lot into drop inlet
WSD	MC	OMC	SURF	Westside Drain outlet LTER MC47

See Appendix 1 for Sampling Table and Appendix 2 for recommendations for FY 14.

Routine Watershed Assessment

Long Term Trends

Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?

- Plots of fecal indicator bacteria (FIB) over time at the main integrator and indicator sites are shown on the following pages. Rainfall patterns are also plotted.
- Data shown are for dry weather only, when there was no recorded rainfall at El Estero over the previous 72 hours.
- Sampling frequency was not consistent, with more frequent sampling earlier in the program.
- Despite wide variability in data, results suggest that there may be some reduction in FIB levels in recent years at some locations, e.g. Arroyo Burro at Cliff Drive. Possible reasons for reductions in FIB levels are low rainfall levels and the installation of catch basin screens. Catch basin screens on storm drain inlets, installed in June 2011, may reduce the amount of FIB growing on rotting plant material in storm drains.
- Statistical tests supported a reduction in FIB numbers at many sites, though few results are statistically significant.
- Conversely, FIB numbers have gone up significantly, and substantially, at Sycamore Creek since June 2011.
- Box plots of fecal indicator bacteria by month at integrator sites show that late summer and early fall have the highest indicator bacteria levels.
- Heal the Bay

Water Year	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13
Rainfall, In.	24.27	9.19	24.41	10.24	36.29	21.99	5.97	16.75	11.06	20.79	28.45	11.06	8.57

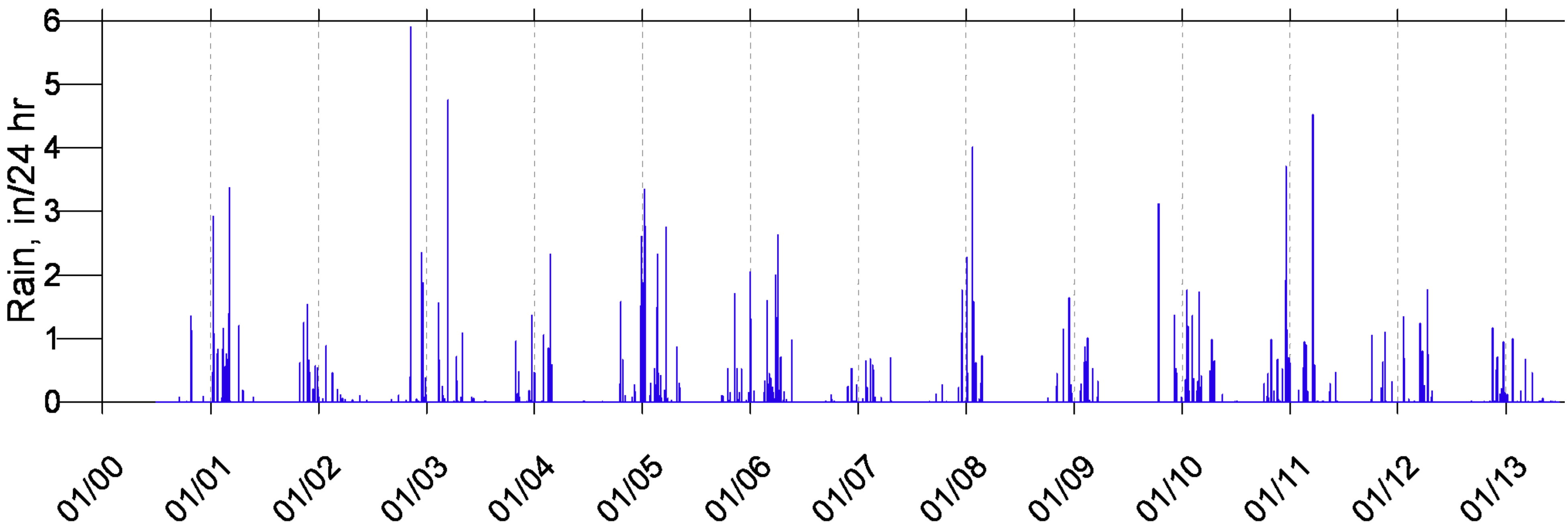


Figure 1. Rainfall at El Estero, 2000-2013.

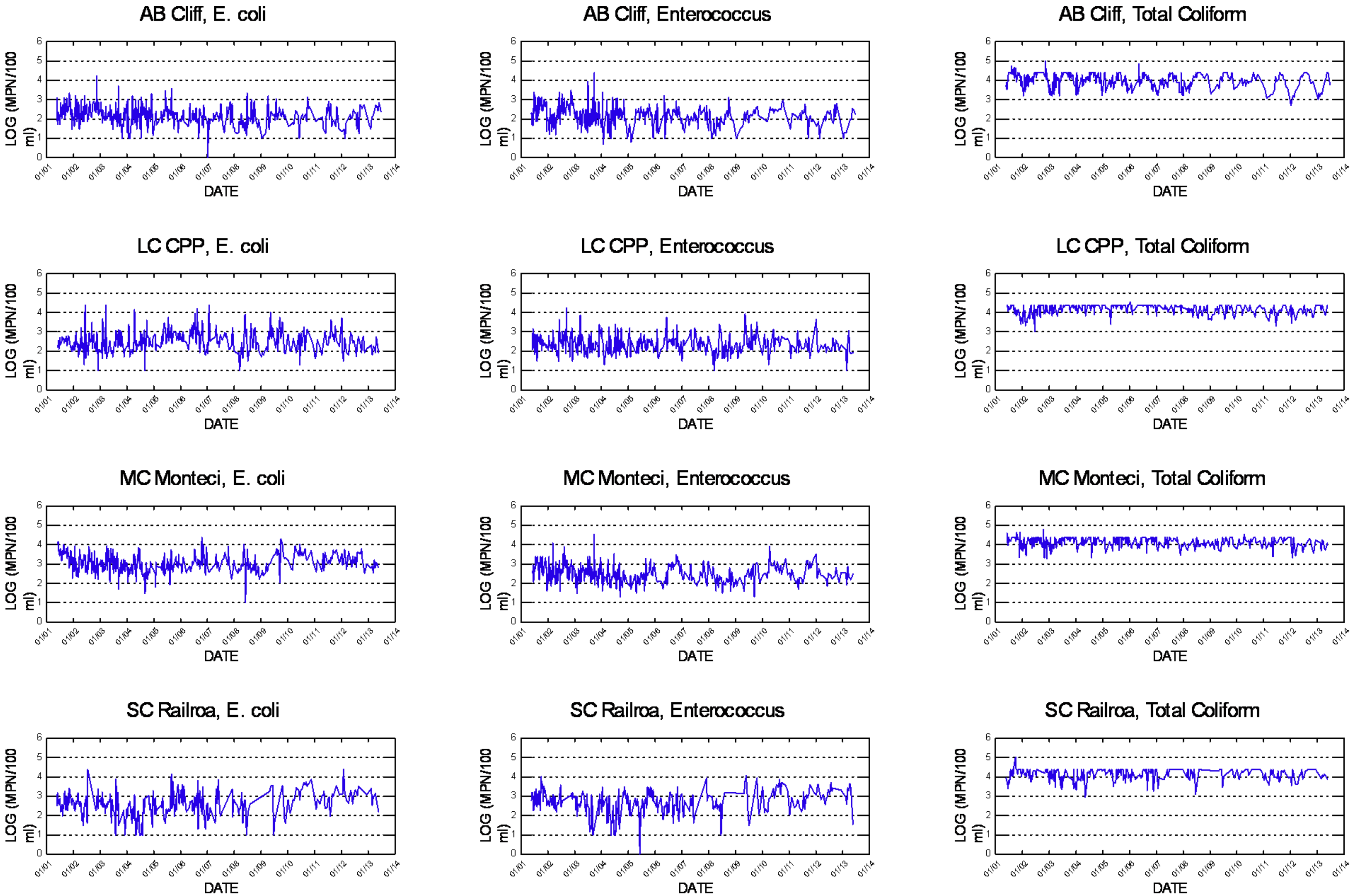


Figure 2. Time series line plot of fecal indicator bacteria at integrator sites.

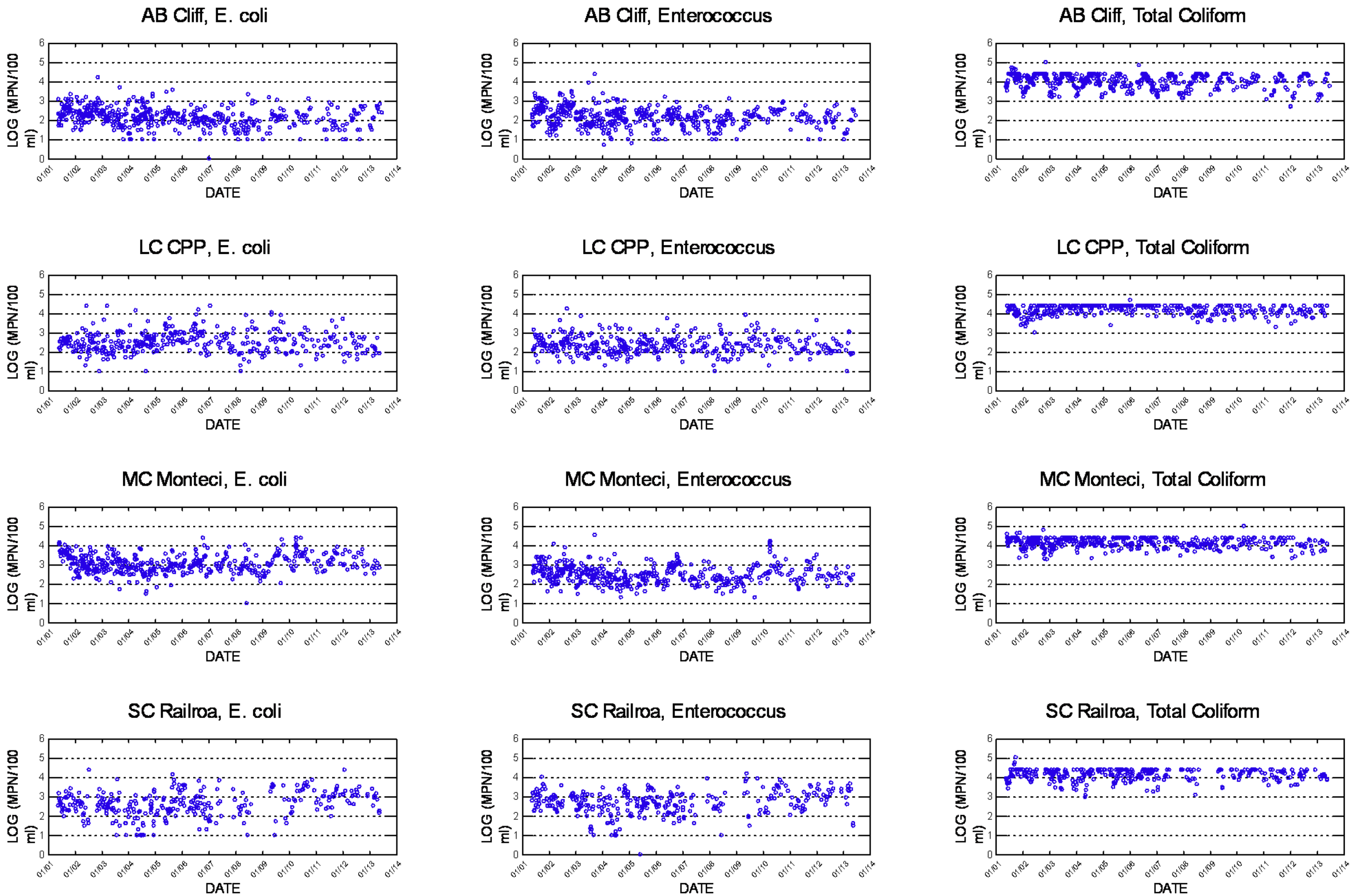


Figure 3. Time series scatterplot of fecal indicator bacteria at integrator sites.

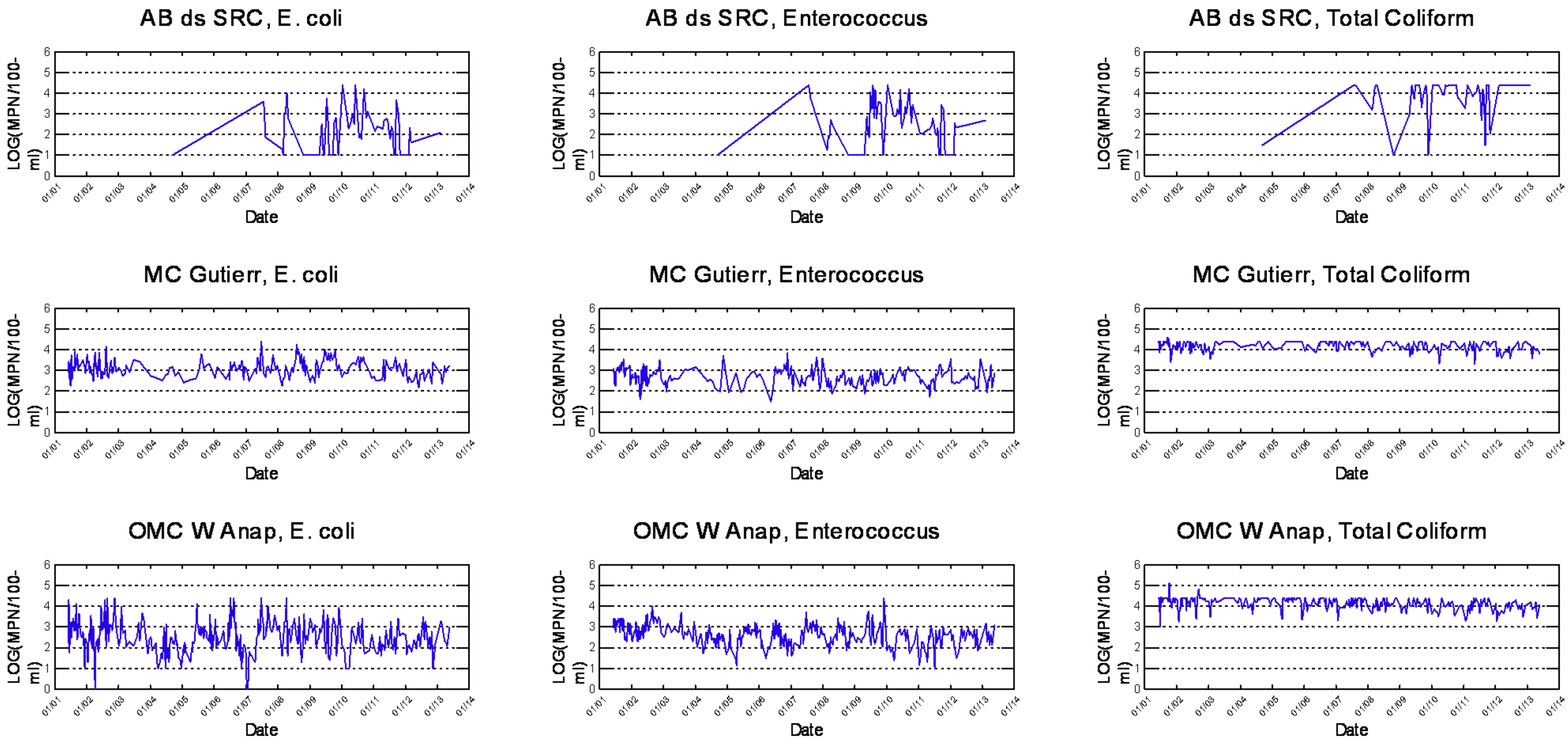


Figure 4. Time series line plot of fecal indicator bacteria at indicator sites.

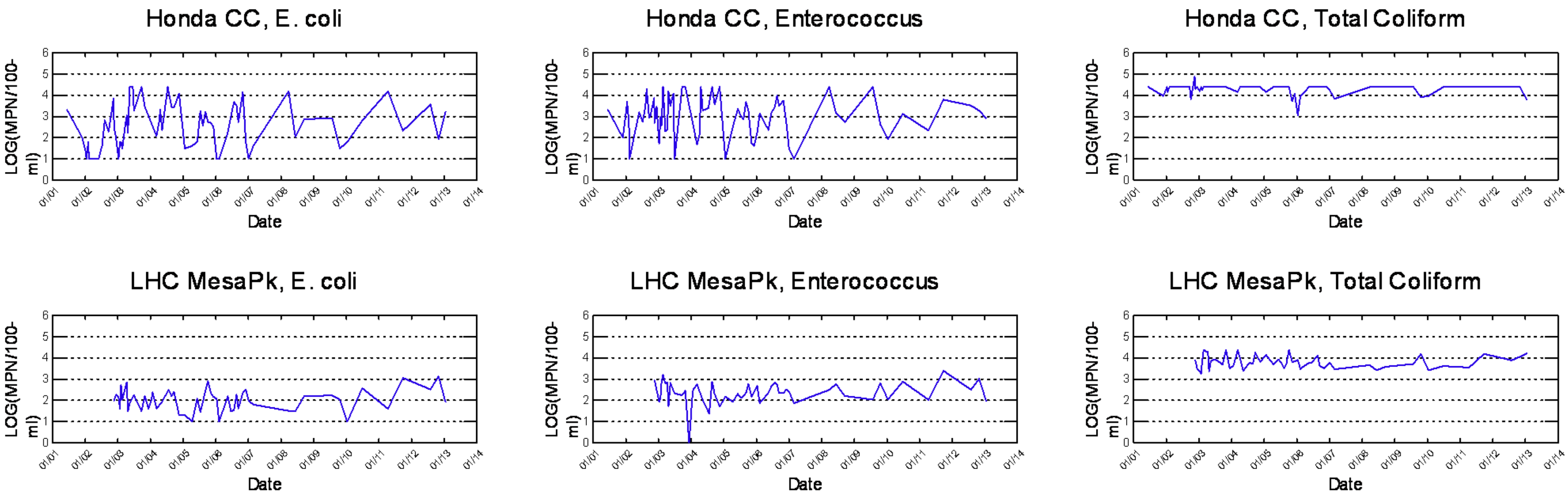


Figure 5. Time series line plot of fecal indicator bacteria at Honda Creek and Lighthouse Creek. Data are collected quarterly.

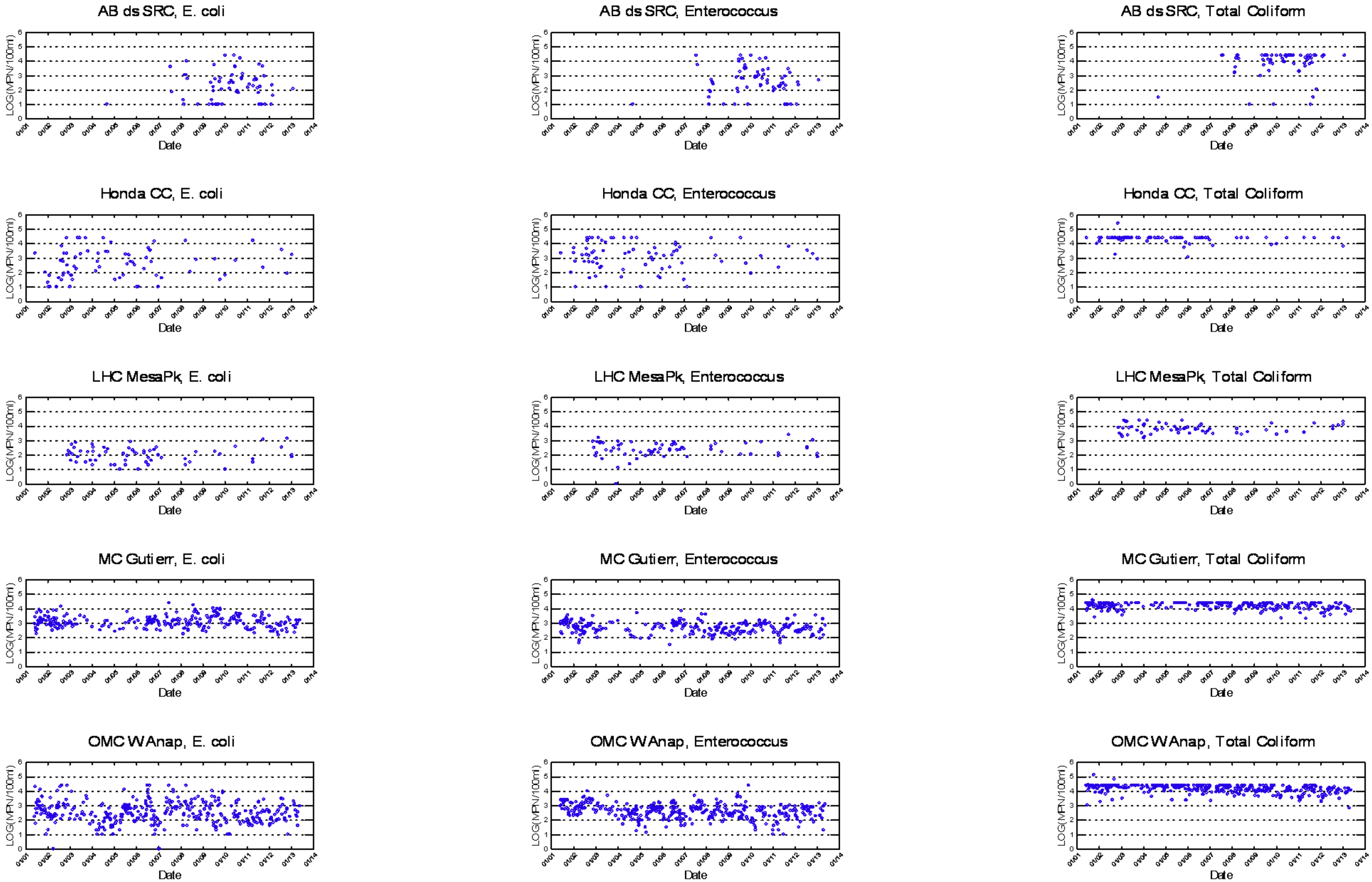
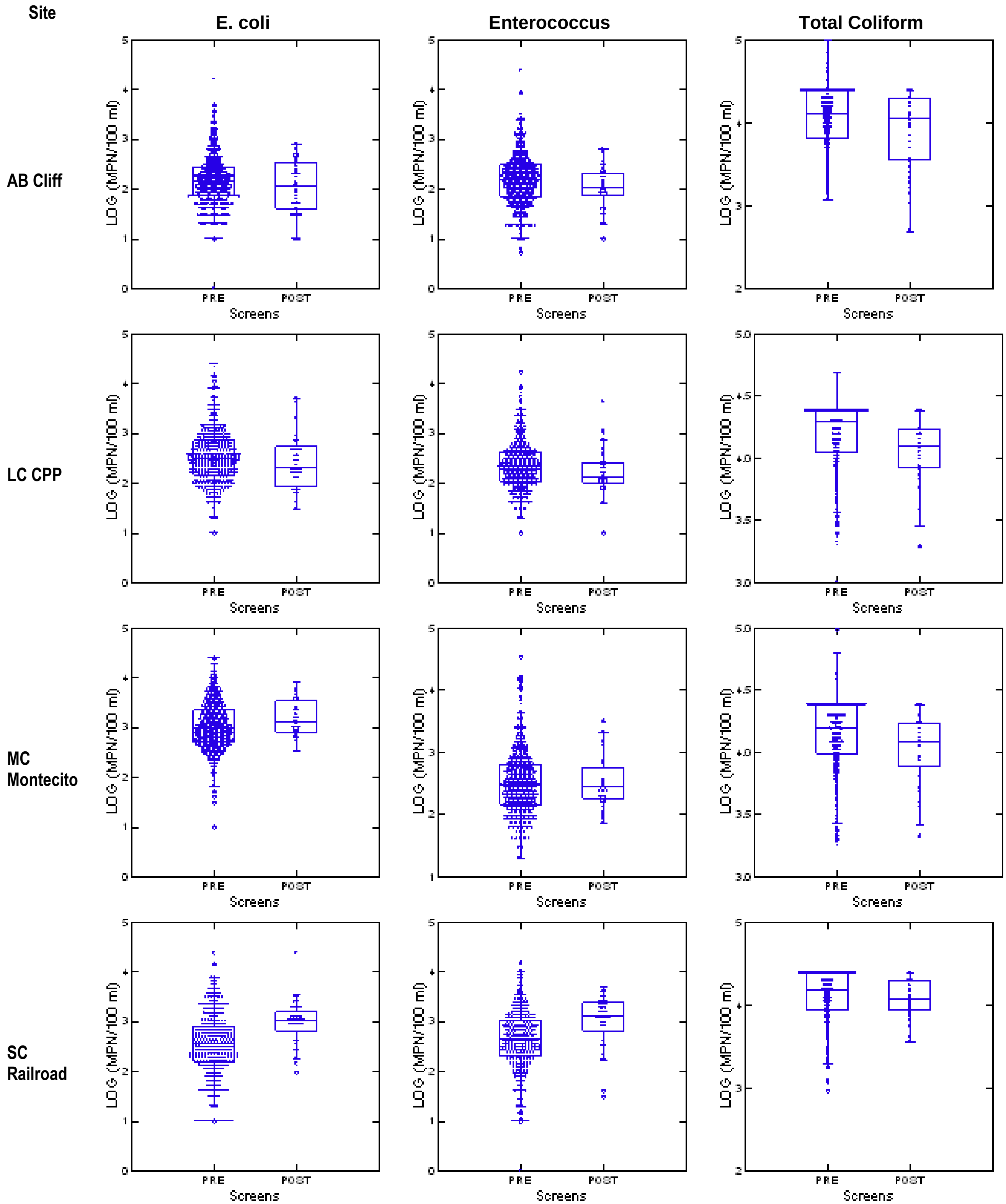
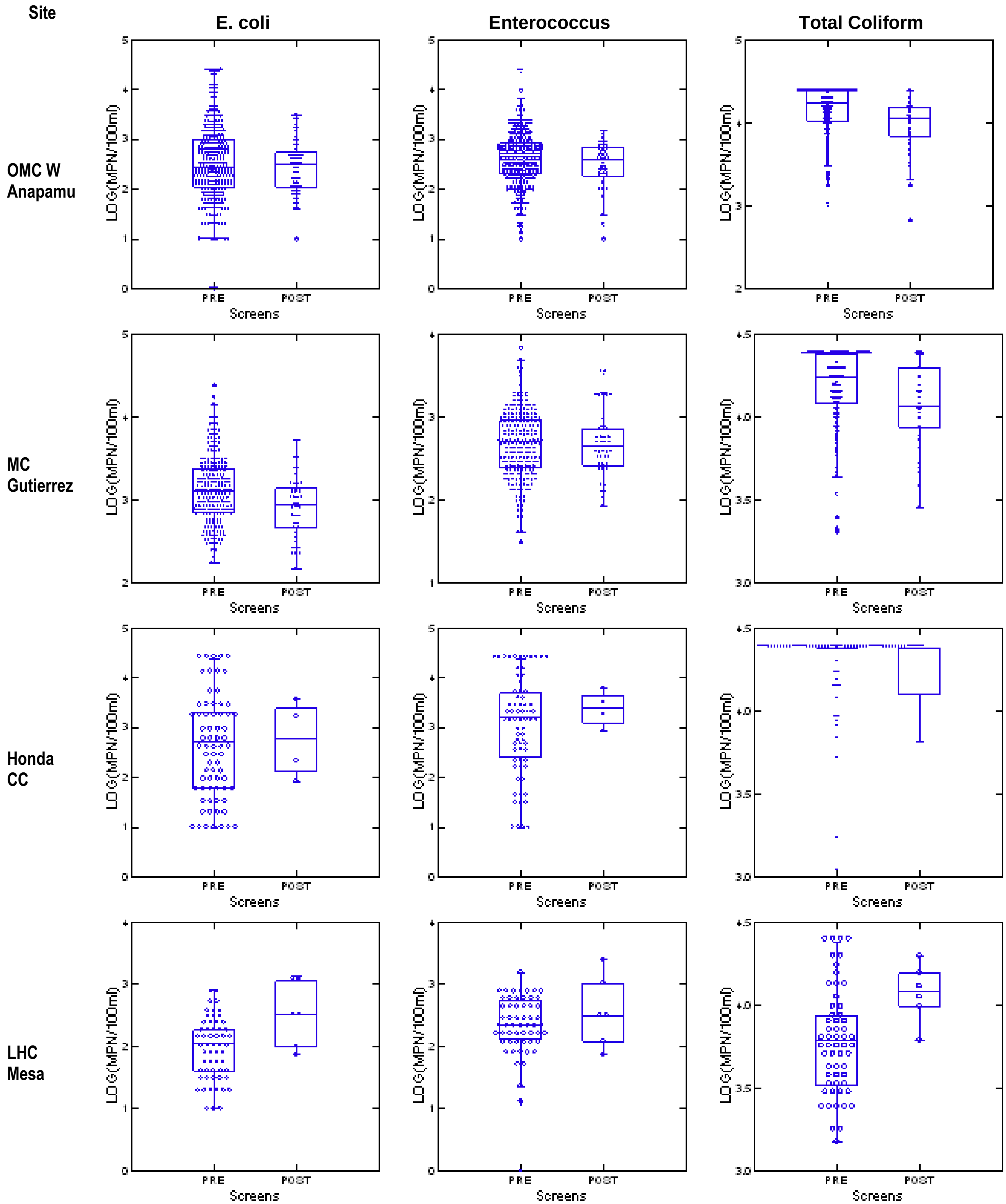


Figure 6. Time series scatterplot of fecal indicator bacteria at indicator sites, Honda Creek, and Lighthouse Creek.


Site
E. coli
Enterococcus
Total Coliform
AB Cliff
LC CPP
MC
Montecito
SC
Railroad
LOG (MPN/100 ml)
PRE
POST
Screens


Site
E. coli
Enterococcus
Total Coliform
OMC W Anapamu
MC Gutierrez
Honda CC
LHC Mesa
LOG(MPN/100ml)
PRE
POST
Screens

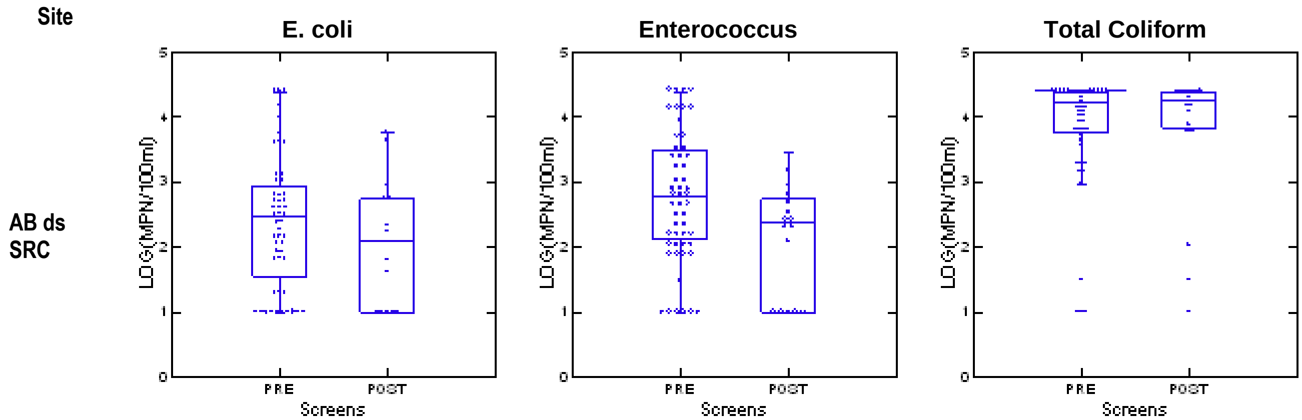


Figure 7. Box plots, with dot-density overlay, of fecal indicator bacteria levels before and after June 2011.

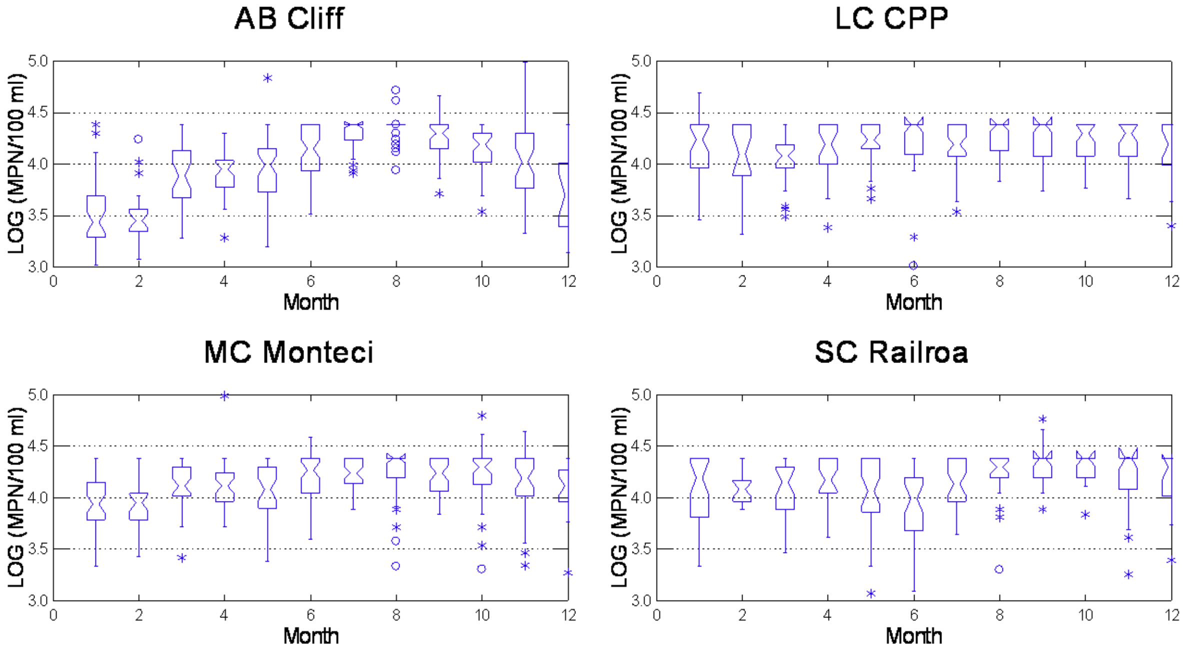
Table 1. Statistics for testing reduction in fecal indicator bacteria since June 2011.

TOTAL COLIFORM	Spearman Corr. FIB Vs time (no P value because too many tests)	Pre Screens (6/1/2011) Median (N)	Post Screens Median (N)	Prob. (K-S, two tail)
AB Cliff	-.185	12,997 (458)	11,199 (47)	0.37
LC CPP	-.064	19,863 (330)	12,515 (40)	0.006
MC Mont	-.125	15,531 (426)	12,033 (57)	0.23
SC Railroad	+.003	15,531 (274)	12,033 (39)	0.13
AB ds SRC		n/a	n/a	n/a
Honda CC		n/a	n/a	n/a
LHC Mesa		n/a	n/a	n/a
MC Gutierrez	-.207	17,329 (219)	11,616 (42)	0.004
OMC W Anap	-.430	17329 (317)	11,199 (53)	<0.001
SUMMARY	5/6 are (-)		6/6 decreased	3 significant diff. (p<0.05)

E. COLI	Spearman Corr. Vs time	Pre Screens (6/1/2011) Median (N)	Post Screens Median (N)	Prob. (K-S, two tail)
AB Cliff	-.267	146	120	0.13
LC CPP	0.22	325	203	0.275
MC Mont	0.02	1,009	1,334	0.048
SC Railroad	0.264	354	1,086	<0.001
AB ds SRC		n/a	n/a	n/a
Honda CC		n/a	n/a	n/a
LHC Mesa		n/a	n/a	n/a
MC Gutierrez	-0.039	1310	873	0.04
OMC W Anap	-.080	278	323	0.19
SUMMARY	3/6 are (-)		4/6 decreased	3/6 sig. diff, SC sig increase

ENTEROCOCCUS	Spearman Corr. Vs time	Pre Screens (6/1/2011) Median (N)	Post Screens Median (N)	Prob. (K-S, two tail)
AB Cliff	-0.197	157	154	0.20
LC CPP	-0.053	216	139	0.081
MC Mont	-0.113	300	282	0.61
SC Railroad	0.135	461	1,301	<0.001
AB ds SRC		n/a	n/a	n/a
Honda CC		n/a	n/a	n/a
LHC Mesa		n/a	n/a	n/a
MC Gutierrez	-0.165	512	439	0.39
OMC W Anap	-0.27	320	53	0.16
SUMMARY	5/6 are (-)		5/6 decreased	1 sig diff, SC sig increase

TOTAL COLIFORM



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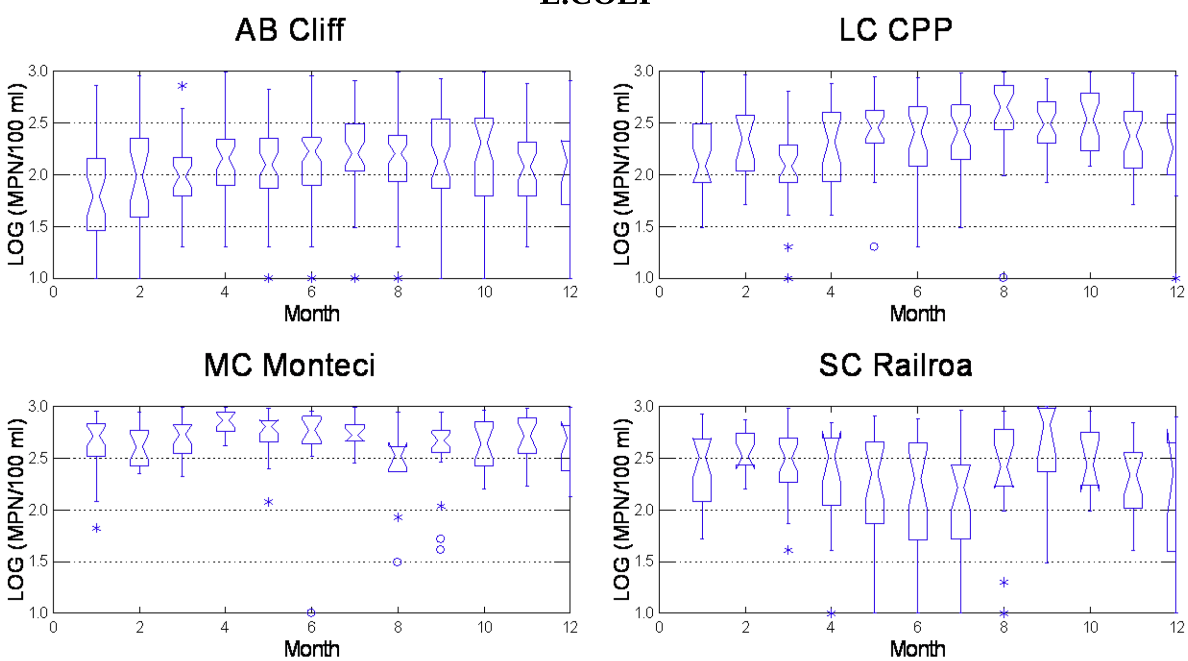


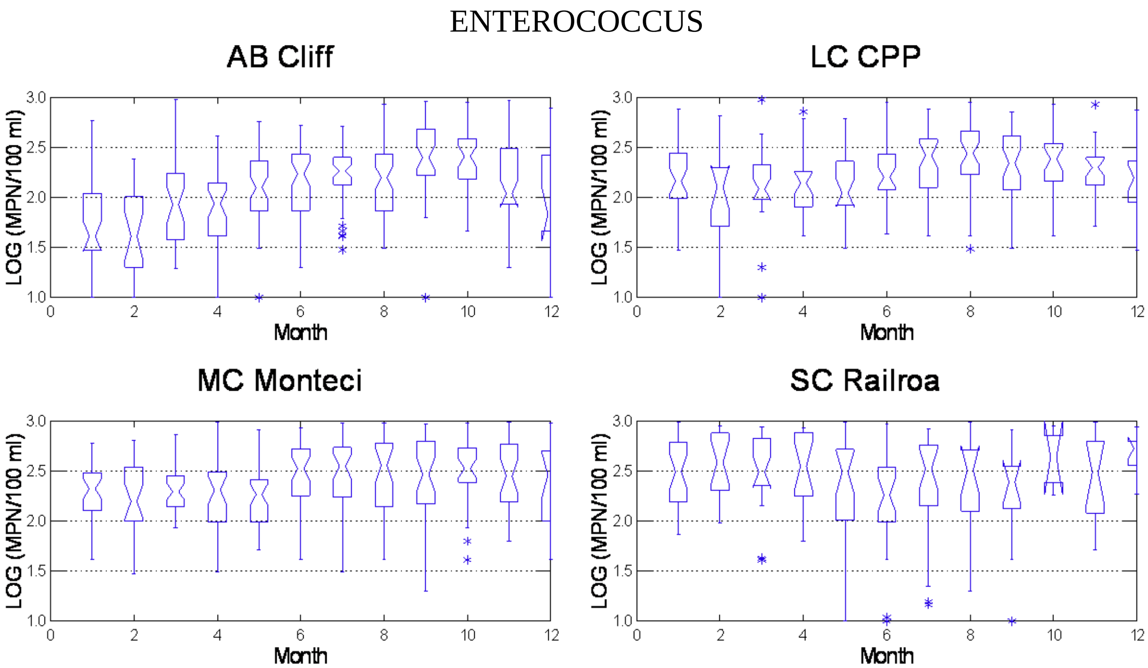


Figure 8. Monthly box plots of fecal indicator bacteria at integrator sites.

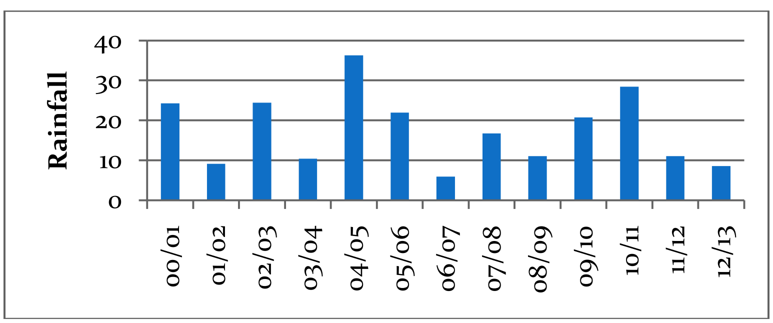
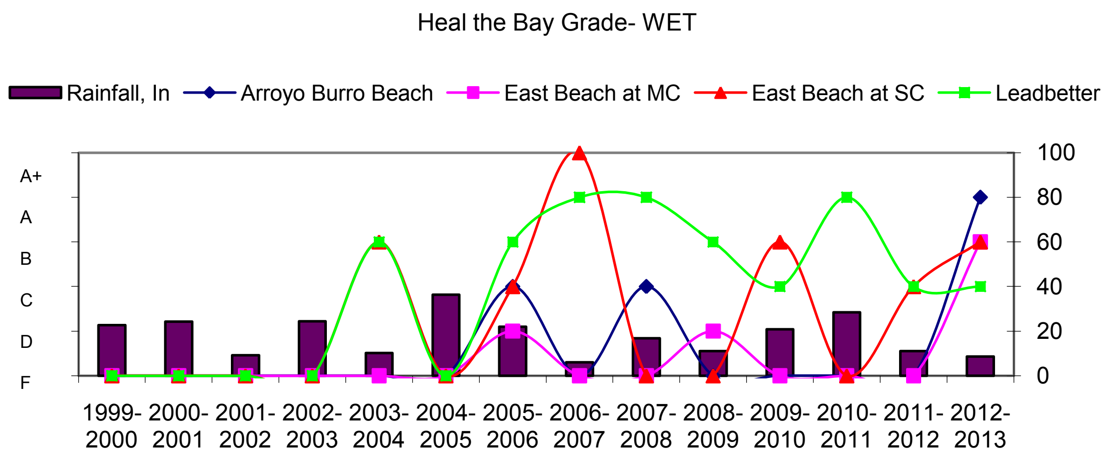
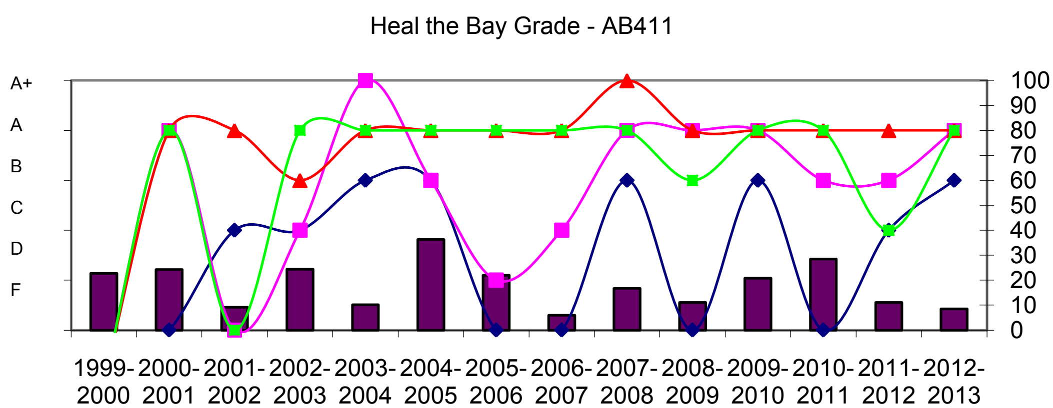


Figure 9. Rainfall totals by water year at El Estero.


Heal the Bay Grade- WET
Rainfall, In
Arroyo Burro Beach
East Beach at MC
East Beach at SC
Leadbetter
A+
A
B
C
D
F
100
80
60
40
20
0
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008
2008-2009
2009-2010
2010-2011
2011-2012
2012-2013


Heal the Bay Grade - AB411
A+
A
B
C
D
F
100
90
80
70
60
50
40
30
20
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0
1999-2000
2000-2001
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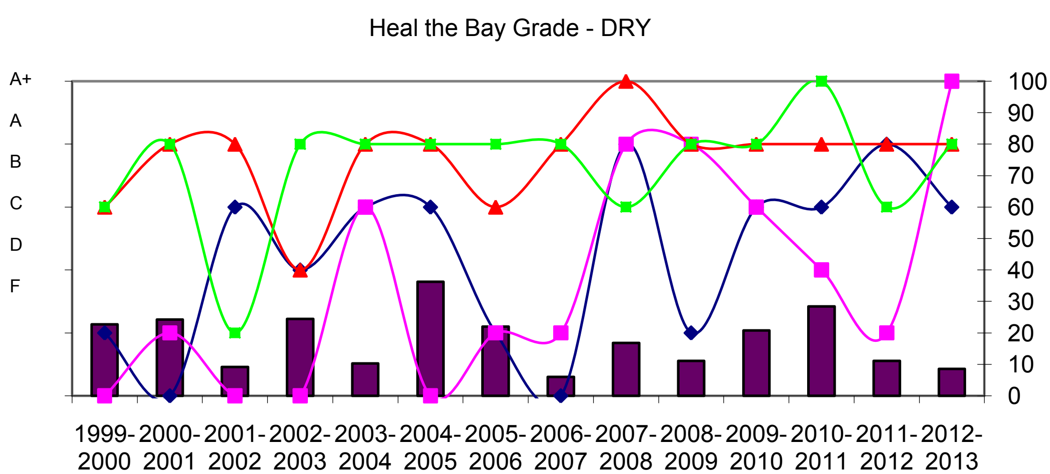
2009-2010
2010-2011
2011-2012
2012-2013


Heal the Bay Grade - DRY
A+
A
B
C
D
F
100
90
80
70
60
50
40
30
20
10
0
1999-2000
2000-2001
2001-2002
2002-2003
2003-2004
2004-2005
2005-2006
2006-2007
2007-2008
2008-2009
2009-2010
2010-2011
2011-2012
2012-2013

Sediment Contamination and Toxicity

How contaminated and/or toxic is sediment at storm drain outfall sites?

- Sediment was collected from Mission Creek Estuary, Arroyo Burro Estuary, Laguna Channel in order to support additional bioassement and/or project development at these sites.
- See text following tables for analysis of results.
- Results suggest from estuary sites are not indicative of chemical pollution problems.

Figure 1. Sediment Chemistry Results 2007-2012

Shading represents cases where concentrations exceeded relevant sediment criteria.

Constituent 2007 2008 2009 2010 2011 2012	Units	MDL[1]	Arroyo Burro Estuary	Mission Lagoon	Sycamore Lagoon	CSI and CALRM Criteria[2]	Laguna Channel	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W Anapamu	SC Cacique/ Soledad	PEC[3]
Metals, mg/kg														
Cadmium	mg/kg		0.51	0.179	0.35	NA/0.49	0.998							4.98
			0.41	0.173	0.71		0.629	0.446						
			0.75	0.16	0.09		0.65	0.42						
		0.14	0.37	ND	ND		1.25	0.874	ND	0.6	ND	0.251	0.183	
		0.49*	ND	ND	ND		0.70	ND	ND	ND	ND	ND	ND	
		0.2	0.53	ND			0.64	ND	ND			ND		
Copper	mg/kg		13.5	8.0	13.2	52.8/77	20							149
			8.6	8.0	15.6		21	58						
			13.3	5.7	8.8		17	20						
			20.2	9.1	7.2		30	58	8.7	7.0	7	7.8	10	
		2	ND	2.9	8.6		33	10	5.8	5.0	13	7.2	13	
		0.38	ND	ND			14	4	5.5		9	9.3		
Lead	mg/kg		4.4	5.41	4.96	26/26.4	37							128
			7.2	13.9	6.84		26	18						
			7.3	6.4	7.3		20	10						
			13.3	8.66	5.84		35	30	5	7.2	5.5	7.3	10	
		2	ND	3.6	8.7		26	5	21	4	7.8	5.3	7	

Constituent 2007 2008 2009 2010 2011 2012	Units	MDL[1]	Arroyo Burro Estuary	Mission Lagoon	Sycamore Lagoon	CSI and CALRM Criteria[2]	Laguna Channel	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W Anapamu	SC Cacique/ Soledad	PEC[3]
		0.5	4.3	2.7			31	3.6	3		9.8	30		
Mercury (not tested in	mg/kg	0.013	ND	ND	ND	0.09/0.58	0.039							1.06
2010)		0.013	ND	0.0317	0.0215		0.033	0.029						
		0.01	0.038	ND	ND		0.046	0.032						
		0.02	ND	ND	ND		0	ND	ND	0.1	ND	0	ND	
		0.012	0.031	0.059			0.41	0.022	ND		0.022	0.068		
Zinc	mg/kg		39	30	22	112/66	109							459
			35	31	57		81	33.7						
			57	25	32		113	36.9						
			65	33	24		186	114	24	33	24	41	36	
		5	ND	14	28		120	22	20	26	43	32	38	
			4.3	12			87	16	22		35	65		
Arsenic	mg/kg		2.4	2.0	2.7	n/a	3.8							33
			3.5	2.6	4.4		3.9	2.5						
			6.4	4.3	3.2		5.6	7.2	3.3	2.7	3.5	1.1	4.6	
		2	2	ND	3.2		2.4	ND	2.2	ND	5.0	ND	ND	
		0.82	2.2	2.2			3.3	ND	4.1		3.6	ND		
Chromium	mg/kg		16	15	10.5	n/a	13	9						111
			20	12	29.2		12							
			46		11.3		20	44	19	26	9	17	14	
			9	16	16		12	8	11	10	16	14	12	
			16	15			9	5	12		10	8		
Nickel	mg/kg		24	13	13	n/a	14	12						48.6
			21	11	33		11							
			48	11	11		16	40	18	15	8	15	13	
			4	6	16		12	7	12	9	13	11	10	
			17	5			10	5	19		11	9		
Selenium	mg/kg	0.308	ND	ND	ND	n/a	ND	ND						n/a
		0.328	1.9	1.6	3.95		2.9							
			0.60	0.18	0.223		1.1	2.3	0.20	0.26	0.14	0.23	0.57	
		2	2.2	2.6	ND		2.4	ND	ND	3.0	ND	ND	3.9	
		1	ND	ND			ND	ND	ND		ND	ND		
Silver (not tested in 2009,	mg/kg	0.015	ND	ND	ND	n/a	0.229	ND						n/a

Constituent 2007 2008 2009 2010 2011 2012	Units	MDL[1]	Arroyo Burro Estuary	Mission Lagoon	Sycamore Lagoon	CSI and CALRM Criteria[2]	Laguna Channel	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W Anapamu	SC Cacique/ Soledad	PEC[3]
2011, and 2012)		0.009	ND 0.258	ND 0.153	ND 0.222		0.33 0.408	0.600	0.274	0.202	0.223	0.151	0.236	

Laboratory Error in 2011 and 2012 (All NDs, but DLs below criteria, except freshwater in 2012)

PAHs 2007 2008 (not tested in 2009) 2010 2011 2012	Units	MDL	Arroyo Burro	Mission	Sycamore	CSI and CALRM Criteria	Laguna	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W Anapamu	SC Cacique	PEC
Total LMW PAHs	µg/kg	<15 for all PAHs	ND 171 122	ND 223 35	ND 129 9	85.4/1700	909 384 ND	77 ND	 ND		 ND	 ND		n/a
Naphthalene	µg/kg	 1.39 180	ND 130 13.8	ND 80 4.01	ND 96 ND		20 160 ND	ND ND	 ND		 ND	 ND		561
Acenaphthylene	µg/kg	 1.39 210	ND ND ND	ND ND ND	ND ND ND		ND ND ND	ND ND	 ND		 ND	 ND		n/a
Acenaphthene	µg/kg	 1.39 180	ND ND ND	ND ND ND	ND ND ND		140 ND ND	ND ND	 ND		 ND	 ND		n/a
Fluorene	µg/kg		ND ND	ND ND	ND 11		ND ND	ND						536

		1.39 210	2.3	1.64	ND		ND	ND	ND		ND	ND		
Phenanthrene	µg/kg	180	ND ND 16.1	ND 23 7.96	ND ND 1.78		39 32 ND	ND ND	ND		ND	ND		1170
Anthracene	µg/kg	1.39 240	ND ND 3.18	ND ND 1.77	ND ND ND		50 ND ND	ND ND	ND		ND	ND		845
Fluoranthene	µg/kg	210	ND ND 44.1	ND 67 19.7	ND ND 3.93		410 72 ND	33 ND	ND		ND	ND		2230
Pyrene	µg/kg	230	ND 41 42.7	ND 53 17.9	ND 22 2.99		250 120 ND	44 ND	ND		ND	ND		1520
Total HMW PAHs	µg/kg		ND 71 194	ND 169 104	ND 404 33	312/5500	328 1165	ND						n/a
Benzo (a) Anthracene	µg/kg	210	ND 18 39.4	ND 29 20.9	ND ND 6.86		54 40	ND ND	ND		ND	ND		1050
Chrysene	µg/kg		ND 27 56.1	ND 49 26	ND 14 8.79		72 78	ND						1290

		220						ND	ND		ND	ND		
Benzo (b) Fluoranthene	µg/kg	150	ND ND 17.1	ND ND 11.1	ND ND 5.21		54 ND	ND ND	ND		ND	ND		n/a
Benzo (k) Fluoranthene	µg/kg	210	ND 60 9.46	ND 16 11.4	ND 390 2.99		40 1000	ND ND	ND		ND	ND		n/a
Benzo (a) Pyrene	µg/kg	160	ND ND 11.4	ND 27 6.69	ND ND 3.23		41 ND	ND ND	ND		ND	ND		1450
Dibenz (a,h) Anthracene	µg/kg	1.39 290	ND ND 15.9	ND ND 12.7	ND ND ND		ND ND	ND ND	ND		ND	ND		n/a
Benzo (g,h,i) Perylene	µg/kg	320	ND 11 13.7	ND 17 10	ND ND 6.32		35 ND	ND ND	ND		ND	ND		n/a
Indeno (1,2,3-c,d) Pyrene	µg/kg	1.39 380	ND ND 23	ND 31 16.3	ND ND ND		32 47	ND ND	ND		ND	ND		n/a
1-Methylnapthalene	µg/kg	1.39	ND 3.89	ND ND	ND ND		ND	ND						n/a
2-Methylnapthalene	µg/kg		ND	ND	ND		ND	ND						n/a

		1.39	4.68	ND	ND									
Total PAHs	µg/kg		ND 242 319	ND 392 139	ND 533 42		1237 1549	77						22800
Chlorinated Pesticides 2007 2008 2009 2010 2011 2012	**Units**	**MDL**	**Arroyo Burro**	**Mission**	**Sycamore**	**CSI and CALRM Criteria**	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Gutierrez**	**OMC W Anapaum**	**SC Cacique**	**PEC**
Chlordane, alpha	µg/kg	4 1 0.15 1.2-6.4 250 4-20	ND ND 1.5	ND ND 0.45	ND ND ND	0.5/4	ND ND 1.3 12.8	 ND ND	 ND ND	 2.92	 ND ND	 5.94	 2.38	17.6
Chlordane, gamma	µg/kg	4 4 0.14 1.2-6.1 250 4-20	ND ND 2.7	ND ND 0.86	ND ND 0.32	0.54/n/a	12 9.7* 4.8 13.4 ND	 ND ND ND	 ND ND	 2.24	 ND ND	 4.57	 2.04	17.6
DDDs, total	µg/kg	<0.68 <0.68 <0.2 1.1-6.1 25 7.5	ND ND 1.31	ND ND 0.16	0.37 ND ND	0.5	3.39 ND 2.9 ND	 0.33 ND 8.4	 ND ND	 ND	 ND ND	 ND	 4.95	28
DDEs, total	µg/kg	<.68 <0.68 <0.2 <1.73 25 3-15	ND ND 1.9 ND	ND ND 0.4 ND	0.55 ND 0.28 ND	0.5	2.6 1.2 2.3 ND	 0.98 ND ND	 ND ND	 ND	 ND ND	 ND ND	 ND	31.3
DDTs, total	µg/kg	<0.68 <0.68 <0.1	ND ND 0.51	ND ND 0.18	ND ND 0.16	0.5	0.73 ND 2.1	 ND						62.9

		1.1-6.1 25 3-15					ND ND ND	ND ND ND	ND ND ND	ND	ND ND ND	ND ND ND	4.41	
Total DDT	µg/kg		ND ND 3.72	ND ND 0.74	0.92 ND 0.76	n/a	6.72 1.2 7.3 ND	1.31 ND	ND	ND	\ ND	ND	9.35	572
Dieldrin	µg/kg	1.1-6.1 25 3-15	ND ND 2.1	ND ND 0.29	ND ND ND	na/2.7	ND ND 2.2 ND ND ND	ND ND ND 13	ND ND ND	ND ND	ND ND ND	ND ND ND	ND	61.8
trans-Nonachlor 2009 2010	µg/kg	1.1-6.1	2.3	0.64	0.29	4.7	2.5 11.3	ND	ND	3.77	ND	6.31	2.54	n/a
Endrin	µg/kg	1.1-6.1 25 3-15	ND ND ND ND	ND ND ND ND	ND ND ND	n/a	0.25 ND ND ND ND	ND ND ND 8	ND ND ND	ND ND	ND ND ND	ND ND ND	ND	207
Heptoclor epoxide	µg/kg	1.1-6.1 25 2-20	ND ND ND ND	ND ND ND ND	ND ND	n/a	ND ND ND	ND ND	ND ND	ND	ND	ND	ND	16
Lindane	µg/kg	25 15	ND ND ND ND	ND ND ND ND	ND ND ND	n/a	ND ND ND	ND ND	ND	ND	ND	ND	ND	4.99
All other EPA 8081A (Chlorinated Pesticides)	µg/kg		ND ND	ND ND	ND ND	n/a	ND ND	ND						n/a
Pyrethroids (EPA 8270CmNCl)	**Units**		**Arroyo Burro**	**Mission**	**Sycamore**	**CSI and CALRM Criteria**	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Gutierrez**	**OMC W Anapaum**	**SC Cacique**	**SCCWR P LC 50**
Bifenthrin	ng/g dry	0.57- 3.07	ND ND 6.7 0.972	ND ND 2.4 ND	ND ND ND ND	n/a	ND ND 7.1 6.11	3 ND ND	ND	ND	ND	2.31	ND	4.5

		1.5- 30x10^3 0.3-1.2 x10^3	ND ND	ND ND	ND									
Cyfluthrin	ng/g dry	0.57- 3.07 1.5-30 0.2-0.6 x10^3	ND ND ND ND ND ND	ND ND ND ND ND ND	ND ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	13.7
Deltamethrin	ng/g dry	0.57- 3.07 1.5-30 0.8-0.7 x10^3	ND ND ND ND ND ND	ND ND ND ND ND ND	ND ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	9.9
Esfenvalerate	ng/g dry	0.57- 3.07 3-12 0.3-1.2 x10^3	ND ND ND ND ND ND	ND ND ND ND ND ND	ND ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	24
Lambda-cyhalothrin	ng/g dry	0.57- 3.07 1.5 0.26-1 x10^3	ND ND ND ND ND ND	ND ND ND ND ND ND	ND ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	5.6
Permethrin	ng/g dry	29-153 3-60 x10^3 0.86 x10^3	ND ND ND ND ND ND	ND ND ND ND ND ND	ND ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	90
All other EPA 8270	ng/g dry	0.57- 3.07	ND ND ND ND	ND ND ND ND	ND ND ND ND	n/a	ND ND ND ND	ND ND ND	ND	ND	ND	ND	ND	n/a

		<30 <1.2 x10^3	ND ND	ND ND	ND		ND ND	ND ND	ND ND	ND	ND ND	ND ND	ND	
Other Pesticides and Herbicides	**Units**		**Arroyo Burro**	**Mission**	**Sycamore**	**CSI and CALRM Criteria**	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Gutierrez**	**OMC W Anapaum**	**SC Cacique**	**SCCWRP LC 50**
EPA 8141A (Organophosphorus Pesticides) Not sampled in 2009.	µg /kg	? 5.1-60	ND ND ND ND	ND ND ND ND	ND ND ND	n/a	ND ND ND ND	ND ND ND	ND ND	ND	ND ND	ND ND	ND	n/a
EPA 8151A (Chlorinated Herbicides) Not sampled in 2009, 2011, 2012)	µg/kg		ND ND	ND ND	ND ND	n/a	ND ND	ND						n/a
Fipronil (phenylpyrazole insecticide). Only tested in 2009, 2010	µg/kg	43-233	ND ND	ND ND	ND ND	n/a	ND ND	ND ND						n/a
Pentachlorophenol (2010, 2011)	µg/kg	57-301 25000	ND	ND	ND		ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	ND ND	
PCBs	µg/kg	12	ND ND 1.13 ND	ND ND 0.70 ND	ND ND 1.16	11.9/325	36 ND 6.92 ND	ND ND	ND		ND	ND		676

(Many NDs could not be used in 2011 and 2012 due to high DLs)
-"Probable Effects Concentration" (PEC) refers to the concentration above which probable toxic effects would be predicted (Macdonald, et al., 2006).
-SCCWRP LC50 are described below and taken from the Habitat Value of Urban Streams (SCCWRP, 2008).
-"n/a" means that the compound was not included in the analysis and that no guidelines have been identified.
-Chlorinated pesticides: Alpha-BHC; Gamma-BHC; Beta-BHC; Heptachlor; Delta-BHC; Aldrin; Heptachlor Epoxide; Endosulfan I; Dieldrin; 4,4'-DDE; Endrin; Endrin Aldehyde; 4,4'-DDD; Endosulfan II; 4,4'DDT; Endosulfan Sulfate; Methoxychlor; Chlordane; Toxaphene; Endrin Ketone
-Pyrethroids (8270): Allethrin, Bifenthrin, Cyfluthrin, Cypermethrin, Danitol, Deltamethrin, Esfenvalerate, Fenvalerate, Fluvalinate, L-Cyhalothrin, Permethrin, Prallethrin, Resmethrin
Organophosphorus pesticides: Azinphos Methyl; Bolstar; Chlorpyrifos; Coumaphos; Demeton-o; Demeton-s; Diazinon; Dichlorvos; Disulfoton; Ethoprop; Fensulfothion; Fenthion; Malathion; Merphos; Methyl Parathion; Mevinphos; Naled; Phorate; Ronnel; Stirophos; Tokuthion; Trichloronate

Table 1 Sediment Toxicity for Estuarine Sites (All Data Scaled to Control)

Year	Test**	Endpoint	Arroyo Burro Estuary	Mission Lagoon	Sycamore Lagoon
2007	Acute, Euhastoriaus 10-day	% Survival	99	98	98
2008	Acute, Euhastoriaus 10-day	% Survival	90*	92*	95*
2009	Chronic, Mytilus	% Normal	91	90	95
2010	Acute, Euhastoriaus 10-day	% Survival	99	100	98
2011	Acute, Euhastoriaus 10-day	% Survival	100	100	100
2012	Acute, Euhastoriaus 10-day	% Survival	100	100	No sample

* Results are significantly different from the control (p<0.05).
** SQO guideline for nontoxic, Euhaustorius survival: 90-100% survival with significant difference, 82-100% no significant difference. For nontoxic, Mytilus normal, 82-100% with significant difference, 77-79% without.

Table 2 Sediment Toxicity for Freshwater Sites (All Data Scaled to Control)

Year	Test	Endpoint	Laguna Channel	Bird Refuge	AB Torino	LPC Modoc	MC Gutierrez	OMC W. Anapamu	SC Cacique
2007	Acute, Euhastoriaus 10-day	% Survival	100						
2008	Acute, Euhastoriaus 10-day	% Survival	92*	93*					
2009	Chronic, Mytilus	% Normal	99						
2010	Acute, Hyalella	% Survival	99	100	100	100	100	100	100
2011		% Survival	97	100	94	97	84*	100	97
2012		% Survival	100	100	100	No sample	100	85	No sample

* Results are significantly different from the control (p<0.05).

Estuarine Sites - SWRCB Sediment Quality Objective Analysis

Chemistry Line of Evidence- The data were used to follow the steps outlined in the SQO to determine the sediment condition based on chemistry and toxicity. The chemistry LOE is used to assess the potential risk to benthic organisms from toxic pollutants in surficial sediments. The sediment chemistry LOE is intended only to evaluate overall exposure risk from chemical pollutants. This LOE does not establish causality associated with specific chemicals.

For each constituent, exposure categories are described in the following table:

Exposure Level	Score	Predicted Effect on Biota
Minimal	1	Sediment-associated contamination may be present, but exposure is unlikely to result in effects.
Low	2	Small increase in pollutant exposure that may be associated with increased effects, but magnitude or frequency of occurrence of biological impacts is low.
Moderate	3	Clear evidence of sediment pollutant exposure that is likely to result in biological effects; an intermediate category.
High	4	Pollutant exposure highly likely to result in possibly severe biological effects; generally present in a small percentage of the samples.

1. The Chemical Score Index (CSI), which predicts the degree of benthic community disturbance, was computed for each estuarine site and constituent. Maximum scores observed over 5-7 years were used in the analysis. Scores above 1 indicate constituents of concern. A weighted score for each constituent is calculated, and then averaged to result in a weighted average for each site. The weighted average is used to determine the overall disturbance category, based on the SQO.

Chemical Score Index (Based on SQO)

	AB	MC	SC
Copper	1	1	1
Lead	1	1	1
Mercury	1	1	1
Zinc	1	1	1
PAHs low	2	2	2
PAHs high	1	1	2
Chlordane, alpha	3	1	1
Chlordane, gamma	3	2	1
DDDs	2	1	1

DDEs	2	1	2
DDTs	2	1	1
PCBs	1	1	1
Weighted Average	1.6	1.2	1.1
Category Assigned	Minimal	Minimal	Minimal
Score Assigned	1	1	1

2. The California Logistic Regression Model (CALRM) was used to predict the probability of sediment toxicity based on concentrations of each constituent. The maximum probability for each site is calculated, and used to identify a category of response. The maximum observed concentration observed over the three years of sampling was used for each compound and site. Probabilities of ≥ 0.33 are considered indicative of probable toxicity, and are highlighted in the table below. Cadmium was the only constituent to exceed the threshold. Zinc was also found at relatively high levels at each site, and dieldrin was high at Arroyo Burro Lagoon.

CA Logistic Regression Model

Constituent	**AB**	**MC**	**SC**
Cadmium	0.47	0.11	0.45
Copper	0.10	0.04	0.08
Lead	0.18	0.19	0.11
Mercury	0.02	0.03	0.01
Zinc	0.32	0.19	0.29
PAHs, high	0.03	0.03	0.06
PAHs, low	0.09	0.08	0.06
Chlordane, alpha	0.07	0.01	0.00
Dieldrin	0.27	0.04	0.00
trans-Nonachlor	0.09	0.01	0.00
PCBs	0.01	0.01	0.01
p,p' DDT	0.01	0.00	0.00
Maximum P	0.47	0.19	0.45
Score	2	1	2
Category Assigned	Low	Minimal	Low

3. *An integration of sediment chemistry* categories is conducted by averaging the score using the two methods, and rounding up to the nearest integer.

Integration of Sediment Chemistry

Site	Chemical Score Index	California Logistic Regression Model	Average, Rounded to Nearest Integer	Integration of Sediment Chemistry Guidelines, Disturbance Category
Arroyo Burro	1	2	2	Low
Mission	1	1	1	Minimal
Sycamore	1	2	2	Low

5. *Potential for Chemically Mediated Effects* - The SQO was used to combine the chemistry and toxicity data to determine the *potential* for chemically mediated effects at each site. At all sites in all years, the toxicity tests were considered nontoxic. Therefore, it is possible that chemicals contained in the sediment at levels of concern are not bioavailable.

Potential for Chemically Mediated Effects, Determined by Chemistry and Toxicity

Site	**Potential for Chemically Mediated Effects**
Arroyo Burro	Minimal Potential
Mission	Minimal Potential
Sycamore	Minimal Potential

Freshwater Sites – SCCWRP

An integration of chemistry data, per SCCWRP, was conducted for freshwater sites. *The highest concentrations found for each constituent were used in the analysis.* First, Probably Effect Concentration (PEC; the concentration at which toxic effects are predicted) quotients were calculated by dividing the result by the PEC. PEC quotients are considered problematic when they are greater than 1, i.e. when the result exceeds the PEC. The average PEC quotient is calculated for As, Cd, Cr, Cu, Pb, Ni, Zn, total PAHs, PCBs, and sum of DDEs. Samples with a mean PEC quotient for all constituents of >0.5 are considered toxic. As shown in the table below, no sites exceeded single or grouped constituent Probable Effect Concentrations (PECs), nor did the mean PECqs exceed the threshold of 0.5.

Probable Effects Concentration Quotients (PECq)

Constituent	**Laguna**	**Bird Refuge**	**AB Torino**	**LPC Modoc**	**MC Guiterrez**	**OMC W. Anapamu**	**SC Cacique**
Cadmium	0.25	0.18	0.00	0.12	0.00	0.05	0.04
Copper	0.20	0.39	0.06	0.05	0.05	0.06	0.09

Lead	0.29	0.23	0.16	0.06	0.04	0.23	0.08
Zinc	0.41	0.25	0.05	0.07	0.05	0.14	0.08
Arsenic	0.17	0.22	0.12	0.08	0.11	0.03	0.14
Chromium	0.18	0.39	0.17	0.24	0.08	0.15	0.13
Nickel	0.34	0.81	0.39	0.30	0.17	0.31	0.28
Total PAHs	0.10	0.00	0.00	No sample	0.00	0.00	No sample
DDEs, total	0.08	0.03	0.00	0.00	0.00	0.00	0.00
PCBs	0.05	0.00	0.00	0.00	0.00	0.00	No sample
Mean PECq	0.21	0.25	0.12	0.11	0.10	0.12	0.10

For pyrethroids, the LC50 quotients (concentration/LC50) are calculated for the constituents that have LC50s, and the mean pyrethroid LC50 quotient is calculated. The mean LC50 quotients for each site, using the maximum concentration observed, is shown in the following table. There were no identified toxicity problems using this averaging method; however, the levels of bifenthrin found in 2009 and 2010 concerning. Toxicity tests did not reveal toxicity problems in sediments.

LC50 Quotients for Pyrethroids

Pyrethroid	Laguna	Bird Refuge	AB Torino	LPC Modoc	MC Guiterrez	OMC W. Anapamu	SC Cacique
Bifenthrin	1.58	0.67	ND	ND	ND	0.51	ND
Cyfluthrin	ND	ND	ND	ND	ND	ND	ND
Deltamethrin	ND	ND	ND	ND	ND	ND	ND
Esfenvalerate	ND	ND	ND	ND	ND	ND	ND
Lambda-cyhalothrin	ND	ND	ND	ND	ND	ND	ND
Permethrin	ND	ND	ND	ND	ND	ND	ND
Mean LC50 Quotient	**0.26**	**0.11**	**0**	**0**	**0**	**0.09**	**0**

Conclusions

Site Assessment - According to the analysis conducted here on estuarine sites, Arroyo Burro Estuary, Mission Lagoon, Sycamore Lagoon have "minimal potential for a chemically mediated effect on the benthic community" and the Bird Refuge, Laguna Channel, Arroyo Burro at Torino, Las Positas Creek at Modoc, Mission Creek at Gutierrez, Old Mission Creek at W. Anapamu, and Sycamore Creek at Cacique/Soledad are "unlikely to cause toxicity." Laguna Channel, which is almost entirely developed, has the highest concentrations of most constituents. Toxicity tests from each site had "nontoxic" results according to the SQO criteria. A bioassessment study would be required to determine if the sites are truly not impacted at a biological level. The City is working to develop an IBI for our estuarine sites. It is important to reiterate that this conclusion is based on the conservative decision to use the maximum constituent values observed over the one to six years of sampling (number of years depends on the site and constituent). Some constituents were missing from the analysis.

Constituents of concern – Compounds which exceeded the most conservative sediment quality criteria include: low molecular weight PAHs, chlorinated pesticides (chlordane, DDDs, DDEs, DDTs), cadmium, and pyrethroid pesticides (bifenthrin). It should be noted that cadium was the stressor leading to the scores of Low at Arroyo Burro and Sycamore Lagoons. Background cadmium levels should be investigated.

References:

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Recycled Water in Creeks

Are pharmaceutical and personal care products (PPCPs) reaching creeks via irrigation runoff and water main breaks of reclaimed water? In FY 13, The first level of this question was addressed: what is coming out of reclaimed water taps in the City?

- Samples were collected on June 19, 2012 from four reclaimed water irrigation taps in the city. The stations and locations were:

StationID	Description
Skate Park	Reclaimed water tap next to Skate Park in Garden St/Cabrillo parking lot
OrtegaPark	Reclaimed water tap in Ortega Park near corner of Ortega St and Quarantina St
Cabr Ambas	Reclaimed water tap in parkway strip along Cabrillo Blvd across from Ambassador Park
CPP Exp	Reclaimed water tap in Chase Palm Park Expansion near restrooms

- Samples were outsourced to Weck Laboratory, on contract with the City. The samples were tested for Group 1 PPCPs, including hormones and some pharmaceuticals. Group 2 (other pharmaceuticals, Group 3 (erfluorinated compounds), Group 4 (PDBEs) and Group 5 (Alkylphenols), with the exception of Bisphool A, were not tested.

Group 1 PPCPs

	Chemical Compound	Use
Group 1 - EDC/PPCP	17-alpha-estradiol	Estrogen
	17-alpha-ethynylestradiol	Synthetic Ovulation Inhibitor
	17-beta-estradiol	Estrogen
	Bisphenol A	Industrial Chemical
	Diethylstilbestrol	Synthetic Estrogen
	Estriol	Estrogen
	Estrone	Estrogen
	Fluoxetine	Antidepressant
	Acetominophen	Analgesic
	Androstenedione	Androgen
	Atrazine	Herbicide
	Caffeine	Stimulant
	Carbamazepine	Anti-seizure
	DEET	Insect Repellent
	Diazepam	Muscle Relaxer
	Hydrocodone	Analgesic
	Meprobamate	Anti-anxiety
	Oxybenzone	Sun Screen
	Pentoxifyline	Improve Blood Flow
	Progesterone	Ovulation Inhibitor/Estrogen
	Sulfamethoxazole	Antibiotic
	Testosterone	Androgen
	Trimethoprim	Antibiotic
	Methadone	Opiate

Plots are shown on the following page. In summary:

- Values were very consistent across sites, suggesting the concentrations at the treatment plant are representative of water discharged to irrigated sites.
- All tested hormones were below detection limits with the exception of Androstenaion ("Andro"), an illegal steroid taken by body builders.
- All tested pharmacetuticals were detected and quantified, at levels ranging from 1-400 parts per trillion.
- The ecological significance of these results, e.g. a comparison with water quality criteria or results from other locations, has not yet been investigated.
- Future tests will involve sampling the same site on multiple days, in addition to creek water.
- The City's Water Resources is installing additional treatment of reclaimed water that is intended to remove PPCPs, in addition to other contaminants.

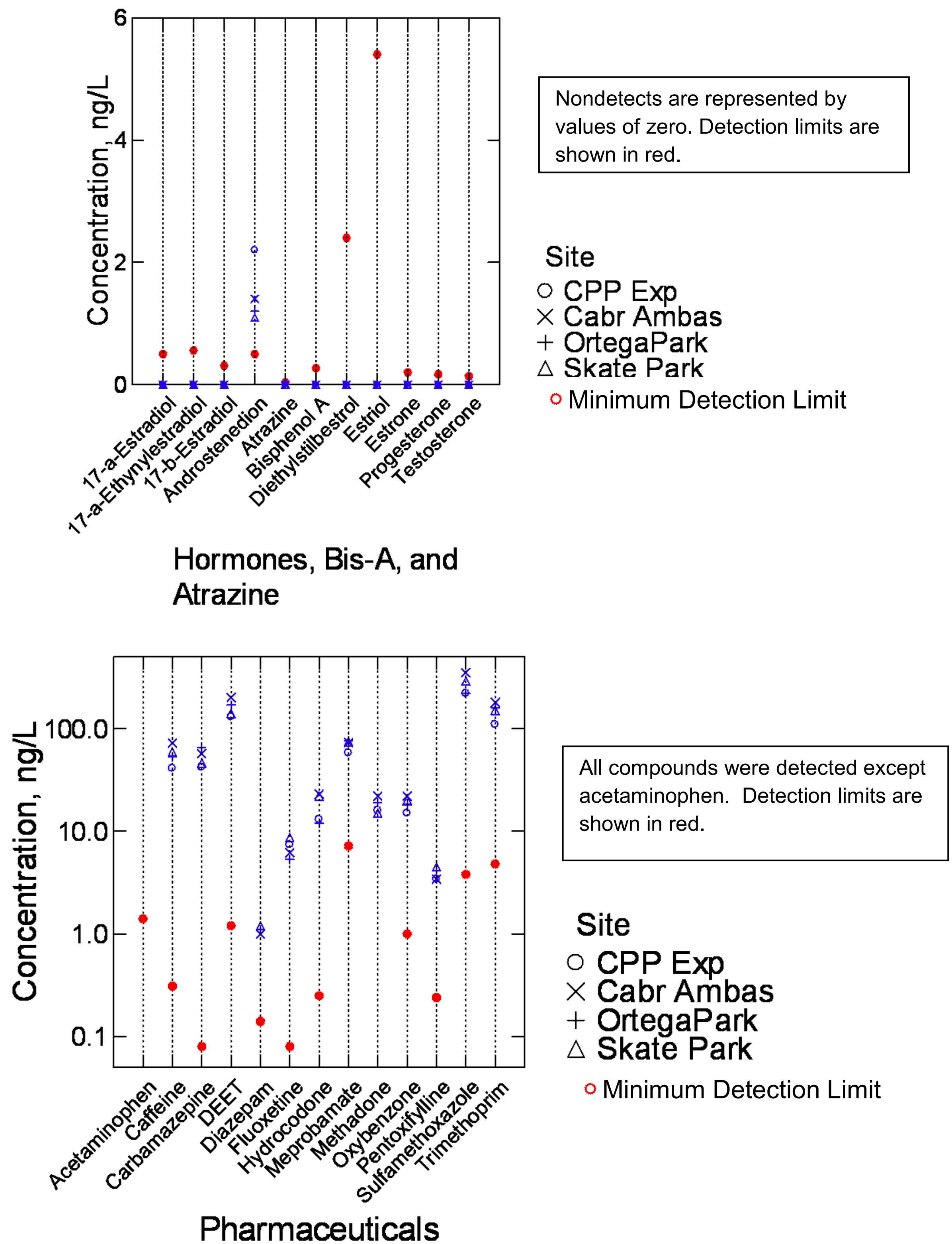


Figure 1. PPCPs in samples collected from reclaimed water irrigation taps in the City of Santa Barbara, June 18, 2012.

The State Waterboard and SCCWRP are investigating CECs, which include PPCPs, in relation to human health and receiving water impacts. While most of the impacts are relate to wastewater treatment plant discharges to rivers, stormwater runoff from irrigated land is also being addressed. The following report summarizes the efforts:

Monitoring Strategies for Chemicals of Emerging Concern (CECs) in California's Aquatic Ecosystems (SCCWRP, 2013) http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/692_CECEcosystemsPanelReport_Final.pdf

The Science Advisory Panel and their report provide extremely valuable background review, analysis, and guidelines that we can use moving forward on this topic. The report describes several scenarios for wastewater and stormwater delivery of CECs to the environment, and provides a list of compounds that should be measured and what the trigger levels should be for action. Relevant to Creeks is Scenario 2 (a coastal embayment that receives both WWTP effluent and stormwater discharge- note that this could include runoff from land irrigated with recycled water). The following acronyms are used in the report tables and text:

CEC: Contaminants of Emerging Concern. The report narrowed them down to a list that are likely to pose the greatest environmental concern, or to be indicators of a larger problem.
MTL: Monitoring Trigger Level
MEC: Measured Environmental Concentration
PEC: Predicted Environmental Concnetration
MTQ: Monitoring Trigger Quotient, or the MEC (or PEC)/MTL

The following table shows the recommended compounds for sampling:

Compounds for testing in receiving waters are highlighted in yellow, for sediments are highlighted in purple, and one additional compound in highlighted in pink. Triclosan should be considered for future sampling. The report recommends that the State incorporate this sampling into regional and local programs. Most of the compounds recommended for testing have already been tested by the Creeks Division in receiving water and in the reclaimed water sampling described above.

Table 1. Recommend Constituent List from SCCWRP Report on Monitoring CECs.

Table ES-1. CECs recommended for initial monitoring (Phase 2) by scenario and environmental matrix (i.e., aqueous, sediment, tissue). M = include in monitoring program (discharges to: E = embayments, F = freshwater, O = ocean waters); NA = not applicable.

Compound	Scenario 1 Inland Waters Aqueous	Scenario 2 Embayment Aqueous	WWTP Effluent	FW Stream - Storm-water (Aqueous and Sediment)	Scenario 2 Embayment Sediment	Scenario 3 Marine Sediment	All Scenarios Tissue
Bis(2-ethylhexyl) phthalate	NA	NA	M-O	NA	NA	M	NA
Bisphenol A	M	M	M–E/F	M	NA	NA	NA
Bifenthrin	M	M	M-E/F	M	M	NA	NA
Butylbenzyl phthalate	NA	NA	M-O	NA	NA	M	NA
Permethrin	M	M	M-E/F	M	M	NA	NA
Chlorpyrifos	M	M	M-E/F	M	NA	NA	NA
Estrone	M	M	M-E/F	M	NA	NA	NA
Ibuprofen	M	NA	M-F	M	NA	NA	NA
17-beta estradiol	M	M	M-E/F	M	NA	NA	NA
Galaxolide (HHCB)	M	M	M-E/F	M	NA	NA	NA
Diclofenac	M	NA	M-F	M	NA	NA	NA
p-Nonylphenol	NA	NA	M-O	NA	NA	M	NA
PBDE -47 and 99	NA	NA	M-E/F/O	M	M	M	M
PFOS	NA	NA	M-E/F/O	M	M	M	M
Triclosan	M	NA	M-F	M	NA	NA	NA

Table 2. Recommended Monitoring Program Development for CECs from SCCWRP.

Table 8.2. Guidance for developing targeted/pilot CEC monitoring workplans. FW = fresh water; M = include in monitoring programs; NA = not applicable; RW = receiving water

General Monitoring Design Parameters	Large POTW Discharging to Ocean[a]	Small POTW Discharging to Embayment[b]	Stormwater (MS4) Discharge -- Receiving Water Stations[c]	POTW Dischaging to Effluent Dominated Waterway[d]
Parameter List	Table 8.1	Table 8.1	Table 8.1	Table 8.1
Spatial coverage – Receiving Water (RW)	2-D grid (up to 6 sites each location)	2-D gradient (up to 6 sites in estuary)	1-D gradient (up to 6 sites for each location)	1-D (up to 6 sites for each location)
Number of POTW and/or FW Locations	Two POTWs and corresponding RWs	Five POTWs in one estuary/embayment	Two large FW streams and the Delta	One POTW and RW
Frequency	Semi-annual over three years	Semi-annual over three years	Wet and Dry Season over three years	Wet and Dry Season over three years
Background	M	M	M	M
Aqueous (non-filtered)	NA	M	M	M
Sediment (top 5 cm)	M	M	M	M
Tissue[e]	M	M	M	M
Bioanalytical Screening Assays[f]	Pilot evaluation and validation studies	Pilot evaluation and validation studies	Pilot evaluation and validation studies	Pilot evaluation and validation studies
Toxicity[g]	Pilot screening study at one POTW	Pilot screening study at one POTW	NA	Pilot screening study at POTW
Antibiotic Resistance[h]	NA	Pilot investigation at one POTW	NA	Pilot investigation at one POTW
Passive Sampling Devices (PSDs)[i]	Pilot investigation at one POTW	NA	NA	Pilot investigation at one POTW

a – Daily discharge ≥100 mgd; potentially conduct pilot investigation in southern California (coordinate with Bight program).

b – Daily discharge <100 mgd; potentially conduct pilot investigation in San Francisco Bay (coordinate with the Regional Monitoring Program).

c -- Potentially conduct pilot investigation for one stream in the San Francisco Bay Area (coordinate with BASMAA – RMC); one stream in Southern California (coordinate with the Stormwater Monitoring Coalition), and the Sacramento-San Joaquin Delta (coordinate with Regional Monitoring Program and the appropriate Delta organization(s)).

d – Potentially conduct pilot investigation in Southern California (coordinate with the Stormwater Monitoring Coalition).

e -- Identify appropriate species and tissues (e.g., bivalve and fish tissue for PBDEs; bird eggs for PFOS) in conjunction with local, regional and Statewide monitoring programs (e.g., SWAMP Bioaccumulation Workgroup; Bight, RMP and National Mussel Watch Programs)

f – Conduct evaluation and validation of bioanalytical screening methods that combine bioassays and subsequent non-targeted analyses to identify bioactive substances using a TIE process (e.g., as described in Sections 7 and 2.4.3).

g – 21 d fathead minnow recrudescence assay for freshwater matrices (see Section 7.2(5)). Implement periodic reproduction assessments using appropriate fish and invertebrate species (see e.g., Box 7.1). Coordinate efforts with NPDES WET and bioassessment monitoring. This assay should be used for research purposes only at the present time.

h -- Conduct a pilot investigation using a bioassay that can be used to screen for antibiotic resistance (see Section 7.2(10); Appendix F).

i – Conduct a pilot investigation using PSDs that provide adequate capacity to concentrate the CECs in Table 8.1. These devices should have demonstrated acceptable performance in laboratory or field validation studies, and published guidance on translation of results.

Last, the report includes a table(E.3) of occurrence data that is very interesting and can be used for comparison with Creeks results. Most interestingly, Bisphenol A was found in rainwater.

Groundwater Contamination

Is contaminated groundwater at cleanup sites reaching creeks?

Background

In summer 2011, Heal the Ocean conducted an analysis of data available on the State's Geotracker website. The City met with Heal the Ocean to review their findings and learn more about potential groundwater contamination from LUST and cleanup sites. In response to the meeting, the City decided to conduct additional data analysis to determine where and for which chemicals contamination could be reaching creeks. It was noted that to understand potential impacts on aquatic life, appropriate criteria would need to be identified, as Heal the Ocean's work was all based on drinking water standards (Maximum Concentration Levels, or MCLs), which were inappropriate for the project. In winter 2012, the Heal the Ocean again contacted the City about the desire to work on a project looking at "big picture" and whether contaminant plumes were merging in the subsurface and reaching creeks.

In spring 2012, the City conducted GIS and data analysis of Geotracker data, and mapped out locations of monitoring wells, the most recent contaminant concentrations, where the last test exceeded criteria, and their horizontal and vertical proximity to creeks and storm drains. For each location in which contaminants are above aquatic life criteria, a detailed map was also created showing the nearby storm drain infrastructure and groundwater depth. Two sets of maps were produced: one set with Drinking Water and California and/or US EPA aquatic life criteria, and one set with NOAA's SQuiRT screening criteria for water.

Groundwater Project Procedure

To begin, the following files were downloaded for Santa Barbara county from the Geotracker website:

Clean Up Sites: locations and description of Open and Closed Clean Up Sites
GeoXY: locations of monitoring wells associated with the Clean Up Sites
GeoWells: depth to groundwater for monitoring wells
EDF: analyte test dates and concentrations for monitoring wells

Next, an Access database was created to house the downloaded data. For each monitoring well, a unique identifier was created by concatenating the clean-up site ID (GLOBAL_ID) and monitoring well ID (FIELD_PT_N). For example, monitoring well 'MW11' is associated with the clean-up site 'T0608300114', so the resulting *Well ID* for that well becomes 'T0608300114MW11'. This step is necessary because many of the monitoring well names are the same across multiple clean-up sites. By having, one unique identifier for each monitoring well, it is possible to link the EDF data to a particular well.

Queries were created and exported to Excel format so that the various GIS layers could be created. From the GeoWells data, a query was created giving the average, minimum, and maximum depth to groundwater values for each well. From the EDF data, queries were created showing the maximum and last concentration observed at each well for each of the following 15 analytes:

- 1,1-dichlorothene
- 1,2-dichloroethane
- Arsenic
- Benzene
- Chromium
- cis-1,2-dichloroethene
- Ethyl benzene
- Lead
- MTBE
- PCE
- Toluene

- trans-1,2-dichloroethene
- TCE
- Vinyl chloride
- Xylenes

Before importing the Excel tables to ArcGIS, all the concentration tables had to be converted to one unit (ug/L). GIS layers for the clean-up sites and monitoring wells were created from the X-Y data included in the downloaded data. The Excel tables were then joined to each shapefile by using the unique *Well ID* field. From these joins, the following maps were created:

CleanUpSites:	Showing the locations of all open and closed clean-up sites
MonitoringWells:	Showing the locations of all monitoring wells
DepthtoGroundwater:	Showing the average depth to groundwater at each monitoring well
DepthSurfaceDowntown:	Showing the monitoring wells overlaid on an interpolated (kriged) depth to groundwater surface
MaxConcentration:	Series of maps showing each analyte's maximum concentration related to drinking water and aquatic life thresholds.
LastConcentration:	Series of maps showing each analyte's last concentration related to drinking water and aquatic life thresholds.
HotSpots-AquaticLife:	Shows the clean-up sites where the aquatic life threshold was exceeded. Only found for three analytes: Benzene, Toluene, and Lead, Vinyl Chloride, and Xylenes.
SQuiRT LastConcentration:	Series of maps showing each analyte's last concentration related to the SQuiRT thresholds. These thresholds are lower so there are more exceedances. All analytes exceeded except DCE12T.
HotSpots-SQuiRT:	Shows the clean-up sites where the SQuiRT threshold was exceeded. Found for all analytes except trans-1,2 Dichloroethene. Monitoring wells must have been within 150 ft. to be mapped.

The 'HotSpots' table below summarizes all the clean-up sites and what threshold(s) they exceeded. Additionally, this spreadsheet contains depth to groundwater and distance to storm drain data for each hot spot clean-up site.

SiteID	Name	Location	AS	BZ	BZME	CR	DCA12	DCE11	DCE12C	DCE12T	EBZ	MTBE	PB	PCE	TCE	VC	LENES	GW Depth Avg.	Closest Storm Structure	Storm Structure Depth	Site To SD (ft.)	Well to SD (ft.)
SL0608345866	Former Cinco De Mayo Cleaners	434 Olive St.							DW						DW	AL		4.41	MH-H08-08	4.11	37	44
SL203061244	Mission Industries/Ambassador Laundry	201 E Haley St.					DW		DW					DW	DW			4.15	CB-H09-13	16.41	108	13
SL203501296	Pacific Scientific	402 E Gutierrez St.							DW					DW	DW	DW		5.14	DI-H09-40	1.93	124	81
SLT3S0241288	Carrillo Plaza Norvell-Bass Dry Cleaners	1015 De La Vina St.												DW				25.73	CB-F09-27	1.90	145	42
SLT3S0391292	Tecknit/Tube Holding Company	N Nopal St.							DW					DW	DW			5.35	DI-H08-01	3.47	104	19
SLT3S0511299	Dutch Maid Cleaners	3323 State St.					DW		DW	DW				DW	DW	AL		16.48	CB-C05-03	3.30	46	92
SLT3S0641304	Ablitt's Cleaners	14 W Gutierrez St.												DW	DW			11.23	CB-G09-25	4.15	176	192
SLT3S1441322	Fresh & Easy Neighborhood Market	324 N Milpas St.							DW					DW	DW			7.29	CB-H08-02	3.11	199	115
SLT3S2371349	Santa Barbara City Parking Lot #12	State St.							DW					DW	DW			6.52	CB-G10-38	4.30	71	17
T0608300020	SB City Police Station	215 E Figueroa St.		DW	DW		DW				DW			DW			AL	44.44	DI-G08-04	6.40	29	7
T0608300026	Park's Texaco Market	1502 San Andres St.		AL	DW		DW				DW	DW					AL	22.36	CB-E09-03	3.80	248	49
T0608300041	World Oil	2837 De La Vina St.		DW							DW	DW					AL	33.64	DI-D05-08	5.40	36	12
T0608300048	Former ARCO	34 E Montecito St.					DW											7.68	DI-H09-04	0.50	74	73
T0608300114	Mike's Texaco	134 S Milpas St.		AL	DW						DW	DW	AL				AL	5.80	CB-J09-35	4.61	138	58
T0608300139	American Contracting Service	4159 State St.		AL	DW		DW				DW	DW					AL	27.76	DI-A05-01	7.00	684	714
T0608300140	Delmonte Management	1233 De La Vina St.		AL	AL						DW						AL	32.63	CB-F08-15	4.00	37	6
T0608300159	SB City Fire Station	2505 Modoc Rd.					DW											13.52	MH-D08-05	7.00	30	19
T0608300167	Agri-Turf Supplies	130 Garden St.		DW	DW		DW	DW	DW		DW	DW	AL	DW	DW	DW		8.30	N-H09-51	1.01	110	32
T0608300168	Mobil Oil	402 W Mission St.		DW														21.53	CB-E08-05	3.35	79	77
T0608300183	Mobil Oil	4151 Foothill Rd.		AL	AL		DW				DW	DW					AL	31.67	MH-A03-01	4.80	362	28
T0608300189	TOSCO 76	3052 De La Vina St.											AL					17.24	CB-D05-17	3.85	230	201
T0608300225	McKenzie Market	3102 State St.		DW			DW				DW	DW	DW	DW			DW	24.07	DI-D05-12	1.34	693	597
T0608300226	Culligan Soft Water of SB	1026 Santa Barbara St.		DW	DW		DW				DW			DW	DW			37.71	MH-G08-15	9.53	255	17
T0608300233	Chevron	803 N Milpas St.		DW	DW		DW				DW	DW					AL	6.26	DI-H07-03	0.50	234	231
T0608300238	Andrews Automotive	8 S Milpas St.		DW			DW				DW	DW		DW	DW	DW	AL	8.97	CB-J09-31	4.65	278	119
T0608300251	SB City Recycling Center	631 Garden St.		DW										DW				4.06	CB-G09-33	3.05	129	16
T0608300252	Unocal	200 S Milpas St.										DW						6.34	MH-J09-16	5.40	165	129
T0608300256	Klaus Braun Automotive	4235 State St.		DW							DW							9.77	DI-A05-02	7.20	451	441
T0608300489	Doug's Bougs	735 N Milpas St.		DW	DW		DW				DW	DW					AL	4.97	MH-H07-17	10.48	100	60
T0608300525	Mission Linen Supply	619 E Montecito St.		DW			DW		DW			DW			DW	DW		4.92	CB-H08-10	2.20	205	17
T0608300549	Thrifty Oil/Circle K	4069 State St.		AL		DW					DW	DW					AL	35.04	CB-A05-03	6.69	366	360
T0608300553	La Cumbre Mini Mart	3905 State St.		DW	DW		DW				DW	DW					AL	37.96	MH-B05-09	8.65	32	62
T0608300554	McCormix Corporation	22 N Calle Cesar Chavez										DW						3.84	CB-J09-02	2.05	106	78
T0608300556	Mission Linen Supply	702 E Montecito St.									DW						AL	6.84	CB-H08-07	3.68	109	93
T0608300562	Thrifty Oil	231 N Milpas St.		DW	DW							DW			DW		AL	8.12	MH-J08-01	12.30	414	257
T0608300587	Mobil Oil Station	2299 Los Positas Rd.		DW	DW		DW				DW	DW					AL	41.75	CB-C07-07	1.90	400	301
T0608300588	Exxon Mobil Oil Corp.	100 S La Cumbre Rd.		DW	DW		DW				DW	DW					AL	20.63	CB-B05-22	4.15	51	9
T0608300601	TOSCO 76	1929 Cliff Dr.										DW		DW				17.56	CB-D12-05	7.40	200	77
T0608300608	SB Co. Dept. of General Services	118 E Figueroa St.		DW							DW			DW			AL	39.44	CB-G08-26	3.80	256	9
T0608300609	Chevron/Educated Car Wash	401 W Montecito St.		DW							DW	DW						7.16	CB-G11-07	1.00	442	359
T0608300630	Equilon Enterprises LLC/Shell	1000 Coast Village Road		AL	DW						DW	DW					AL	41.92	CB-M08-01	3.31	57	4
T0608300631	JR's Gas	1905 Cliff Dr.		AL	DW						DW	DW		DW				24.71	MH-E12-07	7.20	306	153
T0608300632	Shell Service Station	3060 State St.		DW			DW	DW	DW	DW	DW	DW		DW	DW	AL		20.48	DI-D05-13	2.70	546	467
T0608300649	MacDonald Trust/Shell Oil	2034 Cliff Dr.		DW	DW						DW	DW		DW			AL	23.06	CB-D12-04	6.80	40	8
T0608300661	Former Auto Repair	126 W Carrillo St.		DW			DW				DW	DW		DW	DW			22.49	CB-F09-05	3.80	42	18
T0608300673	Roth Property	335 N Milpas St.		DW	DW						DW	DW					AL	6.57	MH-H08-03	4.20	30	58
T0608300674	Peppard/Clark Property	800 N Milpas St.		DW	DW		DW				DW						AL	4.40	MH-H07-14	8.50	214	168
T0608300675	Diving Systems International	425 Garden St.		DW							DW						AL	8.87	CB-H09-11	2.58	203	175
T0608300676	Canon Perdido Car Wash	112 W Canon Perdido St.		AL	AL						DW	DW		DW	DW		AL	20.52	MH-G09-13	4.91	469	256
T0608300695	Porter Auction Company	813 Garden St.		AL	AL						DW	DW		DW			AL	11.02	MH-G08-15	27.70	15	5
T0608300699	ARCO	328 W Montecito St.		DW							DW	DW						7.53	DI-G10-07	8.55	485	453
T0608300700	Former Power Up Station	4085 State St.		DW							DW							24.56	CB-A05-01	10.50	355	296
T0608300712	RJ Carroll and Sons Plumbing	625 N Salsipuedes St.		DW							DW							2.39	CB-H08-13	4.00	305	283
T0608300713	Chevron	1800 State St.					DW										DW	85.88	DI-F07-01	2.00	53	24
T0608300747	ARCO Station	3618 State St.		DW							DW	DW						18.19	CB-C05-17	3.80	67	12
T0608300749	Seaside Shell	101 W Carrillo St.		AL	AL						DW	DW		DW			AL	25.19	MH-G09-13	4.91	110	72
T0608316772	Educated Car Wash	3735 State St.		DW	DW		DW				DW	DW					AL	21.70	CB-B05-03	2.45	106	44
T0608320271	Gas Company	630 E Montecito St.	DW															6.52	DI-H09-44	1.50	239	145
T0608323816	Petre Industries	428 E Haley St.		DW														5.69	DI-H08-07	1.76	147	162
T0608324329	Santa Barbara American Fuel and Gas	2234 De La Vina St.		DW	DW						DW	DW	DW				AL	63.72	CB-E06-25	11.80	133	114
T0608336719	Reagan Ranch Visitor's Center	217 State St.					DW											6.78	DI-G10-01	4.68	25	21
T0608344098	Former Chevron	101 E Victoria St.		DW			DW											60.72	CB-F08-12	4.15	38	43
T0608348115	La Cumbre Texaco	150 S La Cumbre Rd.					DW					DW						28.74	CB-B05-20	5.75	154	84
T0608348535	Gold's Gym	21 W Carrillo St.		AL	DW		DW				DW			DW			AL	23.06	CB-G09-35	3.60	70	70
T0608368725	Former Chevron Station	902 Anacapa St.		AL	DW		DW				DW		AL				AL	26.97	MH-G08-18	5.15	468	377
T0608374511	Former UNOCAL	825 Anacapa St.		AL	DW		DW				DW						AL	20.82	MH-G08-18	5.15	607	594
T0608374992	Pep Boys Store	424 State St.												DW	DW			9.11	CB-G09-22	3.85	101	83
T0608386520	Mobil Oil	1936 State St.		DW							DW	DW		DW		DW	AL	71.60	CB-E07-30	3.55	73	47
T060839200	Chevron	115 S La Cumbre Rd.										DW						25.17	MH-B05-07	10..4	118	169
T0608394259	Muzak Music	735 E Montecito St.							DW			DW		DW	DW	DW		6.12	CB-H08-32	3.67	48	9
T10000001599	In & Out Paint and Collision Center	314 State St.					DW							DW	DW			9.00	CB-G10-38	4.30	223	108
71	Total Sites		1	47	27	1	30	2	11	2	42	37	6	28	19	9	33					
16	Sites > Aquatic Life Threshold																					

AL = Aquatic Life Threshold
DW = Drinking Water Threshold

Site to SD = Distance from Clean Up site to Storm Drain System
Well to SD = Distance from closest AL or DW well to Storm Drain System

Maps were made of all cleanup sites that met the criteria: minimum groundwater depth was within feet of the storm drain system. From Josh Bader: I started making maps from the smallest Well-SD (well to storm drain) values in the Hotspots spreadsheet. If the cleanup site met the groundwater depth constraint, I proceeded to find the latest high result date for the associated wells. I then queried the database for all analytes at that site on that date and made maps of those that exceeded the SQuiRT threshold. The maps include both groundwater and storm drain depths, date, site ID, and analyte concentrations at all associated wells on that test date. Additionally, the distance of the closest well to the storm drain system is labeled by a callout box (Well-SD: ## ft.) between the well and storm drain. You will notice that the Well-SD distance values don't always match up with the Hotspots spreadsheet. This is because the spreadsheet includes the closest well distance for all last test dates which may not necessarily be the overall last test date (like the maps use). I checked all cleanup sites that had a Well-SD distance of <100 feet in the Hotspots spreadsheet (27 of the 54). 100 feet seemed like a good cutoff, but I could repeat the process for the remaining 27 sites if you think it is worthwhile. In total, 11 of the 27 sites met the criteria and were mapped. A folder was created for each of these 11 and the individual analyte maps placed inside them. The filename for each map contains the analyte and test date (ex. BZ_01012001 would be Benzene tested on 1/1/2001).

See the Appendix for the full report and maps.

UCSB Groundwater Project

Dr. Patricia Holden and her laboratory have continued and expanded the research about shallow groundwater contamination, migration and attenuation. They have completed some sampling and analysis, with more information available in the coming year.

303(d) Impairment for Low Dissolved Oxygen on Mission Creek

What is the source of the 303(d) impairment for Low Dissolved Oxygen on Mission Creek? How extensive in time and space is the impairment? (see Section C as well)

In 2008, Mission Creek was listed or Low Dissolved Oxygen

This is the summary of the listing evidence (the Fact File has details about each line of evidence):

Pollutant:	**Low Dissolved Oxygen**
Final Listing Decision:	**List on 303(d) list (TMDL required list)**
Last Listing Cycle's Final Listing Decision:	New Decision
Revision Status	Revised
Sources:	Habitat Modification | Hydromodification | Removal of Riparian Vegetation | Source Unknown
Expected TMDL Completion Date:	2021
Impairment from Pollutant or Pollution:	Pollutant
Weight of Evidence:	This pollutant is being considered for placement on the section 303(d) list under sections 2.1 and 3.2 of the Listing Policy. Twelve lines of evidence are available in the administrative record to assess these pollutants. Two water quality objectives are assessed: Twenty-six of the 89 samples exceed the dissolved oxygen water quality objective for Cold Freshwater Habitat and 35 of 89 samples exceed the general water quality objective for oxygen saturation (when applied as a single sample maximum). However, the Basin Plan objective states that the median oxygen saturation value shall not fall below 85% and the median value did not exceed this criterion. Therefore, the use rating for oxygen saturation is set at insufficient information. Based on the readily available data and information, the weight of evidence indicates that there is sufficient justification in favor of placing this water segment-pollutant combination on the section 303(d) list in the Water Quality Limited Segments category. This conclusion is based on the staff findings that: 1. The data used satisfies the data quality requirements of section 6.1.4 of the Policy. 2. The data used satisfies the data quantity requirements of section 6.1.5 of the Policy. 3. Twenty-six of the 89 samples exceed the dissolved oxygen water quality objective for Cold Freshwater Habitat and this exceeds the allowable frequency listed in Table 3.2 of the Listing Policy. 4. Pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.
RWQCB Board Decision / Staff Recommendation:	After review of the available data and information, RWQCB staff concludes that the water body-pollutant combination should be placed on the section 303(d) list because applicable water quality standards are exceeded and a pollutant contributes to or causes the problem.

The data used by the Regional Board included grab samples and data loggers from MC at Montecito and MC at Mission Canyon. The following standards from the Basin Plan apply (taken from the Fact File):

- **Median values should not fall below 85% saturation** as a result of controllable water quality conditions.
- Water Quality Control Plan, Central Coast Basin, General Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: For waters not mentioned by a specific beneficial use, dissolved oxygen concentration **shall not be reduced below 5.0 mg/l at any time.**
- Water Quality Control Plan, Central Coast Basin, Cold Water Habitat Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: The dissolved oxygen concentration **shall not be reduced below 7.0 mg/l at any time.**

Mission Creek is listed as having COLD habitat as a beneficial use.

The following graphs represent the CCAMP data visually:

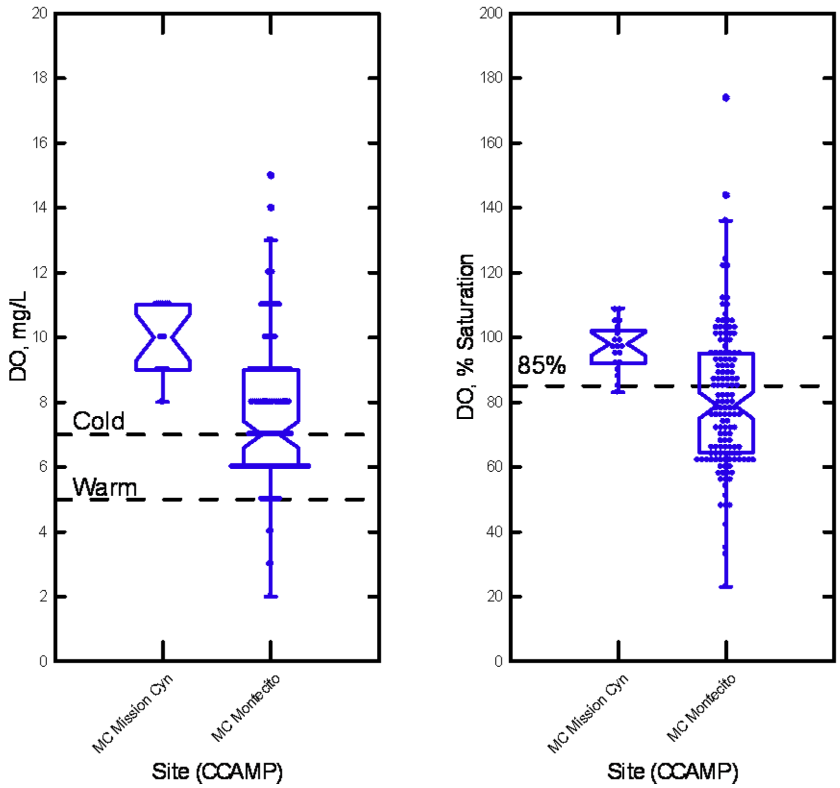


Figure 1. Boxplots of DO data from CCAMP for Low DO Listing on Mission Creek.

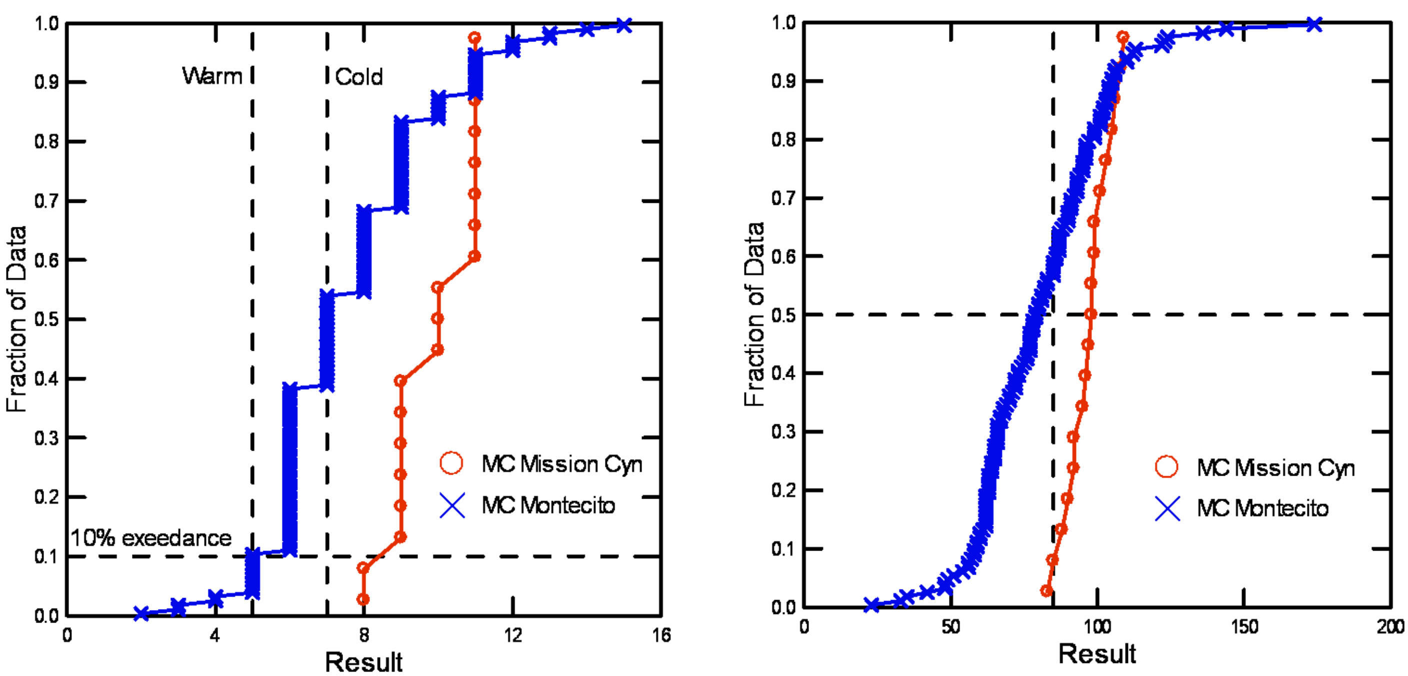


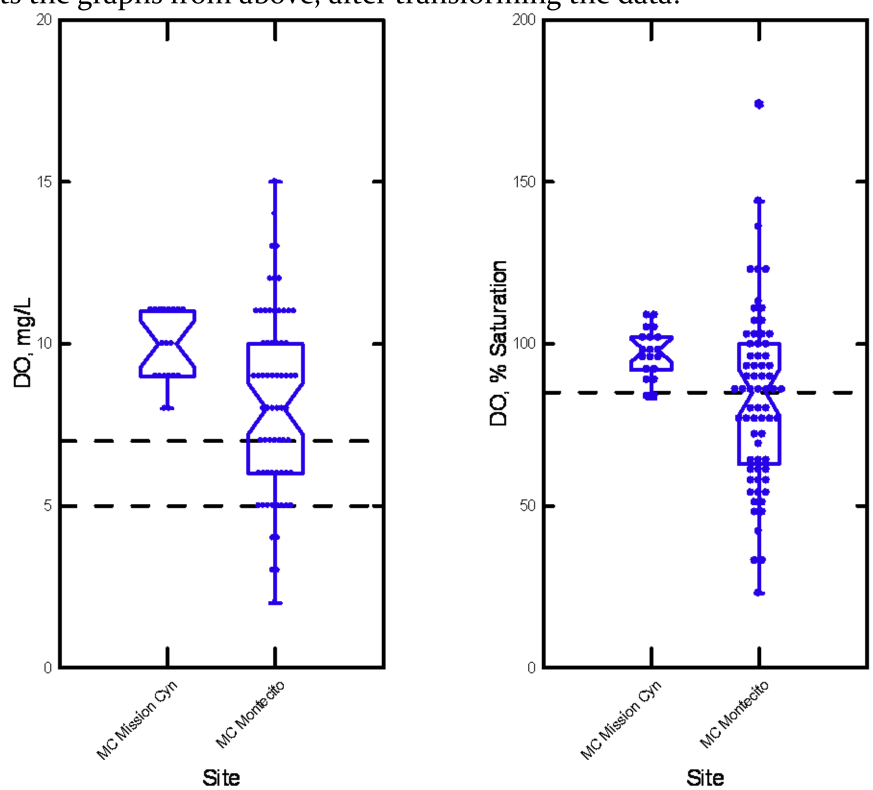
Figure 2. Distribution Plots of DO Data from CCAMP.

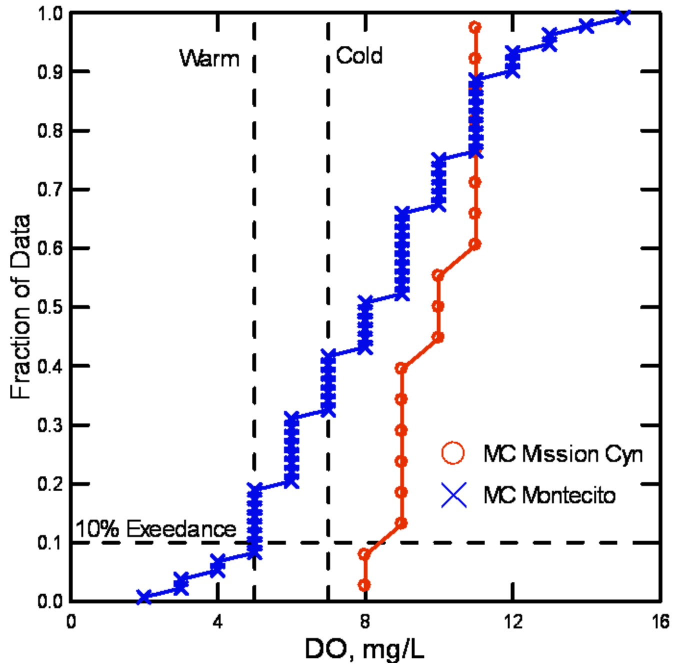
- MC at Mission Canyon meets both criteria: No data points are below 7 mg/L, and the median value of saturation almost 100%.
- MC at Montecito Street does not meet either criteria: 40% of the data are below 7 mg/L and median saturation is ~80%.

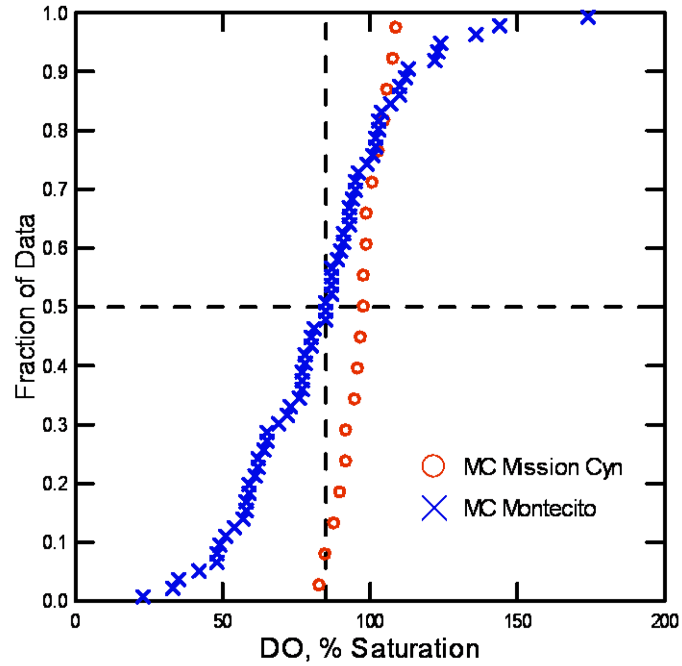
Further inspection of the Waterboard's Listing Policy shows that the data should be transformed according to the following rules:

6.1.5.6 Evaluation of Data Consistent with the Expression of Numeric Water Quality Objectives, Water Quality Criteria, or Evaluation Guidelines
If the water quality objectives, criteria, or guidelines state a specific averaging period and/or mathematical transformation, the data should be evaluated in a consistent manner prior to conducting any statistical analysis for placement of the water on the section 303(d) list. If sufficient data are not available for the stated averaging period, the available data shall be used to represent the averaging period. To be considered temporally independent, samples collected during the averaging period shall be combined and considered one sampling event. For data that is not temporally independent (e.g., when multiple samples are collected at a single location on the same day), the measurements shall be combined and represented by a single resultant value. **For dissolved oxygen measurements, the minimum value shall be used to determine compliance with the water quality objective.** For pH measurements, the minimum or maximum values of the data set shall be used to determine compliance with the water quality objective. If the averaging period is not stated for the standard, objective, criterion, or evaluation guideline, then the samples collected less than 7 days apart shall be averaged.

The following repeats the graphs from above, after transforming the data:

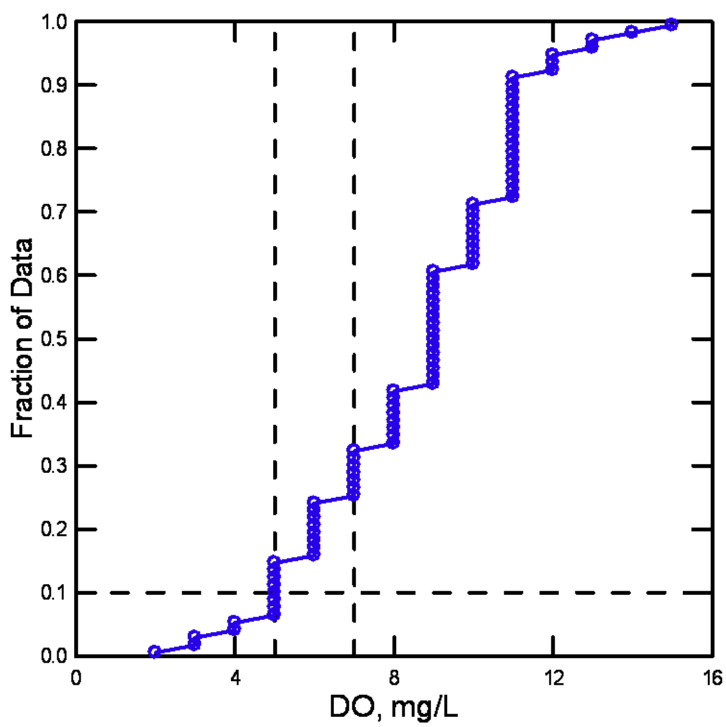


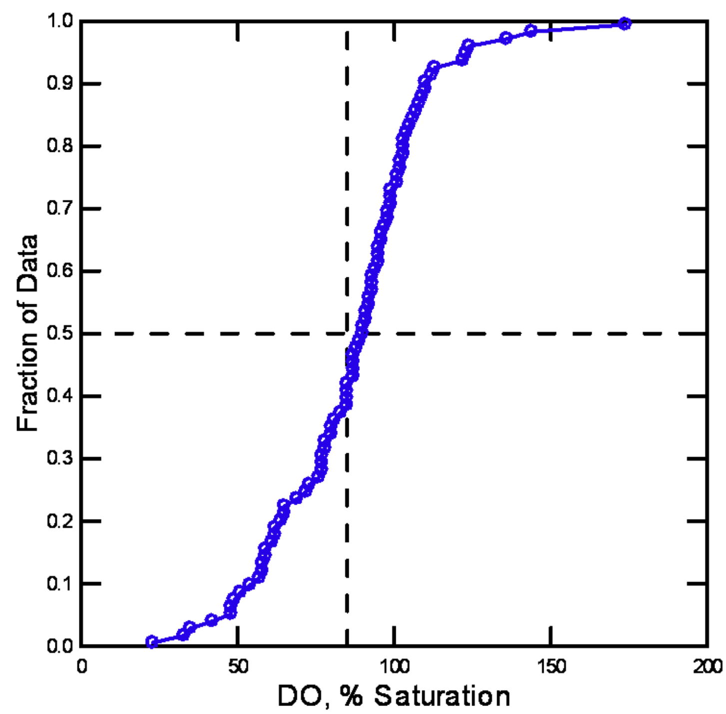




- MC at Mission Canyon continues to meet the criteria.
- For MC at Montecito, 30% of the data are below 7 mg/L, and the median is equal to 85% saturation.

When the data are combined for the two sites:





- 25% of the data are below 7 mg/L and the median saturation is approximately 90% saturation.

Data Review-Creeks Data

The following analysis is of data collected by the Creeks division during storms and dry weather.

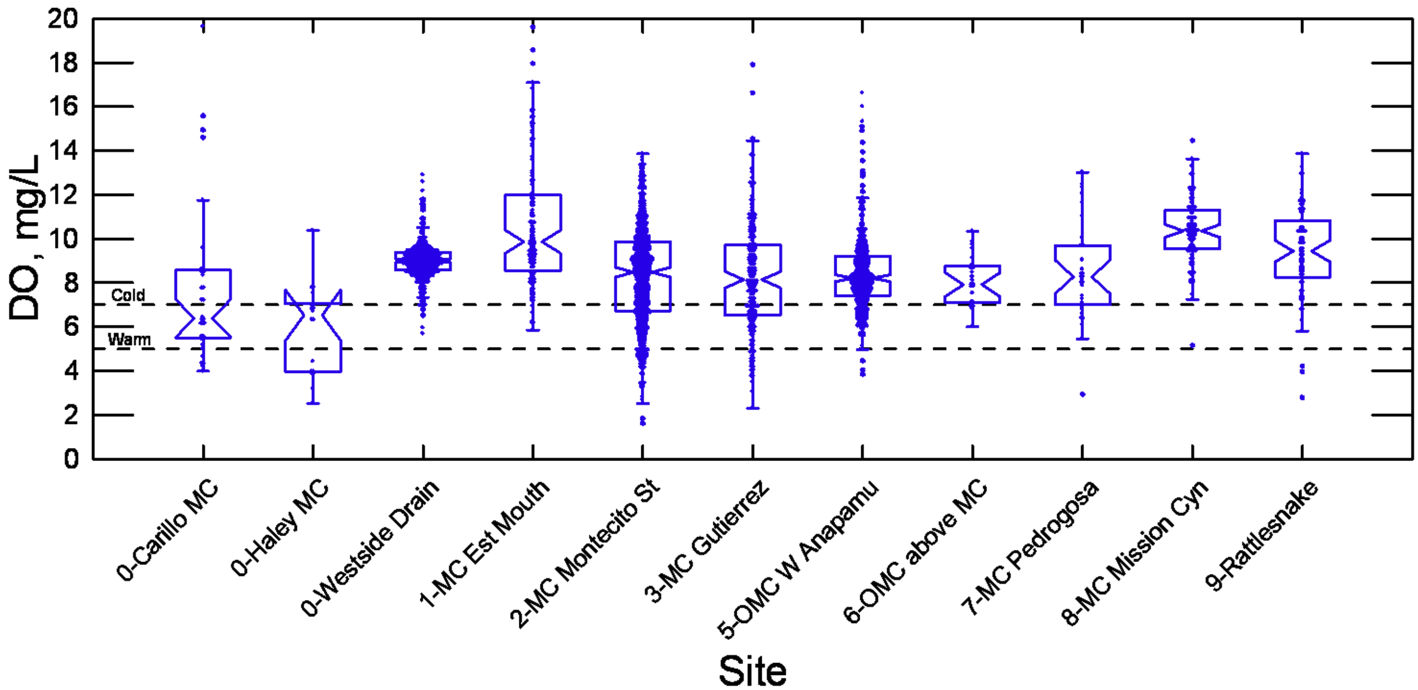


Figure 3. Boxplots with Symmetrical Dot Density of DO Concentration in Mission Creek.

- Sites preceded by "0" are storm drains. The numbered samples are ordered from downstream to upstream.
- The majority of samples were collected mid morning, with some exceptions for storm samples.
- All medians are above Basin Plan WQ Objectives (7 mg/L, COLD; 5 mg/L WARM).
- Rattlesnake and MC at Mission Canyon have higher DO than the urban sites.
- DO is relatively stable through the urban core.
- The City also has a set of data from a 3-d sonde deployment at MC at Ortega; these data show much lower DO concentrations.

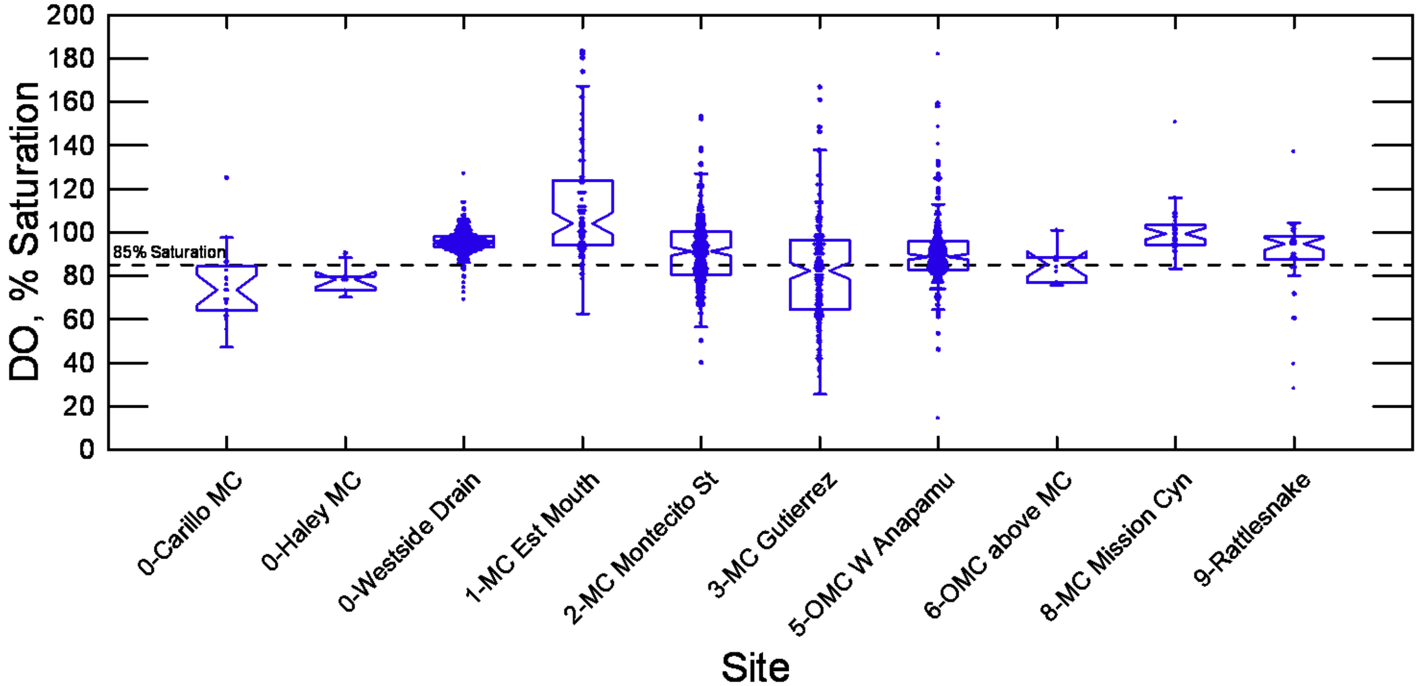


Figure 4. Boxplots with Symmetrical Dot Density for DO Saturation in Mission Creek.

- All medians are greater than 85% saturation with the exception of MC at Gutierrez.
- Differences from upper watershed to lower watershed are less distinct, possibly due to temperature differences. Because warmer water holds less DO at equilibrium with the atmosphere, lower median DO concentrations at downstream sites are generally close to equilibrium values (100% Saturation).

Temperature-Oxygen Solubility Relationship	
Temperature (°C)	Oxygen Solubility (mg/L)
0	14.6
5	12.8
10	11.3
15	10.2
20	9.2
25	8.6
100	0

Figure 5. DO-Temperature Relationship. From:
http://blog.ysi.com/blog/bid/179922/What-is-Affecting-Your-Dissolved-Oxygen-Measurements-Part-1-of-4

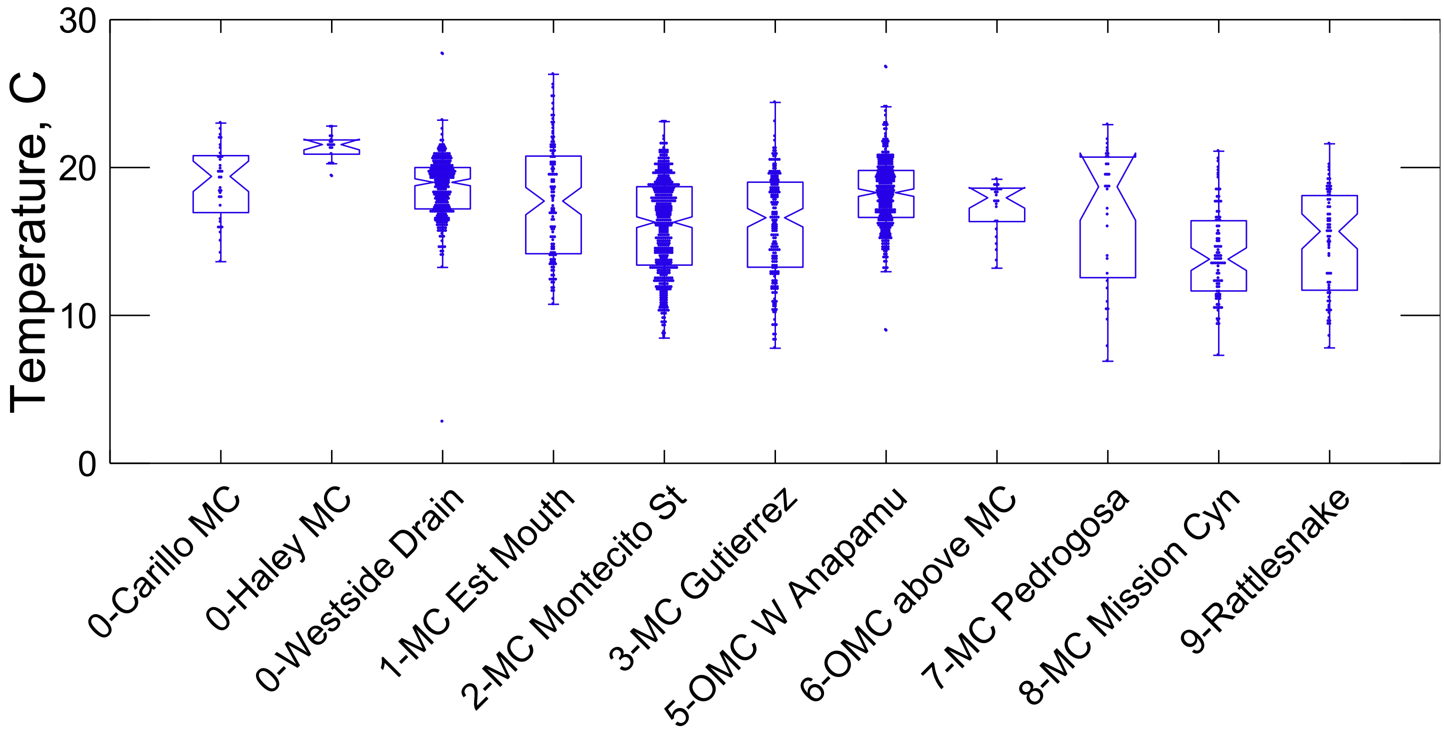


Figure 6.Temperature at Sites on Mission Creek.

- Median temperatures are 1 to 2 degrees higher in the urban core than in the upper watershed.

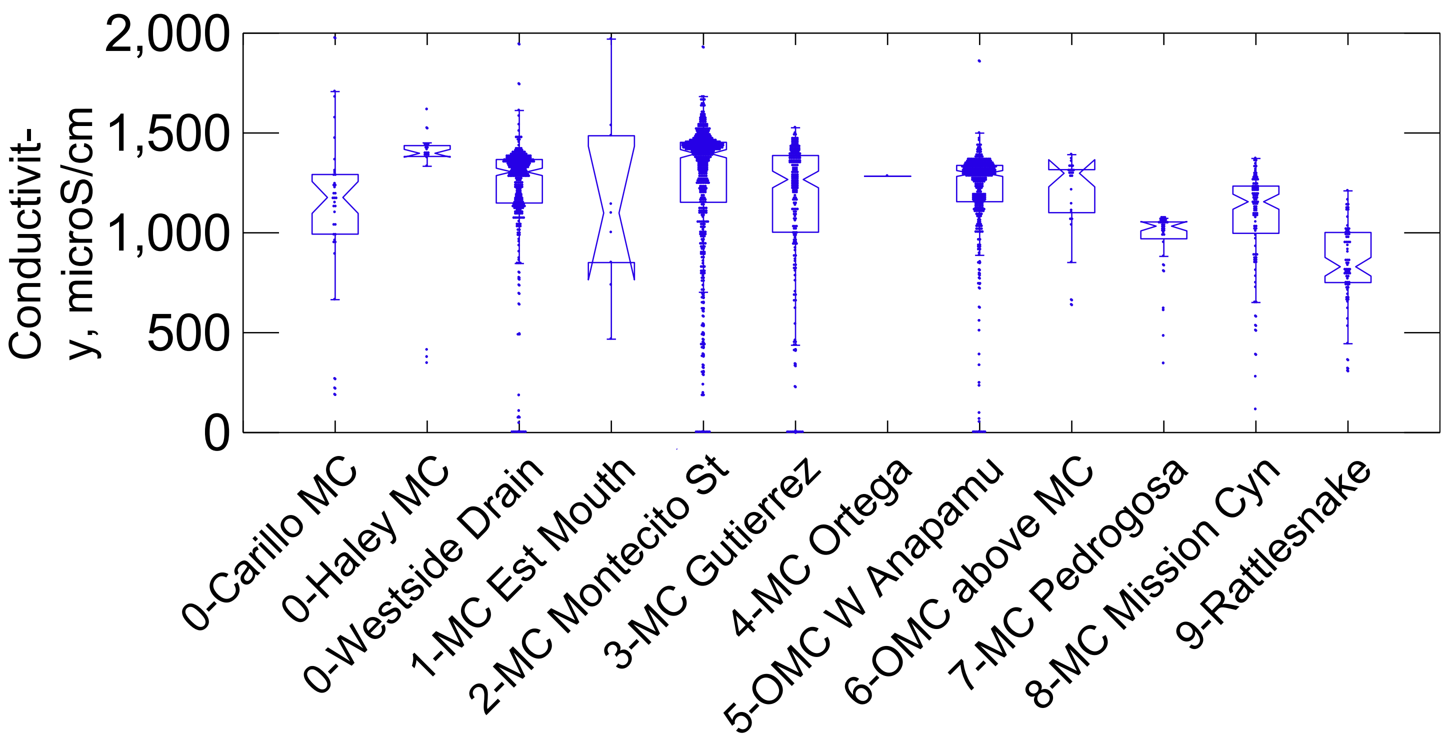


Figure 7.Conductivity at Sites on Mission Creek

- Conductivity increases going downstream, partly due to evaporation and partly due to differences in source groundwater conductivity (see groundwater conductivity plot in next section).
- Some of the lower conductivity readings are collected during storm events, with rainwater dilution.

Percentile distributions are shown below:

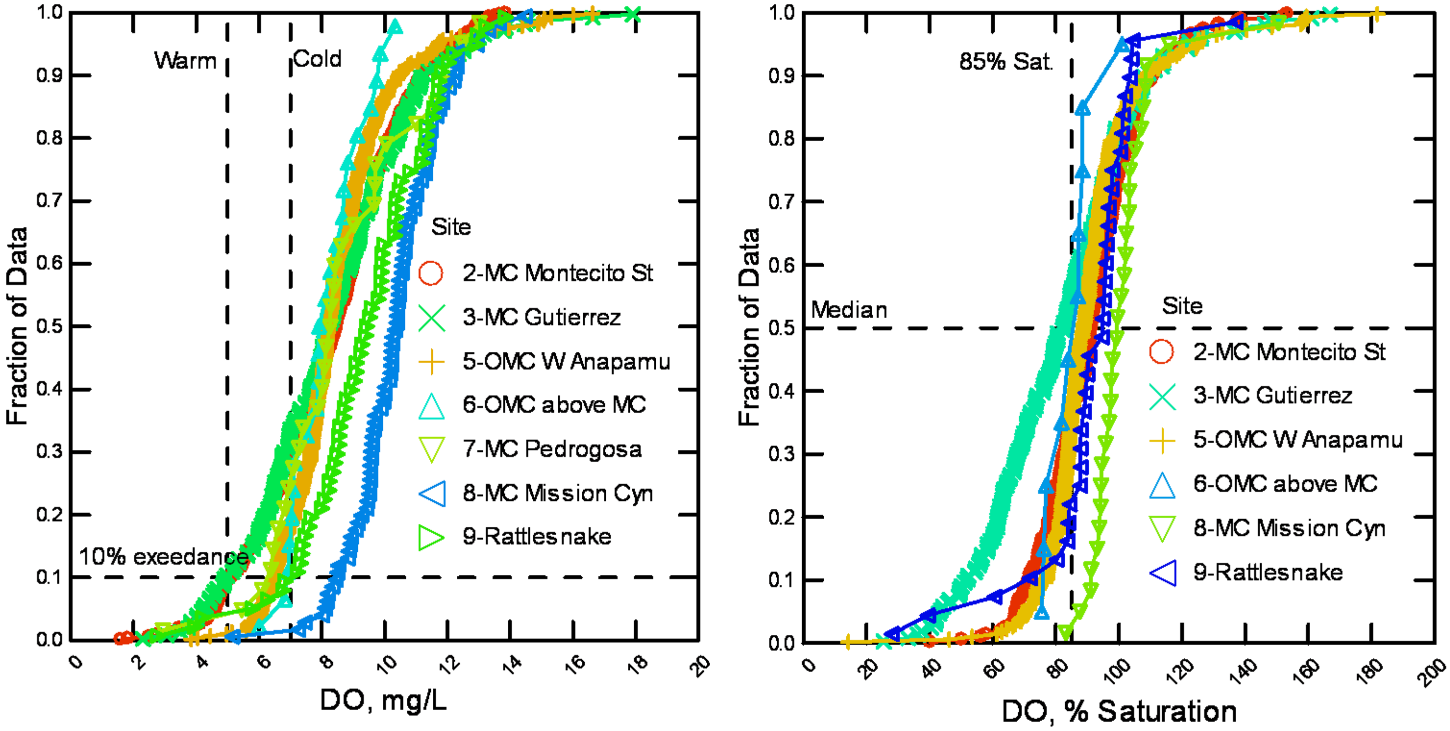
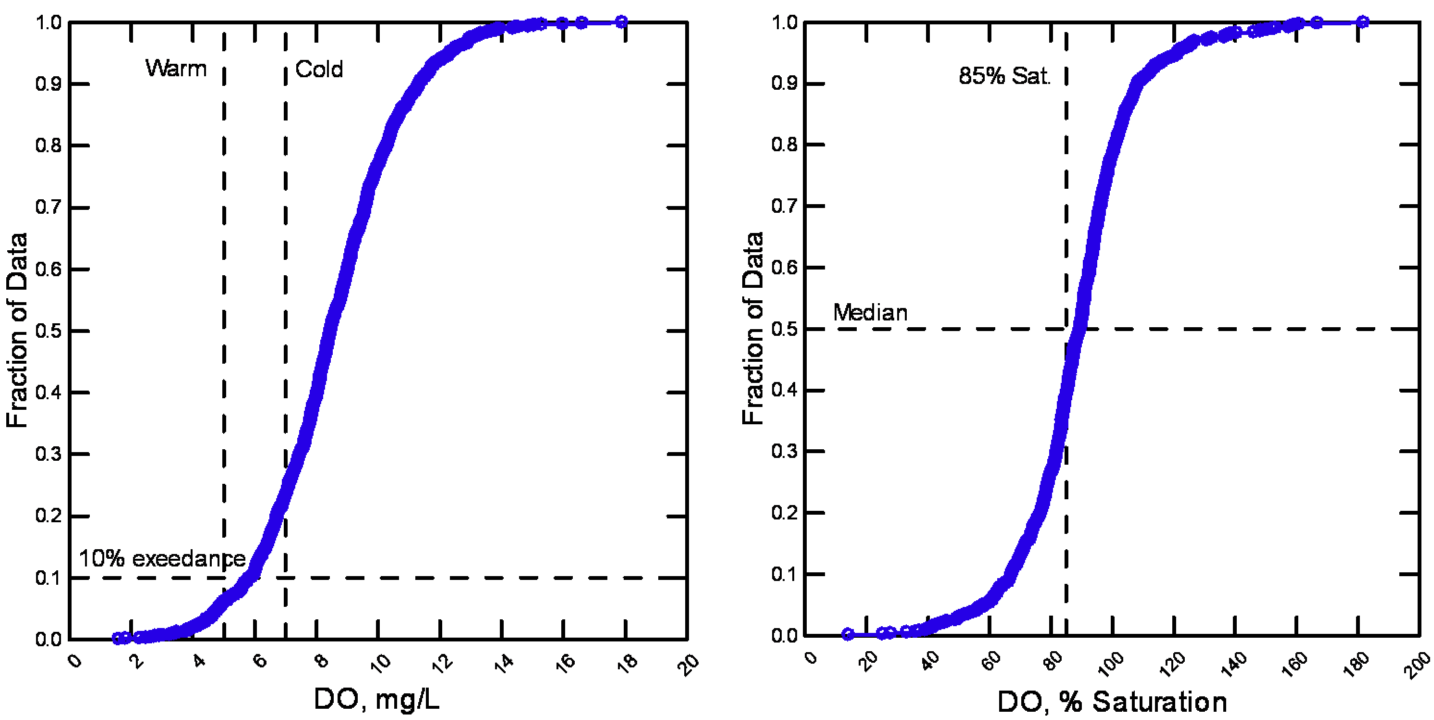


Figure 8. Percentile Distribtions of DO at Sites on Mission Creek.

- All urban sites have greater than 10% exeedance (below 7 mg/L).
- All sites except MC at Gutierrez have a median saturation greater than 85%.

Below is the combined data (does not include drains or estuary data):



- The DO concentration is <7 mg/L approximately 20% of the time (fails objective).
- The DO is greater than 85% saturation approximately 65% of the time (meets objective).

Dissolved Oxygen and Steelhead

Here is some information about DO concentrations and steelhead.

From: Steelhead Assessment and Recovery Opportunities in Southern Santa Barbara County, California (SToecker, 2002)

> 1.3.5 Dissolved Oxygen
> Adequate amounts of dissolved oxygen are required by steelhead during all stages of their life. While in fresh water, steelhead require high amounts of dissolved oxygen in the water column and intragravel waters. Resner and Bjorn (1979) observed that dissolved oxygen be, at least, 80% of saturation for successful spawning to occur. Embryonic and alevin survival is highly dependent on intragravel dissolved oxygen and concentrations of less than 7.2 mg/L can cause total mortality (Reiser and Bjornn, 1979).

Steelhead have been observed in pools in the urban core of Santa Barbara. The following graph shows water quality conditions during a period shortly after steelhead were present near Ortega St.:

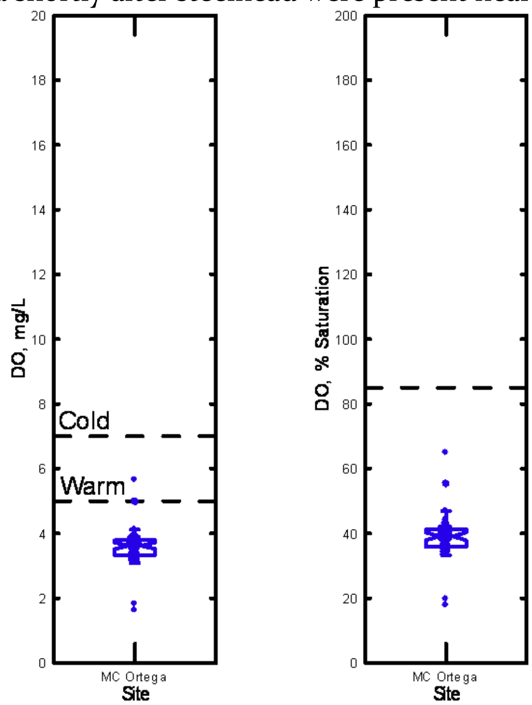


Figure 9. DO at Ortega Street, June 2009.

- DO measure with the sonde was consistently below all water quality objectives, and certainly not meeting ecological objectives for steelhead.
- Unfortunately, temperature data was not recorded.
- Ideally, steelhead will now have access to higher pools, where water quality may be improved.

Conclusions

The Regional Board analysis seemed to overreach, in that it placed an entire waterbody on the 303(d) list with limited sampling, including data from only two stations. Data did not meet the water quality objective for DO concentration, but did meet the objective for % saturation.

Further analysis of Creeks Division data showed that the listing is likely justified, based on multiple years of data from several stations. Sampling times predominately in the mid morning, when photosynthesis had likely elevated DO levels above nighttime values, making this a conservative conclusion.
However, we suspect that the use of a data logger in the upper watershed, especially Rattlesnake Creek, might also show exceedances above water quality objectives. It is unknown whether this would qualify as a "natural source." Regardless, DO worsens in the downstream reaches of Mission Creek, and as we know from previous analyses, nutrients increase.

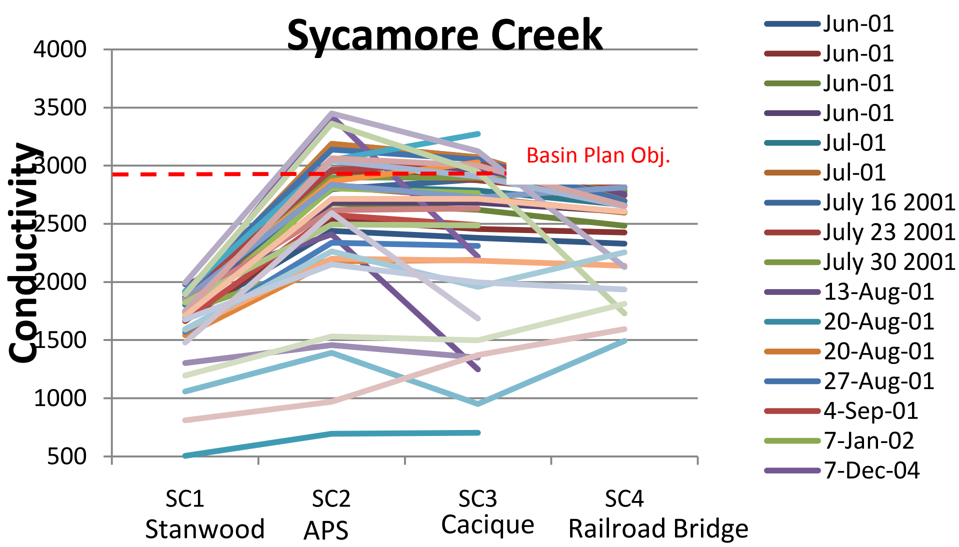
Future work will include placement of data loggers in pools where steelhead are expected to spawn.

303(d) Impairment for Sodium and Chloride in Sycamore Creek

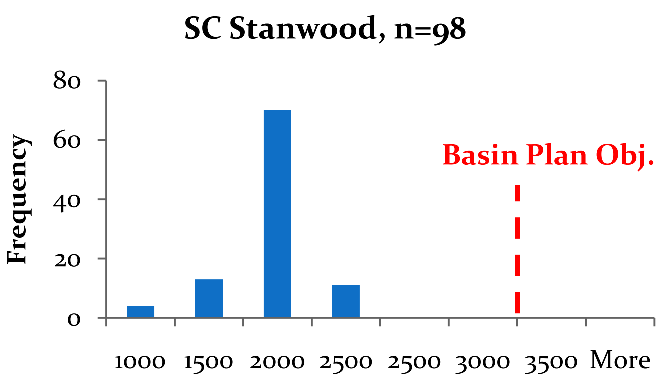
What is the source of the 303(d) impairment for Sodium and Chloride on Sycamore Creek? Is high conductivity near Chelham Creek from natural sources?

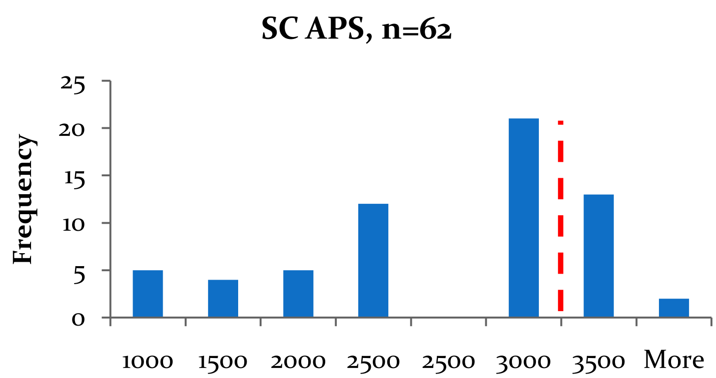
In 2008, Sycamore Creek was listed by the State Water Board for high sodium and chloride, under the beneficial use of Ag.

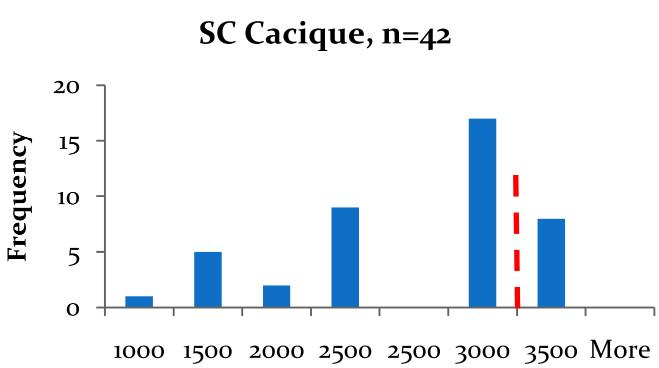
Data Review – Conductivity

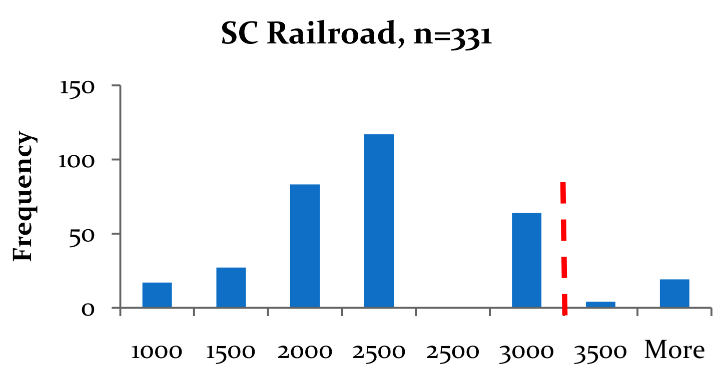


- Consistently large increase in conductivity from Stanwood to APS, then slight decrease to Railroad Bridge.



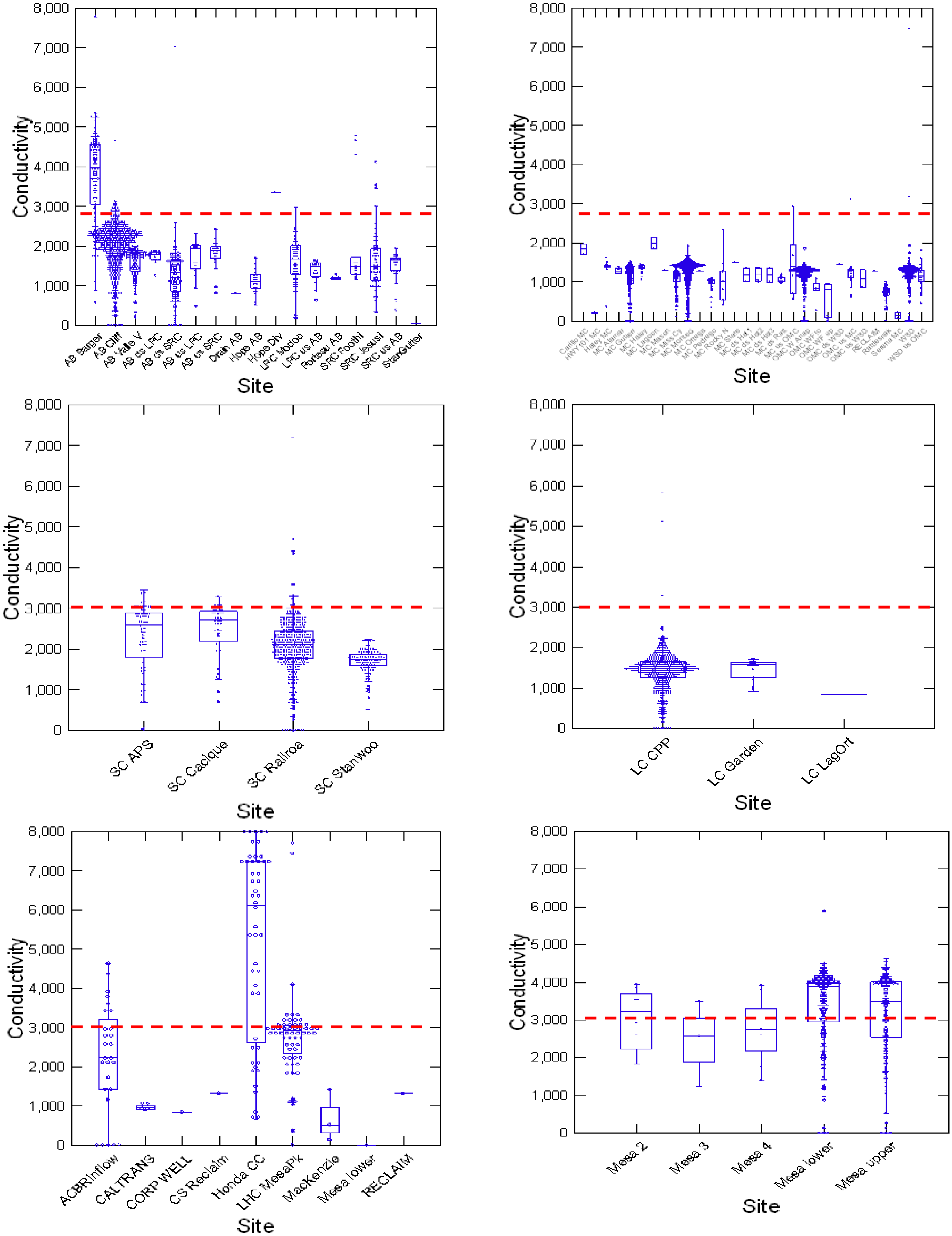






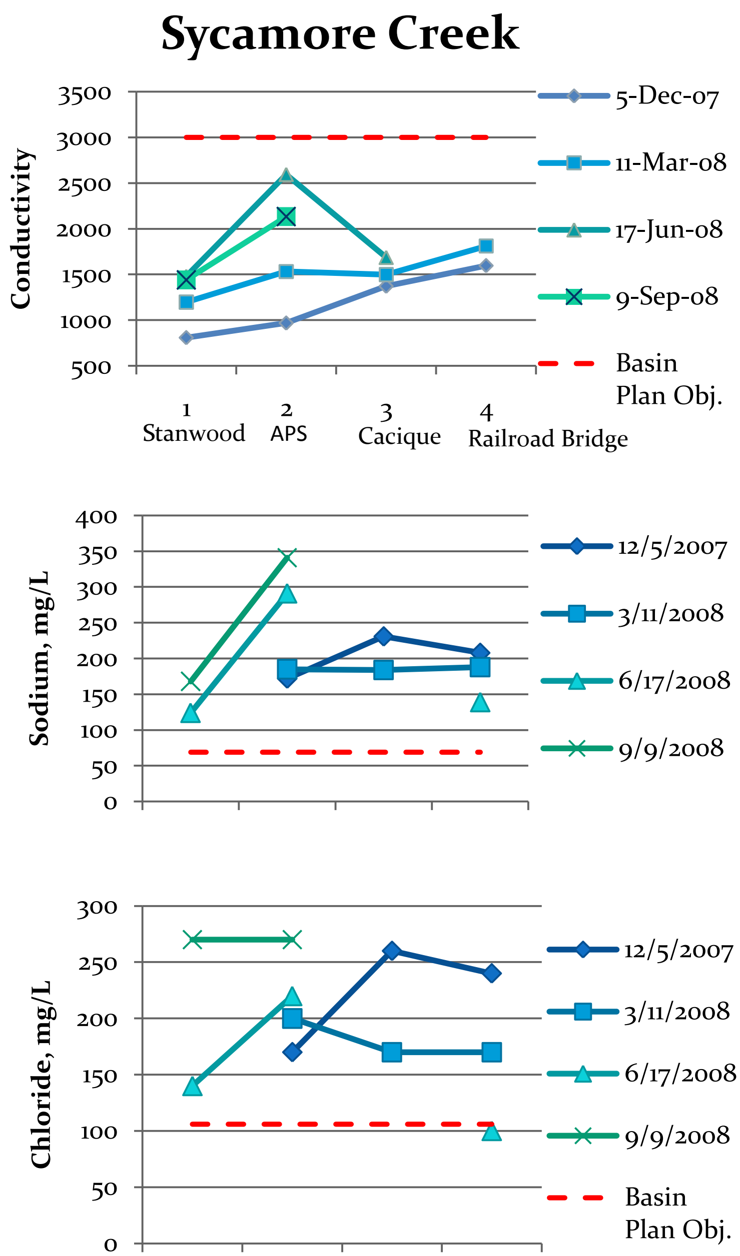
- Conductivity does not exceed at Stanwood.
- 0-15% exceedance at APS through Railroad.
- These plots would work better as probability plots (see section on MC DO)

Conductivity All Creeks



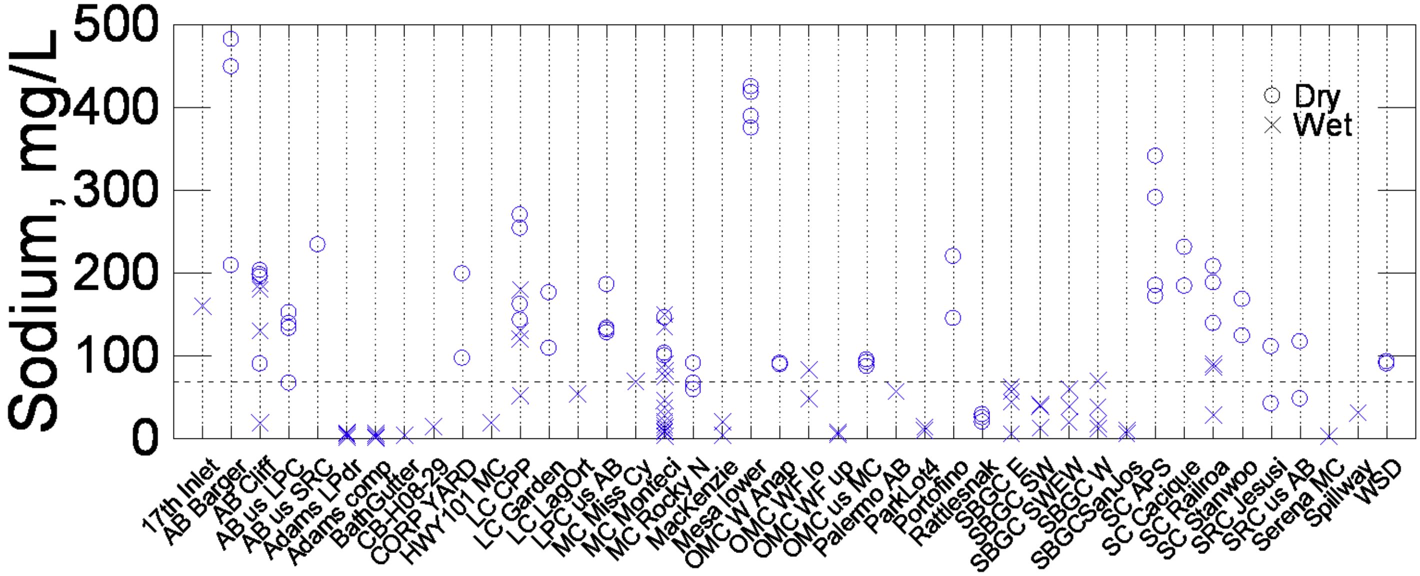
- Barger, Honda, Mesa above Basin Plan Objective.

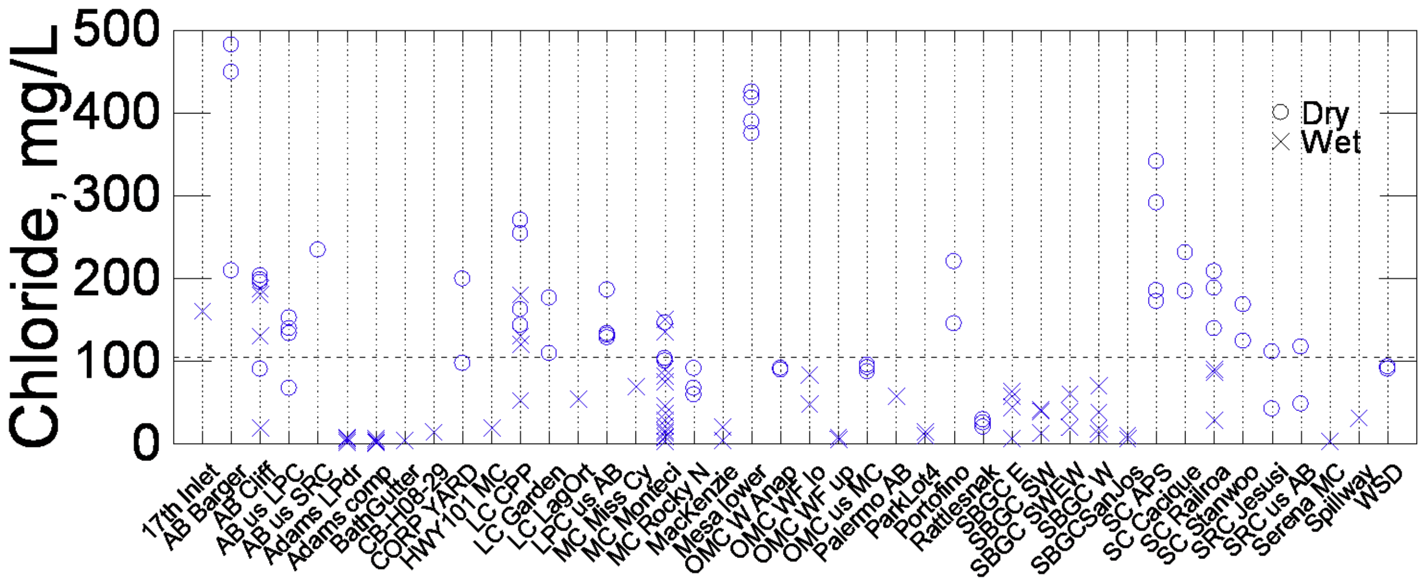
Data Review, Sodium and Chloride



- All days had no conductivity exeedance, but all sites/days had sodium and chloride exceedance.
- Exeedance criterion for listing: 106 mg/L

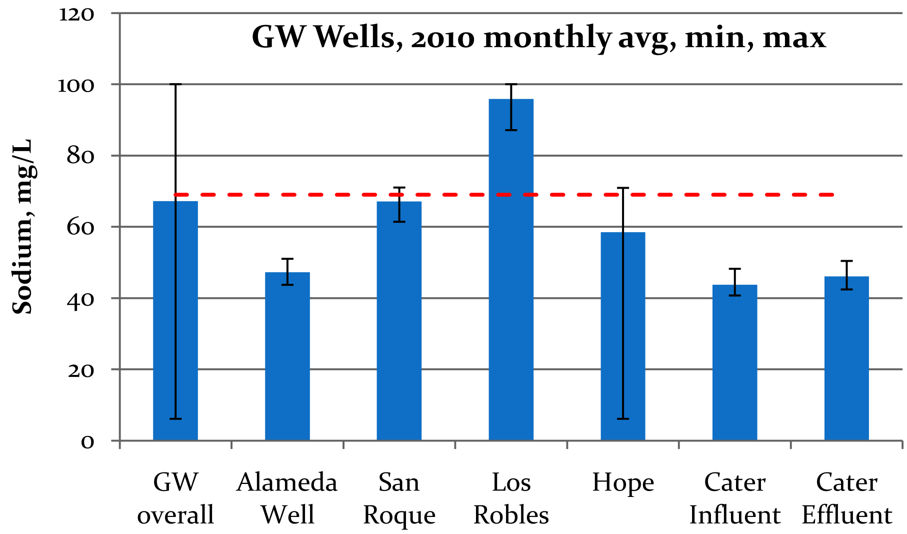
Sodium and Chloride in All Creeks

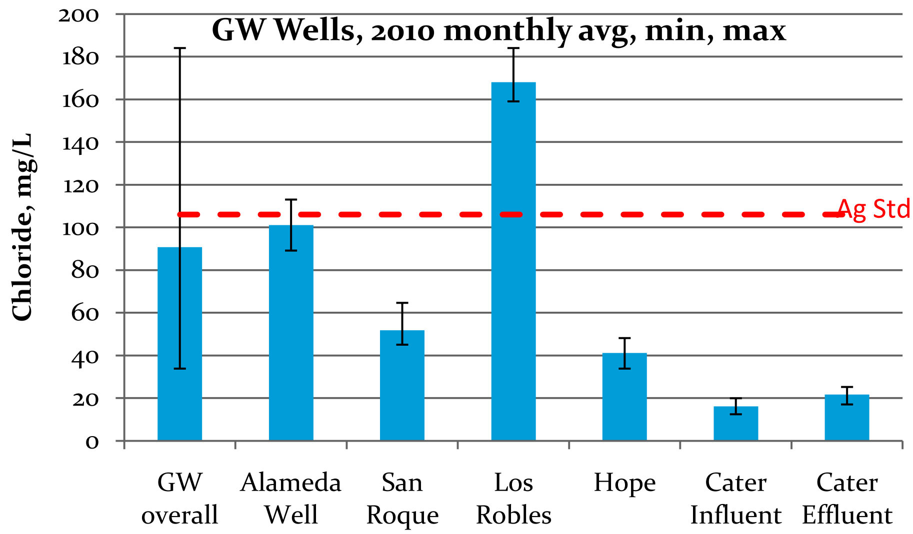




- Most wet weather values below objectives, most dry weather values above objectives.
- Barger, Mesa, SC APS are highest.

Groundwater Well Data (but these are deep)





Creek Walks

November 11, 2011 and February 1, 2012 Creek Walks.

Two creek walks between Stanwood and APS were conducted by Donovan Maccarone to investigate the cause of the increase in conductivity, sodium, and chloride.

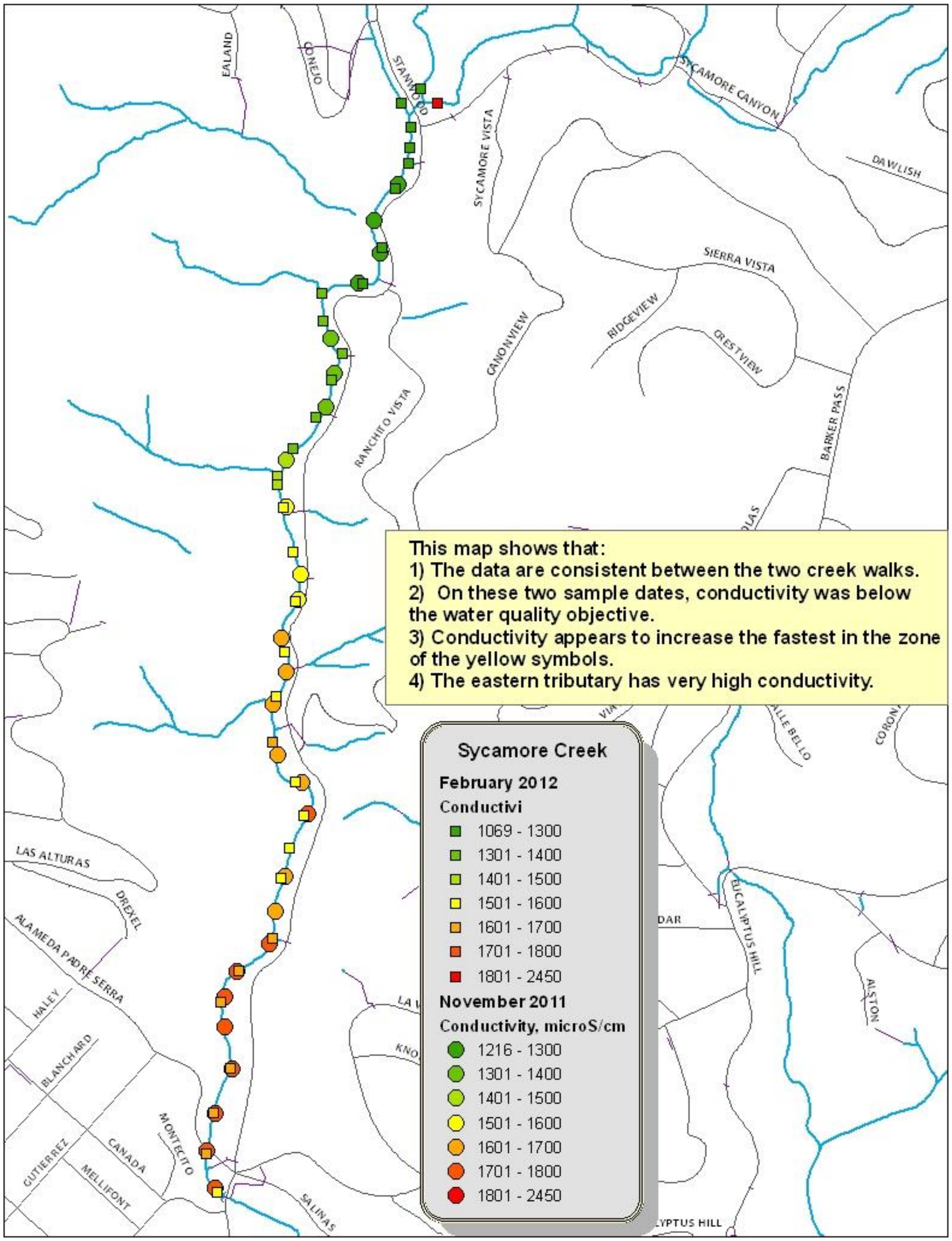


Figure 1. Map of conductivity on Sycamore Creek.

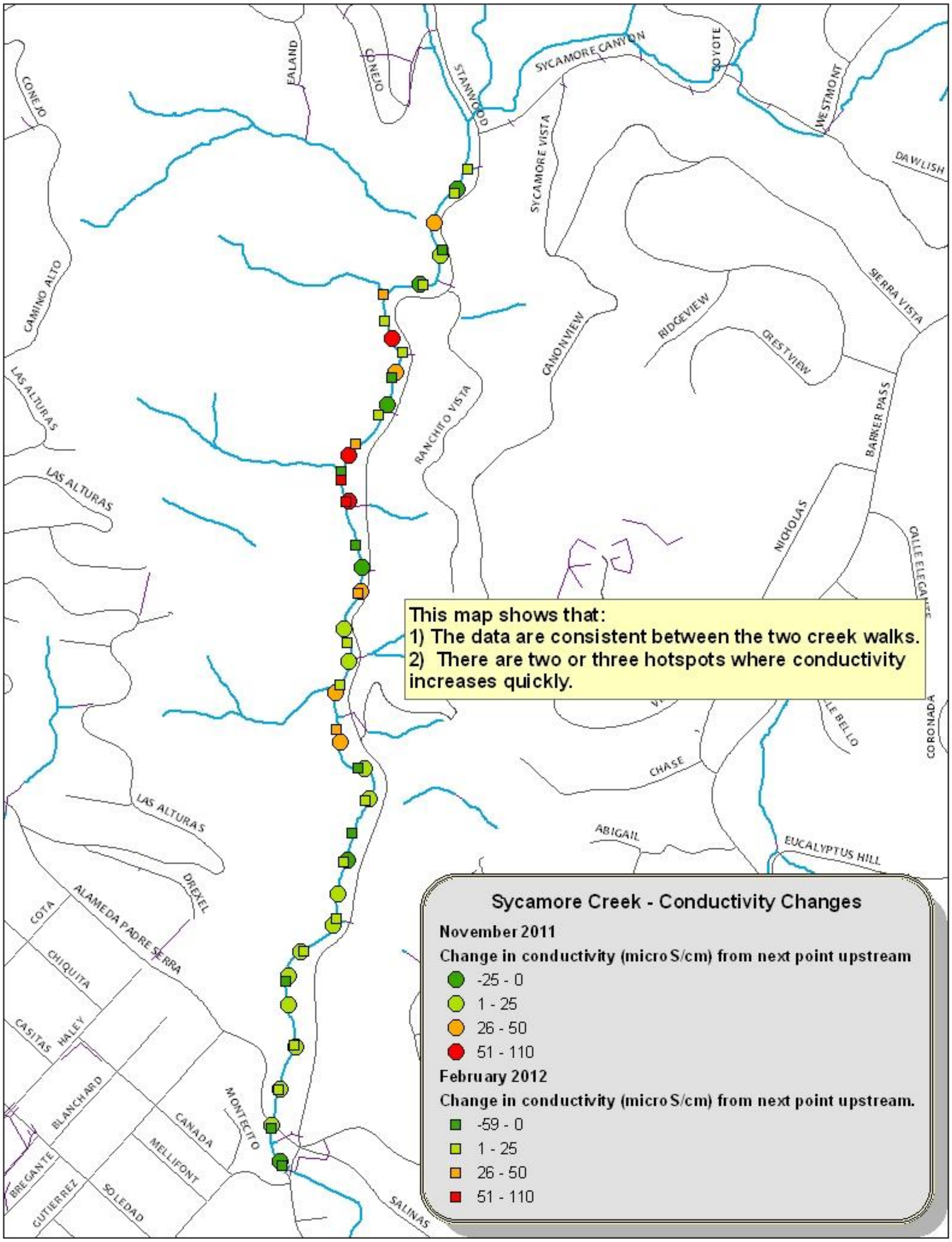


Figure 2. Map of conductivity changes on Sycamore Creek

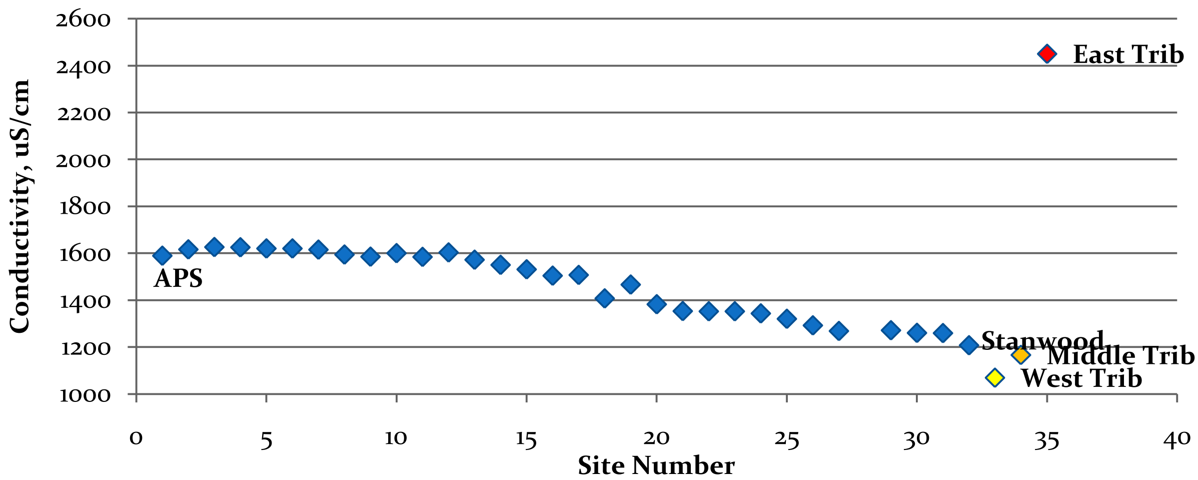


Table 1. Sodium and Chloride Values from February 2012

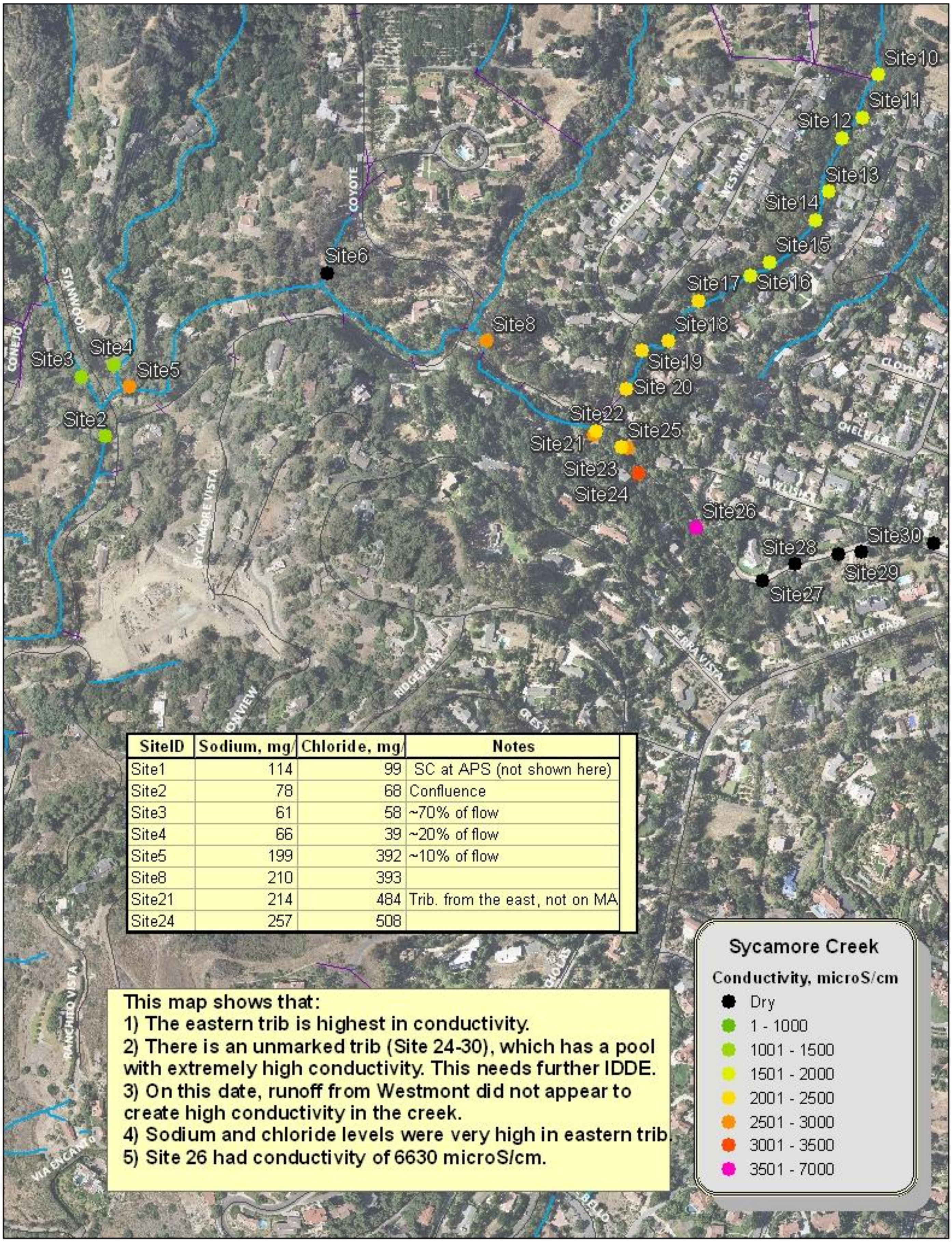
Location	Sodium, mg/L	Chloride, mg/L
Site 21	76	86
Stanwood	72	88
West Trib	55	44
Middle Trib	58	62
East Trib	160	364

- Increasing conductivity downstream, some rapid jumps.
- East most trib had 2.5 x's the conductivity, much higher sodium and chloride
- With a simple mixing model it seems like East trib has to be ~15% of total flow.
- Only E. Trib exceeded conductivity on this day.

March 15, 2012 Creek Walk.

Instructions to Donovan

1. Repeat conductivity and Na/Cl sampling at APS (1), Stanwood (2), each of three tribs (3,4,5). Estimate and record the percent of total flow that each trib contributes to the total flow at Stanwood.
2. If the conductivity of the Eastern trib is more than 500 uS/cm greater than the other too, like last time, continue: Look for flow and test for conductivity/NaCl at each of three inputs to Eastern Trib: Coyote Rd.(6), between Coyote and Circle (7), and Westmont Road (8).
3. Based on conductivity results in the field, decide if you should continue up any of the tribs (6,7,8). Only do so if one is higher than the others by 500 uS/cm. If so, drive upstream a ways and test conductivity again. If it starts to go back down (by at least 200 uS/cm), you know the problem is behind you. Use your best judgement to find out what is going on, or narrow down the location where conductivity increases.



SiteID	Sodium, mg/	Chloride, mg/	Notes
Site1	114	99	SC at APS (not shown here)
Site2	78	68	Confluence
Site3	61	58	~70% of flow
Site4	66	39	~20% of flow
Site5	199	392	~10% of flow
Site8	210	393	
Site21	214	484	Trib. from the east, not on MA
Site24	257	508	

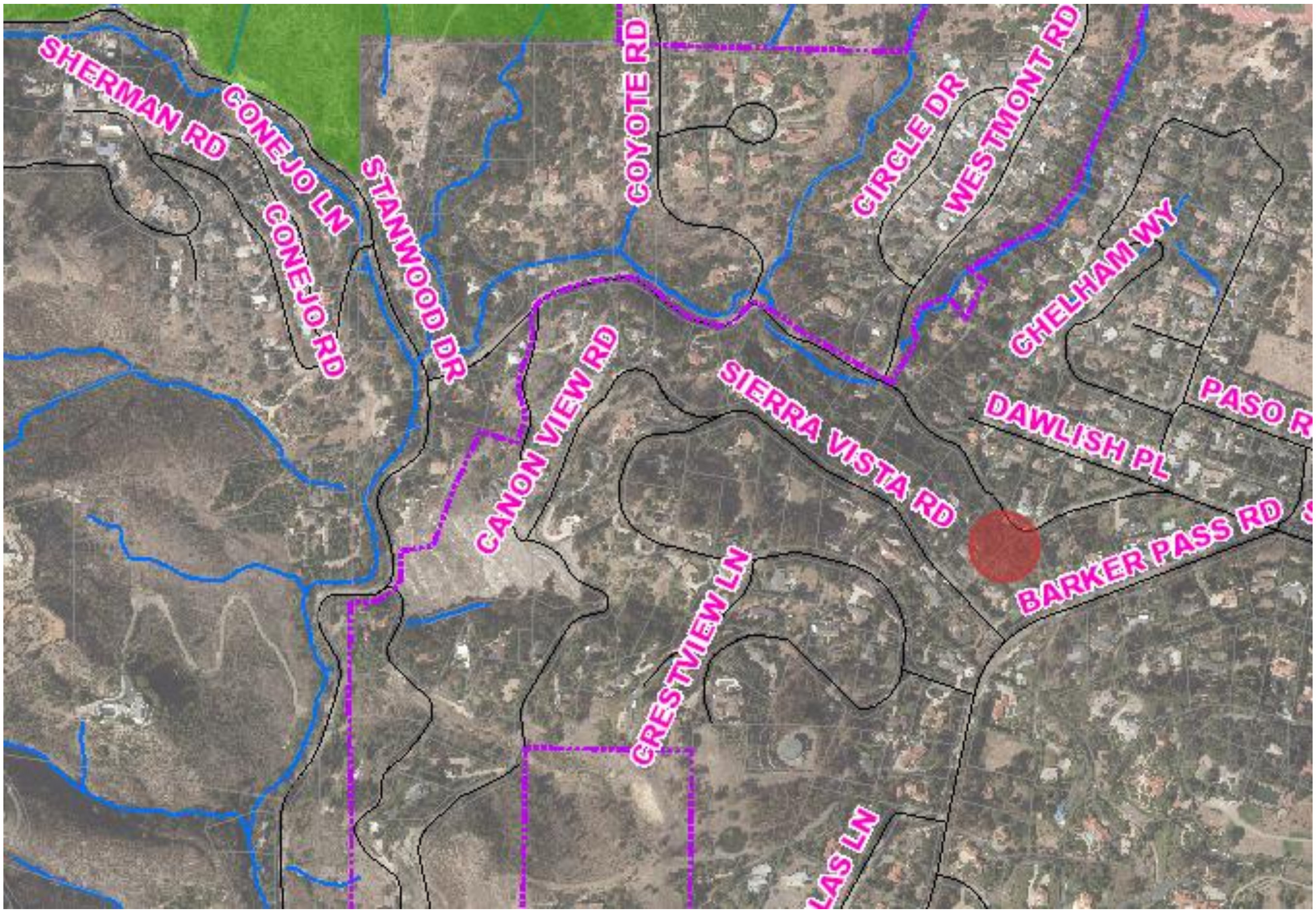
This map shows that:
1) The eastern trib is highest in conductivity.
2) There is an unmarked trib (Site 24-30), which has a pool with extremely high conductivity. This needs further IDDE.
3) On this date, runoff from Westmont did not appear to create high conductivity in the creek.
4) Sodium and chloride levels were very high in eastern trib.
5) Site 26 had conductivity of 6630 microS/cm.

Additional Results

4/19/12

Donovan and Jim walked the upper pool and Honda Creek (also high).

Found one more pool that was on a higher parcel (529 Barker Pass Road). 345 Sierra Vista was first pool from last time (there are irrigation lines crossing creeks, they tested, very low at 600 uS). Both pools were ~4 mS/cm. As shown on the map below (red circle), the pools with high conductivity are outside of the City of Santa Barbara limits.



Regulatory Information

Email from Regional Board about process to delist a waterbody for sodium and chloride

In summary, delisting does seem possible without help from County to investigate high conductivity pools.

Our procedure for the 2008/2010 list was as follows. If natural sources are a likely source we then considered potential for anthropogenic sources. Only watersheds that are have very low percentages of urban, agriculture or grazing landuses were excluded. Big Creek in Big Sur area is the only one I can think of that has this situation. We are being careful and including all things exceeding criteria.

There are three ways to delist

1) Prove that it is natural by providing data from the upper watershed or from seeps/springs above the urban area showing comparable salt concentrations. I can use that to justify natural sources and delist.

2) As part of our triannual review process we can

a) propose waterbody specific objectives for each salt that are based on the natural conditions in the groundwater

b) revise the beneficial use designations (but this takes a LOT of work on your part).

303(d) Impairment for Unknown Toxicity on Mission Creek

What is the source of the impairment for toxicity on Mission Creek? Is high conductivity in Honda Creek from natural sources?

Mission Creek was listed many years ago for "unknown toxicity" due to a fish kill. A water body can no longer be listed with such scant evidence. In order to investigate the toxicity of the creek, and whether the water body should be de-listed, the City and Regional Board (CCAMP) have collected numerous samples over the past decade. The following section documents the regulations, communications with the Regional Board, and data collected by CCAMP and the City. The section ends with a suggestion for future sampling.

How water bodies are listed (State Listing Policy):

3.6 Water/Sediment Toxicity

A water segment shall be placed on the section 303(d) list if the water segment exhibits statistically significant water or sediment toxicity using the binomial distribution as described in section 3.1. The segment shall be listed if the observed toxicity is associated with a pollutant or pollutants. Waters may also be placed on the section 303(d) list for toxicity alone. If the pollutant causing or contributing to the toxicity is identified, the pollutant shall be included on the section 303(d) list as soon as possible (i.e., during the next listing cycle).

Reference conditions may include laboratory controls (using a t-test or other applicable statistical test), the lower confidence interval of the reference envelope, or, for sediments, response less than 90 percent of the minimum significant difference for each specific test organism.

Appropriate reference and control measures must be included in the toxicity testing. Acceptable methods include, but are not limited to, those listed in water quality control plans, the methods used by Surface Water Ambient Monitoring Program (SWAMP), the Southern California Bight Projects of the Southern California Coastal Water Research Project, American Society for Testing and Materials (ASTM), USEPA, the Regional Monitoring Program of the San Francisco Estuary Institute, and the Bay Protection and Toxic Cleanup Program (BPTCP).

Association of pollutant concentrations with toxic or other biological effects should be determined by any one of the following:

A. Sediment quality guidelines (satisfying the requirements of section 6.1.3) are exceeded using the binomial distribution as described in section 3.1. In addition, using rank correlation, the observed effects are correlated with measurements of chemical concentration in sediments. If these conditions are met, the pollutant shall be identified as "sediment pollutant(s)."

B. For sediments, an evaluation of equilibrium partitioning or other type of toxicological response that identifies the pollutant that may cause the observed impact. Comparison to reference conditions within a watershed or ecoregion may be used to establish sediment impacts.

C. Development of an evaluation (such as a toxicity identification evaluation) that identifies the pollutant that contributes to or caused the observed impact.

3.1 Numeric Water Quality Objectives and Criteria for Toxicants in Water

Numeric water quality objectives for toxic pollutants, including maximum contaminant levels where applicable, or California/National Toxics Rule water quality criteria are exceeded as follows:

- Using the binomial distribution, waters shall be placed on the section 303(d) list if the number of measured exceedances supports rejection of the null hypothesis as presented in Table 3.1.

TABLE 3.1: MINIMUM NUMBER OF MEASURED EXCEEDANCES NEEDED TO PLACE A WATER SEGMENT ON THE SECTION 303(D) LIST FOR TOXICANTS. *Null Hypothesis: Actual exceedance proportion ≤ 3 percent.* *Alternate Hypothesis: Actual exceedance proportion > 18 percent.* *The minimum effect size is 15 percent.*	
Sample Size	List if the number of exceedances equal or is greater than
2 – 24	2*
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6
72 – 82	7
83 – 94	8
95 – 106	9
107 – 117	10
118 – 129	11

*Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE)
β = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE)
where n = the number of samples,
k = minimum number of measured exceedances to place a water on the section 303(d) list,
0.03 = acceptable exceedance proportion, and
0.18 = unacceptable exceedance proportion.

According to the table above, and CCAMP's data and email correspondence (see below), Mission Creek could be listed (23 samples, 2 exeedances). However, the CCAMP method of counting samples and exceedances is unclear (see below).

How a water body can be de-listed for toxicity:

4 California Delisting Factors

This section provides the methodology for removing waters from the section 303(d) list (including the Water Quality Limited Segments category and Water Quality Limited Segments Being Addressed category).

All listings of water segments shall be removed from the section 303(d) list if the listing was based on faulty data, and it is demonstrated that the listing would not have occurred in the absence of such faulty data. Faulty data include, but are not limited to, typographical errors, improper quality assurance/quality control procedures, or limitations related to the analytical methods that would lead to improper conclusions regarding the water quality status of the segment.

If objectives or standards have been revised and the site or water meets water quality standards, the water segment shall be removed from the section 303(d) list. The listing of a segment shall be reevaluated if the water quality standard has been changed.

Any interested party may request an existing listing be reassessed under the delisting factors of this Policy. In requesting the reevaluation, the interested party must, using the delisting factors: state the reason(s) the listing is inappropriate and the Policy would lead to a different outcome; and provide the data and information necessary to enable the RWQCB and SWRCB to conduct the review.

Water segments or pollutants shall be removed from the section 303(d) list if any of the following conditions are met.

4.6 Water/Sediment Toxicity

Water/Sediment Toxicity or associated water or sediment quality guidelines are not exceeded using the binomial distribution as described in section 4.1.

TABLE 4.1: MAXIMUM NUMBER OF MEASURED EXCEEDANCES ALLOWED TO REMOVE A WATER SEGMENT FROM THE SECTION 303(D) LIST FOR TOXICANTS.

Null Hypothesis: Actual exceedance proportion ≥ 18 percent.
Alternate Hypothesis: Actual proportion < 3 percent of the samples
The minimum effect size is 15 percent.

Sample Size	Delist if the number of exceedances equal or is less than
28 – 36	2
37 – 47	3
48 – 59	4
60 – 71	5
72 – 82	6
83 – 94	7
95 – 106	8
107 – 117	9
118 – 129	10

For sample sizes greater than 129, the maximum number of measured exceedances allowed is established where α and $\beta \leq 0.10$ and where $|\alpha - \beta|$ is minimized.

α = Excel® Function BINOMDIST(k, n, 0.18, TRUE)
β = Excel® Function BINOMDIST(n-k-1, n, 1 – 0.03, TRUE)
where n = the number of samples,
k = maximum number of measured exceedances allowed,
0.03 = acceptable exceedance proportion, and
0.18 = unacceptable exceedance proportion.

Using the samples from CCAMP and the City (18-29 samples, 1-3 exceedances), for a total of 41-52 samples, 3-5 exceedances, there may or may not be enough data to justify de-listing. Regardless, the City will request a review during the next listing cycle.

A few more important details:
The discrepancy in sample number is due to not understanding how the State treats multiple samples collected on the same date (see below). No rules of thumb applied to the CCAMP data result in the stated number of samples and exceedances (23 and 2).
The discrepancy in the number of exeedances is because one of the toxic responses was noted in estuarine sediments. It is not expected that this sample would be included in the analysis.
CCAMP's toxic results are for *Selenastrum*, an algae species. Mary Hamilton from the Regional Board suggested that there may be herbicides such as chlorpyrifos, which would show up as toxicity to algae, but not invertebrates or vertebrates. The City followed up with additional *Selenastrum* testing, finding no toxicity in seven samples collected during wet and dry weather. In a phone call with the City of Salinas, it was discussed that the State's *Selenastrum* testing may be suspect.

Email with Mary Hamilton (Adams), 7/27/10
From Talking to Mary Adams (7/27/10)

1) Summary: The State is moving toward a much more protective assessment of toxicity. There is a good chance that many other creeks will be listed in the coming round of 303(d) assessments. Mission Creek has passed almost all toxicity tests for fathead minnows and ceriodaphnia (invertebrate), but has failed two out two tests using Selenastrum (algae).
2) Two ways to assess toxic response:
    a. Difference from control (cutoff is usually 80%) – this is how the Regional Board has done it for all previous tests.
    b. Probability that the difference is real (cutoff is usually .95). The EPA has changed to this method, using .8 as the cutoff. This means that a test could have 90% survival but be significantly different from the control and be considered toxic.
3) Mary Adams says that the current thinking is that this round of listings will stick with the 80% survival, but that anything could change. If things do change to the probability method, she is not sure if they will go back and reassess data.
4) In addition, the State considers all tests conducted on the same day as one sample, and if only one is toxic, the entire sample is toxic.
5) Using either method, Mission Creek has 23 samples collected, with 2 toxic responses, we would need 5 – 14 additional nontoxic samples to de-list.

CCAMP Data through 2010

StationName	Date	Collection Method Name	Rep	Time Point	Species Name	Analyte Name	Unit Name	Rep Count	Mean	Prob.	Eval Thresh	Pct Control	Sig Effect Code	Tox Batch Comments
MC Montecito	12/3/01	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	27	1.00	80	137	NSG	QAO: DO > 9.67
MC Montecito	12/3/01	Water_Grab	1	Day 7	Pimephales promelas	Growth (wt/surv indiv)	mg/ind	4	0.6	0.46	80	98	NSG	
MC Montecito	12/3/01	Water_Grab	1	Day 7	Pimephales promelas	Survival	%	4	85	0.11	80	85	NSG	
MC Montecito	12/3/01	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	100	0.50	80	100	NSG	QAO: DO > 9.67
MC Foothill	12/5/01	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	20	0.70	80	111	NSG	QAO: DO > 9.76
MC Foothill	12/5/01	Water_Grab	1	Day 7	Pimephales promelas	Growth (wt/surv indiv)	mg/ind	4	0.9	0.64	80	102	NSG	
MC Foothill	12/5/01	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	100	0.50	80	100	NSG	QAO: DO > 9.76
MC Foothill	12/5/01	Water_Grab	1	Day 7	Pimephales promelas	Survival	%	4	98	0.50	80	100	NSG	
MC Foothill	3/17/02	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	21	0.53	80	101	NSG	QAO:DO >9.67
MC Foothill	3/17/02	Water_Grab	1	Day 7	Pimephales promelas	Growth (wt/surv indiv)	mg/ind	4	0.7	0.18	80	73	NSL	QAO:hardness > 700
MC Foothill	3/17/02	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	100	0.50	80	100	NSG	QAO:DO >9.67
MC Foothill	3/17/02	Water_Grab	1	Day 7	Pimephales promelas	Survival	%	4	73	0.27	80	81	NSG	QAO:hardness > 700
MC Montecito	3/19/02	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	40	1.00	80	166	NSG	QAO: conductiv>3000; DO > 9.67
MC Montecito	3/19/02	Water_Grab	1	Day 7	Pimephales promelas	Growth (wt/surv indiv)	mg/ind	4	1.1	0.68	80	104	NSG	QAO: conducivity > 3000
MC Montecito	3/19/02	Water_Grab	1	Day 7	Pimephales promelas	Survival	%	4	91	0.66	80	103	NSG	QAO: conducivity > 3000
MC Montecito	3/19/02	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	100	0.50	80	100	NSG	QAO: conductivity>3000; DO > 9.67
MC Montecito	3/25/02	Sediment_Grab	1	Day 28	Hyalella azteca	Growth (wt/surv indiv)	mg/ind	8	0.5	0.66	80	104	NSG	Discussed with Reg Brd.Test acceptable no toxic hits on samples, Minor deviations in test conditions (temp, light);cntrl below mean threshold

StationName	Date	Collection Method Name	Rep	Time Point	Species Name	Analyte Name	Unit Name	Rep Count	Mean	Prob.	Eval Thresh	Pct Control	Sig Effect Code	Tox Batch Comments
MC Montecito	3/25/02	Sediment_Grab	1	Day 10	Hyalella azteca	Growth (wt/surv indiv)	mg/ind	8	0.2	0.02	80	79	SL	Tox cntr criteria not met.CNEG not analyzed.Data acceptable for interpretation,statistical comparisons were made with RFST control.
MC Montecito	3/25/02	Sediment_Grab	1	Day 28	Hyalella azteca	Survival	%	8	83	0.88	80	116	NSG	Discussed with Reg Brd.Test acceptable no toxic hits on samples, Minor deviations in test conditions (temp, light);cntrl below mean threshold
MC Montecito	3/25/02	Sediment_Grab	1	Day 10	Hyalella azteca	Survival	%	8	81	0.42	80	97	NSG	Tox cntr criteria not met.CNEG not analyzed.Data acceptable for interpretation,statistical comparisons were made with RFST control.
MC Montecito	6/10/08	Sediment_Grab	1	Day 10	Hyalella azteca	Growth (wt/surv indiv)	mg/ind	8	0.1	0.38	0.12	-88	NSG	some samples outside recommended HT of 14 days
MC Montecito	6/10/08	Sediment_Grab	1	Day 10	Hyalella azteca	Survival	%	8	89	0.05	75	-88	SG	some samples outside recommended HT of 14 days
MC Montecito	8/27/08	Water_Grab	1	Day 7	Pimephales promelas	Survival	%	4	100	0.50	80	-88	NSG	
MC Montecito	8/27/08	Water_Grab	1	Day 7	Pimephales promelas	Biomass (wt/orig indiv)	mg/ind	4	0.5	0.99	0.31	-88	NSG	
MC Montecito	8/27/08	Water_Grab	2	Day 7	Ceriodaphnia dubia	Survival	%	10	90	0.50	70	-88	NSG	Concurrently initiated reference toxicant test did not meet test acceptability criteria.
MC Montecito	8/27/08	Water_Grab	2	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	24	0.98	14.6	-88	NSG	Concurrently initiated reference toxicant test did not meet test acceptability criteria.
MC Montecito	8/27/08	Water_Grab	2	Day 4	Selenastrum capricornutum	Total Cell Count	cells/ml	4	505650	0.00	1872900	-88	SL	Although some samples in this test were high conductivity samples, the low performance of samples relative to the High EC Control indicates that the toxicity of the samples cannot be explained solely by high

StationName	Date	Collection Method Name	Rep	Time Point	Species Name	Analyte Name	Unit Name	Rep Count	Mean	Prob.	Eval Thresh	Pct Control	Sig Effect Code	Tox Batch Comments
														conductivity.
MC Montecito	8/27/08	Water_Grab	2	Day 7	Pimephales promelas	Survival	%	4	100	0.50	80	-88	NSG	
MC Montecito	8/27/08	Water_Grab	2	Day 7	Pimephales promelas	Biomass (wt/orig indiv)	mg/ind	4	0.5	1.00	0.31	-88	NSG	
MC Montecito	8/27/08	Water_Grab	1	Day 4	Selenastrum capricornutum	Total Cell Count	cells/ml	4	417270	0.00	1872900	-88	SL	Although some samples in this test were high conductivity samples, the low performance of samples relative to the High EC Control indicates that the toxicity of the samples cannot be explained solely by high conductivity.
MC Montecito	8/27/08	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	22	0.81	14.6	-88	NSG	Concurrently initiated reference toxicant test did not meet test acceptability criteria.
MC Montecito	8/27/08	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	80	0.28	70	-88	NSG	Concurrently initiated reference toxicant test did not meet test acceptability criteria.
MC Montecito	1/28/09	Water_Grab	1	Day 4	Selenastrum capricornutum	Total Cell Count	cells/ml	4	803820	0.00	3132600	-88	SL	
MC Montecito	1/28/09	Water_Grab	1	Day 7	Pimephales promelas	Survival	%	4	100	0.50	80	-88	NSG	
MC Montecito	1/28/09	Water_Grab	1	Day 7	Pimephales promelas	Biomass (wt/orig indiv)	mg/ind	4	0.6	0.98	0.44	-88	NSG	
MC Montecito	1/28/09	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	29	0.99	21.7	-88	NSG	
MC Montecito	1/28/09	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	100	0.50	80	-88	NSG	
MC Montecito	5/19/09	Sediment_Grab	1	Day 10	Hyalella azteca	Survival	%	8	73	0.01	71.3	-88	SG	
MC Montecito	5/19/09	Sediment_Grab	1	Day 10	Hyalella azteca	Growth (wt/surv indiv)	mg/ind	8	0.1	0.86	0.09	-88	NSG	
MC Montecito	2/24/10	Water_Grab	1	Day 7	Pimephales	Survival	%	4	100	0.50	80	-88	NSG	

StationName	Date	Collection Method Name	Rep	Time Point	Species Name	Analyte Name	Unit Name	Rep Count	Mean	Prob.	Eval Thresh	Pct Control	Sig Effect Code	Tox Batch Comments
					promelas									
MC Montecito	2/24/10	Water_Grab	1	Day 7	Pimephales promelas	Biomass (wt/orig indiv)	mg/ind	4	0.6	0.79	0.49	-88	NSG	
MC Montecito	2/24/10	Water_Grab	1	Day 4	Selenastrum capricornutum	Total Cell Count	cells/ml	4	2E+06	0.02	2436640	-88	SL	
MC Montecito	2/24/10	Water_Grab	1	Day 7	Ceriodaphnia dubia	Survival	%	10	100	0.50	80	-88	NSG	
MC Montecito	2/24/10	Water_Grab	1	Day 7	Ceriodaphnia dubia	Young/female	Num/Rep	10	34	1.00	16.2	-88	NSG	

City Data

StationID	Sample Start Date	Conditions	Matrix	Test Organism	Test	End Point	Result	Sign Diff
MC Cota	5/2/07	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	100	NSG
Rattlesnak	5/2/07	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	95	NSG
MC Monteci	7/17/07	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	90	NSG
MC Monteci	9/21/07	Storm	Freshwater	Fathead Minnow	5-day Acute	% Survival	100	NSG
MC Monteci	10/10/07	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	95	NSG
MC Lagoon	11/12/07	Dry	Sediment	Eohaustorius	10-day Chronic	% survival	98	NSG
MC Monteci	1/15/08	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	100	NSG
MC Monteci	4/8/08	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	97	NSG
MC Monteci	7/1/08	Dry	Freshwater	Fathead Minnow	5-day Acute	% Survival	100	NSG
MC Lagoon	9/23/08	Dry	Brackish Water	Fathead Minnow	5-day Acute	% Survival	92	SL
MC Lagoon	8/26/09	Dry	Sed-Estuarine	Mytilus edulus	Chronic	% Normal	90	SL
MC Miss Cy	10/13/09	Storm	Freshwater	Fathead Minnow	5-day Acute	% Survival	100	NSG
MC Monteci	10/13/09	Storm	Freshwater	Fathead Minnow	5-day Acute	% Survival	100	NSG
MC Monteci	10/6/10	Storm	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	100	NSG
MC Monteci	10/6/10	Storm	Freshwater	Ceriodaphnia	4-Day Acute	% Survival	100	NSG
MC Lagoon	10/28/10	Dry	Sed-Estuarine	Eohaustorius	10-Day Survival	% Survival	100	NSG
MC Gutierr	10/28/10	Dry	Sediment	Hyalella	10-Day Survival	% Survival	100	NSG
MC Monteci	10/5/11	Storm	Freshwater	Ceriodaphnia	4-Day Acute	% Survival	100	NSG
MC Monteci	10/5/11	Storm	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	-8.32	NSG
MC Gutierr	10/13/11	Dry	Sediment	Hyalella	10-Day Survival	% Survival	84.4	SL
MC Lagoon	10/13/11	Dry	Sed-Estuarine	Eohaustorius	10-day Chronic	% Survival	100	NSG
Rattlesnak	10/26/11	Dry	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	-63.16	NSG
MC Miss Cy	10/26/11	Dry	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	-26.68	NSG
MC Rocky N	10/26/11	Dry	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	-50.57	NSG
MC Monteci	10/26/11	Dry	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	-44.68	NSG
MC Gutierr	10/17/12	Dry	Sediment	Hyalella	10-Day Survival	% Survival	100	NSG
MC Lagoon	10/17/12	Dry	Sed-Estuarine	Eohaustorius	10-day Chronic	% Survival	100	NSG
MC Monteci	11/16/12	Storm	Freshwater	Ceriodaphnia	4-Day Acute	% Survival	100	NSG
MC Monteci	11/16/12	Storm	Freshwater	Selenastrum	4-Day Chronic	% Cell Density	-3.62	NSG

(-) values indicate that growth was greater in the creek sample than in the control.

Daily Fluctuations in Stream Flow

What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro?

This question was not addressed in FY 13.

New Pestcides

Are new pesticides (pyerthroids and neonicotinoids) detected in dry conditions?

There were no detections in dry weather. Data provided in next report.

Storm Monitoring

First Flush Monitoring: Chemistry and Toxicity

What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms?

Each fall the Creeks Division samples the first storm of the season, as this "first flush" is known to produce the highest concentrations of most contaminants in stormwater runoff. In most previous years, creek "integrator sites" (lowest sites on creeks, integrating water quality issues across the entire watershed) have been sampled during every first flush event. Over the past two seasons, storm drains and gutters were also sampled; this effort was not continued in FY 13 due to the extensive sampling required for the LID Parking Lot Project. After several fall days with traces of rainfall, the first real storm of the season arrived on November 16 (**Figure 1**). The first flush was sampled on November 16, 2012 at the integrator sites Laguna Channel at Chase Palm Park (LC CPP), Mission Creek at Montecito Street (MC Montecito), Arroyo Burro at Cliff Drive (AB Cliff), and Sycamore Creek at the railroad bridge (SC Railroad). Samples were collected between 11:40 AM and 12:30 PM, after approximately 0.20" of rain had fallen (**Figure 2**). Water was tested for metals, pesticides, hydrocarbons, surfactants, sediment, and toxicity.

Metals and hydrocarbons were not detected at elevated concentrations; however some other results were concerning (**Table 1**). In previous years, very few detections of pesticides have been found in creek samples, during both dry and wet weather. This year, 2,4-DB was detected for the first time, in two samples. The compound is a metabolite of 2,4-D, an ingredient in some weed killers. No toxicity was observed in creek sites.

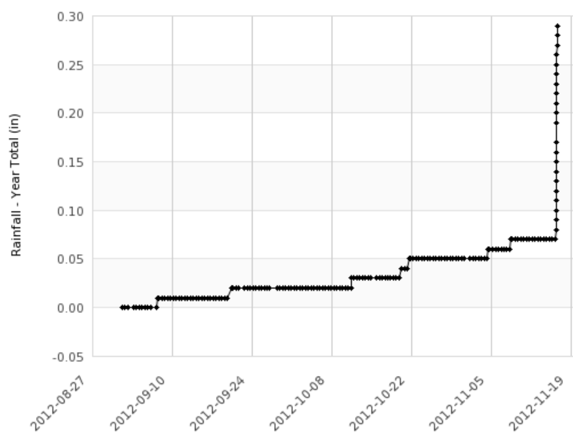


Figure 1. Early season rainfall in Fall 2012, Santa Barbara County Engineering Building.

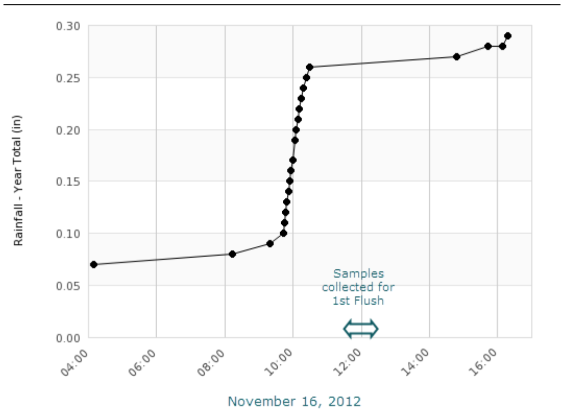


Figure 2. Rainfall during First Flush sampling.

Table 1. First Flush Results at Integrator Creek Sites

Constituent	AB Cliff	LCC CPP	MC Montecito	SC Railroad	Reporting Level	Criteria (source)
Metals (Total), mg/L						
Arsenic	0.001	ND	ND	ND	0.007	0.15 (EPA CCC, old)
Cadmium	ND	ND	ND	ND	0.002	0.00027 (EPA CCC, old)
Chromium	0.01	0.01	0.01	0.01	0.002	0.086 (EPA CCC, old)
Copper	0.02	0.07	0.06	0.012	0.003	0.0094 (EPA CCC, old)
Lead	ND	0.02	0.02	ND	0.004	0.0053 (EPA CCC, old)
Mercury	ND	ND	ND	ND	0.0002	0.00091 (EPA CCC, old)
Nickel	0.02	0.03	0.01	ND	0.01	0.052 (EPA CCC, old)
Silver	ND	ND	ND	ND	0.01	
Zinc	0.05	0.32	0.2	0.08	0.02	0.12 (EPA CCC, old)
Metals (Dissolved), mg/L						
Copper	ND	0.02	0.02	.01	0.01	TBD
Petroleum Hydrocarbons						
EFH (C13-C40), mg/L	ND	1.5	1.4	0.73	0.5	Uncertain
GRO (C6-C12) mg/L	ND	ND	ND	ND	50-250	Uncertain
Herbicides and Pesticides,						
Organochlorine Pesticides (EPA 8081A), µg/L	ND	ND	ND	ND	0.1-5	No criteria
Chlorinated Herbicides (EPA 8151)	ND	ND except except 2,4-DB= 9.8	ND 2,4-DB= 4.1	ND	1 -400 µg/L	Limited criteria
Organophosphorus Pesticides (EPA 8141A), µg/L	ND	ND	ND	ND	0.5-6 µg/L	Limited criteria
Carbaryl, µg/L	ND	ND	ND	ND	5	TBD
Total Suspended Solids, mg/L	190	68	150	25	10	TBD
Surfactants (MBAS), mg/L	0.44	1.2	1.1	0.78	0.25	TBD
Toxicity						
Ceriodaphnia, % Survival	100	100	100	100		
Selenastrum, % Cell Density	99	>100	>100	>100		

Toxicity during Rain Events

Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?
This analysis will be updated in FY 14.

Is runoff from coal tar sealed parking lots more toxic than runoff from asphalt sealed parking lots?
No samples were collected for this question in FY13.

CECs during Rain Events

What are the loads of pyrethroids discharged during storm events?

This question was not addressed during FY13.

Project Performance in Storms

How do restoration/treatment projects impact water quality during storm events?

Fish Passages

See George Johnson for flow data on fish passages.

Stormwater Infiltration Demonstration Project (Prop 84)

See Restoration Section below.

Upper Las Positas Stormwater Management Project

See Restoration Section below.

Restoration and Water Quality Project Assessment

Westside SURF and Old Mission Creek Restoration
No data analysis was completed for FY13.

Arroyo Burro Restoration, including Mesa Creek Daylighting
No data analysis was completed for FY13.

Hope and Haley Diversions
No data analysis was completed for FY13.

Mission Lagoon Restoration and Laguna Channel Disinfection

Stratification and Water Quality in Mission Lagoon

What is the level of stratification in the estuary throughout the year?
What are dissolved oxygen concentrations throughout the water column?

Introduction

Temperature, dissolved oxygen, and conductivity play a major role in the health of a lagoon system and its ability to sustain aquatic life. The above variables are influenced by outside factors such as sunlight, rain, salt-water infiltration, and presence of algae. Dissolved oxygen is dependent on salinity, temperature, respiration, and photosynthesis (NERRS); as a result, the above variables are all interrelated.

The objective of the water quality monitoring in Mission Lagoon was to address the following three questions:

1. How do the observed values and ranges compare to the water quality objectives for Mission Lagoon?
2. How does stratification and mixing change over time, especially in relation to creek flow, storm water, and berm breaching?
3. How does the water column structure vary in space?

Materials and Methods

Water quality monitoring was conducted at least monthly in Mission Lagoon in Santa Barbara from November 2012 through July 2013. The bar-built lagoon is confined by sand along the beach and vertical concrete walls or sandbags once it becomes channelized at Mission Creek and the Laguna tide gates. The water quality was tested at the center of the bridges at Mason Street, State Street and Cabrillo Boulevard, and at the east end of the lagoon at the Laguna tide gates (Figure 1).

Figure 1 Water quality monitoring locations in Mission Lagoon

A Hach HQ40d portable meter was used to collect temperature, conductivity, dissolved oxygen, and dissolved oxygen saturation data. Measurements were taken at the Mason Street, State Street, and Cabrillo Boulevard bridges by standing at the center of the downstream side of the bridges. At the Laguna tide gates, measurements were taken by standing on the platform on the west side of the channel and using a rod to maintain a distance of 12 inches between the probe and the concrete wall. At each location, the probe was lowered down to collect data every six inches, from the surface to an inch above the bottom, in order to obtain a vertical profile.

Results

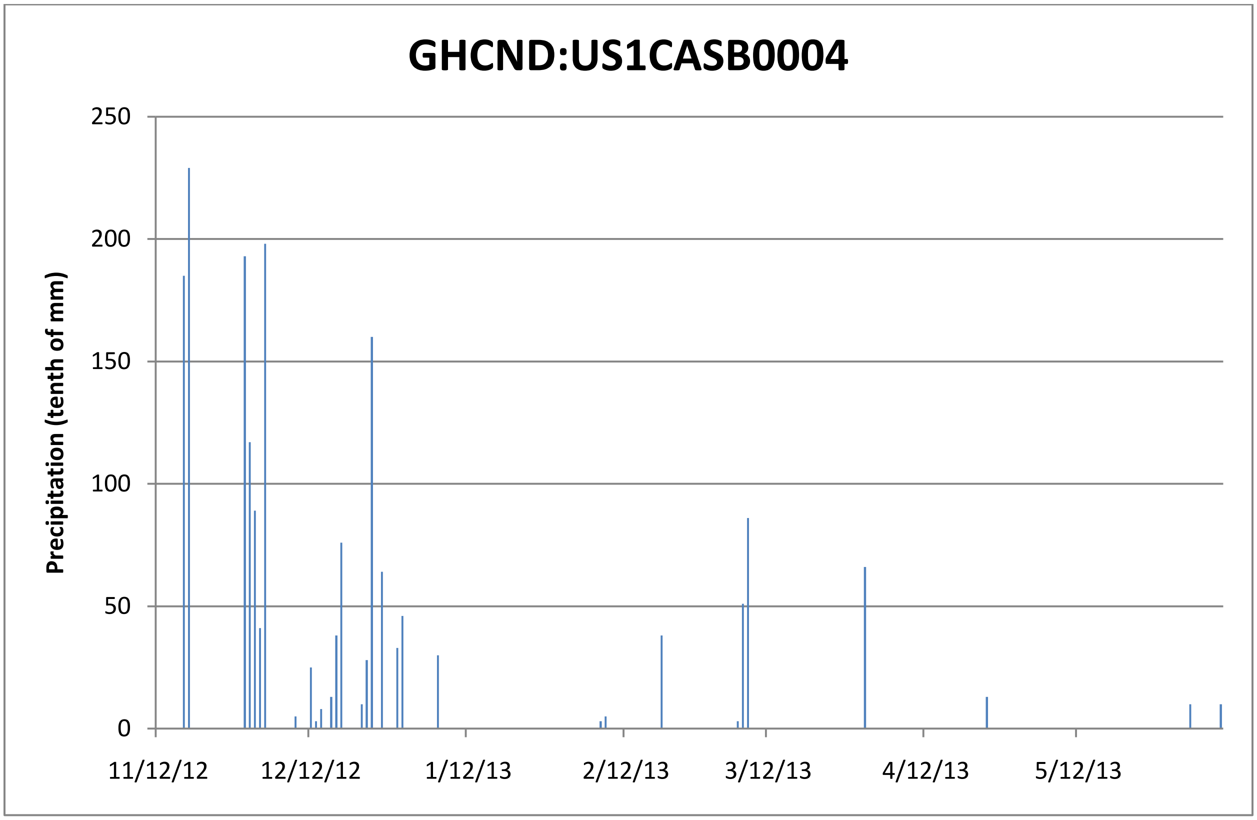
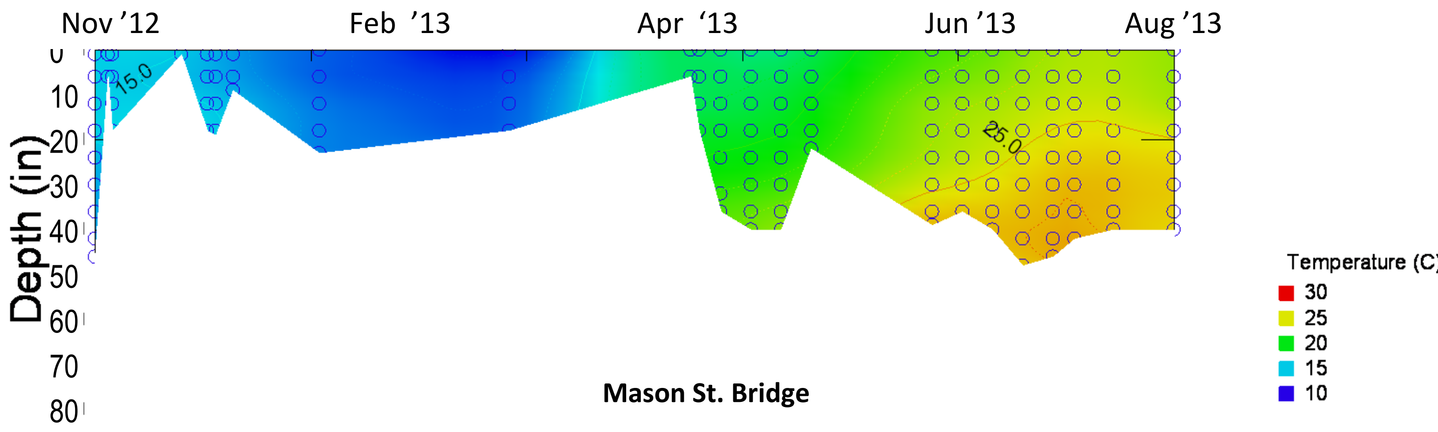
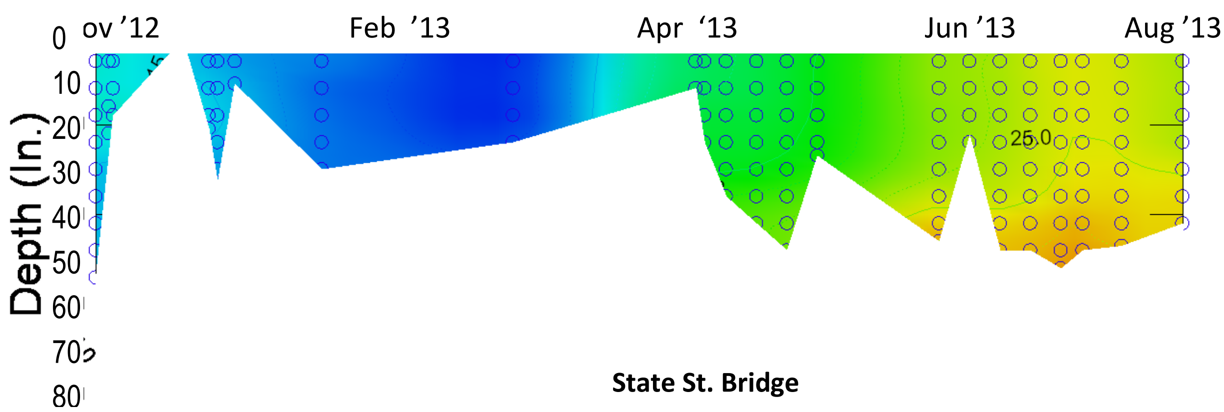
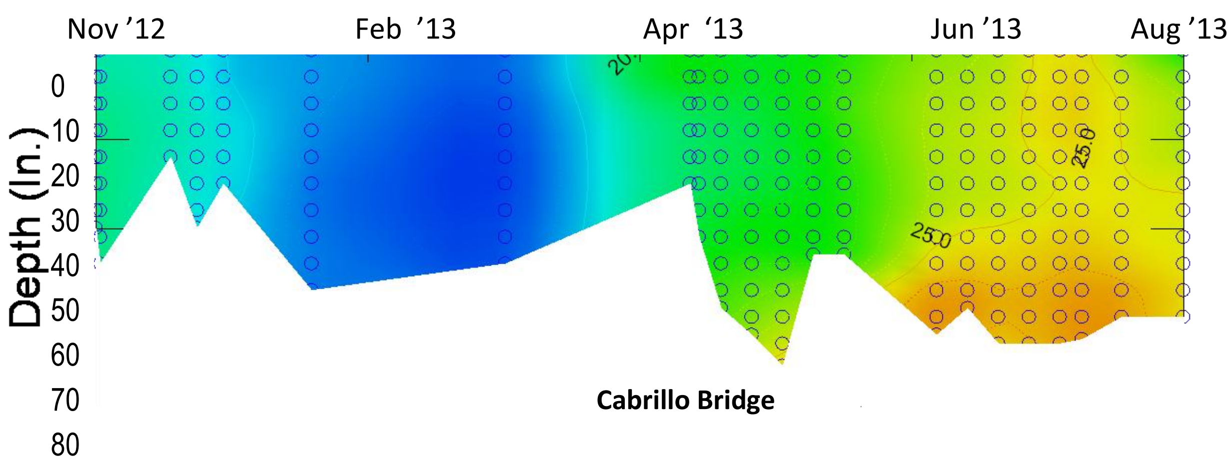


Figure 2. Daily precipitation data from the Global Historical Climatology Network at the Santa Barbara 1.9 NE station (GHCNB:US1CASB0004).

TEMPERATURE

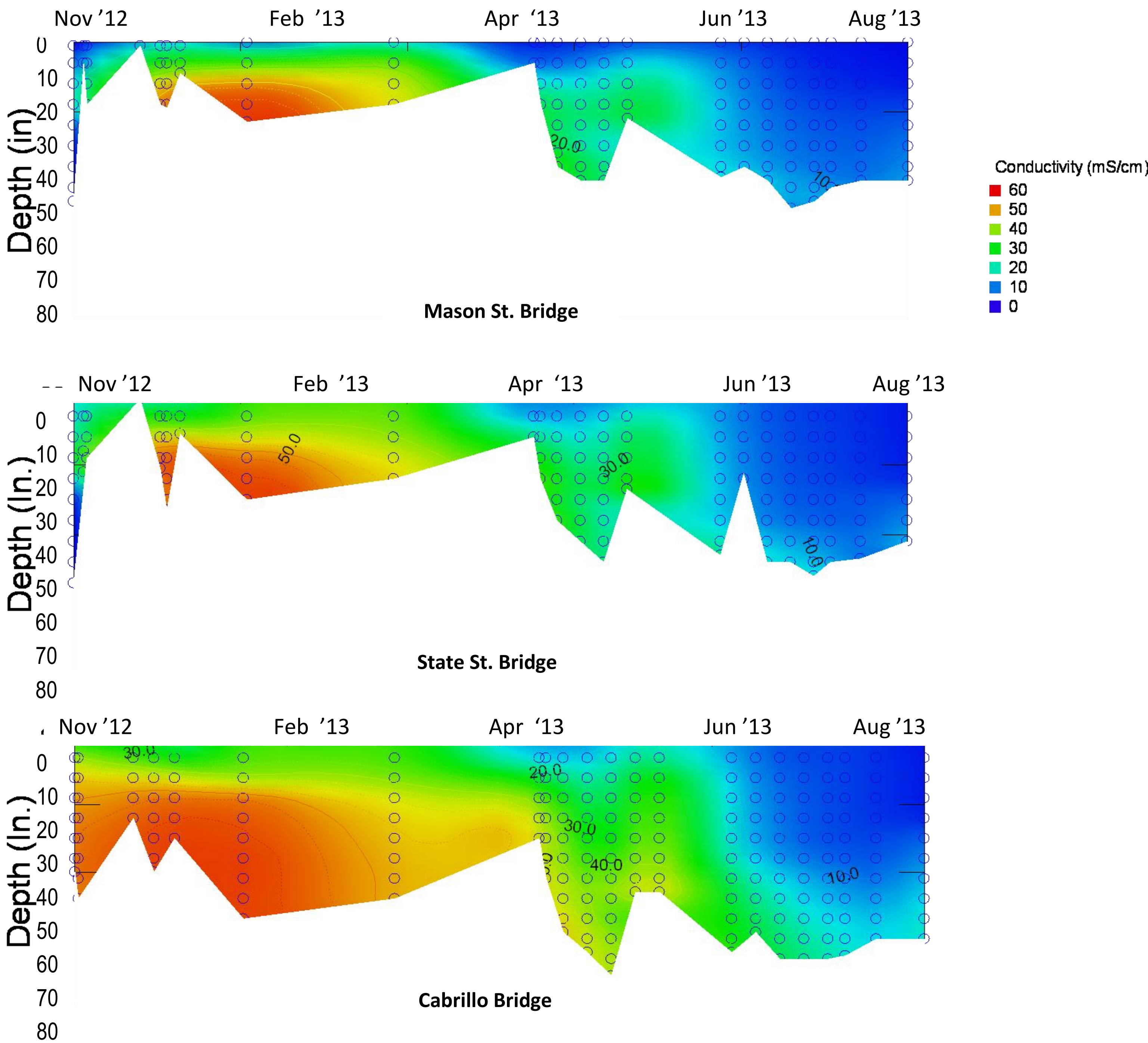






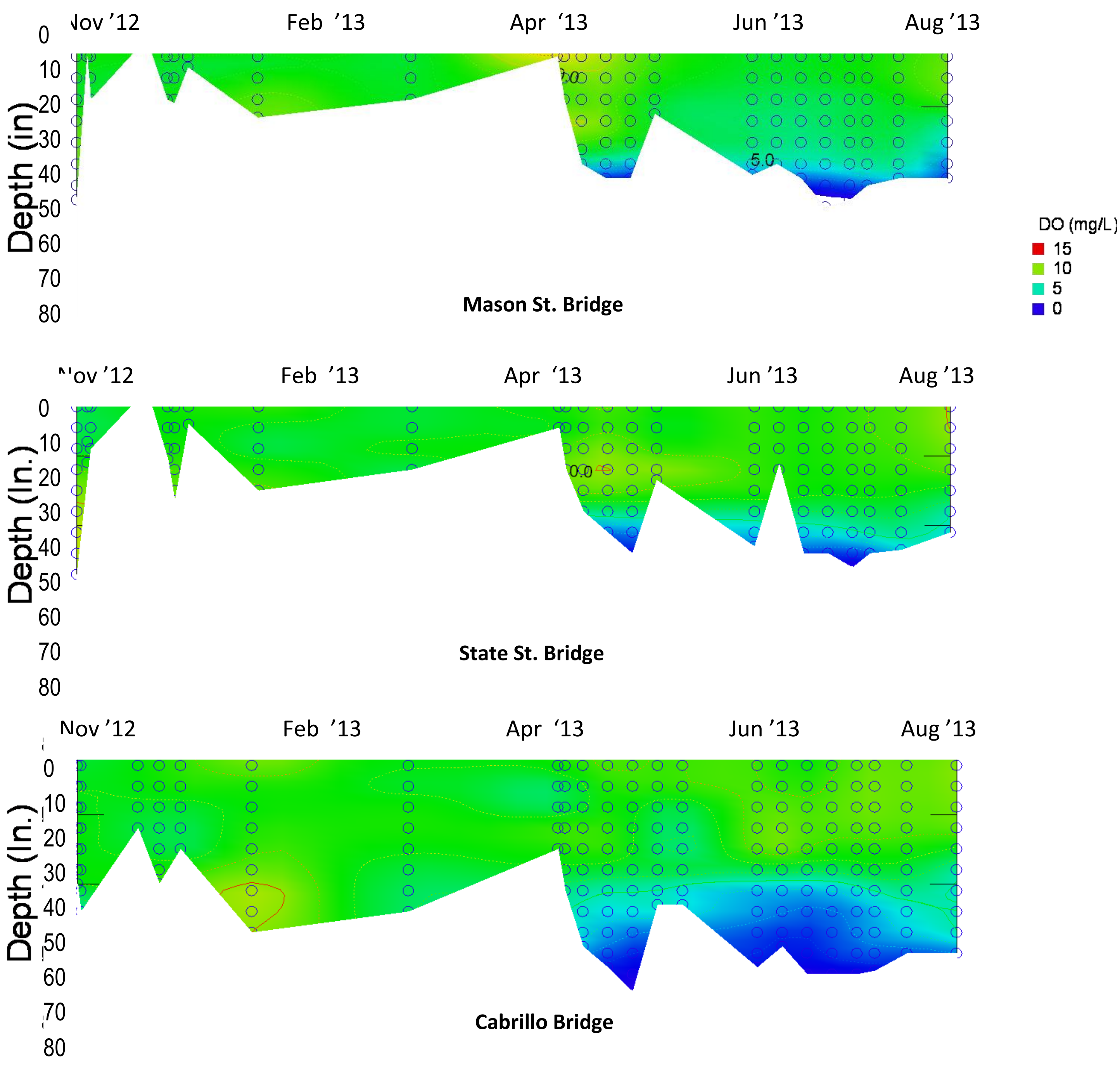
- The first sample date was during a rain event, just before the lagoon breached. From November until April, the depth varied as a result of tide height differences during sampling event. Tidal influence is clearly seen up to the Mason St. Bridge.
- Before the lagoon closed, temperature was uniform with depth, with coldest temperatures during the winter.
- After the lagoon closed in April, stratification set in, first at the deeper Cabrillo site.
- Interestingly, the temperature stratification was inverted, with warmer temperatures at the bottom.
- The warmest temperatures reached 26 °C.

CONDUCTIVITY



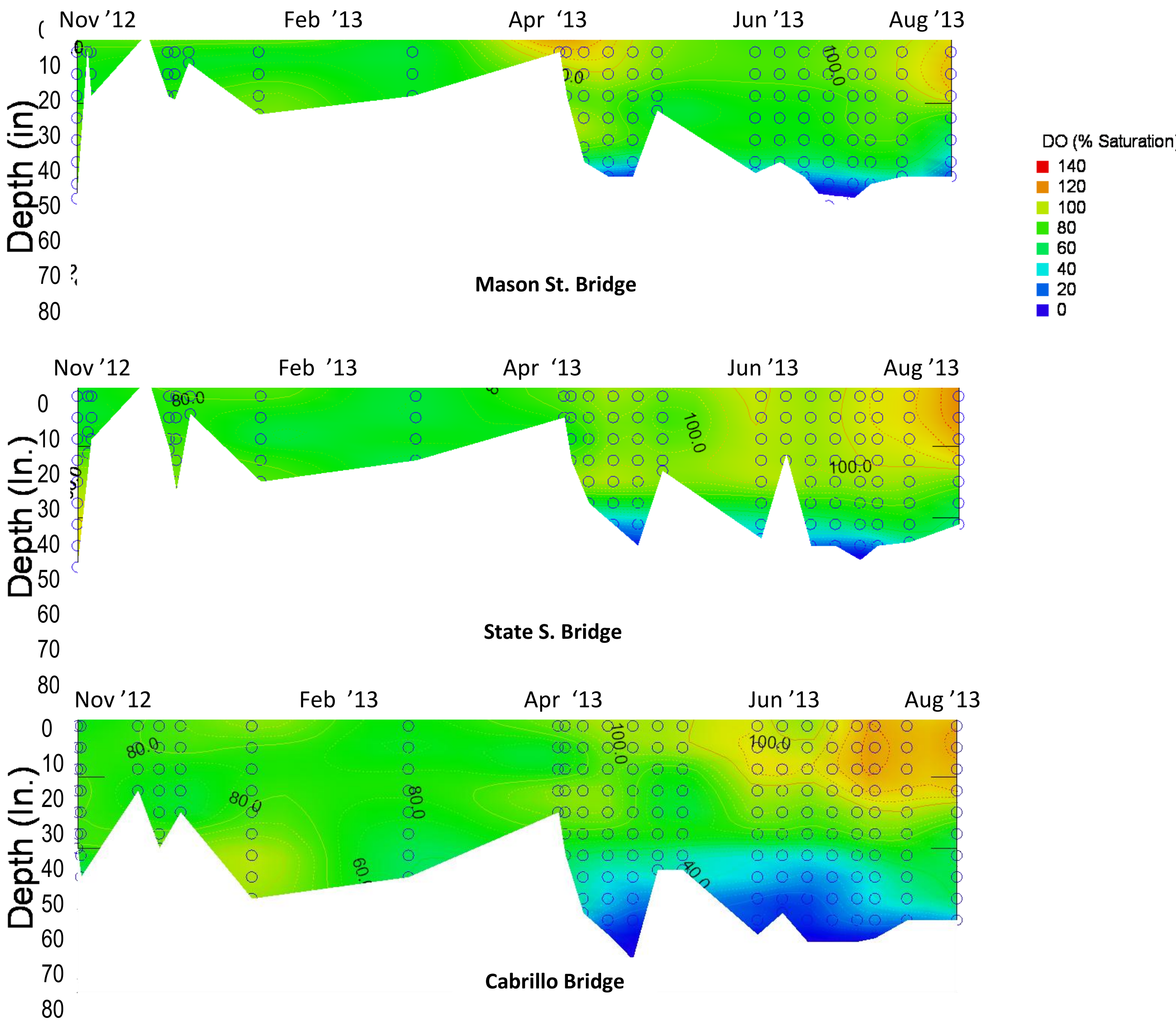
- Ocean salinities reached all the way to Mason.
- Despite temperature uniformity, conductivity was always stratified when the lagoon was open, with fresher water on the surface.
- Below Mason, even surface samples had conductivities representative of mixing.
- Salinity stratification persisted into the summer months, supporting the temperature inversion.
- The highest conductivities, combined with the associated temperatures, results in calculated salinities above those in the ocean. Additional work will be done to resolve this issue.

DO – mg/L



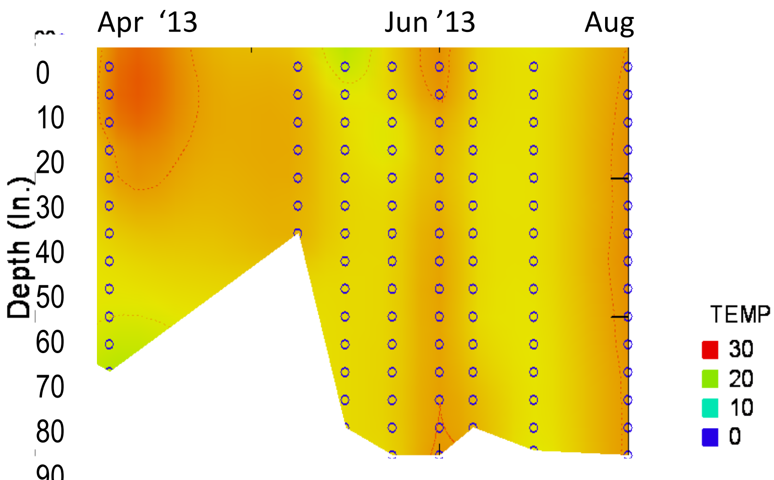
- DO met Basin Plan creek objectives during winter months at all depths.
- Summer stratification resulted in DO below the WARM and COLD objective at the bottom 6”-24” of the water column.

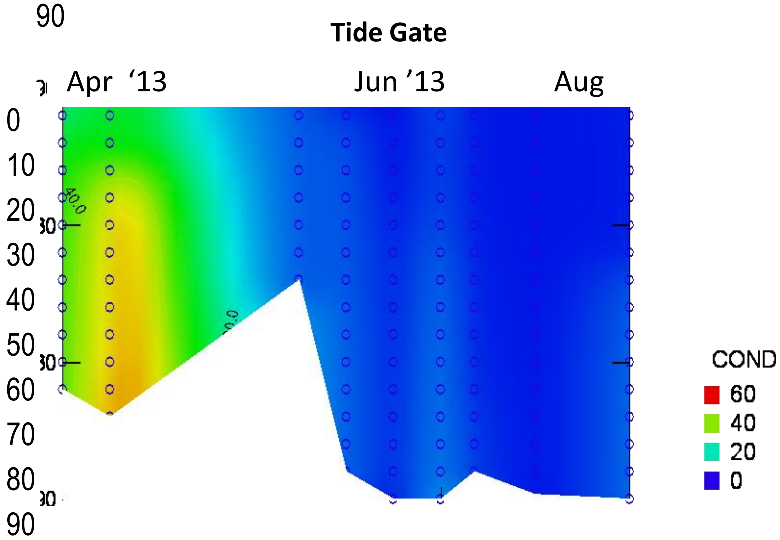
DO – % Saturation

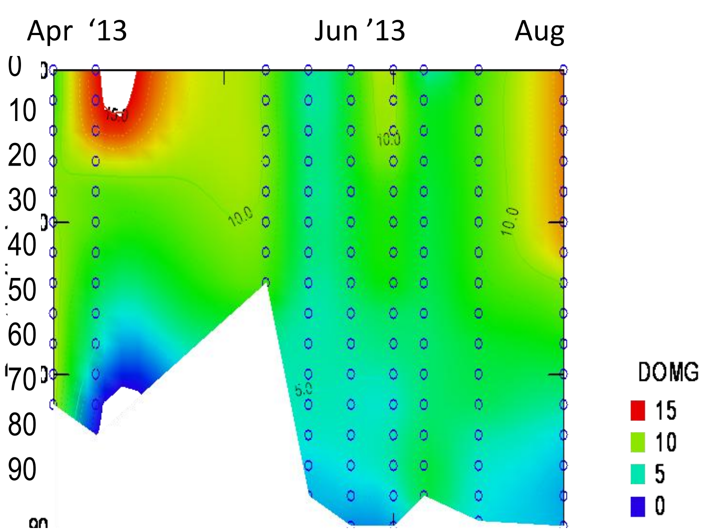


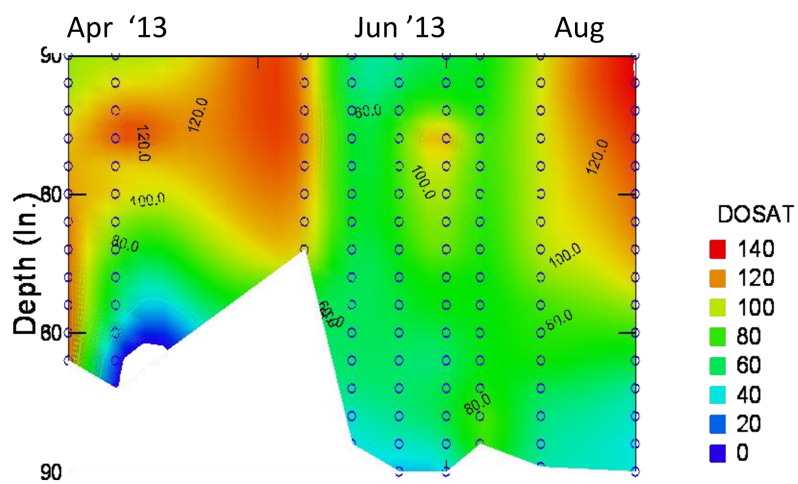
- During Winter, salinity stratification resulted in very little DO stratification. DO percent saturation was generally 80-100%, showing little algae bloom/eutrophication.
- As soon as the lagoon closed, a bloom (>100% Saturation) as seen at the surface, with subsequent DO consumption at the bottom of the lagoon. This pattern resumed in June and persisted through the summer.

Laguna Tide Gate



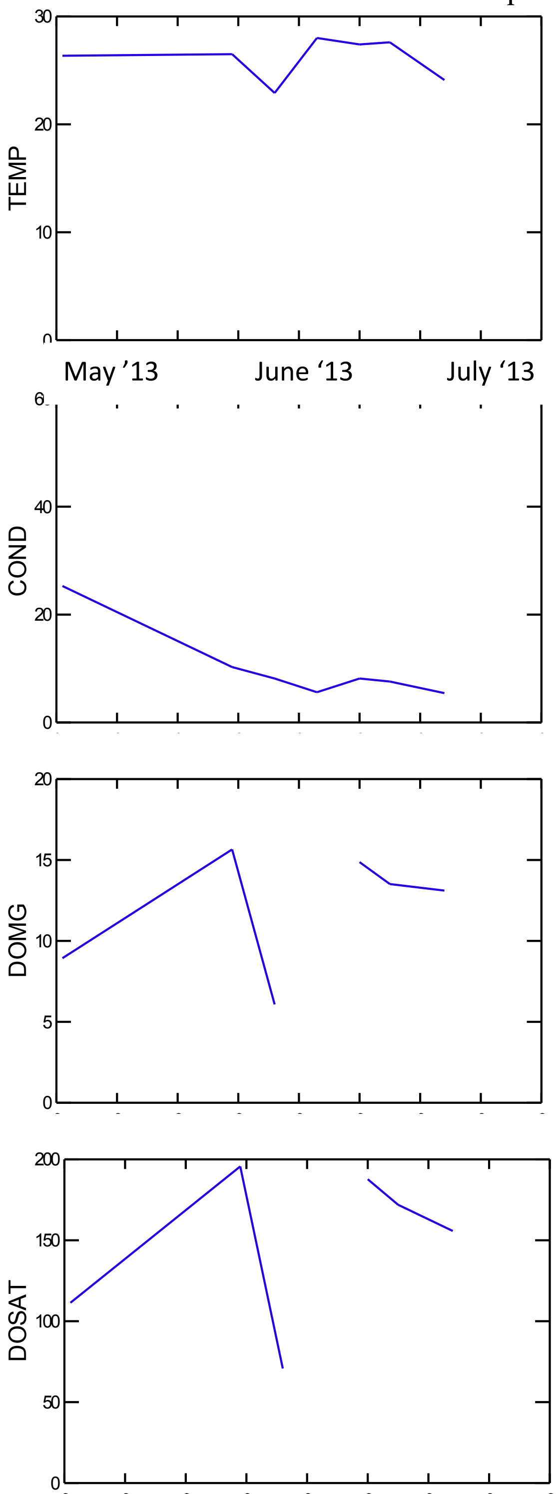






- The deep water at the Laguna tide gate showed surprisingly little temperature and salinity stratification.
- DO showed less stratification than expected

WEST MISSION LAGOON – 0” – 6” deep on all dates.



Dry-weather Nutrient Inputs from Mission Creek and Laguna Channel

1) *What are the loads of nutrients entering Mission Lagoon from Mission Creek and Laguna Channel during dry weather?*
2) *Is there input of nitrate from groundwater entering Laguna Channel between the freeway and the lagoon?*

Sites:

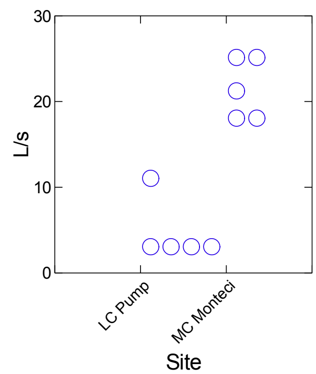
MC Monteci = Mission Creek at Montecito Street, our "integrator site" for Mission Creek
LC FwyonC = Laguna Channel as it exist box culvert under freeway. "C" denotes sample was collected from the center of the three boxes.
LC Pump = Laguna Channel as it drains across apron just above pump station.

Methods:

Samples and flow estimates were collected on five days in summer 2012. Flow was calculated with the fastest flow and the average depth (from approximately 10 measurements), using the equation Flow = 0.67*Velocity*Width*Depth. Water was stagnant at LC FwyonC so no flow data (or load calculations) were collected at that site. Samples were outsourced to TestAmerica Labs for filtration and nutrient analysis.

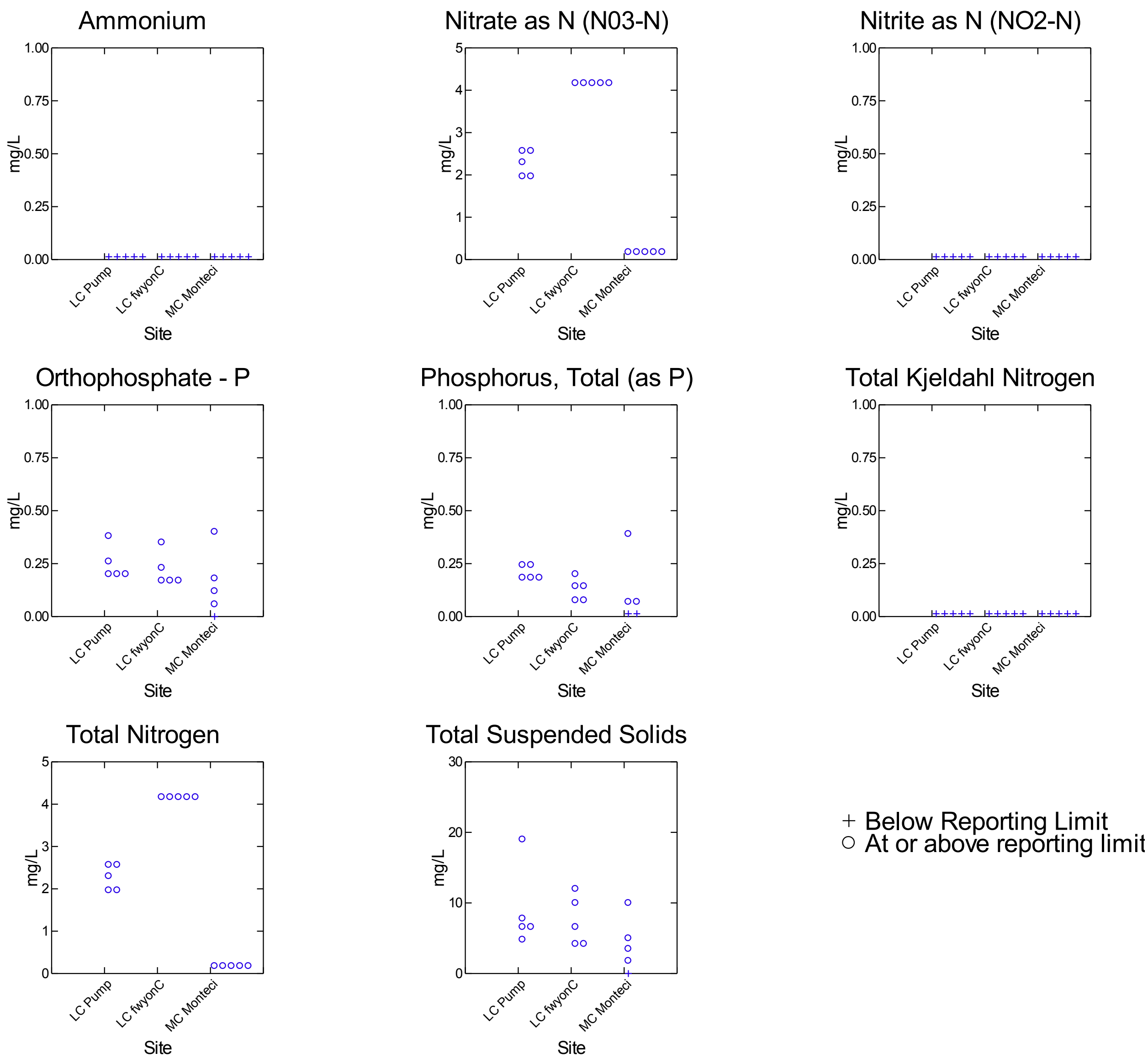
Results:

Flow data are show in the following plot:



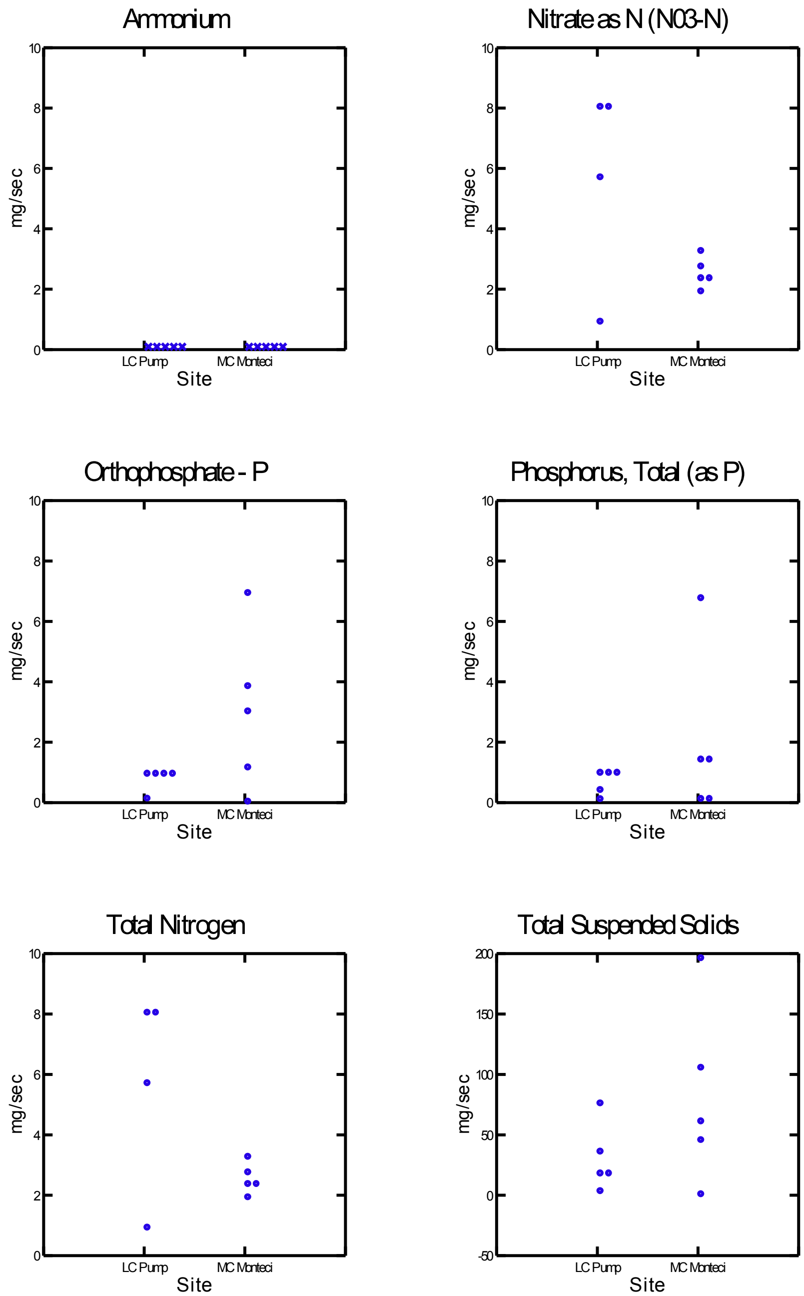
In previous years, the flow from Laguna Channel has been approximately equal to the flow from Mission Creek. In summer 2012, the flow from Laguna Channel (average 5.2 L/s)) was approximately one quarter of that from Mission Creek (average 21.5 L/2).

Nutrient concentrations are shown in the following plots:



At all three sites, the total nitrogen was comprised entirely of nitrate. Nitrate/nitrogen concentrations were higher in Laguna Channel than in Mission Creek, and within Laguna Channel, nitrate/nitrogen concentrations decreased from the freeway to the pump station. On most samples dates/locations, orthophosphate-P was higher than Total Phosphorus-P. The reason for this will be investigated; it might be due to a misinterpretation of units. Phosphorus concentrations were less variable among sites compared to nitrogen, and within Laguna Channel, phosphorus did not change appreciably between the freeway and the pump station.

Nutrient load calculations are shown in the following graphs for the two sites where flow estimates were possible:



The loads of nitrogen/nitrate were higher coming from Laguna Channel compared to Mission Creek, whereas the loads of phosphorus were higher coming from Mission Creek.

Due to the variability of dry weather flow results in the Creeks database, it is not recommended that the design of the project hinge on this limited data set.

Upper Las Positas Stormwater Retrofit Project

Two questions:

1) Management - What is the quality of water that we are releasing from East Basin?
    a. Pre-storm release and mid-pond for field parameters, toxicity, FIB, TSS, nutrients
    b. During a storm
        i. During overflow conditions: Inflow, mid basin, spillway (see below).
    c. Post (or during, if results come back toxic) storm release – Field, possibly toxicity, pending results.
        i. Outlet
        ii. Modoc (see sediment data)
2) Performance – Does the project decrease the load of pollutants? Without the use of flow gauges, we can only test this in places where the flow is not changed (otherwise a decrease in concentration could be due to dilution).
    a. Looking for ~20-30 pairs of data (will depend on variability of data).
    b. Can use autosamplers to get multiple data points per storm.
    c. Site Pairs
        i. Upper Basin (mixed zone)/Mid/Spillover (or close) at East Basin
        ii. Las Positas Drain/upstream of first drain from school.
    d. FIB, TSS, nutrients
    e. First storm – three samples per site (fifteen sets of bottles)

Results-Dry Weather

Samples were collected and December 15, 2011 from the mid-pond area of the East Basin and from the release pipe. The goal of the testing during dry weather was to determine whether releases prior to or during rainstorms could have harmful effects on Las Positas Creek and Arroyo Burro. Results provide information about how water quality has changed since the pond was filled during the last storm. Results show that water quality for potential releases appears satisfactory. Results showed:

- There was no toxicity of the water, based on toxicity testing with fathead minnows.
- Dissolved oxygen concentrations were high, ranging from 75%-95% of saturation.
- Nutrient concentrations were substantially lower than those seen during storm events, which implies nutrient uptake since the last storm. Nitrate was below detection limits.
- Total suspended solid and turbidity concentrations were low compared to storm runoff and acceptable for most species. The results were higher than suggested thresholds for steelhead.
- The pH levels were high.
- Conductivity was within the normal range of our creeks in dry weather.
- Fecal indicator bacteriaa were below recreational criteria in the mid pond sample. The levels were elevated in the release sample, most likely due to biofilm growth in the discharge pipe. If the sample had been collected later during a discharge event, the levels probably mayhave been lower.

Table 1. Results from Dry Weather Sampling at the Golf Course on December 15, 2011.

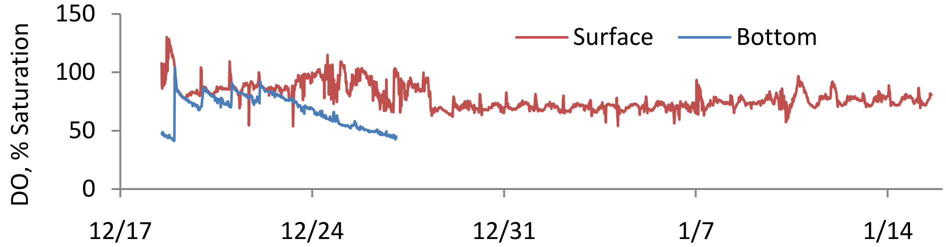
Parameter Group	Parameter	Units	GC E. Basin, Mid Pond	GC E. Basin Release
Nutrients	Ammonium	MG/L	ND	ND
Nutrients	Nitrate as N (N03-N)	MG/L	ND	ND
Nutrients	Nitrite as N (NO2-N)	MG/L	ND	ND
Nutrients	Orthophosphate - P	MG/L	0.15	ND
Nutrients	Phosphorus, Total (as P)	MG/L	0.22	0.24
Nutrients	Total Kjeldahl Nitrogen	MG/L	2	2.4
Indicator Bacteria	Total Coliform	MPN/100 ml	2613	>24,192
Indicator Bacteria	E. coli	MPN/100 ml	185	3448
Indicator Bacteria	Enterococcus	MPN/100 ml	31	3654
Toxicity	Toxicity (5-day acute test, fathead minnow)	% Survival	100	100
Conventional/Field	Total Suspended Solids	MG/L	13	15
Conventional/Field	Turbidity	NTU	8.3	7.1
Conventional/Field	pH		9.29	8.56
Conventional/Field	DO	mg/L	10.28	8.44
Conventional/Field	DO Saturation	%	95.2	76.5
Conventional/Field	Conductivity	uS/cm	780	826

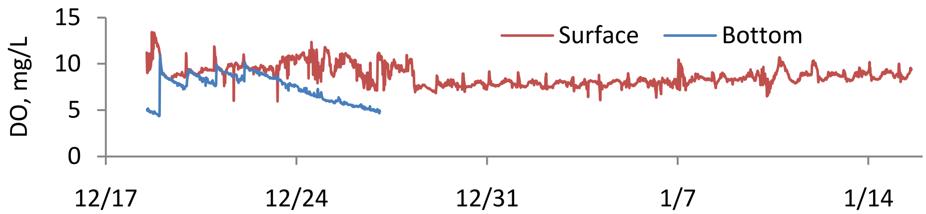
Water quality was also measured continuously during Winter 2013. Two sondes were deployed in the East Basin from 12/18/12 to1/17/13. One sonde hung near the water surface the other was located at the bottom of the pond. Unfortunately the DO sensor on the bottom sonde stopped working on 12/27/12, and the temperature and pH data was not recorded after 1/7/13.

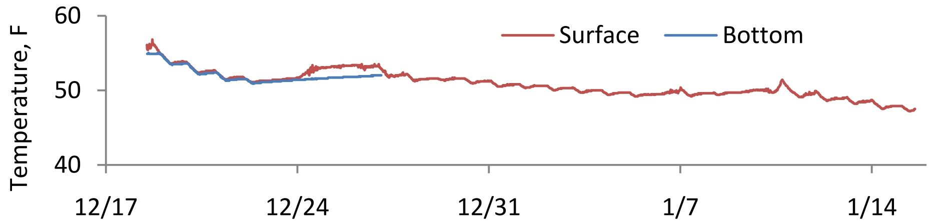
Results showed:

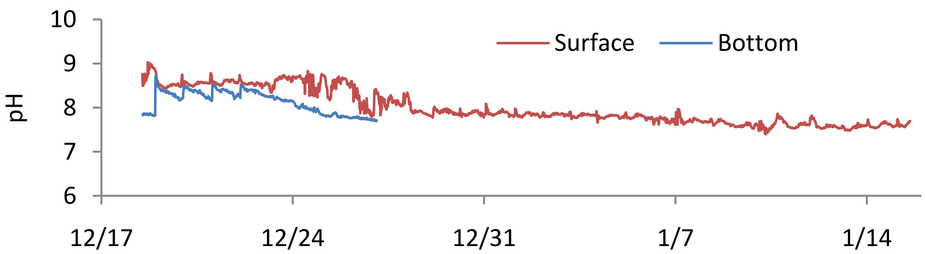
- Higher DO production, pH, and conductivity was observed before the rain event on 12/25/2012.
- Little stratification was observed (winter months).

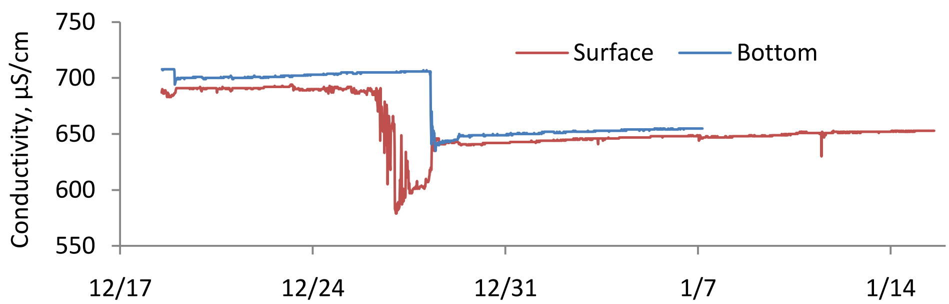
December 2012

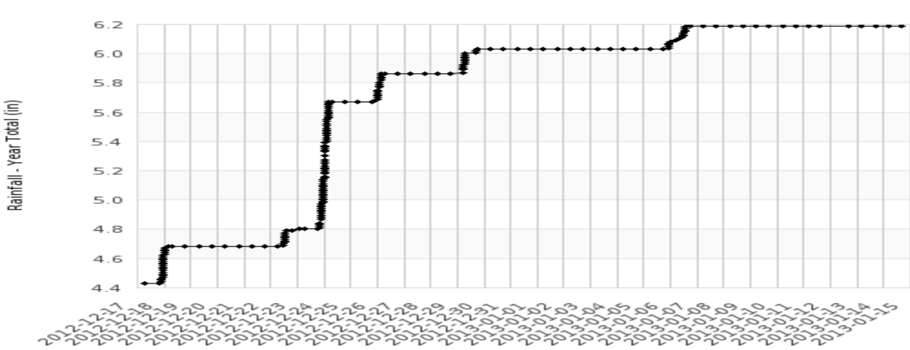


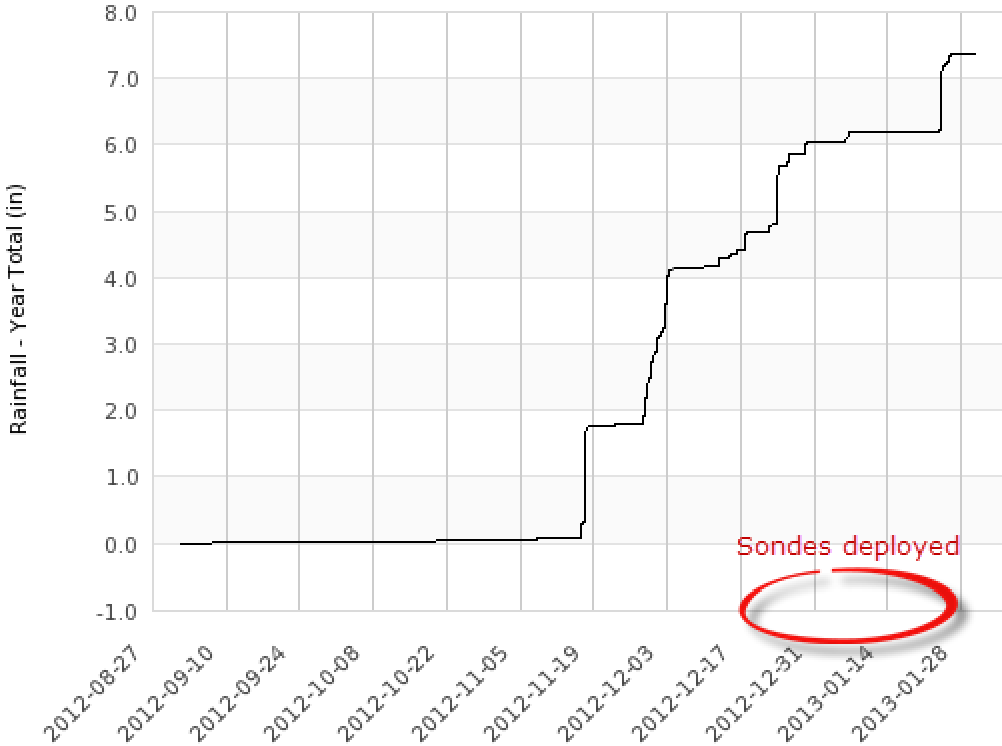




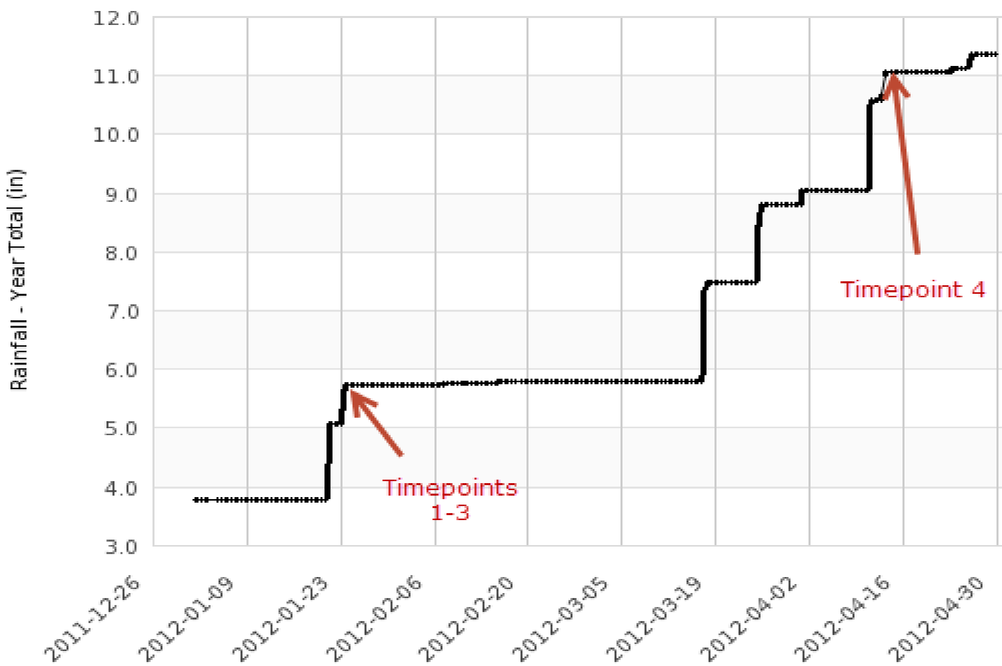




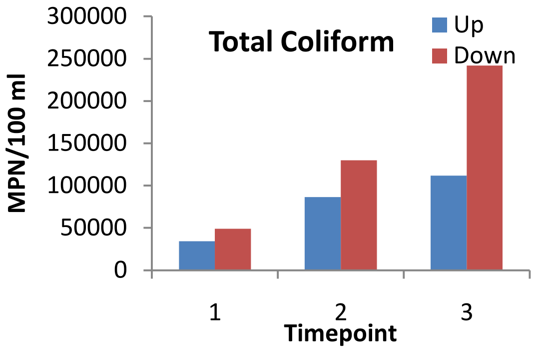


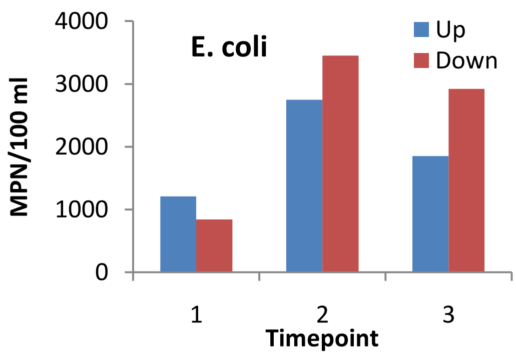


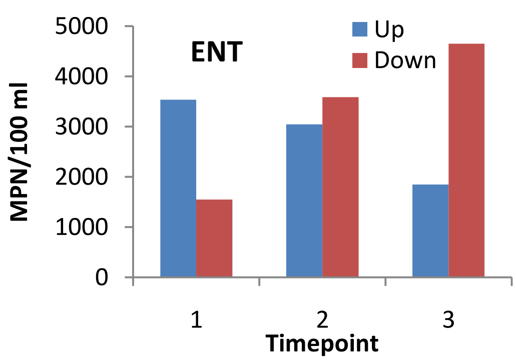
Results-Wet Weather/Performance



Adams Bioswale

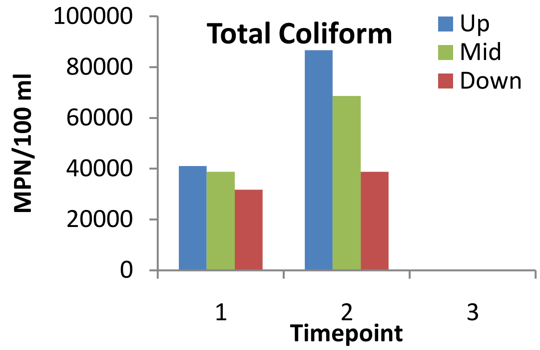


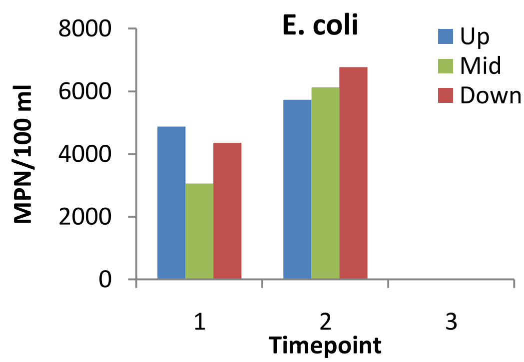


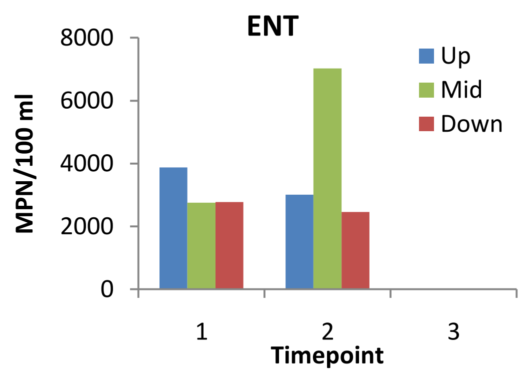


- No consistent pattern over time.
- Most FIB increased through bioswale.

East Basin



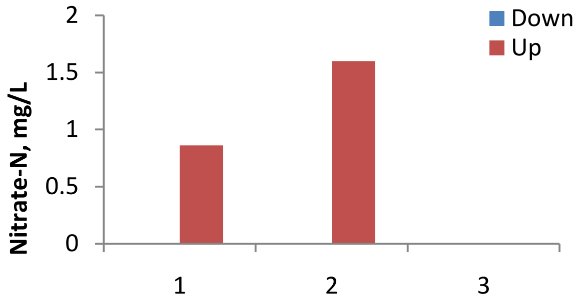


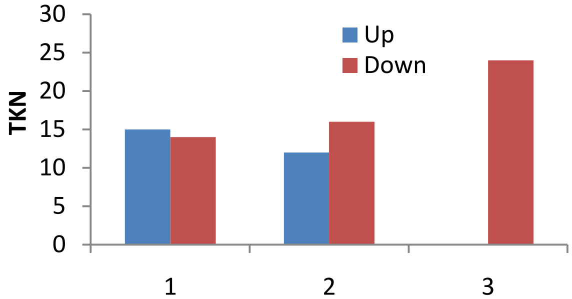


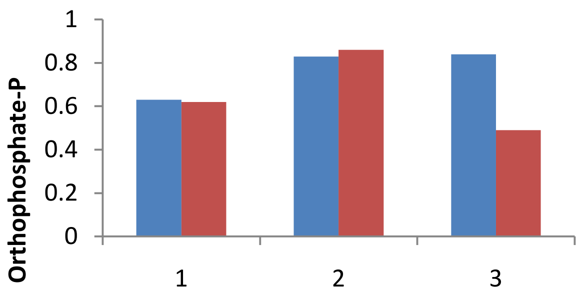
- No consistent pattern over time.
- Some suggestion of FIB removal.

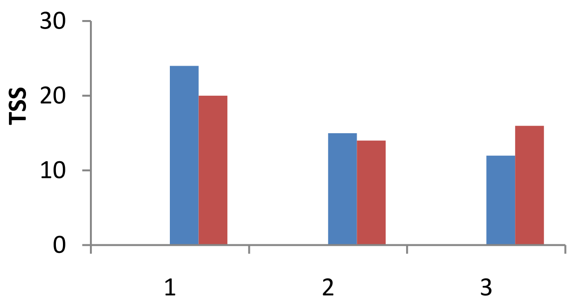
Nutrients and Sediment

Adams Bioswale



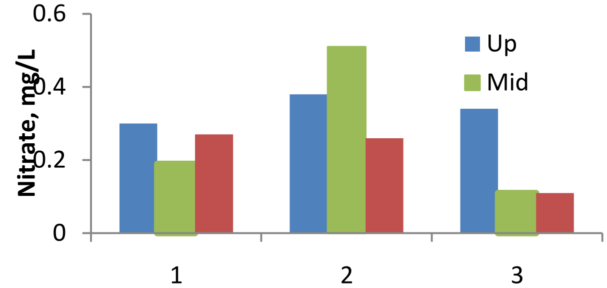


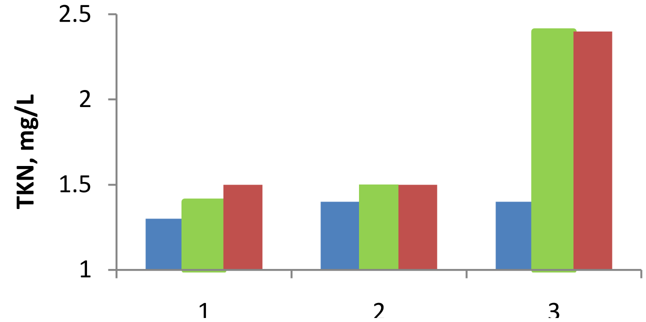


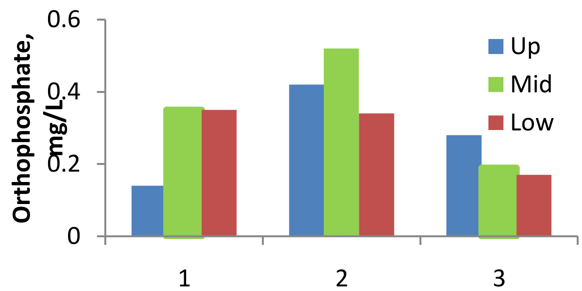


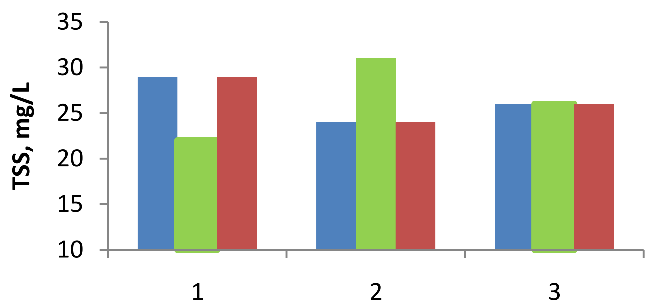
- Nutrient increase over time.
- TSS decreases over time.
- Some suggestion of nutrient and TSS removal.

East Basin



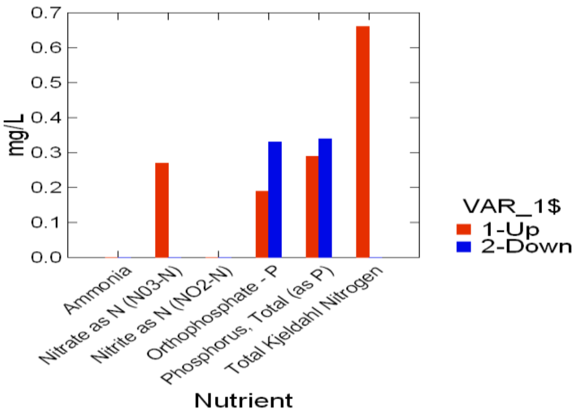






- No pattern over time.
- No consistent pattern of removal.

Timepoint 4, April 13, 2012



The Access database has TSS results but no FIB.

Parking Lot Infiltration Retrofit

The Storm Water Infiltration Demonstration Project, which is currently in construction, will remove the impermeable asphalt surface at six parking lot sites in the City and replace it with permeable interlocking concrete pavers and landscaping in order to restore natural hydrologic conditions and treat storm water. Past monitoring results from City parking lots has revealed hydrocarbons, metals, fecal indicator bacteria, and toxicity to aquatic organisms in storm water runoff. Creeks will measure the infiltration project's benefits in two ways: measuring the amount of rainfall that is infiltrated during storm events and assessing the load of pollutants prevented from reaching surface waters.

During three storms in FY 2013, including the first storm of the season, water quality sampling was conducted in support of performance evaluation of the project. Storm water runoff from each site was tested for pesticides, hydrocarbons, metals, bacteria, toxicity, pH, sediment, turbidity, conductivity, dissolved oxygen, nutrients, and temperature. Because no pesticides were detected in runoff collected during the first storm, pesticide testing was discontinued for the final two storms. Metals, including chromium, copper, lead, and zinc were detected in runoff from all six sites, and were generally found in higher concentrations at sites with more vehicular traffic. Diesel-range organics were detected at all sites. Toxicity testing showed low toxicity of runoff for most sites in most storms sampled, with two exceptions that showed high toxicity.

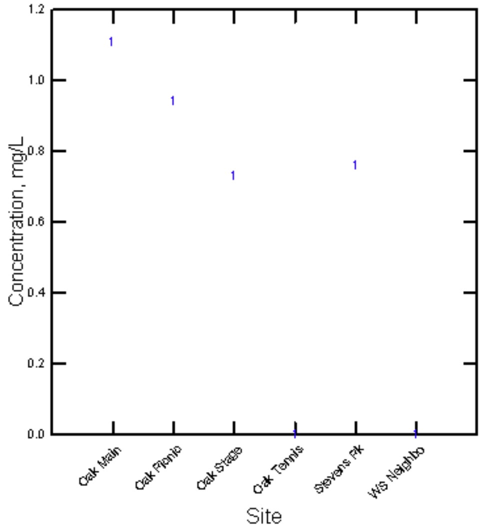
The data collected over the past season will allow for an estimate of the pollutant loads infiltrated by the project during post-construction rain events in coming years. For each site, the three different storm event results will be weighted based on rainfall to determine average event mean concentrations (EMCs), or the average concentration of a pollutant in runoff over an entire rain event. The EMC for each pollutant can then be multiplied by the rainfall amount in future storms to obtain an estimate of the pollutant loads infiltrated to the project sites. These calculations will be presented in the FY 14 report.

Results from Preproject Sampling

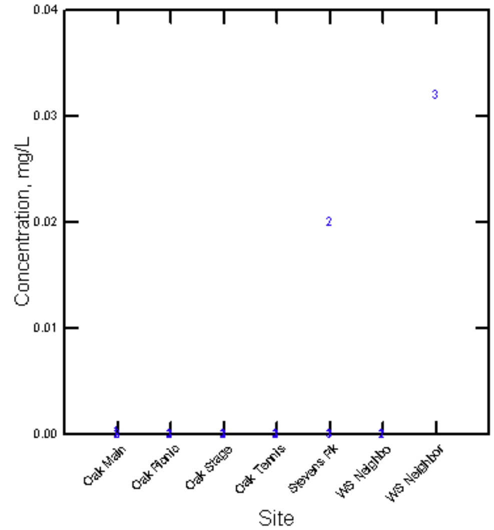
ALSO TESTED, ALL NONDETECTS: Arsenic, Cadmium, Nitrite

Storm 1 – 11/17/12
Storm 2 – 1/24/13
Storm 3 – 3/7/13

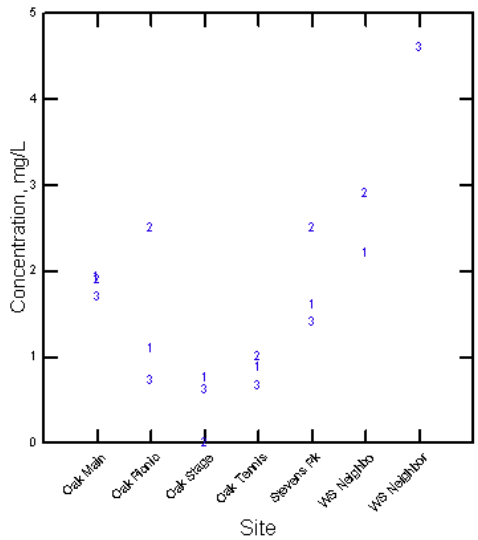
Ammonium ion



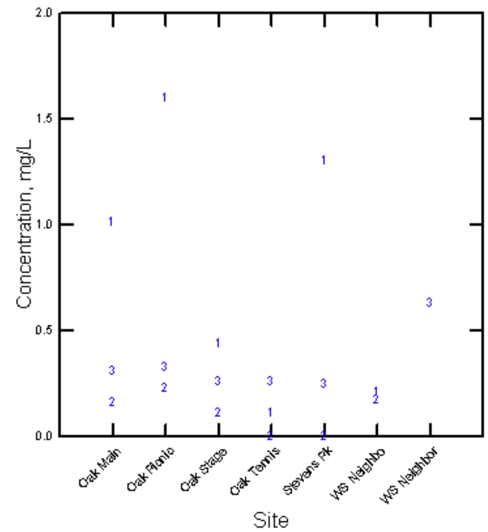
Nickel



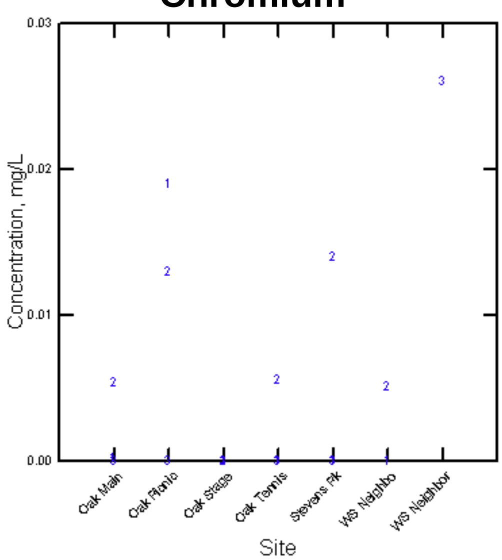
C13 - C40



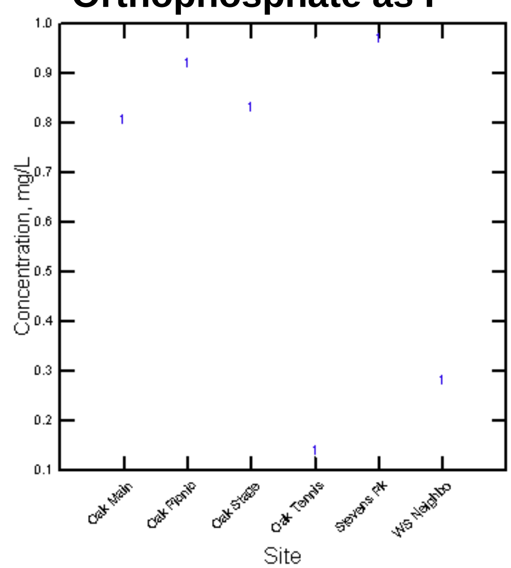
Nitrate as N



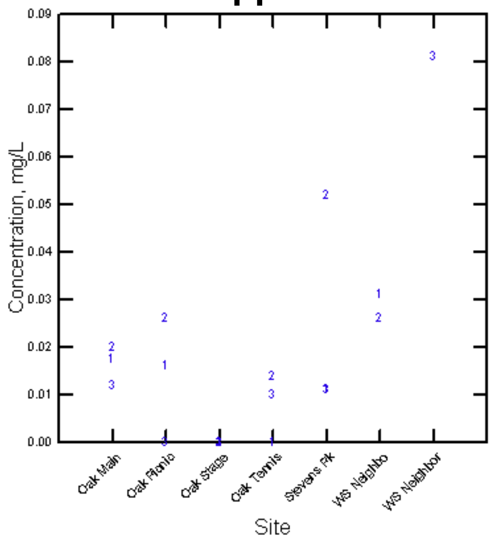
Chromium



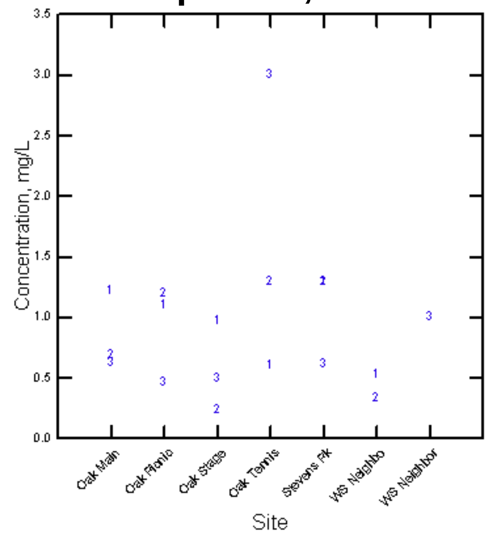
Orthophosphate as P



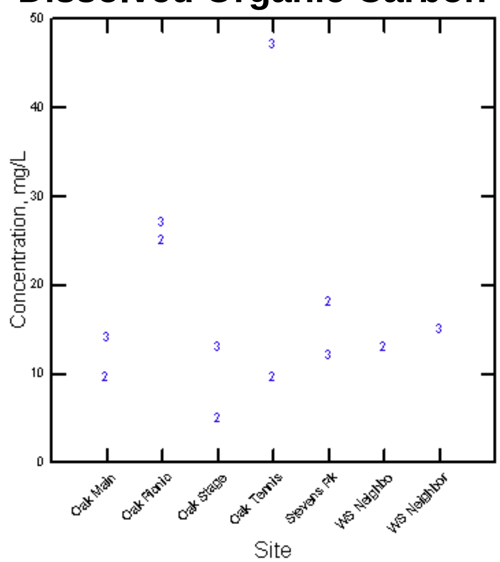
Copper



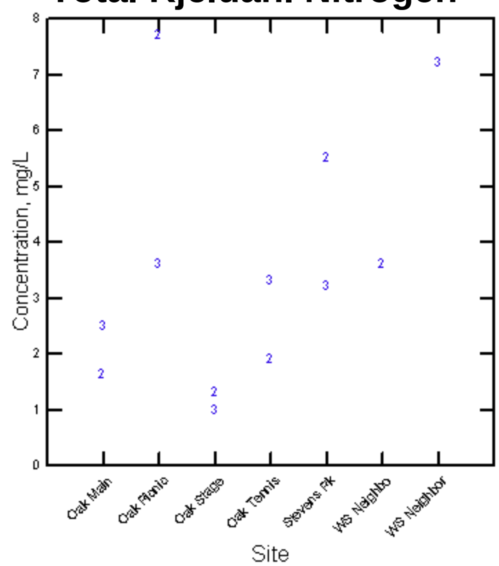
Phosphorus, Total



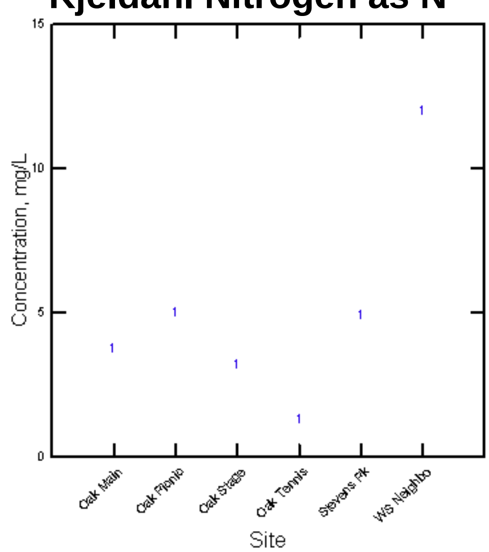
Dissolved Organic Carbon



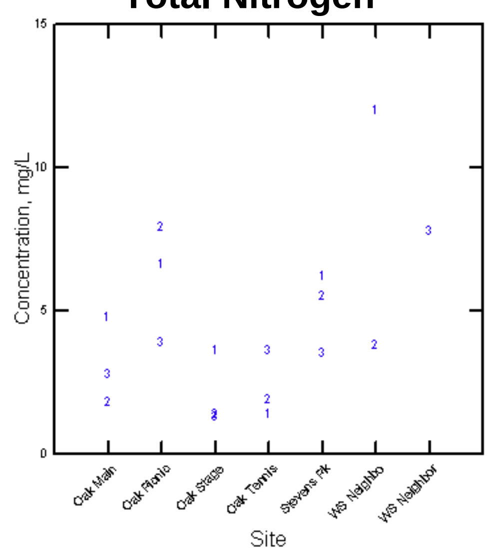
Total Kjeldahl Nitrogen

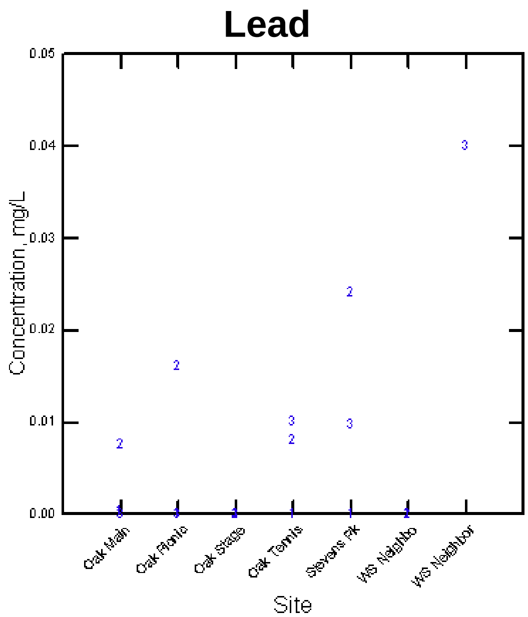


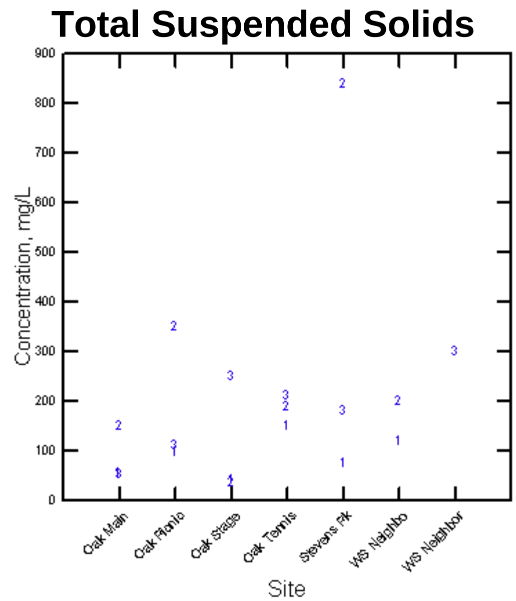
Kjeldahl Nitrogen as N

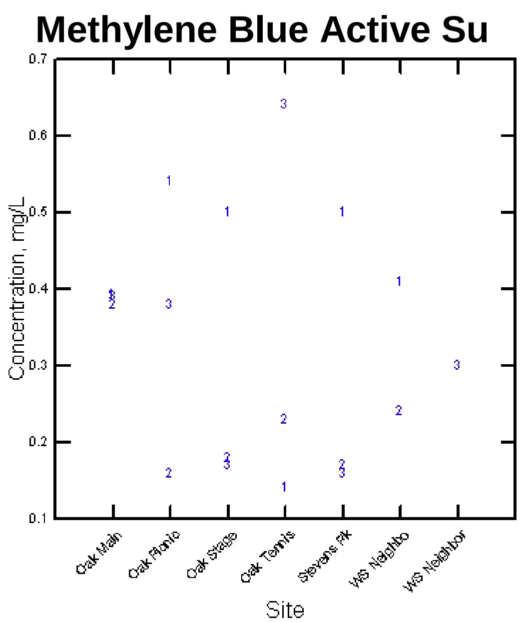


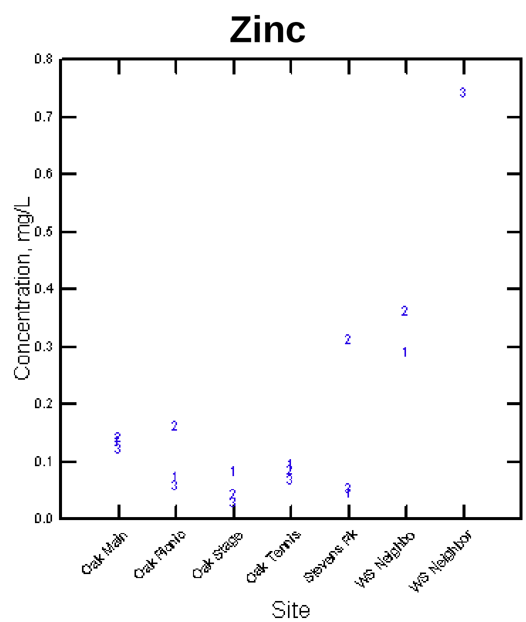
Total Nitrogen











Debris Screens (Creek Walks)

No data analysis was conducted in FY13. See Tim Burgess for catch basin photographs and trash counts.

Mission Creek Fish Passage (Eutrophication/Dissolved Oxygen)

No work was conducted during FY13.

Bird Refuge

Bird Refuge Pilot Project

High nutrient levels in the water, poor water circulation, and low levels of dissolved oxygen are key water quality issues at the Bird Refuge. Eutrophic conditions, an increase in algal growth and die-off, as well as the turnover of anaerobic sediment, leads to the release of noxious odors. The most recent “stink event” occurred in June 2012. In September 2012, the Parks and Recreation Department began a pilot project to test the ability of enhanced circulation to improve water quality and prevent noxious odors at the Bird Refuge. The Creeks Division is conducting water quality monitoring of the pilot project.

The area near the tide gate (outlet arm) was chosen as the test location due to its isolation from the larger lake area. Perforated tubing was installed along bottom of the lake in the outlet arm. Compressed air from the tubing provides micro-aeration, designed to increase vertical and horizontal circulation. Increased circulation is predicted to increase dissolved oxygen levels throughout the water column and to disrupt stagnant conditions that can lead to noxious algal blooms. Creeks staff monitor water quality conditions in the pilot project site and a control site on a weekly basis.

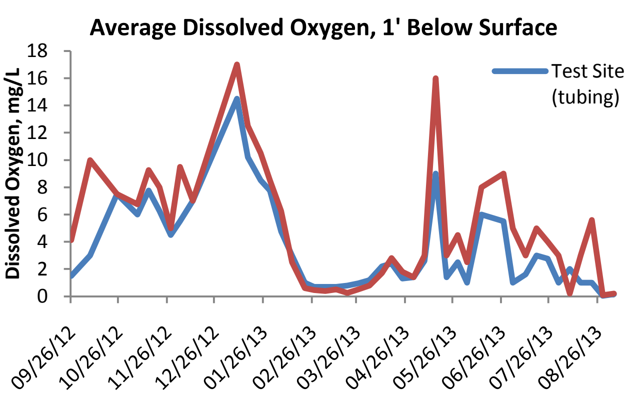
Preliminary results show that the pilot project is creating a small, but statistically significant, difference in circulation and dissolved oxygen concentrations. When dissolved oxygen (DO) concentrations are relatively high, such as during an algae bloom, the test site exhibits lower DO concentrations than the control site, suggesting that low-DO water is brought from the bottom water to the surface. When DO concentrations are relatively low, such as a period of algae die-off, DO concentrations are slightly higher in the test area, suggesting that exchange across the air-water interface is improved. However, it is still too early to determine if the differences are great enough to prevent noxious odors developing in the hot summer months. A possible next step is to add beneficial microbes to the water column, in an effort to increase degradation of organic material on the lake bottom and increase water depth. If water depth can be increased from the current depth of two-four feet to seven feet, additional circulation options will become available.

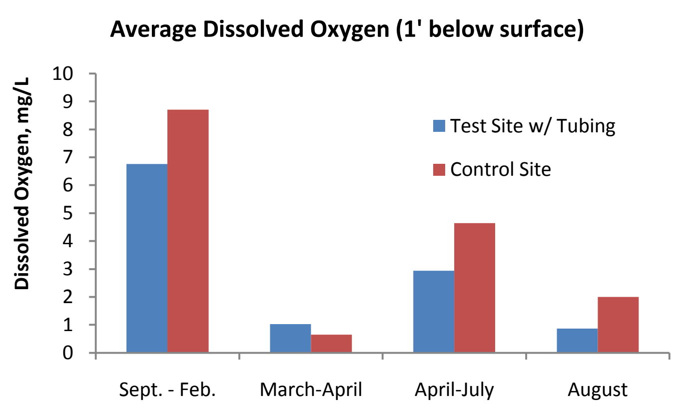
Andre Clark Bird Refuge Aeration and Bioaugmentation Pilot Project 2012
Monitoring Results September 2013

Questions from Monitoring Plan:

1) **Does treatment increase dissolved oxygen (DO) levels througout the water column, compared to the untreated area?**

In general, no. In times of lowest DO, test site is slightly higher.

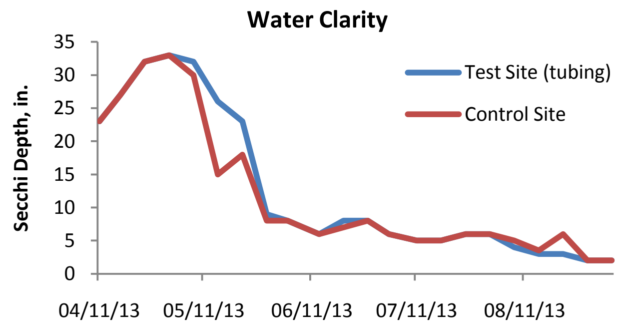




2) **How far horizontally does the improvement in oxygenation extend?**

N/A, because DO was lower in treatment site.
Horizontal pattern is lower DO near bubbles as low DO water is brought to surface.

3) Is the color and/or clarity of the treated area different from the untreated area?
Weekly observations suggest no color difference between sites. Water clarity is usually the same at both sites, with the except of a period in May when a bloom was developing.



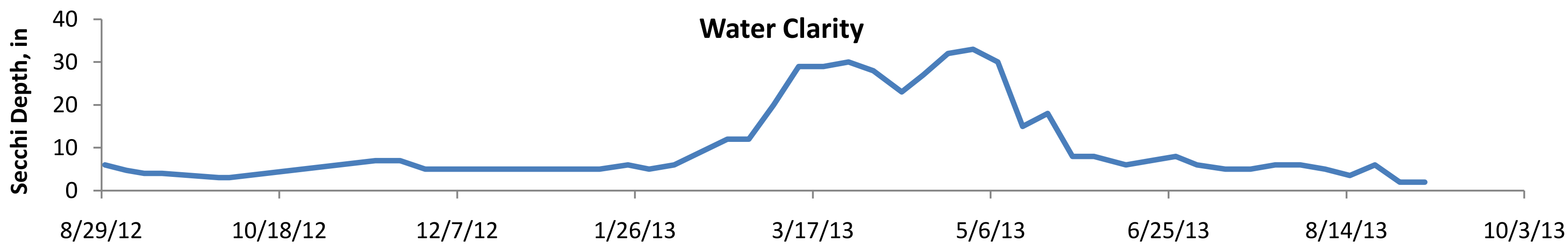
4) Is the odor in the treated area different from the untreated area?
N/A, due to lack of odor events. The weir gate area can be extremely pungent due to stagnation under Cabrillo.

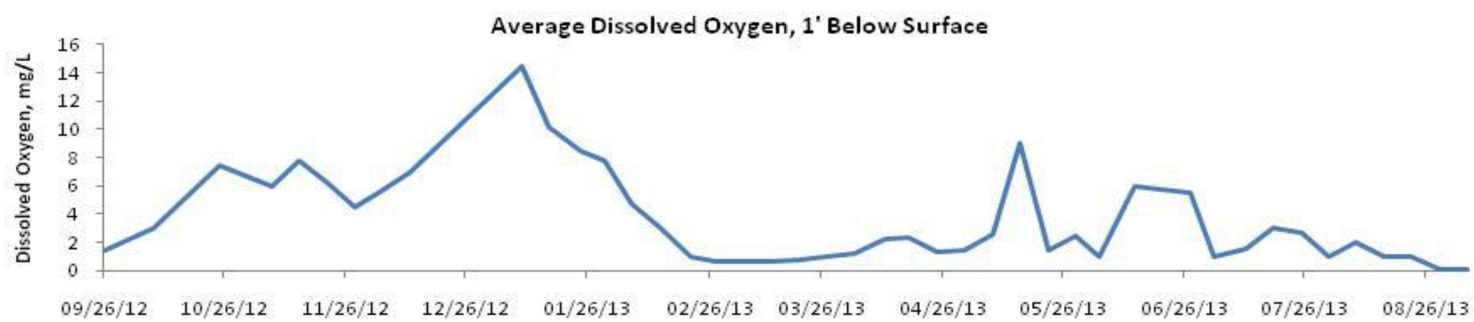
5) Are nutrient levels different in the treated area vs. the untreated area?
We did not pursue this goal.

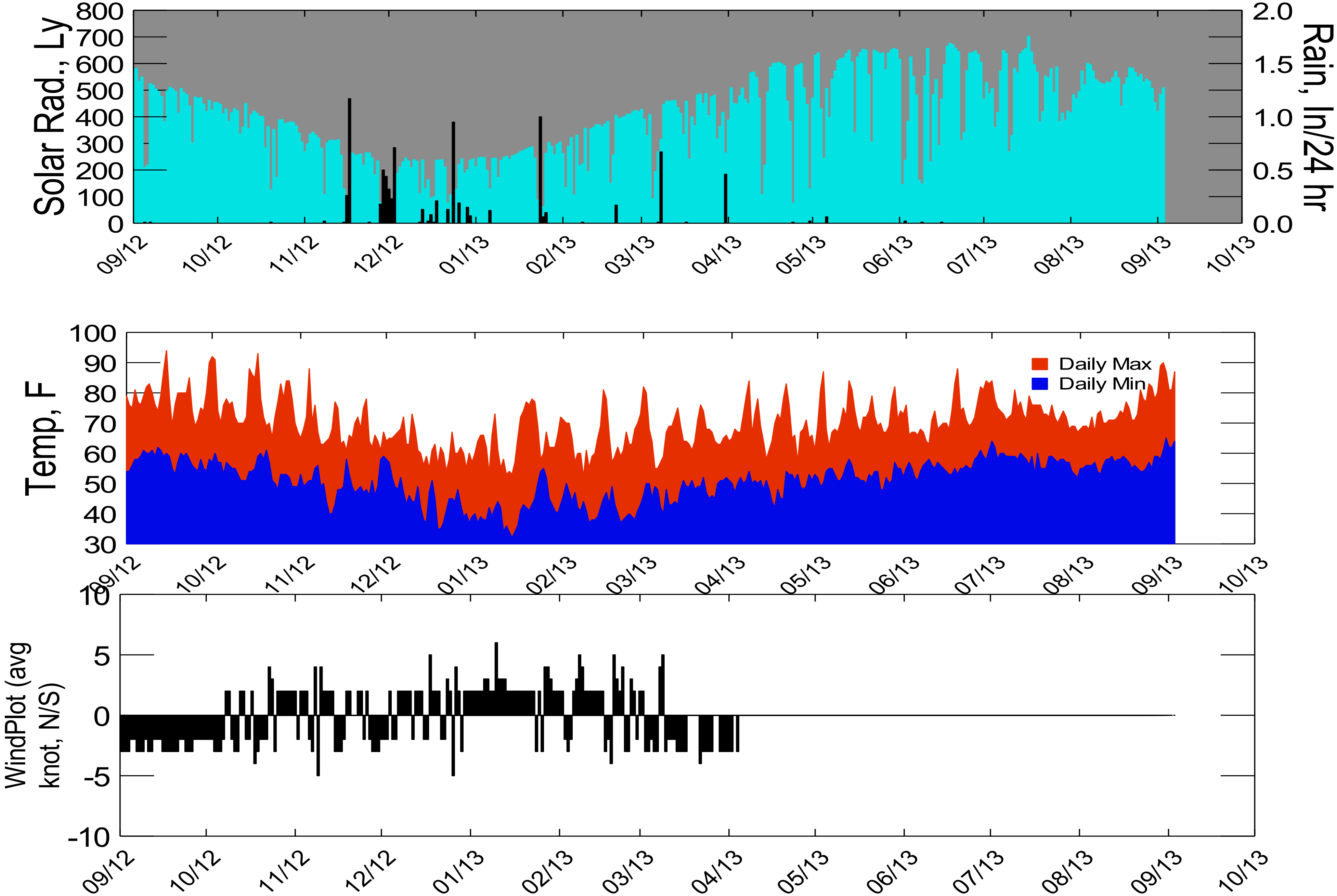
6) Does treatment reduce sludge and/or sediment depth, thereby increasing water depth, in the outlet arm?
We have not completed the "after" portion of this effort.

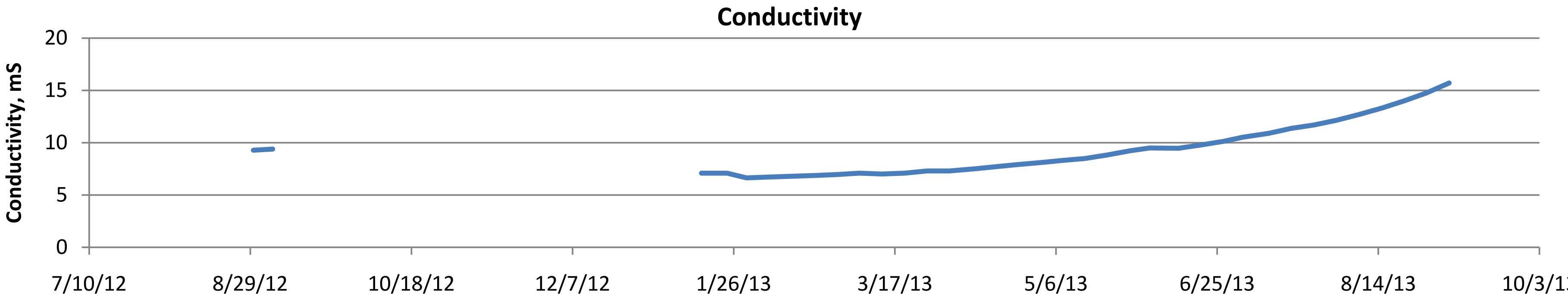
Observations

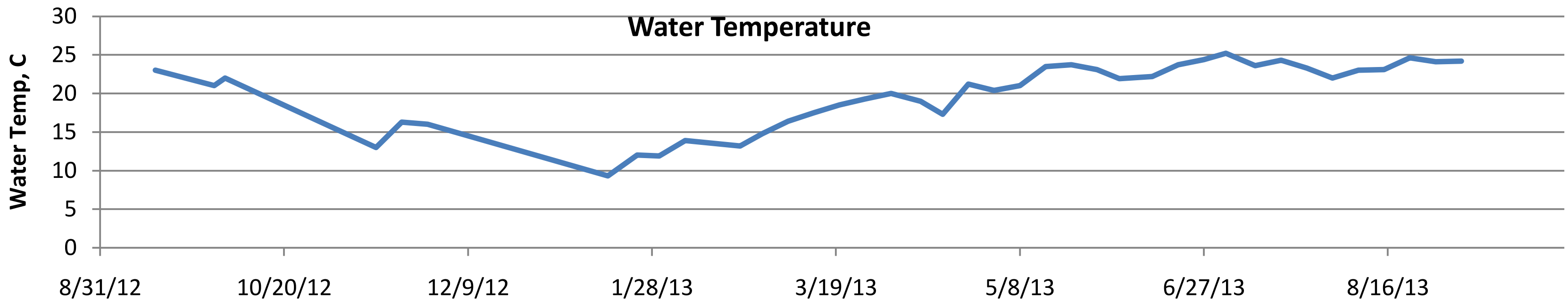
	Sep	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
COLOR		Fluorescent streaks					Clear	Clear	Khaki/rust	Pea soup.	Greenish brown.			
ALGAE	Thick on surface	Green foam-likely cyano-bacteria.	Some - matting, brown algae streaks.	Lots of matted algae	Low algae content on surface.	Foam.	No algae visble.		Oily sheen by tide gate.	Som algae clumps.		Euglena.		
ODOR						Som esmell.	Odor at bubbles.						Outfall lagoon stinks.	
CRITTERS	Coots	Coots	Coots	Coots	Coots	Coots High zooplankton density.	Very high zooplankton density. Few coots.	Fewer Daphnia.	Mosquitos, fewer Daphnia Water beetles,.Baby ducks, swallows eating beetles.	Mosqito fish, mosquito casings, lots of beetles. swallows eating them.	Dead floating fish.	White worms, midge larvae.		
BACTAPUR											Water greasy.	Water surface greasy in outlet arm		






Solar Rad., Ly
Rain, In/24 hr
800
700
600
500
400
300
200
100
0
2.0
1.5
1.0
0.5
0.0
09/12
10/12
11/12
12/12
01/13
02/13
03/13
04/13
05/13
06/13
07/13
08/13
09/13
10/13
Temp, F
100
90
80
70
60
50
40
30
Daily Max
Daily Min
WindPlot (avg knot, N/S)
10
5
0
-5
-10


Conductivity
Conductivity, mS
20
15
10
5
0
7/10/12
8/29/12
10/18/12
12/7/12
1/26/13
3/17/13
5/6/13
6/25/13
8/14/13
10/3/13


Water Temperature
Water Temp, C
30
25
20
15
10
5
0
8/31/12
10/20/12
12/9/12
1/28/13
3/19/13
5/8/13
6/27/13
8/16/13

Additional conclusions, observations, and literature findings.

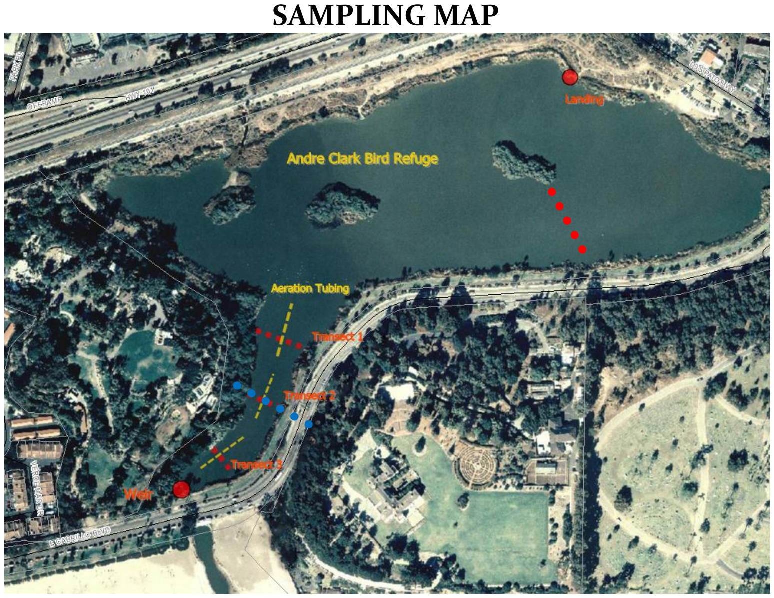
- Very little vertical stratification (no lake "turnover").
- Fairly well mixed, conductivity uniform by morning.
- Daphnia did an excellent job clearing algae, otherwise there would have been a stink event with that low DO.
- Last year's stink event likey preceded by blue-green algae bloom (cyanobacteria).
- Current situation may be a bloom of "Purple Sulfur Bacteria" because there is absolutely no stink with very low DO and a lot of algal biomass. There is undoubtably some hydrogen sulfide on the bottom, so it is likely consumed by bacteria. We don't know why this did not happen last year.
- Currenlty there is very little DO, even at surface, mid-day, suggesting no "typical photosynthesis."

Changes for FY14

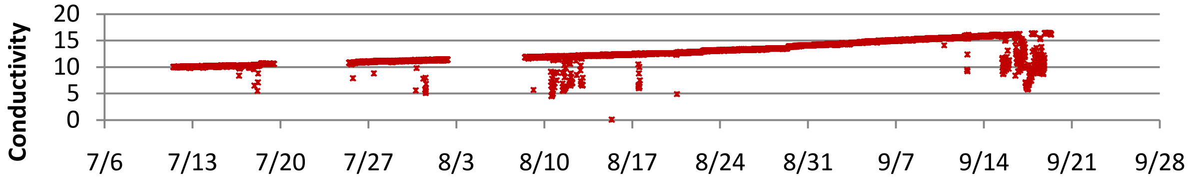
A. For understanding current conditons and stink events:
   1. Continue weeky monitoring, but make data collection shorter and observations more uniform.
      a. One station?
      b. Leave kayak locked up on site?
   2. Stop aeration?
   3. Stop bactapur?
   4. Toxins ($$)
   5. More data mining for past stink events?
   6. Additional data collection during stink event:
      a. H2S concentrations in water/air ($)
      b. Methane concentrations in water/air ($$)
   7. Something else to prevent stink?

B. Additional information for future projects:
   1. Add algae/bacteria/zooplankton ID ($$)
   2. Sediment quality for dredging ($$)

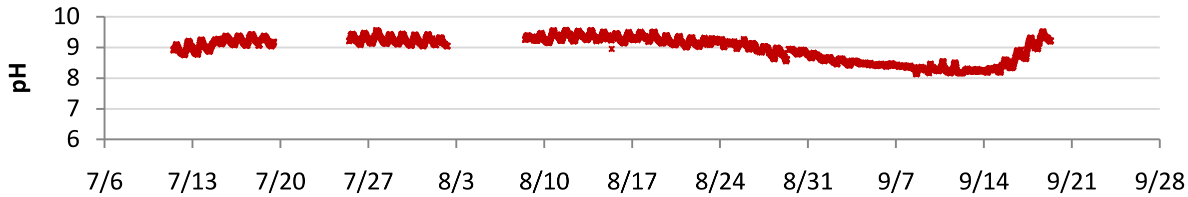
SAMPLING MAP



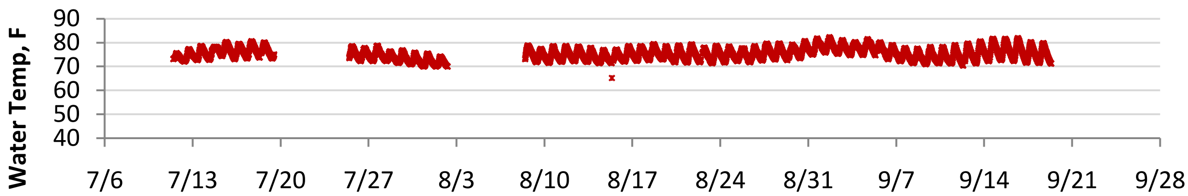
Summer 2013, Test Site with Tubing



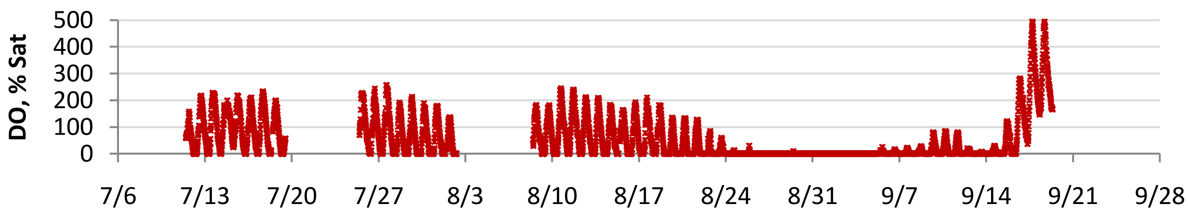
Summer 2013, Test Site wtih Tubing



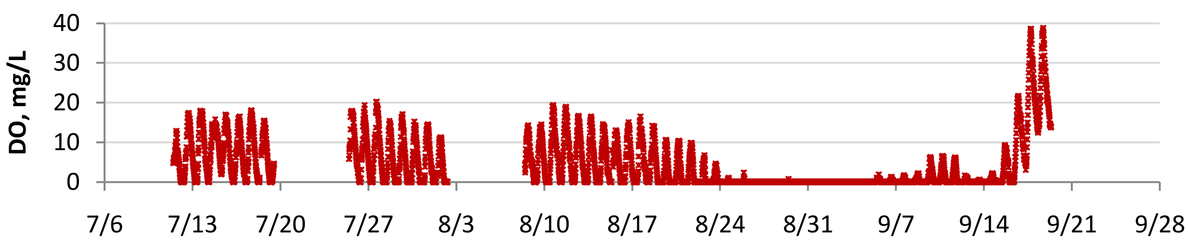
Summer 2013, Test Site with Tubing



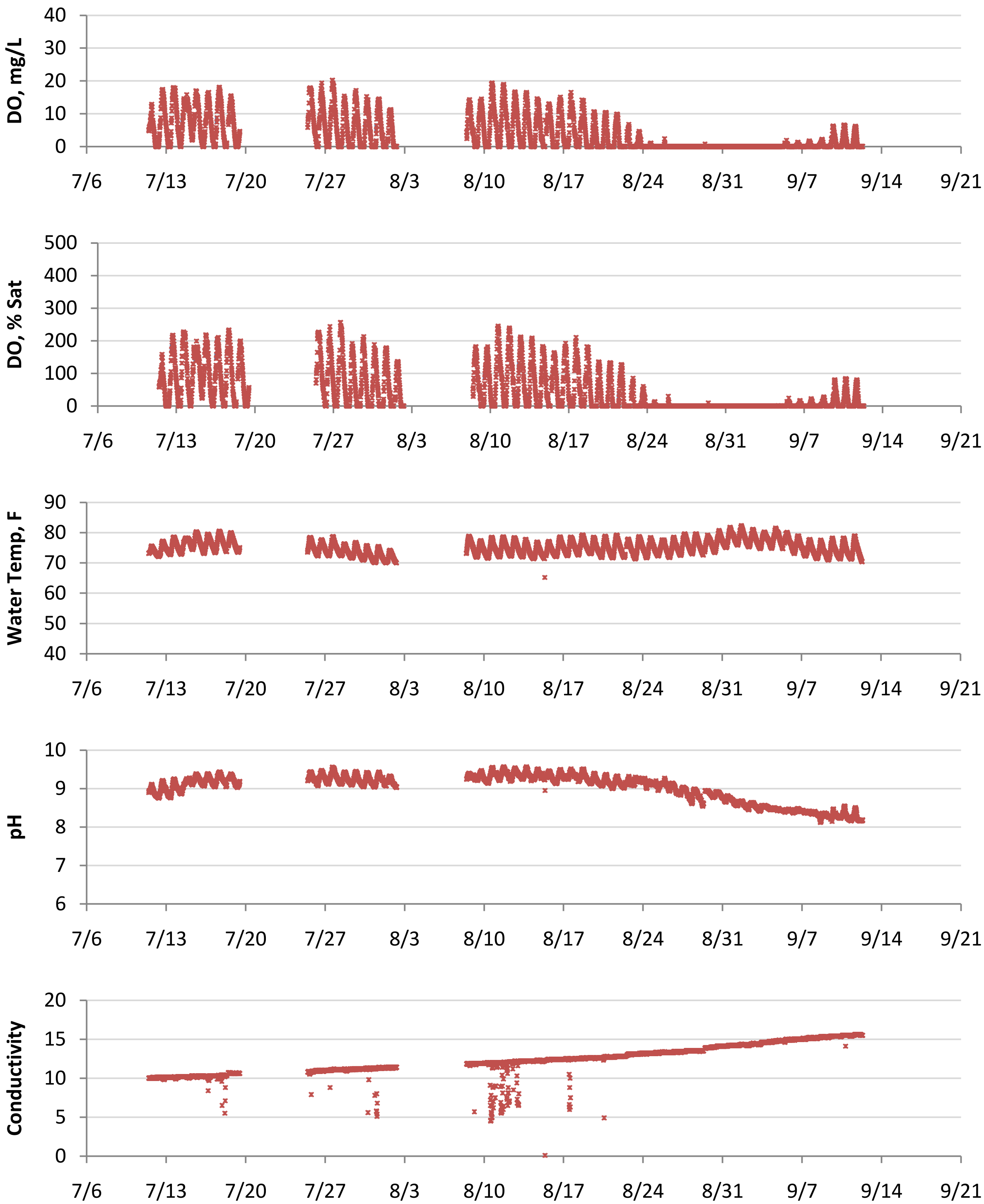
Summer 2013, Test Site with Tubing



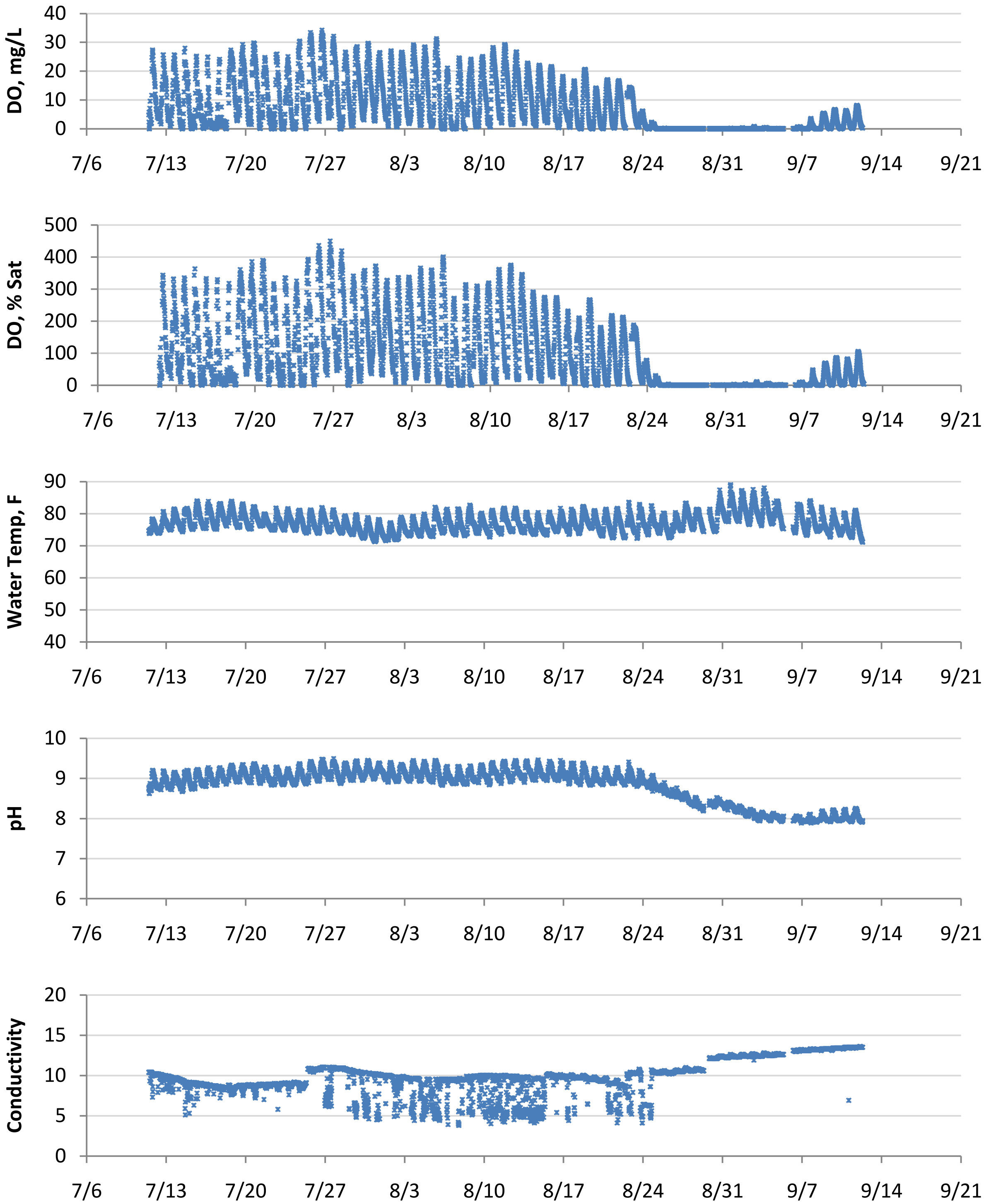
Summer 2013, Test Site with Tubing

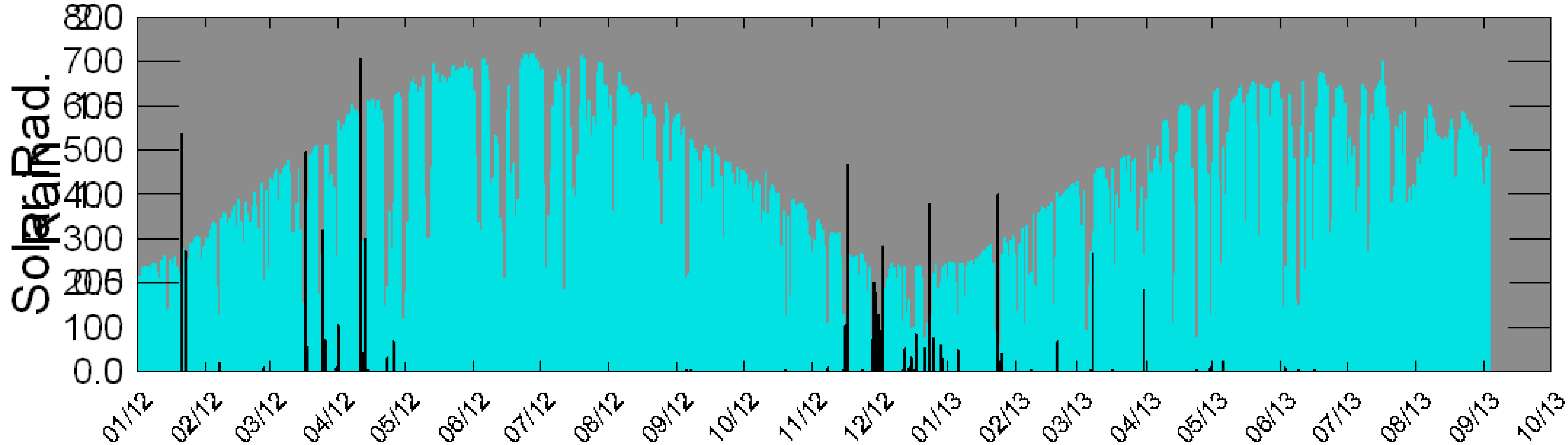


Summer 2013, Test Site with Tubing



Summer 2013, Control Site




Solar Rad.
Rain
800
700
600
500
400
300
200
100
0.0
01/12
02/12
03/12
04/12
05/12
06/12
07/12
08/12
09/12
10/12
11/12
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01/13
02/13
03/13
04/13
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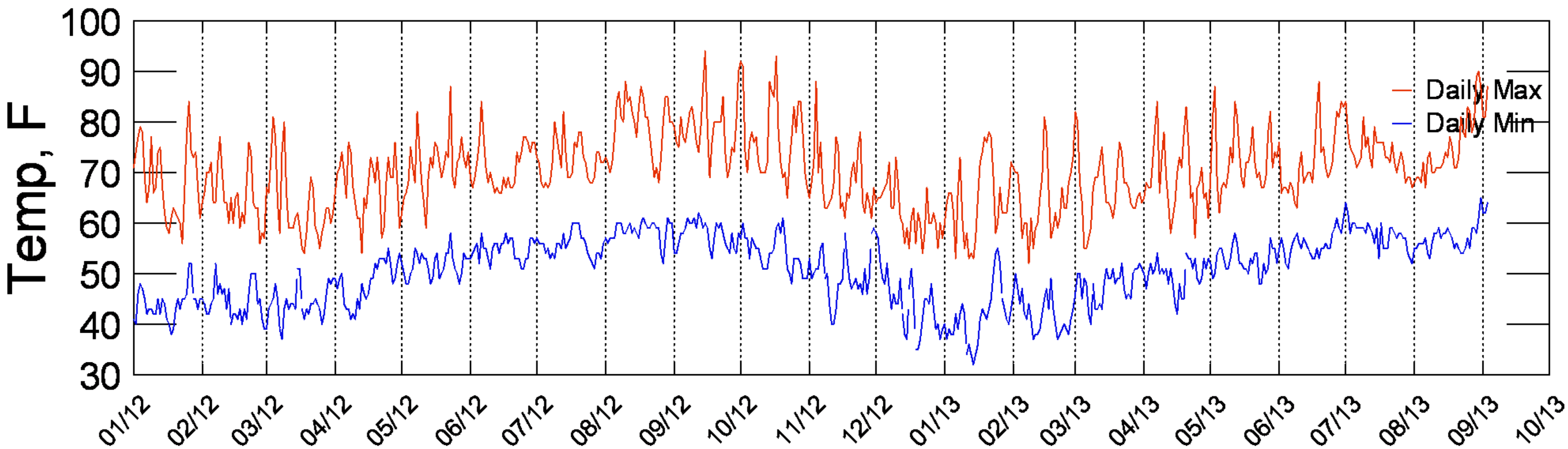
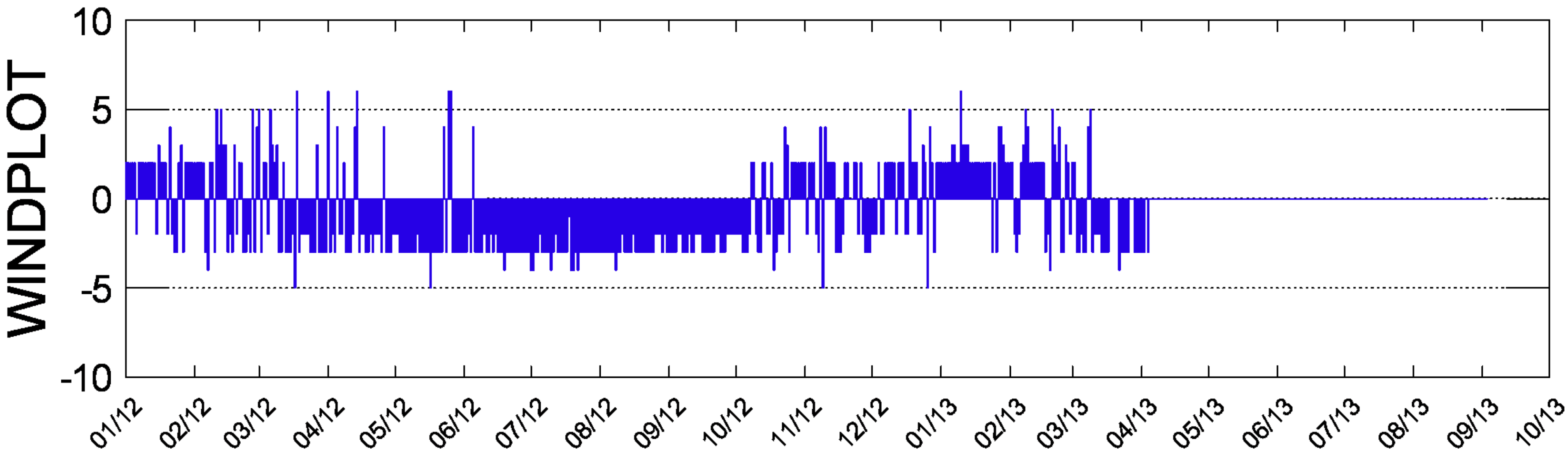
07/13
08/13
09/13
10/13


Temp, F
100
90
80
70
60
50
40
30
Daily Max
Daily Min
01/12
02/12
03/12
04/12
05/12
06/12
07/12
08/12
09/12
10/12
11/12
12/12
01/13
02/13
03/13
04/13
05/13
06/13
07/13
08/13
09/13
10/13


WINDPLOT
10
5
0
-5
-10
01/12
02/12
03/12
04/12
05/12
06/12
07/12
08/12
09/12
10/12
11/12
12/12
01/13
02/13
03/13
04/13
05/13
06/13
07/13
08/13
09/13
10/13

Source Tracking/Illicit Discharge Detection

Persistent Beach Warnings

What are the causes of persistent beach warnings that occur? There were no persistent warnings (during dry weather in FY 13. Most warnings during the past two years were aligned with open lagoon status, rain, or extremely high tides.

Table 1. Beach Warnings during AB411 and Winter Seasons in FY12 and FY 13.

Date	Arroyo Burro	MC E Beach	SC Ebeach	Leadbetter	Comments
4/4/2011	0	0	0	0	
4/11/2011	0	Warning	0	0	
4/18/2011	0	0	0	0	
4/25/2011	0	Warning	0	0	
5/2/2011	0	Warning	0	0	initiated Rapid Response on May 4th (FY 12, no source identified)
5/9/2011	Warning	0	0	0	lagoon open
5/11/2011	0	#N/A	#N/A	#N/A	
5/16/2011	Warning	Warning	0	0	.14 inches of rain on May 15
5/18/2011	Warning	Warning	#N/A	#N/A	.52" of rain on May 17-18
5/23/2011	0	0	0	0	
5/31/2011	0	0	0	0	
6/6/2011	Warning	Warning	0	Warning	.76" of rain on June 5-6.
6/13/2011	0	0	0	0	
6/20/2011	Warning	0	0	0	lagoon open
6/22/2011	0	#N/A	#N/A	#N/A	
6/27/2011	Warning	0	0	0	lagoon open
7/5/2011	0	0	0	0	
7/11/2011	0	0	0	0	
7/18/2011	0	Warning	0	0	
7/25/2011	0	0	0	0	
8/1/2011	Warning	0	0	0	lagoon open
8/3/2011	0	#N/A	#N/A	#N/A	
8/8/2011	Warning	0	0	0	lagoon open
8/15/2011	0	0	0	0	
8/22/2011	0	0	0	0	
8/29/2011	Warning	0	0	0	lagoon open
8/31/2011	0	#N/A	#N/A	#N/A	
9/6/2011	Warning	Warning	0	0	AB lagoon open
9/12/2011	0	0	0	0	
9/19/2011	0	Warning	0	0	
10/3/2011	0	0	0	0	
10/10/2011	0	0	0	0	
10/17/2011	0	0	0	0	
10/24/2011	Warning	0	Warning	Warning	AB lagoon open
10/26/2011	0	#N/A	0	0	
10/31/2011	0	Warning	0	Warning	
11/8/2011	0	Warning	0	0	

11/14/2011	0	0	0	0	
11/21/2011	Warning	Warning	Warning	0	1.14" rain on Oct. 20 and 21
11/28/2011	Warning	0	0	0	
12/5/2011	0	0	0	0	
12/12/2011	Warning	Warning	Warning	0	.44" of rain on Dec. 12th
12/19/2011	0	0	0	0	
1/9/2012	0	0	0	0	
1/17/2012	0	0	0	0	
1/23/2012	Warning	Warning	Warning	Warning	1.28" of rain on Jan. 21 and .35" rain on Jan. 23
1/25/2012	0	0	0	Warning	.65" of rain on Jan 23-24
1/30/2012	0	Warning	0	0	lagoon open
2/6/2012	0	0	0	0	
2/13/2012	0	Warning	0	0	lagoon open
2/15/2012	#N/A	0	#N/A	#N/A	
2/21/2012	0	0	0	0	
2/27/2012	0	0	0	0	
3/5/2012	0	0	0	0	
3/12/2012	0	0	0	0	
3/19/2012	0	Warning	0	0	1.69" of rain on March 17-18
3/26/2012	Warning	0	0	0	lagoon open
3/29/2012	0	#N/A	#N/A	#N/A	
4/2/2012	0	0	0	0	
4/9/2012	0	0	0	0	
4/16/2012	Warning	0	0	0	.72" of rain on April 13-14
4/18/2012	0	#N/A	#N/A	#N/A	
4/23/2012	0	Warning	0	0	MC lagoon open
4/30/2012	0	0	Warning	0	.22" of rain on April 26 and SC lagoon open
5/7/2012	0	0	0	0	
5/14/2012	0	0	0	0	
5/21/2012	0	0	0	0	
5/29/2012	0	0	0	0	
6/4/2012	0	0	0	0	
6/18/2012	0	0	0	0	
6/25/2012	0	0	0	0	
7/2/2012	0	0	0	0	
7/9/2012	0	0	0	0	
7/16/2012	0	0	0	0	
7/23/2012	0	0	0	0	
7/30/2012	0	0	0	0	
8/6/2012	Warning	0	0	0	lagoon open
8/13/2012	0	0	0	0	
8/20/2012	0	0	0	0	
8/27/2012	0	0	0	0	
9/10/2012	0	0	0	0	
9/17/2012	Warning	0	0	0	lagoon open
9/19/2012	0	#N/A	#N/A	#N/A	

9/24/2012	0	0	0	0	
10/1/2012	0	0	0	0	
10/8/2012	0	0	0	0	
10/15/2012	Warning	0	0	Warning	From Willie Brummett: "extremely high tides "rinsing" the wrack line"
10/17/2012	Warning	#N/A	#N/A	Warning	From Willie Brummett: "extremely high tides "rinsing" the wrack line"
10/22/2012	0	0	0	0	
10/29/2012	0	0	0	0	
11/5/2012	0	0	0	0	
11/13/2012	Warning	0	0	Warning	
11/19/2012	0	0	0	0	
11/26/2012	0	0	0	Warning	
12/3/2012	0	Warning	Warning	Warning	
12/5/2012	#N/A	0	0	0	
12/10/2012	Warning	0	0	Warning	
1/2/2013	0	0	0	0	
1/7/2013	0	0	0	0	
1/14/2013	Warning	0	Warning	0	AB lagoon open
1/16/2013	0	#N/A	0	#N/A	
1/22/2013	0	0	0	0	
1/28/2013	0	0	0	0	
2/4/2013	0	0	0	0	
2/11/2013	0	0	0	0	
2/19/2013	0	0	0	0	
2/25/2013	0	0	0	0	
3/4/2013	0	0	0	0	
3/11/2013	0	0	0	0	
3/18/2013	0	0	0	0	
3/25/2013	Warning	0	0	0	
4/1/2013	Warning	Warning	0	0	.36" of rain this day
4/3/2013	0	Warning	#N/A	#N/A	
4/8/2013	0	0	0	Warning	
4/15/2013	0	0	0	0	
4/22/2013	0	0	0	0	
4/29/2013	0	0	0	0	
5/6/2013	0	0	0	0	
5/13/2013	0	0	0	0	
5/20/2013	0	0	0	0	
5/28/2013	0	0	0	0	
6/3/2013	0	0	0	0	
6/10/2013	0	0	0	Warning	
6/17/2013	Warning	0	Warning	Warning	
6/19/2013	0	#N/A	0	0	
6/24/2013	0	0	0	0	
7/1/2013	0	0	0	0	
7/8/2013	Warning	0	0	0	
7/10/2013	0	#N/A	#N/A	#N/A	

7/15/2013	0	0	0	0	
7/22/2013	0	0	0	0	
7/29/2013	0	0	0	0	
8/5/2013	0	0	0	0	
8/12/2013	0	0	0	0	
8/19/2013	Warning	0	0	Warning	
8/21/2013	0	#N/A	#N/A	0	
8/26/2013	0	0	0	0	
9/3/2013	0	0	0	0	
9/9/2013	0	Warning	0	0	
9/11/2013	#N/A	0	#N/A	#N/A	
9/16/2013	0	0	0	0	
9/23/2013	0	0	0	0	
9/30/2013	0	0	0	0	
10/7/2013	0	0	0	0	
10/14/2013	0	0	0	0	

Source Tracking Verification Monitoring

Will Laguna Channel and the East Side Storm Drain show that human waste markers have been eliminated after sewer line repair work is completed? See also Hope and Haley Drains above.

Due to the lack of rainfall and storm drain flushing, this work was not completed during FY 13. The City worked with UCSB to submit a concept proposal to the Clean Beaches Initiative Task Force to fund verification monitoring. The project was invited back for submission of a full proposal, which will take place during FY 14.

RV dumping

Is RV dumping a consistent problem in Santa Barbara?
Does RV dumping and/or leaking occur? Yes
How often/much does RV leaking/dumping occur (time, volume, and percent of RVs in town)?
How does RV dumping/leaking scale to other fecal inputs, e.g. leaking sewers?

Because the City changed signage throughout the City for RV parking, the planned survey was not completed.

Additional Questions

What are the FIB patterns in storm drains that have been identified visually as "clean" vs. "debris-laden" during CCTV work?
Does outfall screening show illicit discharges according to Center for Watershed Protection guidance (Creek Walks)?
Are new hot spots emerging?
Specific areas of concern: Barger Canyon, Las Positas Creek, San Roque
Can we implement a report card system to create an alert for field and sample results that are concerning?
Can we develop a field testing kit for enforcement?
What is the impact of reservoir flushing on metals and pH?

These questions were not addressed during FY13.

Creeks Walks/Clean ups

Are there new problems in creeks that need to be addressed? Conduct outfall screening.
Can we see anything unusual in lower Arroyo Burro, regarding flow patterns?
Is the amount of trash in creeks decreasing over time?
Has the installation of catch basin screens lead to decreased trash observed in creeks?
Can we see any impairment to San Roque Creek, leading to drop in bioassessment scores?
What is the conductivity pattern in tributary to Sycamore Creek?

Creek walks were not completed during FY13.

Bioassessment

What is the baseline of biological integrity for benthic macroinvertebrates in creeks?
Are there differences between upper watershed and lower watershed sites?
Are there differences among watersheds?
How does the biological integrity in our creeks change over time?
How does the biological integrity respond to water quality and restoration projects?
What is the biological integrity of estuaries in Santa Barbara?

The following text is excerpted from the Draft Southern Coastal Santa Barbara Creeks and Estuaries Bioassessment Program 2013 Report, completed by Ecology Consultants.

Executive Summary

Introduction

This report summarizes the results of the 2013 Southern Coastal Santa Barbara Creeks and Estuaries Bioassessment Program, an effort funded by the City of Santa Barbara and County of Santa Barbara. The purpose of the Program is to assess and monitor the biological integrity of creeks and estuaries in the study area as they respond through time to natural and human influences. Ecology Consultants, Inc. (Ecology) prepared the report, and serves as the City's and County's consultant for the Program. This is the 14th year of the Program, which began in 2000.

The Program involves annual collection and analysis of benthic macroinvertebrate (BMI) samples and other pertinent physiochemical and biological data in 15 to 20 creek study reaches using U.S. Environmental Protection Agency (USEPA) endorsed rapid bioassessment techniques. BMI samples are analyzed in the laboratory to determine BMI abundance, composition, and diversity. Scores and classifications of biological integrity are determined for study streams using the Index of Biological Integrity (IBI) developed for study area creeks in 2009. The IBI yields a numeric score and classifies the biological integrity of a stream as Very Poor, Poor, Fair, Good, or Excellent based on the BMI community present in the stream. Seven "core BMI metrics" are calculated and used to determine the IBI score. Each core metric is highly sensitive to human disturbance, and collectively they represent different aspects of the BMI community including diversity, composition, and trophic group representation. By condensing complex biological data into an easily understood score and classification of biological integrity, the IBI serves as an effective tool for the City and County in monitoring the condition of local creeks, and evaluating the benefits or consequences of watershed management actions.

In 2011 the Program was expanded to include the estuaries of three local watersheds. Estuaries are open water bodies where a freshwater stream meets and mixes with saltwater from the ocean, creating brackish water conditions with salinities that change throughout the year depending on varying seasonal inputs from the stream and ocean tides. USEPA endorsed rapid bioassessment techniques for estuaries were used to collect BMI samples and other pertinent physiochemical and biological data. 6 estuaries were studied this year, as in 2012. The IBI cannot be used to assess the condition of local estuaries, which have very different physiochemical conditions (e.g., brackish water, substrate, water flow, etc.) and biological assemblages than do freshwater creeks. It is hoped that an IBI or similar tool to assess the condition of local estuaries can be developed in the future.

Study Area

The study area encompasses approximately 80 km of the southern Santa Barbara County coast from the Rincon Creek watershed at the Santa Barbara/Ventura County line west to Jalama Creek, which is just north of Point Conception. There are approximately 50 1st to 5th order coastal streams along this stretch of coast, all of which drain the southern face of the Santa Ynez Mountains. 52 different stream study reaches in 20 watersheds have been surveyed on one or more occasions from 2000 to 2013. 15 stream study reaches were surveyed this year, and 6 estuaries were surveyed.

Methods

Physiochemical and biological data for the study creeks and estuaries was gathered through a combination of methods including field surveys, laboratory analyses, spatial data analyses using geographic information system software, and review of United States Geological Survey (USGS) 7.5-minute quadrangle maps and recent aerial photographs. Core metrics were calculated and IBI scores and classifications of biological integrity were determined for the creek study reaches. A suite of BMI metrics was calculated for study estuaries, and evaluated for differences along disturbance and salinity gradients.

Results

Over the past 14 years, bioassessment data collected through the Program has provided a wealth of information on the range of habitat conditions and biota (particularly the BMI community) of local streams. The ways in which local stream habitat conditions and biota have been influenced by natural variability in rainfall, stream flow, watershed area, gradient, and water chemistry has been explored and established to varying degrees. The effects of major disturbances including extreme stream flows, drought conditions, and wildfires have been studied and characterized. Negative effects of different types and intensities of human land use on local stream communities (particularly BMIs) have been documented with highly significant statistical test results. Habitat restoration sites have been studied to monitor the responses of the aquatic community, which has shown slight improvements over time following restoration actions. Our understanding of local streams and the factors that affect them will undoubtedly improve as the Program effort continues in future years.

Over the past three years, a relatively limited data set has been compiled for local estuaries. Study sites have included the range available along a disturbance gradient, from "reference" sites that are fairly intact in form with little urbanization in their watersheds to "disturbed" sites that have been substantially altered in form and drain highly urbanized watersheds. Compared with streams, there appears to be less difference in BMI metrics between reference and disturbed estuaries. However, several BMI metrics (mostly indices of sensitive and/or tolerant taxa) look promising as biological indicator metrics. More surveys are needed to further test, validate, and refine potential indicator metrics. Establishing several (perhaps 4 to 6) reliable indicator metrics will be the basis for developing a reliable IBI for local estuaries.

APPENDIX 1

FY 13 SAMPLING TABLE

Creeks Division Water Quality Monitoring and Research Program
Fiscal Year 2013 Research Plan

PROGRAM ELEMENT and QUESTIONS	METHODS/CONSTITUENS	SITES	FREQUENCY	NEW?
A. Watershed Assessment				
1. Is overall water quality, in terms of indicator bacteria and field properties, getting better over time?	FIB, field parameters, flow	Integrator Sites Honda and Lighthouse	Biweekly (26 x 4) Quarterly (4 x 2)	
2. How contaminated and/or toxic is sediment at storm drain outfall sites?	Metals, PAHs, Toxicity, Pyrethroids	8 creeks sites TBD	Yearly, in late summer	
3. Are pharmaceutical and personal care products (PPCPs) reaching creeks via irrigation runoff and water main breaks of reclaimed water?	Salinity and PPCPs	4 discharge sites if not completed in FY 11. Pending results, 2 creeks sites.	Summer 2012	
4. Is contaminated groundwater at cleanup sites reaching creeks?	Semivolatile organics	4 creek sites located in target areas	Summer 2012	
5. What is the source of the 303(d) impairment for Low Dissolved Oxygen on Mission Creek? How extensive in time and space is the impairment? (see Section C as well)	Nutrients, DO, Bioassessment, Algae cover	TBD, basd on Mission Lagoon results below.	TBD	
6. What is the source of the 303(d) impairment for Sodium and Chloride on Sycamore Creek? Is high conductivity near Chelham Creek from natural sources?	Conductivity, Sodium, Chloride	Creek walk, review geologic maps	As needed (~10 sample pairs)	New
7. Is high conductivity in Honda Creek from natural sources?	Conductivity, Sodium, Chloride	Test downstream site biweekly for conductivity. Creek walk, review geologic maps	As needed (~5 sample pairs)	New
8. What is the source of the impairment for toxicity on Mission Creek?	Toxicity Tests, especially algae	Quarterly sampling sites plus Mission Canyon	Quarterly (3x's during dry weather)	
9. What are the background daily cycles of water flow in Santa Barbara creeks? Is there a daily pumping in or removal of water from Arroyo Burro?	Review flow data, creek walk.	Lower Arroyo Burro	Summer 2012	New
10. Are new pesticides (pyerthroids and neonicotinoids) detected in dry conditions?	Pyrethroids, neonicotinoids	Integrator sites	Fall 2012	New
11. What are the impacts of reservoir flushing on metals?	Metals (total)	Sites TBD based on reservoir flushing	Fall 2012	
B. Storm Monitoring				
1. What are the highest concentrations of pollutants of concern during storm events, particularly seasonal first flush storms, in creeks?	Metals, Herbicides, Pesticides, Nutrients, Hydrocarbons, MBAS,	Integrator Sites and four storm drains	Yearly, first flush. Collect drain samples first, then creek samples.	
2. Do creeks and/or storm drains in Santa Barbara have problems with toxicity during storm events?	Toxicity (Vert, invert, algae)	As above.	As above.	
3. What are the loads of pyrethroids discharged from Santa Barbara creeks during storms?	Pyrethroids	Arroyo Burro at Cliff (location of flow gauge and autosampler)	Conduct composite sampling according to Caltrans (2008) during a 1" forecasted storm.	New
4. Is runoff from coal tar sealed parking lots more toxic than runoff from asphalt sealed parking lots?	PAHs, toxicity	4 sites, TBD	One storm, 2013.	New

PROGRAM ELEMENT and QUESTIONS	METHODS/CONSTITUENS	SITES	FREQUENCY	NEW?
5. How do restoration/treatment projects impact water quality during storm events?	See Golf Course, MacKenzie Parking Lot, and Storm Water Retrofit Projects below.			
C. Restoration and Water Quality Project Assessment				
1. Westside SURF and Old Mission Creek Restoration a. Is the UV disinfection equipment functioning? b. What percentage of flow in Westside Storm Drain is the facility treating? c. Have habitat scores and index of biological integrity (IBI) scores in Bohnett Park improved?	FIB and field parameters. Flow from WSD, pump records, camera Bioassessment	SURF Up, SURF Down, WSD, OMC W. Anapamu	Weekly during AB411 season.	
2. Arroyo Burro Restoration, including Mesa Creek daylighting a. Have habitat and IBI scores in Mesa Creek improved? b. Has water quality in Mesa Creek continued to improve? c. How does Arroyo Burro Estuary biological integrity compare to other estuaries?	Indicator bacteria and field parameters Bioassessment	AB at Cliff, Mesa upper, Mesa lower, AB Estuary upper, AB Estuary Mouth, AB Surf	Biweekly	
3. Hope and Haley Diversions a. Are human waste markers still found in Hope and Haley Storm Drains? b. What are the loads of fecal indicator bacteria (FIB) that are diverted to the sanitary sewer by these projects?	Human waste marker suite. Indicator bacteria and field parameters	Hope Diversion, Haley Pump Hope Diversion, Haley Pump	Spring 2013 Biannual	
4. Golf Course Project Performance (Storm) and Operation (Dry weather) a. Do treatment elements (Adams bioswale, East Basin, West Basin) reduce pollutant concentrations during storms? b. What is the quality of water discharged during spillover conditions (East Basin, West Basin)? c. What are the temporal and spatial patterns of pH, temperature, DO, and conductivity in the East Basin during dry weather? d. What is the quality of water released prior to storm events from the East Basin and West Basin? What are the conditions in receiving water during releases?	FIB, nutrients, TSS FIB, nutrients, TSS, toxicity Sonde deployed in E. Basin, spot sampling Field parameters, FIB, nutrients, metals, hydrocarbons, pesticides, TSS, PAHs, and toxicity (PAHs only in sediment laden water, if observed).	Paired samples: Adams bioswale, East Basin, West Basin East Basin and West Basin spillways E Basin E and W Basin releases, Las Positas Creek at Modoc	Three storms (not first flush) Large storm. Continuous As needed.	
5. McKenzie Parking Lot LID Retrofit (Storm) a. Are basins functioning correctly? b. Is design storm fully infiltrated? c. What are rainfall, storage, and draw down patterns?	Depth in basins, via logger. Visual observation during design storm.	MacKenzie Park	All storms.	
6. Debris Screens (Creek Walks) a. Has the installation of catch basin screens lead to decreased trash observed in creeks? b. Have the catch basin screens lead to decreased rotting plant material and/or FIB in storm drains?	See Section E4 See Section D4			
7. Mission Creek Fish Passage (Dissolved Oxygen)				

PROGRAM ELEMENT and QUESTIONS	METHODS/CONSTITUENS	SITES	FREQUENCY	NEW?
a. What are the conditions in creek segments where fish spend time waiting for passage conditions (above or below passages)?	Data collected as part of Mission Lagoon work, below.			
8. Mission Lagoon Restoration and Laguna Channel Disinfection a. Lagoon Inputs i. What does previously collected data show regarding nutrient input in Mission Creek and Laguna Channel? ii. What are the current nutrient inputs (concentration and flow) from Mission Creek and Laguna Channel during dry weather? iii. Does groundwater and/or nitrate enter Laguna Channel in the lower reach? b. Lagoon Water Quality i. What does previously collected data show regarding sediment contamination in Mission Lagoon and Laguna Channel? ii. What are the water quality conditions in the lagoon (DO, temperature, turbidity), at the surface and near the bottom? iii. How do parameters respond to lagoon breaching and closing? iv. How does macro-algae cover and biomass change after the lagoon is closed? v. What is the daily (weekly) condition of the estuary? Lagoon status, color, amount of floating algae?	Review existing data. Nutrient suite, DO, flow. Nutrient suite, DO, flow. Two sondes installed. Same as above. Photos. Same as above.	MC Montecito, LCC CPP LC Hwy 101, LC CPP DO, temp, conductivity Carrillo and State St. Bridges	Biweekly (5 xs) Biweekly (5 xs) Continuous data collection. Daily to weekly	New
9. Storm Water Infiltration Retrofit Projects (Prop 84) a. What are the baseline conditions for the project? i. What is the modeled post-development hydrograph? ii. What are the concentrations of pollutants in runoff from the sites? iii. What is the toxicity of runoff from the sites? iv. What is the modeled pre-development hydrograph? b. Can we identify reference parking lots for which flow rates can be measured in addition to modeled? Include runon and runoff patterns in consideration of sites.	Runoff modeling, testing for FIB, hydrocarbons, metals, pesticides, surfactants, toxicity. Field observation and GIS work for identifying reference sites.	TBD	First flush and two additional storms.	New
10. Bird Refuge a. What are baseline conditions for future restoration project?	On hold.			
D. Source Tracking/Illicit Discharge Detection				
1. What are the causes of persistent beach warnings that occur?	FIB, ammonia	TBD, upstream from beach sits.	As needed, when 3 out of 4 beach tests show a warning.	
2. Will Laguna Channel and the East Side Storm Drain show that human waste markers have been eliminated after sewer line repair work is completed? See also Hope and Haley Drains above.	Human waste marker suite.	Laguna Channel under Hwy 101. East Side Storm Drain outfall.	Spring 2013	New
3. Is RV dumping a consistent problem in Santa Barbara? b. What is the scale of RV dumping (time, volume, percent of RVs in town)? c. How does RV dumping scale to other fecal inputs, e.g. leaking	Counts/observations of RVs in Santa Barbara, compared to number of RVs dumping legally at Marborg. Using calculations to estimate relative scale of	Blocks and parking lots frequented by RV dwellers.	Quarterly.	New

PROGRAM ELEMENT and QUESTIONS	METHODS/CONSTITUENS	SITES	FREQUENCY	NEW?
sewers?	problem.			
4. What are the FIB patterns in storm drains that have been identified visually as “clean” vs. “debris-laden” during CCTV work?	FIB, ammonia	TBD, based on CCTV footage	TBD, Spring 2013	New
5. Does outfall screening show illicit discharges according to Center for Watershed Protection guidance (Creek Walks)?	Ammonia, FIB, MBAS	All discharges to mainstem creeks observed during creek walks.	Yearly	New
6. Are new hot spots emerging?	TBD			
7. Specific areas of concern: Barger Canyon, Las Positas Creek, San Roque	TBD			
8. Can we implement a report card system to create an alert for field and sample results that are concerning?	Review of exisiting data.			New
9. Can we develop a field testing kit for enforcement?	TBD			
10. What is the impact of reservoir flushing on metals and pH?	Metals, sediment.	Rattlesnake Creek and Reservoir outlet.	Single event.	
E. Creeks Walks/Clean ups				
1. Are there new problems in creeks that need to be addressed? Conduct outfall screening.	See section D.	All main stem creeks.	Yearly	New
2. Can we see anything unusual in lower Arroyo Burro, regarding flow patterns?	Creek walk, review existing flow data.	Lower Arroyo Burro	Yearly	New
3. Is the amount of trash in creeks decreasing over time?	Weight of trash removed each year.	All main stem creeks.	Yearly	
4. Has the installation of catch basin screens lead to decreased trash observed in creeks?	Continue measuring and marking GPS coordinates of trash.	Old Mission Creek and Lower Mission Creek (oak Park to beach)	Yearly	
5. Can we see any impairment to San Roque Creek, leading to drop in bioassessment scores?	Observation.	San Roque Creek, above Jesusita	Note if/when creek dries up.	Add San Roque to creek walks.
6. What is the conductivity pattern in tributary to Sycamore Creek?	See Section A			New
F. Bioassessment				
1. What is the baseline of biological integrity for benthic macroinvertebrates in creeks? 2. Are there differences between upper watershed and lower watershed sites? 3. Are there differences among watersheds? 4. How does the biological integrity in our creeks change over time? 5. How does the biological integrity respond to water quality and restoration projects? 6. What is the biological integrity of estuaries in Santa Barbara?	See Bioassessment Proposal and Reports.			

APPENDIX 2

FY 13 CAC REPORT

City of Santa Barbara
Parks and Recreation Department

Memorandum

DATE: June 19, 2013

TO: Creeks Restoration/Water Quality Improvement Program Citizen Advisory Committee

FROM: Jill Murray, Water Quality Research Coordinator

SUBJECT: **WATER QUALITY RESEARCH AND MONITORING PROGRAM UPDATE AND FISCAL YEAR 2014 RESEARCH AND MONITORING PLAN**

COMMITTEE DIRECTION – FOR ACTION

That the Committee receive an update on the Water Quality Research and Monitoring Program and concur with the staff recommendation to implement the proposed Research and Monitoring Plan for Fiscal Year 2014.

DISCUSSION

Background

In June 2012, the Committee concurred with the staff recommendation to implement the Research Plan for Fiscal Year 2013 (FY13). In December 2012 the Committee received an update on the annual Water Quality Report, with a focus on first flush sampling, Mission Creek toxicity, and the Source Tracking Protocol Development Project. At this time, the Committee will receive the proposed changes for the Fiscal Year 2014 (FY14) Research and Monitoring Plan. The proposed FY14 Research and Monitoring Plan is attached. The committee will also receive a mid-year update on FY13 sampling, with a focus on the Storm Water Infiltration Demonstration Project and the Bird Refuge pilot project.

The goals of the monitoring program are to:

1. Quantify the levels (concentration, flux, or load) of microbial contamination and chemical pollution in watersheds throughout the city.
2. Evaluate impacts of pollution on beneficial uses of creeks and beaches, including recreation and habitat for aquatic organisms.
3. Evaluate the effectiveness of the City's restoration and water quality treatment projects, which includes collecting baseline data for future projects.

4. Identify sources of contaminants and pollution in creeks and storm drains.
5. Evaluate long-term trends in water quality.
6. Meet monitoring requirements for grants.
7. Meet General Permit monitoring requirements.

The underlying motivation behind the monitoring program is to obtain information that the City can use to:

1. Develop strategies for water quality improvement, including prioritization of capital projects and outreach/education programs.
2. Communicate effectively with the public about water quality.

The FY 2014 Research and Monitoring Plan represents a major change in the Research and Monitoring Program due to regulatory requirements in the newly adopted Phase II Small MS4 General Permit (General Permit). In addition, the State Water Board has developed more rigorous monitoring requirements for grant-funded projects. Last, the Creeks Division has begun several new projects that require baseline monitoring. Therefore, the main changes proposed for FY 2014 are:

1. Update the program goals and elements to include meeting grant and General Permit requirements.
2. Update the program based on new General Permit requirements for Illicit Discharge Detection and Elimination (IDDE) and Monitoring, including the development of a State-certified Quality Assurance Project Plan and submittal of monitoring data to a Water Board database.
3. Update Source Tracking element to focus on Laguna Channel Watershed, pathogens, and the UCSB Source Identification Protocol Project.
4. Update Project Assessment to focus on the Bird Refuge, Mission Lagoon Restoration, Upper Arroyo Burro Restoration, and Las Positas Creek Restoration Projects.

In support of the program goals, the Research Plan consists of eight key elements and associated research questions (questions are listed in the attached Research Plan :

1. Grant Project Requirements
2. General Permit Requirements: IDDE and Monitoring
3. Watershed Assessment
4. Storm Monitoring
5. Restoration and Water Quality Project Assessment
6. Source Tracking
7. Creeks Walks
8. Bioassessment

The attached Research and Monitoring Plan contains the requirements and research questions associated with each element.

Selected monitoring updates are presented below. Additional results will be presented in the Annual Water Quality Report, to be presented in January 2014.

Storm Water Infiltration Demonstration Project

The Storm Water Infiltration Demonstration Project, which is currently in construction, will remove the impermeable asphalt surface at six parking lot sites in the City and replace it with permeable interlocking concrete pavers and landscaping in order to restore natural hydrologic conditions and treat storm water. Past monitoring results from City parking lots has revealed hydrocarbons, metals, fecal indicator bacteria, and toxicity to aquatic organisms in storm water runoff. Creeks will measure the infiltration project's benefits in two ways: measuring the amount of rainfall that is infiltrated during storm events and assessing the load of pollutants prevented from reaching surface waters.

During three storms in FY 2013, including the first storm of the season, water quality sampling was conducted in support of performance evaluation of the project. Storm water runoff from each site was tested for pesticides, hydrocarbons, metals, bacteria, toxicity, pH, sediment, turbidity, conductivity, dissolved oxygen, nutrients, and temperature. Because no pesticides were detected in runoff collected during the first storm, pesticide testing was discontinued for the final two storms. Metals, including chromium, copper, lead, and zinc were detected in runoff from all six sites, and were generally found in higher concentrations at sites with more vehicular traffic. Diesel-range organics were detected at all sites. Toxicity testing showed low toxicity of runoff for most sites in most storms sampled, with two exceptions that showed high toxicity.

The data collected over the past season will allow for an estimate of the pollutant loads infiltrated by the project during post-construction rain events in coming years. For each site, the three different storm event results will be weighted based on rainfall to determine average event mean concentrations (EMCs), or the average concentration of a pollutant in runoff over an entire rain event. The EMC for each pollutant can then be multiplied by the rainfall amount in future storms to obtain an estimate of the pollutant loads infiltrated to the project sites.

Bird Refuge Pilot Project

High nutrient levels in the water, poor water circulation, and low levels of dissolved oxygen are key water quality issues at the Bird Refuge. Eutrophic conditions, an increase in algal growth and die-off, as well as the turnover of anaerobic sediment, leads to the release of noxious odors. The most recent "stink event" occurred in June 2012. In September 2012, the Parks and Recreation Department began a pilot project to test the ability of enhanced circulation to improve water quality and prevent noxious odors at the Bird Refuge. The Creeks Division is conducting water quality monitoring of the pilot project.

The area near the tide gate (outlet arm) was chosen as the test location due to its isolation from the larger lake area. Perforated tubing was installed along bottom of the lake in the outlet arm. Compressed air from the tubing provides micro-aeration, designed to increase vertical and horizontal circulation. Increased circulation is predicted to increase dissolved oxygen levels throughout the water column and to disrupt stagnant conditions that can lead to noxious algal blooms. Creeks staff monitor water quality conditions in the pilot project site and a control site on a weekly basis.

Preliminary results show that the pilot project is creating a small, but statistically significant, difference in circulation and dissolved oxygen concentrations. When dissolved oxygen (DO) concentrations are relatively high, such as during an algae bloom, the test site exhibits lower DO concentrations than the control site, suggesting that low-DO water is brought from the bottom water to the surface. When DO concentrations are relatively low, such as a period of algae die-off, DO concentrations are slightly higher in the test area, suggesting that exchange across the air-water interface is improved. However, it is still too early to determine if the differences are great enough to prevent noxious odors developing in the hot summer months. A possible next step is to add beneficial microbes to the water column, in an effort to increase degradation of organic material on the lake bottom and increase water depth. If water depth can be increased from the current depth of two-four feet to seven feet, additional circulation options will become available.

Next Steps

Staff will begin implementing the FY14 Research Plan and perform scheduled monitoring beginning July 2013. The Fiscal Year 2013 Annual Report will be completed and presented to the Committee. The FY 2013 Water Quality Report will be focused on presenting data analysis for restoration and water quality improvement projects.

cc: Cameron Benson, Creeks Restoration/Clean Water Manager
Jill E. Zachary, Assistant Parks and Recreation Director