WATER QUALITY

In urban watersheds, rainfall flushes numerous contaminants off of roofs, driveways, gardens, parks, and streets into storm drains and creeks. Rainfall also moves pollutants from the air into storm runoff. Due to the large volumes of runoff in winter, most of these contaminants are transported to San Francisco Bay and are diluted. During the dry season, however, there are also many sources of pollutants in urban watersheds which may reach storm drains and creeks. Due to the low flows in the creeks in summer there is little dilution and pollutants can have a greater effect on aquatic life.

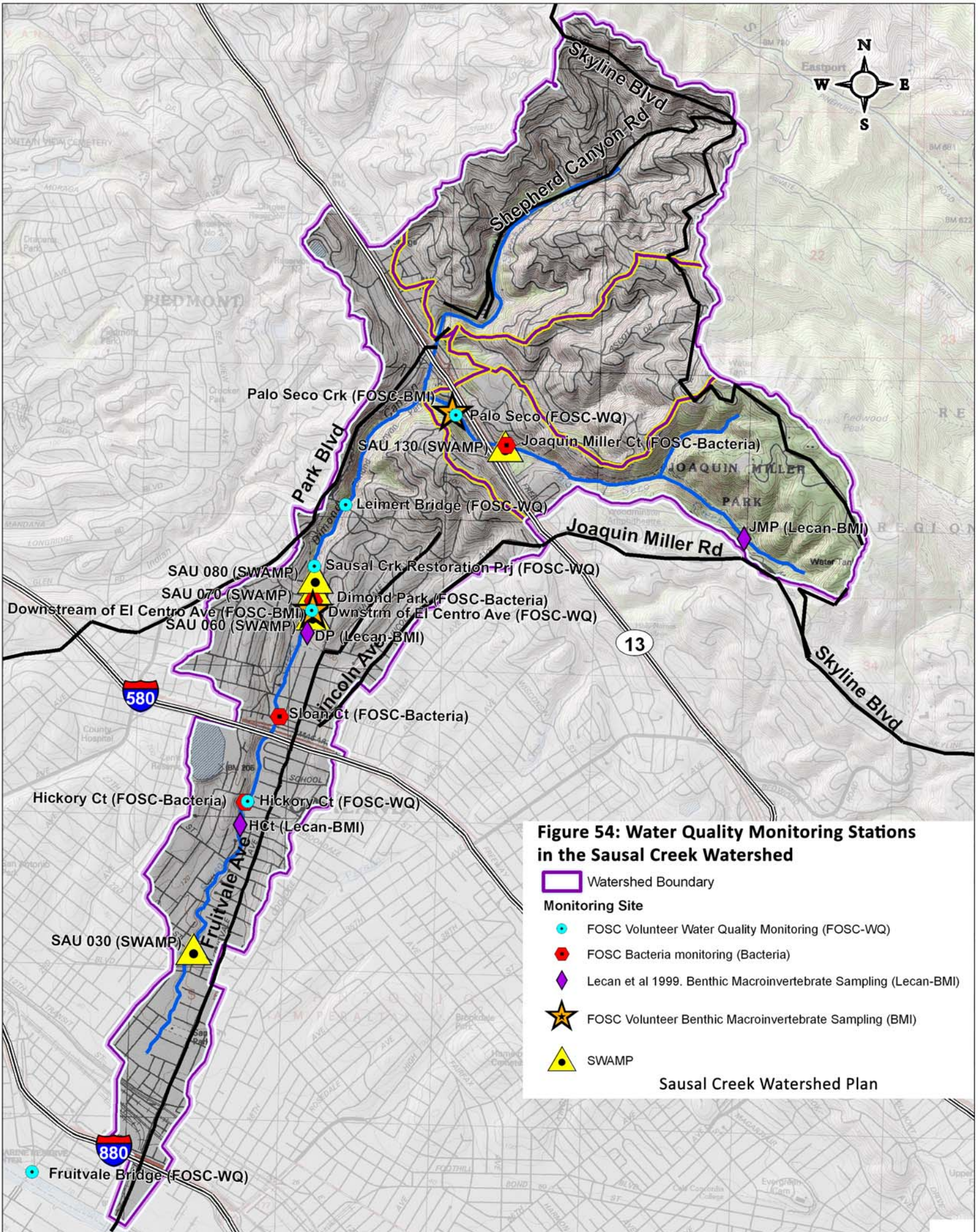
In the Sausal Creek watershed the primary land use is residential with limited commercial areas and some parkland. These land uses produce pollutants including oil and gas residues, trash, pesticides, fertilizers, sediment, dog feces, heavy metals, and other materials. These pollutants are generated by numerous sources in the watershed. One of the only effective methods for reducing pollutants is changing the habits and materials used by urban residents.

Several different programs have measured various water quality parameters in Sausal Creek (Figure 54). Friends of Sausal Creek (FOSC) has carried out a volunteer monitoring program for a number of years for basic water quality parameters in several locations. The FOSC program conducted sampling starting in March 1998. The parameters sampled were air temperature, water temperature, dissolved oxygen, pH, and conductivity and turbidity on an occasional basis. FOSC, in conjunction with the Environmental Protection Agency (EPA), also completed coliform testing in several locations in the watershed.

The San Francisco Bay Regional Water Quality Control Board's Surface Water Ambient Monitoring Program (SWAMP) completed comprehensive water quality, sediment quality, and aquatic insect monitoring in Sausal Creek in 2004-2005.

Water Quality – Volunteer Monitoring

The FOSC volunteer monitoring program used a variety of different stations. In 1998, the first year of the monitoring program, three stations were used: Palo Seco Creek just upstream of the Montclair Golf Course, Sausal Creek just downstream of the El Centro Avenue culvert, and Hickory Court near the Central Reservoir. In 2001-2002 another station at the Fruitvale Bridge was monitored, and in 2003 a station located in Sausal Creek near Leimert Bridge was sampled twice. Starting in 2002 the reach of Sausal Creek upstream of El Centro Avenue, where a major restoration project was implemented, was added as a station. In 2004 the program was revised and only three stations were used: Palo Seco Creek just upstream of the junction with Shephard Creek; Sausal Creek just downstream of the El Centro Avenue culvert; Sausal Creek in the channel area upstream of El Centro Avenue where the restoration project was completed. The monitoring was conducted by volunteers, on an approximately monthly basis. No written protocol was used to indicate the Quality Assurance/Quality Control (QA/QC) procedures used. The sampling program used meters supplied by the EPA, but it is not clear if the meters were calibrated before and after the sampling was done. LaMotte kits and pH strips were also used. These are instantaneous measurements rather than continuous measurements and give a snapshot view of water quality conditions. If this program continues, it is important that a QA/QC program be used and that methods be revised to assure the accuracy and reliability of the water quality data. Without a QA/QC program, the FOSC water quality data is useful only in a general way.



Source: SWAMP 2008; FOSC; Lecan et. al. 1999.

Table 20: FOSC Water Quality Volunteer Monitoring Results 1998-2006 Instantaneous Water Temperatures (°C)																						
	Sausal Creek at El Centro Avenue								Palo Seco Creek								Sausal Creek Restoration Reach				
Month	1998	1999	2001	2002	2003	2004	2005	2006	1998	1999	2001	2002	2003	2004	2005	2006	2002	2003	2004	2005	2006
1		9		11.4	12	10	8.1	10.5		10.0/9.0		10.5	11.2	9.4	7.8	19.5		12.1	10.2	8.3	10.5
2	14	10		6.6	11.8					9.5		6.5	11.2					11.9			
3	14	11.5		9.8	8.9	12.8			10.0/14.0	10.5		8.5	8.7	11.9				9.1	12.9		
4	12/11.5	10		11.9	8.9	10.1		12.7	10.5	9.5		10.6	8.8	9.8		11.9		9.3	10.3		12.6
5	20/14/13.5			12	12.9		13.3		14/11.5			11	11.4					12.8		13.5	
6	15			15	14.9	17.3			14			13.5	13.5	14.8	15.3		15.5	14.7	18.9		
7	17			15.5	15.1	18.4			14			14.4	14.1	15.4			16.7	15.4	19.2		
8	16			17.4	18.3	17.2	16.1		15		15.3	15	15.6	14.9	15.6		17.3	17.8	17.2	15.9	
9	17.5		15	14.3	17.9				15		13.5	12.7	15.7				13.6	17.1			
10	13		15	13.5	15.6		13		12			12.4	13.7		12		13	15.2		12.5	
11	11			9	10.7				10.5			9.1	10.3				8.9	9.7			
12	9		10.7	10	13.3				8.5		9.6	10.1	11.9				10.5	13.3			

In reviewing the FOSC water quality data there are occasional measurements of low dissolved oxygen (<7.0 mg/l) associated with increases in water temperature. Table 20 shows instantaneous water temperatures by month for the three stations with the most data: Sausal Creek at El Centro, Palo Seco Creek, and Sausal Creek at the Restoration Reach. In general, the rainy season (December-March) has the lowest water temperatures, although the data shows a wide range of water temperatures for the same month at the same station. The water temperatures at the Palo Seco Creek station are consistently colder than in Sausal Creek at the El Centro and Restoration locations, indicating that lack of shade canopy along the creek may allow warming or that the stream flows from Cobbledick and Shephard Creeks may be warmer. Unfortunately there is no water temperature data for these two tributary creeks.

Water Quality – SWAMP Monitoring

The San Francisco Bay Regional Water Quality Control Board's Surface Water Ambient Monitoring Program (SWAMP) monitored water quality in Sausal Creek in 2004-2005 at five stations (Figure 54). These stations include:

- Sausal Creek at E. 22nd Street (SAU030)
- Sausal Creek near Lions Pool in Dimond Park (SAU060)
- Sausal Creek at El Centro Ave. (SAU070)
- Sausal Creek in Dimond Park (SAU080)
- Palo Seco Creek (SAU130)

This monitoring was done using a continuous monitoring instrument and with strict QA/QC protocols at a larger number of stations on Sausal Creek. This data shows similar water temperatures as the FOSC monitoring. The station at Dimond Park has low dissolved oxygen levels in May and September 2004 (Table 21).

The SWAMP program also monitored for a range of persistent pollutants more typical of urban contaminants. On Sausal Creek, samples were collected at SAU030 (Sausal Creek at E. 22nd Street), the most downstream station. Both water samples and sediment samples were collected and analyzed for a large number of pollutants and results compared to standards for beneficial uses (Tables 22 through 24). Samples were collected at SAU030 on 1/10/05, 4/12/05, and 6/14/05 for water chemistry and toxicity analysis and on 4/12/05 for sediment chemistry and toxicity analyses. Tables 25 through 29 list the results of the water chemistry and toxicity analysis. All three samples exceeded the guidelines for nitrate and total phosphorous. Metals, pesticides, and other contaminants did not exceed the recommended levels (Table 27).

The water samples were also used in a bioassay test where freshwater test organisms are subject to the water and their survival is determined (Table 30). The organisms did not show any significant effects. Sediment samples from SAU030 were evaluated (Table 31). There were high enough levels of chromium, mercury, and nickel to exceed the threshold effect concentration (TEC). At the TEC level the contaminant is in just high enough concentration to affect aquatic life. When a bioassay was performed with the sediment samples the test organisms did not grow but also did not die in significant numbers. The water and sediment chemistry and toxicity tests indicate some sediment contamination by metals but no acutely toxic effects from water or sediment (Table 32 and 33).

Table 21: SWAMP Program Summary Statistics of Continuous Monitoring Conducted in Sausal Creek

		Spring		Summer			Fall			Winter			
	Start Date	5/14/04		8/2/04			9/10/04			2/4/05			
	End Date	5/21/04		8/9/04			9/20/04			2/10/05			
		SAU030	**SAU080**	**SAU030**	**SAU070**	**SAU130**	**SAU030**	**SAU080**	**SAU130**	**SAU030**	**SAU080**	**SAU130**	
Temp °C	**Min**	14	13.5	15.8	16	13.9	15.1	16.1	12.5	10.1	8.9	8.5	
	Median	14.7	14.8	16.8	17.1	14.8	17.3	16.7	14.8	11.2	10.3	9.3	
	Max	16.3	18.4	19	17.9	15.9	18.9	17.4	15.5	12.1	11.8	10	>24
	7-day Mean	15.1	15.4	17.5	17.1	15.3	17.4	16.8	14.9	11.3	10.3	9.3	>14.8, >17
	Accuracy	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	NR [1]	
DO mg/L	**Min**	8.5	4.0	*7.2*	*7.9*	8.1	7.1	*0.3*	7.6	*10.8*	10.3	11.1	
	Median	9.5	6.6	*8.6*	*10.2*	8.6	8.3	*1.9*	8.1	*11.4*	11.0	11.7	
	Max	11.1	10.7	*11.2*	*15.0*	9.0	11.3	*6.8*	9.8	*12.0*	12.0	12.2	
	7-day Avg. Min	8.8	4.9	*7.7*	*8.5*	8.3	7.5	0.9	7.8	*11.2*	10.5	11.5	<7, < 5
	Accuracy (MQO: ± 0.5 mg/L)	*0.2*	*0.1*	***5%*** [2]	***6.6%*** [2]	*1.2%* [2]	*0.2*	***0.6***	*0.1*	***0.7***	*0.3*	*0.4*	
pH	**Min**	7.6	7.4	7.6	7.7	7.8	7.7	6.7	7.7	7.8	*6.7*	7.9	< 6.5
	Median	7.7	7.8	7.7	7.8	7.9	7.8	6.9	7.9	8.0	*7.2*	8.0	
	Max	7.9	8.3	8.1	8.1	8.0	8.2	7.1	8.0	8.2	*7.4*	8.1	> 8.5
	Accuracy (MQO: ± 0.5)	*0.1*	*0.1*	*0.1*	*0.04*	*0.02*	*0.04*	*0.03*	*0.1*	*0.1*	***2***	*0.02*	
SC µS/cm	**Min**	*330*	634	210	960	726	249	1007	675	202	202	408	
	Median	*464*	759	419	969	739	407	1066	735	612	713	540	
	Max	*490*	781	438	975	749	459	1104	747	645	754	586	>1000, >2000
	Accuracy (MQO: ± 5.0%)	***7.3%***	*3.1%*	*0.9%*	*0.7%*	*0.7%*	*1.4%*	*0.7%*	*0.8%*	*0.4%*	*0.4%*	*0.8%*	
	n	*669*	*667*	*654*	*469*	*655*	*828*	*831*	*958*	*573*	*570*	*567*	

Evaluation thresholds

Notes:
Red italicized font indicates that data did not meet SWAMP MQO's. **NR:** Value not recorded.
1 = Post-deployment accuracy checks performed during annual lab calibration - Temp. probe met SWAMP MQO's.
2 = Accuracy value gleaned from percent saturation check; substituted 5% for 0.5 mg/L SWAMP MQO.
3 = Data met SWAMP MQO's but field operator noted that probe was dewatered during deployment. Data has been clipped but may be unreliable.

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 22: SWAMP Laboratory Analyses, Tests, or Counts Performed with Water Samples

Group	Analyte	Laboratory	Method	Unit	MDLs Min	MDLs Max	RLs Min	RLs Max
Conventional								
	Alkalinity as CaCO3	DFG-WPCL	QC 10303311A	mg/L	3	3	8	10
	Ammonia as N	DFG-WPCL	EPA 350.3	mg/L	0.04	0.04	0.1	0.1
	Boron,Total	MLML-TM	EPA 1638M	mg/L	0.0001	0.0001	0.0003	0.0003
	Boron,Total	SFL	EPA 200.7	mg/L	0.0044	0.0097	0.05	0.05
	Chloride	DFG-WPCL	EPA 300.0	mg/L	0.2	4	0.35	7
	Chlorophyll a	MPSL-DFG	EPA 445.0M	µg/L	0.045	0.045	0.045	0.045
	Dissolved Organic Carbon	AMS	EPA 415.1	mg/L	0.1	0.1	0.1	0.1
	Dissolved Solids,Total	DFG-WPCL	SM 2540 C	mg/L	10	10	10	10
	Hardness as CaCO3	DFG-WPCL	QC 10301311B	mg/L	5	5	10	10
	Hardness as CaCO3	DFG-WPCL	SM 2340 C	mg/L	1	1	1	1
	Manganese,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Nickel,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.05	0.05
	Nitrate as N	DFG-WPCL	QC 10107041B	mg/L	0.01	0.2	0.02	0.4
	Nitrite as N	DFG-WPCL	QC 10107041B	mg/L	0.002	0.005	0.005	0.01
	Nitrogen, Total Kjeldahl	DFG-WPCL	QC 10107062E	mg/L	0.12	0.12	0.25	0.25
	OrthoPhosphate as P,Dissolved	DFG-WPCL	QC 10115011M	mg/L	0.005	0.005	0.01	0.01
	Phosphorus as P,Total	DFG-WPCL	QC 10115011D	mg/L	0.03	0.03	0.05	0.05
	Sulfate	DFG-WPCL	EPA 300.0	mg/L	0.5	10	0.7	14
	Suspended Sediment Concentration	MPSL-DFG	ASTM D3977M or SM 2540 B	mg/L	5	5	5	5
	Total Organic Carbon	AMS	EPA 415.1	mg/L	0.1	0.1	0.1	0.1
	Total Organic Carbon	DFG-WPCL	EPA 415.1M	mg/L	0.2	0.2	1	1
Metals								
	Aluminum,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.5	0.5
	Arsenic,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.5	0.5
	Cadmium,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Chromium,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.03	0.03	0.1	0.1
	Copper,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Lead,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.03	0.03
	Mercury,Total	MPSL-DFG	EPA 1631EM	**ng/L**	0.16	0.2	0.16	0.2
	Selenium,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.5	0.5
	Silver,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.01	0.01	0.05	0.05
	Zinc,Dissolved	MPSL-DFG	EPA 1638M	µg/L	0.1	0.1	0.3	0.3
Organics								
	Chlorpyrifos	UCD-GC or ToxScan	ELISA	µg/L	0.05	0.05	0.1	0.1
	Diazinon	UCD-GC or ToxScan	ELISA	µg/L	0.03	0.03	0.06	0.06
	Herbicides Suite	DFG-WPCL	EPA 619M	µg/L	0.02	0.02	0.05	0.05
	Carbaryl Suite	DFG-WPCL	EPA 632M	µg/L	var	var	var	var
	Organochlorine Pesticides	DFG-WPCL	EPA 8081AM/BM	µg/L	var	var	var	var
	OrganophosphatePesticides	DFG-WPCL	EPA 8141AM	µg/L	var	var	var	var
	PAHs Suite	DFG-WPCL	EPA 8270M	µg/L	0.005	0.005	0.005	0.005
	PCBs Suite	DFG-WPCL	EPA 8082M	µg/L	0.001	0.001	0.002	0.002
Toxicity testing								
	Ceriodaphnia dubia	MPSL-DFG or ToxScan	EPA 600/4-91-002 mod	NA	NA	NA	NA	NA
	Pimephales promelas	MPSL-DFG or ToxScan	EPA 600/4-91-002 mod	NA	NA	NA	NA	NA
	Selenastrum capricornutum	MPSL-DFG or ToxScan	EPA 600/4-91-002 mod	NA	NA	NA	NA	NA
Coliform counts								
	total coliform	EPA R-IX	SM 9223 IDEXX	MPN /100mL	10	10	10	10
	E, coli	EPA R-IX	SM 9223 IDEXX	MPN /100mL	10	10	10	10

MDL - minimum detection limit; RL - reporting limit; NA - not applicable
Complete analytical suites for OCs, OPs, PAHs, and PCBs are presented in appendix Table D-2

AMS: Applied Marine Sciences
DFG-WPCL: Department of Fish and Game Water Pollution Control Laboratory
EPA R-IX: EPA Region IX laroatroy, Richmond CA
MLML-TM
MPSL-DFG: Marine Pollution Studies Laboratory, Department of Fish and Game
SAL: Sequoia Analytical Laboratories, Inc.
SFL: Sierra Foothill Laboratory
ToxScan - ToxScan Inc. Watsonville
UCD-GC: University of California at Davis, Granite Canyon Laboratory

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 23: SWAMP Water Quality Benchmarks for Protection of Aquatic Life

Characteristic	Description of Benchmark	Numeric Limit	Units	Reference
Temperature	Max, salmonids	24	° C	USEPA, 1977
	MWAT for Coho	19.7	° C	Sullivan *et al*, 2000
	7-day Mean for Coho	14.8	° C	Sullivan *et al*, 2000
	MWAT for steelhead	19.6	° C	Sullivan *et al*, 2000
	7-day Mean for steelhead	17	° C	Sullivan *et al*, 2000
Oxygen, dissolved	7-day Avg. Min, WARM	5	mg/L	Basin Plan, 2005
	7-day Avg. Min, COLD	7	mg/L	Basin Plan, 2005
pH	Range	6.5 to 8.5	S.U.	Basin Plan, 2005
Ammonia, unionized	Annual median	0.025	mg/L	Basin Plan, 2005
Nitrate as N	Maximum	0.16	mg/L	USEPA, 2000b
Phosphorus, total as P	Maximum	30	µg/L	USEPA, 2000b
Arsenic, dissolved	1-hour average WQO	340	µg/L	Basin Plan, 2005
	4-day average WQO	150	µg/L	Basin Plan, 2005
Arsenic, total	Maximum	10 µg/L		(Dept. of Public Health)
Cadmium, total[a]	1-hour average WQO	3.9	µg/L	Basin Plan, 2005
	4-day average WQO	1.1	µg/L	Basin Plan, 2005
Chromium VI, dissolved	1-hour average WQO	16	µg/L	Basin Plan, 2005
	4-day average WQO	11	µg/L	Basin Plan, 2005
Copper, dissolved[a]	1-hour average WQO	13	µg/L	Basin Plan, 2005
Copper, dissolved	4-day average WQO	9	µg/L	Basin Plan, 2005
Lead, dissolved[a]	1-hour average WQO	65	µg/L	Basin Plan, 2005
	4-day average WQO	2.5	µg/L	Basin Plan, 2005
Mercury, total	1-hour average WQO	2.4	µg/L	Basin Plan, 2005
Nickel, dissolved[a]	1-hour average WQO	470	µg/L	Basin Plan, 2005
	4-day average WQO	52	µg/L	Basin Plan, 2005
Selenium, total	1-hour average WQO	20	µg/L	Basin Plan, 2005
	4-day average WQO	5	µg/L	Basin Plan, 2005
Silver, dissolved[a]	1-hour average WQO	3.4	µg/L	Basin Plan, 2005
Zinc, dissolved[a]	1-hour average WQO	120	µg/L	Basin Plan, 2005
	4-day average WQO	120	µg/L	Basin Plan, 2005
PCBs	Continuous 4-day average	0.014	µg/L	CTR
Chlorpyrifos	Continuous 4-day average	0.015	µg/L	CVRWQCB, 2006
Dacthal (DCPA)	Instantaneous max. AWQC	14,300	µg/L	USEPA, 1987
Diazinon	1-hour average	0.1	µg/L	SFBRWQCB, 2005
Disulfoton (Disyston)	Instantaneous max. AWQC	0.05	µg/L	USEPA, 1973
Endosulfan	Instantaneous maximum	0.22	µg/L	CTR
	Continuous 4-day average	0.056	µg/L	CTR
HCH, gamma- (gamma-BHC, Lindane)	Maximum 1-hour average	0.95	µg/L	CTR
Parathion, methyl	Instantaneous max. AWQC	0.08	µg/L	CDFG
Thiobencarb	Instantaneous max. AWQC	3.1	µg/L	CDFG
E. coli	log mean	126	MPN/100 mL	Basin Plan, 2005
Total Coliforms	median	240	MPN/100 mL	Basin Plan, 2005
	maximum	10000	MPN/100 mL	Basin Plan, 2005

Note [a]: Table values for total cadmium and for dissolved copper, lead, nickel, silver, and zinc assume a hardness of 100 mg/L CaCO3. Samples at other hardness levels must be calculated using formulas in the Basin Plan.

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 24: SWAMP Sediment Quality Benchmarks

Characteristic	Description of Benchmark [1]	Numeric Limit	Units
Arsenic	PEC	33	mg/kg
	TEC	9.79	mg/kg
Cadmium	PEC	4.98	mg/kg
	TEC	0.99	mg/kg
Chromium	PEC	111	mg/kg
	TEC	43.4	mg/kg
Copper	PEC	149	mg/kg
	TEC	31.6	mg/kg
Lead	PEC	128	mg/kg
	TEC	35.8	mg/kg
Mercury	PEC	1.06	mg/kg
	TEC	0.18	mg/kg
Nickel	PEC	48.6	mg/kg
	TEC	22.7	mg/kg
Zinc	PEC	459	mg/kg
	TEC	121	mg/kg
Anthracene	PEC	845	µg/kg
	TEC	57.2	µg/kg
Benz(a)anthracene	PEC	1050	µg/kg
	TEC	108	µg/kg
Benzo(a)pyrene	PEC	1450	µg/kg
	TEC	150	µg/kg
Chlordane	PEC	17.6	µg/kg
	TEC	3.24	µg/kg
Chrysene	PEC	1290	µg/kg
	TEC	166	µg/kg
DDD (sum op + pp)	PEC	28	µg/kg
	TEC	4.88	µg/kg
DDE (sum op + pp)	PEC	31.3	µg/kg
	TEC	3.16	µg/kg
DDT (sum op + pp)	PEC	62.9	µg/kg
	TEC	4.16	µg/kg
DDT (total)	PEC	572	µg/kg
	TEC	5.28	µg/kg
Dibenz(a,h)anthracene	**TEC**	33	µg/kg
Dieldrin	PEC	61.8	µg/kg
	TEC	1.9	µg/kg
Endrin	PEC	207	µg/kg
	TEC	2.22	µg/kg
Fluoranthene	PEC	2230	µg/kg
	TEC	423	µg/kg
Fluorene	PEC	536	µg/kg
	TEC	77.4	µg/kg
HCH, gamma	PEC	4.99	µg/kg
	TEC	2.37	µg/kg
Heptachlor epoxide	PEC	16	µg/kg
	TEC	2.47	µg/kg
Naphthalene	PEC	561	µg/kg
	TEC	176	µg/kg
PAH (total)	PEC	22800	µg/kg
	TEC	1610	µg/kg
PCB (total)	PEC	676	µg/kg
	TEC	59.8	µg/kg
Phenanthrene	PEC	1170	µg/kg
	TEC	204	µg/kg
Pyrene	PEC	1520	µg/kg
	TEC	195	µg/kg

Source: MacDonald et al 2000a

[1] *PEC=Probable Effect Concentration; TEC=Threshold Effect Concentration*

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 25: SWAMP Program Comparison of Nutrient Concentrations in Years 4 and 5 Samples to Water Quality Benchmarks (WQB) for Sausal Creek

Station	Season	Ammonia as N (mg/L)	qual	pH	Temperature (°C)	Unionized Ammonia as N (mg/L) (WQB=0.025)	Unionized Ammonia Exceedance Factor	Nitrate as N (mg/L) (WQB=0.16)	Nitrate Exceedance Factor	Phosphorus as P, Total (mg/L) (WQB=0.03)	Total P Exceedance Factor
SAU030	1/10/05	0.097	J	7.84	11.5	0.001	0.04	2.27	14.2	0.07	2.3
SAU030	4/12/05		ND	7.56	12.8			1.41	8.8	0.06	2.1
SAU030	6/14/05	0.05	J	7.68	15.5			1.25	7.8	0.08	2.7

* ND=not detected. "J" is defined as 'estimated'; the analyte was detected but the value is below the Reporting Limit

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 26: SWAMP Program Concentrations of Selected Nutrients, Chlorophyll a, TOC, and SSC in Years 4 and 5 Water Samples for Sausal Creek

Station	Season	Nitriteas N (mg/L)	qual	Nitrogen, Total Kjeldahl (mg/L)	qual	Ortho-Phosphate as P (mg/L)	Chlorophyll a (µg/L)	Total Organic Carbon (mg/L)	Suspended Sediment Concentration (mg/L)	qual
SAU030	1/10/05	0.02		0.50		0.07	0.17	2.9	7	
SAU030	4/12/05	0.01	J	0.25		0.07	0.19	4.1		ND
SAU030	6/14/05	0.01	J	0.19	J	0.09	0.28	3.5	6	

* ND=not detected. "J" is defined as 'estimated'; the analyte was detected but the value is below the Reporting Limit

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 27: SWAMP Program Comparison of Metal Concentrations in Years 4 and 5 Samples to Water Quality Objectives (WQOs) for Sausal Creek

Station	Season	Hardness (mg/L)	Metal Name	Metal, Total (ug/L)	Metal, Dissolved (ug/L)	qual	Acute WQ Objective (ug/L)	Acute Exceedance Factor	Chronic WQ Objective (ug/L)	Chronic Exceedance Factor	WQ Objective Fraction
SAU030	1/10/05	209	Cadmium		0.03						
SAU030	4/12/05	276	Cadmium		0.02	J					
SAU030	6/14/05	254	Cadmium		0.01	J					
SAU030	1/10/05	209	Copper		2.86		28.0	0.10	17.5	0.16	Dissolved
SAU030	4/12/05	276	Copper		1.73		36.4	0.05	22.2	0.08	Dissolved
SAU030	6/14/05	254	Copper		2.2		33.7	0.07	20.7	0.11	Dissolved
SAU030	1/10/05	209	Lead		0.05		208.7	0.000	8.13	0.006	Dissolved
SAU030	4/12/05	276	Lead		0.06		297.3	0.000	11.59	0.005	Dissolved
SAU030	6/14/05	254	Lead		0.05		267.5	0.000	10.42	0.005	Dissolved
SAU030	1/10/05	209	Nickel		3.66		875	0.00	97	0.04	Dissolved
SAU030	4/12/05	276	Nickel		2.38		1107	0.00	123	0.02	Dissolved
SAU030	6/14/05	254	Nickel		1.59		1032	0.00	115	0.01	Dissolved
SAU030	1/10/05	209	Silver			ND	14.4				
SAU030	4/12/05	276	Silver			ND	23.3				
SAU030	6/14/05	254	Silver			ND	20.2				
SAU030	1/10/05	209	Zinc		5.34		223.8	0.02	223.8	0.02	Dissolved
SAU030	4/12/05	276	Zinc		5.07		283.2	0.02	283.2	0.02	Dissolved
SAU030	6/14/05	254	Zinc		2.46		264.0	0.01	264.0	0.01	Dissolved
SAU030	1/10/05	209	Arsenic		1.27		340.0	0.00	150.0	0.01	Dissolved
SAU030	4/12/05	276	Arsenic		0.64		340.0	0.00	150.0	0.00	Dissolved
SAU030	6/14/05	254	Arsenic		0.94		340.0	0.00	150.0	0.01	Dissolved
SAU030	1/10/05	209	Chromium		0.77		16	0.05	11	0.07	Dissolved
SAU030	4/12/05	276	Chromium		0.99		16	0.06	11	0.09	Dissolved
SAU030	6/14/05	254	Chromium		0.55		16	0.03	11	0.05	Dissolved
SAU030	1/10/05	209	Mercury	0.0630			2.4	0.026			Total
SAU030	4/12/05	276	Mercury	0.0023			2.4	0.001			Total
SAU030	6/14/05	254	Mercury	0.0022			2.4	0.001			Total
SAU030	1/10/05	209	Selenium		2.62						
SAU030	4/12/05	276	Selenium		1.12						
SAU030	6/14/05	254	Selenium		2.51						
SAU030	1/10/05	209	Aluminum		9.18						

Table 27: SWAMP Program Comparison of Metal Concentrations in Years 4 and 5 Samples to Water Quality Objectives (WQOs) for Sausal Creek (continued)

Station	Season	Hardness (mg/L)	Metal Name	Metal, Total (ug/L)	Metal, Dissolved (ug/L)	qual	Acute WQ Objective (ug/L)	Acute Exceedance Factor	Chronic WQ Objective (ug/L)	Chronic Exceedance Factor	WQ Objective Fraction
SAU030	4/12/05	276	Aluminum		3.35						
SAU030	6/14/05	254	Aluminum		6.09						
SAU030	1/10/05	209	Manganese		27.2						
SAU030	4/12/05	276	Manganese		13						
SAU030	6/14/05	254	Manganese		8.16						

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 28: SWAMP Program Comparison of Concentrations to Water Quality Benchmarks (WQBs) for Sausal Creek

Station	Season	Diazinon (µg/L) (WQB=0.1)
SAU030	1/10/05	ND
SAU030	4/12/05	ND
SAU030	6/14/05	ND

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 29: SWAMP Program Concentrations of All Organic Compounds Detected in Years 4 and 5 Water Samples (µg/L) for Sausal Creek

Station	Season	Total Organic Carbon	Acenaphthene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(e)pyrene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Biphenyl	Carbofuran	Chrysene	Chrysenes, C1-	Chrysenes, C2-	Chrysenes, C3-	Diazinon	Dibenzothiophenes, C1-	Dibenzothiophenes, C2-	Dibenzothiophenes, C3-	Dimethylnaphthalene, 2, 6-	Disulfoton	Diuron	Fluoranthene	Fluoranthene/Pyrenes, C1-
SAU030	1/10/05	2.9	ND	ND	ND	ND	ND	ND	ND	ND	0.110	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SAU030	4/12/05	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SAU030	6/14/05	3.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 29: SWAMP Program Concentrations of All Organic Compounds Detected in Years 4 and 5 Water Samples (µg/L) for Sausal Creek - continued

Station	Season	Fluorene	Fluorenes, C1-	Fluorenes, C3-	Indeno(1,2,3-c,d)pyrene	Methyldibenzothiophene, 4-	Methylfluorene, 1-	Methylnaphthalene, 1-	Methylnaphthalene, 2-	Methylphenanthrene, 1-	Naphthalene	Naphthalenes, C1-	Naphthalenes, C3-	Naphthalenes, C4-	Oxadiazon	Parathion, Methyl	Phenanthrene	Phenanthrene/Anthracene, C1-	Phenanthrene/Anthracene, C2-	Phenanthrene/Anthracene, C3-	Phenanthrene/Anthracene, C4-	Pyrene	Simazine	Timethylnaphthalene, 2, 3, 5-
SAU030	1/10/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.007	ND	ND	ND	ND	ND	ND	ND	0.008	ND	ND	ND	0.026	ND
SAU030	4/12/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SAU030	6/14/05	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.006	ND	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND	n/me	ND

* ND=not detected; n/me=not measured

Table 30: SWAMP Program Bioassay Test—Toxicity of Years 4 and 5 Water Samples to Three Freshwater Test Organisms for Sausal Creek

Station	Season	*Ceriodaphnia dubia*						*Pimephales promelas*						*Selenastrum capricornutum*		
		Mean Survival (%)	% of Control	Code	Avg. # of Young/ Female	% of Control	Code	Survival (%)	% of Control	Code	Growth (Avg. weight, mg/ind)	% of Control	Code	Cell Count (million cells/ml)	% of Control	Code
SAU030	1/10/05	100	100	NSG	30.1	97.41	NSG	87.5	89.7	SG	0.667	98.4	NSG	10067500	134	NSG
SAU030	4/12/05	100	100	NSG	25.4	120.9	NSG	95	97.4	NSG	1.036	125	NSG	6670000	112.3	NSG
SAU030	6/14/05	90	100	NSG	30.4	92.4	NSG	95	95	NSG	0.945	103.5	NSG	5657820	100.95	NSG

* Codes:
NSG=Not significantly different from negative control (alpha=0.05), and sample value was above 80% of control (No 'toxicity criteria' met)
SG=Significantly different from negative control (alpha=0.05), BUT sample value is above 80% of control (Only first 'toxicity criteria' met)

Table 31: SWAMP Metal Concentrations in Comparison to Quality Benchmarks for Sausal Creek

Station	Aluminum (mg/Kg)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Chromium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Manganese (mg/Kg)	Mercury (mg/Kg)	Nickel (mg/Kg)	Silver (mg/Kg)	Zinc (mg/Kg)
SAU030	15552	4.2	0.16	66.5	12.4	12.7	250	0.243	44.3	0.11	50
Threshold Effect Concentration Values:		9.79	0.99	43.4	31.6	35.8		0.18	22.7		121

Table 32: SWAMP Sediment Properties and Concentrations of Detected Pesticides in Comparison to Quality Objectives for Sausal Creek

Station	Total Organic Carbon (%)	Percent Moisture	% Clay & Silt (<0.075mm)	% Fine & Medium Sand (0.075-2mm)	% Coarse (>2mm)	Aldrin	Bifenthrin	Biphenyl	Chlordane, cis-	Chlordane, trans-	Chlordane, Total	Cypermethrin-1	Cypermethrin-2	Cypermethrin-3	Cypermethrin-4	Dieldrin	Endrin	HCH, gamma	Heptachlorepoxide	Hexachlorobenzene	Nonachlor, cis-	Nonachlor, trans-	Oxadiazon	Oxychlordane	Permethrin-1	Permethrin-total	Tedion
SAU030	0.23	20.5	1.5	83.3	15.1			4.68	1.64	1.54	3.18					1.74						1.32					1.52

Tables from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 33: SWAMP Sediment Observed Toxicity and Probable (Toxic) Effect Concentration Quotients for Selected Substances for Sausal Creek

Station	Metals Mean PEC[1] Quotient	PCB PEC Quotient	PAH PEC Quotient	Sample Mean PEC Quotient	*Hyalella azteca* Survival			H. azteca Growth (weight, mg/ind)			% Fines (<0.075 mm)	Total Organic Carbon (%)
					Mean	% of Control	Code	Mean	% of Control	Code		
SAU030	0.280	0.020	0.002	0.10	81	125	NSG	0.40	63	SL	2	0.23

[1] PEC=Probably (Toxic) Effect Concentration

Codes:

NSG=Not significantly different from negative control (alpha=0.05), and sample value was above 80% of control (No 'toxicity criteria' met)

SL=Significantly different from negative control (alpha=0.05), and sample value is below 80% of control (Both 'toxicity criteria' met)

Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Table 34: SWAMP Continuous Field Monitoring Summaries for Sausal Creek in 2004-2005

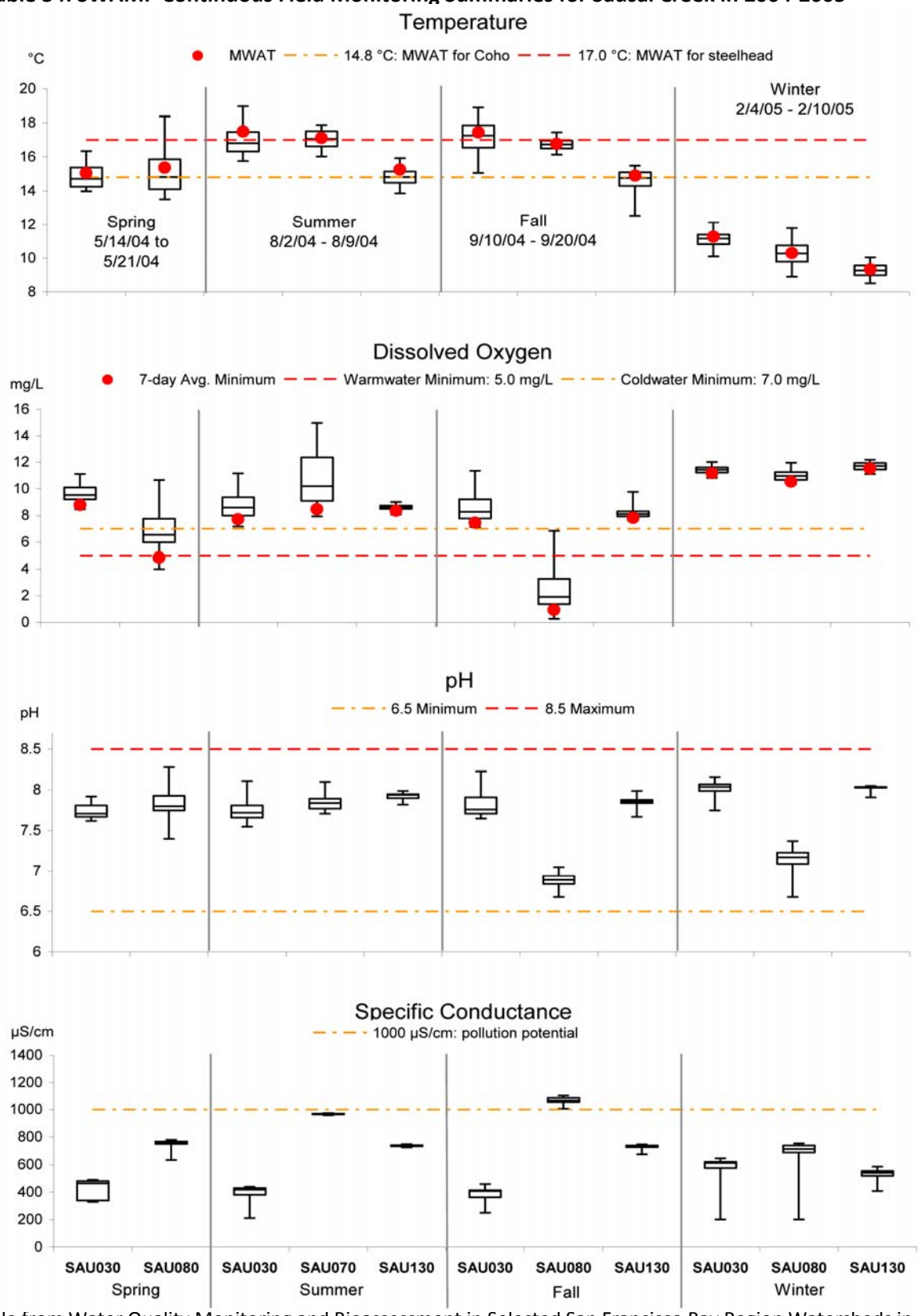


Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Bacteria Monitoring

In 1999 FOSC worked with the EPA to test four sites along the creek for *E. coli* bacteria (Table 35). *E. coli* levels were over the acceptable level of 126 MPN/100ml at all sites. Significant levels (7800 MPN/100ml) of *E. coli* were found at Dimond Park and Sloan Ct. in the spring. High levels of *E. coli* (12,000 MPN/100ml) were also found at Sloan Ct. in the fall. The presence of high levels of *E. coli* indicates likely fecal contamination from leaking sanitary sewer pipes and sewage overflows. High *E. coli* levels represent a health hazard for anyone wading or coming into contact with the creek water.

SWAMP also completed bacterial monitoring. Samples were taken on 7/20/04, 7/27/04, 8/3/04, 8/10/04, and 8/17/04 at SAU060 (Sausal Creek at Lions Pool). Table 36 lists the results for total coliform counts. Total coliform measures coliform bacterial from all sources. *E. coli* tests are for fecal bacteria. The EPA standard for water contact recreation for *E. coli* is 240 for the median value. The SAU060 median for the test period for total coliform was 5500. A separate test for *E. coli* bacteria found a median of 164 MPN/100ml. The EPA standard for water contact recreation is a mean of 126.

The SWAMP numbers for *E. coli* are much lower than the 1999 FOSC numbers. It should be noted that the large sanitary sewer line which runs down the middle of Sausal Creek in Dimond Canyon was partially replaced as part of the creek restoration project between the 1999 and 2004 samples. The new pipe would be expected to have less leakage; however, the sewer pipe upstream of the restoration reach has not been replaced and is known to overflow in storm events (Figure 107).

Table 35: FOSC/EPA E. coli Monitoring in Sausal Creek (in MPN/100ml)

Date	Palo Seco Creek	Sausal Creek		
	Joaquin Miller Ct.	Dimond Park	Sloan Ct.	Hickory Ct.
3/10/1999-4/7/1999	400	7800	7800	1900
9/8/1999-10/6/1999	150	1500	12000	1900

* MPN=Most Probable Number

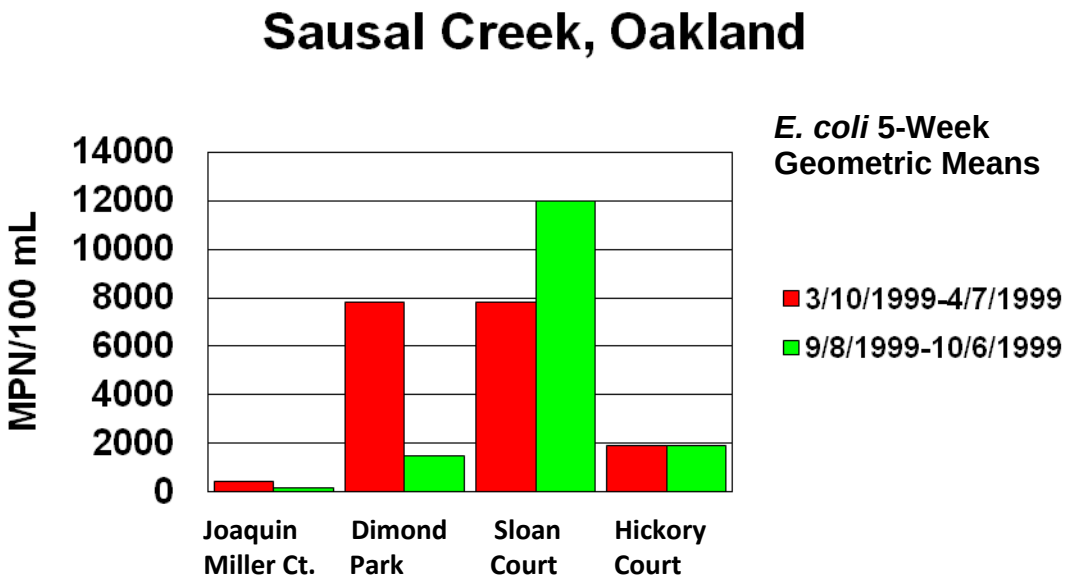


Table 36: SWAMP Total Coliform Counts and *E. coli* Counts (MPN/100ml) in Sausal Creek in Years 4 and 5 as Determined by the Colilert Method

Station: SAU060	7/20/04	7/27/04	8/3/04	8/10/04	8/17/04	Median
Total Coliform	7300	5500	1800	17000	1200	5500
E. coli	260	120	160	150	160	164

* Counts are Most Probable Number per 100 milliliters (MPN/100ml). Values in red exceed the limit for freshwater recreation (126 MPN for the geomean).
Table from Water Quality Monitoring and Bioassessment in Selected San Francisco Bay Region Watersheds in 2004-2006, San Francisco Bay Regional Water Quality Control Board, 2008.

Summary: Water Quality

Several different sets of water quality and bacteria monitoring data have been collected in the Sausal Creek watershed. The Regional Water Quality Control Board's Surface Water Ambient Monitoring Program (SWAMP) provides high-quality monitoring data subjected to strict Quality Assessment/Quality Control (QA/QC) measures. In 2004-2005 SWAMP measured a comprehensive number of parameters at five stations on Sausal Creek. The results of the SWAMP monitoring found excessive levels of nutrients (nitrate and total phosphorus), slightly high water temperatures, and a few low dissolved oxygen measurements. Water and sediment samples were tested for a number of persistent pollutants including metals, pesticides, PCBs, and PAHs. Sediment samples from the downstream area of Sausal Creek had concentrations of chromium, mercury, and nickel that exceed the threshold effect concentrations (TEC). Water samples did not show any high contaminant levels. Bioassays on water and sediment found no acute toxicities, but sediment sample tests found hindered growth in the test organism.

FOSC water quality data lacks any description of methods or QA/QC measures and as such its accuracy and reliability cannot be established.

Bacterial data was collected by FOSC in 1999 and analyzed by the EPA, and shows high *E. coli* levels in all locations sampled. SWAMP bacterial monitoring in 2004 found lower *E. coli* levels, but levels still exceeded water contact recreation standards.

AQUATIC AND RIPARIAN HABITATS

Introduction

The Sausal Creek watershed, unlike most urban areas, has many open, unculverted creek channels. Compared to culverted reaches, these creeks have the ability to support aquatic and riparian habitats for fish and wildlife. One of the goals of this plan is to determine what watershed improvements are needed to reduce the negative effects of urbanization on these habitats. This section will review how urban development affects creeks and their habitats and will inventory open channel reaches and their enhancement potential.